Disruptive Technologies and Digital Transformations for Society 5.0

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Digital Transformation

Industry 4.0 to Society 5.0

Springer

Disruptive Technologies and Digital Transformations for Society 5.0

Disruptive technologies and digital transformations for Society 5.0 aims to report innovations to enable a futuristic society in which new values and services are created continuously, making people's lives more conformable and sustainable. It aims to present how problems can be solved in different areas, including mobility, health, agriculture, food, manufacturing, disaster prevention, and energy to name a few. Society 5.0 framework is based on data captured by real-world sensors and sent to the virtual cloud world for Artificial intelligence (AI)-based analysis, which in turn will return to the real world in physical form through robots, machines, and motor vehicles. People, objects, and systems are all connected in Society 5.0 and converge in cyber and physical space to collect a large amount of data from a variety of sources using sensors and devices. In Society 5.0, new values created by social innovation eliminate regional, age, gender, and language disparities and enable the delivery of personalized products and services that meet many individuals and potential needs. Digital transformation marks a radical rethinking of how an organization uses technology, people, and processes to fundamentally change business performance. Disruptive technologies including AI, affective computing, Blockchain, biological computing, cloud computing, emotion theory, human-computer interaction, Internet of Things (IoT) predictive analysis, probabilistic methods, swarm intelligence, socio-cognitive neuroscience, quantum computing, web intelligence have monumental roles to play in digital reality and Society 5.0. These technologies are shifting the economic landscape and the time has come to imbibe these technologies and empower organizations to exploit them now and in the future. The Series accepts research monographs, introductory and advanced textbooks, professional books, and reference works.

Aim and Scope

- The series is focused to explore how disruptive technologies are helping in digital transformation and how organizations are changing the way they do business, concerning innovation processes and business model transformations.
- This series is focused on how various disruptive technologies are creating opportunities across the business landscape.
- This series provides a comprehensive guide to Industry 4.0 applications, not only introducing implementation aspects but also presenting conceptual frameworks to the design principles of Society 5.0. Besides, it discusses such effects in new business models and workforce transformation.
- Changing dynamics of global production, its complexities, high end automated processes, high-level competitiveness, and emerging technologies for new generation goods, products, and services.
- Special focus on AI, affective computing, Blockchain, biological computing, cloud computing, cognitive intelligence, digital business transformation, decision sciences, e-health services, emotion theory, Futuristic digital society, habitat Innovation, human-computer interaction, Internet of Things (IoT), Internet of Humans (IoH), IoT-oriented Infrastructure, mobile computing, neural computing, predictive analysis, probabilistic methods, resilience in cyber-physical systems, robotics and automation for futuristic applications, swarm intelligence, synergies, and tradeoffs of food, energy, and water (F-E-W) nexus, socio-cognitive neuroscience, smart homes, and smart buildings, smart mobility and transportation, smart factories, embedded devices, quantum computing, and web intelligence to name a few.

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Preface

The transformation of a conventional machine to the mindful and self-learning machines of Industry 4.0 improved their general execution and preservation of the executives with encompassing communication. Constant observation of information, following the status and positions of the product completion, can have held on the directions for the completion of the fundamental needs of Industry 4.0. The four primary drivers of Industry 4.0 are IoT, IIoT, cloud computing assembling, and smart fabricating, which helps transform the assembling procedure into a completely digitized form. All the features of Industry 4.0 will change detached and streamlined cell creation into a completely incorporated, computerized, and enhanced creation stream. This prompts more prominent effectiveness and change in customary creation connections among providers, makers, and clients that are between humans and machines. This book will help researchers and practitioners to understand the various computing methodologies of Industry 4.0. As we know in Industry 4.0, several emerging technologies are explored for integration and implementation in smart manufacturing industries. Several prediction models are developed which constantly improve in the due course of time as an enormous number of data is captured and assimilated. The intention of this book is to avail the contribution from the experts in cloud computing, cyber-physical systems, artificial intelligence, Internet of Things, Industrial Internet of Things, and cognitive computing across the world, contributing their knowledge to identify the different characteristics of the above domains towards Industry 4.0. The main objective of this edited book is to administer related technologies and different findings by the researchers through its chapter organization. The focused audiences of the book are the experts, researchers, graduates, consultants, engineers, etc., who are engaged with research in the latest problems related to Industry 4.0. The edited book is organized in such a way that it helps readers with immense readability, adaptability, and flexibility.

Greater Noida, India

Avadhesh Kumar
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Introduction

The main objective of introducing Society 5.0 is to solve various social issues by integrating physical and virtual domains. It facilitates an environment to realize everyone's potential, provides balanced opportunities, and brings economic benefits. It promotes Human-Computer Interaction (HCI) by incorporating advanced technologies which include robotics, IoT, Artificial Intelligence (AI), Augmented Reality (AR), etc. Furthermore, it affords more convenience and benefits for every individual. The intellectual resources and systems of an individual pave the way for the habitat more attractive to lead their everyday life. Computing for Industry 4.0 illustrates different domains of it to integrate with the existing domains for the automation of processes. It will give readers an idea about the number of various challenges and design structures for the computing of industry 4.0. This book will help researchers and practitioners to understand the various computing methodologies of industry 4.0. As we know in industry 4.0, several emerging technologies are explored for integration and implementation in smart manufacturing industries. The transformation of a conventional machine to the mindful and self-learning machines of industry 4.0, for the improvement in their general execution and preservation of the executives with encompassing communication. A synthesis of interdisciplinary concepts, definitions, and models makes this book a valuable guide and references for industry 4.0 and society 5.0. Furthermore, it provides real-world scenarios and applications, allowing a wider audience to access it.

Features

- A brief overview of Industry 4.0 towards Society 5.0 will be provided to the readers.
- The researchers will get an insight into how Industry 4.0 is actively converged with Cyber-Physical Systems, Manufacturing Systems, Cloud Computing, Cognitive Computing, and Big Data Analytics.

- Discusses trends and research challenges in adopting the industry 4.0 in various domains.
- Students, researchers, industrial experts, and business innovators can access information in a user-friendly manner.

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Editors and Contributors

About the Editors

Dr. Avadhesh Kumar is PVC at Galgotias University, Greater Noida, Uttar Pradesh, India. He has more than 21 years of Academic and Research Experience. He was awarded a Ph.D. in Computer Science and Engineering in 2010 from Thapar University, Patiala, Punjab, India. He did his M.Tech. in Information Technology and B.Tech. in Computer Science and Engineering from Harcourt Butler Technological Institute (HBTI), Kanpur, UP, India. His research area includes software engineering, aspect-oriented software systems, component-based software development, soft computing, and artificial intelligence. He has published more than 40 research papers in reputed journals and conferences. He has authored three books. He is a reviewer of many international journals and conferences. He has been a keynote speaker at many international conferences.

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Abbreviations

AD	Alzheimer Disease
AGI	Artificial General intelligence
AI	Artificial Intelligence
ALGOL	Algorithmic Language
ANI	Artificial Narrow Intelligence
API	Application Programming Interface
AR/VR	Augmented Reality/Virtual Reality
ASI	Artificial Super Intelligence
ATS	Applicant Tracking System
AVT	Advanced Vehicle Technology
BCE	Before Common Era
BTS	Backpropagation Technological Structure
CAGR	Compound Annual Growth Rate
CAI	Collaborative Artificial intelligence
CNN	Convolutional Neural Network
CNS	Central Nervous System
CPS	Cyber Physical Systems
DARPA	Defense Approach Research Agency
DBM	Deep Boltzmann Machine
DBN	Deep Belief Networks
DCNs	Deep Convolutional Networks
DGN	Deep Generative Networks
ECL	Energy Consumption Losses
EEE	Environmental Equipment Effectiveness
EHR	Electronic Health Record
EPRS	Electronic Patient Record System
FTC	Federal Trade Commission
GAN	Generative Adversarial Network
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GIS	Geographic Information System

HIPAA	The Health Insurance Portability and Accountability Act
HR	Human Resource
HRC	Human Robot Collaboration
HRI	Human Robot Interaction
HRM	Human Resource Management
IBM	International Business Machines
ICT	Information and Communication Technology
IIoT	Industrial Internet of Things
IoPaT	Internet of Personalized and Autonomous Things
IoT	Internet of Things
IR	Industrial Revolution/Industry
ISO	International Organization for Standardization
IT	Information Technology
KFC	Kentucky Fried Chicken
KPI	Key Performance Indicators
KSA	Knowledge, Skill, and Attitude
L&D	Learning and Development
LGPD	The General Data Protection Law
LISP	List Processing
LMS	Learning Management System
LSTM	Long Short Term Memory
MCI	Mild Cognitive Impairment
MES	Manufacturing Execution System
MLP	Multi Layer Perceptron
NLP	Natural Language Processing
OEE	Overall Equipment Effectiveness
OT	Operational Technology
PII	Personal Identifiable Information
PLC	Programmable Logic Controller
PwC	PricewaterhouseCoopers
RAAM	Recursive Auto-Associative Memory
RBM	Deep Restricted Boltzmann Machines
Relu	Rectified Linear Unit
RNNs	Recurrent Neural Networks
ROI	Return on Investment
RvNN	Recursive Neural Network
SAEs	Stacked Auto-Encoders
SAR	Synthetic Aperture Radar
SCM	Supply Chain Management
SIRI	Speech Interpretation and Recognition Interface
SLR	Statutory Liquidity Ratio
TAM	Technology Acceptance Model
TNA	Training Need Analysis
TOE	Technology-Organization-Environment
TQM	Total Quality Management

USD	United States Dollar
UTAUT	Unified Theory of Acceptance and Use of Technology
VAE	Variational Autoencoder

Chapter 1
Evolution of Industry 4.0 and Its Fundamental Characteristics

G. Deepti Raj, B. Prabadevi, and R. Gopal

1 Introduction

1.1 Industry 4.0 Introduction

Industrial Revolution (IR) 4.0 is treated as a new industrial revolution where fusing of manufacturing process and production delivers higher benefits to the industries. IR 4.0 provides digital solutions to manufacturing firms in several areas by incorporating new technologies. Digitalization and intelligentization help in customized production, which are in need of today's society. The real-time and strategic decision-making with the changing tasks enables high efficacy in production. Sustainability is also an important concern for all the organizations to take the benefits from IR 4.0. Through IR 4.0, the digital transformation of industries is advancing exponentially. Through IR 4.0, there is an improvement in speed, automation, accuracy, which forms the basic building blocks for the smart factory concept. The concepts such as Additive Manufacturing, Block Chain, Artificial Intelligence, Robotics, and Internet of Things (IoT) provide incremental development of industrial production systems. Optimization of products, supply chain, flexibility assessment is also spurred, which provides transparency to organizations observing IR 4.0 characteristics. Economic

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Table 1 Survey of various definitions related to IR 4.0

Authors	IR 4.0 definitions
Koch et al. (2014)	The author stated IR 4.0 as "The term IR 4.0 stands for the fourth industrial revolution and is best understood as a new level of organization and control over the entire value chain of the life cycle of products, it is geared towards increasingly individualized customer requirements"
McKinsey Digital (2015)	McKinsey inferred IR 4.0 as "IR 4.0 can be seen as a digitization of the manufacturing sector, with embedded sensors, manufacturing equipment, ubiquitous cyber physical systems, and analysis of all relevant data"
Pfohl et al. (2015)	Pfohl has another definition for IR 4.0. It is "IR 4.0 is the sum of all disruptive innovations derived and implemented in a value chain to address the trends of digitalization, automation, transparency, mobility, modularization, and network collaboration and socializing of products and processes"
Hermann et al. (2015)	Hermann stated that "Industry 4.0 tells about concepts of value chain organization". He also includes cyber-physical systems (CPS) as main term in IR 4.0 as "CPS and Smart Factories of Industry 4.0 observe processes, create a virtual copy of the physical world and take decentralized decisions through the communication and cooperation with humans in real time"

growth, management, implementation capability strongly support the technological infrastructure of IR 4.0.

1.2 Industry 4.0 Definitions

IR 4.0 brings together machines, networks, facilities of connected factories by linking suppliers, customers, business partners etc., for enabling faster decisions. Table 1 presents the survey of various definitions related to IR 4.0.

1.3 Benefits of Industry 4.0

The distinct advantages we obtain from IR 4.0 are time, cost, flexibility, integration, digitalization, and workplace diversity. IR 4.0 is regarded as new standard by supply chain managers, which help in communication of people, machines, sensors, and devices that are connected. Creation of cyber-physical system for seamless data sharing is another benefit. Figure 1 lists out all the representative words of IR 4.0 such as artificial intelligence (AI), production, factory architecture, development, optimization, automation, security, cyber-physical systems, integration, etc. The connected systems in IR 4.0 are autonomous for enabling simple decisions in real time, and this feature will be profitable for companies to expand their business. Table 2 gives out the different benefits we obtain from incorporating IR 4.0.

Fig. 1 Representative words of IR 4.0

1.4 Motivations Behind the Evolution of Industry 4.0

The First Industrial Revolution also termed as Industry 1.0 began in eighteenth century in England introduced mechanical production and steam engines. In IR 1.0, there is a replacement of human activities and involvement by machines where production process was more fastened and materialized.

Division of labor, improvements in communication and transportation happened in a leisured manner, which flagged a way for industry 2.0. IR 1.0 is the beginning of industry culture whereas IR 2.0's significant transit is in the form of product volume. IR 2.0 period is 1870, which observed technological innovations in mechanical devices, electricity, and areas. Gas and oil are the other remarkable sources of energy that ushered economic development and also helped in traversing communication among different regions.

IR 3.0 happened around 1970, computing knowledge, computers, and electronics and information technologies aided in production process automation in IR 3.0. Figure 2 depicts the evolution of industrial revolutions from IR 1.0 to IR 4.0. Internet introduced programming logic controllers, connectivity and robots, which replaced

Table 2 Various IR 4.0 benefits

Authors	IR 4.0 benefits
Waibel et al. (2018)	• Lower the overproduction and waste • Saving of natural resources • Lowering transportation and travel effort • Higher quality, flexible production • Increased level of customer satisfaction
Pereira et al. (2017)	• Decentralized and digitalized production • Products are modular and configurable, promoting mass customization and specific customer requirements • Transforming jobs with required skills • Safe work conditions and workplaces • Increase in revenue and reduction in cost and wastes • Personalization of products
Yasanur Kayikci (2018)	• Logistics cost • Delivery time • Transport delay changes • Inventory reduction • Loss/damage of goods • Frequency of service • Forecast accuracy • Reliability • Flexibility in shipments without undue delay • Transport volumes • Applications
Koch et al. (2014)	• The author stated that "Increased productivity has operational efficiencies that increases by an average of 3.3% annually for the following five years leading to an average annual reduction in costs of 2.6%" • Koch also mentioned that "Revenue increases faster and higher than the costs incurred to automate or digitize the manufacturing process in terms of IR 4.0" • Regarding responses in real time, the author mentioned that "with IR 4.0 concepts and methods applied, logistics and statistics are generated and collected in an automated manner, so responses are faster"

human workforce. However, although automated systems were brought into practice, all the systems still rely on human input and intervention.

The period from 2011 is a period of favorable transition towards the contemporary era of industrialization era 4.0 [1]. What drives the shift to IR 4.0 is personalization, volatility, energy and resource efficiency [2]. The main idea of IR 4.0 is to research; develop personalized consumer requirements for order management [3]. In addition, IR 4.0 allows a higher flexibility in developing diagnostics and maintenance and automated systems [4]. The purpose of IR 4.0 is to improve performance and maintenance management by analyzing the surroundings, which helps current machines to become self-aware and self-learn, and this could be achieved through integrated processing and communication capabilities of all objects of a factory [5–7]. Therefore, IR 4.0 focal point is to see overall digitization through integrated solutions of digital industrial ecosystems [8, 9].

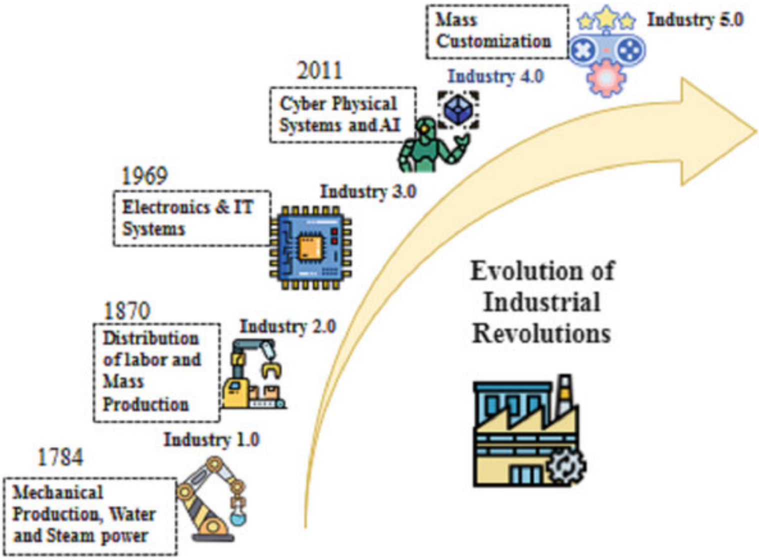

Fig. 2 Evolution of industrial revolutions

2 Industry 4.0 Concepts, State of Arts, and Challenges

2.1 Basic Components of Industry 4.0

IR 4.0 also focuses on Data and Analytics as core capability. With the digitization of product and service offerings, there is a possibility of upgrading digital business models and giving permission for the customized access. Figure 3 suggests the basic components of IR 4.0. Cloud computing enhances simple data transfer with real-time visibility. Through cloud computing, storage space can be scalable with the collaboration of advanced technologies. Mobile devices are pillar in IR 4.0 processing intelligent algorithms for advanced robotics to improve efficiency thereby bringing about the concept of smart factory. IoT platforms run and manage analytic applications for flexibility of various industrial companies to integrate and collaborate with each other to maximize production processes by satisfying individualized needs of customers. Location detection technologies in IR 4.0 trace various industrial assets and assist in workers' safety. Object positioning, automation allows organizations in locating the product and detect any defects before delivery to eliminate any unnecessary costs associated with it. Authentication and fraud detection are essential for all companies in managing risks. The human-machine interface helps stimulate the manufacturing process of products that can be controlled by the operator.

3D printing technology is used by industries such as aerospace, robotics, education, manufacturing that upgrades quality of a product and boosts efficiency of production process. Systems that adapt smart sensors to predict errors, improve

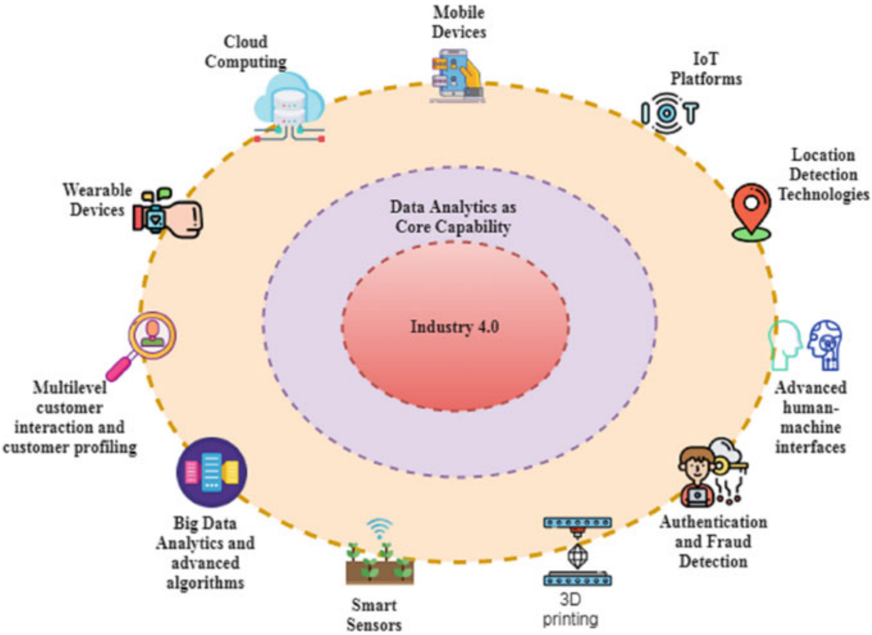

Fig. 3 Components of IR 4.0

communications, are pivotal for IR 4.0. Big data analytics and advanced algorithms integrate countless data sets to better understand smart manufacturing. The advanced artificial and machine learning algorithms with big-data software tools generate data streams for connectivity and design. Multi-level customer interactions and customer profiling, wearable devices monitor and optimize interactions with different customers for reducing the error rate, automation with the support of real-time responses to achieve smart growth.

2.2 *Characteristics of Industry 4.0*

IR 4.0 opens door for mass production, customized products and also aims in minimizing production cost per unit. IR 4.0 is designated by three important aspects—Interconnection, Integration, and Big data. Human-to-machine relationship and communication capabilities are interconnected to form digitized value chain to exchange data. More analytical capabilities for analyzing larger volumes of data result in efficient, reliable, and effective manufacturing. This is possible with horizontal, vertical, and overall integration of connected business units. Big data additionally assists in knowledge creation and grants efficient management of constantly

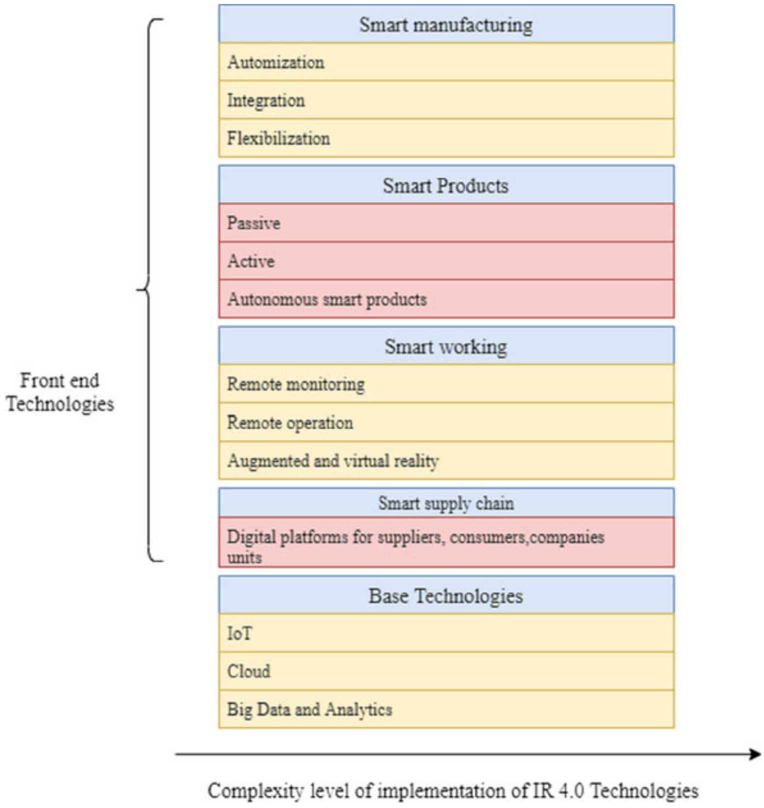

Fig. 4 Patterns of IR 4.0

databases. Figure 4 gives the depiction of different patterns of IR 4.0 with frontend and base technologies.

2.3 State of Arts

IR 4.0 is the new revolutionary research encouraged by different themes such as Industrial IoT, Fog on the Edge, Digital Manufacturing and Design etc., and the key objective is to build faster, reliable, efficient, customer-centrism models. The recent stage of technological developments in IR 4.0 helps in achieving the requirements for intelligent manufacturing.

2.4 Conceptualizing the Fourth Industrial Revolution

IR 4.0 era has witnessed a profound transformation in most of the industries. IR 4.0 enhances individualization by leveraging machine intelligence, taking production in manufacturing industries to the next level. The production process is automated but still dependent in IR 3.0 while this dependency will disappear in IR 4.0. There are some fundamental concepts to be at first perceived before going out to the real-world scenario.

- Smart Factory: Manufacturing companies armed with sensors and autonomous systems for digitized models thus devising a new word "SMART MANUFACTURING".
- Cyber-Physical Systems: Cyber-physical systems focus on networking several devices. These systems also promote remote access, which helps in processing information that uplifts the communication infrastructure. Figure 5 portrays how cyber-physical production system platform acts as a bus between smart devices, smart materials, RFID and service management, process control, alarm monitoring. Data exchange is the prominent feature of a CPS.

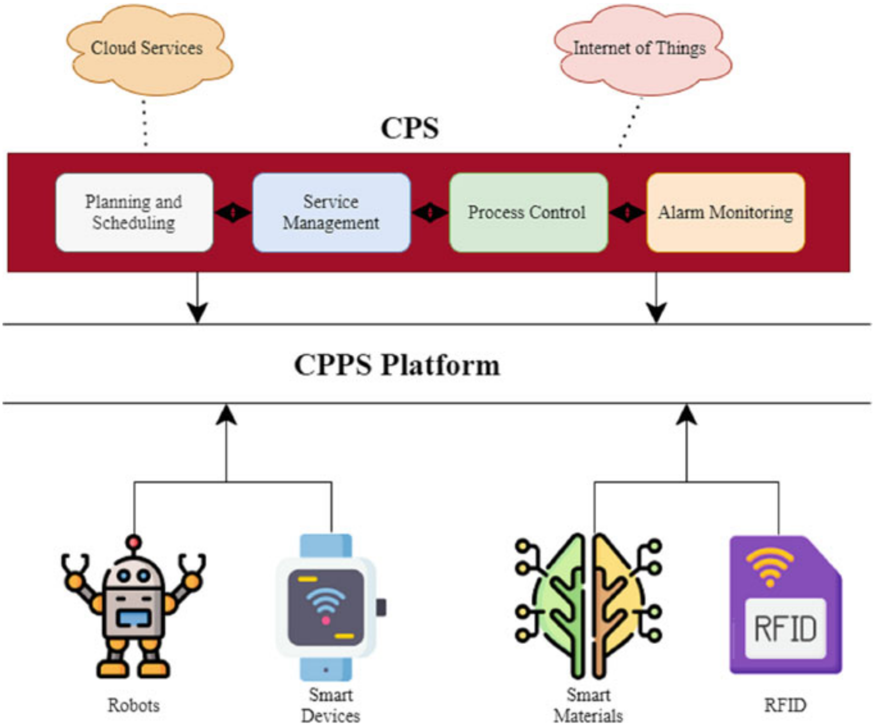

Fig. 5 Cyber-physical system platform in IR 4.0

- Self-organization: Decentralized self-organization is necessary for outrageous benefits.
- Distribution and procurement: Distribution and procurement increases individualization handled by various channels.
- Adaptation to human needs: Advanced manufacturing methods are designed that understand, support, and satisfy human needs.
- Social Responsibility: Sustainability and resource efficiency are taken into consideration while designing models for manufacturing systems that encourage societal responsibilities.

Smart factories are considered the new frontiers of manufacturing systems. Table 3 elevates the difference of traditional factory and smart factory. Smart factories involve autonomous smart machines, which are also flexible and adaptable. Smart manufacturing like AI operates on cyber-physical systems and sensors, IT-based tools for achieving industry goals. Figure 6 gives the description of framework of IR 4.0. The quintessence of smart manufacturing is reproduced in six shafts: materials, data, predictive engineering, resource sharing, networking, and sustainability [10].

Cloud-based solutions through IR 4.0 bring transparency and flexibility across a global network and with the new developments in AI, automation support has been achieved and can be boosted by utilizing 5G characteristics for high reliable communication. IoT, AI helps in real-time access to pertinent information.

The defence industry requires identification of new technologies for design and production of drones, helicopters, battle tanks, aircraft, space crafts, armor vehicles, guns, etc.; Improvement in production and marketing structure is accomplished by smart factories with the amalgamation of defence technologies and autonomous robotic systems. Figure 7 gives us the characteristics of a smart factory through which IR 4.0 goal is achieved. Through this, the defence industry achieves the benefits of lower costs and improved performance without the presence of workers in the production process chain.

Table 3 Traditional factory versus smart factory

Traditional factory	Smart factory
Centrally controlled and monitored	De-centrally control and monitor of production processes
No continual responses and exchange of information between workers, machines, tools	Humans, smart devices communicate and collaborate continuously
Machine, human resource utilization is low because of limited resources	High due to resource efficiency
Traditional production	Intelligent production
Productivity, flexibility, and sustainability are low	High
Frequent errors in production process	Errors can be minimized
Larger workforce is necessary	Workforce might be reduced and replaced by intelligent devices

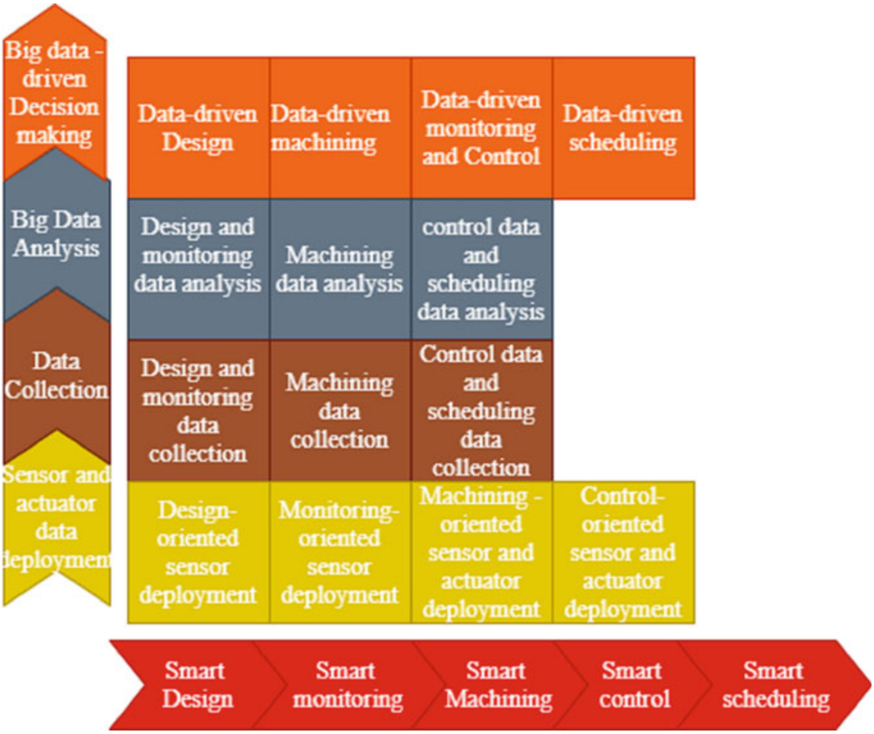

Fig. 6 Framework of IR 4.0

Fig. 7 Smart factory characteristics

2.5 Goals to Consummate Industry 4.0

Some planning goals to achieve IR 4.0 are:

- *Associating architecture creation and regularization of systems*: Interconnection and integration of different factories and companies must be allowed according to some network of standards.
- *Performing efficient management*: Appropriate planning should be monitored for optimization management with the use of an illustrative model.

- *Authentic industrial infrastructure*: IR 4.0 takes the advantage of different concepts such as reliability, comprehensive quality for the communication networks.
- S*afe and secure environment setup*: There should be a setup of safe and secure environment such that the new products developed should not be a threat to people and environment. Unauthorized access to such products should be completely prohibited.
- *Organizing and designing the work*: IR 4.0 strives for production management by following certain standards, which insists on organizing and designing the work for processes.
- *Personnel training*: All the organizations will train and educate their employees according to the demands of work.
- *Creating a supervisory framework*: New innovations lead to new challenges. So an organizational framework is necessary to carry out trade transactions, handling personal and organizational data with appropriate control measures.
- *Effective use of resources*: Balancing resources with new measures and processes improves effective use of resources.
- *Self-behavior*: IR 4.0 aims for minimum human interaction.
- *Process and Product interaction*: Equipping the machines for product and process interaction.
- *Big data analysis*: Big data analysis is required to achieve manufacturing goals.
- *Adaptability and flexibility*: The systems developed should be responsive to the changes by allowing the system to be adaptable and flexible.

2.6 Drivers of Industry 4.0

The main drivers for IR 4.0 are "3D printing or additive manufacturing, Sensor and Nanotechnologies, Artificial intelligence, Robotics", in additional with Drone technologies. Changing market demands, individualization, volatility, and technological possibilities are also characterized to be important drivers for IR 4.0.

- Changing market demands: Due to global changes and developments, there is an increased demand for individualized products.
- Individualization: Industries such as textile, cars, and machines consider customer wishes that leads to mass production that has been a basis for companies extend their market for international operations. This helps companies exist for long run in business. These days customer desires and needs are observed by the manufacturing companies and they develop and process products significantly. The approach at the work level must be new so that customers are satisfied with the product even if the product design and quantity change from day to day.
- Volatility: Markets fluctuate over time so as the prices, exchange and interest rates. Volatile markets affect manufacturing industry [11]. Volatility should be considered a key driver for flexible and sustainable manufacturing. So, the newly

setup companies should also invest in resource efficiency, energy reduction and sustainability for overcoming the competitiveness.

- Upcoming possibilities for manufacturing: CPS, IoT, Cloud computing, smart factory concepts are the developments in IR 5.0. The other technology developments such as big data and IR 5.0 (human–machine interaction) with the collaboration of electronics, bio, nano, optical, and micro-systems are influencing the manufacturing sector in a positive way.

2.7 Implementation Challenges of Industry 4.0

Technological requirements to deploy IR 4.0 are AI, IoT, machine learning (ML), cloud systems, cyber security, and robotics systems with a tough communication network. Designing new standard interfaces in a smart factory is a challenge in IR 4.0. Low latency, reliability, bandwidth, and data rates are incapable of convergence with present-day connection systems for automation of plethora of devices [12]. Sometimes it is difficult to upskill/transition existing employees to perform new tasks because not all employees are ready to upskill. Device reliability and power consumption are critical for extremely dense IoT devices. End-to-end latency and latency of connected systems will be less.

3 Methodologies in Industry 4.0

3.1 Validating Technologies/Base Technologies of Industry 4.0

IR 4.0 targets on management of value chain process in the entire manufacturing industry. So, for the smooth functioning, we need to perceive some of the empowering/base technologies of IR 4.0. Table 4 gives the detailed description of different technologies of IR 4.0. Figure 8 represents different key enabling technologies of IR 4.0, and Fig. 9 gives the representation of nine peers of IR 4.0.

3.2 Nine Technology Peers of Industry 4.0

- Big Data with analytics: Helps in forecast issues in plethora data sets that come from various sources.
- Autonomous robots: Intelligent robots will have a clear view on safety, versatility, flexibility.

Table 4 Empowering technologies of IR 4.0

Empowering technologies of Industry 4.0	Description
Data technologies	More analysis of data with smart decisions provides efficacy in manufacturing
Analytic technologies	Analytics support manufacturers in segmenting the production process to analyze the patterns in data and to know the processing with the collected information. If the updated data are not communicated properly then the whole analysis process goes in vain
Platform technologies	Platforms are required for providing tools that are necessary for developing applications for data storage, robotics integration, supporting digital twin intelligence. Stand-alone, fog/edge, and cloud are the three platform technologies that are currently in use
Operations technologies	Operations Technologies endeavors customer relationship, resource planning, supply chain governance, product life cycle management, and manufacturing execution systems [13]. High efficacy and economic impact are benchmarks for operation technologies through self-adjust, self-optimize, and self-configure characteristics [14]

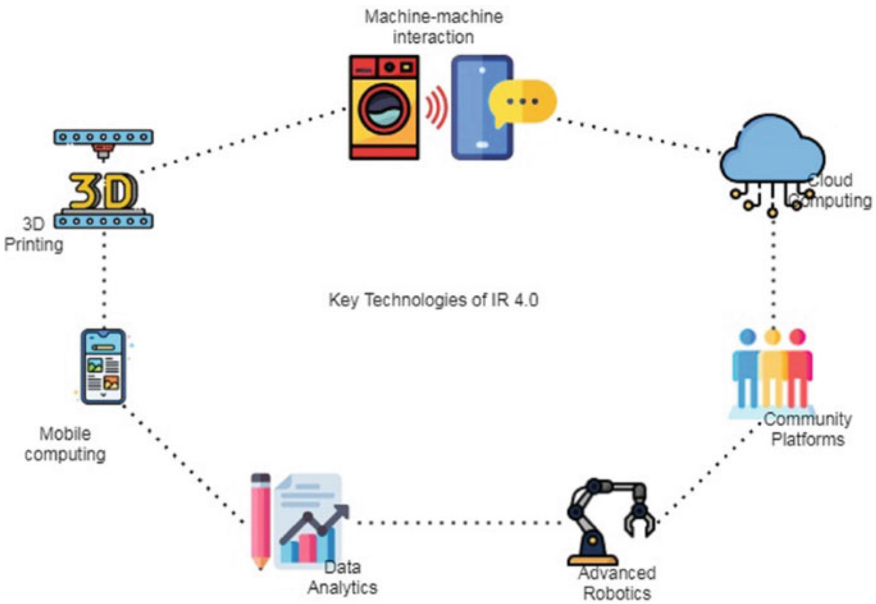

Fig. 8 Key enabling technologies of IR 4.0

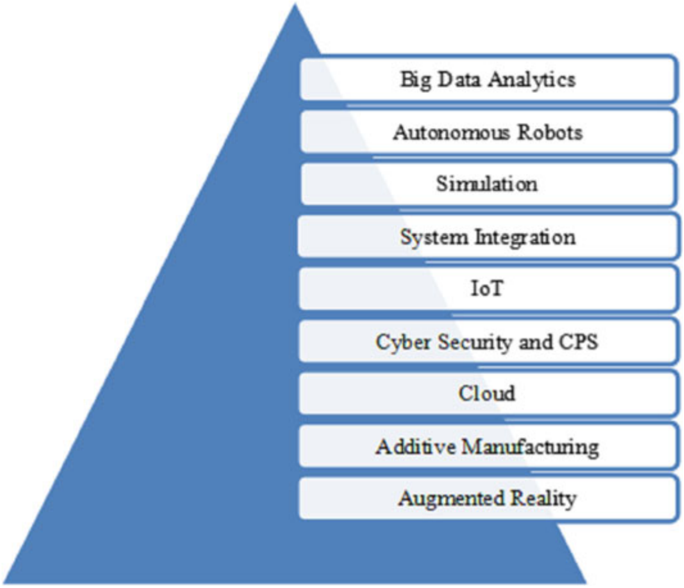

Fig. 9 Representation of nine peers of IR 4.0

- Simulation: Simulation software assists an engineer in the process of testing, analyzing, and optimizing the manufacturing system.
- Augmented reality: AR technology provides visual, auditory, and haptic sensors for perceiving information through 3D models.
- System Integration: Horizontal, vertical integration in a network system pushes feasibility to the next level which helps in linking different companies and departments.
- Cyber security and CPS: There is a need for advanced system for access control to address cyber security threats. CPS describes relations among physical, virtual, and digital components, which are monitored and controlled by computer-based algorithms.
- Industrial Internet of Things (IIoT): IIoT helps in interconnecting and communication between the devices. Through IIoT, we can have real-time responses.
- Cloud: Cloud computing permits the user to store and manage their data on a remote server and access anywhere with internet.
- Additive manufacturing: through additive manufacturing, we can have control of sequential layering materials to create 3D shapes.

3.3 Architectural Design of Industry 4.0

The Industry 4.0 architecture is vendor-independent and is modular in design, which helps in managing unstructured and structured data. The decision-making process and streaming analytics provide real-time response of the voluminous data. Analytical support for data communication and response takes less time for any type of use case. Real-time control and system scalability are the additional manufacturing facilities. We see that the architecture should be flexible to process the information and should be adaptable to the changes. Maintainability and IoT solution availability foresee the operations system, which pause the unauthorized access. User and application security allows system to securely access the persisted data. Big data support is required for data transmissions because the data is mostly located remotely and there are chances of mobile sources of data. Therefore, tools such as incident management and solution management are needed. Science and technological development led to the mobile support in IR 4.0. Intelligent industrialization with IoT and big data in supply chain manufacturing assists to achieve more production efficiency and lessen production costs thereby satisfying individualized needs for product and services.

The establishment of smart factories for intuitive production and manufacturing requires manufacturing companies' transformation from mass production to mass customization. Industrial big data promote data management with controls over security and risk and then improves operations efficiency. Manufacturing companies maintain a relationship with customers, resources, services etc., to accelerate its competencies [15]. Execution capabilities, common behavior of system use a platform that maintains a correlation between sales and production. Device characteristics under IR 4.0 are interoperability, virtual communication, distribution, on-time, service orientation, and modularization. Upgrading of manufacturing industries and changes in supply chain management is still a challenge. The IBM reference architecture of IR 4.0 as illustrated in Fig. 10 is divided into three stages—Edge, Platform, and Enterprise. Here, all the three stages are connected with an Edge service access network with platform and enterprise base, respectively. All the three stages commonly use a IIoT platform, which utilizes services like security, visualization support, configuration automation and management, API management, user management, and application runtime. The edge stage consists of users, actuators/sensors, production equipment tools, which are interlinked with digital management chest, device data, gateway device management and analytics. All these layers are controlled by DT and IT protocols.

The Plant stage consists of Plant applications with plant users colliding with modern plant applications. There is a connect broker with in-flight analytics and data transformation service, which enhances shop workflow by a services network plant. The device management area will provide all the necessary connections. Data lake, AI analytics, plant information model all are interrelated, which are overlooked by this plant stage. All these services utilize security, user management tools for the operational services that led manufacturing industries/systems get enough support to work with all the latest technologies and have the rewards from Industry 4.0.

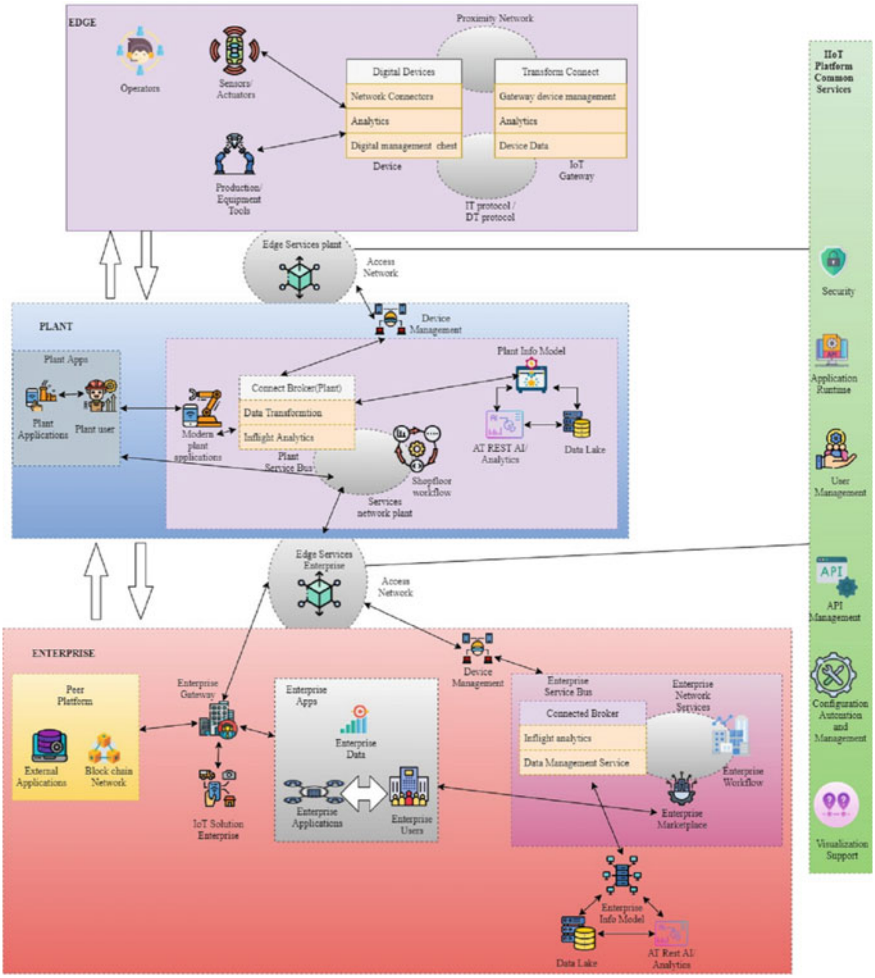

Fig. 10 Reference architecture of IR 4.0 by IBM

The Enterprise phase, which will be the final phase, includes all external applications, the blockchain network with all the IoT solutions that keeps records of the company's data, users and applications. There is also a device management support in this layer to establish a relation with platform stage through enterprise bus. The data management service connects to the enterprise market place and enterprise workflow with API management and configuration automation and management. The enterprise information model helps in collecting all the related information within the industry to manage and analyze the data through AI analytics, which in turn improves the efficiency of various organizations in terms of low costs and maximum production.

3.4 Artificial Intelligence in Industry 4.0

3.4.1 Features of Industry 4.0 with Artificial Intelligence

There are many features of IR 4.0 with the utilization of AI. They are

- Product personalization.
- Risk and supply chain digitization and integration.
- Social welfare enhancement.
- Big data analysis.
- Adaptability and flexibility.
- Defect detection.

Let us go into detail of the features:

Product Personalization:

Personalization helps analyze each customer's needs, thereby satisfying them with a personalized product. Personalization is a critical feature for all business sectors. Easier manufacturing is achieved through AI and Robotics concepts. AI methods analyze big volumes of real-time data gathered from various sensors [16]. Material sections are optimized with the advantages of recent AI techniques.

Risk and Supply Chain Digitization and Integration:

The lively and expeditious digitization of IR 4.0 helps in supply chain governance. By consolidating risks, supply chain digitization helps in cultivating valuable information for organizations. The supply chain system framework is full of discrete and digitization helps in transparency network. The digital supply network will be responsive and resilient to the companies in avoiding risks and anticipates the capacity for building more products. The risk management should also be given the significance and the integration with the supply chain management delivers fast, low-cost benefits and harnesses the power of innovations in big data, IoT, AI, ML, and augmented reality [17].

Social Welfare Enhancement:

The transformation of occupations and job profiles with IR 4.0 influences workforce performance and development. Shifting of work environment, technology training and education of new skills have created new competitive advantages in terms of societal welfare. IR 4.0 made a way for human empathy with transmission of wealth and growth in income distribution. IR 4.0 is a converging revolution and the social security features it brings are personalized welfare, flexible welfare, smart welfare, productive welfare, social innovation welfare, transparent welfare and sympathetic welfare. Social welfare through IR 4.0 is faster but is limited by certain policy challenges such as promotion of social innovation, introduction of universal basic income, building social welfare community, etc.

Big Data Analysis:

Big data analytical techniques operate on large data sets. Forecasting production process, failure avoidance with relationship among data is required for optimization. For consumer satisfaction, data analysis on obtained information is necessary with mathematical and statistical methods.

Adaptability and Flexibility:

Human–machine interfaces support sustainability in IR 4.0 paradigm. The design of a new production system should be adaptable to increasing trend towards individualization of products and the self-orchestration mechanisms that may be required for product requirements and production parameters [18]. Deliberate planning is necessary for improving the level of flexibility possible during production systems operation. Flexible factory addresses adaptable factory and seamless dynamic engineering of the production systems.

Defect Detection:

Defect detection and diagnosis requires increased maintenance time, which can be up to several days or, surprisingly, several weeks. Fault detection and diagnosis mainly involves collecting data, extracting features, and fault classification [19]. ML helps in supply chain advancement, cyber-attacks reduction, surface defect, and weld defect detections.

3.4.2 Relevance of AI in Different Industries

- Manufacturing and Supply Chain Management: Robust demand forecasting, better decision-making through statistical modeling techniques enable the manufacturing industries to reduce costs, and build higher value.
- Public Health and Safety: AI solutions help in predicting symptoms and customize the treatment plans for individuals. AI-powered robots can assist surgeons in conducting precise surgical procedures [20]. AI platforms make healthcare approachable to extensive strata of society.
- Agribusiness: AI intelligent solutions specify data about crop health, storage, distribution, which helps farmers to mount the production. In agribusiness, we can have low wastage, improve production through AI and ML systems.
- Banking and Financial Services: Banking and financial services now a days make use of Chabot's for customer service, help in financial planning, identify fraudulent transactions. These Chabot's are nothing but AI-driven devices. Back-office efficiency, economic stability, risk assessment are the other functions of AI amalgamation into the finance sector.
- Education: The net impact of AI in education would be quite high [21]. Data collected from the students and AI applications build on such data help in assessment, feedback which connect students and teachers more.

- Marketing and Customer Care: AI models are used to predict customer demand and orders and provide personalized services. AI applications are also useful for decisions on stocking of products and delivery management.
- Energy Sector: Clean energy, resource efficiency, reduces wastage of power are some of the prominent areas where AI has a role in energy sector.
- Defense and National Security: Detecting mines, space exploration, anomalous behavior detection are the possible use cases of AI in defense and national security.

3.4.3 Artificial Intelligence and Robotic Process Automation in Industry 4.0

AI usage helps in completing complex tasks, improving quality of services, reducing costs in manufacturing scenarios achieved through cyber-physical systems. Robotic systems with AI enable us to produce customized products. The replacement of work done by humans through mechanization or automation of services is called Robotic Process Automation (RPA) [22]. Some of the robotic actions include copy and paste data, open emails, filling forms, log into applications, etc. There is a surge in use of RPA tools since 2016 and is being extended in various other industries. RPA is prognostication of worker's repeated tasks by a robot. There are different RPA tools that assist in executing optimization, classification, extraction, recognition assignments such as UiPath, Kofax, WinAutomation, AssistEdge, Automagica. IR 4.0 revolution, AI, RPA fusion changes industrial processes [23].

3.4.4 Empowerment of Smart Manufacturing Through Industrial Artificial Intelligence

The execution of AI in enterprise environments needs a well-ordered structure. Industrial artificial intelligence (IAI) helps industries to be defect-tolerant, self-sustaining by providing standardized structures. Communication and management of data with ultra-low latency and higher reliability and security are also notable features in IAI. IAI can be defined as "to develop, validate and deploy different ML algorithms for industrial applications with achievable performance [24]". IAI provides the tools and flexibility to create industry-specific core functionalities [25].

3.5 Processes and Interaction in Industry 4.0

3.5.1 Intelligent Manufacturing

Intelligent manufacturing triggers the production and all other processes automatically and also assist in failure prediction. All of this is possible through device-device communication, device-man human interaction, cloud computing and analytics [26].

Visibility, traceability, predictability with speed, agility, and flexibleness are the underlying characteristics of intelligent manufacturing. Intelligent manufacturing helps companies track the success of manufacturing operations, optimizing by integrating and automating of cyber-physical and supply chain systems.

3.5.2 Business Process Management in Industry 4.0

All manufacturing organizations think in a business way to meet customer demands. They develop novel models and create business architecture to achieve this goal. Through Business Process Management (BPM) enterprises are able to analyze, measure, model and optimize manufacturing processes by improving efficacy and flexibility of daily operations. Modeling business is important in an IR 4.0 atmosphere as different processes involved in production digitally support through AI, robots, ML, cloud computing, RFID, and block chain [27].

3.5.3 Human–Machine Interaction in IR 4.0 Era

Integrated processing and communication capabilities are a requirement for factory objects in IR 4.0 paradigm, which affect machine-machine communication. The primary function of human is to design and develop a strategy as well as to verify production execution. The decision and monitoring processes can be observed from remote places.

3.5.4 Information Communication Technology Support Workflow Management

Information communication technologies support workflow management. In industrial environments, sourcing management work flow is tracked and the information is carry forwarded for re-engineering. The intra and inter-organizational workflow architectures support IR 4.0 for coordinated business processes. The classification and optimization of different business models are achieved through the proper utilization of appropriate information communication technologies (ICT).

3.5.5 Economic Potential by Industry 4.0

Planning, control, and execution of processes are supported by comprehensive digital integration of technological systems that provide opportunities and solutions in production logistics. IR 4.0 has huge influence on employment by increasing employment efficiency and labor productivity that transforms the market environment. IR 4.0 raises global income levels and thus improves the quality of life of people round the world [28]. IR 4.0 has a global impact that reforms the businesses in various

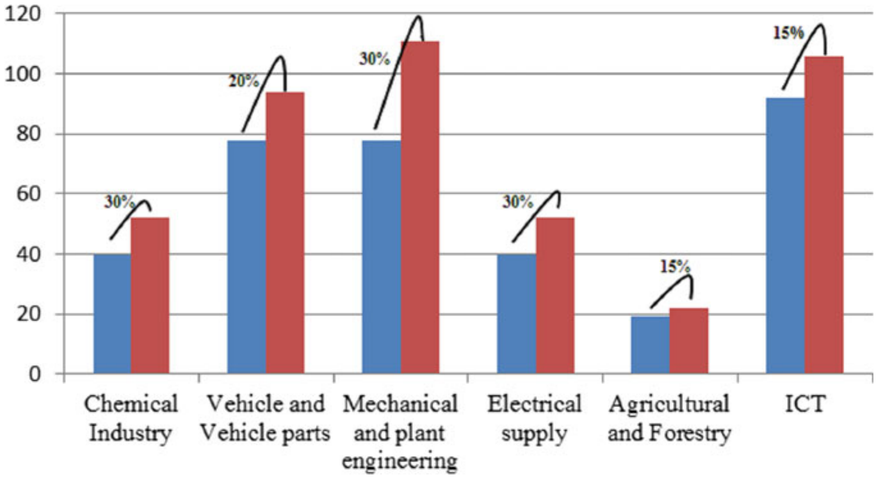

Fig. 11 Potential economic increase of IR 4.0 in some of the sectors

industries. As IR 4.0 is a combination of advanced technologies, its implementation leads to a re-orientation of work and learning and make human capital to have significant participation in the work [29]. Figure 11 outlines potential economic increase of IR 4.0 in some of the sectors like chemical industry, mechanical industry, agriculture and forestry, etc. Innovations in business models facilitate the companies to acquire intelligent and sustainable competitive power [30]. To overcome the pressure on the labor market and educational system through the introduction of various ICT technologies in IR 4.0, there is a need to find redesigned resources and methods, which will expand the skills and competencies of the workers. Thus, a new conclusion is that it is necessary to introduce better educational systems, which promotes the performance of the skilled labor thereby raising the competitiveness of companies. Smart environment accelerates change and enhances customer experience.

4 Applications, Use Cases, and Projects of Industry 4.0

4.1 Influence of 5G Technologies on Industry 4.0

Today we are at the edge of 5G, a technology that has the potential of changing mobile communications with an upgraded architecture with separate layers for different applications that include dynamic programming. With the assistance of 5G technologies, we can enjoy the benefits of relaxed and strict latency, high levels of network reliability, high volume of information, and low device cost. 5G technology influences vast IoT applications by providing regularity in architecture and scalability.

4.2 5G Tech Support for Industry 4.0

5G allows manufacturers to go for automation of operations or make virtual functionality of entire factories. 5G will have a vast impact on socio and economic development, which helps the workforce to work in even more safer conditions. Time-based machine management, robot communications, and edge cloud analytics enables the smart factories to achieve enormous productivity gains with IoT technology, cloud solutions, etc., involved in digitalization processes [31]. "Networking, computing and storage resources" are the main characteristics, which integrated into unique and modifiable framework with 5G technologies and, through this feature, there is flexible usage optimization resources are distributed. 5G offers standardization in flexibility with association of fixed and wireless technologies to achieve reliability of 99.9% and latency of 1 m/s as well as low power consumption.

4.3 Industry 4.0 Application Scenarios Accredited by 5G

Some of the IR 4.0 use cases recognized by 5G are cellular automation, process automation, logistic transportation, component tracking, remote assistance, and remote robot control. To prototype IR 4.0, there are several projects are underway to provide an aid to smaller and medium enterprises. All the projects are developed to provide learning that is shareable and accessible from any place in the world [32]. Below is the list of IR 4.0 projects.

- ENTOC
- ARIZ
- MetamoFAB
- ParsiFAI 4.0
- SOPHIE
- OPAK
- ESIMA
- PLANSEE
- e–Factory
- INESA smart factory
- FUSION

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Chapter 2
Transportation System Using Deep Learning Algorithms in Industry 4.0 Towards Society 5.0

Shrddha Sagar, Nilanjana Pradhan, and T. Poongodi

1 Introduction

Machine learning has gained a huge attention in the recent era as deep learning has also become a predominant technology in the artificial intelligence fast pacing domain. Deep learning (DL) implements multiple layers which provide an abstraction for data to construct prediction models. Deep learning methodologies and computational models have entirely changed the perception and scope of information processing. A comprehensive analysis of the recent state-of-the-art technologies and methodologies followed by performing in-depth analysis in intelligent transport system is being done.

In the recent days, machine learning has become more popular as it has been incorporated in numerous applications. "Deep learning" is representation learning, broadly used and steadily evolved in many applications, because of yielding promising results [1]. The exponential growth in the immense amount of data and encroachment in methodologies have led to the requirement of thorough research in DL. DL outperforms in the transformation of neurons in developing multi-layered learning models. The recent deep learning methodologies enclose implementation in several kinds of applications such as audio, video, and text processing, Natural Language Processing (NLP), social network analysis, and many other applications as well. In modern days, the deep learning concept was introduced in 1943, named the prototype as artificial neural models [2]. The computer model that mimics neocortex of human brain was created based on neural networks [3]. The combination of mathematical and algorithmic concepts known as "threshold logic" was followed that imitates the human thought processes. The electronic device "perceptron" was introduced in 1958, in the context of cognitive systems. To overcome the errors arises in learning models of DL,

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Convolutional Neural Network (CNN), and Recurrent Neural Network (RNN) were introduced in 1980 and 1986 [4, 5]. Numerous models of DL frameworks are built for enhancing the training modules of deep learning techniques. The large amount of data arrived with noisy labels or without labels, more studies have been practiced to improve the robustness of training modules by employing semi-supervised or unsupervised deep learning techniques. The significant challenge of deep learning experiences nowadays is to instruct the large datasets available at present. Since the datasets are highly complex, heterogeneous, and larger, DL has been in a crucial path in terms of categorization for big data analysis.

2 Deep Learning Techniques/Algorithms

2.1 Recursive Neural Network

In Recursive Neural Network (RvNN), hierarchical order is followed for prediction and the output is classified based on compositional vectors. The concept of RvNN is derived from Recursive Auto-Associative Memory (RAAM) [6]. RAAM architecture is proposed for processing objects that were structured using graphs or trees. It considers the repeated data structure with different changeable sizes and a fixed-width representation is formed. The Backpropagation Technological Structure (BTS) was proposed as a learning scheme in order to train the network, where the procedure of BTS is similar to the conventional backpropagation algorithm by incorporating tree-like structure. The pattern in the input layer is reproduced at the output layer by applying auto-association in the network. In [7], another RvNN architecture is presented to handle the inputs retrieved from different modalities. In the proposed system, RvNN algorithm is used to classify natural language sentences and images. Once the image is segregated into a number of segments, the sentences are divided into words. The score is computed by merging the possible combinations and a syntactic tree is constructed. The score is computed for every pair of units by considering the plausibility of combination. After computation, the highest score pair will be chosen and merged into a compositional vector. Later, RvNN will create a wide area of numerous units:

- a compositional vector which represents the area.
- class label.

A sample RvNN tree is depicted in Fig. 2.1, where the root refers to the compositional vector representation of the complete area.

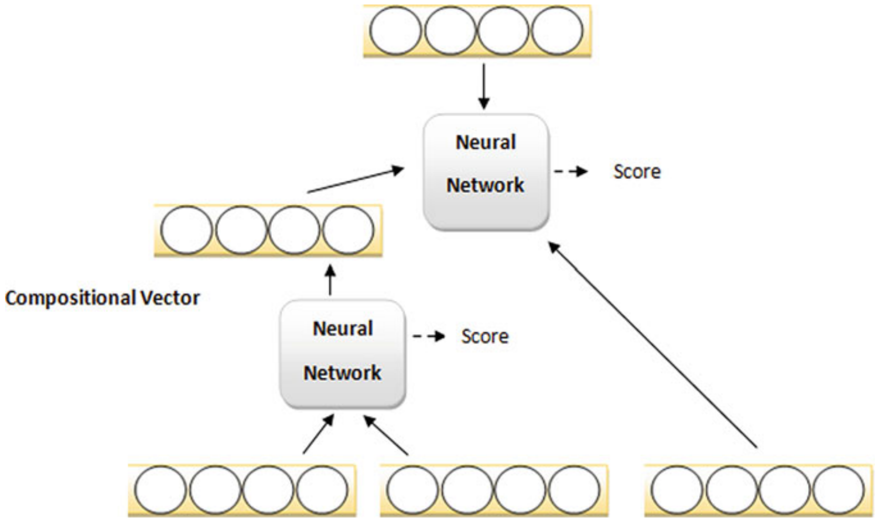

Fig. 2.1 Recursive neural network architecture

2.2 *Recurrent Neural Network (RNN)*

RNN algorithm is one of the most popular algorithms in speech processing and NLP [8]. RNN exploits the sequential information, where it is highly essential in several applications because the embedded structure helps in inferring useful knowledge from the data sequence. For instance, a word from a sentence is understood by knowing the context. Hence, an RNN is viewed as a short-term memory unit which includes input x, hidden (state) s, and output layer y. A typical RNN diagram consists of three deep learning approaches such as input-to-hidden, hidden-to-hidden, and hidden-to-output [9] as depicted in Fig. 2.2. A deep RNN achieves the benefits and minimizes the complex learning that is faced in deep networks. The significant problem occurs in RNN because of sensitivity in disappearing and exploding gradients [10]. Rather, the gradients would have decayed or exploded exponentially by multiplying numerous derivatives at the time of training. Therefore, the approach, named Long Short-Term Memory (LSTM) [11], is introduced to resolve the problem by offering memory blocks in the repeated connections. The memory cell in every memory block stores and maintains the temporal states of information in the network. Moreover, the information flow is controlled with the support of gated units.

2.3 *Convolution Neural Network*

Convolutional Neural Network (CNN) [12] is one of the most widely and extensively used algorithms in many applications such as computer vision, speech processing,

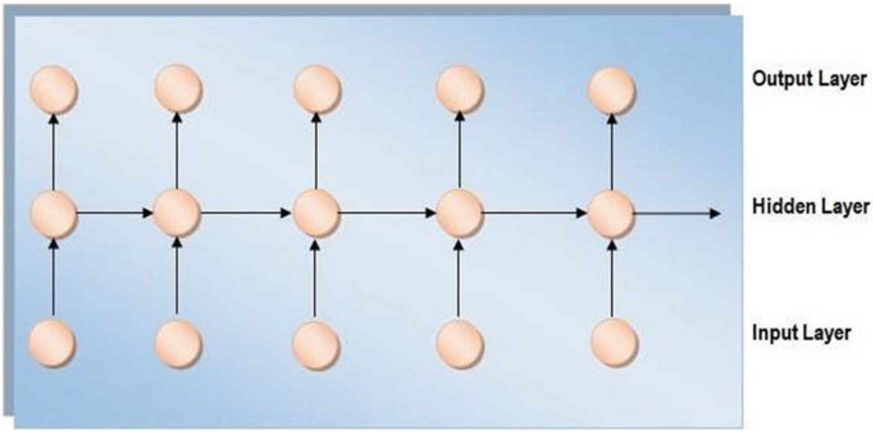

Fig. 2.2 Recurrent neural network architecture

and NLP. The structure of CNN is inspired specifically by the neurons in the human brain and animals as in the conventional neural network. The three major benefits of CNN are:

- parameter sharing.
- sparse interactions.
- equivalent representations.

For the complete utilization of two-dimensional input data, shared weights and local connections in the network are exploited. It makes easier to train the network and process faster because of fewer parameters. The process is similar to visual cortex cells which are very sensitive to smaller units of a scenario slightly considering the complete scenario. The cells execute over the input as a local filter for identifying the local correlation available in the data. In typical CNN, several layers together with many convolutional layers, sub-sampling layers, and completely connected layers are commonly used.

2.4 Deep Generative Network

The Deep Generative Networks (DGN) are Deep Belief Network (DBN), Generative Adversarial Network (GAN), Deep Boltzmann Machine (DBM), and Variational Autoencoder (VAE). In DBN [13], the top two layers are used undirected connections, and lower layers are used for directed connections in order to accept the inputs from the above layer. The lowest layer refers to the input units such as data vector. The inputs in DBN are learned in an unsupervised manner and the layers are acted as the characteristic detector. Furthermore, the training process is continued in a supervised manner for the classification process. DBM [14] is highly capable of learning difficult internal demonstration, it is perceived as a robust model for object and speech identification activities. Moreover, the reasoning procedure permits DBM to manage ambiguous inputs efficiently. GAN [15] comprises a discriminative (*D*) model and a generative (*G*) model. If *G* acquires the distribution from the real data locally, then *D* attempts to differentiate a sample. retrieved from the modeling data. VAE [16] exploits the log data and employs a strategy to obtain a lower bound estimator from the graphical models primarily with continuous variables. The algorithm aims to increase the probability of each x available in the training set.

3 Transportation Network Representation Using Deep Learning

The capacity to process a lot of information to give exact traffic figures is significant in present-day transportation decision support systems. A productive decision support system can possibly assist with limiting circumstances for response time, improve circumstance mindfulness, and decrease blockage span. In any case, traffic information processing and modeling is one of the biggest challenges due to road network complexity and spatial-fleeting conditions among them. Moreover, traffic designs are heterogeneous, which means diverse road fragments frequently have particular time-variation traffic designs. A lot of traffic information is recorded hourly from numerous information sources and sensors; however, it is hard to consolidate into highlights for training estimation models, because of contrasts in time, coverage of network, and information quality. After reviewing a number of research papers, we have concluded that a large number of applications of conventional machine learning approaches are being used for the estimation of data for traffic [17–21]. The prediction models that are used for traffic models are very shallow, as they are not suitable for big data circumstances [22]. According to the ability of spatial and temporal dependency models of traffic networks, a huge number of deep learning algorithms have been implemented for the significance of traffic condition on road links of transport networks [23] (Fig. 2.3).

However, requests in transportation are ever-expanding because of patterns in populace development, developing methodologies, and the extended globalization of the economy which has kept pushing the structure beyond what many would consider possible. The pace of expanding the quantity of vehicles is at focuses considerably more than the general populace increment rate, which prompts progressively congested and risky roadways. This issue won't be tended to by simply accumulation of the quantity of streets to any further extent. The development expenditure is exceptionally soaring and an opportunity to restore the outcome is very long to even consider catching up with the vehicle increment rate. The size of conventional information in the transportation framework and even the cooperation of different segments of the framework that create the information have become a bottleneck

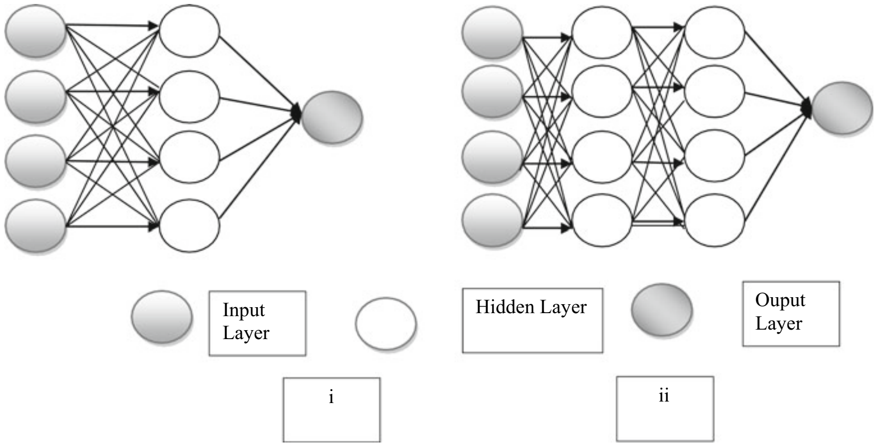

Fig. 2.3 Comparison of ANN and deep learning

for the conventional data analytics methodologies. Then again, machine learning is a type of Artificial Intelligence (AI) and information-driven arrangement that can adapt to the new framework necessities. AI learns the inert examples of verifiable information to demonstrate the conduct of a framework and to react in like manner so as to computerize the analytical model structure.

The size of conventional information in the transportation system and still the cooperation of different parts of the system which creates the information have become a bottleneck for the customary data analytics solution. Then again, ML is a type of Artificial Intelligence (AI) and information determined by the arrangement which can adapt to the requirement of the new system. ML studies the inactive examples of conventional data to show the conduct of a system and to react appropriately so as to automate the analytical model structure. The increase in computational complexity and collection of huge quantity of data has reformulated the approaches of machine learning for concentrating on the rise in the demand and requirements for transportation systems.

As of late, ML approaches have become a vital piece of acknowledging smart transportation. In this specific situation, utilizing enhanced DL algorithms, the complicated cooperation among the roadways, transportation traffic, environment components, and traffic accidents have been analyzed.

4 Various Domains that are Being Revolutionized by Deep Learning

Grouping strategies have identified the way in a progressively broad sense in transportation systems. Learning the dormant examples of recorded information in a proficient manner to demonstrate a transportation framework is a significant requirement for settling on the right choices. In any case, various classification methodologies by reviewing literature we have analyzed that most of the data values are unorganized, which leads to the problem of inheritance issues in the values of the class [24]. Distributed driving is broadly articulated to be a significant contributing feature of traffic collisions. With the development of new learning-based strategies, tending to the driver's interruption issue is turning into a subject of enthusiasm among industry and academia. In the exceptional issue, we examine techniques to recognize and moderate the driving pattern utilizing profound learning and using RGB pictures got from a camera mounted over the dashboard.

4.1 Self-Driving Cars

Purchasers all around the entire world are energetic about the approach of self-sufficient vehicles for public. A self-driven car can work without human control and doesn't require any human intercession. It has been expressed that advanced independent vehicle can detect their nearby condition, group various types of items that they distinguish, can decipher tangible data to recognize suitable route ways while obeying transportation rules [25]. With the continuous advancement, appropriate responses are being given for the unforeseen conditions where either a backlash can happen in the vehicular frameworks or some medium in the outer condition may not carry on as anticipated by inner models.

The possibility that people are poor drivers is very much archived in mainstream society [26, 27]. The 2007 DARPA Urban Challenge [28] was a milestone accomplishment in robotic technology, when 6 of the 11 self-driven vehicles in the finals effectively explored a urban domain to arrive at the end goal, with the primary spot finisher going at a normal speed of 15 mph. The accomplishment of this opposition drove numerous to pronounce the completely self-driven driving undertaking a "solved issue", one with just a couple of staying muddled subtleties to be settled via automakers as a major aspect of conveying a business item.

Today, more than 10 years after the fact, the issues of localization, mapping, scene observation, vehicle control, path optimization, and more significant level of decision planning related with self-driven vehicle advancement full of open difficulties that presently can't seem to be completely unraveled by frameworks consolidated into a creation stage for even a limited operational space. The testing of model vehicles with a human executive liable for taking control during periods where the AI framework is "uncertain" or incapable of securely continue remains the standard [29, 30].

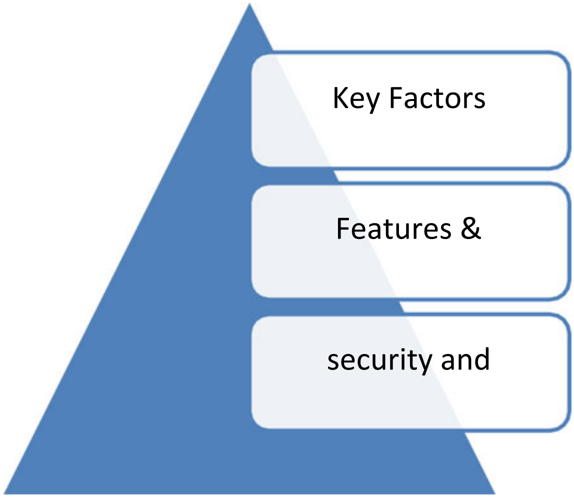

Fig. 2.4 Important features of driverless cars

According to the MIT Advanced Vehicle Technology (MIT-AVT), the DARPA Urban Challenge was just an initial step down a lengthy, difficult experience toward creating self-sufficient vehicle frameworks. The Urban Challenge had no individuals taking part in the situation with the exception of the expert drivers controlling the other 30 vehicles out and about that day. it is believed that the present certifiable test is one that has the person as an essential piece of each part of the framework (Fig. 2.4).

4.2 Traffic Congestion Identification and Prediction

The issue of urban traffic blockage, from the earliest starting point of the introduction of motor vehicles to the boundless prevalence of motor vehicles, has been a significant issue that puzzles nations everywhere throughout the world [31]. A traffic financial hypothesis study consists of the redesigning of fundamental transportation facilities as an effective method to predict congestion; hence this scenario cannot be totally predicted by just constructing better streets and offices [32–34].

Congestion Estimation Methodologies which are on the basis of image by surveillance which has generic applicability in conventional traffic management, which is on the grounds that observation camera is broadly utilized in urban street development as a vital framework for street development as of late. Hence, the methodologies for infrastructure configuration prerequisites are low. However, because image processing increases the demand for image transmission beyond that of traditional information transmission, and because managing image data is much larger than handling regular information, it will require much more computational resources. Along these lines, the trouble of continuous congestion estimation for all roads in urban road network is considerably more troublesome than that of basic information [35]. In spite of the way that the extreme learning machine (ELM) methodology has worldwide estimate ability, it normally has no special cases. That is the reason it is both significant and important to examine the ELM methodology, intertwining the symmetric a prior data and carefully fulfilling the balance of the assessed framework. Through the improvement of the even enactment work, along with the introduction of the ELM methodology, the balanced and earlier data can be combined.

4.3 Predicting Vehicle Maintenance Needs

The European Commission conjectures a half increment in transportation throughout the following 20 years. This will prompt a limit smash as the foundation advancement won't coordinate the expansion in traffic. It will require highly proficient transportation answers to keep up the vehicle execution of today. Along with the interest for maintainable vehicle solutions, progressively complex vehicle frameworks will develop. Such transportation frameworks could be modular change frameworks for load and transport quick travel frameworks for open transportation. In these, the vehicle is an incorporated piece of the total transportation chain. High unwavering quality and accessibility become progressively significant as the transportation frameworks get increasingly perplexing and rely upon more entertainers.

High vehicle proficiency is likewise significant in the present traffic as haulage is a low-edge business with a high turnover. Benefit can without much of a stretch transform into misfortune by startling changes in outside conditions, for example, fuel costs, financial downturns, or vehicle disappointments. By persistently checking transport proficiency, haulage organizations can build seriousness and remain profitable. This is empowered with cutting-edge Intelligent Transport System (ITS) solution, for example, Fleet Management Softwares (FMS), which give proficient haulage to the executives.

Vehicle reliability and opportunity, or uptime, is progressively critical to haulers as FMS frameworks become increasingly boundless. Reliability is another stream of progress and the interest for less spontaneous stops is driven by the furious rivalry in haulage as the greater part of different pieces of their business as of now is upgraded. Dependability is mostly controllable through vehicle quality and halfway by preventive upkeep activities and driver preparing. Preventive upkeep lessens the danger of unexpected stops, while it might expand the spending on support. Different methods of taking care of the danger of spontaneous stops are by protections and extra vehicle limit, for example, having excess vehicles.

A vehicle lease program with a comparing administration contract is another method of taking care of the danger of spontaneous stops. Relationship-based business, for example, a lease program or administration contract, gives haulers greater steadiness as their vehicle cost is unsurprising. Vehicle uptime is probably going to improve as the upkeep duty is either imparted to or totally moved to, the vehicle produces. They benefit by vehicle master information and the experience of past disappointments and support techniques from different clients. This data lever produces above even the biggest hauler with regards to understanding and ability.

In any case, relationship-based plans of action are a gigantic test to the makes. Customarily the benefit begins from deals of vehicles and extra parts. To put it straightforward, the more vehicles and parts sold the bigger the benefit. A relationship-based plan of action flips around this. The less extra parts utilized, while keeping uptime all through the agreement time, the bigger the benefit.

4.4 Public Transportation Optimization

Urban transportation, especially the congestion and contamination, are among the serious issues of society [36]. In this sense, exact proof has appeared, over and over, that the development of new framework or extension of existing streets isn't the best elective arrangement. There must be a sufficiently arranging of the framework—giving motivations to utilize open transportation to moderate the unfriendly impacts related with the activity of the framework. Travel ought to likewise be intended to improve its presentation to help clients and the city. With the development of urban communities, the requirement for individuals for transport increments, and not these excursions might be in private vehicle because of congestion that is created. This must be arranged with a comprehensive perspective on the issue so as to get the best utilization of financial assets, the best usefulness for workers, safeguard the earth, and make vitality investment funds [37].

To legitimize the requirement for a transit route is important to decide the present and future interest of the framework and its inclusion, i.e., dissect both the present and essential flexibility to give a productive, agreeable, safe, and affordable assistance. In this way, the interesting study establishes fundamental data for legitimate arranging of transportation.

The arranging of travel frameworks can be for short period (operational planning) or for medium to long period (vital planning). Normally, the structure of transport courses, frequencies, and planning of vehicles are transient issues. This operational arranging comprises of a few consecutive advances [37].

Investigation of the interest that travels from various sources to various destinations in the city:

- Modal split.
- Plan of the lines or routes.

Recurrence assurance of the quantity of travelers for each line

- Deciding timetables.
- Scheduling of vehicles.
- Driver scheduling.

5 Architecture of Convolutional Neural Network (CNN) Model

Neural networks are powerful and flexible tools utilized in modern technologies like data processing or classification problems and also in computer vision.

The most appropriate choice for these problems are convolution neural network(CNN). In real-time object detection systems or in solving real-time classification problems on mobile platforms (e.g. credit card expiration date recognition [37]) we may face challenges while trying to solve it with CNN. It is because even though CNN provide high recognition accuracy they can be very computationally demanding as the number of classifier execution per frame are enormous.

In some cases, it is worth noting that industrial recognition systems may not include GPUs and often have limited performance, strong memory, and power restrictions. Neural networks have high computational efficiency which is very necessary for all these circumstances [38, 39]. One of the most time-consuming parts of CNN processing is computation of convolution. Linear combination of separable filter in convolution is one way to increase performance of CNN. Application of standard 2D filters has lesser advantages than application of separable filters which requires less calculations and hence higher computational ability.

Experiments on ARM processor Samsung 5422 with CNN is performed for digit and letter recognition. In order to improve performance of processing of neural network, we have used fixed-point arithmetic, approximation of 2D convolution filter by a set of separable filters [40, 41]. The image recognition system can be accelerated by the usage of fixed point arithmetic by 40% with the help of 16-bit quantization [42], and the factor of 3 combined with 8-bit quantization for speech recognition systems at no cost accuracy [43]. In a research work [43], the authors have utilized low-rank approximation and clustering of filters. As a result, convolutional layers are created with 1,6 speedup with an 11% increment in error rate. Researchers explain how it is possible to approximate convolutional filters by separable 1D filters. This in return increases the performance of processing without any loss of accuracy [43].

Deep neural networks which comprise of multiple hidden layers between input and output layers build an efficient technique known as deep learning. There are two hidden layers for Classical artificial neural network (ANN), whereas critical machine learning tasks can be handled by deep learning by means of more efficient and effective technique which can handle more. Image recognition and speech recognition and reinforcement learning are few such examples. In order to perform documentation recognition tasks special types of deep learning networks and convolutional neural networks (CNNs) evolved in 1998. A well-trained fully connected network classifier was the main objective behind this idea of a combination of module for learning features.

CNN comprises of several such fully connected convolution and pooling layers. In Fig. 2.5, LC channel filters of standard CNN are replaced by a two-filter structure and fusing convolution.

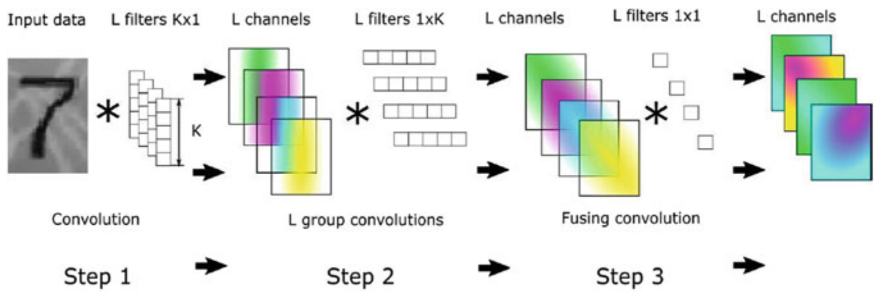

Fig. 2.5 Introduced CNN structure

The following are the steps:

1. LC channel filters of size KX1 are applied.
2. The channels are divided into L groups and then 1 channel filter 1 × K is applied to each group.
3. 1 × 1 sized L convolutions are applied to get linear combinations of step 2 outputs.
4. Non-linear activation function is applied.

Hence, the complexity of such layer calculation is O(NML(KC + K + L)).

Most of the research associated with CNN was directed towards the field of training CNNs [7] and other areas like computer vision [44]. Some researchers have addressed that hyperparameter of CNN can be optimized and has a direct influence on the design of CNN. "A set of hyperparameters have values which can be chosen for the design of CNN network design and a number of units in the hidden layer, the kernel size of a layer, the total number of dense layers, their rate of learning, activation function category, ordering of layers, etc." [44].

After many successful implementations of CNN for various real-world problems still its difficult to design CNN architectures. The reason is each specific problem requires a specific structure of CNN. Manual search, grid search, and random search [45] are three most common methods for the selection of CNN.

A researcher manually chooses a set of CNN hyperparameters' values from their previous knowledge of this domain. The researcher sets each time new hyperparameters' values in order to train the CNN each time and CNN training is costly because of the usage of various computational resources.

Reproducible results can be obtained by employing grid search. However, for searching high-dimensional parameter space this method is not effective.

Since a lot of computational resources are wasted in exploring values of hyperparameters with the help of grid search method as it does not have enough influence to present problem.

"Random search method is more efficient than grid search methods because it overcomes the problem of under-sampling eminent dimensions" [8]. In random search method, the process of selection of hyperparameters is not taken into account from previously generated results. The process of optimization of hyperparameter of CNN few researches have been applied. Genetic algorithm and swarm intelligence are few such methods. In the process of backpropagation procedure, several metaheuristics approaches are used which in turn replace gradient descent (SGD).

5.1 High-Resolution Data Collection

Scientific researchers generally pay more attention on the detection of object with the help of convolutional neural network (CNN) with the advent of deep learning. It trains various features automatically with high efficiency and also deals with large scale images. In detection of ship, high resolution remote sensing images are used and there is still a lack of CNN based experiments that have been performed to evaluate.

Well known swarm intelligence approaches and Firefly Algorithm (FA) are used for the selection of hyperparameter for CNN [8]. CNNs' hyperparameters are required to get optimized which in turn will define the architecture of network which comprises of number of dense convolutional layers and the number of kernels per layer and size of the kernel.

Because of the restrictions of available computing power of simulations hyperparameters like learning rate, activation function, dropout, etc., were not taken into consideration.

In order to validate and improve the quality and the performance of the proposed framework MNIST dataset is used for handwritten digits [46].

Remote sensing images and Synthetic Aperture Radar (SAR) images are the two kinds of images widely used for ship detection. The wide variety of information on the sea is present within the SAR images. Ships can be easily distinguished from the sea with the help of SAR images. However, SAR images have low resolution hence smaller sized and cluttered ships are difficult to detect with it. Instead, high resolution remote sensing images and optical satellite images are more appropriate in this scenario. In the preprocessing stage of ship detection method various methods like denoising, enhancement and segmentation [46].

After preprocessing feature extraction is performed which extracts segments of line, shape and texture. In ship proposal detection various category of ships have different shapes and sizes, and it present details to various extend in images captured at a high resolution. In high resolution remote sensing image there are too much of details present as shown in Fig. 2.6.

In the Fig. 2.6 we find lot of minute and fragmented line segments. In order to efficiently detect ships with various size and resolutions hence it's very difficult to discriminate the ships from those detected line segments. For efficient detection of ships of different sizes from high resolution remote sensing image Minimum bounding rectangles (MBRs) are used and fed into convolution neural network (CNN).

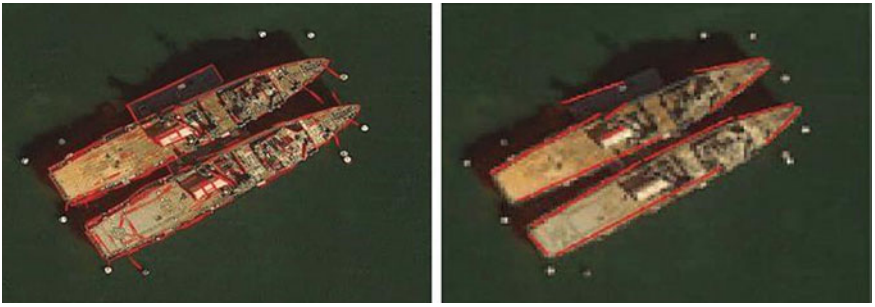

Fig. 2.6 Various resolutions of a warship image: (i) original resolution (ii) low resolution with down-sampling

5.2 *CNN for Crash Predict*

"This investigation proposes three distinctive network designs dependent on Ordinary NN (Neural network), CNN (Convolution Neural Network), and RNN (Recurrent Neural Network) models" [45]. Figure shows the engineering of the NN model with two hidden layers of 50 concealed units. The model takes a vector with eight factors as information on sources and predicts the seriousness of car crashes as just property harm, conceivable/clear injury, or impairing injury/casualty. The backpropagation algorithm prepares the model utilizing the Nadam analyzer and a batch size of four. The network parameters are chosen through grid search and ten times cross-approval evaluations [45] (Fig. 2.7).

Figure 2.8, represents the second proposed model which is dependent on CNN. Information related to deal with the arrangement of mishap information is applicable

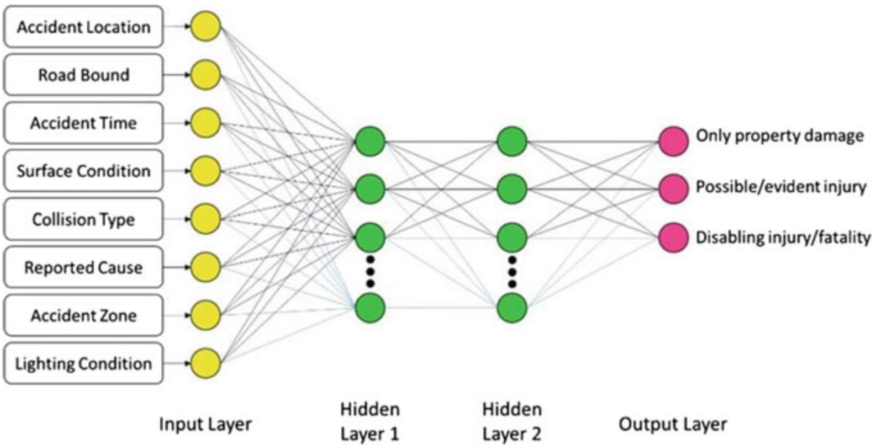

Fig. 2.7 (Model I) NN model for estimation of traffic accidents severity

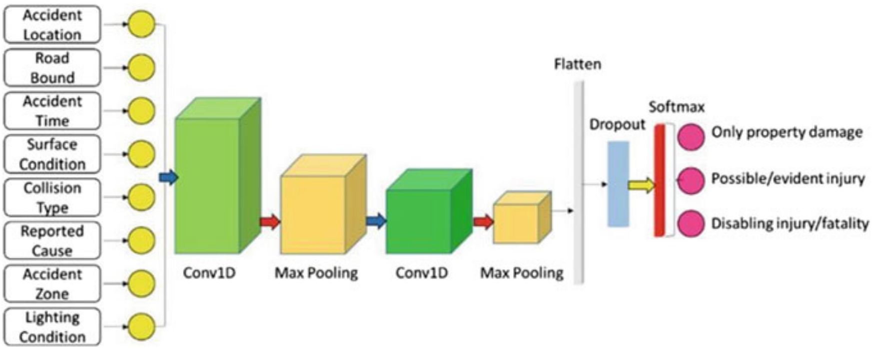

Fig. 2.8 (Model II) CNN model for estimation of traffic accidents severity

using 1D convolution activity. Utilizing convolution and pooling activities the information is changed into the portrayal of another new element in this model. Most extreme pooling tasks are applied to extract the corrected highlights. At that point, the highlights are straightened to be utilized for arrangement. In order to abstain from over fitting a dropout layer is added. Softmax layer helps in the anticipation about the seriousness of injury because of auto collisions.4739 is the absolute number of the boundaries of CNN [45].

6 Traffic Flow Prediction

Enormous urban information originates from numerous sources. While analyzing the ongoing traffic volume across the city we observe that most of the information originates from taxi sensor, exploratory information, checking information and internet web information. For instance, gathered information from three different ways, which are 155 street fragments conveyed with circle identifiers, constant GPS readings of 6918 taxis and street system and focal point (POI) in Guiyang, to construe the urban traffic volume [47]. While foreseeing city-wide crowd streams, we can acquire information from cell phone signals, Internet web information, exploratory information, etc. Information can be obtained in two different ways for anticipating urban group streams, in particular, Beijing's taxi GPS information and meteorology information to acquire dataset TaxiBJ, and NYC bicycle framework to get dataset BikeNYC.

Furthermore, enormous urban information is heterogeneous, which is reflected in various kinds and diverse existing fields. From one viewpoint, huge urban information presents various categories. Huge urban information incorporates spatial information, transient information, static information, dynamic information and property information. For instance, when understanding the constant urban traffic volume, the network of roads occupies a place with spatial information, day of week occupies a place with worldly information, point of interest (POI) has a place with static information, the traffic stream of every street at various time stretches has a place with dynamic information, and the quantity of street paths has a place with information about traits [47].

Traffic information, geographic information and meteorological information are utilized to anticipate urban taxi request. For instance, when contemplating the constant while analyzing the urban air quality, information of various models is utilized, including text information, numerical information, etc. Three datasets are utilized to foresee air quality, to be specific, air quality information, climate gauge information and meteorological information [47].

7 Urban Traffic Flow Prediction

Scientists anticipated the momentary traffic stream by proposing a mixture multi-modular deep learning structure, which comprises of convolution model, GRU model, and joint model, and together learns the spatial-worldly connection highlights and relationship of multi-modular traffic information. The simplified multi-modular deep learning structure for traffic stream determining outline appears in Fig. 2.8. The convolution model is utilized to gain proficiency with the spatial element portrayal of grouping numbers' nearby propensity.

The GRU model is utilized to become familiar with the time to learn multi-modular information portrayal combination. In early combination, the CNN and GRU models are utilized to remove deep correlation highlights, which are spatial-transient highlights Zhang et al. [45] manufactured an ongoing group stream determining framework Urban Flow by a Deep ST architecture, which is made out of three segments: temporal subordinate examples, convolutional neural systems, and early and late combinations.

In the principal phase of DeepST, the info is created from all fleeting properties, for example, worldly closeness, period, and irregularity pattern. In the second phase of DeepST, the CNN module is utilized to catch spatial closeness reliance [47]. In the last stage, early and late combinations are utilized to meld various kinds of ST information. In early combination, comparable spaces' information is melded by a convolution layer to catch closeness, intermittent and irregularity pattern designs together.

8 Open Research Challenges and Future Directions

Here, we endeavor to give an outline of the field of urban spatial-fleeting streams expectation during 2014–2019, which executes an inexorably critical job in urban computing research and is closely related with traffic management, land use and public security. However, we are just ready to cover a small percentage of work in this fast-developing region of examination. Most techniques are information-driven strategies in the urban streams forecast issue and hence we have to give more consideration to the information. This paper helps one in recognizing issues with given spatial-fleeting datasets and some great decision of preprocessing or forecast strategies to manage urban streams expectation issues. In spite of the fact that the field of urban streams expectation has gotten a lot of accomplishment, there are additionally many challenges.

like how to intertwine various source information at the same time, how to choose which impact factors are key factors for our concern, and successfully tackle the information sparsely issue. Finally, we plan to see prediction methods for urban traffic flow technique which is increasingly generative and pragmatic.

9 Conclusion

In outline, with the determination of AI, data analytics, and all the more meta-heuristic approaches, there is no ambiguity that the transportation system would get smarter and more intelligent. After the collection, storage, and analysis of multisource transportation information become simpler and less expensive, new and emergence of new applications will be there. Introduction of the DL framework of the CNN model for the accident forecast dependent on uniform frameworks. Thinking about the model structure, we have discussed a system to change over information into cells to get high-resolution information for every framework. Three customary models (i.e., negative binomial model, spatial Poisson Lognormal model, and counterfeit neural system model) were also discussed in brief. With the advancement of the smart transportation domain, this will help the researchers in the latest and new domain for further research by implementing more ML algorithms for having more secure smart cities and transportation systems.

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Chapter 3
A Brief Study of Adaptive Clustering for Self-aware Machine Analytics

K. M. Baalamurugan and Aanchal Phutela

1 Introduction

Nowadays, a significant amount of data is generated in a variety of areas, including marketing, biomedical, geospatial, transportation, business, and finance. This enormous volume of data is produced and shared through the Internet. The growth of the Internet, as well as the evolution of social media, exemplifies this. Mobile phones with several functions are becoming increasingly popular. Data from numerous sensors is received and sent through the Internet of Things (IoT) and the Impact of Computer Devices.

In reality, the key issue in this subject is determining how to analyze the obtained data in order to comprehend and gain unique insights in a fair amount of time. Clustering algorithms are the most extensively used, powerful, and popular methods for dealing with this data [1]. This method includes grouping objects into clusters based on two criteria: objects must be more similar inside a cluster and less similar across clusters. The most extensively used large data clustering techniques are compared and contrasted in this study: single machine clustering strategies, which include some of the first data analysis algorithms, and multiple machine clustering techniques, which are more contemporary and scalable [2, 3]. This work's main contribution is the development of a self-adaptive group formation for mapping data processing. The classical method, relative approach, subjective approach, and conditional approach are all considered. The input data sets are translated into the appropriate technique, which identifies comparable characters and validates the probability of such occurrences occurring clustering system [4].

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The rest of this paper is organized as follows: Data clustering and a mathematical formulation of the clustering issue are discussed in Sect. 2. The classical clustering technique is compared to bio-inspired algorithms in Sect. 3. Section 4 discusses self-aware clustering approaches. Section 5 is a brief review of adaptive Self-Aware clustering algorithms. In Sect. 6, the process is explained. Experimental results for the data sets used in this study are reported in Sect. 7. Finally, Sect. 8 concludes the proposed paperwork.

2 Clustering

One of the many common Machine Learning (ML) approaches is the Clustering Algorithm. It involves grouping datasets together that are comparable in some way. Clustering is a concept in which similar data inputs are grouped together and unlike or diversified data inputs are grouped together. The process of splitting a set of data items (or observations) into subgroups is known as clustering. Each subset is a cluster, with elements that are similar to those in other clusters but unique from those in others. A cluster analysis produces a clustering, which is a grouping of clusters. The data sets are divided into subgroups using a clustering method. In some applications, clustering is also known as data segmentation since it divides big data sets into categories based on their commonalities. Because the class label information is not provided, clustering is a type of unsupervised learning. It's more of a case of learning by observing than learning of the system.

2.1 Types of Clustering

Clustering is the unsupervised classification of patterns (observations, data objects, or feature vectors) into groups (clusters). The process of organizing a set of patterns into clusters based on their similarity is known as cluster analysis. Patterns inside a valid cluster, on the surface, appear to be more similar to one another and more distinct from patterns from other clusters. Clustering is critical in data mining applications such as research, data exploration, information retrieval, and text mining. Clustering is appropriate for exploratory pattern analysis, grouping, decision-making, and machine learning applications such as data mining, document retrieval, data segmentation, and pattern classification. Partitioned, hierarchical, density-based, and grid-based approaches are the four types of clustering techniques. Figure 1 represents the types of clustering algorithms using tree structure.

(A) **Partitioning Methods**

A partitioning method divides a data collection of n objects into k partitions, with each partition representing a cluster and $k \leq n$. That is, it divides the data into k groups, each

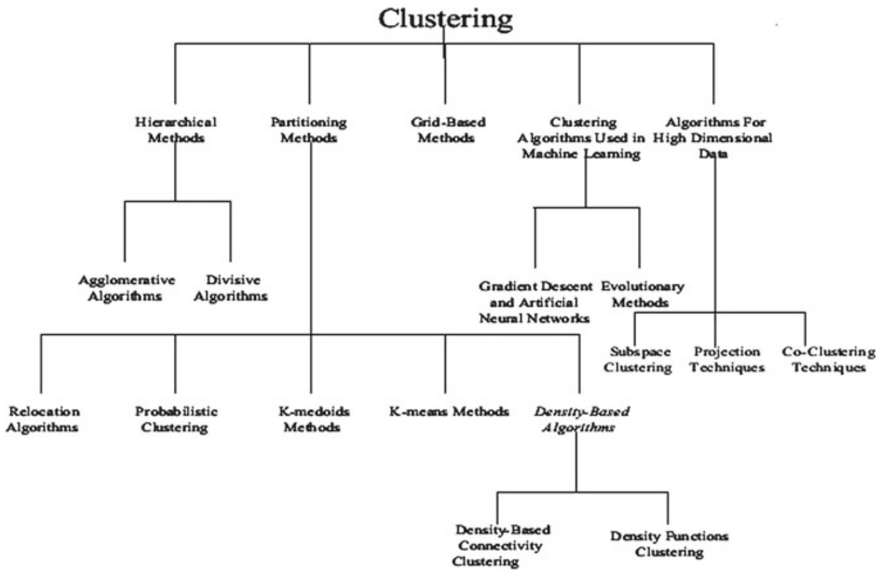

Fig. 1 Types of clustering algorithm

with at least one item [5–7]. In other words, partitioning strategies divide data sets into one-level partitions. Partitioning-based algorithms must be expanded to locate clusters with complicated forms and for very big data sets. The terms K-MEANS and K-MEDOIDS [8–10] are often used.

(B) Hierarchical Methods

In a hierarchical method, a set of data elements is decomposed in a hierarchical fashion. A hierarchical approach can be classified as either agglomerative or divisive depending on how the hierarchical breakdown is formed. The agglomerative approach, often known as the bottom-up strategy, starts with each object forming its own group. It combines similar items or groups until all of them are integrated into one (the top level of the hierarchy) or a termination requirement is met. The top-down technique, also known as the splitting strategy, begins with all objects in the same cluster. A cluster is broken into smaller clusters with each iteration until all elements are in one cluster or a termination condition is met. BIRCH [11] and CHAMELEON [12] are two well-known algorithms.

(C) Density-Based Methods

The distance between items is used to cluster things in most partitioning algorithms. Only spherical-shaped clusters can be found using these approaches, and clusters of any form are difficult to locate. Other clustering algorithms based on the concept of density have been developed. The most often utilized algorithms are DBSCAN [13], OPTICS [15], and DENCLU [14].

(D) **Grid-Based Methods**

Grid-based approaches divide the object space into a finite number of cells, forming a grid. The grid structure is used for all clustering procedures (i.e., on the quantized space). The key benefit of this method is its quick processing time, which is often independent of the amount of data items and only depends on the number of cells in each dimension of the quantized space. The well-known algorithms are STING [16] and CLIQUE [17].

Table 1 describes the general characteristics of clustering algorithm based on different features.

(E) **Clustering Algorithm Used in Machine Learning**

Cluster analysis, often known as clustering, is an unsupervised machine learning procedure. It requires automatically detecting natural grouping in data. Unlike supervised learning (such as predictive modeling), clustering algorithms simply examine the incoming data and search for natural groups or clusters in feature space. Clustering is an unsupervised machine learning technique for discovering and grouping related data points in large datasets regardless of the outcome. Clustering (also known as cluster analysis) is a data organization approach that makes data easier to understand and manage.

Table 1 General characteristics of the clustering algorithm

Method	General characteristic
Partitioning methods	– Find mutually exclusive clusters of spherical shape – Distance-based – May use mean or medoid (etc.) to represent cluster center – Effective for small-to medium-size data sets
Hierarchical methods	– Clustering is a hierarchical decomposition (i.e., multiple levels) – Cannot correct erroneous merges or splits – May incorporate other techniques like micro clustering or consider object "linkages"
Density-based methods	– Can find arbitrary clusters – Clusters are dense regions of objects in space that are Separated by low-density regions – Cluster density: Each point must have a minimum number of points within its "neighborhood" – May filter out outliers
Grid-based methods	– Use a multi-resolution grid data structure – Fast processing time (typically independent of the number of data objects, yet dependent on grid size)

(F) **Algorithm for High-Dimensional Data**

Graph-based clustering (Spectral, SNN-cliq, and Seurat) is possibly the most resilient for high-dimensional data because it employs graph distance, such as the number of common neighbors, rather than Euclidean distance, which is less significant in high dimensions.

3 Traditional Clustering Algorithm versus Bio-inspired Clustering

For efficient data analysis in various applications there are two data redundancy techniques are utilized (i) Traditional clustering algorithm (ii) Bio-inspired clustering algorithm which described in the below section.

A. **Traditional Clustering Algorithm**

Traditional clustering is a technique for grouping data on a big dataset by detecting similar properties. To segment the bonds in the suggested research, K-Means, Hierarchical, Self-Organizing Map, Fuzzy-C Mean, and Gaussian Mixture Model clustering methods have been utilized. Traditional clustering methods can be classified into nine groups, with 26 of the most often-used algorithms listed in Table 2.

B. **Bio-Inspired Clustering Algorithm**

To address the limits of present artificial intelligence technologies, a new form of intelligent computing approach has just been developed. One of the most essential characteristics of these intelligent computer technologies is that their working mechanisms are more lifelike to a single organism or a collection of well-studied

Table 2 Traditional clustering algorithm

Category	Typical algorithm
Clustering algorithm based on partition	K-means, K-medoids, PAM, CLARA, CLARANS
Clustering algorithm based on hierarchy	BIRCH, CURE, ROCK, Chameleon
Clustering algorithm based on fuzzy theory	FCM, FCS, MM
Clustering algorithm based on distribution	DBCLASD, GMM
Clustering algorithm based on density	DBSCAN, OPTICS, Mean-Shift
Clustering algorithm based on graph theory	CLICK, MST
Clustering algorithm based on grid	STING, CLIQUE
Clustering algorithm based on fractal theory	FC

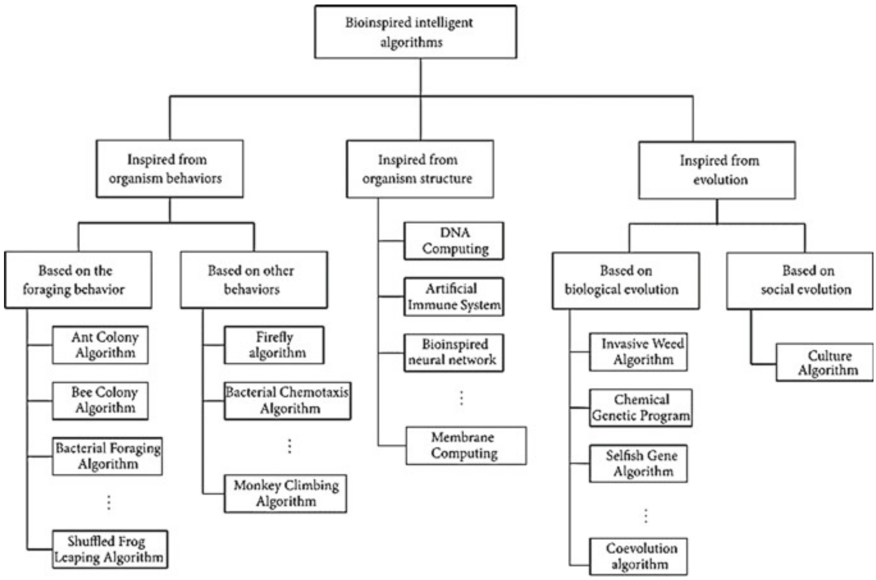

Fig. 2 Bio-inspired clustering algorithms

animals. These technologies, on the other hand, surpass standard artificial intelligence methods in the vast majority of cases. To distinguish them from typical artificial intelligence methodologies, these intelligent computing technologies are referred to as Bio-Inspired Intelligent Algorithms (BIAs). Figure 2 shows the bio-inspired clustering algorithm-based tree structure.

4 Self-aware Clustering

The ability to determine the condition of each machine makes it tough to establish a "time machine" of monitored assets by taking effective and efficient data. To establish the status, possible operating situations, machine conditions, level of degradation, performance data, and failure mechanisms could all be employed. To enable CPS's self-awareness and self-learning capabilities, it must not only recognize snapshots inside a known cluster but also discover new clusters that have never been seen before. Clustering is a method of combining similar samples into a single group using a distance kernel and an optimization methodology to maximize inner-cluster similarity and minimize inter-cluster dissimilarity [18].

Clustering is a crucial activity in machine learning, pattern recognition, machine translation, and bioinformatics. Dynamic clustering algorithms are used to cluster stream data, and the clustering process is a pipelined procedure for evaluating samples

[19]. The technical underpinning for developing time machines to do the following tasks is dynamic clustering:

- Clustering of unlabeled historical data in an unsupervised strategy to identify distinct working in an industrial environment.
- Cluster identification and similarity evaluation for simplified testing data
- Maintenance of existing clusters and construction of new clusters based on test findings that have been optimized.

Self-organizing maps, discriminant diffusion maps, and Laplacian, Eigen maps are examples of unsupervised learning algorithms that can be used to create clusters for various working regimes and health conditions. Figure 3 shows a system that uses an online technique to update the status awareness of a monitored object. The algorithm updates the status in one of two ways after comparing the most recent sample to existing clusters: (1) the snapshot is assigned to an existing cluster and labeled as the same as the identified cluster, or (2) no identical cluster is found, and the algorithm keeps this sample until enough counts are seen to form a new cluster.

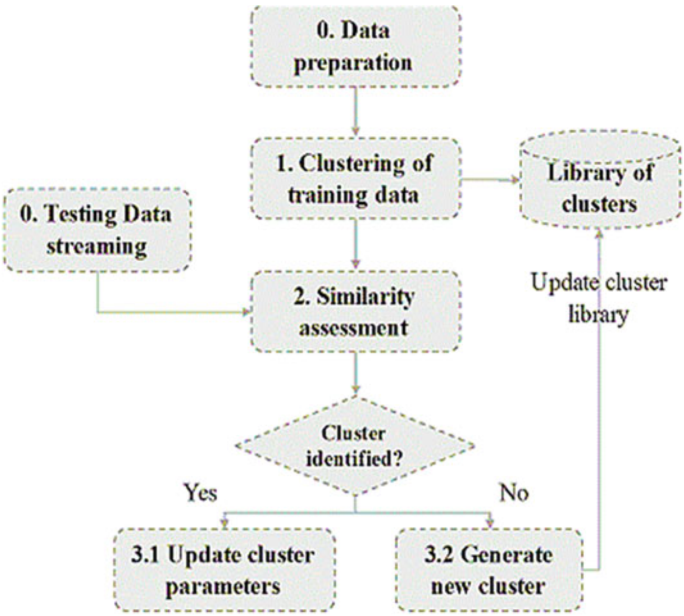

Fig. 3 Flow chart for self-awareness clustering algorithm

5 Adaptive Clustering for Industry 4.0

As a consequence of Industry 4.0, clusters have a number of challenges and opportunities. Concepts appear to be in opposition rather than complimenting each other it might be claimed that Industry 4.0 promotes the idea that "distance no longer matters," and that geographical co-location and spatial proximity are no longer significant. The properties of internet communications may appear to put the sticky, location-specific offer of clusters to the test. As a result, clusters' principal risk is that they will become redundant as Industry 4.0 allows for remote collaboration and reduces the need for collocation or spatial proximity. Considering this inconsistency, clusters can play an important role in the development of Industry 4.0. A recent study focused specifically on clusters' significance in the fourth industrial revolution and found multiple pathways of effect [20]. Knowledge generation and distribution features that are crucial for Industry 4.0 can be harmonized with the unique characteristics of cluster-specific innovation processes. Clusters appear to be well-positioned to serve as a viable policy tool for structuring the fourth industrial revolution and ensuring enterprises' smooth digital transformation. Adaptive clustering for industry 4.0 can, function as test beds for Industry 4.0 experiments, create a favorable environment for knowledge generation and dissemination, act as a policy instrument for the implementation of advanced initiatives, and serve as the nodes in the architecture of platforms or networks.

5.1 Adaptive Clustering in Mobile Computing

In order to manage multimedia traffic, the wireless network layer must provide QoS (bandwidth and latency) to real-time traffic components. The two steps in our strategy for providing QoS to multimedia are as follows: (1) the multi-hop network is segmented into clusters, allowing for controlled and responsible bandwidth sharing inside each cluster; and (2) virtual circuits with guaranteed QoS are created. This section [21] describes how to implement the Adaptive Clustering in Mobile Computing (ACMC) design. The ACMC's goal is to divide the network into numerous clusters. The tradeoff between spatial reuse of the channel (which drives toward small sizes) and delay minimization determines the ideal cluster size (which drives toward large sizes). Other limits exist, such as the use of power and the location of the business. The size of the cluster is determined by the radio transmission power [22]. For the cluster technique, it has been assumed that transmission power is constant and homogeneous across the network till now. Each cluster's nodes can only communicate with each other after two hops. The node ID can be used to create clusters. Following the method described below, the multi-hop network is divided into non-overlapping clusters [23]. The following operational assumptions are made in order to design the algorithm in a radio network. The vast number of radio data transmission techniques are evaluated [24, 25].

(A1) Each node has its own identifier and is aware of its one-hop neighbor's identifiers. A physical layer can be used to provide mutual location and identification of radio nodes.

(A2) In a specific length of time, a message sent by a node is accurately received by all of its one-hop neighbors.

(A3) The network topology does not alter while the algorithm is running.

Algorithm for Adaptive clustering in mobile computing

```
Γ : the set of ID's of my one-hop neighbors and myself
   {
        If (my_id==min(Γ))
{
          my_cid= my_id;
                 broadcast cluster (my_id, my_cid);
}
For (;;)
{
             On receiving cluster (id, cid)
{
                   Set the cluster ID of node id to cid;
                    If (id==cid and my_cid==UNKNOWN or my_cid>cid))
                   My_cid=cid;
                    Γ= Γ-{id};
If (my_id==miin(Γ))
{
               If (my_cid==UNKNOWN ) my_cid=my_cid;
                  broadcast cluster (my_id, my_cid);
                          = Γ-{my_id};
}
  }
      If (Γ= =∅) stop;
        }
        }
```

5.2 Adaptive Clustering in Wireless Network

This section discusses how to extract position and distance information from the remaining energy data. This system provides an adaptive grouping approach based on a range of learning findings. It's worth mentioning that the proposed adaptive clustering approach [26] doesn't make any assumptions about the data.

- Each sensor's position information,
- Localization capability and precision,
- The current power level used at each sensor
- Cluster initialization techniques;
- Cluster formation algorithms;
- Cluster shape;
- Channel quality and path loss;
- Topology, homogeneity, and synchronization;

Only the remaining energy information from each sensor is required for the recommended technique. Because manifold learning is nonparametric, the distance is nonparametric, or the "virtual" topological data obtained here "distance," implying that the data has already accounted for the effects of a number of random factors, such as terrain, interference, shadows, and other factors that can have a significant impact and are analyzed in various clustering methods.

The algorithm delivers a multidimensional data set containing a series of multidimensional remaining energy data samples from each node in the network. The method develops a collection of new cluster heads, one for each cluster, based on a variety of learning results. As a result, in the next round, the node in each cluster with the lowest Y-coordinate in its embedding will be chosen as the new cluster head. The adaption interval, which should be properly defined, is referred to as "round." If it's too long, the proposed adaptive clustering algorithm won't be able to capture network dynamics; if it's too short, the proposed adaptive clustering algorithm won't be able to capture network dynamics; if it's too short, there will be a lot of overhead. The actual operation of a wireless sensor network usually determines this value. It's important to note that this study only looks at cluster adaptation inside a single cluster. The following is a synopsis of the adaptive clustering algorithm we recommend.

The Proposed Adaptive Clustering Algorithm

The remaining energy data E, which is a multidimensional data collection, is used as an input

The collection of cluster heads H, which is a two-dimensional data set, is the output

Step 1: Find the two-dimensional embedding using the proposed manifold learning approach

Step 2: In the next round, choose the node with the lowest Y-coordinate of its embedding as the cluster head for each cluster

Step 3: After all new cluster heads have been derived, the inter-cluster routing table must be changed

Step 4: When the next round arrives, return to Step 1

5.3 Adaptive Clustering in IoT

Enormous amounts of real-time streaming data have been generated as a result of the Internet of Things (IoT). Effective approaches are required to process IoT data streams. To develop conclusions and take action based on observations and measurements made in the real world. The application or domain is the basis for the bulk of modern approaches that are analyzed. This defines the number of probable clusters that can be detected based on the data distribution in a stream based on the result of the option. Use an online clustering algorithm to reduce the number of clusters. Our technique for classifying the data coming in from the streams is as follows: It adjusts as the data changes to stay adaptive to drifts. Our approach is compared to cutting-edge stream processing. On data streams containing data drift, clustering methods are used. In this proposed system adaptive clustering strategy can be applied in a real-world situation for efficient data analysis [27]. Data on traffic that is practically real time. Clustering algorithms are employed on data streams with data drift.

Algorithm Steps

Step 1: The data streams from the IOT network are first evaluated.

Step 2: Mine the data using the best fit clustering technique.

Step 3: At first, the adaptive clustering algorithm measures performance on a regular basis. If the performance falls below the threshold, the process returns to Step 2 and examines and describes the data streams once more.

Step 4: Keep using the clustering algorithms to create data clusters.

Step 5: stop.

5.4 Adaptive Clustering in Cloud

This work [28] addressed the issues of adaptive cluster selection in wireless cloud computing systems with physically distant resources. The need for cluster selection that is network-aware has been established and justified. For example, suppose you have a wireless network with a variety of different circumstances where bandwidth is limited, and you need to serve cloud services.

In this system created a new feature for clients who are aware of the network which is shown in Fig. 4. Path-measurement and-reporting protocol that updates bandwidth to clients in real time while maintaining acceptable precision over multi-hop paths. Encryption boundaries, including those now used by the industrial sector [29]. The lab has validated the protocol's operation and application based on cluster selection.

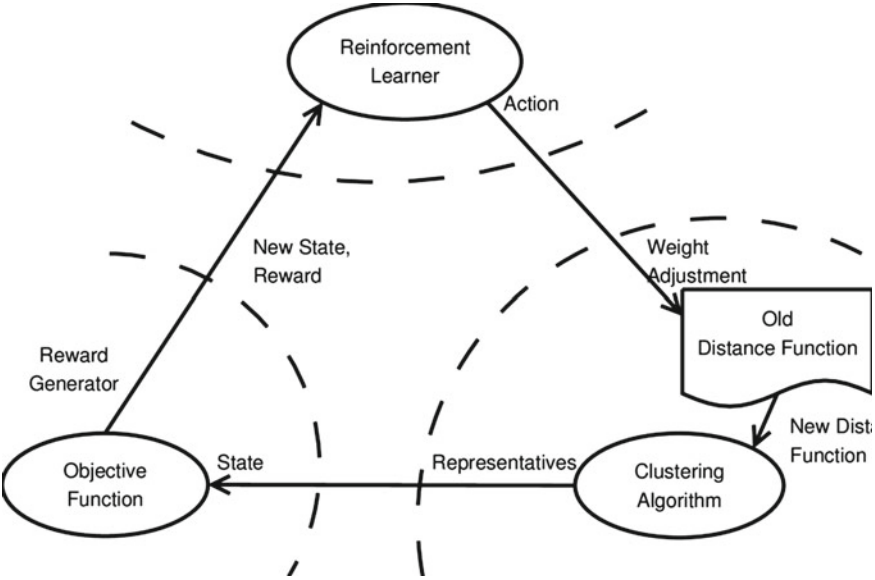

Fig. 4 Processing of adaptive clustering in cloud

5.5 Role of Clustering in Machine Analytics

The effectiveness of the proposed CPS structure depends on the performance of the clustering data analysis services implemented at the cyber level [30]. The cyber level is in charge of autonomously synthesizing, learning, and accumulating system knowledge based on data collected from a set of machines. It serves as a link between lower-level data collecting and higher-level cognition activities. System information includes possible operating regimes, machine condition, failure mechanisms, and degradation patterns, which are used by cognition and reconfiguration functions for optimization and failure avoidance. Due to the intricacies of machine design and usage patterns, autonomous data processing and machine learning are a top concern, as the traditional ad hoc algorithm method can only be used in challenging or even unpredictable conditions.

This system also presents an adaptive computation methodology to speed up clustering by shedding burden based on the characteristics of the incoming data process are shown in Fig. 5. The suggested approach for real-time data stream clustering is accurate and efficient, according to experimental results.

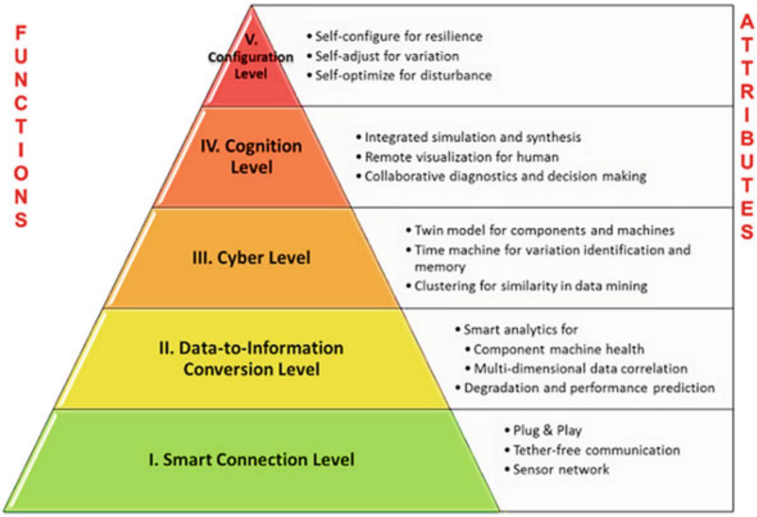

Fig. 5 Architecture for clustering in machine analytics

5.6 Importance of Adaptive Clustering for Self-aware in Machine Analytics

Self-adaptation is divided into seven "waves" in a recent novel [31], each of which emphasizes important study fields from the previous two decades that have contributed to the existing corpus of knowledge. The seventh wave focuses on machine learning approaches in order to improve the implementation of adaptive clustering for self-awareness in Machine Analytics systems. The goal of this paper is to demonstrate how machine learning can be used to support various operations in the MAPE workflow of self-adaptive systems, with three use examples emphasized. The first use case improves a self-adaptive system's monitor function by using a Bayesian estimator to keep a runtime model up to date.

- This simple use case demonstrates how machine learning can help runtime models cope with parametric uncertainty.
- The second use case adds a classifier to the analyzer function, which minimizes large sets of adaptation possibilities at runtime, boosting the efficiency of the self-adaptation analysis phase [32].
- This use case highlights how learning can help self-adaptive systems cope with their increasing complexity. Finally, to improve various feedback loop features, the third use case employs a learning technique that employs adaptive clustering for self-awareness to update and improve the auto-scaling rules of a cloud infrastructure at runtime.
- This use case highlights how machine learning can help self-adaptive systems make decisions in the face of a variety of uncertainties.

6 Result and Discussion

The purpose of our simulation is to examine the proposed Adaptive clustering for self-aware in Machine Analytics. A repetitive environment is constructed in NS-2, which is then used as a semantic command language tool. As a result, the sophisticated Tool Command Language (TCL) has a significant advantage. All network simulations will employ the proposed method, and all code will be written in TCL script. Based on the simulation findings, a predetermined output is obtained.

Table 3 describes the node whitespace simulation parameters analysis and uses the energy-aware spectrum frequency based on resource allocation in the proposed algorithm Adaptive Clustering for Self-Aware (ACSA). It provides better performance compared to the existing algorithm.

Table 4 shows the energy consumption that lowers the amount of node failure energy-consuming node spaces, and it is better to use the proposed way to consume energy.

Figure 6 shows the Energy Consumption Analysis of the Level of Node Energy; it decreases or consumes node energy based on a comparison of the proposed and existing methods; the present technique Firefly consumes 69 J, and the proposed method ACSA consumes only 58 J to reduce node energy.

Table 5 shows that the latency is improving the performance of node space and is considered a problem by measuring the improvement of the amount of threshold within time.

Figure 7 shows the network lifetime based on node spaces; it examines increasing the amount of packets sent in the node while maintaining the same time. Based on

Table 3 Simulation parameters for the proposed method

Parameter	Value
Simulation tool	Network simulator (NS-2), Cygwin
Packet size	512 kb
Transferring packets	150
Algorithm	Adaptive clustering for self-aware (ACSA)

Table 4 Analysis of the energy consumption

Num. of. packets	Firefly (Joules)	Bee colony (Joules)	ACSA (Joules)
20	36	32	30
40	50	44	40
80	65	53	50
120	67	60	55
150	69	61	58

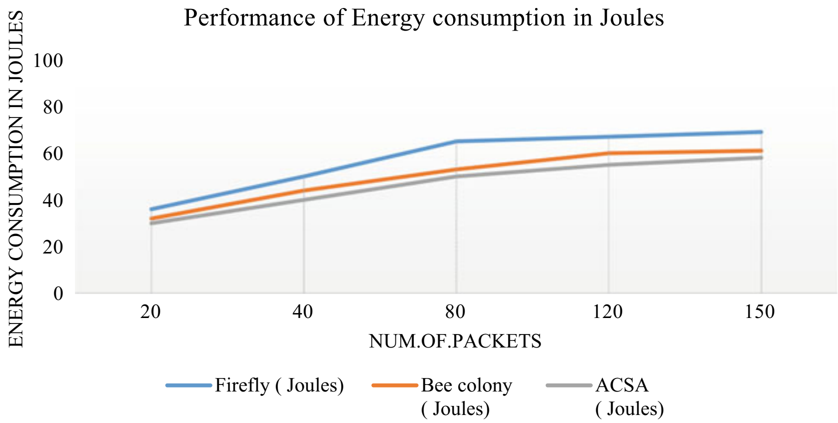

Fig. 6 Analysis of the energy consumption

Table 5 Analysis of the network lifetime

Num. of. packets	Firefly (Joules)	Bee colony (Joules)	ACSA (Joules)
20	33	35	38
50	34	37	42
80	36	38	48
120	40	42	52
150	41	47	59

the above graph the proposed ACSA produces efficient results compared with the conventional techniques.

Table 6 shows the throughput performance analysis of the performance test and the amount of data to be moved from one node to another neighbor node specifies that the period is increasing, and the analysis of the overall performance is compared between existing and proposed methods.

Figure 8 shows the Throughput performance when comparing one-to-one communication between nodes. A comparison is made between the suggested and existing methods. Firefly gives 80% throughput, Bee colony provides 85% throughput, however, the suggested approach ACSA delivers a better performance by offering 87 percent throughput improvement for nodes in the network.

The packet delay performance is shown in Table 7 based on the average delay and time to transmit data packets from the source node to the destination node. This delay equals node processing and the time of occurrence of data packets when comparing the previous and proposed approaches, and the interval between the last bits arrives is called the average delay time.

Figure 9 shows the Packet delay performance by reducing the delay to send and receive packets between the nodes, the delay performance is compared between the

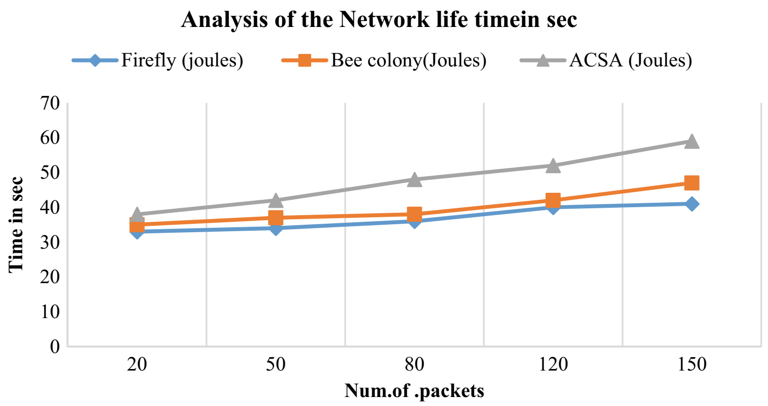

Fig. 7 Analysis of the network lifetime

Table 6 Analysis of the throughput performance

Num. of. packets	Firefly (Joules)	Bee colony (Joules)	ACSA (Joules)
20	66	71	73
50	70	75	80
80	75	80	83
120	77	81	84
150	80	85	87

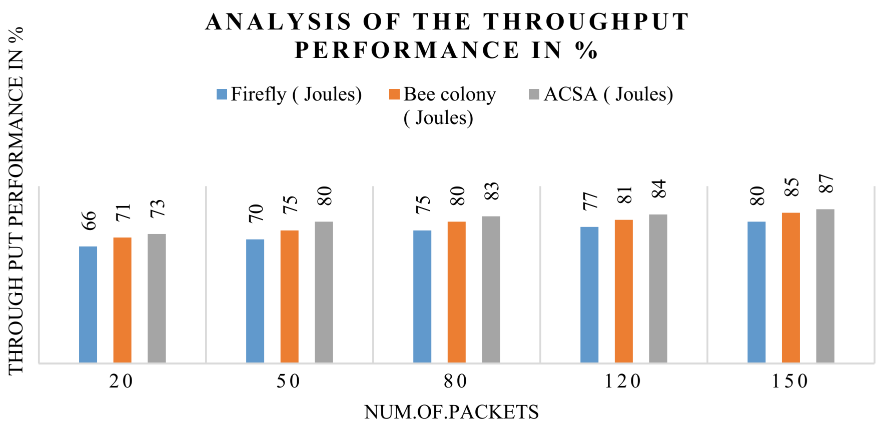

Fig. 8 Analysis of the throughput performance

Table 7 Analysis of the packet delay performance

Num. of. packets	Firefly	Bee colony	ACSA
	(Joules)	(Joules)	(Joules)
20	27	22	20
50	34	30	28
80	40	36	34
120	45	41	39
150	54	50	45

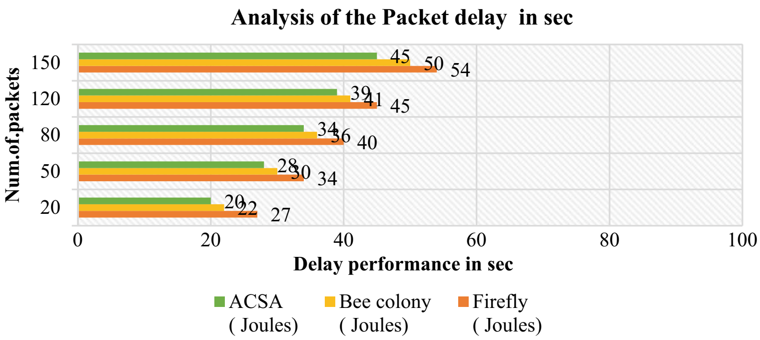

Fig. 9 Analysis of the packet delay

existing and proposed method. As shown in the graph above, the proposed ACSA provides better outcomes when compared to traditional approaches.

7 Conclusion

From the data analysis, the first process for assisting designers who want to use machine learning to create adaptable cluster self-aware in machine analytical systems was identified. As we learn more about the role of learning in self-adaptation systems, to build an open technique that may be expanded with new understanding. The newly deliberated "clusters-Industry 4.0" alternative pathways should be found and discussed. For example, the role of uncertainty reduction and the value of adaptive self-aware clustering techniques may deserve research studies. Finally, the idea that clusters might simply emerge as a result of an Industry 4.0-triggered transition, should be investigated in this system discussed a number of promising areas for future research, managing effect uncertainty, dealing with open world changes, dealing with data distribution and heterogeneity, determining the bounds on guarantees for machine learning-implemented adaptation goals, applying transfer learning to related problems, and finally dealing with more complex adaptation goals To hope that the results of this comprehensive study will encourage researchers to look into these and other topics in this interesting field.

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Chapter 4
Managing Healthcare Data Using ML Algorithms and Society 5.0

D. Anupama, A. Ravi Kumar, and D. Sumathi

1 Introduction

The healthcare sector has attracted many researchers, and businesspeople worldwide since it is found to be prosperous and applicable to making use of AI tools and methodologies. Deployment of AI/ML tools increases the value of the process and thus leads to the enhancement in automation quality. Moreover, the decision-making process in primary/tertiary patient care, as well as public healthcare systems, could be made intelligently. AI could be used on a variety of structured and unstructured datasets healthcare datasets (structured and unstructured). Cancer, neurology, and cardiology are three major illness areas that use AI techniques. Tremendous progress in the big data analysis methodologies results in improving the effective usage of AI in healthcare.

Such novel predictive techniques are beginning to revolutionize several aspects of clinical treatment, including laboratory medicine practice. Many of these ML methods & investigations are beginning to appear in our literary landscape as we know it, but the average reader's lack of interaction with basic AI/ML knowledge and critical concepts has necessitated the need to better prepare the audience for such rather foreign concepts. A basic comprehension of such platforms will certainly improve cross-disciplinary literacy, resulting in improved integration and understanding of such technologies inside our profession. We present a comprehensive review of AI/ML in this chapter, as well as an explanation of the key ideas of ML

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categories, including supervised, unsupervised, and reinforcement learning. Furthermore, because most of our current ML techniques in laboratory medicine and healthcare use supervised algorithms, we will primarily focus on such platforms. Finally, the need to make such tools better accessible to the typical investigators is fueling the demand for automation within these machine learning systems.

The influence of Industry 4.0 on the medical management system will also be investigated in the present study. In Industry 4.0, the healthcare system is primarily reliant on automation and the fast-moving Internet is bringing about variants in the medical system that are both productive and efficient. In the recent decade, the key study areas in Industry 4.0 have been healthcare systems, cloud computing, and digital technology. The technologies and services affected by Industry 4.0 have considerably enhanced healthcare. The study's findings suggest that Industry 4.0 is considerably improving healthcare standards. Many new technologies, such as blockchain, big data, cloud computing, and IoTs, are enabled by Industry 4.0 to track patients' medical records. This makes it easier for healthcare providers to comprehend the patient's history and respond appropriately. The results of Industry 4.0 and the healthcare system are depicted in Fig. 1. Some obstacles, such as transferring electronic health records, persist in the framework of primary health systems and have yet to be resolved.

The healthcare system is extremely reliant on digital technology in Industry 4.0, and high-speed Internet is bringing about improvements that are productive and efficient. Society 5.0 expands on the concept of Industry 4.0 by considering current

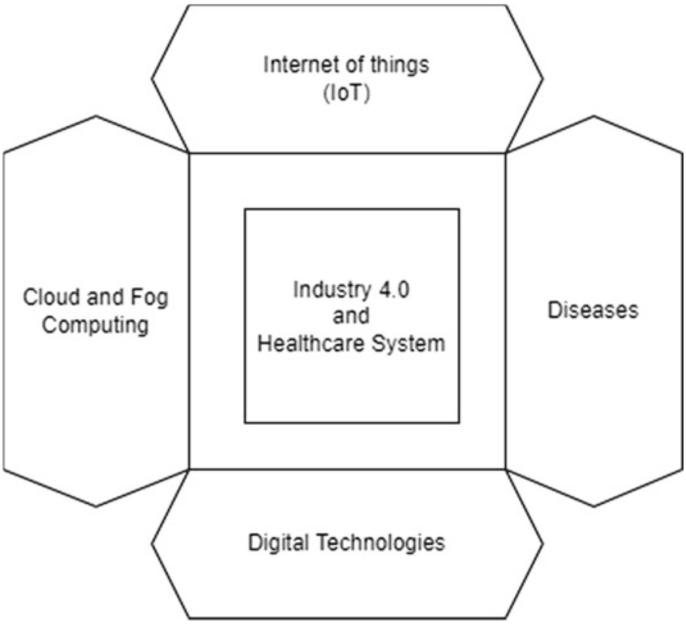

Fig. 1 The healthcare systems and industry 4.0's outcomes

social and technological challenges to humanize and expand it beyond the technological, organizational, and economic transformations of industrial production based on cutting-edge scientific and technological developments. The problems with the digitalization of the economy, particularly in the Healthcare industrial sector, stimulate the research interest of different scientists.

As a result, the primary goal of this chapter is to identify possibilities and challenges for adopting Industry 4.0 and Society 5.0 principles in public health preventative programs. We used a cancer survey in this investigation, which included questions about family and personal histories of the three most common skin cancers (BCC, SCC, and melanoma), as well as risk variables established through a review of current skin cancer literature.

2 Skin Cancer

The epidermis, dermis, and subcutis are the three layers that make up the skin, which is the biggest organ in the human body. The skin and its appendages are shown in Fig. 2.

2.1 *Human Skin Cancer*

Skin cancer is the third most prevalent carcinoma in humans [2]. Skin cancer is divided into two types: melanoma and non-melanoma. Melanoma develops in melanocytes, while non-melanoma develops in keratinocytes. Although it is not the most common type of cancer, melanoma seems to have a significant fatality rate. Fortunately, most skin malignancies can be treated with surgical intervention

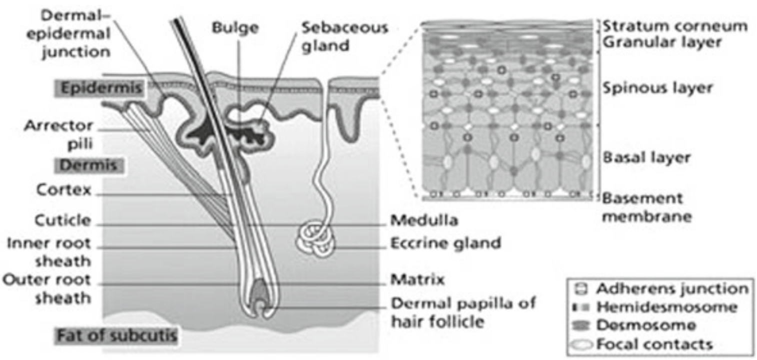

Fig. 2 The skin and its appendages [1]

if caught early enough. The much more common cause of skin cancer is ultraviolet radiation (UV) from sun exposure. Sunburns and prolonged exposure to the sun create cumulative damage, that leads to immunosuppression as well as the development of skin malignancies. The progression of both kinds of cancers is described in the chapter that follows.

The malignant alteration of melanocytes or associated progenitor cells is known as melanoma. Although it is one of the most common kinds of skin cancer. This is a very awful disease produced by Ultraviolet DNA methylation that accounts for a significant portion of all melanoma cases. The incidence of cutaneous melanoma is increasing at a considerably quicker rate than that of other solid malignancies, which may be attributable to greater natural Ultraviolet rays exposures to pale white epidermis (particularly intense, intermittent exposure) [3]. To detect melanoma, one must examine the complete surface of the skin. The "ABCD" criteria, which identifies the presence of Asymmetry, Border irregularity, Color patterns, and Diameter, is a widely used rule for identifying melanoma. Due to the scarcity of clinical data, this results in high-dimensional feature spaces that are computationally expensive and sparse.

One of the familiar forms of epidermis cancer among fair individuals is non-Melanoma skin cancer (NMSC or keratinocyte carcinomas), which comprises Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC) [4, 5], with Australia having the world's highest NMSC incidence [6]. NMSC, on the other hand, has a low risk of mortality when discovered early. Both BCC and SCC are caused by keratinocytes, UVB (ultraviolet B) and UVA (ultraviolet A) rays damage DNA and RNA, resulting in cancer, as well as changes in the DNA repair mechanism and immune system [7]. BCC is the most common kind of skin cancer, accounting for more than 80% of all cases. There are four types of Basal cell carcinoma (BCC). Basal cell carcinomas are colored, irregular, externally spreading, sclerosing tumors.

(a) Nodular basal cell carcinoma manifests medically as a transparent nodule with prominent telangiectatic arteries.

    The most common location for shallow spread of basal cell carcinoma is the top back. It consists of superficial tumors that come in various colors from reddish to nearly skin tone and grow over time.
(b) Sclerosing basal cell carcinoma is a common diagnostic stumbling block. The early stage of the lesion may appear as a little white scar on the skin. This scar-like region gradually grows larger.
(c) Non-whites, especially Asians, are more likely to develop pigmentation basal cell carcinoma.

2.2 Obstacles to Detecting Skin Lesions

Because of the differences in picture type and source, diagnosing skin lesions can be difficult. The following are some of the challenges:

- Different shapes.
- The existence of artifacts and noise
- Borders that are hazy and uneven.
- The contrast is low.
- Lighting in different colors.

According to Robbins, more people have developed cancers in the last 30 years than all the other malignancies combined; he also claims that 1 in 5 people will develop skin cancer in their lifetime. According to Robbins, one person has died from melanoma every hour, and while melanoma accounts for less than 1% of all skin cancer occurrences, it is responsible for many skin cancer-related deaths. Excessive exposure to the sun is responsible for 86 percent of melanomas, and a person's chance of developing melanoma doubles when he or she has had several sunburns. The statistical analysis is shown in Fig. 3.

Medical image processing is a technique for diagnosing that involves employing radiation, radio frequencies, and sound waves to show the inside or exterior of the body in visual form. One such topic is Artificial Intelligence (AI), which focuses on automating clinical diagnosis through the development of complicated algorithms and has the potential to outperform human experts. The Artificial intelligence system employs a variety of strategies that allow algorithms to learn from data iteratively. Machine Learning is the term for this type of learning (ML). Early detection is the most efficient strategy to prevent an increase in skin cancer. Early detection is possible because of the use of machine learning (ML) algorithms in the detection of symptoms of skin cancer.

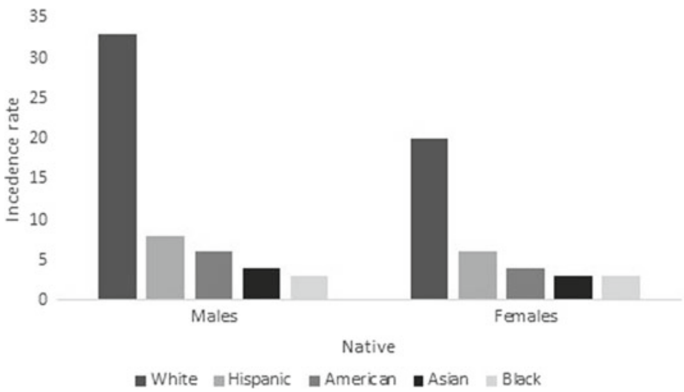

Fig. 3 Melanoma of the skin representation by ethnicity and race

2.3 Literature Survey

Numerous approaches have been developed to handle the complete melanoma detection process. The authors of [8] employed the rule asymmetry, border, color, and diameter (ABCD) to examine the border and color of skin lesions. They used a Multi-Layer Perceptron Network (MLP) with a backpropagating algorithm trained to classify the features. Gabor filter along with active contours was used to improve the image and remove hair [9]. After that, features were extracted using the ABCD scoring approach. Finally, to classify lesions, a combination of known approaches was applied. The authors of [10] categorized melanoma into three categories considering lesion width. Two categorization schemes are classified: the earlier lesions are classified as the thinnest and the deep, while the second is divided into thinnest, moderate, and deep categories. For categorization, they used a combination of logistic regression and artificial neural networks. Skin tears are improved with various filters on every RGB image independently in [11]. Ultimately, a deformable model was used to partition these tumors. Oliveira et al. [12] proposed a Chan–Vase model-based segmentation method. An isotropic material diffusion coefficient filter was employed to improve images before ABCD was utilized for feature extraction from the segmentation regions. A support vector machine was used to classify these characteristics (SVM). The authors of [13] suggested a categorization approach for BCC and MELANOMA based on paraconsistent logic (PL) and two-value annotation. The levels of evidence, formation patterns, and diagnosis comparability were all extracted. To distinguish among normal, MELANOMA, and BCC, spectra values of 30, 19, and 96 were utilized. Pennisi et al. [14] employed a Delaunay-Triangulation(DT) to recover the binary image of ROIs. The authors of [15] employed intensity profiles to classify only two lesions after segmenting the histopathology images by removing the granular level border.

Odeh et al. [16] summarizes a comparison of four classification systems for skin tumor diagnosis to select the optimum strategy. The researchers of [17] integrated multiple Fourier transforms (2 or 3) features to generate a Z-Transform feature based on the histology of BCC. To classify skin psoriasis, a Computer-Aided system based on principal component analysis (PCA) and support vector machine is developed in [18]. In [19], a framework for BCC segmentation was presented. Using k-means, the hemoglobin component was clustered. The grading approach of skin cancer in [20] was based on a 3D reconstruction of thick lesions. For segmentation and classification, they used stereo vision, adaptive snake, structure from motion, and depth from focus.

A self-generated neural network was used to extract the lesion [21]. Then the borders, texture, and color aspects that were descriptive were deleted. Finally, based on the collected features, the lesions were identified using an Ensembled Classifier network with fuzzy set neural network models including backpropagation (BP) networks. [22] employed a fixed grid wavelet network to enhance and segregate skin lesions. Following that, D-optimality orthogonal matching pursuit was used to classify these characteristics. Khodadadi et al. [23] used the Lyapunov exponent and

Kolmogorov–Sinai entropy to assess the uneven intervals on a chaotic time series investigation on both boundaries of an infected skin lesion. Roberta et al. [24] developed an input image diagnosis based on feature manipulation using an ensemble model. Przystalski et al. [25] proposed fractal algorithms for multispectral lesion characterization. Using the k-means and Grab-Cut algorithm, Jaisakthi et al. [26] devised the skin lesion segmentation approach.

A technique for automatically segmenting and classifying skin lesions was proposed by Akram et al. [27]. Linear Discriminant Analysis(LDA), HOG, ABCD, pairwise threshold binary decomposition, and fuzzy C-means were among the approaches used by the researchers. Jamil et al. [28] presented a method for detecting skin lesions. Finally, lesions were classified using color, structure, Gabor wavelets, and GreyLevel intensity data. Khan et al. [29] created a Bhattacharya distance(d)and Variance(V)-based, Entropy-based approach for skin mole diagnosis & categorization.

Tan et al. [30] improved Particle Swarm Optimization (PSO) to optimize epidermis lesion features. The writers updated duo PSO models using distinguishing features extraction, the foremost of which performed a universal search by merging mole attributes and the second of which performed a deep local search by dividing lesions into particular sections. Random acceleration coefficients were the subject of the second modified PSO. Following that, these characteristics were categorized using several classification methods. Tajeddin et al. [31] used highly discriminative characteristics to classify skin melanoma. For segmentation and classification, they started with boundary propagation. Lesions are projected via log-polar capacity by increasing Daugman's transformation to identify characteristics based on the periphery. Ultimately, the performance of several classifiers was compared.

Sabbagh et al. [32] proposed QuadTree(QT) for lesion color perceptron. Melanoma comes in three colors: blue-gray, black, and pink, according to the researchers. Finally, they used a variety of classifiers, including ANN, SVM, LDA, and RF (random forests), among others (RFs). Watershed segmentation was used by Murugan et al. [33] to obtain ROI. ABCD and GLCM were used for the extraction of features. Lastly, KNN, RF, and SVM were used to classify these characteristics. Khalid et al. [34] proposed utilizing a mix of wavelet transform and morphological techniques to segment dermoscopic skin lesion images.

Chatterjee et al. [35] used Fractal-based Regional Texture Analysis (FRTA) to identify three lesions using SVM with RBF by extracting form, fractal dimension, texture, and color variables. Color, orientations histogram of gradients location of skin lesion characteristics were retrieved by Upadhyay et al. [36]. Using an SVM, these traits were combined and classed as benign or cancerous (Tables 1 and 2).

- N-G is short for Not Given
- MEL means Melanoma
- NMEL means non-Melanoma
- SE means Sensitivity
- SP means Specificity.

Table 1 Literature survey on skin cancer

Features	Classifier	Datasets	MEL	NMEL	ACC	SEN	SPEC
Irregularity, asymmetry & color	Supervised	NewYork Univ	135	46	81	N-G	N-G
Color, pattern & geometry	Supervised	Solar scan	382	2048	N-G	91	68
Shape, color & text	Supervised	Dermoscopy atlases	88	476	N-G	92.3	93.3
CH & MFH	Supervised	V.G. hospital	102	5278	82.6	N-G	N-G
Asymmetry	Supervised	Dataset	88	263	83.4	86.4	82.1
Parameters of MRF	Statistics	Interactive atlas of dermoscopy	128		78.4	N-G	N-G
Shape & color	Supervised	V.G. hospital	102	5278	N-G	99	71

- First, while Malignant Melanoma is linked to UVR exposure, the body site distribution of Malignant Melanoma differs from that of other sun-related malignancies such as squamous cell carcinoma (SCC) of the skin. The lack of a precise description of persons of color is also a major gap discovered.
- Second, like with other human malignancies, SCC rates rise exponentially with age. Another gap highlighted is dermatologists' prevalent misconception that persons of color do not engage in tanning activities and are therefore not at risk of UV-induced skin cancer. The third gap discovered is individuals of color's mistaken perception that darker pigmentation gives "complete immunity" toward skin cancer.
- This myth could be dispelled by using social media to raise awareness about the danger of skin cancer in people of color, as well as the importance of greater UVR protection, skin cancer screening tests, and early detection of any developing skin lesion. Furthermore, partnerships with governmental and healthcare advocacy organizations should be developed to push for the implementation of skin cancer preventive measures for people of color in the current healthcare system.

Overall, putting these recommendations into action will help to close such gaps, which will have a considerable positive impact on the future treatment of skin cancer for all persons of color. The proposed model uses some optimization techniques that will give more efficient and accurate results (Table 3).

- HCS-Healthcare Systems, BCT-Block Chain Technology, VM-Virtual Machines, MR- Medical Records, IoT-Internet of Things

The existing methodologies of machine learning have classified the features extracted from the dataset. In a modified model the features are also reduced to comprise the classification and improve the accuracy.

Table 2 A comparison of skin cancer detection using CNN [37, 38]

Author	Methods	Algorithm	Dataset	Description	Results
Ali et al,	Binary skin classification (Ben/Malig)	Lightnet (DL framework)	ISIC dataset	Less parameters, most suitable for mobile apps	Acc: 82, Sen: 15, Spec: 98
Esteva et al.	Ben/Malig, keratinocyte carcinoma/ Ben	Convolutional neural network	ISIC images	Expert-level performance	Acc: 72
Shoieb et al,	Mel/NMel	Pre-trained CNN- SVM	DermIS, DermQuest datasets	Noise removal: median filter CNN: feature extraction	Acc: 94
Harangi et al,	Malig Mel/ SK/Nevus	Convolutional neural network	ISIC 2017	Combining AlexNet, VGGNet & GoogleNet	Acc: 98.48
Mandache et al,	BCC/NBCC	Convolutional neural network	40 FF-OCT images	Features extracted using CNN with 10 layers	Acc: 96, Sen: 95, Spec: 97
Sabouri et al,	Can/Noncan	CNN	Approx. 1800 skin lesions	Edge detection	Acc: 86.67
Hasan et al,	Ben/Malig	Convolutional neural network	ISIC	Features extracted using ABCD rule	Acc: 90
Rezvantalab et al,	Multi skin lesions	Deep convolutional neural network	PH2 & HAM10000	Deep learning models	ROC AUC 98.79–98.16
Nida et al,	Lipoma/ fibroma/ sclerosis/ melanoma	Deep Convolutional Neural Network & fuzzy C means	ISIC dataset	RCNN and FCM gave more accuracy	Acc: 94.8 Sen: 97.81 Spec: 94.17
Mahecha et al,	Malig/Ben	Deep CNN	ISIC dataset	The system effected due to image illumination	Acc: 76
Attia et al,	Mel/NMel	Hybrid CNN	ISIC dataset	The proposed model beat the FCN	Acc: 98 Sen: 95, Spec: 94

(continued)

Table 2 (continued)

Author	Methods	Algorithm	Dataset	Description	Results
Albahar, et al,	Ben/Malig	2-layer Convolutional neural network with regularized	ISIC dataset	Proposed regularization technique	Acc: 97.49 Sen: 94.3, Spec: 93.6
Namozov et al,	Multi-Class	Deep CNN	ISIC dataset	An adaptive piecewise linear activation function	Acc: 95.86
Singh et al,	Ben/Malig	Convolutional neural network	ISIC dataset	Data augmentation	Acc: 80

* Ben—Benign, Malig—Malignant, Mel—Melanoma, Nmel—NonMelanoma, NBCC—NonBCC, Can—Cancerous, NCan—NonCancerous

Table 3 Literature survey on industry 4.0 on healthcare [39]

Authors	Classifications	Segments	Type
Parekh et al, [40]	HCS	BCT	MR
Persico et al, [41]	HCS	Information and Comm Tech (ICTs)	Industry 4.0 paradigm
Nauman et al, [42]	HCS	Medicine 4.0	Artif Intl (AI)
Tanwar et al, [43]	HCS	Healthcare 4.0	Healthcare 4.0
Distefano et al, [44]	HCS	(IoT)	Healthcare industry
De Falco et al, [45]	HCS	Internet of things technologies	Photoplethysmography
Moffie et al, [46]	HCS	Patients' data	Healthcare industry architecture
Abdelaziz et al, [47]	HCS	IoT	VM

3 Methodology

An enhanced clustering technique has been developed in the proposed method, which effectively isolates lesion borders with feature extraction. It also has feature reduction to reduce the model burden. The advantage of the proposed method is that skin cancer detection can be performed using dermoscopic images captured by an ordinary camera. This proposed work can be applied in an uncomplicated manner for telemedicine or remote monitoring since dermoscopic image-based skin cancer detection is suggested. The flow representation of the proposed methodology is shown in Fig. 4.

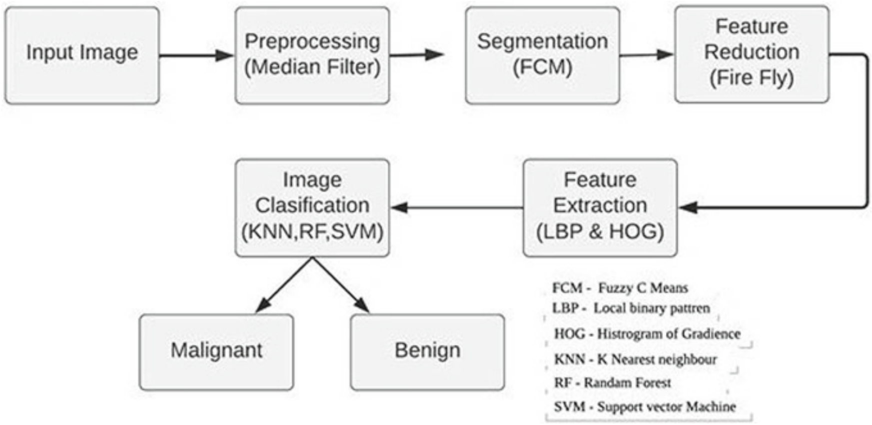

Fig. 4 Block diagram of proposed work

Our Approach is Divided into Three Stages:

Phase 1–The very first phase entails gathering datasets; images are gathered first from the ISIC dataset (International Skin Imaging Collaboration). Preprocessing of the images is also a part of it that involves image color and size conversions, noise removal, as well as other artifact removal, are all included.

Phase 2–In this phase, it consists of the segmentation and feature extraction; Again, for the preprocessed image, segmentation is possible. using fuzzy C means algorithm and features are extracted using LBP and HOG.

Phase 3–This is the most crucial step of our models; it entails both model design and training. Upon that dataset obtained in phase 1, our model has been trained for SVM, RF, and KNN. After training, the model was assessed for accuracy.

3.1 Image Preprocessing

Because it has a very large impact on the picture segmentation step, image preprocessing is an important part of the image processing process. The accuracy of the proposed methodology may be harmed if an image has noise and is not enhanced. As a result, the preprocessing stage must be carefully monitored. Preprocessing entails taking an image as an input, converting it to grayscale, noise filtering, and generating a binary picture. These methods include contrast adjustment, which extends an image's histogram for increased clarity; intensity correction, which increases an image's intensity values to produce an output image with a high-quality display; and histogram equalization, which evenly distributes pixel intensities across the entire range of intensities intending to expand the global contrast of images. The Median Filter is employed in this process.

3.2 Median Filter

The median filter [48] is used to eliminate noise from images and is a nonlinear digital filter since it keeps the image's edge while removing noise. Grayscale images are created by converting RGB images to grayscale images, which contain only intensity values and are commonly utilized by digital systems. (ii) The grayscale image was subjected to median filtering to remove noise and improve the image of the skin lesion; the median-filtered image was then used to identify and eliminate hair. The median filter is calculated by Eq. (1).

$$I'(u, v) \leftarrow median\{I(u + 1,\ v + j)|(i, j) \in R\} \quad (1)$$

3.3 Lesion Segmentation

Image segmentation is the process of categorizing and dividing image pixels into multiple groups or areas based on their pixel values. Based on some resemblance, each pixel of an image is assigned to one of the zones. (i) pixels in one region with almost comparable pixel values (ii) pixels in the next region with distinct pixel values are among the segmentation steps. The skin and lesion regions are segmented using a clustering-based technique.

FCM (fuzzy C-means) is a clustering algorithm that allows an individual piece of data to belong to two or more clusters. The multi-valued logic of fuzzy logic is derived from fuzzy set theory. Because of these factors, the FCM was used to partition an image into skin and mole areas in this study. The mole region is then partitioned by itself using the cropping technique.

The fuzzy C means the algorithm divides a bunch of pixels into two or more clusters using the following objective Eq. (2). Because the image has only two regions, epidermis and lesions, that comprise the mole, the number of clusters is two. The FCM's primary function is given in Eq. (2):

$$\mathrm{F_m} = \mathrm{P^j}_{\mathrm{mn}}\left|\left|\mathrm{x_m} - \mathrm{c_n}^2\right|\right|1 \leq \mathrm{j} < \infty \quad (2)$$

where j can be any number between one and one, and it must be larger than one, P_{mn} signifies the cluster details of x_m's membership function, x_m denotes the m^{th} point in the d-dimensional measurement values, c_n denotes the cluster's Center, and ||*|| indicates the similarity between both the data and the Centre.

Segmenting is an iterative procedure in which the Center value is updated, and the objective function is processed. The function for updating membership is defined in Eq. (3):

$$P_{mn} = \frac{1}{\sum_{k-1}^{c} \left(\frac{||x_m - c_n||}{||x_m - c_n||} \right)^{\frac{2}{j-1}}} \tag{3}$$

The following Eq. (4) is the updated Center value:

$$C_n = \frac{\sum_{m-1}^{N} P_{mn}^{j} x_m}{\sum_{m-1}^{N} P_{mn}^{j}} \tag{4}$$

When the system reaches its maximum number of iterations, it will stop as said in Eq. (5):

$$max_{mn}\left\{\left|P_m n^{(k+1)} - P_m n^{k}\right|\right\} < \varepsilon \tag{5}$$

where "ε" stands for the halting condition and the value ranges from 0 to 1. The iteration steps are denoted by the letter "k." The iterations will eventually come to a halt at a saddle point. The FCM's output is a black-and-white segmentation input image that depicts two different regions: skin and mole. The mole region is then manually clipped in preparation for feature extraction.

3.4 Feature Extraction

3.4.1 Local Binary Pattern (LBP)

The following approach is used to calculate the LBP feature vector:

- It segments the images into cells.
- Each pixel value is compared with neighbors in either a clockwise or anti-clockwise direction.
- A feature's point will be 0. The value of the central pixel is higher than the value of the bordering pixel in this case; otherwise, it is 1. Because the 8-neighboring technique is utilized, the result is a binary number.
- This number in binary is normalized and turned into histogram bins.
- The feature vector was determined from the cell's normalized histogram bins.

To compute the LBP code, for each pixel p, the 8 neighbors of the central pixel are compared with the pixel p, and the neighbors x are assigned a value of 1 if x ≥ p. The calculation is shown below in Fig. 5.

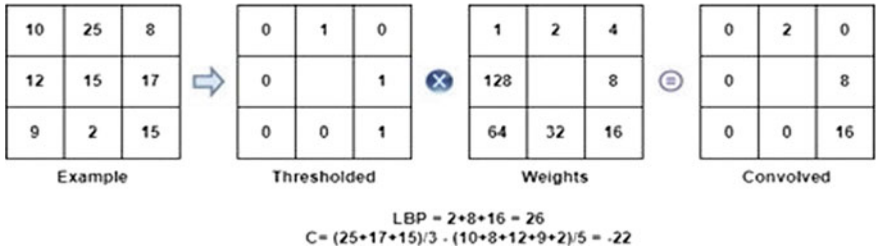

Fig. 5 LBP calculation

3.4.2 Histogram of gradients (HOG)

In recognizing the items from the image, use the feature descriptor histogram of directed gradients. It is determined by the presence of gradients orients in an image's region. Gradient computation, orientations L1-normalization, binning, and block descriptor are the steps involved in a HOG. The feature is fully recognized based on the lesion area using Eq. (6).

$$cdf(x) = \sum_{k=-\infty}^{x} P(k) \tag{6}$$

3.5 Feature Reduction

An optimization procedure is used to reduce the number of features. The firefly-based algorithm is utilized here. For optimization, the algorithm travels toward the brighter firefly. It aids in determining the classification's more robust feature. The FA's operation is based on the flashing characteristic of a firefly. The flashing of the firefly is used to communicate between the fireflies here. FA is a population-based optimization approach that resembles the attraction of a firefly to a flashing light. A firefly's position Y_i is used to symbolize a solution vector to an optimization approach. At iteration t, the position vector of firefly i is updated by

$$Y_i^{(t+1)} = Y_i^t + \beta_0 e^{(-\gamma)} r_{ij}^2 \left(Y_j^t - Y_i^t\right) + \alpha \in_i^t \tag{7}$$

where $\beta_0 > 0$ is the attractiveness at zero distance, i.e., rij = 0. Even though there is no explicit perfect solution in the equation, the fittest solution is chosen from a population of n solutions at each iteration.

The Firefly's Algorithm [49] is as follows:

- The firefly is initially unisexual, it is attracted to certain other fireflies, though.
- A firefly's brightness is an attracting factor. Different illumination intensities are attracted to one another, and the method continues until the bright firefly is attracted to it. Below Algorithm 1 illustrates the Firefly Algorithm.

Algorithm 1: Firefly Algorithm.

Objective function $f(\mathbf{x})$, $\mathbf{x} = (x_1, ..., x_d)^T$.
Generate an initial population of n fireflies $\mathbf{x}_i$ $(i = 1, 2, ..., n)$.
Light intensity I_i at $\mathbf{x}_i$ is determined by $f(\mathbf{x}_i)$.
Define light absorption coefficient γ.
while (t <MaxGeneration),
for $i = 1 : n$ (all n fireflies)
    for $j = 1 : n$ (all n fireflies) (inner loop)
    if $(I_i < I_j)$
        Move firefly i towards j.
    end if
        Vary attractiveness with distance r via $\exp[-\gamma r^2]$.
        Evaluate new solutions and update light intensity.
    end for j
end for i
Rank the fireflies and find the current global best $\mathbf{g}_*$.
end while
Postprocess results and visualization.

3.6 *Image Classification*

The classification phase is the last step, in which the image is classified as benign or malignant. The term benign refers to a normal image, whereas melanoma refers to a malignant image. SVM, KNN, and the RF technique are three systems that can be used.

3.6.1 Support Vector Machine (SVM) Algorithm

Algorithm: SVM generation algorithm.

Input: Data that has been trained and data that has been tested

Output: Data that has been classified as an output

Step 1: The system is provided the data set.

Step 2: Based on the identified class, features and attributes are categorized.

Step 3: Estimation of Candidate Support Value.

Step 4: If the value of the instance is not null, repeat Steps 1–4 for all instances.

Step 5: The Support Value equals the Similarity of each property instance. Calculate the Total Error Value.

Step 6: Estimate the decision value if any of the instances are less than 0.

Support Value/Total Error = Decision Value

Rep the procedures above until the container is emptied.

End If

3.6.2 Random Forest

It comprises two phases: The first is to combine N decision trees to build a random forest, and the second is to generate predictions for each tree created in the initial phase.

The steps of the algorithm are as follows:

Step 1: At random, select K sample values from the training dataset.

Step 2: Create decision trees for the data points you've chosen once more (Subsets).

Step 3: Determine the number of decision trees you wish to create with N.

Step 4: Repeat the first and second steps.

Step 5: Determine the forecasts for latest data items for each iteration and allocate them to the group with the highest probability.

3.6.3 KNN Algorithm

KNN's operation can be described using the following algorithm:

Step 1: Find the total number of neighbors (K).

Step 2: Determine the Distance measure between these K neighbors.

Step 3: By using the obtained Distance measure, find the K closest neighbors.

Step 4: Measure the number of data points in each of the k nearest neighbors' categories.

Step 5: Allocate the freshly collected data pieces to the most neighboring group.

4 Digital Health Using Federated Learning

Data-driven machine learning (ML) has emerged as a feasible approach to creating reliable and robust statistical models using medical data supplied by current healthcare systems. Because it is held in silos and access to it is restricted owing to privacy concerns, existing medical data is underutilized by machine learning. However, without the right data, machine learning will be unable to reach its full potential and, as a result, will be unable to make the transition from research to clinical practice. This examines the elements that contribute to this problem, looks at how federated learning (FL) [50] can be a solution for the future of digital health, and identifies the problems and issues that must be addressed. As increasingly data from various organizations, including medical institutions, is becoming public, individual patients, medical firms, and the pharmaceutical industry, among others, there has been a spike of interest in healthcare data analytics in recent years. Because of the complexities of the healthcare system and procedures, healthcare data is frequently fragmented. Federated learning is a process of using a central server to train the high-quality shared globalized model using decentralized data spread over numerous clients as shown in Fig. 6. It is mathematically defined in the Eq. (7 and 8).

Federated learning (FL) is a learning paradigm that aims to solve the problem of data governance and privacy by collectively training algorithms without transferring data. FL allows for collaborative insights, such as in the form of a consensus model, without transferring patient data outside of the institutions' firewalls. Instead, the machine learning process takes place locally at each participating institution, with

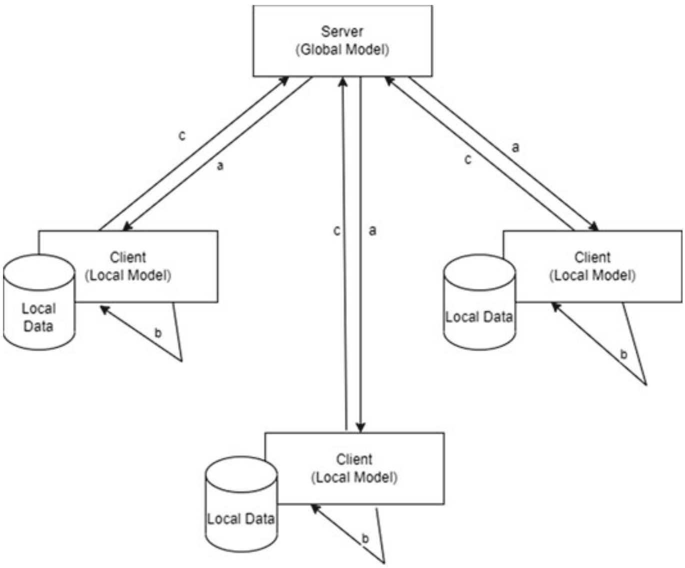

Fig. 6 Federated learning framework

only model characteristics (such as parameters and gradients) being shared. Assume that the data is saved on K-enabled clients (a client could be a clinical institution data warehouse, mobile phone, wearable device, etc.). Let D_k be the dataset distribution for client k, and n_k denotes the sample count of that corresponding client. The Federated Learning is given in Algorithm 1.

The total sample size is n = PK k = 1 n_k. The challenge of federated learning is to solve the problem of pragmatic risk reduction of the form:

$$\underset{w \in}{\text{Min}} \; F(w) := \sum_{(k=1)}^{K} \frac{n_k}{n} Fk(w) \tag{8}$$

$$R^d \text{ where } F_k(w) := \frac{1}{n_k} \sum\nolimits_{x_i \in D_k} f_i(w) \tag{9}$$

The steps below explain the flow of the model illustrated in Fig. 6

Step 1: Broadcast model parameters vector from server to all clients.

Step 2: Local model update by each client using its local dataset (steps of gradient descent).

Step 3: Send the updated local parameter vector from each client back to the server.

Step 4: The server computes the global model parameter by aggregating received local parameters.

(The above steps are continued until training is completed).

Algorithms supporting federated learning encounter several difficulties, including:

Statistical—The distribution of data varies significantly between the clients, that is Ɏn $\neq \check{k}$ we have $E_{xi\sim Dn}$ $[f_i$ (w; x_i)] $\neq$ $E_{xi\sim Dn}$ $[f_i$(w; x_i)]as a result, any data points immediately available are unlikely to be representative to the broader diffusion, i.e., $E_{xi\sim Dn}$ $[f_i$ (w; x_i)] $\neq F$ (w).

Communication— The client's "N" during communication is high in number, and it is higher than the average number of trained samples kept by inactive clients, i.e., N > (*n*/**N**).

Security and Privacy—Though untrustworthy participants, more privacy safeguards are required. It is hard to guarantee that none of the millions of customers are malicious.

4.1 Federated Learning's Statistical Challenges

Algorithm 2 explains the Fedavg.

Algorithm 2 Federated Learning with FedAvg Algorithm.

Input: T global round, C number of fractions for each training round, K number of clients, η learning rate at a local client, E number of epochs at a local client, B local minibatch at a local client.

Initialize global model $w^g_{t=0}$
for each round $t = 1, 2, \ldots, T$ **do**
  $m \leftarrow \max(C \times K, 1)$
  $S_t \leftarrow (m\ clients\ in\ a\ random\ order)$
  for each client $k \in S_t$ **do**
    $w^k_{t+1} \leftarrow ClientUpdate\left(k, w^g_t\right)$
    $w^g_{t+1} \leftarrow \sum_{k=1}^{K} \alpha_k \times w^k_{t+1}$

ClientUpdate$\left(k, w^g_t\right)$:
  $w_k \leftarrow \mathrm{w}^g_t$
  for each local epoch $e = 1, 2, \ldots E$ **do**
    for each local batch $b \in B$ **do**
      $w_k \leftarrow w_k - \eta \nabla \mathcal{L}(b; \mathrm{w_k})$
  return local model w_k

Output: w^g_{t+1} a global model at round $t+1$

Federated Averaging (FedAvg) is a fundamental approach to federated learning [51]. It is proven that it can operate with non-independent identical distribution (non-IID) data that needs all active clients to use the same design. There are two types of solutions to the statistical difficulty of federated learning that have been studied: consensus and pluralistic methods. FedAvg, on the other hand, is unable to handle the statistical challenges posed by highly skewed data distributions. Weight divergence may have a major impact on the efficiency of FedAvg-trained deep neural networks.

4.2 Federated Learning Communication Efficiency

Training data in an FL (Federated Learning) context is distributed across a variety of clients, each having unstable and generally poor network access. The total amount of bits required by each of the K clients during uplink (clients to server) and downlink (server to clients) interaction during learning is provided in Eq. (9),

$$B^{high/low} \in \frac{o(UX|w|)X\left(H\left(\Delta w\ high/low\right)+\beta\right)}{update\ size} \tag{10}$$

Here U is the maximum number of updates conducted by every client, |w| is the size of the model and H (Δw $^{high/low}$) is the difference in update length between both the minimal update and real update sizes, is the overall decay of the weights updates conveyed in the transmission process. There are multiple ways to bring the communication costs down:

(1) Minimize the number of consumers K.
(2) Minimize the size of updates.
(3) Minimize the number of updates.

We may split research findings on information exchange federated learning into four groups based on these three points: model minimization, client authentication, update reduction, and peer-to-peer learning.

4.3 Security and Privacy

We assume that the number of participants (phones, cars, clinical institutions, etc.) in federated learning is huge, possibly in the thousands or even millions. It's hard to guarantee that neither of the customers is malicious. Due to the local training of the model, federated learning can prevent direct leaking without the need for input data or output data exploitation. However, based on the implementation of f(w) or the shared predictive model, clients may deduce the respective information of the other client's private dataset.

4.4 Multiple-Party Computation with Security

Secure multiple-party computing (SMC) is an ordinary method that could be suitable for federated learning scenarios. In this, the client makes use of the various cryptographic methods and the other techniques to compute the function to handle the transmission in a secure manner. The public key that is used for data encryption is used on both sides in various applications. Several iterations are carried out during the process of encryption and decryption and as well as repetitive communication among the participants has been deployed due to its success rate in the cloud environment.

4.5 Privacy Differential

Differential privacy (DP) is a well-established conceptual paradigm for protecting individual data privacy in a variety of fields, including not just traditional approaches like boosting, Principal Component Analysis (PCA), and support vector machine (SVM). Apart from these, it also includes intensive research in deep learning.

Conversely, because DP is a lossy method, it only protects customers to a limited extent against data leakage and may reduce the accuracy rate. As a result, a few people who do research in security combine Differential privacy with Secure multiple-party computing to reduce noise injection as the number of players grows while retaining provable privacy guarantees and avoiding extracting attacks and collusion problems.

4.6 Applications

Federated Learning (FL) was implemented and used in various fields. It gains extensive popularity since it provides the shared modeling approach that enables effective machine learning while assuring data security and regulatory compliance across several parties or computer nodes. Virtual keyboard prediction, smart purchasing, banking, and vehicle-to-vehicle communication are just a few examples of these capabilities. This division focuses on healthcare applications, but we also look at interesting applications in other sectors that have been applied to healthcare.

4.6.1 Healthcare

EHR has transpired with a substantial resource from healthcare that could be utilized for various crucial scientific applications and research that involves the state-of-the-art technologies. EHR provides information about the patient for research that comprises both structural and random biases that limit the generalizability of outcomes. These poorly calibrated algorithms might emerge for various factors such as discrepancies in the essential parts of affordable healthcare or a lack of depiction in training data. The most significant act is that one must identify the required information from the EHR data, and it could be linked with the various activities that happen in hospitals so that it could be focused on those biased algorithms. Unfortunately, due to several factors, including separate data methods, security, and privacy issues, linking data with the centralized database is more complex, and hence learning becomes difficult. As a result, alternative solutions are used to learn various EHR datasets that are beyond focusing on increasing data. Federated learning might be a technique that could encompass a huge volume of EHRs [52, 53], which discusses several studies that illustrate this below in Fig. 7

Federated Learning (FL) is a realistic approach for communicating EHR data from health organizations for them to exhibit their actions while protecting their information. Continuous improvements in learning enormous and assorted medical datasets will significantly improve the ML prediction error in these settings. Some healthcare activities, such as patient correlation learning, patient classification techniques, blood typing, estimation, and so forth, have been studied in a federated training approach.

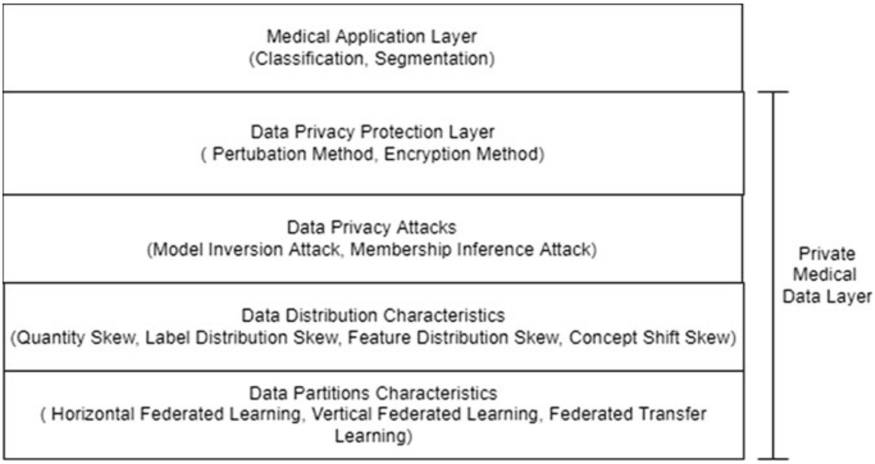

Fig. 7 Medical data properties in federated learning for medical applications

5 Communal Issues that Concern Various Applications of ML in Medicine

Several various societal challenges, including fairness, security, and confidentiality, as well as explainability and conciseness, as well as some broad social issues, just for legislation and ethics, are influencing the progress of ML and AI technologies. A relaxation in the constraints can be implemented in learning algorithms in the quality health sector, where relevant data about the person is commonly accessible. Many of these would have been of involvement to healthcare sector professionals and have been made public.

Medicine has become a more data-driven field of study, as part of a wider trend affecting all sections of life sciences [54]. Medical research methodology has traditionally been the arena of statisticians, but the main goal of healthcare information is to gather the requirements and analyze them. Data could be of numerical values that could be collected from various sensors, Electronics Health Records (EHR), pictures with several styles of their own or in comparison with other methods of signals, or graphs attempting to describe biological mechanisms or several indications of the state of diseases [55]. This complexity of data is driving the change from traditional multiple regression models to the relatively new field of data science [56], which encompasses a new reality comprised of connected wearable sensing devices from the point of view of medicine.

Aside from the more traditional analytical techniques, AI and ML are growing rapidly for health data processing with a limited impact on clinical practice [57]. This characteristic is primarily of interest to large IT industries, but it accurately reflects the real AI industrialization process, wherein academic and industrial research boundary lines are becoming increasingly obscured, with the leading researchers in AI and ML working for private firms. From several studies, it has been understood that the usage of AI in various domains has been experienced but, the societal issues related to the use of AI in general, and ML, should no longer be overlooked, particularly in the medical and healthcare fields.

These communal problems might be in any way they always include the model building with a human-centered orientation, that is, models with human-relevant criteria and constraints. This is, without a doubt, a purely technical problem.

5.1 Legislation

Legislative bodies govern societies. While remaining inside this realm, AI and ML breakthroughs have largely been unaffected by legal implications; however, as these innovations begin to enter the larger social arena, their influence on humans is expected to address a limited permissible roadblock. The most common example is self-driving cars. Legal obligations are clearly outlined when a human decides behind the wheel of a vehicle. However, the industrial growth of semi-autonomous automobiles has strained the joint of current regulations, leading to the goal of completely autonomous driving.

Again, the use of AI and ML in the official healthcare profession will inevitably spark controversy about their legal boundaries and implications. The European Union directive for such General Data Protection Regulation (GDPR) was recently implemented (May 2018). Most decisions made by "robotic or artificially intelligent algorithmic systems" [58] must be explained under this regulation. According to Article 13 of the declaration, the "data controller" is legitimately required to offer "valuable information about the trickery involved, as well as the importance and the anticipated consequences of certain processing [automated decision-making, as explained in Article 22] for such personal information" [58]. AI and machine learning could be used to provide robotic decision-making, putting these innovations the focus in the legal world. Certain GDPR-compliant ML development benchmarks were recently published.

The suggestion of GDPR, making use of Artificial intelligence and machine learning in healthcare and medicine are straightforward. The objective of the decision support system which works based on the principle of ML is that it makes the job of the medical experts during the decision process flexible so that they could explicitly deliver a quasi-decision on a person. The data controllers in this scenario refer to the medical person (ranging from nurses to consultants or specialists [59]) and the organization to which this expert is related.

It is significant to mention that this portion of the regulation (which is compulsory by law in all countries of European Union members) entails a very specific response from ML and AI techniques decipherable and intelligible. A medical professional or any executive of a public healthcare system that uses these innovations should be able to deduce what exactly decisions were made and discuss those decisions with any individual affected by people. When the life of a patient is in danger, one must be very careful during the decision-making process.

Despite its perceptions, a medical care system may choose not to even work with an ambiguous MDSS in health practice at a later stage, considering protections such as the GDPR, to avoid the possibility of unaffordable action costs caused by fabricated cases that might be both positive and negative or inaccurate future projections and estimations generated by these automation systems.

5.2 Interpretability and Explainability

The ability to explain one's existence has not always evolved in biological minds. Others think it could only have happened in social creatures, but it has been contended that social behaviors only occur in classes whose brains can communicate with one another. Initially, AI was intended to mimic aspects of genetic intelligence, but identity abilities were never a key consideration. AI, like the living brain, was designed to be seen as a type of knowledge device, and the idea of social AI is still in its infancy, as evidenced by autonomous algorithms and multiagent systems [60]. The applicability and predictability of AI/ML systems is a relatively new area of study [61]. One important intention for this is the development made possible by DL technologies. Conventional artificial neural networks are supplemented by deep learning. Those have long been derided as "black box" models that are impenetrable. DL models run the risk of being viewed as augmented black boxes.

AI and ML-based technologies may have specific goals, but they are inefficient unless they adhere to clinical guidelines. This should be noted that schemes based on computers, like MDSS, are regularly viewed as an extra burden in doctors' daily practices [62]. The issue may arise when the MDSS contradicts medical practice recommendations. Ash et al. [63], which is unavoidable since these guidelines are provided to the intelligent systems as prior knowledge. In this case, evaluation could be viewed as a chance to align predictive accuracy with guidelines.

Machine learning can be described in healthcare as "a way to help and perfect certain activities done by people practitioners" [64]. The above means that assessment should not be regarded as a separate technical flaw from the human interpreter's cognitive abilities. Dreiseitl and Binder [65] acknowledge that when addressing the low extent of compliance of MDSS at the delivery of access, researchers frequently completely avoid relevant questions including whether sufficient "hypotheses [are] given again for device's diagnosis"; "the form of clarification [is] sufficient for the clinicians using the system"; or "how convenient is its use."

Efforts are made to incorporate health expert details into one of the ML and AI models, or to use well before expert knowledge in structured architectures for interaction with machines, to improve interpretability and consistency. The method of getting medical expert validation must be initiated by the data analyst. In interaction, the healthcare professional must ensure that the findings of the research are subject to interpretation and appropriate through clinical practice.

5.3 Privacy and Anonymity

Data is hastening into our societies because of technical breakthroughs and increasing usage of computer systems and communications processes (mainly governments and technology developers). Our use of digital social networking sites is rapidly increasing the number of physicals creating networks. Data privacy and confidentially have emerged as major societal issues in this environment, prompting impacts the quality like the European GDPR.

Undoubtedly, secrecy and privacy were far more important issues for healthcare systems than they've ever been in society. Because sensitive consumer data is communicated electronically with networked systems that have varying levels of security standards and guidelines, the expanding use of electronic health records (EHRs) in medical practice exacerbates the situation. The parameters of EHRs are shown in Fig. 8. An overview of EHR secrecy and privacy [66] was provided by Fernández-Alemán et al. [67]. Even though it is acknowledged that "there is very little action in policy development encompassing the numerous significant privacy issues raised by a shift from a primarily disconnected, paper-based healthcare system to one that is incorporated and digital," this study clearly describes the strong coupling between anonymity and privacy, on one hand, and the other hand regulation.

The AI and ML communities were not ignoring this issue. As soon as 2002, these journals explored data confidentiality of information in data processing clinical applications. Berman [68], emphasizing data miners' responsibility to healthy patients. Models and techniques for protecting privacy have been thoroughly discussed [69]. In healthcare settings, data analysts are frequently required to focus on the requirement to assess data transferred between numerous clinical parties. Privacy controls may be in place at these parties (for example, clinics) to prevent data from different sources from being diversified and consolidated. To avoid this bottleneck, the AI and machine learning communities have already begun to work on developing decentralized analytical solutions [70].

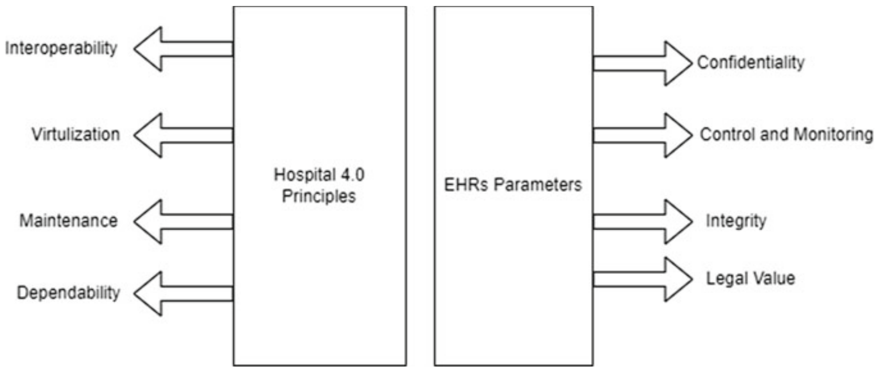

Fig. 8 Principles of hospital 4.0 and parameters for EHRs [53]

5.4 Ethics and Fairness

The primary objective of artificial intelligence has long been to replicate genetic intellectual ability in a computer. Biological intellect, on the other hand, is part of innovation and, as such, is multifaceted, as well as, to some extent, the product of cultural stresses in humankind. Ethics, as a scope of political decision, is one of these dimensions, and it can be argued that it provides the foundations for societal legislative rules, which have already been discussed in this chapter's significance for medical AI and ML applications.

However, the AI and ML fields are currently ill-prepared to deal with this critical issue [71]. Surprisingly, this topic has recently become important in the AI debate, despite previously being a prominent item on the leading research agenda [72]. As an example, consider the ongoing discussion over the use of AI in independent weapons for defense and combat. Driverless independent vehicles, at least to some extent driven by AI, are used as targets for airstrikes in sensitive zones. International treaties identify the ethical difficulties relevant to human decisions regarding the targeting of human beings during wartime. But, in the case of targets selected in part by AI-driven robots, who is ethically responsible? This is the type of issue that is currently driving non-profit organization efforts, such as Article 36's [73], "to stop killer robots" [74].

Ethics is a significant theme in healthcare that has generated a great deal of scholarly debate [75]. Can remedies powered by AI and machine learning address the fundamental biological and medical ethical concepts of individuality, humanitarianism, and justice? Should they, or should the doctors, make this decision? Medical practitioners, on the other hand, rarely develop Artificial Intelligence and Machine Learning technologies for clinical applications. Humans, not methods, can identify moral questions, according to Magoulas and Prentza [76], so it is critical to investigate "the motives and moral considerations of researchers, developers, and clinical users of ML approaches in clinical applications." In any case, such a convergence of objectives necessitates the development of a clear direction for the social use of Artificial intelligence and machine learning in health, involving players from both medical and AI fields.

The idea of fairness is as subjective as, if not worse than, the study of ethics. If establishing who is and isn't fair in human culture is complex and often conflicting, attempting to install the idea of fairness in AI-based strategic planning may appear to be a futile exercise. Nonetheless, the use of machine learning and artificial intelligence (AI) in socially significant areas should strive for fairness. "Real-world fairness issues in ML are institutionally and ethnically founded," writes Veale and Binns [77].

Gender balance, for example, can be achieved by skewing the information used to learn this same machine learning technique. Caliskan et al. [51] recently, it was demonstrated that semantics created directly from suites utilizing machine learning encompass human-like stereotypical unconscious bias. According to Veale and Binns [78], an accidental lack of equality can happen when businesses do not keep data on sensitive characteristics like age, race, gender identity, or disability for legal, organizational, or commercial reasons. In the utter lack of such data, the risks of discrimination via proxy increase.

6 Conclusion

This chapter introduces an original and thought-provoking concept concerning skin cancer and how digital health utilizes and improves using automated instruments. The goal of this chapter is to provide insight into the requirements of the health domain as well as a proper choice of available techniques. Before implementing a classification technique, it is necessary to identify the redundant and inappropriate features because these features act as noise and outliers, slowing down the processing activity. These characteristics also harm the classifier's performance. These characteristics are recognized using statistical approaches. On the other hand, feature selection approaches can identify the most significant and valuable qualities, which improves the performance and accuracy of the classification algorithm.

Enhancing and securing health data exchange among various parties is required for the efficient use of federated learning in health organizations. Society 5.0 envisions a unified system that will provide complete, automatic, end-to-end services and fulfill the demands of linked living. Society 5.0 envisions a system with edge intelligence, extensive network deployment, and quick data delivery to meet the needs of individual users.

In many healthcare disciplines, the most challenging issue for AI is ensuring its adoption in daily clinical practice, rather than whether the technologies are powerful enough to be effective. Regulators should first approve Artificial intelligence systems, which must then be linked to electronic health records, regulated to the level whereby similar items function in the same way, presented to physicians, funded by public or private payers, and upgraded in the environment with time. Such issues will eventually be handled, but it will take far longer than the innovations themselves to develop. Consequently, we expect Artificial intelligence to be used only in limited ways in medical practice.

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Chapter 5
Cloud Computing—Everything as a Cloud Service in Industry 4.0

S. S. Aravinth, A. Siva Rama Krishnan, R. Ranganathan, M. Sasikala, M. Senthil Kumar, and R. Thiyagarajan

1 Introduction

The following scenario is provided for better understanding about the requirement of the technology. Sam is a college girl, and she uses her social media account a lot. And on one day when she is posting a picture, she got one doubt [1]. That is when she opens her account, she was able to see only the photos that she posted and when she is opened her friend's account, she was able to see pictures posted by her friends. What is the one thing that is stopping without mixing her posts and her friend's posts. As she is a student, she knows little about some technologies and started browsing them [2]. And finally confirmed that it is because of the cloud technology. And now she wants to learn much about the technology.

Let us help her,

1. About the Cloud and Cloud Computing.
2. Qualities of Cloud Computing.
3. Why we really require Cloud?
4. Different key words explaining about cloud in a detailed way.

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1.1 Introduction to Cloud Computing

The term cloud defines to a network or internet. It is a technology that is used for storing, managing, and accessing the data. Cloud is a parallel and distributed computing system.

Different operations that we can do using cloud:

1. We can develop new applications and provide different services using cloud.
2. Cloud can be used for storage, back up and to recovery the data back.
3. We can also host blogs and websites using cloud.
4. We can delivery any software on demand using cloud.
5. As we know cloud provide storage for data, we also can analyze the data that is being stored [3].
6. We can also watch streaming videos, audios. All these will be stored on cloud.

Cloud work on all this by making the network as a medium. This is because, suppose there are 5 servers in a room and no server is connected to other. Then there is no use in having them [4]. Hence matter less of how many servers are there all should be connected such that information should be passed to each other.

We can say compute (CPU) and memory (RAM) are the brain of the server. These both helps client to get all his needs [5].

1.2 Why We Need Cloud Computing?

Issues faced before cloud came into existence:

Initially, everyone's databases were used to be in a garage and after it moved to a separate space in the office which is called as database centre.

So, what are the disadvantages occurred at that time are:

- Must pay rent.
- Continuous power supply (because if we see for cloud even at the night 2 also google is responding [6]. It means server should continuously work because we do not know when the end-user sends a request).
- 24/7 a team must monitor the server such that its performance is not going down.
- In case if the data center got affected by any natural disaster, then there is no chance to get the data back.
- Scaling is limited. (If we want to add any new server to the existing servers then it will be a hectic task to the team).

Basing on all these disadvantages there existed a modern technology called Cloud.

Cloud Computing is the conveyance (Delivering the services) of computing services to servers, capacity, data storage like database, networking etc. [7] and more over the global internet(cloud) to offer quicker innovation, flexibility in having resources, and also economies of scale what's more in particular is that we can pay just to the assets that we really want [8].

In cloud computing:

- Do not need to manage data centers.
- Do not need to buy physical hardware upfront.
- Create a resource on demand on the cloud.
- Only pay how much you use.
- It is the future of computing.

2 Different Services in Cloud Computing

- Infrastructure as a service generally called as IaaS.
- Platform as a service generally referred as PaaS.
- Software as a service generally know as SaaS.
- Everything as a service (XaaS) [not explained in this book].

As we discussed before you must pay for what you use. And these are the different models that are present. The client will be able to select what is his need from the above model based on his requirements. In Cloud all those requirements will be divided into 9 categories as shown in the given below Fig. 1.

They are:

1. Application.
2. Data.
3. Runtime.
4. Virtualization.
5. Middleware.
6. Networking.
7. Operating System.

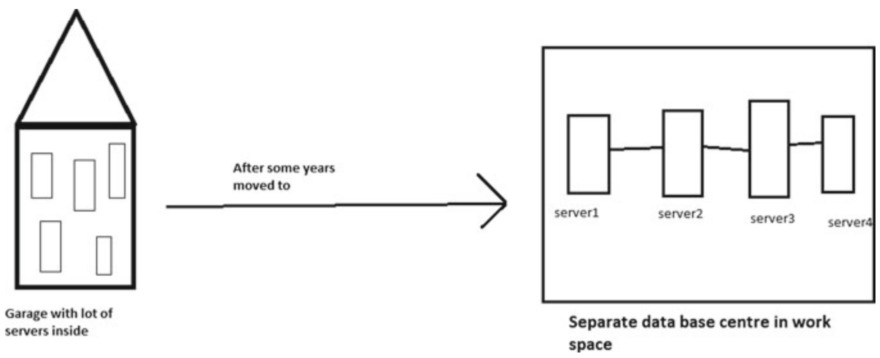


Fig. 1 Component of cloud

On Premises	IaaS	PaaS	SaaS
Applications	Applications	Applications	Applications
Data	Data	Data	Data
Run Time	Run Time	Run Time	Run Time
Middleware	Middleware	Middleware	Middleware
OS	OS	OS	OS
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

Fig. 2 Various cloud services

8. Servers.
9. Storage or Capacity.

As per the above Fig. 2. all those which in red colour are the services that provided by cloud in that model and remaining will be organized by the organization itself [9].

Let us try to learn little more about these models.

2.1 Infrastructure as a Service: [IaaS]

Here cloud provides you with servers, storage, networking, and virtualization in short it handles only the server-side. While the application, data, operating system, the runtime will be handled by the organization itself.

EX: Rackspace, Digital Ocean and some deployments of Microsoft Azure and AWS (Amazon Web Services).

2.2 Platform as Service: [PaaS]

User will select this model if he feels that application and data is little confidential and if he does not want to share.

And the remaining runtime–servers–os–virtualization–middleware–storage–networking will be handled by the cloud. By this the total information about his application will be still in the client hands and he can commit changes if he wants.

PaaS reduces groups time and assets associated with building solutions. All things being equal, they can pick a pre-constructed stage that gives the central abilities of the expected code and spend their assets deciding the elements and utility ideal for the necessary arrangement [10].

Example: Azure, Google App Engine etc.

2.3 *Software as a Service: [SaaS]*

If we take SAAS (Software as a service), the entire application will be dependent on the cloud.

Software that is available via a third-party over the internet.

Example: Gmail, MS (Microsoft Office), Google Apps…etc.

We never receive anything in Gmail or in MS Office saying there is a bug at that spot please fix it. This is because the entire application here will be handled by the cloud only. You will not have any access to change any front-end or user-interface or fixing any errors that occurred as everything is handled by the cloud itself. **So, we can observe that model to model the dependency of the organization on cloud increases and cost will be decreased** [11] (Fig. 3).

Use cases of IAAS, PAAS, SAAS:

See Fig. 4.

3 Different Cloud Models

- **Public Cloud**.
- **Private Cloud**.
- **Hybrid Cloud**.
- **Multi Cloud**.

IAAS: HOST

PAAS: BUILD

SAAS: CONSUME

Fig. 3 Types of services

IAAS	PAAS	SAAS
Admin & Architects	Application Developers	End Users
Amazon, Azure & Google	Elastic BeanStalk, Hereku, Google App Engine	Zoom, Webex, Google Workspace

Fig. 4 Examples of service providers

Any organization that needs cloud computing can choose to use a public cloud (if they want all their services and applications will be hosted by third-party and their applications will be shared with all other tenants), a private cloud (where cloud services will be hosted by organization itself), a hybrid cloud (a mixture of both public and private), multi cloud (if he wants to use more than one cloud at a time) [12].

3.1 Public Cloud

Here all the information will be accessible to everyone and everyone can see what are all the facilities available in your application. Generally, IT companies uses this to scale their company with all other companies (Fig. 5).

All those above customer1, customer2, customer3… are the different users of cloud with their requirements who are located all around the world.

Hyper vision is also called as virtual layer.

This is how the public cloud will work.

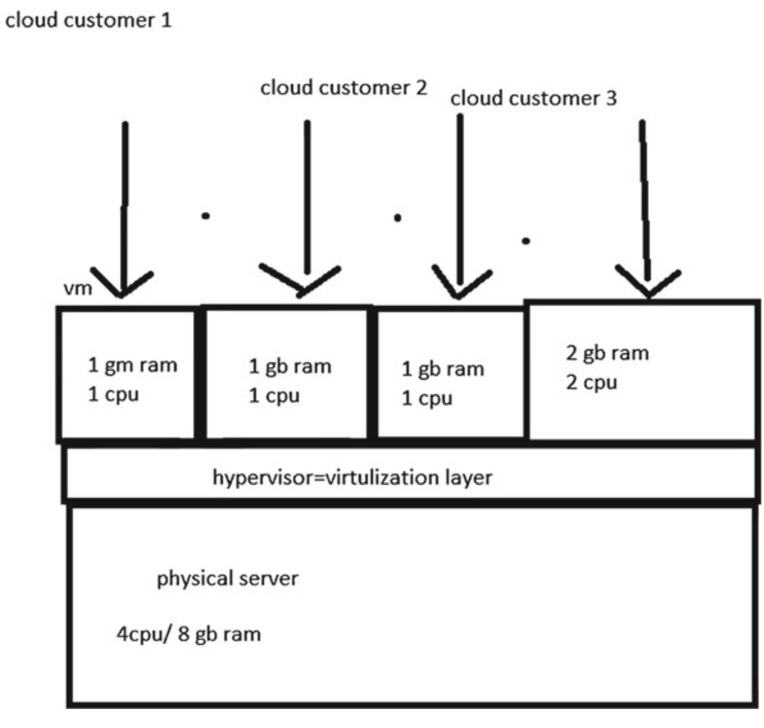


Fig. 5 Customer provision of cloud services

3.1.1 Advantages

Using public cloud can save business money, in diverse ways. They are:

1. Lower equipment purchase cost
2. Lower equipment maintenance cost.

A small new company can easily migrate to public cloud.

3.1.2 Disadvantages

1. Data transparency or theft.
2. Data leakage.
3. Service hijacking.
4. Service Vulnerability.

3.2 Private Cloud

When it comes to private cloud it would be accessible only to the organization. This is mostly used by all the IT (Information Technology) companies because they do not want all their information to be in public and to be in confidential mode [13].

In Private Cloud, they will give access to create our own cloud and our own services and we are the boss for it. In this only we are having entire control on the cloud and we will be giving access to other who are in our organization only (Fig. 6).

Here as per the above diagram the whole Cloud is maintained by a single cloud computer and then only he will be passing these cloud requirements within his organization [7].

3.2.1 Advantages

1. Performance.
2. Security.
3. Availability.
4. Resources.
5. Control.
6. Flexibility.

3.2.2 Disadvantages

1. Cost.
2. Maintenance.

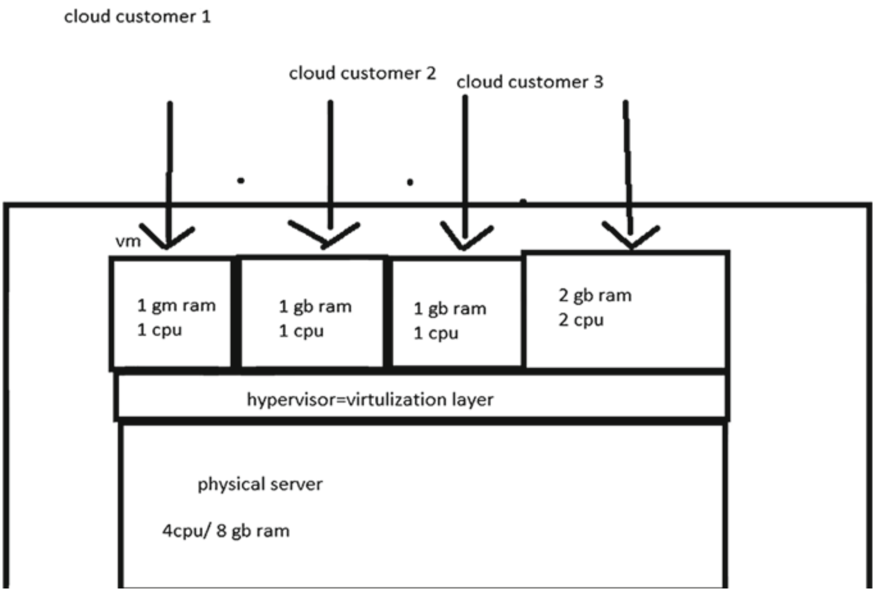


Fig. 6 Single cloud maintenance

3. Deployment.
4. Scalability.
5. Options.
6. Remote Access.

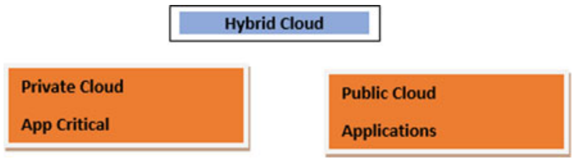
3.3 Hybrid Cloud

In this type of cloud it combines private cloud with one / more public cloud services,

Companies using both Private and personal clouds such that they are shifting in between them according to the needs of the user. This business strategy provides a great flexibility by moving workloads between cloud solutions.

But we must make sure that private cloud is not going down. When it goes down then all the information in it will be gone. There will not be anyway of cloud coming and rescuing the information on the server that is lost [14] (Fig. 7).

Fig. 7 Hybrid cloud setup



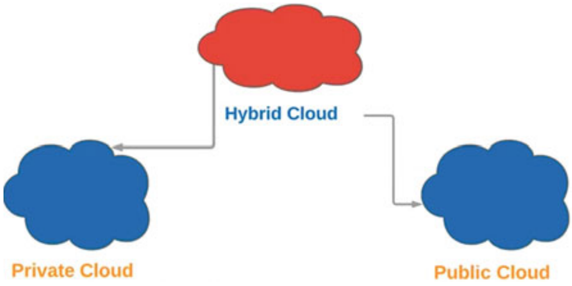


Fig. 8 Hybrid cloud architecture

Here all the information regarding your critical application we are storing it in private cloud and all the information regarding advertisement and all other data which the user feels it is not confidential can store in public cloud.

Because in public cloud there will be a lot of data transparency and hence confidential information will not be deployed on the public cloud.

For example, consider a flip kart website. In that application, all the information regarding the products, reviews on the products, etc. details will be stored on the public cloud and the user's confidential information like the payment details, credit card number, address of the customer will be stored in private cloud. This is how the information will be divided and stored in the hybrid cloud as depicted in the given below Fig. 8 [15].

3.3.1 Advantages

- Provides Best help for remote workforce.
- Decreased price.
- Increased scalability and control.
- Improved agility and innovation.
- Increased security and risk management.
- Hardware prices.
- Need to deal with different sellers and platforms.

3.3.2 Disadvantages

- Implementation.
- Security Issues.
- Hardware Cost (Table 1).

Table 1 Difference between public, private, hybrid cloud

Public cloud	Private cloud	Hybrid cloud
1. No maintenance costs	1. Dedicated, secure	1. Policy-driven deployment
2. High scalability and flexibility	2. Regulation compliant	2. High Scalability, flexibility
3. Reduced complexity	3. Customizable	3. Minimal Security risks
4. Flexible pricing	4. High Scalability	4. Work-load diversity
5. Potential is too high	5. Expenses are too high	5. Maintenance is too high
6. Decreased Security	6. Minimal mobile access	6. Added complexity
7. Minimal control	7. Limiting infrastructure	7. Compatibility and integration

3.4 Multi Cloud

Every Cloud provider provides a wide range of facilities for users. But when user needs to use multiple cloud platforms at a time then they can use multi cloud [16].

Differences between on-premise and cloud

See Table 2.

Some of the Important Things Regarding Cloud:

1. **Availability**: For an example consider you are working on a virtual machine for your application. Suppose that your application and virtual machine went down. So there will not be any other way for the user to access the information about the application.

   Hence it is always not a good practice to have only one virtual machine. In fact, your application needs 2 virtual machines so that if one goes down, the other contains all the data and can retrieve the data (Fig. 9).
2. **Scalability**: Suppose that there is an Amazon Big India sale is going on. During that time the load on the CPU will be very high. It would be very tough to manage the load. So to void that server down situation, we are adding more virtual machines such that if load on one cpu got increased the other will be there

Table 2 Difference b/w on-premise and cloud

On-premise	Cloud
1. Manage risks with our own risks	1. Managed by cloud servide provider
2. Maintain separate IT team to manage the infrastructure	2. Maintained by cloud service provider
3. Increasing resources is a big constant	3. Resources are assigned as per the requirement by the provider
4. It is costly as like server hardware, power consumption, and space	4. We can pay for what we use

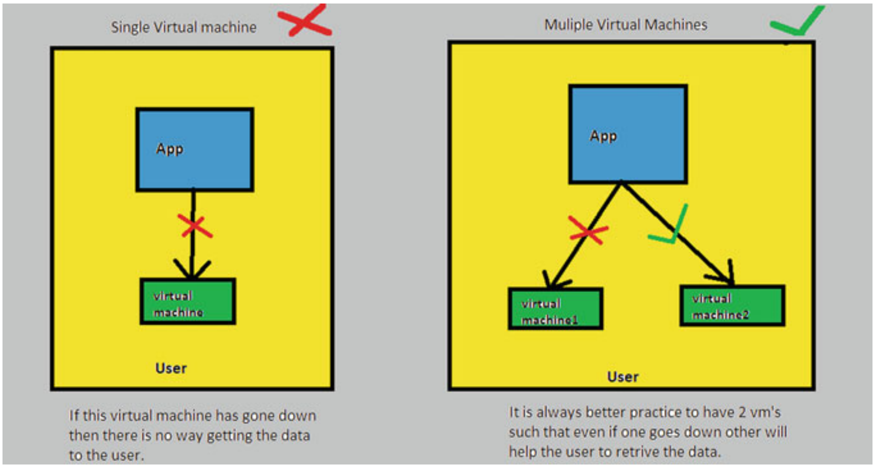


Fig. 9 Virtual machine environment

to manage and it will not allow to the server to go down. This is called Scalability [17].

Based on amount of traffic the virtual machines will scale up and once the traffic got reduced virtual machines will scale down. When this is happening basing on the requirements then it is called as scalability.

3. Benefits from enormous financial aspects of scale.
4. User can stop guessing capacity.
5. Increases speed and agility.
6. User can stop sending money on running and maintaining data centers.
7. User can go global in minutes.

4 Applications of Cloud

Since this cloud computing is essential for all the industries, it is playing a prominent role in effective utilization of resources. As discussed in the previous chapters, this cloud computing offers various services to the business to make higher degree decision making of product delivery [18].

4.1 Cloud in Business Sector

To achieve the high degree of revenues, various techniques are implemented with help of cloud computing in business sectors. The following are the benefits of cloud in business sector.

- Scalable Infrastructure.
- Cost savings.
- Software as a Services.
- Data storage and backup.
- Data analytics and Business intelligence.
- Collaboration and communications.
- Development and testing.
- Security with compliances.
- Business continuity.
- Disaster recovery of data.
- Global expansion.
- Scalability.
- Customer relationship management.
- Insights extraction.
- Content management.
- Performance measurement.
- Flexibility.

4.2 Cloud in Education System

This cloud technologies are providing the effective usage of e learning materials to students, teachers and other types learners. So that, the learners will access these contents any time and any where in the world through cloud internet. The following are some examples of cloud in education system [19] (Fig. 10).

- E Learning Platforms.
- Collaboration and remote learning.
- Content storage and delivery.
- Cost effective infrastructure.
- Online assessments and grading.
- Personalized learning.
- Virtual labs and simulations.
- Global Knowledge sharing.
- Administrative management.
- Scalability.
- Accessibility.

4.3 Cloud in Medical and Healthcare

The contribution of cloud computing in medical and healthcare are playing a predominant role. As per the below Fig. 11, the prompt and accurate contributions are cloud in medical field is explored [20].

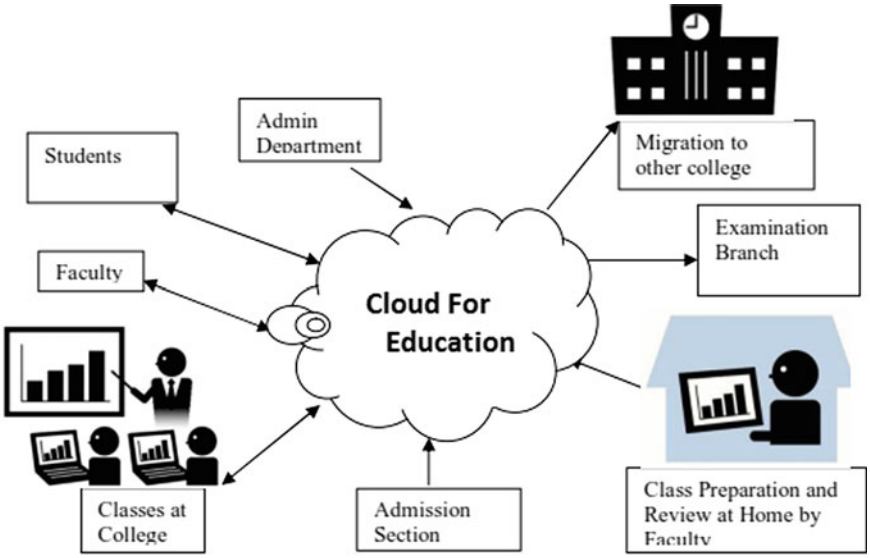


Fig. 10 Services attached to the education cloud

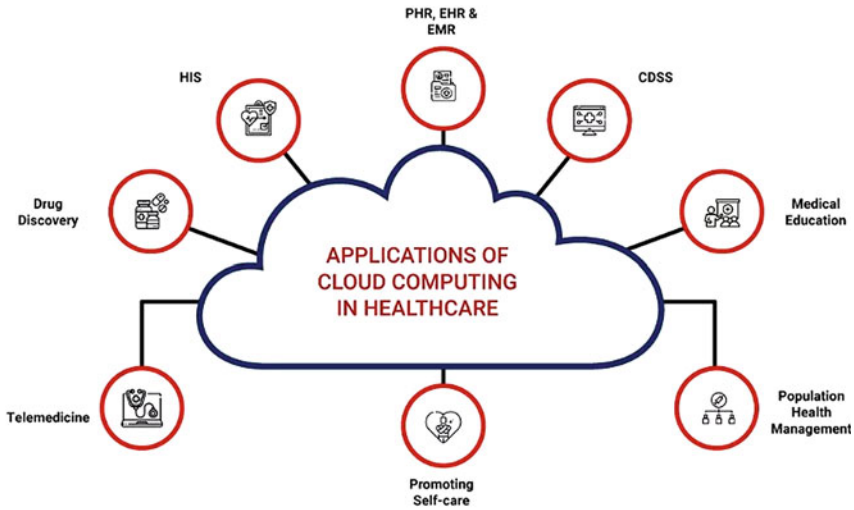


Fig. 11 Cloud deployment in healthcare

The following are the way of cloud computing supports in healthcare industries

- Telemedicine.
- Drug discovery.
- Electronic health records.

- Remote patient monitoring.
- Health information exchange.
- Medical research and collaboration.
- Wearable devices.
- Secured patient data.
- Cloud based consultation.
- Virtual medical assistant.

4.4 Cloud in Software Development

Many software has been developed with the help of cloud technologies to store the data in cloud due to the storage issues as illustrated in the following Fig. 12 [21].

The following software are developed and deployed in industries for storage purpose.

- Mailchimp.
- Salesforce.
- Chatter.
- Bitrix24.
- Paypal.
- Slack.
- Quickbooks.
- Boxx.

Fig. 12 Cloud based software and usage

- Mozy.
- Joukuu.
- Gsuite.

5 Comparison of Various Cloud Platforms

To know more about the various cloud computing models, this Table 3 is formed. As per this Table 3. The various services rendered by cloud platforms are compared [22].

The following Platforms are considered in this table for comparison

- Amazon
- Microsoft Azure
- Google App Engine
- Sun grids
- Aneka
  - Free version
  - Business version
  - Enterprise edition

The following Parameters are considered in this above table for comparison.

- Programming framework
- QOS Negotiation

Table 3 Comparison of different cloud platforms

Different platforms					
Property	Amazon ECC	Mircrosoft Azure	Google App Engine	Sun Network.com	GRIDS Lab
Focus	Infrastructure	Platform	Platform	Infrastructure	Enterprise Cloud
Service type	Amazon S3	Web Application	Web Application	Computing	Computing
User access interface	Command Line Tools	Windows Azure Portal	Web Based Access	Sun Grid Portal	Work bench portal
Value added services	Yes	Yes	No	Yes	No
Virtualization support	Yes	Yes	Yes	Yes	Yes
WEB API's	Yes	Yes	Yes	Yes	Yes
QOS services	None	None	None	None	SLA based
Programming frameworks	AMI	.Net	Python	Java	C#

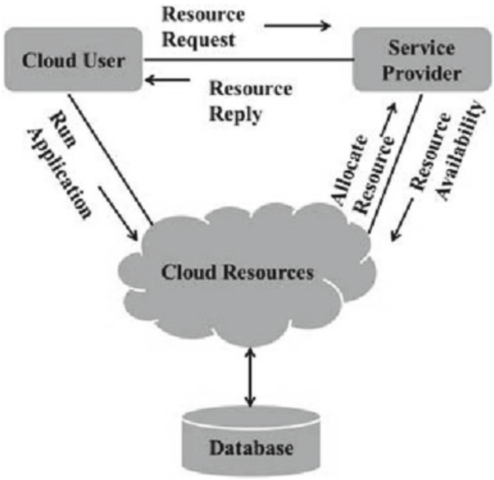


Fig. 13 Resource allocation in cloud model

- Property
- Focus
- Service type
- User access interface
- Service providers
- Web API's
- Pooled Resources
- Network latency.

5.1 Resource Allocation on All Models

To ensure the proper reachability of the resources, the resource allocation method is proposed [23]. Irrespective of all types and models of cloud, the concept of employing the resource allocation is not varied. They all are relied on the triad closure sharing and synchronising as given in the Fig. 13 [24].

6 Conclusion

The cloud computing models are being deployed in industries for implementing wide variety of web and cloud-based applications [25]. For those who needs basic knowledge about cloud computing our paper will be helpful. We can see that cloud technology is being used in every industry irrespective of the sector they are working. In this time, it is really important for everyone to understand the working of cloud and all its different models in order to choose the model basing on their specification

[26]. And the future scope of this book is to improve this basing on different models and to understand different types of cloud provider services like AWS, AZURE, GOOGLE and multi-cloud like AVIATRIX. This book chapter is divided into four major categories. In section 1, the introduction of cloud computing is written [27]. Followed by in Chap. 2, the need of cloud technologies is discussed. In connection to that, as a next chapter, the deployment models have been studied and discussed. Finally, this chapter concludes by explaining about the types of cloud computing services and applications [28]. In addition to that, the various applications of cloud in different fields are explained with necessary examples. A comparison table is also given to get the exposure of different models with various comparative parameters [29].

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Chapter 6
Glimpse of Cognitive Computing Towards Society 5.0

Soumya Varma, M. R. Manu, and Divya Mohandas Menon

1 Introduction

The Japanese government coined the concept of “Society 5.0” in 2016, which is a technology-based and human-centered society [1, 2]. Society 5.0 is a future society proposed in “The 5th Science and Technology Basic Plan” by Japan. It is defined as a society that is human-centered which emphasis the balance of economic development at par with resolving social problems with the aid of a smart system that tremendously coalesce the cyber-physical spaces [2]. Chronologically speaking, it represents the 5th form of society in our history, following hunting, farming, industry, and information. A society which can tackle a variety of social problems through a digital transformation program must be created; the Japanese government recognizes the need of achieving a digital transformation of society. The Society 5.0 framework calls for a more human-centered approach [3]. The program’s main functions include balancing the nation’s economic advancement with resolution techniques for social challenges, as well as the construction of a system that integrates internet and physical space. Cognitive computing technology, which is a fusion of Artificial Intelligence, Blockchain Technology, Internet of Things, Deep Learning, Machine learning, Natural Language Processing could provide better results than when they are used alone for a specific task. The idea of cognitive analysis is to clone the human-thought process and aid in quicker decision-making assistance. The far-flung reality of Artificial Intelligence call for cognitive analysis in problem-solving and yielding quicker decisions. The future society could be envisaged to have the potential by clubbing the promising technology to have better yield.

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1.1 A Glimpse into the Evolution off Societies

The mankind has witnessed a series of transformations in the structure of the society since its origin. According to Anthropologists, it all began with a small group of people who started hunting and gathering food for their livelihood. They just wanted to live the day-to-day life somehow and were nomads mostly. This “Hunter society” is defined as Society 1.0. The people then understood the need for cultivating crops and food for more people and for unforeseen circumstances, and they were transformed to “Agrarian society” who cultivated and stored crops and food materials. They wanted to settle at a place to look after their cultivation and they also developed irrigation mechanisms to ensure water availability for their crops. This society is termed as Society 2.0. The next stage of transformation was remarkable as it embarked on lots of inventions and had a drastic impact globally. This was the era that witnessed a huge economic growth and sustained for a greater duration in history. To ease the burden of humans, this society invented many machines and has revolutionized the entire globe. Mass productions of various consumables were flourished during this reign of “Industry Society-3.0”. The advancement in technology and computing has paved the way for the next level society which is the ongoing Society 4.0 which is Information Society. Invention of computer and distribution of information were two major milestones in Society 4.0. This society is an intellectual society which is capable of transforming the conventional system of life into a big space of cyber systems. Huge amounts of data are generated per second and systems were introduced to deal with his hectic data that can bring useful insights that can bring about intellectual insights. The manual labor of analysis of data is a huge challenge faced by this society. This society is on the phase of transformation to a novel “Super Smart Society” that has relatively higher degree of convergence between Cyber Space and Physical space. Figure 6.1 depicts the societies evolved so far.

Even though the ongoing Society 4.0 has huge amounts of data, advanced equipment, complex computational capability etc., it encounters various challenges [4].

1. Sharing and co-operation of knowledge and information is difficult.
2. It seems cumbersome to find the relevant information from an overwhelming quantity of data.
3. Information analysis is a burden, as capability differs from person to person.

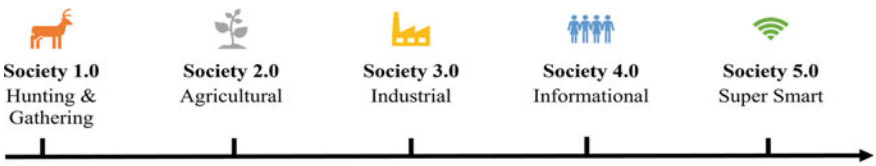

Fig. 6.1 The representation of various societies evolved so far

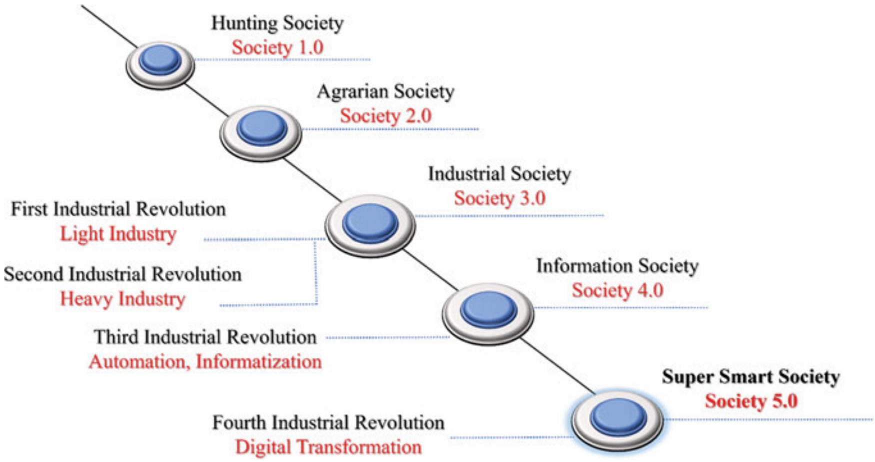

Fig. 6.2 The timeline of transition of societies and industries

4. The varying degree of ability of aging population, reduced birthrate and regional depopulation are major factors that hinders this society from tapping the best of its technical advancements.

Figure 6.2 depicts the transition from the basic society to the most sophisticated one and industry from light to the advanced one.

1.1.1 Society 5.0 and Industry 4.0

There are huge differences between Industry 4.0 and Society 5.0 [5]. The super smart society concept of Japan will make the life of people more comfortable and happier in major fields associated with humans. It is far way more different from Industry 4.0 which tries to replace human interventions and decision-making capabilities with smart and intelligent machines. When Industry 4.0 emphasizes on just getting the job done, Society 5.0 has a different perspective of getting the job accomplished by optimizing the human effort to its maximum possible extend. Unlike Industry 4.0 which features on the effectiveness of automated machine usage, Society 5.0 focuses on the effectiveness of optimizing the knowledge so that humans could be assisted by intelligent machines. Industry 4.0 was all regarding computerized communication whereas the Society 5.0 is aiming at harmonization of work with the aid of intelligent machines for supporting the workers. Overall Industry 4.0 needs a machine-centered era, whereas the latter needs a human-centered era. The following Table 6.1 lists out the differences between Industry 4.0 and Society 5.0.

Table 6.1 Differences between Industry 4.0 and Society 5.0

Idea	Industry 4.0	Society 5.0
Emphasize	Getting job done	Optimization of human effort to get the job done
Main Feature	Effectiveness of using automated machines	Effectiveness of optimizing knowledge, intelligent machines assist humans
Highlight	Computerized communication by all means	Co-ordination of work with the assistance of intelligent machines for the workers' advantage
Focus	Machine centered	Human centered

1.2 The Need for Society 5.0

Society 5.0 envisions a happy, content, progressive, and dynamic society that can eliminate the current economic stagnation by introducing innovative reforms in the society. It aims at reducing the burden on people to analyze the huge amount of data to gain insights [2]. Society 5.0 will have greater convergence between the cyber and physical systems by enabling human to retrieve the processed data/ knowledge in the most optimized manner from the cyber space. The data from sensors and devices in physical space will be accumulated in cyber space; processed by cognitive computing technologies and AI powered systems to generate most optimal outcome and is fed to humans in physical space, thus leveraging the cumbersome task of data analysis of humans. This is expected to bring about a new standard to the society and industry as depicted in Fig. 6.3.

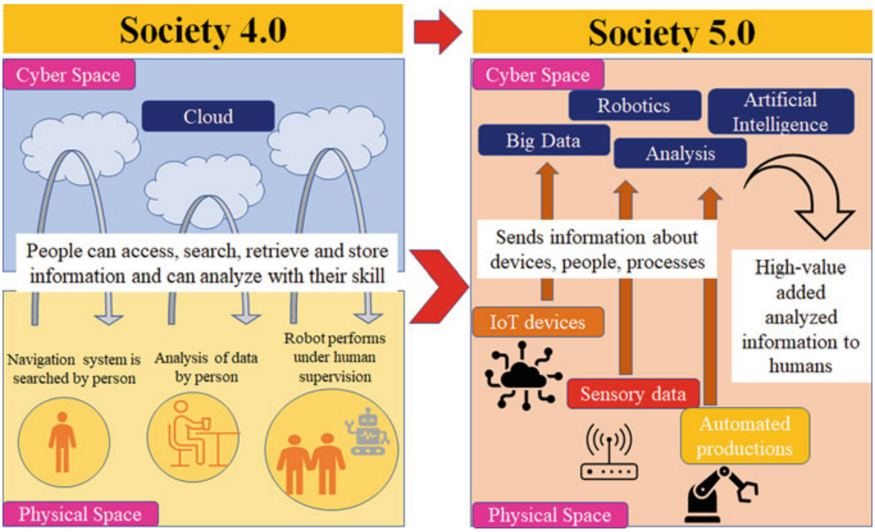

Fig. 6.3 Cyber space and physical space in society 4.0 and society 5.0

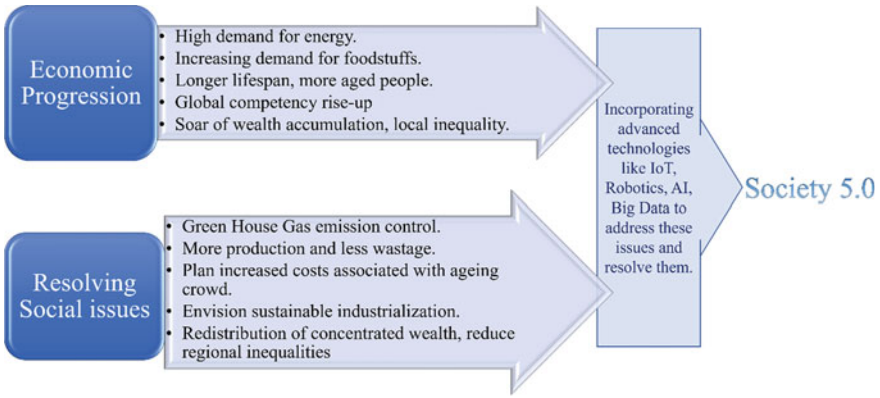

Fig. 6.4 Social issues and its resolution by Society 5.0

1.3 The Working of Society 5.0 as A Solution to Social Problems

The entire world is witnessing a huge change in the environment. When countries achieve economic stability, the standard of life of people also get improvised. When people enjoy a prosperous and commodious life, there occurs increasing demands for foodstuffs, energy, increased lifespan generates aged population amidst of highly competitive world. This also creates local inequalities and wealth concentration to specific group of people. To tackle with these increasing social issues, measures are to be taken with the help of advancing technology like AI, Big Data, Robotics, and IoT to industries and social activities. Figure 6.4 depicts the socio-economic issues and how society 5.0 resolves them.

The four vital social concerns of Japan are emphasized in Fig. 6.5 and Society 5.0 sorts out the issues proper solutions.

1.4 Attaining Society 5.0

By achieving advanced confluence between cyberspace and physical space, society 5.0 enables big data and technology-based artificial intelligence to perform or assist humans in performing the jobs and adjustments they have been doing for centuries, rather than replacing them. Human beings are freed from everyday cumbersome work and tasks that they are not very good at, and by creating new value through new products and services, they are able to provide, only the ones they need to those who need them at the moment. This is helpful in bringing about an optimal socio-organizational system. Humanity is the center of this society, not machines and AI which control and monitor it. It would be possible not only for Japan, but also for the

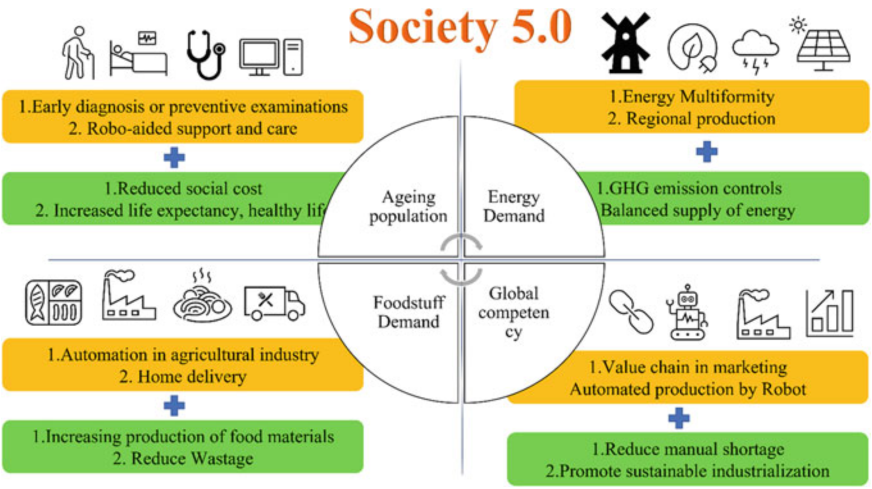

Fig. 6.5 Social concerns and solution in Society 5.0

world, to achieve economic development while solving key social problems, as well as contribute to meeting the Sustainable Development Goals (SDGs) established by the United Nations[UN]. Through the incorporation of advanced technologies in a wide range of industries and social activities, Japan seeks to become the first country in the world to achieve a human-centered society (Society 5.0).

It intends to cultivate innovation and value creation by implementing advanced technologies across a broad range of industries and social activities. Figure 6.6 shows the benefits of Society 5.0.

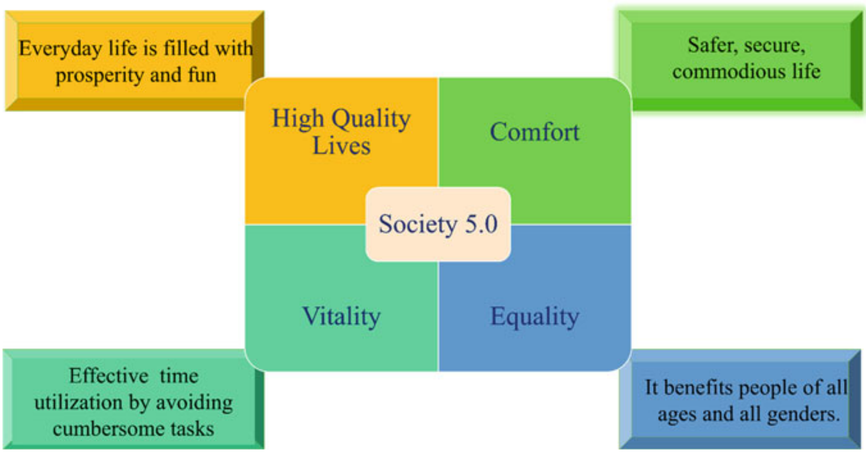

Fig. 6.6 Benefits of Society 5.0

As part of Society 5.0, infrastructure will be updated, finance technology will be utilized, healthcare will be improved, logistics will be improved and, of course, AI will be used [6]. Japan is proving to be an exceptional leader in this regard. Countries like United States of America, France, Britain are investing billions for the advancements in AI systems and thus gearing up in the goal towards a smart future. The next section will detail the implementation and impacts of Society 5.0 in various domains.

2 The Implementation and Impact of Society 5.0

The Society 5.0 is expected to bring about positive changes in almost all walks of life [7]. The human-centered society is about to witness a prosperous and happy life with the integration of high-end cutting-edge technologies of AI, Robotics, Big Data, and IoT. The impacts of Society 5.0 in plethora of domains are being discussed below.

2.1 Infrastructure

Efforts must be taken to improve the roads, rails that help us for fast transit [8]. With the amalgamation of AI and technologies like robotics, drones, sensors, and IoT, there can be a complete rebuild of such problems.

1. Automated vehicles can bring about a huge positive change in this sector; at the same time, the data produced by them will have to be handled quickly and optimized to produce insights that can aid humans.
2. Technologists and entrepreneurs have an exceptional advantage to use this information to foresee everything from the needs of infrastructure advancements to all bridges and roads being utilized by the automated vehicles.
3. With less human effort, automated sensor systems could detect the road or rail damage and initiate the repair by scheduling the repair in the least peak time by analyzing the traffic data over the region.

2.2 Mobility

In Society 5.0, new values could be generated with the help of cognitive Artificial Intelligence algorithms that can process Big Data from sensors, IoT devices, from self-driving cars, real-time weather data, real-time traffic congestions, food, travel, and accommodation patterns of the individual and the like [9]. This results in the following.

1. Personal trips and sightseeing become more enjoyable as the trip planning, expenses, food, and accommodation are customized as per the history and preferences of the individual. The most optimized data will bring about the option for the travelers to choose the best out of the suggestions by the AI algorithms.
2. Mobility could be alternated between self-driving cars and public transportation facilities to balance the traffic, to reduce metropolitan congestions and to reduce CO_2 emission.
3. Self-driving wheelchairs can be helpful for elderly and physically disabled people to aid in mobility.

2.3 Health

The current society suffers from increasing healthcare cost and declining public health. Moreover, a country like Japan having more elderly people because of increased life expectancy, a well-optimized healthcare system is a mandating requirement. With Society 5.0, a new value in this sector could be created with the aid of cognitive AI technologies and Robotics, personal health data, real-time health parameter readings from sensors, live location of person being monitored/treated, complete medical history, current environmental factors etc. The effects are as follows.

1. Elderly people can enjoy a happy and safe life with the help of Robot care takers, when staying alone or when their offspring are out of home for work/study reasons. The real-time monitoring of their medical parameters with sophisticated equipment offers them a stress-free and secure life.
2. The medical parameters being observed can be made available to the doctor concerned at regular intervals to monitor progress or weakness in the health of the patients.
3. A healthy life for all people regardless of age could be ensured as early detection of diseases and 24×7 monitoring of health can spot out anomalies or diagnose issues much rapidly.
4. The barrier of geography is eradicated, as the complete medical history is available from elsewhere in the world, hence world-class treatment could be provided in a pocket friendly manner.
5. AI and related technologies in health care can leverage the administrative tasks to be performed by medical practitioners thereby allowing them to focus on productive works that directly benefit the patients.

Overall health care functionalities and human satisfaction could be improvised to a great extent.

2.4 Education

With Society 5.0, Education sector can also have benefit by incorporating the cognitive AI technologies in the following ways.

1. AI technologies can analyze the capabilities of students towards specific subjects and can predict individualized plan for each learner according to his/her needs.
2. The system can also provide proper guidance in the progression of academics and report the learning progression to teachers for feedback.
3. The learning can be made more interactive and could be supported with real-life scenarios for the specific topics under study.
4. By gathering the information of students with similar tastes, a counseling support could be arranged for candidates based on his interests and tastes for choosing his career.
5. Teachers could get insightful information regarding each student and thus help them to figure out the differentiated teaching skills for varied-skilled students.
6. Students around the globe can avail best courses from the best institutions with the facility of e-learning offered by premium universities without the need for physically shifting to the campus that may be geographically far apart. This can produce skilled candidates from any part of the world to compete in the global work market that improve their lives, careers, and talents.
7. The technical, administrative tasks of teachers are also expected to be lessened by the adoption of cutting-edge technology integrated mechanisms.

This can have a huge impact in the quality of teaching and learning, thus molding individuals who choose their career upon their own willingness; hence productivity is guaranteed at workplace because people are doing what they like. Individuals can thus lead a happy life.

2.5 Manufacturing

In Society 5.0, a novel worth can be created by applying big data analysis for aspects such as C2C transaction requests, inventory tracking, purchase orders, and delivery details [10]. It allows the following.

1. By analyzing the current needs, an efficient inventory planning can be accomplished and monitored by collaborating with dealers and suppliers involved in the industry. This task of inventory replenishment can be made automated by the use of IoT-enabled stock keeping warehouse, which will intimate the inventory about the shortage of items when fallen below a threshold.
2. The usage of AI and robots can improvise the production process by coordinating among factories to make more effective production and can enable the inheritance of craftmanship skills.

3. Postproduction, the delivery of items manufactured, must be carried out after analyzing the need, location, logistic requirement etc. The AI system will help in recommending the perfect logistic partner based on their reviews, previous ratings, location, and the requirements. Also the customers and consumers must be provided with the right product on right time within the perfect budget without incurring delays in shipping and delivery.

These measures can aid in increased competitiveness among companies, better response to disasters, mitigate the under-employment issue, reduce GHG emissions and expenses, ensure customer satisfaction.

2.6 Agriculture

In Society 5.0, the use of AI and big data can create a new value by considering the market fluctuations and needs, environmental data, meteorological data, consumer needs, and food trends. Agriculture when collaborated with cognitive computing methods of AI, IoT, and Robots will lead into a smart environment of cultivation where the sensors will collect data about the crop growth, nutrition, water requirement, and based on the data available, the AI systems could analyze and reach at predictions thereby reducing a lot of human effort [11]. Smart Agriculture will create lots of new job opportunities, increased production by implementing automated tractor robots, drones to check crop data, and sensors to determine water needs for the crops. This can be incorporated with groundwater data to have a sustainable use of resources. This will lead to the following benefits.

1. Market analyzed agricultural proposal could be drafted that can meet the demands of consumers and demands of other business partners and suppliers. This will make use of climatic data, experiential knowledge, meteorological data, market flow data etc.
2. On-demand supply of crops for consumers could be made possible with the advancements in this domain.
3. With the aid of self-driving cars, the agricultural products could be delivered to needed customers on time.

The development in this domain has a greater impact in society as it can stabilize the food production and supply, massive production, reduced wastage of food, labor shortage, and employment issues.

2.7 Energy

In line with the sustainable development goals set by the United Nations, Renewable energy, sustainable cities etc. are with higher significance around the globe. With

Society 5.0, the requirement of energy in each household can be analyzed and they can be made self-reliant with the help of solar energy panels if it is feasible in the geographical area. Also, the weather data, climatic data, working status of the power generating plants. Other benefits are listed below.

1. Energy saving schemes and policies to conserve the energy could be put forth to families to promote energy conservation. This must be a customized one treating each family differently based on their usage statistics and family size. The analysis of data powered by AI-based systems can make optimized results.
2. Families will be encouraged to adopt self-production of energy at their premises to meet their needs.
3. Electric vehicles must be promoted, self-driving cabs can also be promoted to reduce Carbon emission to the atmosphere.

In due course of time, it is possible to achieve a stable constant power supply and declination in GHG emission rates.

2.8 Disaster Prevention

When natural calamities or disasters take place, whatever machinery or infrastructure we have, do not matter; mankind always stood helpless before the power of nature. The very less we can do to prevent it, however, we can anticipate what is going to happen well in advance and make protective measures at the right time to escape from it with cognitive AI technologies and robots. In Society 5.0, a novel standard can be created through satellite monitoring of areas affected by disaster and recommend the high-priority tasks to be performed at the right time, radar monitoring to detect volcanic eruption probabilities, forest and land fires, drones to make mobility to places where humans cannot visit, sensors, and the condition of roads. Other merits are listed below.

1. On a natural disaster, people are panicked and need support to rescue their lives. With AI-integrated applications, using a smartphone with each person, information about the nearest relief camps and shelter facilities could be provided, and can navigate them to safe place. The application will also provide information about the successful transit of individuals and can provide the list of needy people who couldn't be successful. Safety and security of the lives of people can be ensured with this technology.
2. When a disaster occurs, it is difficult for humans to offer service to rescue people, as it will be a risk for their lives. In that case, rescue robots and service assistant robots could be sent to the field to safely transfer people to relief camps and the progress of the activity could be monitored in real-time. This can save the lives of people and offer them security amidst calamities.
3. Self-driving vehicles, drones, and other autonomous robot-assists can ensure the prompt delivery of foodstuff and medicines for needed people.

Thus, with the incorporation of cognitive AI suits, the lives of people and quick recovery from a disaster can be ensured.

2.9 Food Products

Ahead is a society which is smart in all aspects. The refrigerator can send an order to the nearest grocery to replenish the food material when its level/ quantity goes low!! This is not a dream, rather it is possible by making every home smart; every device in the home is connected and are capable of communication. The world of real IoT and the information analysis from their huge data is not very far.

Society 5.0 sets up a new standard that considers the information about individual interests in foodstuffs, family choices, sensitivity towards specific food products, retail and market conditions, and supplies. The other merits are as listed below.

1. Based on personal preferences and individual choices, personal recommendations could be provided to people for ordering food; it could also analyze the health parameters of the individual and give suggestions on what to consume and what not. Certain food materials are sensitive to some people and when consumed, it can create health casualty. In such situations, the system can send information to the health profile about the unusual food product and thus will be easy for the doctor to give right treatment at the right time.
2. Reducing food wastage is of great concern around the globe, and with AI-based systems, only the right amount of food will be suggested before ordering, based on past food consumption behavior and current calory content of the individual. The stock of food in the refrigerator is replenished only based on the usage and need, thus reducing food wastage.
3. Healthy eating habits and suggestions could be given by the system based on individual and family preferences, thus creating a generation aware of their health statistics in a better manner. This will offer a healthy, content, and prosperous life.
4. The system can make a supply chain network right from the farm directly to the customers, offering quality food that is affordable and healthy. Based on the needs of customers and retail stores, the farm can manage the production to meet increased or decreased demand for food products. This can reduce the risk associated with the farmers and enable them to tailor their production based on the needs for specific food products.

Overall, the food industry will become more competitive, and consumers can get quality food by reducing food wastage.

2.10 Fintech

Financial sector is currently under a huge transition that rely mostly on technology for most financial needs. People are enjoying the comfort of sitting at home and availing most banking and financial deals which once were cumbersome and needed lots of paper works and financial institution visits, moreover, delay in commitment of transactions. Fortunately, the current society is enjoying all these benefits of technology and the caveat is the security and authenticity. Society 5.0 can integrate block chain technology, big data analysis, and cognitive reasoning AI algorithms to advance the security, fraud prevention, and transparency in all financial deals. The other benefits are listed as below.

1. The need for physical banks with cement and mortar will not be a mandatory requirement in future. This can save the infrastructure investments, electrical and water needs for the physical offices. This can lead to lessen energy crisis, GHG emissions, and the like.
2. The financial offers could be suggested to the individual based on their credit scores and the AI system can also analyze the limit to be sanctioned for everyone based on his/her monthly purchase history, medical needs, financial liabilities, and commitments.
3. People can enjoy the life when they are provided with safer and secure means of financial support without hazzles and could avoid stepping out of home for such needs.
4. The system can recommend individuals for customized savings plan, or schemes to foresee unexceptional needs in future and thus help them to offer a stress-free life.

Thus, the financial domain can bring about personalized choices with technology to offer a secure and fraudulent free service.

2.11 Tourism

With the advent of air routes and land routes and water routes, the world has become a global village that attracts tourists from elsewhere in the world, to visit and enjoy their countries. Tourism is one of the key factors that decides the slope-up or slope-down of economy for most countries. The implementation of Society 5.0 can bring out a new phase in the field of tourism by offering the following benefits.

1. A centralized transparent channel or umbrella for entry and exit to a country could be more advantageous as it attracts tourists without any ambiguities. This can be offered by the AI-enabled systems and give insights to the department of tourism regarding the expectation of visitors to their country during specific periods in the year. This insight can also include the type of visitors and their

source country so that the food and accommodation facilities could be more tailored to meet their expectations.
2. As far as the visitors are concerned, they must be able to avail a safer, cheaper, and worthy travel in the country they visit. The recommendation to the visitors could offer them places to visit, sightseeing, booking of self-driving vehicles, restaurants, and accommodation facilities as per their previous travel history.
3. Any medical contingency or natural calamity if occurs, the system must properly intimate the presence of visitors to official departments, and their rescue must be ensured. The families of the tourists must also be intimated about the mishap and proper measures to be taken care to recover from the issue.
4. Cashless and safer transactions for tourists can ensure a safe and secure travel which makes their trip happy and enjoyable.
5. Based on the rating and interests of the current trip the individuals will be notified of future travel plans and recommendations with the help of the system.

2.12 Cyber Space

Cyber space was a mystery a few decades ago, however, it's a part of life in the current society. The services offered by the cyber space for organizations, economy, politics, industries, communication sector, travel sector and international financial sector, stock exchange transactions, commercial, and retail transactions are praiseworthy and inevitable. The new standard to be brought into cyber space in Society 5.0 must include the following.

1. The matters concerning state and national affairs must have the most secure means of communication channel which cannot be compromised at any cost. The technology must take care of the possible attacks and prevent it and thus keep the confidential information secure and encrypted.
2. People must have freedom to express their feelings, opinions in cyber space, without affecting the liberty of others. The AI systems should be designed such that the communication and information in the cyber space is from authentic source and are dependent on facts rather than revenge, anger, or intention to bully/insult.
3. The electronic communications and transactions pertaining to a financial institution or bank must be protected with advanced means to safeguard the privacy of individuals and corporates or companies. The data available on website and company portal must be accessed only through authentic people and credential verification must be accomplished with maximum security.
4. Procedures must come into place where the intellectual property rights pertaining to scientists, artists, poets, companies must be properly taken care with authentic means. Cybercrimes that may occur in these fields must be encountered with proper measures set by the AI systems that can determine the fraudulent moves if any from any part of the globe over the Internet.

5. The usage of digital signatures by individuals, rulers, officials, bureaucrats, judiciary must be secured by employing block chain and similar safer techniques with an AI system to track and detect the fraudulent moves or crimes from elsewhere.
6. Proper systems to track terrorist activities and spread of vengeful information, messages that convey violence, murders or threats to lives, criminal activities etc. to offer a peaceful and happy life for the nations and individuals. The commitment of crimes could be prevented to a great extent, and time to nab the criminals become quicker with the help of new AI-powered systems.

The following Table 6.2 will give a quick glimpse of applications that could potentially make use of cognitive computing technology in varied domains.

Technology integration to most necessary walks of lives can bring about safety, security, and confidentiality to everyone in the world. The cyber space is to be enabled with the most advanced cybersecurity techniques, AI-based system that analyze and produce optimized results and suggestions. This will urge for competition among countries around the globe to strive harder in IT solutions and innovations. The next section will describe about cognitive computing.

3 Cognitive Computing in a Nutshell

Cognitive computing is a branch of Artificial Intelligence that is developed to work and think alongside human. The idea is to leverage the complexity in analysis and computing to be processed manually, thus human focus could be diverted to useful work that can improvise productivity. With the advent of modern technology and computing power, huge wave of data is being generated every second and this amount of data must be properly analyzed. Cognitive computing has the ability to disseminate the pile of data to appropriate processing units so that insightful information would be generated for humans to perform a decision making. It also can deal with complex and sophisticated data that may sound conflicting, ambiguous and differs based on context [12].

3.1 Characteristics of Cognitive Computing

According to Cognitive Computing Consortium, which is a forum to bring together the cognitive computing community, it has four specific characteristics [12] as shown in the Fig. 6.7.

1. **Adaptive**

The cognitive systems are expected to adapt to the changes that happen to the data on the go. Whenever a new data is introduced, the system must be able to handle it by adapting itself on real time.

Table 6.2 Domains and applications of Cognitive computing in smart society

Domain	Technologies in action	Applications
Infrastructure	Fusion of AI with drones, IoT, sensor networks, robotics	Autonomous driving, easy detection of road, rail damages, traffic data analysis
Mobility	Amalgamation of AI with sensor networks, satellite networks, big data analysis, navigation systems	Customized travel plans and recommendations, accommodation pattern suggestions
Health	A mix of AI with medical networks, big data analysis, robotics, sensor networks	Comprehensive health data availability, robotic assistants for care-taking, real-time patient health monitoring
Education	A commutation of AI with big data and pattern analysis	Personalized learning pattern recommendation, wholistic student data in entire duration of study, e-learning suggestions for a student from around the globe
Manufacturing	A fusion of AI, Robots, IoT-enabled inventory, and stock base	Inventory planning, production controlling based on demand, postproduction logistic selection recommendation
Agriculture	AI, Robots, sensor networks, big data analysis, satellite data for meteorological analysis	Market analyzed crop proposals, On demand supply of crops, automated delivery of crops based on order
Energy	AI, autonomous vehicle network, navigation systems, satellite data, big data analysis	Customized energy saving schemes for families, carbon-free driving, self-production of energy scheme
Disaster prevention	AI-powered drones, satellite networks, robots, sensor networks, IoT networks	Smart rescue operations, deployment of rescue robots
Food products	AI with IoT and data analysis	Health-based food recommendations, auto ordering food supplies based on kitchen inventory, history-based food order placing to reduce wastage
Fintech	Cognitive reasoning enabled big data analysis, block chain technology	Customized recommendations on financial needs, non-physical financial transactions at ease
Tourism	AI with big data analysis, navigation networks, satellite networks	Personalized trip planners, access to the world as a global village, single window medical emergency, and cash transaction around the globe

2. **Interactive**

The cognitive system must interact with humans and be able to do communicate in real time. This is termed as Human-Computer Interaction (HCI). This enables to receive and send information from/to hardware devices like sensors and access cloud services.

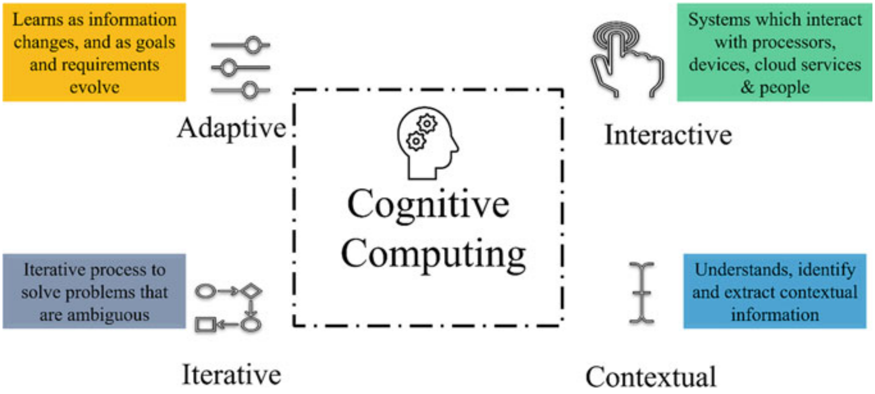

Fig. 6.7 Characteristics of Cognitive Computing

3. **Iterative and Stateful**

Cognitive computing system must be able to keep alerted when any problem remains unsolved. The problem when recognized to unsolved, the cognitive system must seek several ways to solve it, based on the history of solving similar problems. Hence it should memorize the past problems and ways using which it's been solved.

4. **Contextual**

The cognitive computing must be able to learn the context of the problem, as the context matters a lot in finding the right path for solving the problem. Humans are experts in understanding the context and act according to the situation, and this common sense of human must also be imitated by the cognitive computing system. Structured, unstructured, and sensor data could be made use of to achieve it.

The goal of Cognitive computing is not to replace humans from the context of workplace, rather to assist humans to bring about the focus to quality work [12]. Cognitive Computing is able to develop Cognitive models by the combination of various technologies which includes Natural Language Processing, Machine Learning, Deep Learning, and Artificial Neural Networks as shown in Fig. 6.8 [13, 14].

1. **Natural Language Processing**

Natural Language Processing is the domain of computer science which can understand the natural language of humans, both written and spoken, and process it to produce useful information. When cognitive computing mimics the human, it must also be able to access, interpret, retrieve, and process these natural languages in written and spoken form which emulate human syntax.

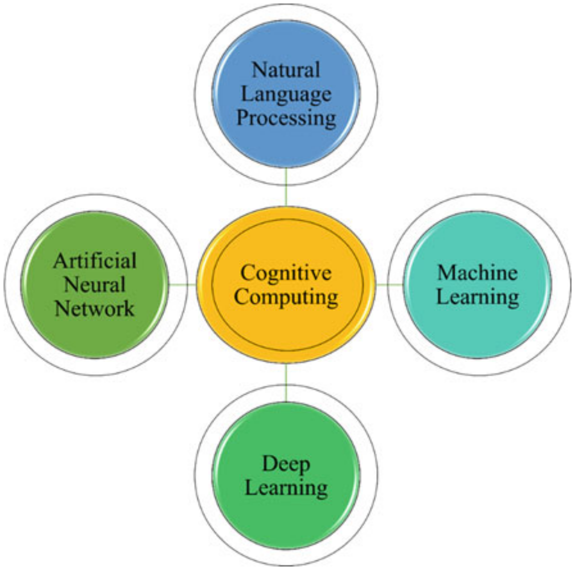

Fig. 6.8 Combination of technologies to develop Cognitive Computing Model

2. **Machine Learning**

Machine Learning is the domain under Artificial Intelligence that uses neural networks that can imitate the human brain functioning. Machine Learning algorithms can identify the specific patterns in the data, interpret it, and make predictions if provided/trained with a sufficient quantity of data.

3. **Deep Learning**

Deep learning is a complex approach to Machine learning that comes under AI. They are able to handle huge amounts of data and with complex Artificial Neural Networks.

4. **Artificial Neural Network**

Artificial Neural Network is an approach towards Machine learning which are widely used in computer vision, pattern recognition, speech recognition, medical diagnosis applications, and several types of categorization applications. ANN imitates a human brain that has numerous connections to other neurons. An ANN has input, hidden, and output layers connected with specific weights for the process of computation. It is widely used for labeled data and problems.

3.2 The Differences Between Artificial Intelligence and Cognitive Computing

Artificial Intelligence and Cognitive computing have their origins from the same basic building blocks. What makes Cognitive computing different is that it adds a human touch beyond AI. It mimics to have the human ability to have common sense. Artificial intelligence can handle huge amounts of data, access, retrieve, process, and analyze big data, find patterns in the data, learn from the data, and devise solutions to the problem. AI is a number cruncher; on the other hand, Cognitive Computing can use those outputs generated by AI to analyze the gradation in the output. The major differences between AI and cognitive computing as are follows [15].

1. **Cognitive Computing Can Imitate and Learn Human-Thought Process**

While the aim of AI system is to solve a problem using predefined algorithms, the goal of cognitive computing is learning the patterns in the data and provide a useful insight to humans in the form of suggestion. Humans are then capable of taking relevant action based on the recommendation provided by the cognitive computing systems. When a problem is being submitted to an AI-based system, it completely takes care of that problem until it is solved. It will select the necessary steps which could possibly solve the problem, it knows how to bypass certain contexts using prior knowledge of existing algorithms. On the flip side, the cognitive computing will act like an assistant rather than a problem solver. It acts as a personal assistant to humans which offers the decision-making power to humans. The situation where the system makes a wrong decision is totally eradicated in cognitive computing systems.

2. **Cognitive Computing Will No Way Replace The Humans from Workplace**

Humans are masters in decision making, and cognitive computing acts as an assistant. This will endow humans the command over decision making after analysis of result. To distinguish between both, let's investigate an example in health care system. The decisions about what kind of treatment to be provided for a patient will be taken by an AI system without consulting with the doctor. The impact of such a treatment plan, if wrong can risk the life of a patient. When it comes to cognitive computing, the human diagnosis is supported by the findings of cognitive computing systems thereby improvises the decision-making process which is done by a doctor.

3.3 Advantages of Cognitive Computing

Cognitive computing is about to revolutionize the information society and is about to replace the technologies and legacy systems that have been widely used for the past 20 years [15]. As cognitive computing has the ability to handle large volume of data, it is expected that it will employ a real-time system to handle multitude of tasks. The benefits of Cognitive computing are listed below.

1. **Precise Data Analysis**

Cognitive computing systems are efficient in collecting, analyzing, and cross matching relevant information to produce a better recommendation [15]. One of the best example in healthcare is the IBM Watson [16] that collects various records related to patients, gather similar treatment case studies, grab opinions from doctor fraternity, and thus suggest a treatment plan for the patient. Thus the doctor is backed up with useful insights about the patient and treatment plan and is helpful for patients as well. Here the doctor is not replaced, instead the capabilities of doctor and productive time of doctor has been optimized, thus improving the quality of health care system.

2. **Improved Human–Computer Interaction**

Robotic process automation enables the customers to interact with the robot, instead of staff, thereby to get unbiased information, which is relevant, contextual, and vital in all aspects. Cognitive computing equips the system to have contextual knowledge, and this can be tapped to improvise the customer satisfaction.

3. **Increased Efficacy in Business Processes**

In real time, cognitive computing can recognize developing trends, spot business possibilities, and handle crucial process-centric challenges. A cognitive computing system like Watson can streamline operations, minimize risk, and pivot in response to changing circumstances by analyzing a large amount of data [15]. This helps firms construct a correct response to uncontrollable factors while also assisting in the creation of lean business operations.

3.4 Caveats of Cognitive Computing

People are always afraid of changes happening in the society. They have an intuition that cognitive computing will replace the role of humans from workplaces. Their thought process raises a few concerns about the limitations of cognitive computing systems which are listed as follows [15].

1. **Security**

In cognitive computing systems, voluminous amount of data is handled by it and hence there arise a question of security to the data that it handles. Data security and encryption is of utmost concern and priority in such kind of systems. Cognitive computing must develop a strong security design as it deals with more connected devices and its related data.

2. **Adoption**

The main obstacle to any modern technology's effectiveness is spontaneous acceptance or adoption. It is critical to build a long-term strategy of how cognitive computing will improve processes and enterprises for it to be effective. The adoption mechanism can be simplified by working together with diverse stakeholders such as tech-innovators, businesses, governments, and individuals. Simultaneously, a data privacy policy is essential to accelerate the adoption of cognitive computing.

3. **Change Management**

Another significant problem that cognitive computing will face is change management [15]. Because of their innate human behavior, individuals are inflexible, and because cognitive computing has the ability to learn like humans, people are concerned that robots may one day replace humans. This has had a significant impact on future growth prospects.

Cognitive technology, on the other hand, is designed to work in tandem with humans. Humans will provide information into the systems to feed the technology. As a result, it serves as an excellent example of a human-machine connection that people will have to accept.

4. **Lengthy Development Cycle**

One of the most significant obstacles is the amount of time required to construct scenario-based applications using cognitive computing [15]. Cognitive computing is currently being developed as a generalist solution, which means it cannot be deployed across many industrial segments without the use of large development teams and a significant amount of time. Smaller businesses find it more difficult to acquire cognitive capabilities on their own due to long development cycles. Cognitive computing will undoubtedly become more prominent in the future as development lifecycles become shorter.

With all the barriers and bottlenecks, cognitive technology's advantages cannot be disregarded. Starting the transition process and adopting innovative technology for a brighter and more efficient future will benefit all organizations and humanity as a whole. The impact of cognitive technology on enterprises is predicted to grow significantly in less than 5 years. Stakeholders across all industries and disciplines must determine whether, how, and where to invest in cognitive technologies.

The next section discusses some major successful use cases of cognitive computing at business and market.

4 Use Case Scenarios of Cognitive Computing at Work

Cognitive Computing is the future technology. There are lots of successful business models that have integrated the cognitive computing technology into their business. A few of such use cases are listed below.

Fig. 6.9 Cora-the intelligent assistant for Royal Bank of Scotland (image source [17])

4.1 Intelligent Assistant-Cora (Royal Bank of Scotland-RBS)

Cora is an intelligent agent used in Royal Bank of Scotland, which was developed with the help of IBM Watson [16]. This assistant is capable of handling 5000 queries a day [17]. With its cognitive computing learning ability, Cora was able to analyze the customer grievances and generate a repository of FAQs by customers. Cora learnt the pattern in frequently asked questions and was able to handle the queries by itself, unless it is too complex to switch over to human service executive. The Fig. 6.9 shows Cora, the intelligent assistant of RBS.

4.2 Personal Travel Planner by WayBlazer

WayBlazer is the world's first cognitive recommendation system for travel planning [18]. Cognitive computing paves the way for personalized travel planning for travelers by asking for travel plan in natural language. The travelers need not search internet multiple times to gather information regarding flight, restaurants, accommodation, sightseeing, cab booking etc. The customized plan based on the personal travel preferences will be provided to travelers which makes their trip planning easier and hazzle free. This cognitive-powered system is being used by travel agencies and their revenues got improvised based on reviews and surveys by delightful customers. The logo of WayBlazer is shown in Fig. 6.10.

Fig. 6.10 Logo of WayBlazer (image source (Lind [19])

Fig. 6.11 Cafewell mobile application interface and logo (image source [20])

4.3 Cafewell—A Healthcare Concierge by Welltok

Cafewell is developed by Welltok and is a healthcare concierge that acts as a holistic population toolkit used by providers health insurance that ensures customers with their relevant health data. It can handle queries of the customers, can collect and process data relevant to health and thus provide the end-customers with a healthy recommendation. According to the words of their CEO Jeff Margolis, the health care system must be transformed to health-status systems from a sick-care system. Figure 6.11 depicts the Cafewell application.

4.4 Fantasy Football Team Decision Maker by Edge up Sports

With cognitive computing capabilities, Edge Up Sport [22] has successfully integrated in their mobile application, a mechanism to pick Fantasy Football teams by raising a few simple questions. The questions are available in natural language, and this enables the system to analyze the data and arrive at a conclusion about the player by searching over all possible means over internet from social media, news reports, and sentiment gages to find the right player.

Fig. 6.12 Football Team (image source [21])

The Table 6.3 shows the summary of Use cases of cognitive computing discussed so far.

Table 6.3 Summary of use cases of cognitive computing

Cognitive Technology	Business/ User	#1 Idea	#2 Idea
Cora-Intelligent Agent	Royal Bank of Scotland	Can handle 5000 queries per day	Can respond to varied frequently asked questions by customers, and only transfer to humans if it is complex
Personal Travel Planner	WayBlazer	Can ask travel-related queries in natural language	Saves time by finding customized travel preferences without the need to check internet multiple times
Cafewell-Healthcare Concierge	Welltok	Provides a holistic population tool for health insurance providers about customer's health	Offers smart and custom health recommendations that enhance the health quotient
Fantasy Football Team Decision maker	Edge Up Sports	Help fantasy football "owners" make better roster decisions	Capture what's being said across the sports and social media spectrum about real-world players and synthesizes it into concise, up-to-date assessments of positive, negative, and neutral. [16]

5 Conclusion

Even though the concept of Society 5.0 is introduced by Japan and is their roadmap to smart future society, this is going to impact the whole world and benefit in various ways. The social issues in the society could be wiped off with the advent of cognitive computing technologies and hence this will be a blueprint for all countries around the globe. With the integration of cyber space and physical space, a healthy, happy, safer, and better lives could be offered to people by leveraging the routine mundane tasks by humans. The intention of this work is to find the potential applicability of Society 5.0, the need for it, the impacts if implemented, and the vital sectors that are affected with its materialization. It also examined the domains that are mostly going to benefit out of its implementation. It is evident from this work that Society 5.0 has a huge potential in aiding the economical and social issues of any country, thus creating a smart future society. Plethora of industries and domains will be benefited by automating human assistants in various sectors of everyday life and business. In line with the Sustainable Development Goals (SDGs) of United Nations, the mobility, energy, transportation, logistics sectors can bring about reduced GHG emissions and thus affect climate condition positively. The advancements in the health care sector will ensure a peaceful, happy, and healthy life for each individual and thus life becomes enjoyable and filled with fun. Similarly, all other fields where Society 5.0 impacts, positive growth and radical changes can be expected. Organizations must conduct a thorough study of their processes, data, talent model, and market in order to gain the greatest benefits from cognitive computing. In addition to cost reduction, one of the most significant benefits of cognitive technology is the ability to create value, as well as the ability to restructure work and boost efficiency by making a variety of processes leaner.

5.1 Future Scope and Discussion

The future smart society 5.0 is a cognitive computing-powered society that must put forth proposals for the following matters.

1. A full-proof security plan for Cognitive Computing system as huge voluminous data are handled by the system
2. Most modern cyber security and data encryption standards to ensure the safety of data handled by the system.
3. Skilled manpower to make decisions based on the insights obtained from the system after data analysis.
4. The system development life cycle must be specific to each requirement and must have a lessen time span to develop.

Cognitive technology implementation begins with the discovery of manual tasks that can be transformed into automated utilizing the technology in line with the digital evolutionary cycle. Many corporations, like IBM, already had established the cognitive technology arena, which is powering several genuinely digital businesses throughout the world.

Let the future be a heaven on Earth to live upon!

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Chapter 7
Big Data Analytics in Industry 4.0 in Legal Perspective: Past, Present and Future

Jayanta Ghosh and Vijoy Kumar Sinha

1 Introduction

Big Data is a new sort of technology that gathers and analyses client data to forecast sales and marketing tactics in the future. Companies often utilise this new branch of research to better their operations by analysing and enhancing their marketing efforts. In addition to government and industry, individuals are interested in influencing their judgments [5]. A shop may believe that technology is assisting them in improving customer service, but in truth, it is assisting them in influencing their customers' buying choices by analysing their data [13]. This method succeeds because the organisation essentially sells itself to prospective contributors by gathering this information.

The more individuals are aware of the existence, the simpler it will be to solicit funds. The fewer knowledge individuals have about you, the easier it is for them to take from you. Being a victim of a robbery is similar to being a victim of fraud. With all of this information about yourself available on the internet, a criminal group will have an easier time stealing from you. For example, A young woman who discloses her personal life on Facebook is one of the most typical frauds. The robbers then pretend to be the cops who detained her and phone her grandparents. After that, the grandparents are convinced to contribute money to get her out of prison. The criminals employ a variety of emotive tricks to get grandparents to pay money to help their grandson get out of prison [31]. The more privacy we have online, the more protected we are against crooks. Having greater privacy may aid grandparents in avoiding being duped into a scam.

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Big data may be tracked back to the beginning of time. Industries and organisations physically gathered it and utilised it to analyse their diverse requirements and markets. Big data is becoming an essential component of any company's strategy. It allows them to recognise and analyse the different aspects that influence their company's success. Data collecting firms must address the safety and security of their acquired data in light of the growing danger of cybercrime. This study seeks to give a complete overview of the numerous procedural requirements for industry and societal security compliance. It will also look at the legal issues and solutions surrounding data industry 4.0.

2 The Basic Flow of Big Data's Past, Present, and Future

Although Big Data is a relatively new concept, many of its foundations were set years ago. Even before computers were commonplace, researchers believed that people created an ever-growing corpus of data that could be analysed. Even though it is tough to remember, our ability to retain and analyse enormous amounts of data has steadily increased through time. Here is a timeline of the concepts and innovations that resulted in the emergence of Big Data (Fig. 1).

2.1 The Origins of Data

C 18000 BCE

Tally sticks were one of the first examples of people keeping and analysing data. The Ishango Bone in Uganda, founded in 1960, is regarded as one of the first examples of prehistoric data storage. It was common for Palaeolithic people to keep track of their supplies and economic activities by marking or engraving grooves on their bones or sticks. They had to learn how to divide and multiply sticks and notches to understand the basic math of food supply better [28].

C 2400 BCE

The abacus, which was first invented in Babylon, is the world's first specialised device for calculation. Around this time, the first libraries for large-scale data storage were also founded [28].

300 B.C. to 48 A.D.

The Library of Alexandria is the biggest store of knowledge ever compiled in the ancient period. It is the world's largest repository of information ever assembled in the ancient world. According to popular belief, the library was destroyed by the Romans in 48 A.D. Not everything in the structure was destroyed, contrary

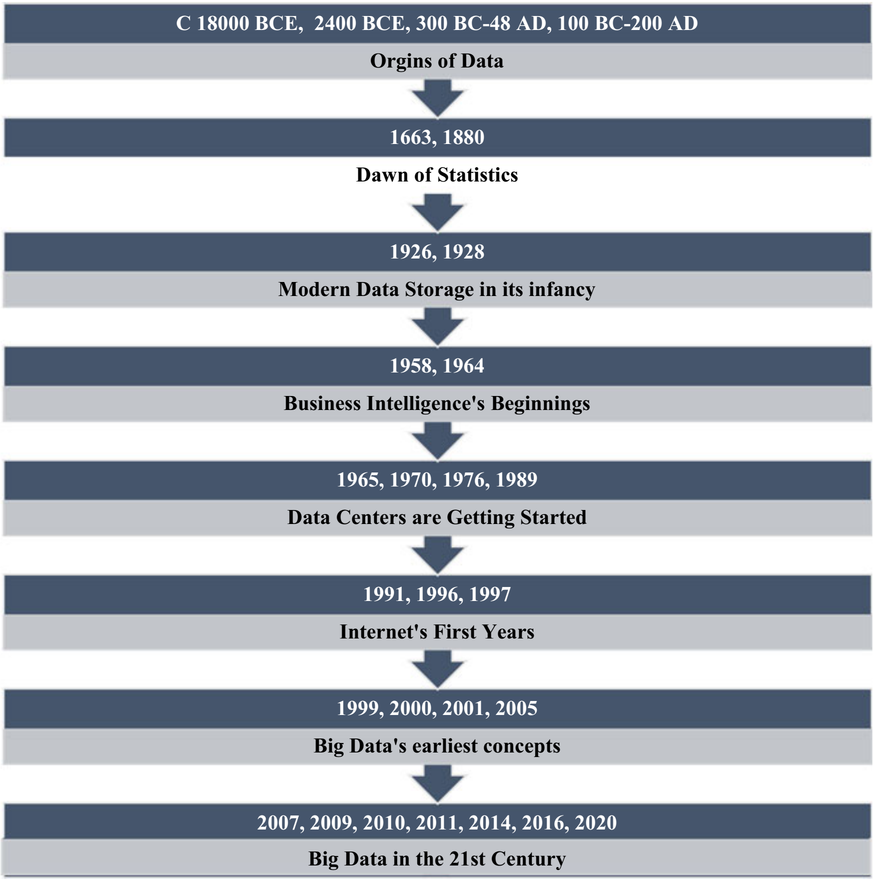

Fig. 1 Flow chart of Big Data from past to future

to common perception, and enormous sections were either transported to other cities or distributed across the prehistoric period [28].

C. 100–200 A.D.

In Greece, Antikythera Mechanism was found [9]. It is thought that the concepts of ancient mythology were used in its construction by its creators. According to legend, this mechanical device's design, which is said to have been influenced by the Olympic Games' cycles, was also intended to mark the beginning of a new generation of mechanical gadgets.

2.2 The Dawn of Statistics

1663

In London, in 1854, John Graunt conducted the world's first recorded statistical data experiment. In his reasoning, he believed that by researching human mortality, he would design an early warning system in the event of a devastating epidemic.

1880

The Census Department of the United States had an issue that it plans to process the data collected in the 1880 census for eight years, and it will take longer to process the data it gathered in the 1890 census. Herman Hollerith, a young bureau engineer, invented the Hollerith Tabulating Machine in 1881. He uses punch cards to reduce ten years of labour to three months, giving him the moniker "Father of Modern Automated Computation." IBM will be the name of the company he found [30].

2.3 Modern Data Storage in Its Infancy

1926

Inventor Nikola Tesla in an interview with Collier's magazine, asserts about wireless technology that when it is "perfectly applied, the entire Earth will be transformed into a gigantic brain, as it already is, with all things constituting particles of a real and rhythmic whole… and the instruments by which we will accomplish this will be straightforward in comparison to our current telephone" [30].

1928

A German-Austrian engineer, Fritz Pfleumer, was the first to develop the magnetic tape for storing information. Although his ideas are still being used today, the magnetic storage of digital data on computer hard drives accounts for the great bulk of computer data [30].

2.4 Business Intelligence's Beginnings

1958

When it comes to business intelligence, Hans Peter Luhn, a researcher at IBM, says it is all about seeing the connections between data sets and creating a plan that serves a particular goal [30].

2.5 1964

According to New Statesman discusses challenges to cope with the ever-increasing quantity of information accessible nowadays [30].

2.6 Data Centres Are Getting Started

1965

The US government has announced that it plans to build the world's largest data centre, house more than seven hundred million tax records [30].

1970

Edgar F Codd, a mathematician at IBM, proposes a "relational database" design in his paper. Many current data services utilise it to store information hierarchically that anybody may access if they know the search criteria. It was previously necessary to seek the aid of a specialist in order to get access to data stored in a computer's memory banks [30].

1976

The utilisation of Material Requirements is essential. Previously commercial applications for computers were used to hurry up and simplify routine operations in corporate planning systems, which are becoming more common. Until recently, the vast majority of individuals have only seen them in academic or research contexts [30].

1989

Erik Larson, a New York Times best-selling author, wrote an essay for Harper's Magazine on the origins of the junk mail he gets. According to him, "the defenders of big data feel they are acting in the best interests of customers. However, data tends to get misappropriated and utilised for things other than what it was initially meant for." Aside from that, the term "business intelligence," which has been in use since the late 1950s, is seeing a resurgence in prominence as new software and methods for analysing commercial and operational performance are introduced [30].

2.7 The Internet's First Years

1991

A computer scientist, Tim Berners-Lee, was the first to formally proclaim the creation of the Internet. An interconnected global network of data that can be accessed from anywhere on the earth is described in an article posted to the alt.hypertext Usenet newsgroup [30].

1996

B J Truskowski's and R J T Morris's book "The Evolution of Storage Systems" claims that this was the moment when storing in cloud became more economical for the majority of people than paper storage [30].

1997

What is the total amount of information available on the planet? [26] The novel by Michael Lesk has been released. According to the hypothesis, this is "probably not an outrageous assumption" since 12,000 petabytes of storage are available. Additionally, he points out that the web is expanding at a rate of ten times every year, even at this early stage of development. He points out that nobody will ever see the vast majority of this data and, as a result, will provide no useful information. Google Search makes its debut that year, and the phrase "Google Search" will be used as a shorthand for looking for information on the internet for at least the next 20 years [30].

2.8 Big Data's Earliest Concepts

1999

The word "Big Data" first appears in a book released by the "Association for Computing Machinery" a few years later, titled "Visually Exploring Gigabyte Datasets in Real-Time." A new round of criticism has been levelled at the tendency to store massive amounts of data without providing a way for adequately analysing it. It continues to refer computing inventor "Richard W, Hamming." The phrase "Internet of Things" was used for the first time to characterise the expanding number of objects connected to the internet and their capacity to interact with one another, frequently without the involvement of a human "middle man" [30].

2000

How Much Information Do You Possess? First, Hal Varian and Peter Lyman sought to measure the worldwide volume of digital information and its pace of expansion." They estimated that the yearly production of print, film, optical, and magnetic material would need roughly 1.5 billion gigabytes of storage." This equates to 250 megabytes every person on the earth for every man, woman, and child" [30].

2001

Gartner researcher Doug Laney highlights three characteristics of Big Data that will become widely recognised in his study "3D Data Management: Controlling Data Volume, Velocity, and Variety." This year, the "Software and Information Industry Association" published the column "Strategic Backgrounder: Software as a Service", in which they stated, “software as a service"—a theory which is critical to massive internet-based applications that are now industry standards—is used for the first time [30].

2005

The emergence of “Web 2.0”—user-generated content in which the great number of material is created by users of internet rather than who are providing services. This is done via standard HTML-style web pages in conjunction with big SQL-based back-end databases. A total of 5.5 million people have already joined up to Facebook, which was launched a year ago and allowed users to publish and share personal information with their friends. This year also commemorates the first anniversary of the release of Hadoop, an open-source platform built mainly for storing and analysing enormous quantities of data. Because of its versatility, it is well suited for dealing with unclustered data, which are creating and accumulating in large quantities [30].

2.9 Big Data in the Twenty-First Century

2007

Wired presented the idea of “Big Data” to the broader audience in their article “The End of Theory: The Data Deluge Is Making the Scientific Model Obsolete,” released in 2011 [30].

2009

Large corporations in the United States with more than 1,000 employees, as per the “McKinsey Global Institute’s Big Data: The Next Frontier for Innovation, Competition, and Productivity,” store more than 200 terabytes of data on average [30].

2010

The executive chairman of Google, Eric Schmidt, claims that every two days, as much data is generated as was produced between the birth of human civilization until 2003. [30].

2011

Approximately 140,000 to 190,000 trained data scientists would be required in the United States by 2018, according to the McKinsey report. Additionally, intellectual property, security, and data privacy must be solved before Big Data’s full promise can be realised [30].

2014

For the first time, due to the proliferation of mobile devices, more individuals are accessing digital data through mobile devices than via office or home PCs. According to a poll performed by GE in collaboration with Accenture, 88 per cent of business leaders rank big data analytics as a critical priority [30].

2016

The exponential growth of mobile devices—For the first time in history, more individuals access digital material through mobile devices than desktop or laptop computers. Eighty-eight per cent of company leaders surveyed by GE and Accenture consider big data analytics a significant priority [30].

2020

As reported by "Allied Market Research," global business analytics and big data reached $193.14 billion in 2019 and is predicted to reach $420.98 billion by 2027, rising at a compound annual growth rate (CAGR) of 10.9 per cent. According to predictions, data handling and processing in critical sectors will be transformed by edge computing. It is edge computing that will be the next frontier for big data. Edge computing refers to processing done close to where the data is collected rather than in the cloud or a centralised data centre.

3 From Industry 4.0 to Society 4.0

Industry 4.0 is the merging of the physical and digital worlds. This digital revolution is characterised by technology that harnesses Big Data and Artificial Intelligence to foster the development of self-learning systems. Manufacturers now strive for business intelligence by collecting, analysing, and exchanging data across all critical functional areas to achieve manufacturing excellence. Modern factories are growing more sophisticated and linked, posing new difficulties that automation enabled by Big Data can handle. The massive volumes of data generated by the IoT and current computer systems have allowed intelligent factories to rapidly raise their efficiency and achieve considerable benefits in terms of uptime, production speed, and error reduction. The connecting possibilities enabled by the IoT have resulted in creating very massive and complicated information networks. Without Big Data, 4.0 technologies would not be capable of deciphering and extracting value from all that information to learn, produce predictive analytical patterns, and operate autonomously and with such precision. As a result, without Big Data, there would be no Industry 4.0, nor would there be intelligent technology to enable it.

The term "fourth industrial revolution" implies that it is not entirely new and has many traits with its predecessors. Technology developments have often spurred worries of job losses, but these predictions have proven baseless. The fourth industrial revolution's speed of change is exponential, not linear, and society may not adapt in time. Regulation and bureaucracy may create barriers to change, and socio-economic institutions are extremely inertial. The EU is becoming more risk-averse and less entrepreneurial. As a result, we do not have the time (or often the guts) to embrace rapidly evolving technologies. In the meantime, Japan has initiated work on Society

5.0. A super-smart society is one in which "all people may get high-quality services and live a comfortable, vigorous life regardless of their age, sex, region, or language," according to Japan's 5th Science and Technology Basic Plan [15].

4 From Industry 4.0 to Market 4.0

The emergence of ideas like big data, social media, corporate social responsibility, and e-commerce has made Marketing 4.0 a reality in our daily lives, driving the shift to Marketing 4.0 [22]. E-commerce is a significant factor in influencing client buying choices. E-commerce has had a significant influence on the buying process and stages. As a result, e-commerce has developed into a challenge that highlights the importance of people in the purchasing process and decision daily.

In 2020, the worldwide Industry 4.0 market valued at USD 101.69 billion. As a result of the pandemic, industry products and services have seen a surge in demand in every area. The worldwide effect of COVID-19 has been unparalleled. According to our research, the worldwide market is expected to rise by 14.5% in 2020 compared to the year-on-year growth seen between 2017 and 2019 [36]. From USD 116.14 billion to USD 337.10 billion in twenty years, the market is expected to increase at a CAGR of 16.4 per cent from 2021–2028. Once the pandemic is finished, this market's growth and demand will revert to pre-pandemic levels, explaining the steady increase in CAGR. Robotics, PLC automation, control room solutions, and motors and generators are some of the products offered by technology companies like ABB Ltd. Furthermore, Siemens AG offers various services, including building technologies and industrial automation and mobility. Increased emphasis on efficiency and cost-effective productivity across various sectors improves the market's potential for development. There has been an increase in industrial value chain disruption due to recent breakthroughs in digital technology and industrial automation. Improved efficiency, reduced costs, higher productivity, tailored offerings, and new revenue and business models are all being realised due to the fourth industrial revolution (4.0).

4.1 Phases of Marketing 4.0

Basically, there are four phases, discussed as below (Fig. 2):

Phase 1: Marketing 1.0, which appeared in the industrial period, is the foundational stage of the marketing lifecycle. Marketing 1.0 is primarily concerned with selling items independent of the market's wants and expectations [21]. In Marketing 1.0, the term *"product-based marketing"* is used to describe it. Aiming for high-quality items that give clients functional advantages is the goal here [25]. In 1.0, marketing is at the

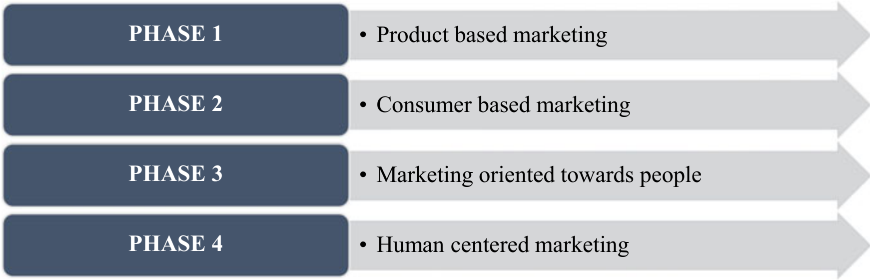

Fig. 2 Phases of marketing

centre of product marketing. The traditional means of communication (such as television, radio, and email) are the only ones included in Marketing 1.0's communication evaluation [10].

Phase 2: As the information age begins to take hold, so does a new phase in the notion of marketing, known as "Marketing 2.0." During Marketing 2.0, the consumer takes centre stage. When it comes to identifying new target markets, thorough customer analysis is at the top of the list in this time frame [21]. Marketing 2.0 emphasises listening to and meeting the wants and requirements of customers (Fucui 2018). After receiving marketing messages, clients are actively involved in all aspects of the process of advertising and promotion in Marketing 2.0 [10]. Traditional and online media are used in Marketing 2.0 to communicate and promote products [35].

Phase 3: Marketers in Marketing 3.0 are considered humans, with their minds, emotions and souls integrated with their clients' consumer attributes [25]. It is clear from this passage that in Marketing 3.0, his focus has entirely switched towards human beings [38]. Consumers' wants and requirements have often shifted over this period. As a result, corporations have begun to pay more attention to this issue. As a result, firms have undertaken ongoing market research, tracked technical advancements, and adapted them to align with customer preferences [32].

Phase 4: Big data analysis enhanced production and service customisation. Customers' need for "*simply done for them*" services grows as they become more sociable. This transformation necessitated a new strategy for marketing. This is "Marketing 4.0" [25]. Companies and customers may interact online and offline with each other in Marketing 4.0. The human-to-human connection is strengthened by integrating machine or artificial intelligence with other technologies and thus improves the customer engagement process at the same time (Fucui 2018).

Because of the postmodern revolution-Fourth Industrial Revolution, technology and the digital world are moving at a rapid pace in every field and every sector of the corporate world [2]. Marketing 4.0 has been expedited by the emergence of big data and social media concepts, corporate social responsibility, and e-commerce in today's society [35]. A strong connection between the customer and the company may be effectively built by digitalization, big data, content development on social media, and good social media management (Soyak 2018).

5 Literature Review

The following table is the list of literature reviews (Table 1).

6 The Legal Constraints of Big Data Analytics

In today's era number of businesses that handle and maintain personal data face a shared legal risk due to big data. If a business collects massive data collection, including personal data, privacy protection rules will apply. The legal difficulties surrounding big data begin with individual privacy, which contains sensitive personal data such as names, addresses, medical records, bank account information, or unique identifiers. The legal constraints that big data faces are discussed below:

A. Ownership of Data

Data ownership should be a logical place to start when looking at data privacy and security. This technique, however, may be problematic due to the nature of the data and how it was gathered. Consumers and users are most concerned about privacy regarding big data. The problem will most likely not be the increased availability and amount of data; rather, it will be insufficient or unsuitable reference, erroneous interpretations, and detrimental, or protruding behaviours [3]. While legal analysis is vital to find the right owner of certain data. Now, the question arises that who owns consumer-generated data will revolve around the data's source and ownership. The data ownership is determined by who has access to it and how it is utilised. As courts and regulators look to the future, the intricacy of legal practice and technology evolves. It is becoming more challenging to keep up with the rate at which technology changes how we conduct business. The law cannot keep up with the rapid technological advances brought on by big data. As a result, businesses must keep a careful watch on law developments to reduce the threat.

B. Data Protection

Big data may exacerbate security and privacy issues. That means attorneys and IT administrators must address data privacy and security while collecting, reporting, and storing data. All of the following factors contribute to big data information security: data integrity, encryption, access control, privacy chain of custody, regulations, and corporate practices [4]. In addition to vendor agreements, company information security policies should also monitor data ownership and custody requirements, international rules, conditions of secrecy, data retention, and archiving. Customers, companies, and governments should work together to develop a sound regulatory

Table 1 Literature review

Author(s)/Year	Title	Literature review	Research gaps
Gulia, P. and Hemlata (2020)	Legal issues related to big data	Discusses about the legal concerns about big data like consumer privacy, protection of personal data, who owns the data, IPR protection	The researcher did not connected the issues with the existing provisions related to big data
Espinosa, J.A., Kaisler, S. et.al. (2019)	Big Data Redux: New Issues and Challenges Moving Forward	In this paper, the author discusses about challenges about the big data. The author mentioned some new challenges like functional domains, highlighting the pervasiveness nature of Big Data Analytics (BDA) and importance to understand and use of BDA	In this paper, the author discusses about the some challenges which is not new and general in part
Zhang, D. (2018)	Big data security and privacy protection	Big data, privacy, and security are discussed in the context of today's world	It is necessary to build a new paradigm in order to keep data safe
Gruschka, N., Mavroeidis, V. et al. (2018)	Privacy Issues and Data Protection in Big Data: A Case Study Analysis under GDPR	The General Data Protection Regulation (GDPR) of the European Union is being discussed. The kind of information that might pose a threat to one's privacy. They adhered to the legal requirements in terms of privacy protection by using the techniques prescribed by law. The influence of the methodologies on data processing when anonymization is used is examined	Their primary emphasis is on GDPR compliance via the use of anonymization. Other methods of protecting one's privacy may be used for the same objective
Fatma Mohammed (2018)	Privacy, security, and legal challenges in big data	Conventional safety mechanisms, Small-scale static data 5v's of Big Data	In future security techniques for large scale, static data can also be analysed. Security may be enhanced by considering the other five v's (variety, validity, variability, visualisation, and volatility), among others
Fang, W., Wen, X. et a l. (2017)	A survey of big data security and privacy preserving	The author highlights the need of maintaining one's privacy while dealing with big data	The approaches that are now in use, as shown in this research, are not particularly developed. The other strategies may also be used in order to protect one's privacy

framework that manages social data analysis, sensitive user data, and data cross-referencing and mixing [6]. This method may help protect data creators, consumers, collectors, and analysts of massive data sets.

C. Consumer Privacy is Essential

Big data contracts are built on privacy agreements. It is necessary to first understand personal information and how a privacy policy handles it before one can grasp these policies. Personal identifiable information includes information such as social security number, mother's maiden name, birth date, person's name, biometric characteristics, and location among other things [27].

The US data privacy law distinguishes between private and public data. Private data is information that is being kept secret. The phrase "public data" refers to material that has been made wholly or partly public under certain conditions. Because the line between private and public data is blurred in reality, disclosing vast volumes of data raises legal issues. To understand and deal with legal concerns, one must turn the legal distinction between public and private property into a real-world distinction. Identifying data owners enables an organisation to determine whom to contact if there is a privacy concern.

D. Reasonable Privacy Expectations

Privacy issues may be handled after identifying participants and their potential ownership interests. Everyone may assume that the majority will be kept private if not all of their data. They may not comprehend how a data processor will use their data. A real expectation of privacy may lead to a lawsuit. The possibility of discovery and the danger of discovery by a malicious third party are two indicators of a reasonable expectation of privacy recognised by the courts [29]. A privacy policy is an agreement between a data collector and the data originator, the person or organisation that provided the information. It is legally enforceable.

E. Concerns About Third-Party Contracts and Discrimination

Contracts with third-party big data suppliers and analysts must be handled with caution. Solid controls are essential. Third-party suppliers of big data solutions and technologies are increasing, demanding constraints and controls to prevent the discovery of PII through backdoors [8].

Products and services from these third parties analyse, manage, and store highly complex and sensitive data such as consumer behaviour or personal health data. The output data may be based on erroneous or insufficient data, expected correlations may not exist, or hackers may be able to re-identify persons using several data sources. According to some analysts, data mining [17] has led to more automated and difficult-to-detect discrimination. Data may be gathered via social media, healthcare, and biometrics, among other sources. Increasing transparency about how data brokers and companies use data to make client choices can help [24]. The researchers anticipate an increase in consumer complaints and government investigations in this area.

F. Regulatory Compliance and the Contracts that Support It

The legal implications of a big data transaction are best understood by reviewing the contracts between the parties. The degree of regulatory control an outsourced data collector faces is a big issue. Some examples include healthcare and financial services. The Federal Trade Commission is an excellent location to research big data regulatory problems because many big data transactions include consumer marketing, the FTC regulates them [34]. Legal counsel must consider relevant federal and state laws and regulations when analysing a contract on big data. The attorneys engaged will also have to assess whether data is sent beyond the US and the norms and rules of the various nations involved.

G. Obtaining Legal Information

Legal discovery requests from rival litigants and government entities are possible. Businesses using big data analytics must be aware of this risk. Big data has eliminated technical and other obstacles to data retrieval, and organisations may be required to disclose raw data used in big data research. This may comprise both proprietary and personal data. Before making a large data research public, a corporation should assess the legal risks. As a result, a firm and its lawyers may release much more information than required once the legal discovery process begins because legal challenges to protracted investigations are new, there are no established industry best practices. Parties to massive data exchanges must be expressly identified in contracts. The question arises that who is responsible for meeting legal requirements in a massive data transaction: the data collector, processor, or end-user?

7 Analysis of Data Protection Principles in the Context of Big Data

The General Data Protection Regulation (GDPR) establishes essential principles at the core of the general data protection framework in Article 5. These fundamental principles are spelled out straight at the start of the GDPR, and they have a direct and indirect impact on the rest of the legislation's regulations and duties. As a result, compliance with these basic data protection principles is the first step for controllers in ensuring that they meet their GDPR requirements. The following is a quick rundown of the Data Protection Principles mentioned in Article 5 of the GDPR:

1. **Lawfulness, Fairness, and Transparency**

"Personal data shall be processed lawfully, fairly, and transparently concerning the data subject ('lawfulness, fairness, transparency)" states GDPR Article 5(1)(a). This principle specifies that organisations must ensure that their data collection practices do not violate the law and that their data is transparent to data subjects. To comply with the law, you must thoroughly understand the GDPR and its data collection principles. To ensure transparency with data subjects, you must outline the types of data you collect and why you collect it in a privacy policy.

2. **Purpose Limitation**

"Personal data shall be collected for specified, explicit, and legitimate purposes and not further processed in a manner incompatible with those purposes," according to GDPR Article 5(1)(b)." Further processing for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes shall not be considered incompatible with the initial purposes." Personal data must only be collected for a specific purpose by organisations. They must define the final objective and only gather data for the time required to achieve it. Processing carried out for archival, historical, scientific, or statistical purposes or reasons of public interest is given more leeway.

3. **Data Minimisation**

According to Article 5(1)(c), "Personal data should be sufficient, relevant, and restricted to what is required in connection to the purposes for which they are processed (data minimization)," organisations should only save the least amount of data essential for their needs. Organisations cannot gather personal information hoping that it may be beneficial in the future. This GDPR guideline is likely to be broken if they hold more data than is required.

4. **Accuracy**

"Personal data should be correct and, when required, maintained up to date; every reasonable action must be made to ensure that personal data that are erroneous, in light of the purposes for which they are processed, are deleted or rectified without delay ('accuracy')," according to Article 5(1)(d). Personal data acquired should be appropriate for the organization's declared purpose and accurate and up-to-date. Organisations must examine the data they have about people regularly. They must also correct or remove any incorrect information. Within 30 days, data subjects can request that incomplete or inaccurate data be corrected or erased.

5. **Storage Limitations**

"Personal data shall be kept in a form that permits identification of data subjects for no longer than is necessary for the purposes for which the personal data are processed; personal data may be stored for longer periods insofar as the personal data will be processed solely for archiving purposes in the public interest, scientific or historical research purposes, or statistical purposes subject to the implementation of the appropriate technical measures," according to Article 5(1)(e). Personal data should be erased after an organisation no longer needs it for the purpose for which it was collected. If there is an excellent reason to maintain the data, such as for public interest or historical study, the organisation must set a retention time and explain why it was decided.

6. **Integrity and Confidentiality**

"Personal data shall be processed in a manner that ensures appropriate security of the personal data, including protection against unauthorised or unlawful processing, as well as accidental loss, destruction, or damage, using appropriate technical or organisational measures ('integrity and confidentiality)," according to Article 5(1)(f). The information you keep must be secure. Your company should ensure that all necessary safeguards are in place to protect personal information. This might involve protecting against internal dangers such as unintentional damage or loss, as well as external threats such as cyber-attacks. To demonstrate your commitment to cyber security, your company might consider pursuing formal certification, such as ISO 27001. Offline and online data theft are both possible. Securing your physical facility, encrypting data at rest and in transit, and saving a backup of personal information in an off-site location are standard security measures.

7. **Accountability**

"The controller shall be responsible for, and be able to demonstrate compliance with [the other data protection principles]," according to Article 5(2) of the GDPR. The last point is that companies should be accountable for the data they keep and demonstrate adherence to all principles. This means that businesses should provide proof of the steps they have taken to guarantee compliance.

This could entail:

- Examining existing procedures
- appointing a Data Protection Officer (DPO)
- Creating a list of personal information
- Ascertaining that proper consent is given
- Conducting Impact Assessments on Data Protection..

8 Big Data and Black Data Affairs

Unexplored, unknown, and unused data created by users' everyday interactions with various devices and systems is referred to as "black data." This includes machine data, server log files, and unstructured data from social media. This data may be deemed too old to be valuable, inadequate or redundant, or constrained by a format that organisations cannot access using presently available technology. They are frequently unaware of its existence. On the other hand, Black data might be one of a company's most underused assets. Data is rapidly becoming a valuable organisational asset, and competitive businesses must capitalise on it. Furthermore, as data regulations become more stringent, a company may be forced to control its data entirely.

According to a recent State of Black Data analysis sponsored by Splunk, over 55% of an organization's data is "black," meaning unknown, unexplored, unquantified, underused, or untapped [37]. Further research indicated that a third of respondents think more than 75% of their data is black, while just 11% believe less than 25% is black [37]. The figures varied across the seven global economies that were surveyed. For example, whereas 44 per cent of Chinese respondents claimed at least half of their data was black, 65 per cent of French and Japanese respondents indicated the same [37].

Big data, according to Gartner, is defined as high-volume and high-variety information assets that need cost-effective, creative data processing. (Gartner.) However, as the quantity of big data grows at an exponential rate, so does the amount of concealed black data. Enterprise machine data, for example, is growing at a considerably faster pace than conventional organisational data, and it contains information that is becoming more important for strategic corporate decision-making. As a result, it is not a surprise that it is a big source of black data. Concrete black data research is just now becoming available since most businesses are still in the early phases of addressing these issues. Gartner, the leading worldwide analysis group that originated the phrase “black data,” has published a white paper on how businesses might begin to handle “data hoarding” and other related issues [33]. Deloitte, a consultancy business, hinted at upcoming data difficulties with a paper on how companies might uncover possibilities inside unstructured data before it was formally dubbed “black data,” offering significant insight into industry-wide struggles surrounding anonymous data later on (Deloitte, 2017).

Black data will play an essential part in powering AI-powered solutions since more data improves the amount of data that AI can analyse, allowing AI tools to deliver even more profound, more accurate insights. There are several specialised use cases. The creation and development of new and more productive corporate business strategies will be most important. This involves assisting businesses in determining which departments hold what data, the types of data that management and leadership possess, and the data they should own. It may also enhance quality assurance procedures, discover and rectify process problems, and search for privacy flaws, security vulnerabilities, and other compliance issues [7]. Black data may be utilised to establish new data management methods around quickly emerging technologies like IoT in the future and offer the fuel for short- and long-term trend analysis to provide measurable outcomes to managers, directors, and leadership. Businesses must efficiently utilise data in today’s ever-changing, hyper-connected market to innovate, maximise efficiency, and develop a substantial customer base. Businesses may learn about customer behaviours, industry trends and remain ahead of the curve by incorporating the correct data into their everyday operations.

However, a significant amount of data remains unused, which has positive and negative implications for businesses and consumers. “Black data” is the term for this kind of information. Black data is described as data that corporations have access to but are not successfully utilising. This large quantity of data is virtually untapped and unprotected from outside influence. New patterns may be detected, and insights can be considerably increased for better decision-making processes that improve thin margins and improve customer interactions if organisations establish a system to handle this information.

8.1 Advantages

If this valuable data is not used, teams such as design, engineering, and product development, among others, will miss out on incredible insights that could have a significant impact on a company's bottom line. Consumer behaviours, product use, and overall performance might all benefit from black data. As consumers become more than just customers to a brand in the age of social media, this information becomes increasingly important to research. They have become ambassadors for corporations having the capacity to favourably or adversely impact enormous numbers of people with a single tweet or update. It is now vitally necessary to connect with a customer base using this data. Certain firms, such as M-Files, an enterprise information management provider, have recently stepped up to help businesses exploit the massive quantity of black data that already exists. With adequate research, companies may identify important patterns about their consumers, rivals, and the marketplace. Companies may achieve new levels of creativity and resilience by broadening the breadth of data they analyse and explore the value chain's furthest reaches. This is crucial because the digitally aware customer constantly evolves towards customisation, convenience, and mobility. Companies may quickly become stagnant and plateau if they do not learn to incorporate new data types into their organisational structure.

8.2 Disadvantages

The resources required to take on such a massive effort properly are the key reasons why many firms have not learned to handle black data. Without a doubt, structuring and extracting significant meaning from this data takes a significant amount of time, resources, and available tools. Allowing the data to remain hidden, on the other hand, could have much more severe consequences for a company. In the wrong hands, the unencrypted, usually neglected data might include sensitive information about the organisation, its customers, and its activities.

The following are some of the dangers:

- Intelligence risks—If your black data contains proprietary or sensitive information about competitive advantages, business operations, essential partnerships, or other insights, the loss of this data to hackers can severely damage, if not wholly destroy, your business relationships and activities.
- Legal dangers—Any data protected by law, such as credit card information, might result in financial and legal consequences.
- Risks to a company's reputation—Any type of digital security breach, including black data, reflects poorly on the company. It could be disastrous for the organisation if unauthorised parties obtain this information.

9 Legal Standpoint—Comparative Reflection

In the international context, it is very debatable that there is a holistic legal standpoint. But as far as the present comparative legal sanctioned legislation, if we can think of, it can be measured country-wise different legislations. Therefore, some of the identical nations are highlighted in this below table (Table 2).

Table 2 List of countries legislations

Country	Legislation	Objective
United States of America	The Health Insurance Portability and Accountability Act of 1996	National rules are being developed to prevent sensitive patient health information from being shared without the permission or knowledge of the patient
United Kingdom	Data Protection Act, 2018	To empower individuals to take control of their personal data and to support organisations with their lawful processing of personal data
	The Health Service (Control of Patient Information Regulations) 2002	These *Regulations* make provision for the processing of *patient information*, including confidential *patient information*
India	Clinical Establishments (Central Government) Rules, 2012	To protect sensitive medical data from being disclosed or shared without patient knowledge
	Information Technology (Amendment) Act, 2008	To promote the IT industry, regulate e-commerce, facilitate e-governance, and prevent cybercrime
	Right to Information Act, 2005	To empower the citizens, promote transparency and accountability in the working of the Public Authorities, contain corruption, and make our democracy work for the people in real sense
	Indian Medical Council (Professional Conduct, Etiquette and Ethics) Regulations, 2002	To set globally accepted standards for collecting, using, and disclosing medical patients' personal information
Brazil	Brazilian General Data Protection Law 2020	The fundamental rights of freedom and privacy and the free development of the personality of the natural person
Bangladesh	The Medical Practice and Private Clinics and Laboratories (Regulation) Ordinance, 1982	To *regulate medical practice* and functioning of *private clinics* and *laboratories*
Australia	Information Privacy Act 2014 (Australian Capital Territory)	To regulates the way individuals' personal information is handled

9.1 United States of America

The Health Insurance Portability and Accountability Act of 1996 (HIPAA)

National guidelines for protecting patient health information are mandated by the Health Insurance Portability and Accountability Act of 1996, passed in 1996. The HIPAA Privacy Rule and the HIPAA Security Rule are the two rules that govern health-related information privacy and security. According to the Privacy Rule, persons' health information should be protected while permitting the correct flow of information to encourage high-quality health care. When it comes to the use and disclosure of information about persons subject to this rule, the Privacy Rule applies. This covers hospitals, physicians, and other organisations that deal with health-related data and information. It is the responsibility of each healthcare practitioner to ensure that health information about transactions that they undertake is sent securely.

9.2 United Kingdom

Data Protection Act, 2018

Specifically, the Data Protection Act 1998 was designed to safeguard individuals' data inside the European Union and in the United Kingdom. It was modified to ensure compliance with the General Data Protection Regulation earlier this year. It is outlined in the Data Protection Act of 2018, which details the procedures that data controllers must take to keep their users' personal information safe. It also protects against illegal access to and use of the information in question. This Act aims to guarantee the privacy of individuals' data while also making it more straightforward for businesses to manage it. As a result, businesses must verify that their data is safe and not misused.

The Health Service (Control of Patient Information Regulations) 2002

The Health Service (Control of Patient Information Regulations 2002), as modified by Section 117 of the Care Act 2014, establishes the rules to be followed when processing patient information in England and Wales for medical research or treatment. A provision exists for processing patient information without permission in situations when it is not reasonably practical to get consent.

9.3 India

Clinical Establishments (Central Government) Rules, 2012

A vulnerability to exploitation is highlighted in the Clinical Establishments (Central Government) Rules, 2012, due to the nature of health information in the health business. An excellent example of this is the absence of a comprehensive legal framework for preserving the privacy of this critical resource. Electronic medical records were mandated to be stored and maintained by medical institutions under the Clinical Establishments Rules, which took effect in 2012.

Information Technology (Amendment) Act, 2008

The individuals who breach the security of personal data may now be subjected to civil and criminal sanctions under the Information Technology Act of 2008. Section 43A of the Information Technology Act, 2008, provides that if a business organisation suddenly stops maintaining records and safety measures, it may be held accountable for the activities of the persons who were harmed due to their conduct. Individuals, businesses, and even healthcare institutions that deal with sensitive personal data are subject to the SPDI Rules.

Right to Information Act, 2005

In India, the Right to Information Act, 2005, comes with the contention that *"the practical regime of right to information for citizens to secure information under the control of public authorities in order to promote transparency and accountability…… for matters connected in addition to that or incidental thereto."* This is the preamble to the Act 2005. Section 2(j) of the Act 2005 discusses the meaning of the term "right to information." Suppose the data acquired and managed by public authorities is secure or not.

It is being ensured that the data protection part of this Act is addressed concerning the individual's right to know. In Bennett Coleman v. Union of India, (1994) 6 SCC 632, the Supreme Court of India found that the freedom of the press ensures that all people had the right to express and publish their opinions without interference. The Supreme Court of India recognised the notion of freedom of expression and speech in Indian Express Newspaper (Bombay) v. Union of India, (1994) 6 SCC 632, published in 1994. According to the court, to enable public members to convey their thoughts and opinions freely, "the people's right to know" is the essential concept involved in this field and must be respected.

Indian Medical Council (Professional Conduct, Etiquette and Ethics) Regulations, 2002

Regulations on professional behaviour, etiquette, and ethics, promulgated by the Indian Medical Council in 2002, provide professional standards for medical practitioners. They also create globally accepted standards for the permission of patients and the collecting of personal information about those who agree to participate in research. This code of conduct defines a set of globally accepted standards for collecting, using, and disclosing medical patients' personal information. A universal restriction on the number of times medical practitioners may access and disseminate this information is also established under the legislation. It is the responsibility of medical practitioners to protect the information that they acquire about their patients. The confidentiality of their patient's information must be protected throughout their operations and provide comprehensive and correct information about them. If the law demands the disclosure of certain information or the danger of serious harm to a person, the only exemption is that individual's case. Currently enacted laws and regulations need updates and reform [17].

9.4 Brazil

Brazilian General Data Protection Law 2020

There was no comprehensive data protection regulation in place in Brazil until the introduction of Law No. 13,709/2018. The General Data Protection Law 2020 (LGPD) of Brazil on August 14, 2018. Privacy regulations have been enacted on several occasions in the past. Even though the legislation does not offer a precise definition of what constitutes health data, it is commonly understood to relate to any piece of information that may be used to identify or contact an individual. There is no legal definition for "sensitive personal data." Instead, it refers to specific information about an individual's health and well-being. When health information comes within the purview of the LGPD and is considered personal information, it is protected by the law. Information on a natural person's bodily or mental health, for example, falls under this category. It is illegal to use health information for commercial gain. There are exceptions to this general norm in some instances, such as when delivering health services or conducting financial transactions. In accordance with the legislation, insurance firms are not permitted to utilise health data for scoring purposes. The information gathered for public health research is intended to be helpful and accurate in providing information about health issues.

On the other hand, the data should not be processed outside safe and restricted settings. The data should not be anonymised during the research, if feasible. However, before being made public, the data must be anonymised. A stricter requirement for security measures used to secure sensitive data, such as health information, may also be imposed by the National Data Protection Authority.

9.5 Bangladesh

The Medical Practice and Private Clinics and Laboratories (Regulation) Ordinance, 1982

A 1982 statute, the Medical Practice and Private Clinics and Laboratories (Regulation) Ordinance, governs the operation of all private clinics and laboratories across the nation. In order to comply, they must store patient data and contact information in an electronic format. As part of its effort to manage the data produced by hospitals and clinics, Bangladesh has implemented an electronic patient record system (EPRS). Many government hospitals are also using this technology due to the large amount of patient data in Bangladesh. This is because most consumers are not aware of the proper data protection and security mechanisms. A robust privacy and security policy is essential for companies and hospitals that depend on the information they have about their patients to continue to operate effectively. This problem can negatively impact the quality of their patient treatment.

9.6 Australia

In Australia, privacy and security rules are primarily controlled by a patchwork of state and federal legislation, which may be confusing. Generally, all private businesses with a yearly income of at least AU$3 million are subject to the federal "Privacy Act" and the "Australian Privacy Principles." The Commissioner has the authority to conduct investigations and impose civil fines in the event of significant breaches of the law on privacy.

The "Privacy Act" oversees the way businesses and people handle personal information, including credit card information. The Privacy Commissioner has the authority to investigate privacy infractions and pursue civil fines when appropriate. Most Australian states and territories have their own data privacy rules. These rules apply to all private businesses and state government agencies that do business with them.

These acts include:

- "Information Privacy Act 2014 (Australian Capital Territory)"
- "Information Act 2002 (Northern Territory)"
- "Privacy and Personal Information Protection Act 1998 (New South Wales)"
- "Information Privacy Act 2009 (Queensland)"
- "Personal Information Protection Act 2004 (Tasmania)", and
- "Privacy and Data Protection Act 2014 (Victoria)".

9.7 Conclusion

Big data is a hot topic in the public realm and in the business world, and it's causing a lot of legal debate. Big data initiatives are increasingly being undertaken by businesses, organisations, and governments in an effort to boost revenue and improve corporate processes in order to boost output and profits by anticipating market demands. Taking into consideration the multidisciplinary nature of the topic, legal difficulties of digitalization and automation were examined in the context of Industry 4.0 to prevent criminal and civil liability, it is imperative to adhere to the law and agreed-upon regulations, notably in the areas of data protection, IT security, and corporate accountability, which are all affected by the digital transformation of production. The implementation of technological pillars to achieve the idea of Industry 4.0 not only increases the efficiency of the firm, but also increases the legal risk of the organisation. Individual technical pillars of Industry 4.0 have distinct characteristics that should be taken into account when drafting legal solutions for every country. Individual technologies were shown to have a variety of drawbacks. With existing system in legal field, legal responsibility is a complex issue, particularly in the case of intelligent autonomous robots. This lead to the future scope address the high automation robotics requires a stringent legal perspective to mitigate complexities.

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Chapter 8
Unified Architectural Framework for Industrial Internet of Things

G. Vennira Selvi, T. Ganesh Kumar, D. Seema Dev Aksatha, and Bharathi Anbarasan

1 Introduction

The Internet of Things (IoT) is a rapidly issue rising and a frequent conversation topic in the emerging field of information technology. The Internet of Things (IoT) has the potential to transform how people utilize the internet in the future. In the future, the IoT combines all the "things" under a commonly shared infrastructure with the sensors connected using the network to gather environmental data. The collected data is analyzed, and transformed into relevant information based on the application [1].

Muntjir et al., [2] defines the Internet of Things as a link between the physical and cyber worlds that uses goods or objects with sensing capabilities and transmits the measured findings through a network to achieve a goal. From home appliances to cellphones, an ever-increasing number of devices are connecting to the internet regularly [3]. IoT has the potential to revolutionize the way industrial companies operate in terms of security during production. Any large industrial sector would benefit from improved safety, security, and production.

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The industrial application development based on the Internet of Things (IoT) is termed the Industrial Internet of Things (IIoT), referred to as the industrial subset of the IoT which is often encountered in the manufacturing industries. The vision of IIoT is to connect equipment and machinery with various levels of intelligent functionality to make a smart manufacturing unit. The smart machinery senses its environment and its conditions and does the required adjustments by itself. The machines will not wait until the breakdown but they schedule their maintenance on their own and sometimes regulate the control algorithm to correct the problematic part and advertise this issue to other machines.

IIoT can provide solutions to issues that were previously deemed unsolvable. However, if it were any simpler, everybody would be doing it, as the proverb goes. The complexity of IIoT innovation is increasing along with it, making it an extremely difficult problem that no one organization can overcome on its own. According to a recent Forbes article (), by 2025, the Industrial Internet of Things could generate up to $11.1 trillion in total value annually, with business-to-business solutions accounting for around 70% of this value and the consumer Internet accounting for the remaining $3.5 trillion. The Industrial Internet will therefore be valued more than twice as much as the Consumer Internet.

2 The Technologies Associated with IIoT

2.1 Industry 4.0

The driving force behind the first three industrial revolutions is water, steam, mass labor, electrical energy, electronics, and automated production. Industry 4.0, the fourth industrial revolution was first proposed by the German economic development [4] in the year 2011. This revolution is defined by its reliance on the usage of Cyber-Physical systems capable of communicating with one another and making autonomous, decentralized decisions to improve industrial efficiency, production, safety, and transparency.

The German-developed Industry 4.0 concept and the United States-based developed Industrial Internet concept have a lot in common. In [5], the authors discussed some major technologies of industry 4.0 which are shown in the Fig. 1.

i. Big data means the collection of large and complex data sets from different sensors and computer-based interactions [6]. The variety, velocity, and volume are three major characteristics of big data that define various data types' amount, nature, and speed. In manufacturing, big data analytics helps in making decisions. The three-application area of big data in production organization is machine objects maintenance, quality measurement, and production management.
ii. Internet of things: internet of things is made of two words internet and things which means it is the interconnection of living and non-living things. It allows

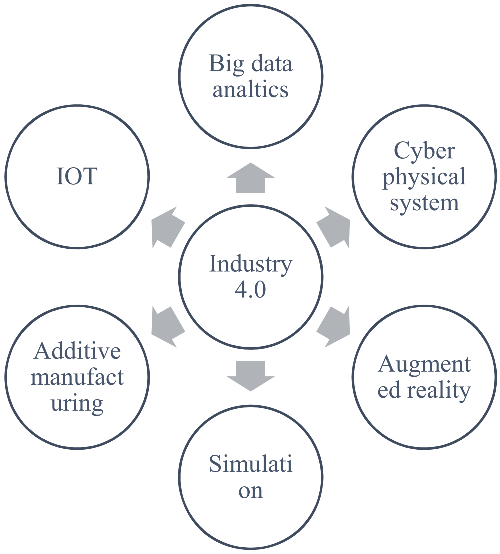

Fig. 1 Backbone of industry 4.0

communication between human to machine, machine to machine, and human to human by using wireless communication technologies such as Wireless Sensing Networks, Wi-Fi, Radio Frequency Identification, Bluetooth, and many more [7].

iii. In Cyber-Physical Systems, cyber is an electronic system and physical are objects. cyber-physical systems are a technology that manages the connection between physical objects and computational capabilities [8]. The integration of Cyber-Physical Systems with production and service can change the existing system into something new.

iv. Simulation is defined as a limitation of real-world process operations over time. It is used as a tool to analyze systems and can be used anywhere such as in healthcare, marketing, military, and supply chain [9]. In manufacturing, simulation is used to identify bottlenecks and opportunities to increase outputs and validate the performance of new products.

v. Augmented reality is a variation of virtual reality in which the virtual environment is superimposed on the real environment [10]. The applications of augmented in manufacturing are assembly, repairing, and maintenance.

vi. Additive manufacturing is a layer-based manufacturing procedure named Anaglyph 3D [11]. This 3d model of the product is designed by using the scanning method and computer-aided design and drafting technology.

2.2 Cyber-Physical Systems (CPS)

While there are several definitions of CPS [11], the one used in this chapter is: "A system made up of cooperating physical and digital parts that can be distributed or centralized and that combine sensing, control, processing, and networking functions to affect outcomes in the physical environment" [12].

The real-time nature of CPS interactions with the physical world distinguishes it from more traditional information and communications systems (IT or ICT). While both CPS and ICT systems process data and/or information, CPS is focused on physical process control. CPS uses sensors to collect physical factors, including measurements, and actuators to regulate physical processes. CPS frequently entails a high level of autonomy. CPS, for example, can often determine whether to modify the state of an actuator or to draw the attention of a human operator to an aspect of the environment being sensed.

3 Industrial Automation and Control Systems (IACS)

IACS or ICS stands for Industrial Automation Control Systems and Instrumentation, which refers to the devices, systems, networks, and controls that are utilized to operate and/or automate industrial processes. The following are authoritative American and European organizations' descriptions of ICS.

The Internet of Things is defined as a "group of infrastructures that interconnect connected objects and allow their management, data mining, and access to data they generate," with connected objects defined as "sensor(s) and/or actuator(s) carrying out a specific function that can communicate with other equipment" [13].

"The names "Internet of Things" and "IoT" refer to the expansion of network connectivity and computing capabilities to objects, gadgets, sensors, and other items that aren't often thought of as computers." These "smart objects" generate, share, and consume data with minimal human intervention, and they frequently include connectivity to remote data gathering, analysis, and management capabilities" [14].

4 Literature Review

Reference [15] stated that the industry 4.0-based information and communication technologies are dominating the production and service world. This statement is true in the health sector as IoT, Big Data, Cloud, and Fog Computing are revolutionizing, and making Healthcare 4.0. Industrial IoT is being developed with the help of emerging technology trends and uses of the Internet of Things (IoT) in industrial systems (IIoT) [16]. IIoT automates smart objects by using sensors to collect data, process the data, and communicate with real-time events in industrial systems.

IIoT provides extreme operational efficiency, high productivity, advanced administration of industrial assets, predictive maintenance, and intelligent monitoring of industrial equipment. The IIoT opened a range of platforms to various technologies by communicating with various devices with the help of automated sensors without the intervention of humans, and computers [17]. Smart environments were created by integrating the physical world with the cyber world, called the IoT which makes it possible to communicate objects with objects without human intervention [18]. IoT communications are the basis for the Industrial IoT (IIoT) in business applications focusing on interoperability between machines. The author has stated a few challenges such as dynamicity, heterogeneity, volume, and velocity of data which leads to incomplete, inaccurate, and inconsistent results. 40% of IIoT applications are based on IoT benefits. Advanced technological concepts like data fusion, big data, machine learning, blockchain, and cloud computing can control, and leverage IoT values.

The Industrial Internet of Things models in the machine-to-machine (M2M) context. They developed a conceptual framework to classify various business models for industries based on machine-to-machine communication [19]. They proposed four types of IIoT business models: (I) Company-specific business models, (II) Systemic business models, (III) Value designs, and (IV) Systemic value designs. (Kim & Tran-Dang, 2019) The boom in wireless communication and embedded systems has opened up the way for massive electronic devices to sustain innovative services. They have also stated that it is an industrial production system, that provides economic, and efficacy benefits to the installation, scalability, reliability, interoperability, and maintainability of industrial systems.

5 IoT to IIoT

IoT, connects the physical object through the wireless and wired network, whereas IIoT deals with multifaceted physical machinery connected with software and industrial sensors. IIoT involves human interference for smooth and error-free systems [20]. It is assumed that the Industrial Internet of Things (IIOT) will replace repetitive jobs like administration, planning, assembly, and control. IIOT is increasing the use of business models like on-the-spot 3D printing, or machine-as-a-service [21].

In 2010, Google initiated the concept of Industry 4.0, following which the Chinese government has introduced the industrial internet of things into their Five-year plan. The German government has pushed the IoT revolution and proposed that IoT devices are not for just turning on and off remotely, but these devices contain self-processing units, an information exchange unit [22].

IIoT transforms the IoT to a new level by providing a standard system for the universal connection through the Internet Protocol which is the crucial element to exchanging information through the internet irrespective of the devices used [23]. IIoT made a shift in the automation technology by introducing the auto diagnosis, and rectification capability. The thrust technology behind the IIoT is big data, machine learning, Programmable logic controller (PLC), and Supervisory Control and Data Acquisition (SCADA). The traditional devices are used to collect data only but the IIoT-enabled device collects the data, analyses, corrects, and exchanges the data in a novel way [24].

6 Basic Overview of IIoT Architecture

IoT-based industrial projects need a solid framework of IIoT as it provides a robust environment to do quality projects. The process view of IIoT reduces the use of multiple industrial IoT devices connected to the internet [25].

The following figure shows the basic overview of the IIoT architecture design. The devices or things form the basic layer of the architecture. Gateway is the second layer followed by the data management layer and the cloud data center is the apex layer (Fig. 2).

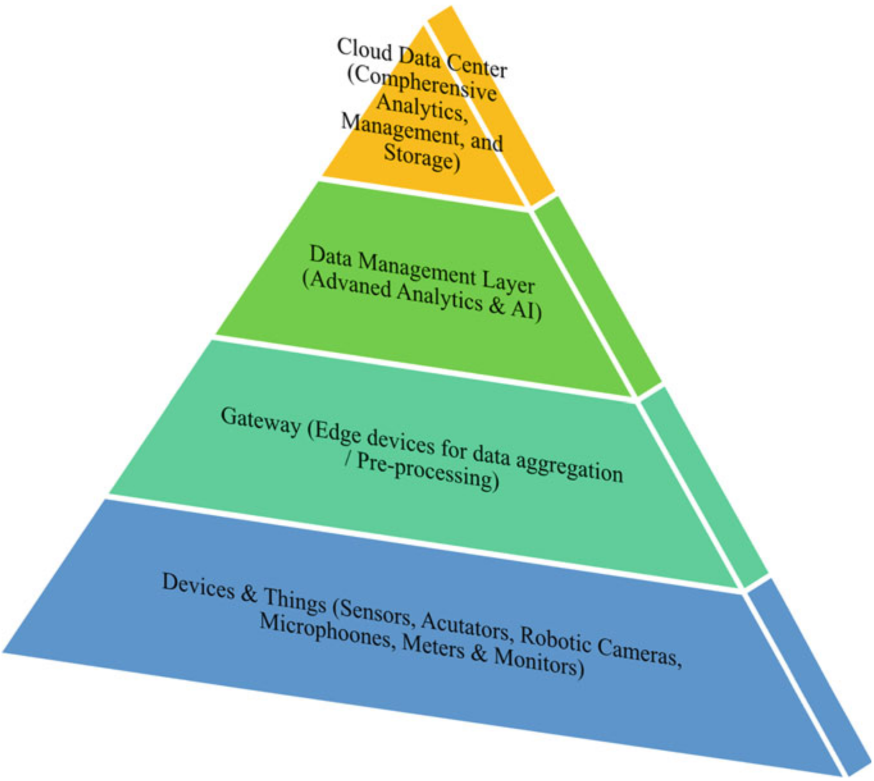

Fig. 2 Basic overview of IIoT architecture

The collected quality data is analyzed, managed, and stored in the cloud data centers where in-depth processing is done. Enough power is available from the cloud service providers to analyze and manage the data in a secure environment. Insights from various sources are used to discover new knowledge [26].

7 IIoT Architecture

The IIoT architecture is a combined set of mechanisms required for the success of IIoT, as stated in the IIoT framework. There would be no way to benefit from the IIoT without the architecture. The IIoT architecture includes Software, Hardware, Communication, and Security. The following architecture is based on the reference from the authors [13, 27, 28] (Fig. 3).

Data safety and integrity are the main concerns of this layer to prevent the stoppage in product production. The data collected and stored are frequently accessed by the connected devices which make the hardware function continuously.

The final layer is the data contextualization layer which provides the data in a way that the company can easily understand. Within this layer, data becomes information, which can be visually presented in a Supervisory Control and Data Acquisition (SCADA) display. This layer can potentially be used for analytics, machine learning, and pattern recognition. Value-generating methods are mentioned by Conboy et al. [29]. In terms of analytics, these techniques could work in tandem with the proposed IIoT architecture's data contextualization layer.

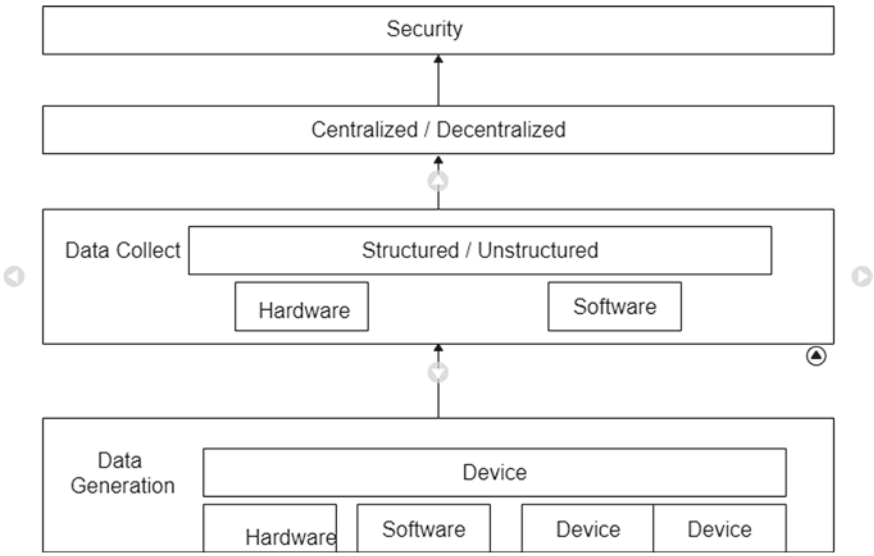

Fig. 3 IIoT architecture

Hardware

Hardware that can resist tough manufacturing circumstances is a crucial element when selecting a piece of equipment in an industrial environment. Extreme hotness, dust, mechanical pressures, and rain are all possible environmental concerns in a mining setting. Any hardware must be able to survive these factors to continue to work. The device's ability to operate in an industrial environment is also critical. If the hardware fails, it could result in dangerous situations or productivity losses. Equipment should be extremely dependable, durable, and resistant to failure, and it should be available whenever the process requires it.

IIoT Devices

Before deploying IIoT hardware devices, consider the scalability of IIoT devices as it is growing enormously day by day.

Networks

The data collection, storage, and contextualization are all handled by the hardware platform. Because connecting to the cloud is critical, data should be processed locally if there is no stable connection to the cloud. To prevent business risks, data storage, gathering, and contextualization must be managed on-site if there is no dependable connectivity to the cloud.

Software

Karschnia [30] states that these "things" connect to online and offline platforms to enable monitoring, remote control, and asset management, relying on either specialized data analysis software or dedicated expert teams to create value when paired with big data.

Intelligence may be lowered to the instrument level in the IIoT and hence, the device-level intelligence and the automation control capacity at a minor level is necessary. To accommodate changing processes, industrial systems should be reprogrammable simply and often. Process improvements are frequently tried inside complex industrial processes. As a result, the systems that support these activities must be adaptive.

The platforms required for the IIoT solution must be considered, as well as if they will simply interface with existing systems. Platforms are important when implementing IIoT on a prevailing site.

The software should be extremely dependable, robust, and resilient to failure, and it should be available anytime the process requires it. In industrial processes, system uptime is crucial.

The IIoT system must have a protected communications protocol and data security. The IIoT ecosystem, which depends on the reliability, safety, and security of its operations, places a premium on security.

Due to the crucial issue of a disruption of a high-volume industrial operation or the shutdown of the electrical grid, the IIoT has a higher level of security which could have an economic impact [31]. Before beginning any installations, security issues with sensors must be taken into account [32]. The IIoT's security of data transmission is one of the most urgent problems.

Communication

Communication is a condition of information transfer from one location to another, followed by the aggregation or congregation of data from various bases and periods. According to the respondents, network availability and viability of using these networks should be considered, and the protocol for industrial-oriented communication should be converted to low-power extensive area network technology [33].

Existing IIoT hardware and software communication platforms shouldn't obstruct the implementation of an IIoT solution. For IIoT implementation, existing networks should be examined. Few studies suggested that legislation in South Africa be changed to enable communication between gadgets. The law was described as difficult, and "communications regulators must unify their policies governing IIoT communications," according to the report. There could be no successful adoption of the IIoT that lacks trustworthy communication across the various levels.

The communications in IIoT solutions must be very dependable, robust, and resilient to failure, and they must be available anytime the process requires them to work. Communications uptime is critical in industrial operations due to the fast production methods being used, and the solution should have minimal latency.

8 IIoT Framework

The IIoT architecture would not be complete without sensors. The fall in the sensor prices created a breakthrough in the field of big data management, AI, and ML. Due to the advancement and availability of data analytics and IoT sensors, the IIoT has only recently been deployed in industrial areas. As a result, just a few IIoT installations in the industrial context have been completed. Based on various academic literature, the IIoT can be defined using phrases like ("Industrial Machines" OR "Industrial Systems") AND "Internet" OR ("Industrial Internet") AND "Machines". If there was pertinent exposure or instructions on the deployment of IIoT, more industries would be able to exploit and harness the benefits of IIoT in a short span of time. The advantage of explicit rules in the industrial sector is that implementations could achieve some of the objectives of an IIoT solution's improvement in safety and efficiency more quickly.

The figure shows an IIoT framework to assist technical and management personnel in comprehending various IIoT aspects. This architecture enlightens businesses about the factors that must be considered when implementing an IIoT solution. At the product, technical, and commercial levels, the IIoT framework would improve decision-making. The IIoT framework would also aid in unlocking the potential benefits of the IIoT for industrial firms. Future research on the topic could use the proposed framework as a starting point.

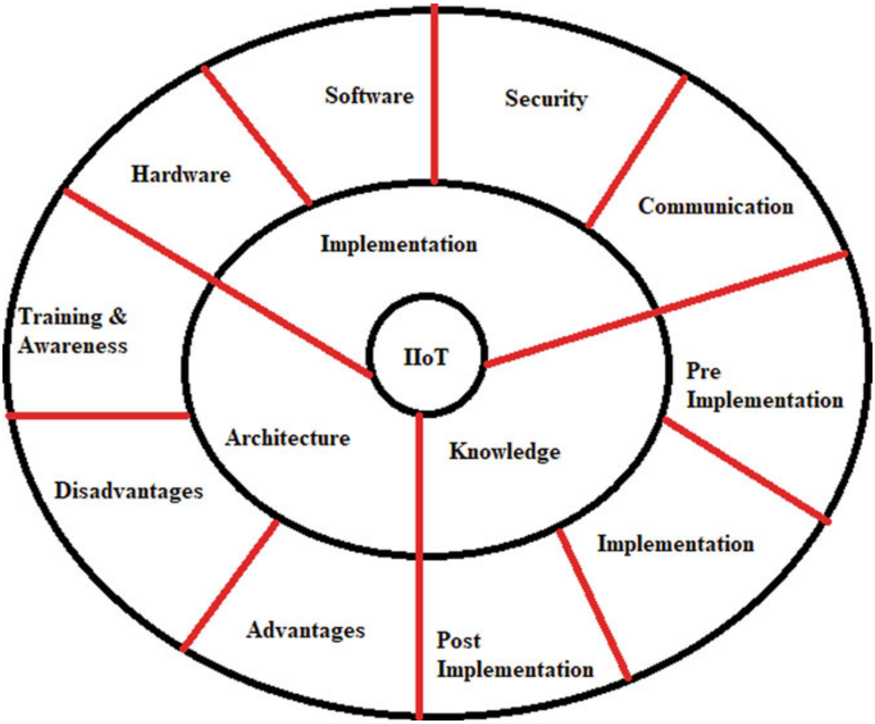

Fig. 4 The industrial internet of things framework

The IIoT framework is shown in Fig. 4.

- **IIoT architecture**:

The architecture contains IIoT security components, communication inside.
the IIoT, and hardware and software components.

- **Implementation category**:

The pre, post, and current implementation topics were addressed in the implementation.
category.

- **IIoT knowledge category**:

This category consists of the benefits, drawbacks, training, and awareness.

Industrial Internet of Things Implementation

(i) Pre-implementation

Prior to any IIoT solution can be deployed, a problem needs to be solved. It's vital to have a thorough knowledge of the business user requirements and data. A good business case that supports the technology's installation and ensures that the technology's investment pays off should be backed up by the business requirement. It should be documented to make sure the IIoT solution can satisfy this business requirement.

It is necessary to make a technological decision. This technology should be chosen based on its ease of maintenance and serviceability, and pathways should be improved. The company should have a clear idea of how the realization will work after it is implemented, as well as what the application's expectations are. In terms of personnel, after the installation, preparation for competent workers to maintain the IIoT deployment should be done. It's important to think about if the solution implementation went well. Is there a market for the additional goods created as a result of a successful IIoT deployment?

Before beginning any IIoT installation, the author [28] stressed the significance of rigorous preparation. Because no formal IIoT rules have been identified, planning has been recognized as an important component before any IIoT rollouts can begin.

In this regard, Lueth [29] claims that IIoT initiatives take an average of 18 months longer than expected. Blanchette [28] iterates the construction of a baseline (as-is) scenario for the organization as the foundation of complete planning. If the cloud services are employed, the presence of data analytics, the relevant needed reports for choices, and the amount of automation, according to the respondents.

- The demography of the company.
- IIoT device scalability when the number of devices grows into the thousands.
- In the IIoT, interoperability between modern technology and existing or legacy systems.
- Before deployment, the consolidation of several sources of data.
- A clear understanding of where the company intends to go in the future.
- A thorough awareness of the requirements.

Implementation:

When implementing IIoT solutions, a detailed architecture is required, which must include judgments about the technology to be used. To guarantee that the solution is adopted and the advantages are realized, change management is essential during execution. It is critical to use an expert team while executing the IIoT deployment. Respondents recommended that short, attainable project goals be created and pursued during the installation of IIoT solutions to ensure IIoT implementation success. It's important to consider how long a large-scale IIoT installation will take.

Post-Implementation:

An examination of IIoT outputs should be conducted to determine whether they have been met. To manage the IIoT infrastructure and environment, appropriate procedures and governance should be implemented.

A review of the IIoT deliverables should be conducted to determine whether they have been met. To oversee the IIoT environment and infrastructure, appropriate procedures and governance should be implemented.

IIoT Knowledge

Training and Awareness

There may be a scarcity of in-house expertise for IIoT implementations and maintenance. The absence of internal expertise for IIoT deployments is a barrier for the company, and it should be considered whether the essential people skills required during implementation and afterward for maintenance are available. At various levels of IIoT architecture, there may also be a scarcity of necessary skills. According to the findings, there is room for development in terms of company education regarding the prospects of Industry 4.0.

There is a need to raise awareness inside the organization about how to manage the cultural and organizational changes that will be required as a result of the IIoT implementation. If adequate change management was not performed, these cultural and organizational shifts would be a major cause of the low adoption of the provided solutions.

Any lack of in-house capabilities for IIoT implementations and maintenance should be addressed through awareness and training. Maintenance would imply that skilled employees would be required after the installation to keep the implementation running well. In this situation, the firm needs business education regarding Industry 4.0 prospects in order to realize the potential value-adding business cases.

Challenges

Personnel with the necessary experience providing IIoT solutions in a particular industry are needed for the implementation and maintenance of deployed solutions.

- Managing cultural and organizational changes are among the other obstacles.
- Business representatives are unwilling to endorse installed solutions if appropriate change management was not completed before the IIoT implementation.
- In terms of connectivity, security, and platform integration, new technology is being introduced into the already-existing infrastructure and environment.
- When deploying IIoT, there is already infrastructure and platforms in place.
- There are no legacy systems to contend with in greenfield organizations.

In terms of IIoT, people skills are important.

- Currently in use communication protocols
- Currently operational systems and hardware.
- Issues with network connectivity.

Advantages

The IIoT has the potential to help industrial organizations and can complement existing technology investments, according to the benefits outlined. Gaining market share, increased efficiencies, knowledge of corporate operations, and visibility into many parts of the organization are all advantages.

9 IIoT Framework Application

Industrial businesses might make IIoT-related product, technical, and business choices with the use of the IIoT framework, allowing them to reap the benefits of the IIoT. The following stages can be used to leverage the framework that has been discovered to identify the requirements for making technical and business decisions across the various layers of the IIoT.

1. The user would make sure that any advantages that IIoT might offer to industrial operations had a clear business need for them.
2. The case is an evaluation of the necessary hardware and software infrastructure for any IIoT installation following the business.
3. After evaluating and understanding the technical requirements required for an IIoT solution, the user would refer to the considerations before, during, and following the deployment of an IIoT project within industrial contexts.

9.1 Industrial IoT Platforms (IIoT)

IIoT platforms connect frontend industrial processes with information systems at the backend. Using hardware and software, the platform allows organizations to create new applications. Gartner's Magic Quadrant platform for IIoT integrates the capability of the advanced software that was released in October 2020 that enhances the asset management and controlling of plants, equipment, and infrastructure. As per Gartner, the industrial IoT platform is a group of software capabilities to enhance the control of plants, equipment, infrastructure, decision support, asset management, and operational visibility. Here are some IIoT platforms to make the task simpler.

Amazon Web Services

Amazon Web Services (AWS) provides various cloud-based IoT Services that make a single roof for computing, gadget connectivity, and analytics. It provides the real-time operating systems FreeRTOS for microcontroller gadgets. To manage and store the data for local processing, AWS provides IoT Greengrass.

Altizon Datonis

It provides an IIoT platform that manages real-time analytics, machine learning capabilities, and device management. This platform is accompanied by a data lake manager, Datonis Manufacturing Intelligence which manages the productivity modules, and the digital twins along with other things. This platform can be used on any on-premise or cloud framework as a platform-as-a-service (PAAS).

Flutura Cerebra

It provides Artificial Intelligence solutions for nano applications and various types of tools. This platform consists of two objectives with an exclusive on specialty chemicals, oil and gas, and huge machinery industries with resource uptime and operational proficiency.

Braincube

It is based on a proof-of-concept project that handles Machine Learning based applications and time-slacked information in a multifaced manufacturing industry. It contains an efficient data cleaning tool that is truly awesome in the market. Braincube supports strong manpower and customer service.

Azure IoT

Microsoft Azure makes the manufacturing unit collect a huge volume of data easily, process the edge real-time data, and transfers them to the cloud services for analytics using the data analysis tool PowerBI. The production and manufacturing companies can use these data directly without any preparation.

IBM Watson IoT

It is a cloud-hosted service that facilitates connecting, registering, and to control the devices for data storage and visualization. IBM Watson can analyze the machine-generated information irrespective of the data type like speech, text, video, or sentimental analysis. The security features can administer applications and devices by detecting anomalies.

PTC ThingWorx

It is an outstanding platform amongst other IIoT platforms available in the market. It provides the capabilities to connect and speak up with all the devices connected to the system. It provides scalability so that the industries can add any number of sensors or machines with the already connected devices.

Programming AG Cumulocity

It provides data visualization, device management, application integration, edge processing, and connectivity. To connect and oversee the resources in the industries, it incorporates Cloud Fieldbus with conventions like OPC UA and Modbus.

Hitachi Vantara Lumada

This platform is meant for resource-concentrated businesses like transportation, energy utilities, and assembling. It provides security concerns for IT systems, OT doors, data management, digital twin modeling, and AI capabilities.

Oracle IoT Cloud

It provides idealistic integration with the industrial manufacturing execution unit. Industries employing the Oracle IoT Cloud are highly fulfilled with the advanced technical features and the capacity to manage the data from the sensors in the manufacturing unit. The client's suggestions and ideas are addressed by listening to the 'voice' which drives the platform to be most popular.

9.2 Conclusion

Security and safety are essential parts of the industrial systems to avoid damage and reduce hazards to employees, industrial assets, and the surrounding environment. IIoT highlights smart services like smart cities, healthcare, and other manufacturing sites while decreasing energy costs and increasing performance. IIoT revolutionizes the manufacturing processes by incorporating internet access to enhance excellence with the help of electronic equipment that handles a huge volume of data, does analysis, and comes up with smart perception techniques. The espousal of IIoT connects systems to cloud or enterprise-based systems to handle security and safety-related breaches.

The framework discussed in this chapter includes the IIoT architecture which includes Software, Hardware, Communication, and Security aspects. The architecture considers the pre-and post-implementation procedures and discussed the benefits, challenges, and training in terms of IIoT.

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Chapter 9
Human–Robot Coordination and Collaboration in Industry 4.0

Yamini Ghanghorkar and Rajasshrie Pillai

1 Introduction

1.1 Robots at Workplace

Industry 4.0 technology has revamped the workplace and improved business process efficiencies. With accelerated business development on a global scale, Artificial Intelligence (AI) plays a significant role in introducing a wide variety of technology for automation in business processes [75]. "AI can be defined as systems or algorithms with learning functions and cognitive abilities which can perform tasks that would usually require human intelligence" [50, p. 1]. AI-based systems are significantly applied at different business functions such as services, process automation, managing customers and employees [54, 75]. AI and digital transformation enhance business model and performance and also elucidate long-term value creation for sustainable business [7]. Organizations are leveraging the various industry 4.0 technologies such as Artificial Intelligence, Chatbots and Robots and it is providing numerous benefits to the business performance [73].

Artificial Intelligence and robots are ready to seize significant jobs done by humans. Robots are here to stay in the workplace [3]. Robots are defined as "Actuated mechanism programmable into two to more axes with a degree of autonomy moving within its environment to perform intended tasks" [33 p. 1]. Also, the classification of robots is based on their application part in various industries and sectors [33] few of which are mentioned in Table 1. These robots are: (a) industrial robots are "an automatically controlled, re-programmable, multipurpose manipulator programmable

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in three or more axes" [6, 55] (b) Service robots are defined "as a system based autonomous and adaptable interfaces that interact, communicate and deliver service to an organization's customers" [80, p. 3] (c) "Humanoids robots meaning robots that take human-like forms, behavior or other characteristics, have progressed from a science fiction obsession to an increasingly mature anthropomorphic technological reality" [37, p. 318].

When incorporated at the workplace, humans need to collaborate with robots for various business activities. Human–robot collaboration is crucial in adopting industry 4.0 [39] as robots will stay across multiple sectors. Advanced AI systems, Deep Learning, Machine Learning and the Internet of Things (IoT) are driving the advancement of robots for current and future work purposes in businesses [27]. Robots eventually lead to better decision-making capabilities, performance and production capacities [57, 79]. The advancement of technology corresponds to how industries function compared to previous times [69]. Human–robot collaboration in an industrial environment elucidates the interaction and co-working to accomplish business goals [16]. The business can leverage the benefit by combining and complementing humans' and robots 'skills to achieve a common goal [26].

1.1.1 Industry Revolution to Industry 4.0 and Society 5.0

The industrial revolution recorded from the past years brings technological developments in each era (1) The first industry 1.0 revolution observed in the 18th century notifying the era of mechanical machines, (2) Industry 2.0 was observed in the nineteenth century with electricity-powered operations, (3) Industry 3.0 in the twentieth-century speaks on internet-based technologies and (4) Industry 4.0 of the twenty-first century glorifies smart operations in businesses and industries through digital transformations replacing manual work with digital arrangements [52, 61]. Industry 4.0 has brought a lot of digital shifts in the business practices adopted during the mentioned era. It includes AI, robotics, and the (IoT), bringing changes in business processes and impacting society at large [1]. The evolution of society records vast changes observed amongst the people of the significant era. *Society 1.0* marked with people having an approach to hunt while maintaining a harmonious relationship with nature, Agricultural activities recording the *society 2.0,* industrialization recording *society3.0*, Adding internet into function during the era of *society 4.0*, *Society 5.0* is adopted above the previous society with the human-centric approach [1]. Society 5.0 emphasizes the super-smart society. Figure 1 describes a clear understanding of the evolution of society5.0 over the past years.

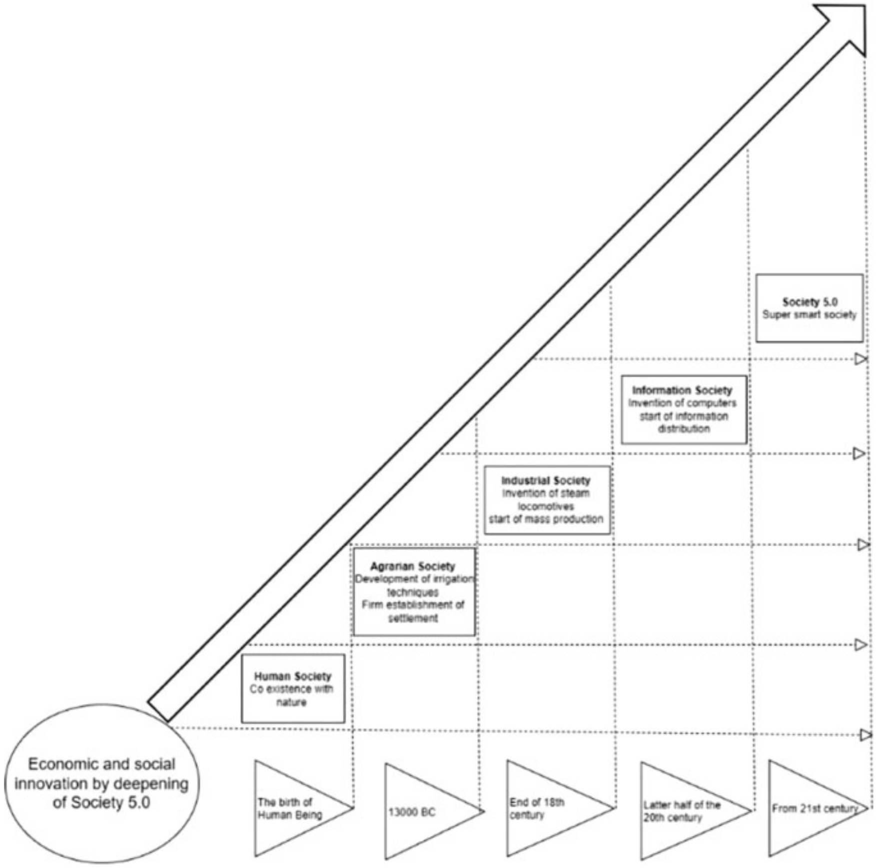

Fig. 1 Society 5.0

1.1.2 Figure 1: Society 5.0-Adapted from [1]–Visual Understanding of the Evolution of Society 5.0 in Industry 4.0 Over Time

The technology up-gradation and rapid automation, however, is transforming business practices. Technology also poses a subsequent negative impact on the environment and people [9]. The tools and technologies adopted in Industry 4.0 will contribute to society 5.0 in terms of upgrading the quality of life of an individual but with a focused approach for improving productivity and performance [52]. It is required to understand and study the interface and interaction of advanced technology (Artificial Intelligence, big data and robotics) with society to benefit humanity [52]. The objective of organization 5.0 projects on an individual appreciating life while ignoring the possible limitations over the adoption and inclusion of various technologies [49]. It is necessary to research the human–robot collaboration to learn about the factors affecting the change in the work process and its effect on humans [83].

There is a dearth need for research in understanding the strategic decision-making process to adopt to develop and design the new relationship context concerning technology and human interface for sustainable integration: industry 4.0 and society 5.0 [5] Fig. 1. The researchers can study various practices to create value via innovation in line with human needs and improve equality of life [58].

1.2 Inclusion of Robot Workforce

With the introduction of industry 4.0, there is a shift in the business landscape to bring intelligent robots into the workforce to collaborate with humans [76]. Including robots in the workplace poses various dimensions of work for business success. For example, in an industry setting for human–robot collaboration, there is a need to create a collision-free environment to work in designated tasks [43]. Industry 4.0 has supported the advancement of intelligent robots at the workplace [64]. The manufacturing sector has traditionally been manually driven. However, the increased production requirement has introduced industrial robots to match the industry requirement [21]. The manufacturing companies with current trends require mass customized production, especially in hybrid systems, which require humans and robots to collaborate as it has proved successful for business purposes [15]. The field of robotics is evolving with industry 4.0 while adding to the workplace and humans in the healthcare industry [25]. Robots being added to the workplace cause collision with humans and require physical adjustments [36]. Industry 4.0 intends future-oriented work to require unique skills and hence the inclusion of sensitive robots supporting the future production requirement in the manufacturing sector [39].

Businesses across the industries and sectors are experiencing a shift in the workspace with robots to improve business production and performance. Robots are enhancing business performance [20, 28, 44]. However, there is a dire need for the productive inclusion of these robots with the human interface to ease the business operation to sustain across industry 4.0 [16, 30, 44, 57]. Managers and academicians must develop effective human–robot coordination and collaboration strategies to enhance business benefits. The human interaction with robots in this chapter is taken from all the perspectives such as employees, customers and users.

1.2.1 Types of Robots

The technology advancement in industry 4.0 is implementing AI and robotics in business spears.78% of organizations already have robots functioning and plan to accentuate the investment in subsequent years as confirmed in the report published by Deloitte [81]. Robots have replaced the full-time equivalent of reported 20% with an average in a year with predicted next growth projection indicating its performance in various business dimensions such as compliances, quality productivity, and reduction in cost [81]. There are many robots introduced across the industries working in total capacity to augment the respective business process, for example, Gantry robots by sage automation, Delivery robots by starship [29], Pepper humanoid robot by Softbank robotics [63], Penny, the robotic waitress by the Silicon Valley startup [68].

However, the differentiation of robots in a business context is not justifiable as each robot is developed to have its unique features, functionality and application. Still, an attempt to segregate them will prove to be an affair view on understanding the type of robot, features, and business application. Table 1 showcase different types of robots across the industries.

1.2.2 Table 1: Types of Robots

(See Table 1)

1.3 Organizational Benefits of Including Robot Workforce

The inclusion of robots provides benefits to the organization in several categories as picturized in the Fig. 2. With significant advantages listed, the businesses are leveraging robots at the workplace. Hence, it is required for the companies to create a conducive environment designed with strategies to device effective and efficient human–robot coordination and collaboration. Figure 2 describes the various organizational benefits of including robots in the workplace.

Productivity: The global business landscape narrows humans' geographical access and presence, limiting business performance scope; however, robots can operate in various conditions adding to business profits [13]. Also, automated functioning leads to voluminous production with speed [15]. So, robots collaborating with humans constitutes improved productivity.

Safety: The unforeseen environment and working conditions can make humans unsuitable to work in such a context. However, with their non-human nature, robots make it feasible to sustain and working this context [13]. Opening doors for the organizations to operate even in a manipulative environment.

Return on investment: Advancement in business operation with robots operating can reap better ROI and help organizations earn profit segments [31].

Table 1 Types of robots based on functionality in business space (primary creation)

Type of robot	Feature	Business application
Pre-programmed robots	These robots are involved in repetitive and monotonous tasks at workplace [31, 64]	Welding, assembly, machine tending, part transfer, material removal and assembly line functioning
Humanoid robots	These robots possess human appearance and functional capabilities [35]	Health care provider, client interaction in the supermarket, easy navigation and multilingual, search and rescue mission, industrial work and client service operation
Autonomous robots	They are fully automated which are freely working with no intervention of humans [15, 57]	Cleaning, lawn maintenance, drones, restaurant assistance and operation, industrial work and client service operation
Augmenting robots	These robots augment the capabilities of human manifolds or can be supplemented in the completely lost capabilities [23]	Wheelchair, prosthetic limb, arms and exoskeleton
Consumer robots	These robots are part of consumers daily routine activities about consumer preferences showcasing companionship and sociability [14]	Cleaning, entertainment, security and old family member care facility
TeleoperatedRobots	The robots work with human intervention [11]	Underwater excavation, submarines and space exploration
Military and security application	These robots are designed for military support and safety functions [34]	Safety to the soldiers, watchman for soldiers, safety tactics at the war zone, fighters and marine navigation
Medical application	The robots responsible for delivering quality care to the patients and preventing the spread of infectious disease [40]	Surgical assistance, patient care, delivery of medicines and exoskeletons
Research application	The robots support and value addition in scientists research work	Research support
Self-assisting passenger cars	The care is a highly self-governing and self-sufficient guide and navigates for driving on its own [4]	Autonomous driving, self-driving delivery for food, grocery and restaurants

2 Literature Review

The evidence in extant literature showcases the importance of business benefits that can be achieved with effective human–robot collaboration. However, its implementation is still at the nascent stage. The human resource contribution to intervene to

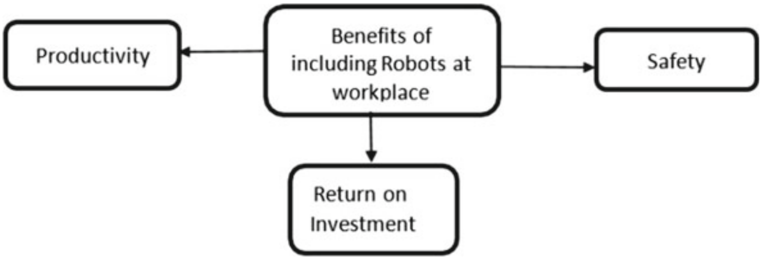

Fig. 2 Benefits of including robots in workplace (primary creation)

enhance the skill and knowledge of employees to create a seamless team with a robot is an area to be explored [51]. Although the literature focuses on enhancing the operational aspect to perform specific tasks, very little attention is given to humans on their vision, learning process, interaction, and collaboration with robots [60]. It is essential to investigate the various constructs responsible for seamless human–robot collaboration [51, 74]. Also, it is necessary to examine the role of HR in human–robot collaboration [46, 50]. Table of Literature review–**Human–Robot collaboration and co-ordination** showcase the literature in human–robot collaboration.

2.1 Table of Literature Review–Human–Robot Collaboration and Co-Ordination

See (Table 2)

3 Human–Robot Coordination and Collaboration

Human–robot collaboration is defined as humans and robots seeking to be working together towards a common goal [16]. Human–robot interaction can be defined as a human robot working on tasks together in a well-coordinated manner towards accomplishing a common goal [76]. Human–robot collaboration allows humans to work with robots in the same context [43]. Robots are made human-like with the technology of artificial intelligence, neural network, cognitive architect, and adaptive motor control, conversational, natural language processing and collective intelligence to substitute human intelligence [62]. This technological innovation, primarily in industry 4.0 and its spread in various sectors, requires the careful inclusion of humans. The managers must meet the objectives of society 5.0 to sustain the environment and human goals to achieve progressive development. The extensive research across the industries highlights the primary interface of human and robot

Table 2 Table of literature review–human–robot collaboration and co-ordination

Table of literature review–human robot collaboration and co ordination					
Sr. No	Author	Research method used	Theory used/ theoretical framework	Variable tested	Findings
1	Brantner and Khatib [12]	Qualitative-experiment	Constrained haptic interaction architecture	Haptic device, robot and skill	The controlled environment experiment to examine the human–robot collaboration for accomplishing manipulating tasks. The synergy was achieved between human and humanoid robots to exercise decision-making and problem-solving. Also, an increase in robot autonomy leads to a reduction in workload for the human in the interface
2	Liu and Wang [43]	Qualitative-experiment	NA	Human–robot position, robot control command, human poses	The experiment to identify the potential collisions between human–robot and constructed to facilitate a system for the overall effectiveness
3	Roveda et al. [65]	Qualitative-experiment	NA	Collaborative task demonstration, task trajectory selection, impedance control, robot performing assembly, assembly task optimization	The demonstrated experiment shows that robots can perform the assembly tasks with human knowledge by optimizing the operations for better capabilities
4	Al-Yacoub et al. [2]	Qualitative-experiment	NA	Position feedback, demonstration, force feedback, optimization, ML algorithm, ML model, Cartesian space control, Internal force compensation	The experiment of imbibing learning capabilities in robots for the human interface can be done through machine learning for agility. Also, the human–robot interaction shows better work accuracy than its human counterparts

(continued)

Table 2 (continued)

Table of literature review–human robot collaboration and co ordination

Sr. No	Author	Research method used	Theory used/ theoretical framework	Variable tested	Findings
5	Buerkle et al. [15]	Qualitative-experiment	NA	Drop emergency hit rate, crush emergency hit rate, unexpected movement emergent hit rate	Awareness of the symbiotic association of humans and robots is significantly related to safety in a chaotic factory environment. The lack of knowledge and level of experience pose to potential emergencies the human feel working with robots
6	Dianatfar et al. [22]	Qualitative	Meta-analysis	Augmented reality, virtual reality, mixed reality, human–robot collaboration	Based on the research done by the scholars, the AR/VR technology adopted makes the collaboration of human and robots safer and creates a more realistic environment to work as a team
7	Kim et al. [38]	Quantitative–experiment	Human whole-body model	Overloading joint torques, manipulative capacity value and muscle activity	Human ergonomics with robots can be compatible for completing tasks and achieving production capacities for dexterous operations
8	Kofer et al. [39]	Qualitative	Not specific	Not specific	The hybrid assembly work environment needs humans and robots to interact closely without the concern for safety by creating a safe ecosystem and exercising risk identification and reduction for seamless collaboration

(continued)

Table 2 (continued)

Table of literature review–human robot collaboration and co ordination

Sr. No	Author	Research method used	Theory used/ theoretical framework	Variable tested	Findings
9	Pillai and Sivathanu [56]	Quantitative	Technology organisation environment framework	Perceived compatibility*, perceived benefits*, IT physical resources, IT intangible resources, IT human resources, External pressure*, support from vendors*, government support	The adoption of AI-powered industrial robots in manufacturing companies leverages various benefits in enhancing production capacities, elevating return on investment etc. However, the cost element is a major component for adopting robots at the workplace
10	D'Andrea [19]	Qualitative	Not specific	Increasing market pressure, societal considerations, automation cost	The warehouses will achieve the full benefit of higher productivity and growth while combining the competence of humans and robot working together
11	Mukherjee et al. [47]	Qualitative	Not specific	Robot-related, tool related, basic safety function-related, human factors related	Deploying human–robot collaboration at the workplace requires application research in psychology, behavioural sciences, and anthropology
12	Ferracuti et al. [23]	Qualitative	Skill model	Human–robot co-existence, Human–robot coordination and collaboration, ISO 15066, pre-collision control scheme, post collision control scheme, verbal HRI, visual HRI, physical HRI, Task definition and task sequence planning	The production floor needs humans and robots to communicate verbally and non-verbal to achieve the goal. Several technological up-gradation and policies are required for creating a sustainable environment for this duo to work collaboratively

(continued)

Table 2 (continued)

Table of literature review–human robot collaboration and co ordination

Sr. No	Author	Research method used	Theory used/ theoretical framework	Variable tested	Findings
13	Li et al. [41]	Qualitative	Not specific	Inter collaboration cognition, spatio-temporal cooperation prediction, self-organizing teamwork	In the cognitive manufacturing space for appealing mass personalization, proactive human–robot collaboration is needed of an hour to achieve long-term goals with the mutual association
14	Zhang et al. [83]	Qualitative	Assembly model	Agent human, agent robot, reward*, action, state, environment	A reinforcement learning method can be applied in assembly line tasks for effective human–robot collaboration about task allocation and work optimization
15	Molitor [46]	Quantitative	TAM, UTAUT	Performance expectancy*, trust, effort expectancy*, social support, organizational support, computer anxiety*	The employee can have positive collaboration with the robot while focusing on performance and work achievement
16	Libert [42]	Quantitative	TAM	Perceived usefulness*, perceived ease of use*, attitude towards use, behavioural intention to use, actual system use	The gap exists at the implementation level to align the organization's human–robot collaboration and HRM practices for its easy implementation. Also, trust is the major component for human–robot collaboration implementation at the workplace

(continued)

Table 2 (continued)

Table of literature review–human robot collaboration and co ordination					
Sr. No	Author	Research method used	Theory used/ theoretical framework	Variable tested	Findings
17	Parvez et al. [51]	Quantitative	TAM	Perceived usefulness*, perceived ease of use*, robot awareness*, advantages of robots, the disadvantage of robots, robots user motivation, behavioural intentions*, strategic HRM*	The robot's ease of use affects humans' awareness towards it for the effective implementation of human–robot collaboration perceived usefulness. Therefore, humans who are most aware of the robot find it easy to adapt in collaborating with robots
18	Ramadurai and Jeong [60]	Qualitative–experiment	NA	Accuracy, human time, robot time, fluency, comfort	The experiment showcased increase in the level of involvement of humans with robot increases the accuracy and success of human–robot collaboration at the workplace
19	Michalos et al. [45]	Qualitative	NA	The particularity of task to be performed, types of robots, type of human–robot collaboration, the requirement of the tasks	The implementation of human–robot collaboration and projection for seamless human–robot interaction in the factory
20	Charalambous [17]	Qualitative	NA	Trust, productivity, quality	Trust is a crucial component for positive collaboration and interaction between humans and robots to enhance productivity and quality in production lines at the workplace

(continued)

Table 2 (continued)

Table of literature review–human robot collaboration and co ordination

Sr. No	Author	Research method used	Theory used/ theoretical framework	Variable tested	Findings
21	Wynsberghe [82]	Qualitative	NA	Emotional impact, limited movement, the effect of working with one's replacement, chilling effects, disclosure of unintended information, inability to challenge the computerized decision	In an industrial setting, the prevailing ethical concerns and need to be addressed for productive human–robot collaboration
22	Story et al. [74]	Quantitative–experiment	NA	Mental demand, physical demand, temporal demand, performance, effort, frustration	The workload and trust are significant towards the performance, efficiency, and accepting robots in industrial settings, which constitutes changes in workload and speed of work
23	Nourmohammadi et al. [48]	Qualitative–experiment		Human time, human task, robot time, robot task	Human–robot collaboration can enhance the advanced manufacturing system, resource optimization, productivity, and well-being of humans
24	Inkulu et al. [32]	Qualitative	Not specific	Not specific	There are various challenges for human–robot collaboration which are needed to be addressed in mass production and mass customization
25	Kim [36]	Qualitative	Not specific	Employee attitude, readiness for robot technology, communication with robots, human robot team building, leading multiple robots, system wide collaboration, safety intervention, ethical issues	The human robot collaboration and interaction require the human to be more responsible and the implementation of HRI require a human centric approach with the effective intervention of human resource department

coordination and collaboration. It is confirmed that robots with some level of intelligence with the human pilot [13]. Industry 4.0 creates an environment for enhanced production, with intelligent systems like robots adding value to the production while working with humans [65]. Assembly tasks presume the collaboration of humans and robots to perform specific functions with human demonstration [65]. Utilizing machine learning accentuates the human–robot collaboration in which humans guide the robots for work activities in the same workspace [2].

The robots in the healthcare industry provide perfect assistance to medical staff and patients with various medical requirements of taking care of patients and performing tasks to help nurses be exposed to infectious diseases [25]. Industry 4.0 has given robots key technology, for its best operation requires close interface and interaction between humans and robots without any safety barrier [39]. In the construction industry, robots play a critical role in working in a dangerous environment with effective human collaboration in the same team [43]. Optimization-based algorithms and approaches enable humans and robots to co-exist and function according to the work requirements [59]. Service robots are utilized at the personal and professional front for better service and satisfaction driven towards humans, specifically the social interface or industry-based medical, cleaning and logistical [24]. Industry 4.0 induced to work towards building humans with less motor skills to be complemented with robots to boost capability [23]. War efficiency is far more improvised with surveillance assistance at war lands, keeping the soldiers safe and vigilant [34].

The wide disruption of technology in industry 4.0 in various business spaces enables humans and robots to collaborate and derive synergy from achieving society's goal of society 5.0. This dynamic duo reaps various benefits to humans and organizations at large. However, there are multiple advantages and barriers to its application. So, it is detrimental to explore on numerous advantages and obstacles for human–robot collaboration and coordination.

3.1 Drivers for Human–Robot Coordination and Collaboration

Robots are the key technology innovation in industry 4.0. They are getting added rigorously into the lives of humans through various interventions such as business workspace, availing customer services, production and operation functionality. Technological enhancement leads to many advantages in humans' business and personal space. The drivers for human–robot coordination and collaboration are notified in the extant literature. Such robots 'anthropomorphism benefits humans with their human-like communication, behavior and appearance [10]. Human perceived benefits related to robots are organizational performance and cost-effectiveness [57]. Personalization of human's personalized experience towards robots and feeling the human touch [67]. The ability of the robot to capture and understand the emotions and exercise empathy based on the situation [78]. The entertainment factor showcases customer

Table 3 Drivers for human–robot coordination and collaboration

Sl no	Drivers/advantage	Feature	Adapted
1	Anthropomorphism	The ability of the robot to have attribution of human characteristics	Betriana et al. [10]
2	Perceived benefits	Adoption of towards performance and economic savings	Pillai et al. [57]
3	Personalization	The ability of the robot to be specific to individual needs and requirement	Saxena et al. [67]
4	Emotional engagement	The ability of the robot to capture the emotions of an individual to make the right suggestions	Wheelock [78]
5	Entertainment factor	Robots are capable of entertaining individuals to be engaged and enhancing the experience	Wheelock [78]
6	Automation of repetitive tasks	The ability of robots of automating mundane tasks	Sparrow and Howard [72]

engagement and enhances the family experience [78]. Robots' ability to automate repetitive tasks makes the job easy for humans [72]. Table 3 showcase the drivers towards human–robot coordination and collaboration.

3.1.1 Defined Drivers for Human–Robot Coordination and Collaboration

See Table 3

3.2 Barriers for Human–Robot Coordination and Collaboration

Organizations are striving to work on the various barriers to adopting robots. Organizations have immense opportunities to scale upon their business performance with the advantages of robots [81]. Industry 4.0 requires agility for the organization's strategies and quick decisions regarding barriers foreseen in human–robot coordination and collaboration. The present research discusses the various barriers to human–robot coordination and collaboration. They are discussed as follows.

Robots appear and act like humans, forcing humans to develop more trust and empathy towards robots. Uncanny valley theory proposed by Japanese professor Mori describes that when individuals perceive robots as human-like beyond, human likeability drops drastically. It leads to negative likeability and change in human response towards the robot [10, 78].

Safety concerns of humans while operating and functioning with robots in different scales of production in human–robot collaboration [59]. The knowledge

Table 4 Barriers in human–robot coordination and collaboration

Barriers	Feature	Adapted
Passing uncanny valley point	Human disassociating human like ability to robot leading to change in behavior and response towards robots	Betriana et al. [10, 78]
Safety	Humans feel unsafe in the physical environment while operating with robots	Pupa et al. [59]
Knowledge barrier	Humans lack in sufficient knowledge about collaborative robot functioning	Di Lallo et al. [40]
Macro contextual barrier	Anthropological application of intelligent technology	Vrontis et al. [75]
Potential risk	Humans, while sharing the workspace with robots, sense a risk towards potential hazards or mishaps	Awad et al. [8]
Cost factor	The cost incurred to installing robots requires substantial investment to be done	Wheelock et al. [78]

barrier poses humans with less or no knowledge about the collaborative function of robots [40]. Macro contextual barriers of implementing intelligent technology like robots in the anthropological application [75]. A potential risk is experienced while working on one collaborative task with humans [8]. The cost of instilling robots at the workspace for collaborative functioning requires organizations to induce charge. It can be a drawback for companies with financial incapability or risk to invest in it [78]. Table 4 reflect the barriers for human–robot coordination and collaboration.

3.2.1 Defined Barriers in Human–robot Coordination and Collaboration

With high-level precision and decision-making, the robots give proper work insights to a human when collaborating to achieve goals [12]. However, the identified drivers reaping benefit in the collaboration and barriers pose challenges to its practical adoption. Furthermore, society 5.0 and industry 4.0 objectifies sustainable development of the society while solving the critical social problems towards human society with intelligent technology advancements [58]. Therefore, organizations need to develop strategies for effective human and robot collaboration for business sustainability. Furthermore, the ecosystem furnished in industry 4.0 needs to consider and overcome the various barriers posing difficulties for humans in the collaborative adoption of robots for progressive direction towards society's objectives of society 5.0.

4 Human–Robot Coordination and Collaboration Towards Organization Performance

It is confirmed that human–robot coordination and collaboration where the robots accomplish knowledge able tasks in an uncertain and manipulative environment provide better operational efficiency [12]. Robots can function in unforeseen conditions while providing precision in allocated work [65]. It is specified that the human–robot collaboration outperforms the work implementation [2]. Practical cooperation and coordination require a proper safety and interaction interface for the real-time performance of robots working with humans [25]. It is discussed that the robot compliments humans for accentuating the capabilities to function in the same workspace [36]. The human–robot collaboration (HRC) brings work synergy with the strengths of each side while bridging the gap as a mutual consignment [15]. HRC benefits manufacturing processes for various product ranges with required customization [36]. To achieve the common goal, the work tasks are performed by humans and robots in coordination as a sequence of shared actions towards shared goals [76]. Robots are an essential technological invention in industry 4.0, equipping the service sector with productive collaboration to gain a competitive advantage and sustain the business [24]. The contemporary research in the HRC field confirms that human–robot collaboration indicates organizational goal achievement. The companies across the industries are leveraging the new evolved work team with humans and robots to benefit the business outcome. The evoked transformation triggered by the evolution of industry 4.0 led to the gradual shift in workplace and practices; however, this movement requires humans to adapt and accept the changes and start complementing the new business scenarios.

4.1 Organizational Performance

There are various dimensions of measuring the performance of an organization which accounts for financial, non-financial, qualitative and quantitative, which is supervised in meeting the international standards such as TQM, ISO and Deming prize to self-assess for enhancing organizations' performance [18]. Organizational performance caters to defining factors like short-term forecasts, pricing, cost control, technical and managerial activities on time helps the organization improve business performance [71]. There are substantial frameworks documented to measure the organization's performance, such as balanced scorecard and data envelopment analysis [66]. The performance measurement quantifies the overall organizational efficiency and effectiveness. Traditionally, the organizations were more focused on the company's financial performance, such as sales, turn over and gross profits. Still in a contemporary scenario, performance measurement goes beyond examining and measuring various factors behind them, leading to organizational excellence such as quality, customer/ client satisfaction and the number of innovations [18]. "Organizational performance means financial performance, shareholder return, organizational effectiveness, customer satisfaction, operational effectiveness and other outcomes, which lead to financial growth" [70, p.462]. Industry 4.0 has led to the invention of intelligent robots working in ateam with humans towards shared goals, responsibility, role, task, robot adaptability while aiming for organizational performance [26].

On the other hand, humans sharing the workplace with robots in the same team need to develop trust to optimize performance in the collaborative work environment [30]. The fourth industrial revolution has encouraged machines to exercise decision-making and problem-solving in collaboration and coordination with humans to bring value to organizational performance [44]. However, humans need to evolve and adjust to working with robots to drive value to the organization [44]. With the confirmed evidence in research about the technological innovation under industry 4.0, it is observed that human–robot collaboration and coordination can bring substantial value towards organizational performance.

5 Framework for Human–Robot Coordination and Collaboration

Industry 4.0 and society 5.0 are driving the business towards technology inventions and their sustainability with humans and the environmental large. Therefore, it is essential to assess the effect of such innovations on organizational performance. Considering extant research, we propose a framework that is solely based upon the literature.

The proposed framework Fig. 3 in this study elaborates on the impact of human–robot collaboration and coordination at the workplace on organizational performance. The framework is developed in the extant literature. The framework confers the various constructs contributing to the coordination and collaboration of humans and robots, leading to organizational performance. Organizational performance is achieved through practical human–robot cooperation and coordination at the workplace [12, 38, 47, 57, 64, 77]. Human robots collaborating for a shared work goal can be achieved with higher efficiency complemented with the intelligence of robots to make decisions and solve problems about business scenarios. Towards the practical adoption of this intelligent collaboration to work in a team, various pertinent drivers and barriers are adding to its adaptation at the workplace [8, 40, 53, 57, 59, 67, 72, 78]. Industry 4.0 revolutionized the technology with intelligent robots as part of human society with capabilities of decision making and problem-solving. In contrast, society 5.0 focuses on technology innovation centered on human quality of life [52].

Robotic automation in business processes is forecasted to grow more than USD13 million by 2030, with a substantial increase than 2020 to accelerate business operation and cost reduction [43]. In addition, human–robot coordination and collaboration add value to organizational performance with increase productivity, faster process, flexibility and customer service.

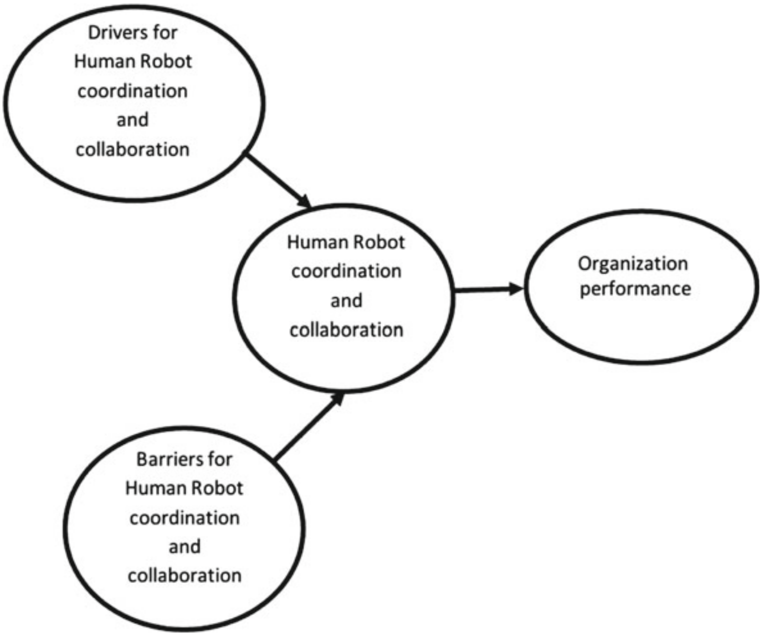

Fig. 3 Framework for human–robot coordination and collaboration towards organization performance

Therefore, the proposed framework depicted in Fig. 2 narrates the various constructs that act as drivers and barriers towards human–robot collaboration and coordination, eventually leading to organizational performance.

5.1 Framework for Human–Robot Coordination and Collaboration Towards Organization Performance

6 Implications

The proposed framework Fig. 3. in the study has implications for academics and managerial perspectives. The framework gives a strategic direction to the managers in business spears to ensure human–robot collaboration in working teams to achieve organizational performance. The managers need to work and strategize on the various drivers and barriers towards the new setup while teaming the work under human–robot collaboration to ensure easy integration and reap the organizational benefit. The proposed framework provides deep insights to managers in enhancing organizational performance with effective and efficient human–robot coordination and collaboration. Designers, developers and marketing have significant implications from this framework. The designer, developers and marketers need to understand the various factors during the development and marketing of robots to accommodate the possible barriers prevailing towards its adoption, also accentuating the drivers for effective human–robot coordination and collaboration at the workplace. Designers, developers, and marketers should reduce administrative and operational burdens on organizational performance.

This work adds to the extant literature by creating a framework for understanding the various factors towards human–robot coordination and collaboration at the workplace. This work contributes to the literature of industry 4.0, society 5.0 and organizational performance by using robots at the workplace. This work fills up the research gap by providing the model for human–robot collaboration towards organizational performance. It also provides the barriers and drivers of human–robot collaboration in a single framework. This study considers the critical aspect of society 5.0 and contributes to the literature of human–robot collaboration, which is vital for society 5.0.

7 Conclusion and Future Research Scope

Society 5.0 has the vision to bring sustainable development while incorporating the technological advancement of the fourth industrial revolution. It also aims to develop a new community that projects on amalgamating robots and humans towards improving human's quality of life [58]. This study provide the insights to achieve human–robot collaboration and coordination towards the organizational performance using the extant literature [12, 47, 57, 64, 76]. The theoretical framework is presented for human robot collaboration and coordination. It reveals the facilitators and inhibitors of human robot collaboration and coordination.The crucial drivers of human robot collaboration are as identified in Table 3-*Anthropomorphism, perceived benefits, Personalization, Emotional engagement, Safety, Entertainment factor, Automation of repetitive tasks an*d barriers are as identified in Table 3-0-*passing uncanny valley point, knowledge barrier, Macro contextual barrier, Potential risk, Cost factor) towards human–robot coordination and collaboration* [8, 40, 52, 67, 72, 78].

In summary, Organization performance can be achieved through human robot collaboration by managing the drivers and barriers of human robot collaboration and coordination. The framework development is based on the qualitative method and further research can be conducted, considering the quantitative method to test the framework empirically. Also research can be performed to empirically examine the drivers and barriers to investigate its' impact on organizational performance and explore additional barriers and drivers.

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Chapter 10
Revolutionizing the Techno-Human Space in Human Resource Practices in Industry 4.0 to Usage in Society 5.0

Aditi V. Aljapurkar and Satyajit D. Ingawale

1 Introduction: What is Artificial Intelligence?

INTELLIGENCE BECOMES A UTILITY.........SIRI!

This tagline by Apple Inc. for its voice virtual assistant embedding artificial intelligence in a machine opens a gamut of comprehension to be done for the AI technology today. Artificial Intelligence (AI) can deliver a tool for change. AI is a concept defined as a system's ability to correctly interpret external data, learn from such data, and use that learning to achieve specific goals and tasks through flexible adaptation [1]. Inferred from this statement is, intelligence embedded in a machine that reflects human thinking with rationality as a predictor for decision-making. AI is based on the development of autonomous agents that can reason and plan towards their goal without any built-in knowledge base of their environment [2]. Organizations, communities, societies today can look around, find, and observe the usage of machines involvement to help them orient towards a knowledge-driven agenda to reach their goals. AI holds the promise of making us healthier, wealthier, and happier by reducing the need for human labor and by vastly increasing our scientific and technological progress [3]. The field provides us with a human-technology-driven fraternity that reduces our human efforts to drive out more effective and efficient in what we do.

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1.1 Literature Review

This chapter has focused on different kinds of literature for review purposes to find out gaps in previous research. It has also covered the gap under four categories, artificial intelligence, artificial intelligence in HR, artificial intelligence usage in urban planning using IoT, challenges. The researchers have considered the past work done on artificial intelligence. For this purpose, the researcher has considered the journals in which the articles related to artificial intelligence are published by eminent researchers. The internet articles are considered for the review purpose with the view to understand the present situation in the different countries regarding usage of artificial intelligence in different sectors viz: urban development as smart cities. The researcher has tried to find the gap in different articles, books, and research work considered here for the review. It is also found that there is a shortage of literature regarding collaborative artificial intelligence. Table 1 shows the works of literature considered and the gap identified.

1.2 The AI Present Scenario

AI realm today holds the idea of developing intelligent systems algorithms that work and act like humans. With most systems focusing on decision making today's application span speech recognition, natural language processing, translation, learning, reasoning, inferring, visual perceptions, intelligent agents thus characterizing Industry 4.0. Industry 4.0 will irrevocably change how we interact with technology and each other. The interaction of technology has even touched businesses and industries. The inclusion of artificial intelligence is now a significant part of the business model e.g., Google AlphaGo beating Go world Champion, KFC restaurants Baidu's assistant taking orders in China. Artificial intelligence has evolved in three different stages: Artificial narrow intelligence (ANI), Artificial general intelligence (AGI), and artificial superintelligence (ASI). The time for transiting from phase 1 to phase 2 has been the longest and now the technology has moved to the third and final stage where humans and machines are the same.

1.3 Racing to AI in Business

The racing of usage of artificial intelligence in business is evident as it unleashes many financial opportunities. It will provide the industry players, the corporates, government bodies a technological power unparallel with any other. Across the globe, some economies endeavor in sustaining the birth of different industries. These industries in the twenty-first century are disrupted with new-age technologies leading to industrial convergences. With the background of digitization and hyper-connectivity,

Table 1 Literature review

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
1	A Framework for Collaborative Artificial Intelligence in Marketing	Ming-Hui Huang and Roland T. Rust 2021	Theoretical model development of Artificial intelligence and human intelligence	NA	1. different levels of Ai and Hi must be identified. 2. Human intelligence and artificial intelligence are supporters of each other. 3. AI will help Human Intelligence by replacing the HI when the system-defined intelligence is reached. 4 It is necessary to apply Ai to tasks/processes by automating them	The model is used for consumer consumption wherein AI will help marketers to comprehend at what stage/level the consumer's behavior can be modeled through the combined nature of human intelligence and artificial intelligence. There is a requirement of identifying the skills/competencies needed by the marketer to make use of the collaborative intelligence

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
2	Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence	Andreas Kaplan Michael Haenlein 2019	Literature review	NA	1. There is an incremental growth in the type of AI and today has reached Artificial superintelligence. 2. The growing field of AI has helped to have collaborative artificial intelligence systems where human and machine power can work hand in hand. 3. Applications can extend to universities, governments, and corporations 0.4. There is a need to evolve the business environment as per technology changes 0.5. There is a need to have proper rules, legislations, and control over AI usage design and implementation	The authors have not considered the risk factor while proposing artificial intelligence usage and the case-based approach is also lacking

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
3	Evolution of Artificial Intelligence Research in Human Resources	Mariana Jatobá et al. 2019	Quantitative and descriptive analysis	Literature review analysis and drafting of selected variables (AI in management, recruitment, and selection, Application of teams), Neural network analysis for recruitment and selection data retrieved from Online Knowledge library for 2000–2018 period	There have been different cycles in which research for AI in HR was conducted	The current paper has not researched the growth of AI in HR and the factors that have shown either increase/decrease in the usage in a period format
4	Collaborative Intelligence A Blueprint for a New Artificial Intelligence Institute	André Corrêa d'Almeida Adam Ingle 2020	Round table discussions amongst stakeholders	Primary survey of Academicians, industrialist industrialists' policymakers, AI practitioners, AI users communities across the US economy	There is a huge gap between the demand and supply of AI competency holders. The AI training bodies (institutions/ foundations lack a broad practical approach to imparting skills and competencies There is a need for collaborative cross-sector research engagement involving all stakeholders Ethical and governing practices for AI should be well documented	The current paper has not put forth the skill set, and competencies requirement needed to work in the AI ecosystem 2. For usage of society 5.0, there is a lack of ethical and governing practices approach to be used by industries while focusing on training designs to acquire AI competencies

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
5	Stifling artificial intelligence: Human perils	Gonenc Gurkaynak et al. 2016	Literature review	NA	Usage of AI is inevitable in the coming future It is necessary that we adopt, adapt, assimilate the presence of AI in a friendly manner. There is a need to regulate the usage of AI by laws made to safeguard against misappropriating usage. Copyrights and IPR would be the platforms for AI regularisation	The current paper has not included the laws surrounding the usage of AI and how to safeguard against collaborative actions by humans and machines, especially for HR practices. While developing society 5.0 through IoT based interventions the laws are not considered, making sure there is no harm at the data level, information level, and human level
6	Book chapter-Universal Artificial Intelligence Practical Agents and Fundamental Challenges	Tom Everitt, Marcus Hutter 2018	Literature review	NA	A framework of a universal system of AI which talks about the interaction of intelligent agents in an environment based upon mathematical statements	The current paper proposition of Collaborative systems is not validated through any mathematical modeling

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
7	How HR can create competitive advantage for the firm: Applying the principles of resource-based theory	Davis, P. J. 2017	Literature review	NA	The human resources do not contribute to competitive advantage, but they are the competitive advantage	A theoretical framework for human resources contribution or responsibility is not considered while the application of AI In HR is being proposed
8	A machine learning-based method for the large-scale evaluation of the qualities of the urban environment	Lun Liu et al.	SIFT histograms and convolutional networks (AlexNet), Correlational analysis model	Machine learning models- and secondary literature	The paper provides a model for city profiling, to understand through the algorithm up-gradation and decaying of the areas. Real-time updating of Geospatial pics of the city could help in tracing the changes 3	In terms of smart city development, the current chapter lacks propositions through algorithm and relational modeling of the city area development and capturing images through sensing technology
11	What makes Paris look like Paris?	Doersch, Singh et al.	Google VIEW street database	K-Nearest neighbors for normal correlational analysis	1. geoinformatics survey can be used to find out the characteristics of city spaces	The current paper does not include algorithmic execution over database information retrieved from any source for smart city and application of IoT

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
12	The power of social media analytics	Gu, Y., Qian et al. 2016	Data acquisition through Twitter server RESTAPI, Iterative NLP	Twitter analytics (data mining), Binary vector analysis for tweet mapping	The analytical tools helped to find out incidents to handle the accident rate and nature, planning for road development and up-gradation, hazard, and weather management	the author's written paper has not mentioned any analytical tool and platform of social media from where data sourcing and analysis can be executed
13	A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems	Lee et al. 2015; Palazzeschi et al. 2018; Savaget et al. 2019	Architecture proposition for cyber-physical systems	Sensing techniques, image capturing through machining systems, and prediction techniques	Architecture that will help efficient machine usage by data capturing data conversion, data mining, d decision-making at the cognitive level through simulation and diagnostic analysis for required actions	The current paper has not proposed an in-depth system architecture of how to apply the sensing, capturing, and diagnosis for smart cities under IoT technology
14	On the way from Industry 4.0 to Industry 5.0: from digital manufacturing to digital society	Skobelev et al. 2021	Literature review	NA	Society 5.0 is the convergence of science and technology—robotics, dealing with big data with multiagent systems, helping the technology people in one system leading to IoA (Internet of agents)	The chapter lacks the multiagent framework as an important component of the Industry4.0

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
15	Organizational responsibility: doing good and doing well	Aguinis, 2011; Kish-Gephart et al., 2019	Literature review	NA	I/O practitioners have a huge responsibility to enhance organizational performance. There is a difference between organizational and corporate responsibility There is vast scope for strategic responsibility management to be taken up by the organizational members	The written chapter has not focused on technical aspects of IoT and CAI stakeholder's responsibility in the organization and society especially when technology and industry processes are brought on one platform for convergence
16	Society 5.0 co-creating the future	Keidanren, K. 2018	Literature and expert opinions	NA	The world must adapt to changing technologies like AI, Robotics, and IoT and economies must have plans to assimilate into the business industries and everyday life of humans. The adoption must be done keeping in mind the world's sustainable development goals. Society 5.0 embraces an environment where people have freedom of will and are creative to live and pursue a happy life	The current chapter has focused on the application of IoT over smart city development, the sustainable development goals are not explored

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
17	The Future of Retailing	Grewal, Roggeveen, and Nordfalt 2017	Literature review	NA	1. Tools and technologies facilitating decision-making to retailers 2. Apps and drones to be used for understanding consumer behavior. 3. IoT to comprehend buying behavior	Applications like app development for city/ location-specific information seeking and analysis are not considered. Also, for a smart city, the component analysis for city planning and urban development through drones is not included
18	Natural Language Annotations for Question Answering*	Katz and Felshin 2006	Literature review	NA	Natural language processing through START Information system facilitates in answering complex questions posed	For locating the data from different locations only sensing data and machine learning techniques are proposed. Use of NLP is not included
19	Conceptualizing the future of HRM and technology research	Tanya Bondarouk 2016	Literature review	NA	There is an interface between HRM and technology. The impact of HR on stakeholders is needed to be analyzed. Those organizations whose technology interventions are high would qualify as ‘smart’ organizations	The current chapter has lacked in providing the stakeholders and society as in large with technological interventions

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Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
20	Talent acquisition due diligence leading to high employee engagement case of Motorola India MDB	Srivastava, P. and Bhatnagar, J. 2008	Secondary data	NA	1. Changing technological aspects makes it imperative for organizations to have niche talent acquisition strategies 2. Recruitment strategy should ensure person and cultural fit to increase engagement and reduce attrition amongst the employees. Changing environmental aspects should be aligned with a talent acquisition strategy, like what the Motorola company did while choosing India as a market for their product and business expansion	A case-based approach is not being considered by the authors, for defining HR strategies by an organization for the Industry4.0 scenario especially in recruitment and training and development practices to be designed and implemented

(continued)

Table 1 (continued)

Article number	Title	Author name	Methodology used	Analytical tools used	Findings	Gap identified
21	Artificial Intelligence adoption-AI readiness at firm level	Sulaiman Alsheibani et al. 2018	TOE framework	Online survey data analysis to test TOE framework	An organization's technological, organizational, and environmental aspects should consider the readiness of AI adoption. Businesses must see the impact of AI adoption in business processes	To have AI in the business process, the current paper has not used any framework that would help to understand the human resources skill requirements to use AI which will then be a part of the recruitment strategy of the organization
23	What happens when industries collide?	EY 2019	Secondary information	NA	The report mentioned the industry convergence and how smart cities surges as a concept from this	The business and societal challenges are not covered fully solving business, governmental aspects

the disruption caused even convergence of many unrelated industries together. For example, the 2,000% growth of the use of private and commercial robots from 2015 to 2030 could create a US$190b market is an example of unrelated industry convergence. The example here infers that convergence leads to the opening of new markets or opportunities for different stakeholders like companies or governments. Industry convergences shake up the workplaces too. The industry trend today looks for human resources to be the differentiator for the firm's competitiveness. Employees do not just contribute to competitive advantage; they can themselves be a direct source of competitive advantage [4]. To achieve this, it calls for the Business leaders and HR to capitalize the disruptive technology to reshape the workforces by having greater insights into the organizational functioning, outcome, and variables. Artificial intelligence as a disruptive technology seems to be unfolding the realms of opportunities in redefining the business process. AI has also been disrupting the human resources nature and practices at the workplace. The real challenge is how many businesses or executives are ready to adapt, adopt this technology? Do they think that this technology is a solution to everyday workplace problems? The adoption of Artificial intelligence had its own pace across industries and sectors in the context of revolutions happening in the technology. It has already been applied to self-driving cars, media and entertainment, healthcare, and smart cities. However, this has not been the case for AI readiness factors for preparing organizations to adopt AI [5]. Economies and business houses should ready themselves for the adoption of AI, as according to the PwC report AI offers the biggest commercial opportunity helping the GDP to higher by 14% by 2030 equivalent to %15.7 trillion. As economies are set to unearth the usage of AI in business, it is also significant to comprehend the interventions in business functions too. Though the statistics reflect a developing notion, still, there are many facets like Human Resources Management in Business which is far yet to experience the full potential intervention of AI!! The scope of technology intervention and its impact on workplaces today covers the objective of Society 5.0. This is crafted with the need to numerically express the work done at the organizations, replacing the routine work with the technology/automated processes/intelligent agents, etc. also demanding that the industry changes with calling the workplace structure to change too.

1.4 The HR World

With evolving business goals, structure, and technology the world of HR faces a dearth of talent—mainly in acquiring the right talent in the organization. To deal with this, organizations' recruitment and culture need fit, an environment is created at the workplace where employees feel more passionate about their work and exhibit the behavior that organizations need to drive better results [6]. Organizational strategies, systems, policies, and procedures help but even then, the problems persist in the talent acquisition process.

- Candidate power to define the job role makes it challenging for the company and recruiters how to meet this demand (Is there a need for intervention that involves a collaboration of humans and technology to make online job search easier?).
- During the candidate assessment process there would be a need felt to know real competitiveness by a candidate (Is there a need to change psychometric test by job simulation models?—with a simulated environment employers can assess the job performance of the candidate, without the support of Interview responses and personality testing tools like a questionnaire).
- The Lighthouse Research 2017 Talent Acquisition Priorities study found that talent acquisition leaders were focused heavily on improving their relationship with the business and improving their practice, but the primary areas of hands-on recruiting that they wanted to fix were onboarding and sourcing.
- Can technology help in deciding how and where to invest the training budget?
- Do technology interventions help organizations to transact from employee engagement to employee experience?

1.5 Technology and HR

To answer the questions and to solve the problem, Business houses can take help of the technology like Artificial Intelligence and mature systems like collaborative intelligence to mark the HR functionalities' which is essentially an open system consisting of people, technology, organizations, and management processes [7]. Technological growth and enhancements thus form a significant pillar. The HR industry is transforming and is absorbing technology at a brisk pace. The rationale for this is the different challenges like employee engagement, talent retention, competitive compensations across operating markets and cross-industries, and leadership development. These challenges have sparked innovation to be brought in HR departments. So, the interest now is in comprehending technologies like artificial intelligence, collaborative intelligence Virtual and augmented reality, IoT, Autonomous agents, and things, Wearables, etc. changing the way HR departments will function in the coming future. There has been an increase in the research of artificial intelligence in AI. From 2000 to 2018, 71.4% of the research was applied to the topics of recruitment and selection, activities involving attraction, and more adequate choice of workers, as a support system for the companies. It thus becomes significant to comprehend what encompasses the AI ecosystem and how it can impact the HR environment.

2 AI Ecosystem

Every technology that exists today has its ecosystem which helps it get evolved and improve on its utility factor. So, in these aspects, every technology like TV, Phones, satellites, Internet, Computers have all made exponential growth interim of the platforms, content, tools used, accessibility, and the experience it provides. There is a need for an ecosystem for this growth. On similar grounds, we do observe that Artificial intelligence as a technology is evolving.

John McCarthy who gave birth to the concept of AI hailed from the United States and was a computer and cognitive scientist. McCarthy was a pioneer in the field of artificial intelligence. To his credit is coining the term artificial intelligence in his research paper he co-authored for. He holds the credit to create a programming language named 'LISP' and is a significant contributor to the design of the ALGOL programming language. However, interest in technology waned significantly during the 70s–80s decade and then disappeared. The concentration in A.I. reappeared through the tech industry's positive explosion, as hardware technologies advanced, providing more opportunities for the usage of A.I. *Google made technological advances in 2012 by developing a machine that could recognize cats.*

In recent years, the Ecosystem of AI has become more comprehensive and hence needs to be explored at a higher level. This ecosystem is built with capabilities that connect all our technologies, devices in its environment. In the coming years, the interrelationship of A.I., the Internet of the Internet, and data could unravel boundless potential in terms of outputs with high metrics, enhanced standard of living, and a society characterized by better aspects. However, with so many parts in an AI ecosystem, it can be difficult to keep track of everything. Machine learning, deep learning, and artificial narrow intelligence are examples of concepts that can be found in an A.I. ecosystem. Table 2 ecosystem of AI reflects the components in the ecosystem and the utility factor with an example.

Table 2 Ecosystem of AI

Sr. no.	Ecosystem component	Example	Utility
1	Artificial narrow Intelligence (its focus on one task at a time)	Siri, Alexa, Facebook's newsfeed, Email spam filters	An everyday usage technology system
2	Machine learning (Systems with self-learning ability without being programmed)	Speech recognition, problem-solving, learning, and planning	With no human interventions, these systems are self-learned systems that are equipped to adapt also
3	Deep learning (a subset of machine learning)	Self-driving vehicles, Healthcare, etc.	Utilizes both structured and unstructured data for training

2.1 Trends in the AI Ecosystem

Of the industries studied, information and communication, manufacturing and financial services are the three sectors that will see the highest annual GVA growth rates in an AI scenario, with 4.8%, 4.4% and 4.3% respectively by 2035 [8]. The market is huge and growing with different trends. Amongst this cloud-based, AI is trending. Cloud computing and artificial intelligence (AI) are inseparable. The latter is a supporter in enhancing the utility factor of the other in terms of data management, uncovering acumen, and optimizing the flow of work. Cloud-based services standardize AI, thus, provisioning it to increase the efficiency of organizations, thus helping them to stand out in the market, that have faced a high entry barrier. Investing in AI has traditionally required top technical skills, massive computing power, and a massive amount of capital. However, because of the cloud-based AI service, businesses can implement it and benefit too. Both applications benefit at large the combination of AI and cloud services allows businesses to maximize the benefits. The cloud-based service offers a profitable alternative to costly on-site hardware and software. Simultaneously, AI assists the cloud in managing data and gaining insights into information. A business organization can opt for any trend for its ecosystem depending on the need, strengths, and limitations of the information technology infrastructure, the skills amongst the human workforce, and the financial feasibility. The decision-makers in the organization can set a strategic plan to develop the roadmap for AI addressing key business aspects.

2.2 AI Roadmap Development

An AI guide is an arrangement of checked AI openings focused on accomplishing key business objectives over the short and long haul. It's the initial step to having a strong system for AI, yet it's anything but a complete arrangement to change the entire endeavor. All things considered, it starts off the grouping of work spread out in the four mainstays of wise AI reception: Strategy, Data and Technology, People and Organization, and Governance. The roadmap would include 3 phases in it as shown in Fig. 1.

The AI utility value for the business can be be-folded in the three terms that are stated. Every stage renders value to business either effective or efficient business operations.

Discover Stage, the result is to construct an arrangement of AI use cases to assess in the ensuing stages. For example, Fig. 2 shows the used case for Amazon company. The business decision-maker in this stage can use the following.

"***What can your business improve by utilizing AI?***"

1. *Organization can focus on a process, program, or structure, that shall be impacted in terms of bringing a change in the value chain of the company.*

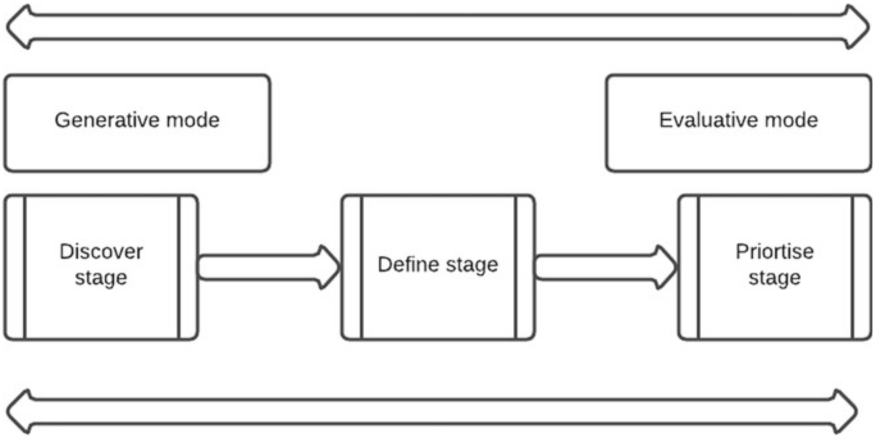

Fig. 1 AI roadmap development

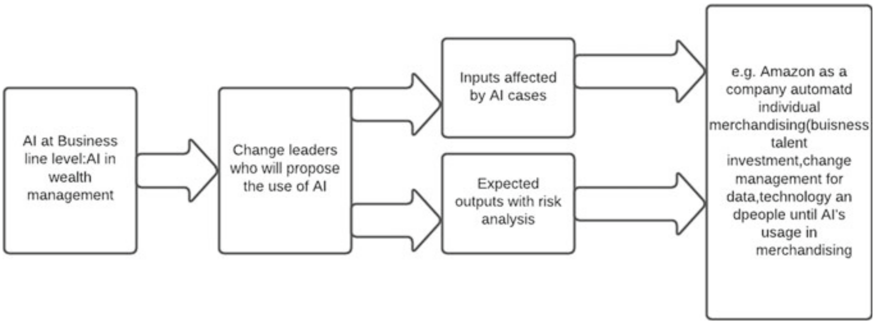

Fig. 2 Example discovering AI used case

How would it be able to respond that is new?

1. *Are organizational feasibilities being checked for AI adaptation?*
2. *Are change management strategies for people and structure in place to mitigate the resistance to change?*

What worth would it be advisable for you to make straightaway, and why?

1. *Financial feasibility and returns over the usage of AI in business lines or processes must be analyzed by the decision-makers.*

Define stage Decision-makers in the organization should pay special attention to Artificial intelligence capabilities internally present and that which can be reused in manifold scenarios. This stage qualifies to comprehend the used cases and proficiencies. When a used case viz. ***timesaving*** is considered, it is significant to observe and record how it impacts incrementally to improve business efficiency or process efficiency, or resource efficiency.

E.g., for a recruiter in the human resources domain, usage of NLP—natural language processing in an enhanced automated interview environment would help in determining the Person–Job (P–J) fit and Person-organization (P-O) fit through words, speech and facial analysis. Person–job fit is defined as the degree of alignment between the individual and the job [9]. Each of these requires a certain roadmap of how to go ahead with the development of the function with an AI base, then to integrate the technology in the process and drive change management practices in the organization to mitigate the resistance to change and improve the adaptability index. So, this stage of the ecosystem requires that sufficient data is available to validate that AI usage is safe, reliable, accountable, and trustable. There must be enough evidence to ensure that the system possesses no harm to physical, psychological, and economic harm to organizational stakeholders.

Prioritize stage This stage looks in for aligning business requirements with AI strategy keeping in the return expected out of AI projects.

2.3 Utilizing the AI Roadmap

In the beginning, organizations should try to deploy AI to the business line—and not the whole business nor a single task or process. Within the financial organizations, for instance, we would see use cases in which AI interventions are seen in the ***wealth management operations*** **or** ***the credit lending procedure*** **enhancements**.

1. In the wake of picking your center, teach change pioneers (from top management-middle management) on the most proficient method to perceive a decent AI use case. A utilization case ought to have information that portrays both the info and expected yield for a business task—like the definite item portrayals accessible in various dialects that empowered eBay to practice the execution of its machine interpretation AI utilizing to and for models.
2. At last, work across groups to plan additional opportunities, coordinating with AI capacities, (for example, regular language handling) to utilize cases, (for example, interpretation of item postings).
3. Thoughts do should be pragmatic, for instance: what forecast will be made, utilizing what information, and how might the expectations be applied to make it more effective and efficient.

Nonetheless, creative mind and aspiration pay off, as well—among early adopters of AI, over 60% detailed finding another plan of action as indicated by an IDC overview. To create the best thoughts, balance hierarchy, and base up experiences. Meetings with workers and clients, for instance, can assist with making an early purchase in just as a more profound comprehension of on-the-ground business tasks. At the finish of the Discovery stage, your group ought to have a bunch of utilization cases assessed to be of high effect that requires itemized approval.

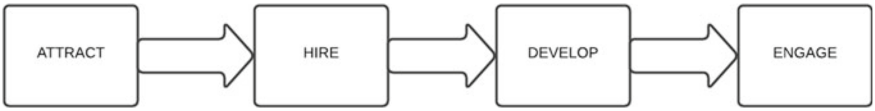

Fig. 3 Human resources management functions

For example, the usage of the IBM Watson cognitive system. The Watson portfolio is intended to make it simple for you to utilize information from different sources, trust the proposals and forecasts from your AI models, and get more worth from your AI, quicker. With Watson, you approach the most complete arrangement of AI abilities for business, regardless of whether it's instrumented for building your models, prefabricated applications to speed up an ideal opportunity to esteem, or admittance to a powerful environment of accomplices across various enterprises. As a cognitive computing system, it allows creating value, finding answers and insights that are locked in bog volumes of data. Be it the healthcare industry using the system for diagnosis or be a wealth manager using it for a client to propose a retirement plan, or a chef who wants to make a new recipe. All these new approaches put together the voluminous data at hand to provide new insight and add value.

2.4 Enhancing the HR Processes Using AI

Automation of any business process is inclined towards the experience the end-user gets.

The same analogy applies to human resource management processes too. AI applied to HR helps the HR team of the organization to extract understandings from the sources data and to provide real-time recommendations.

2.4.1 How Can AI Be Used in HR?

AI helps in analysis, prediction, and diagnosis helping the HR team to make better-informed decisions for the organizations. Every HR functional process as shown in Fig. 3 can be automated and facilitated by artificial intelligence. Table 3 enlists the companies that have used AI in HR functional processes enhancing the recruitment and selection process.

The evolution of artificial intelligence to Artificial superintelligence (ASI)[1] puts forth a platform where automation through self-aware and vigilant machines start comprehending human intelligence and behavioral characteristics. Even though this is in the nascent stage of its design and implementation there have been exemplary developments like IBM Watson and SIRI. However, there have been fewer amount

[1] Computer's capability surpassing human capabilities would qualify for artificial superintelligence.

Table 3 Landscape for AI recruitment

Sr. no.	Recruitment buckets	Description	Example
1	Pre-Hire assessments	Usage of Game-based as a pre-assessment tool to check and evaluate the skills of candidates to provide a rich and engaging experience. Video-based assessments	HireVue company uses a team of experienced organizational psychologists that use this tool to identify the competencies best suited for each role
2	Candidate rediscovery	Supports with analyzing the database to rediscover who would be a job fit to the declared job positions	IDEAL, Leverages candidate pool, re-engage with qualified candidates that have expressed interest in joining your organization
3	Job description optimization	Enhancing the job description wherein recommendations for wordings and phrases make it more inclusive	Recruitment process data is analyzed by machine learning by the Tool. The tool is efficient as it 'learns' the organization's identity and language. Helps in effective hiring Augmented writing then helps the HR staff to create more effective job descriptions
4	Ad automation	The organization can optimize the spending on Ads. The automation helps in placing and testing the job Ads on a variety of platforms	Reveal Bot: It automates analyses and launches strategies for media Ads using different metrics that help in strategic decisions rather than reactive actions
5	Job market forecasting	Job market forecasting software gives insight into available pools of talent for different job types, experience levels, or locations	The tool can predict which employees will leave a job. This accuracy is 95% accurate
6	Candidate relationship management	These tools provide personalization services to the candidate, also may help in re-engaging those previously applied	ADP workforce now: Manages—payroll function, HR function, time management, talent management, and benefits management—in a single database
7	Resume sorting	These tools help in the process of screening	Newton: ATS with resume parsing tools to add, organize, and discover. These a impact the recruitment data value and are insightful, for recruiters, HR directors, and the candidate

machines that simulate in full capacity what a human can do. We propose to think about a system that has the capacity of what humans and machines can do. This introduces a concept of collaborative artificial intelligence wherein humans exhibit machining capabilities and machines exhibit few human capabilities-collaborative artificial intelligence.[2]

2.5 Collaborative Intelligence in Recruitment Function: All About Estimations!

The potential of the AI effect on the business process is a huge and recruiting function of HR is no exemption. Talent procurement succeeds when it predicts the best contender for a task and assembles the connections that convert them to potential employees. Man-made intelligence can scale and deal with an enormous part of this forecasting work. At its best, AI reasoning strengthens the extraordinary ability of recruitment specialists and supervisors, surfacing the best fit to role and organization, paying little attention to work experience, competencies, and sector they have worked. This is essential to remember when beginning a discussion with any AI seller. It very well may be enticing—and fascinating—to examine the specialized subtleties of a seller's AI arrangement, yet this shouldn't be the concentration. Appropriately carried out, AI can convey sensational upgrades in nature of recruit, time to fill recently added team member variety, and other basic enlisting measurements.

When organizations venture into finding vendors for providing features of AI-based Recruitment tools, the features may be similar across many vendors. Significantly, every organization focuses on the impact on the enhancement of the recruitment metrics and its ROI. The table description talks about the humanistic abilities of AI-based tools/bots. Collaborative intelligence would require and has features that will complete the hiring process using the AI tools/Bots and then human interventions to complete the other remaining steps like background verification, etc.

There are numerous examples of usage of AI in the corporate environment

- JPMorgan Chase performs legitimate checks of business advance concurrences with AI, opening 360,000 h of lawful survey each year.
- The Associated Press robotizes profit detailing, distributing 4400 AI-composed stories per quarter.
- Hilton utilizes AI to assess competitor interviews, further developing meeting to-enlist rates by 40% while diminishing the opportunity to fill 90%.

Table 4 describes a few other examples of how different companies are using tools and enhancing the recruitment process.

[2] Collaborative intelligence traces its roots to the Pandemonium Architecture proposed by artificial intelligence pioneer Oliver Selfridge as a paradigm for learning.

Table 4 Tools used for recruitment process enhanced by AI

	Name of the tool	Core features	HR area	AI interventions
1	XENOSTACK	Revolutionized recruitment platforms Skill matching recruitment Self-assessment tool for career growth and development	Recruitment-applicant tracking systems, candidate reach management, candidate experience management, online job postings, interview recording through video conferencing recruitment forecasting	Assisted intelligence by human decision-making augmentation De-tasking–automation of the auxiliary tasks in processes Assisting through candidate sourcing, screening, and interview conduction
2	Mya systems	Conversation recruitment platform, Automated candidate engagement and communication	Guidance in the hiring process	Uses NLP for natural conversations with recruiters and candidates in job search and onboarding, Enhanced ATS, Removal of Blackhole effect
3	HiredScore	Employee grading in finding the best fit	Hiring and employee retention	Job postings Potential job offers initiation Career trees
4	Wade and Wendy's	Automation-recruiter and job seekers	Recruitment	Ai based recruitment conversations-qualifying screening Chat conversation analysis within AI for effective scheduling Ready schedules for a recruiter for everyday routine
5	Belong (formerly known as DataEmo)	Data science enables candidate sourcing platforms	Acquisition	Profile analysis for skill and culture fit Personalized candidate conversations

2.6 AI in Learning and Development Function of Human Resources Management

An intensive awareness of Rapidly changing and developing technology and its usage in L&D process enhancement is required by the L&D specialist. The role of L&D experts/specialists should be in exploring the new techniques and strategies they could design, deploy, and evaluate accordingly. As per Gartner's report, 2020 was the year that would have witnessed the handling of customer-related services to be performed by robots and the rate would be almost 85%. In the L&D process, the instructional material needed would also be now produced by the AI technology in hand. A $14.33 trillion annual industrial expansion would be seen by 2025, as stated by Bank of America. This expansion rate would require L&D specialists to work on training modules for existing employees and those who would be recruited in near future with AI pruned skills requirements. The experts must work on the usage of AI software to track voluminous data and make usage of machine learning techniques to have and use insights for effective learning.

2.6.1 Role of Artificial Intelligence in Learning and Development

L&D experts need to keep steady over quickly changing innovation to upgrade the learning experience and results, growing new learning procedures and philosophies that exploit these enhancements, particularly with regards to AI. For instance, a Gartner report predicts that AI bots will control 85% of client assistance connections by 2025 and another report expresses that 20% of business content (counting preparing content) will at this point be created by AI., the Bank of America predicts that AI will drive between $14and 33 trillion yearly of monetary development by 2025.

Man-made intelligence will tremendously affect the L&D business. Organizations have an immense measure of information accessible to them, which they can dissect and use to upgrade preparing projects and learning educational programs. Gone are the days when each worker needs to gain proficiency with similar course content. Content can be customized to suit the student's necessities, center around more vulnerable spaces of the student, suggest appropriate substance dependent on past conduct, anticipate needs dependent on their job, and surprisingly auto-produce content utilizing different substance creation calculations. For AI to be used completely, associations need to tackle the gigantic measures of information utilizing AI, information experts, AI developers, and then some. The yield from this information empowers L&D offices to acquire bits of knowledge into the student excursion and assists them with making preparing programs that drive esteem and empower versatile learning.

People have different learning styles Learning styles sway the advancement of learning arrangements. An individual's learning style might be impacted by age, nationality, social foundation, and different components which should be considered in the improvement interaction. For instance, a review by the University of Georgia exhibited that "guys scored essentially higher on the Abstract Sequential channel than females, and ladies scored fundamentally higher on the Abstract Random channel than guys", showing that an alternate showing style (which could be advanced by AI) would help every sexual orientation. Employers need to perceive this and begin sending AI to prepare representatives by streamlining the content to suit the client's favored learning style. This won't just make the learning experience more charming for them however assist with information maintenance and hands-on execution.

Personalizing the learning experience an AI-fueled preparing program permits the preparation program to be versatile, where the modules are adjusted to suit the necessities of every worker. The LMS may offer video instructional exercises to specific workers, yet auto deciphers the recordings to message-based articles for different representatives. It very well may have the option to make visuals dependent on a composed substance and recommend the representative take an in-person preparing day on areas of the course they are battling with. Learning experiences additionally assist with fostering a more extensive comprehension of student conduct, prompting prescient limits. Utilizing the bits of knowledge, associations can make savvy and more brilliant, situated substance, that is versatile, natural, and receptive to a student's very own excursion.

Incorporating training into the regular work plan. Stephen Walsh, a prime supporter of Andres Pink, expresses that 93% of associations wish to incorporate learning into the normal work process. In any case, 56% of learning is exceptionally formal and conveyed vis-à-vis. Most of the students are not fulfilled either with the timetable of preparing or the configuration of data conveyance. A learning framework, controlled with computerized reasoning is the answer for this issue too and the advantages are essentially something similar: timesaving, representatives are locked in and involved, the learning system is mechanized, and the benefit of the association develops at the speed of light! When powered with AI, this framework will give a system, resources, and timetables that are produced for every worker.

Strengthening training and development. It's a well-known fact that representatives are excessively occupied and here and there lethargic to deal with their turn of events. Bryan Austin in his "Cutting edge Corporate Learner" paper claims that experts are anxious to commit just 1% of their valuable chance to learning and expert turn of events. Also, the MASIE Center, a global learning LAB, expresses those representatives finish just 15% of the learning programs that were allotted to them. Regardless of this reality, associations burn through billions of dollars on worker improvement programs all year. Artificial intelligence braced learning programs are called to take care of the issue with helpless support of preparing and advancement and can further develop your support program, including:

1. Timesaving through process automation.
2. Boosting the engagement by personalizing the learning process
3. Improving the completion rates through personalization.
4. Measurement of learning effectiveness through analytics automation.

Improving completion rates in many organizations, it is found the HR managers do find a challenge in covering up the completion rates. However, the AI platform delivery of training content is personalized and customized to the learner's format which is then followed up by stimulating methods the chances of covering the completion rates are improved. What can be done?

1. Though the organization TNA (training need analysis is more focused on the overall 'KSA' knowledge, skill, and attitude development, the training content rendered must be personalized to meet each employee's need.

2. It is important that the number of hours/trainings is kept short and is more engaging.
3. A professional approach to automate the training process must be done.
4. Learning effectiveness measurement should be in line with reward systems, once appropriate effectiveness levels are obtained, rewards should be disbursed.

Offering user-friendly accessibility Artificial intelligence-based insight things make planning programs reachable to a wide assembling of understudies, fusing people with different kinds of ineptitudes. For example, Google presented an Automatic Captions Video App in 2009, which could help hard-of-hearing people. Moreover, the App is equipped with auto-understanding convenience that helps people with liking watching accounts more than 50 vernaculars. For blind people, AI passes on undertakings and courses of action that make elective texts for pictures. Google presented Cloud Vision API that utilizes neural associations to perceive the situation and make a scholarly variation for an image. Thusly, with AI, experts will cultivate planning programs open to any understudy.

Determining the effectiveness Determining the average capability of the learning system execution is exceptionally pivotal, yet tedious. When L&D experts use AI frameworks they gather and dissect information rapidly to get specific bits of knowledge on learning viability. The experiences call attention to students' advances and accentuate students' information holes, assuming any. Then, at that point, an AI-prepared learning program proposes ways of satisfying the revealed holes. A 4–level Kirkpatrick Evaluation Model supported with AI, will perform fundamentally more reasonably to guarantee that the basic learning targets are developed.

Zeroing in on AI-based computerized mentors Artificial intelligence-based guides can supplant instructors, teachers, speakers, and mentors. DARPA (Defense Approach Research Agency) supported a review that was called to foster an advanced guide to duplicate the interaction between an accomplished subject matter expert and a student. The point was to lessen the time spent by naval force students to accomplish some super-advanced abilities. The trial uncovered that when working with AI-based computerized mentors, students got the right stuff rapidly as well as overperformed experienced specialists. It implies that conceivably AI-based guides could supplant existing specialists with time, and the learning system will be considerably more successful.

At last, applying AI in preparing, learning and advancement will permit students to get preparing content dependent on their inclinations, abilities, and individual qualities. Additionally, AI makes programs open to all students even with various kinds of inabilities. Whenever customized, AI-controlled learning courses will altogether further develop fulfillment rates and lift commitment. What's more, a learning stage driven by man-made consciousness empowers coordinators to offer to prepare choices for the workers every minute of every day, track results, examine information, measure learning adequacy, and make learning significantly more viable and proficient.

AI-based employee engagement is an extremely dynamic idea. It is the "passionate associate" that a representative feels towards its association. What causes one to feel associated with an association and persuades to convey her/his best shifts from one individual to another. It likewise changes with what's going on in and throughout the planet. With each new age in the labor force, worker commitment patterns change. Groundbreaking business pioneers and supervisors should keep themselves refreshed on these commitment techniques.

2.6.2 How Can AI Contribute to Employee Engagement Work?

Data mining and Predictive analysis: Assessing responsibility level, analyzing significant results accordingly, and giving decisions will be the unmistakable benefit that AI will drive. Advanced data assessment and AI instruments can develop running responsibility programs. Working with judicious assessment using valid/current data across factors will open useful, altered courses of action. For example, on the off chance that there is a social affair of people who are baffled and need to leave the affiliation, assessment could help with instructing HR before they decide to leave and therefore hold some of them.

Natural Language Processing and Machine learning: A ton of dissatisfaction between representatives frequently identifies with non-monetary parts e.g., absence of lucidity on professional ways, the shortfall of testing tasks, deficient thoughtfulness regarding preparing needs, inadequacy, unattended criticisms, and so forth the volumes and subjectivity in input make the errand of breaking down them massively. Advancements in NLP/ML have made opinion examination of composed/communicated in language simpler. Heartbeat reviews have become distinct advantages for estimating effects and following practices continuously.

Chatbots: Correspondence is an indispensable piece of worker commitment. Simulated intelligence devices, for example, chatbots, when utilized reasonably, offer freedoms for making the correspondence communitarian, brief, intuitive, and fun. Incorporated AI/bots in the correspondence frameworks assist with further developing execution audits and the board, designing distinguishing proof/acumen, conducting examination and expectation, etc.

2.6.3 AI Visible Footprints in Employee Engagement.

An employee lifecycle is highly impacted by the open culture that organizations carry to have a positive impact. In terms of engagement, the employee journey starts during the onboarding stage. Artificial intelligence with its strengths can positively impact the entry to exit cycle of the employee. This involves the following areas-

Remote learning and training: Skilling is a region where AI can have a checked effect. From inventive, intelligent figuring out how to genuine recreated situations for ability evaluation, AI can be utilized to give excellent preparation and permit field staff to be directed distantly. The investigation could likewise be utilized to recognize regions/workforce where preparing/reskilling might be fundamental or convey tweaked preparing and improvement programs for representatives.

Equality and fairness: Al instruments can eliminate human biases, fabricating an impartial, various, and fair-minded working environment. With the capacity to kill human inclination, AI makes a stage for a quick, effective complaint relief framework where clashes are tended to speedily.

Managing Rewards and Benefits: Organization of Benefits and Rewards can be monotonous, especially in perplexing, progressive levels (the fuel repayment advantage is a genuine illustration of this). Perhaps the greatest gainer from the utilization of AI would be this part of the representative commitment. However, innovation has facilitated execution and the board of customized bundles, AI makes the entire interaction more proficient and enhances the advantages. With an easy-to-understand interface, simplicity of activity, opportunity, and adaptability, AI helps consistent combination of whimsical, trendy worker benefits with conventional motivating force bundles and along these lines makes an original representative encounter.

Enable better decision making: By eliminating the relentless thoroughness and empowering prescient examination, AI helps better dynamic, supported by profound information. Unencumbered by geological areas and time regions, applying AI can empower a more nuanced choice, considering far-reaching content analysis.AI is maybe one of the most invigorating disruptors in a ceaselessly advancing, innovation-driven business field. Bridling its potential for worker commitment will require a colossal change in perspective in work environment tasks. Associations will check out the compromise—Benefits of AI versus Fear of Redundancy. While offsetting the human factor with innovation empowered arrangements, AI is a certain fire method of weighty advancement in worker commitment that no association would need to be abandoned.

3 Collaborative Artificial Intelligence (CAI) Conceptual Background

Artificial intelligence opened the forums where there was a notion that it could replace the human presence. Collaborative Artificial Intelligence would involve people partnership in carrying out the work/process by reasonably delegating the tasks between humans and machines. This would imply that the machines/technology will complement and augment human capabilities and not replace them. Machines were built so that they could help humans in routine and strategic decisions. If we as humans must trust artificial intelligence in any form, we would like to know what is the premise with which the machine work and reasons out. Facts should have provenance [10] and rationales should be transparent to human users. Through collaborative intelligence, strengths like leadership, teamwork social skills, and creativity of the human force can be enhanced. As CAI has a two-fold benefit, the augmentation will help in improving the speed, scalability, and quantitative capabilities of the machines/ technology.

3.1 Business and Collaborative Artificial Intelligence

To utilize the full potential of ***machine+ human* intelligence**, organizations must rethink their business processes. Companies need to reimagine how AI can be utilized to provide effective business outcomes like flexibility in operations improved speed-process, operations, decisions, etc., or in personalization of products and services. According to McKinsey report 2018, sectors like telecom, high tech and financial services lead the way in adopting AI usage in business. In an overview of the business and artificial intelligence usage in the field of human resources, High tech industry tops the table. Business integration with CAI would require organizations to have a peculiar framework (see Fig. 4).

Humanistic Machines as humans start working collectively with machines, they should be able to train(tutelage) them to do activities (the usage of machine learning

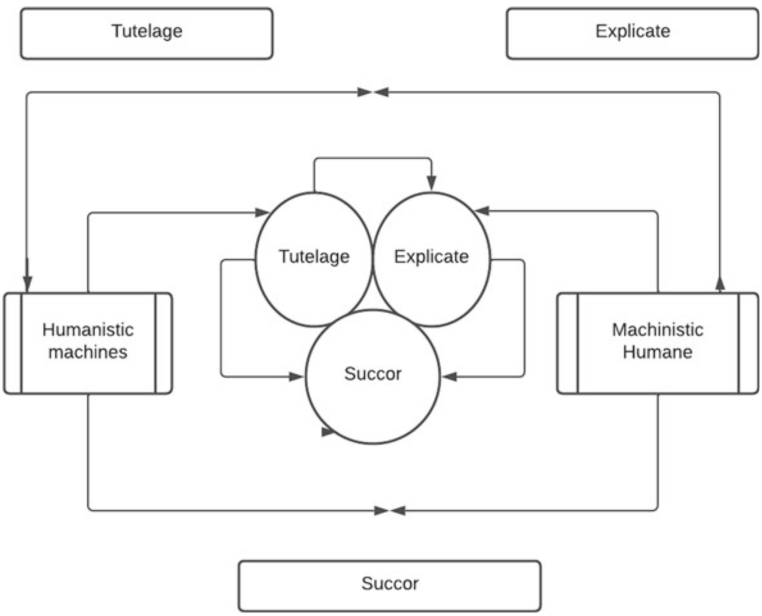

Fig. 4 Framework for CAI

approach), explain(explicate) the rationale for responding to a scenario, and succor them not to indulge in any harmful activity toward the humans.Take for example, in the human resources function, as a recruiter, you would be involved in many activities, sourcing, screening, sending mails, callings, etc. In a collaborative environment, a RecruiterBot (R_BOT) could parallel do multiple activities within the ATS (applicant tracking system) and can help individual recruiters concurrently. How does this enhance the recruitment process? Ideally, those who wait for responses after resume submissions can be dealt with by the BOT thus ensuring the candidate experience and employer branding factors for the host organization. Employer branding in the context of recruitment is the package of psychological, economic, and functional benefits that potential employees associate with employment with a particular company [11]. The R_BOT here ensues the psychological component of candidate engagement through the recruitment cycle (see Fig. 5).

In the HR realm, the collation of humans to use machines and humans expected to do machinist activities is a challenge and opportunity both. In the fraternity of Collaborative Artificial intelligence, businesses with their IT infrastructure can adapt to cognitive computing. Cognitive computing works on similar patterns wherein these systems learn and interact naturally with people. This interaction allows extending what humans or machines could do on their own. Interestingly there would be different tasks/processes which can be delivered efficiently by these systems that enhance the processes viz. HR processes in the discussion. The system would learn inhumane ways about the structured and unstructured data dealt with in the process. Since they are here a learned machine/system they can then do the tasks one by the HR administrator that is used by the organization.

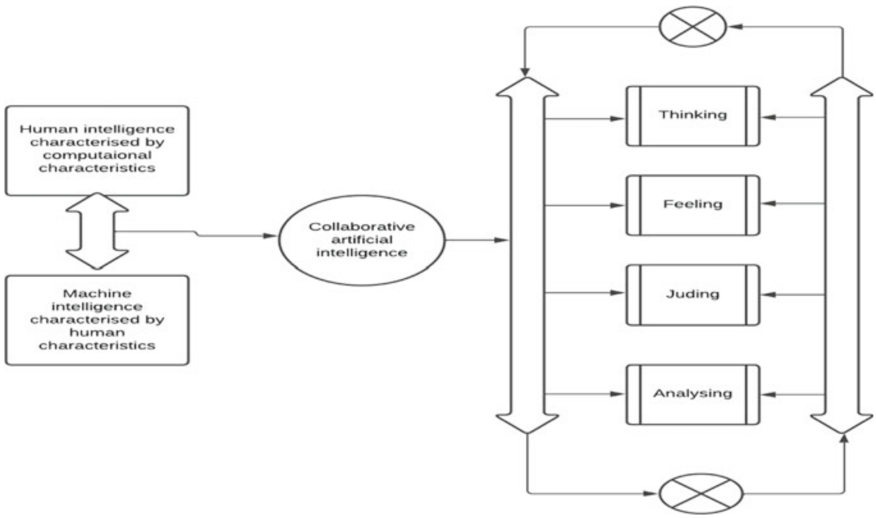

Fig. 5 Collaborative artificial intelligence framework working

3.2 Collaborative Artificial Intelligence in Business–Case 1

In the customer-centric market and economies using AI for efficiency and effectiveness is a trend and practice today. For the marketing domain, price predictions through data analytics, using robotics for customer services, decisions over personalization's over products using recommender systems usage of natural language processing for the engaging customer in the retail stores, etc. are concepts now. AI has moved retailing forward in many ways, such as making big data available for prediction, facilitating more informed retail and consumption decisions, enabling visual display and merchandise, and creating customer engagement [12].

Proposition 1 *In collaborative systems, the strengths of both humans and machines is to be capitalized. Under this, it is significant to develop a system that captures the biological characteristics of humans and the mechanical/analytical capabilities of machines. The intelligence provided by these humanistic machines is backed by non-contextual data as the machine does not comprehend what is the source of data (majorly big data is the input), models in the processing unit/system that along with algorithm knows how to learn by themselves and intelligence to predict the outcomes. If this is applied to the domain of Human resources, the following framework can be used.*

3.3 Challenge Problems in CAI Scenarios

It is significant to observe and gauge that the AI initiatives taken make it to production in business lines. The very first challenge lies in translating the data into business data, having the right data for decision making, and collaborating so that there is business value addition. All stakeholders from top to bottom must build a robust framework so that it is accepted at all levels. This helps in mitigating the bias, risks, and drifts in AI deployments across business lines and the realization that it will give in broader contributions.

1. Understand why collaboration is required and a necessity
2. Choosing the right platform for collaborative AI is significant, otherwise gaining insights is difficult.
3. It is challenging for organizations to decide what buy-in should happen and review it as possible to determine the ROI benefit to be rendered.
4. Even the organization chooses the best model for feasible solutions, AI is not perfect, so decision-makers should not expect full automation.
5. Models' effectiveness and ineffectiveness decide the measurable successful milestone an organization can achieve. Realizing this is significant in terms of cost-saving metrics for the organization.
6. Design your model to complement the strengths/weaknesses of human subject matter experts.
7. Optimizing human reviews for models' performance.

4 What is Society 5.0?

If the world looks over to prosperity it is essential that the economic and technological advancements happening should solve the problems of society. With the artificial intelligence profoundness as technological advancement, the societal problem can be identified, resolved, and mitigated using super artificial intelligence data systems. Japan, as an economy envisioned the futuristic society that Japan would have and called it Society 5.0. New development issues of modern society [13] led Japan Business Federation (Keidanren) to model Society 5.0 [14]. Society 5.0 presented a new vision of society, that follows the evolution of Society 1.0 (Pursuing society), Society 2.0 (Agricultural society), Society 3.0 (Industrial society), Society 4.0 (Information society). Society 5.0 keeps humans as the center focus creating a super-smart society that has a balanced usage of technology, nature, and social systems. This society covers AGI-Augmented general intelligence, Smart Society-Smart cities-smart government. All these systems focus on the Sustainable goals of 2030 on digital twin in cyberspace. Moreover, this super-intelligent society talks about genetic neuroscience, green economy, biohacking-multiple human development, smart cities, etc. As a pathway to this smart society, IoT (internet of things) including IIoT (Industrial Internet of Things) plays a momentous role. IoT (including industrial IoT (IIoT)) is an intensively developing technology that complements traditional and is usual to us (Internet of people) and is an automation basis in Industry 4.0 and Society 5.0 [15]. In conditions of restricted resources, severe competition, and growing globalization, organizations can improve the solving of social problems with the usage of advanced technologies, which enables connections of people, things, and technologies in cyberspace for the creation of new values for the industry in society [16].

4.1 IOT-CAI-Smart Cities

IoT is turning out to be progressively unavoidable to metropolitan conditions and giving the fundamental premise to maintainability and strength of the shrewd future urban communities. With the fast expansion within the sight of the Internet of Things (IoT) and future web innovations in the shrewd urban communities' unique situation, a lot of information (a.k.a. enormous information) is created, which should be appropriately overseen and dissected for different applications utilizing an organized and coordinated ICT approach. Frequently ICT instruments for a keen city manage diverse application spaces, for example, land use, transport, and energy, and seldom give a coordinated data point of view to manage land. Be that as it may, such data use requires proper programming apparatuses, administrations, and innovations to gather, store, examinations, and imagine a lot of information from the city climate, residents, and different land advancement offices and organizations at the city's scale to produce new information and backing dynamic.

The genuine worth of such information is acquired by new information procured by performing information examination utilizing different information mining, AI, or measurable strategies. Notwithstanding, the utilization of information examination for land improvement and the board is very wide, complex, and is quickly advancing. The intricacy in the land of the executives by information investigation is shown because of an assortment of issues:

1. Requirements of cross-topical applications e.g., energy, transport, water, metropolitan, and so on, and
2. Different wellsprings of information giving unstructured, semi-organized, or organized information, and
3. Dependability of the information.

A geo-Twitter analysis has proven to be a very successful data collection method [17]; A geo-Twitter analysis increases efficiency in analyzing many shared thoughts and opinions [18] and real-time information on ongoing social issues [19]. For instance, social media analytics has contributed to safeguarding Australian cities and their residents from the coronavirus outbreak (COVID-19) in 2020 [17]. Initially, sentiment and content analyses can be completed for the total location of the city bed example undertaken.

1. Nvivo content analysis for sentiment analysis using a year's trend data
2. Frequency analysis that measures the words repeated through the platform
3. Co-occurrence analysis that backs the usage of AI technology usage-keywords advanced keywords-expressing sentiments for urban development variables.

All these help in the spatial evidence creation for further learning-unsupervised and supervise.

4.2 IOT and Urban Knowledge

Roughly half of the total populace lives in metropolitan regions, a number which is relied upon to increment to almost 60% by 2030. For a country like India urbanization is inevitable and on record, 31% of Indians live in metropolitan regions. A consistent expansion in the metropolitan populace strains the restricted assets of a city, influences its flexibility to the expanding requests on assets and metropolitan administration faces truly expanding difficulties. Besides, supportable metropolitan turn of events, monetary development, and the executives of regular assets, for example, energy and water require better arranging and communitarian dynamic at the neighborhood level. In such a manner, the advancement in IoT and AI methods can give coordinated data knowledge to better metropolitan development. The board and administration, maintainable financial development and strategy improvement can utilize participatory cycles. As well as making a manageable modern savvy framework, defeating these difficulties can engage the residents as far as having an individual stake in the prosperity and improvement of their community life.

Therefore, city organizations can get new data and information that is concealed in enormous scope information to give better metropolitan administration and the board by applying these IoT arrangements. Such IoT empowered arrangements in this way empower proficient vehicle arranging, better water the board, worked on squandering the executives, new energy production systems, new developments, and underlying techniques for soundness of structures and successful climate. An incorporated information base has been proposed—a compartment of an assortment of detectable data required for the semantic portrayal of the metropolitan setting Fig. 6 The exploration has two interconnected goals: (1) to investigate the achievability of making a metropolitan information base and proposing an apparatus to help the development of parts of metropolitan elements and (2) to investigate how prescient demonstrating as a piece of examination can be utilized corresponding with AI innovation to improve the information needed for metropolitan advancement drives. The work of a few devices and canny procedures could uphold the method involved with catching and envisioning the recognizable appearance of conduct patterns and examples i.e., the parts of the metropolitan element. Removing subjective information from huge amounts of information is the ideal start of our quest for importance and conceivable clarification of metropolitan elements.

IoT and related innovations detecting advancements can clear away in a get-together, arranging, and the information however unstructured in nature from the metropolitan zones. The reasoning in choosing the zones would rely on the measures of improvement, the need for issue evolvements, and so on. What points out for the utilization of examination is the get-together of the proof and impressions of metropolitan change and besides then proposing how proficiently land advancement can be followed for future. We propose to inspect the manners by which metropolitan changes may be impacted by different segment, situational and ecological variables that portray the setting of interest. We recommend that work of smart advancements, for example, AI and information mining calculations give a likely answer for a portion of the difficulties in the metropolitan demonstrating, particularly programmed

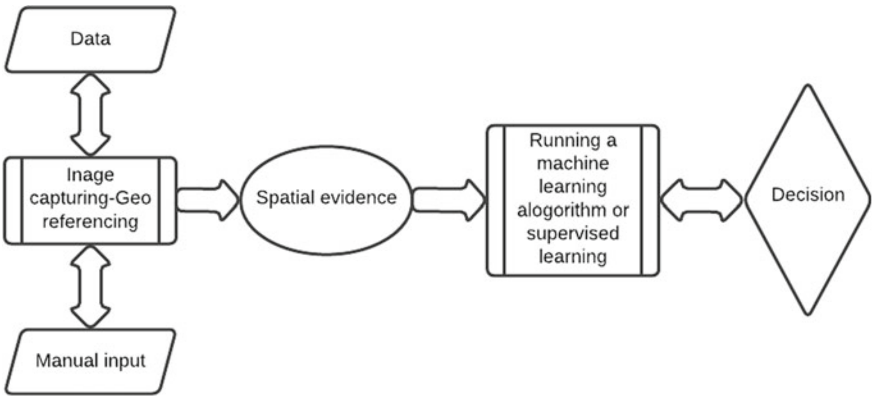

Fig. 6 Model for smart cities data acquisition and machine learning for decision making

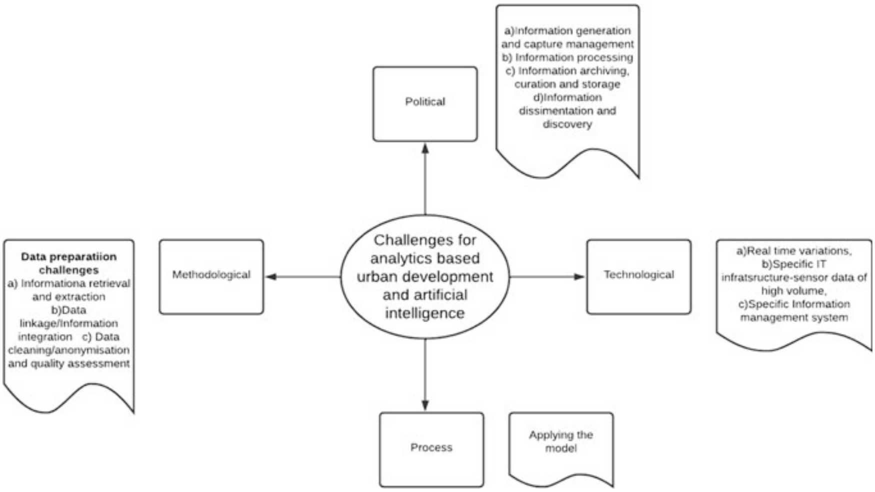

Fig. 7 AI-based Challenges through Analytics for Urban Developments

extraction, and acknowledgment of examples in immense amounts of different kinds of proof. Clarifications of patterns and signs got from the prescient model are bound to coordinate with the truth, since this records for more profound and more extravagant connections under information than oversimplified measurable investigation (see Fig. 7).

There have long been attempts in measuring a city's appearance in a consistent manner and on a larger scale [20]. The dominant method is by sending human auditors to the field to observe and record [21]. Recently, the availability of online street view images, which have unprecedentedly wide coverage of the built environment, provides a new methodological opportunity for this topic [22]. When combined with computer vision techniques, there is a possibility for the large-scale automatic evaluation of various high-level judgments on the urban built environment [23]. There is a need to preprocess information to give a reasonable structure to perform the general calculation. that shall gather the information in a structure that is valid for calculations. The system might utilize any city information which is an ideal proving ground for assessment distinguished as land prepared for improvement or it is a current created land that should have been remodified. The system proposed will link with the GIS system, and on linkage it shall send records (also called a bunch of tuples). These records are from the chosen city by the system. The structured layer and packaged layer would be the two data set tables to form where the system will initiate.

1. The First step is to group structures into a bunch of competitor regions and to carry out a basic information preprocessor for this reason. As they are delegated to be created and existing yet to be adjusted, we would initially group business structures inside a specific nearness limit. Little groups that have under 10 business structures will be sifted through in this progression.

2. The Second step is to stretch out as far as possible to consolidate nearby designs and bundles as a part of picked land to be remodified. The number of constructions in coming with regards to district contenders moved from tens through hundreds. To characterize more right gathering limits, we should join more separator data, e.g., geographic hindrances like mountains or streams, or man-made obstacles like frameworks and roads. At the point when the system had the gatherings, we used amassed data, like the typical size of constructions, as the plan of arrangements. This basis would assist with creating the pace of urbanization, accordingly, helping the emphasis on bunches characterized in the starter stage. These endeavors are coordinated toward prescient displaying of metropolitan advancement by presenting variable arrangements of the populace and financial factors—moving past the tight spotlight on actual availability and the climate—and investigating their connection and importance inside various AI calculations. The experience focuses on the significance of applying smart advances and prescient demonstrating that might help in comprehension and addressing metropolitan peculiarities. Still, in the beginning, stages of exploratory testing and model execution, the proposed coordinated information mining approach gives a promising beginning in building an establishment for the metropolitan displaying that the target is being both hypothetically and observationally based examination on the fate of this review.

5 Conclusions

Collaborative artificial intelligence as a facilitator to AI complimenting human intelligence and aptitude. It will endure advancing rapidly in the coming future. It is important to comprehend the usage and benefits this technology brings in, keeping in mind the societal dimension. This responsibility lies with the regulators, entrepreneurs, and businesses who are deploying AI solutions. In the deployment process the major challenge lies in matching the standards of innovation and demands AI talent to gear up with the expectations, this is where HR practices in organizations take a front seat. The rationale is that the AI talent supply is in deficit with the demand. There is a need for all stakeholders to bring together the AI leaders, business houses, academicians to identify the gap, find strategies to fill in the gap by goal setting with societal benefit and ease of usage and comprehension. Lastly, the AI professionals are needed who shall bear the responsibility for the solutions proposed. These professionals would be coming from any corner of the society who are well educated, strong, and diversified skill holders (technically) to create solutions for a creative society like the society 5.0.

For future scope: it is necessary to continue the investigation keeping in mind that the use, design, and implementation of AI and its types are regularized. There is a need for mathematical model development for smart city data capturing and analysis leading to the validation of the framework proposed. The technology is acting as a support to tasks and jobs, which would mean that few jobs will become obsolete.

This poses a challenge to the government, which is forming policies that would cater to the unemployed and obsolete job profile re-fillings through definite recruitment practices. As the authors propose the use of IoT for urban planning and development it is necessary that cyber security concerns are dealt with and then policies are formed.

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Chapter 11
An Architecture of Cyber-Physical System for Industry 4.0

S. Karthikeyan and G. Muni Nagamani

1 Introduction

1.1 Cyber-Physical Systems

Cyber-Physical Systems (CPS) automate the connection among the real world and computer networks. The purpose of CPS is to link a wide range of devices, as opposed to normal embedded systems, which are meant to operate independently of any other device. In today's technologically networked culture, having information and services at your fingertips is a need.

Today, embedded systems like cellphones, automobiles and household appliances are an essential part of our daily lives. However, only a few of them can be accessed remotely. On the way home, it would be ideal if we could activate the heating system so that the house is already warm when we arrive. When you wake up in the morning, your coffee maker can begin brewing so that you don't have to wait till you get out of bed to have a cup. It is also possible to use this remote access to process data for the performance of the systems in question. The remote diagnostics information lets the service workers deliver the proper tools and spare parts. With the support of a communication infrastructure, the system can order spare parts on its own.

Today, CPS continues to find use in a wide range of industries, from medical devices to automobile driving assistance systems to industrial process control and automation. CPS also finds use in systems that help utilities manage their power supplies to make optimal use of renewable energy sources. Sensors and actuators used to interact with the actual environment are controlled and processed by a control

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unit, usually a single microprocessor, in a CPS. An interface for exchanging data with other systems is also required by these systems. Since the data may be linked and reviewed essentially, data sharing is the most significant component of a CPS. To put it another way, a CPS is a network-enabled embedded system capable of transmitting and receiving data. The term “Internet of Things” refers to the CPS that is connected to the Internet.

1.2 Industry 4.0

Industry 4.0 was originally introduced to the public at the Hannover Fair, where the “Industry 4.0” initiative was introduced [1]. Using CPS and IoT, we are now entering into a fourth industrial revolution, one that follows the “Mechanization” and “Mass Production” of the first three, as well as “Digitization” and “Electronics and Information Technology” (ICT) in the second and third. Germany has been at the forefront of CPS for nearly two decades and may draw from that expertise. Internet-enabled items allow for cost-effective and efficient diagnostics, maintenance, and operations to be carried out through the Internet cost-effectively and efficiently. The goal of Industry 4.0 is to create digital factories which have the following characteristics [2].

A. **Smart networking**

Internal logistics, as well as operational supplies, are constantly linked with the wireless and wired communication services, the smart actuators and the sensors, and more, as well as communications technologies. They now have direct access to more advanced procedures and services. New technologies and business models with added value may therefore be developed, allowing for more efficient use of existing resources and more precise control of those resources.

B. **Mobility**

The use of mobile devices like smartphones and tablets in industrial automation has already begun. Processes and services offered by the automated systems are accessible at any point in time and from any location. A new level of diagnostics, maintenance, as well as operation is possible because of this.

C. **Flexibility**

Industry 4.0 offers a high degree of adaptability in design, diagnosis, and automated systems as well as the use of those systems themselves. You can choose from a wide range of providers of components, modules, and services while developing these systems. A portion of the diagnostic can be handled by the user. Automated processes are aided by the availability of “Big Data.” The data can be retrieved at any time, intelligently utilized, and linked so that an automatic diagnosis can be made. It is possible to order spare parts automatically from the most cost-effective suppliers, thus alleviating shortages of skilled workers.

D. **Integration of customers**

A new generation of products will be tailored to the distinct and unique needs of each customer. Users of all ages can benefit from automated technologies in the twenty-first century. For example, a modern ticket vending machine has a variety of alternatives for operation so that persons with impairments can use it. To ensure that people remain healthy, mobile, and sustainable throughout their lives, automated technology will be available to assist them in all situations.

E. **New business models**

Distributed and adaptable production will be the norm in the future. There will be new methods, infrastructure, and services. The goods will be modular and configurable; therefore, the product can be tailored to the customer's needs. With the advent of Industry 4.0, a slew of new issues will need to be investigated in depth. There are many unanswered problems, such as how the dependability and safety of these distributed products may be determined and approved. Data privacy and security are other critical issues that need to be addressed. A person's knowledge and privacy must be safeguarded at all times. To do this, new ideas and technologies are needed to enable a trustworthy collaboration between many organizations and units. There will also have to be a rethinking of ethical, legal, and social issues.

1.3 CPS Industry Compatibility with 4.0

To connect an embedded system, which is typically composed of control units, sensors, and actuators, to a CPS, an interface to the Internet or another network is required. Several ways have been tested in the context of this development and will be detailed.

A. **Direct system extension**

If a communication interface is not yet available, the embedded system can be expanded to connect to the Internet, and the software can be modified to allow communication via the web, for example with the cloud. To achieve this, the control unit must communicate all sensor data from the system to the cloud. Actuators should be able to be controlled over the Internet using established protocols. As seen in Fig. 1, this solution is arranged in this way.

B. **Growth of the system using a microcontroller**

A microcontroller board with many communication interfaces, such as CAN, UART, WLAN, and Ethernet, is created in this solution variation. The embedded system communicates with the Internet or a cloud through this device. However, this necessitates that the board be connected to the embedded system via standard interfaces. For each system, the board's software needs to be customized specifically for that

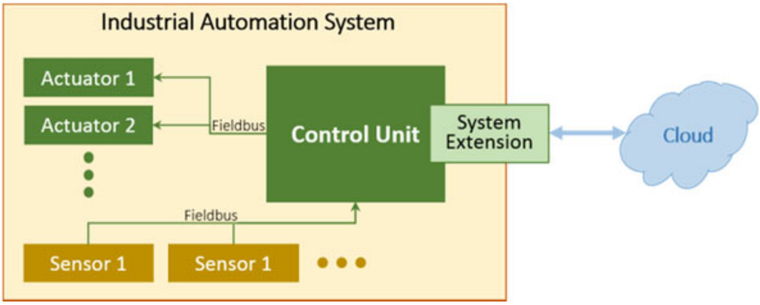

Fig. 1 Direct system control

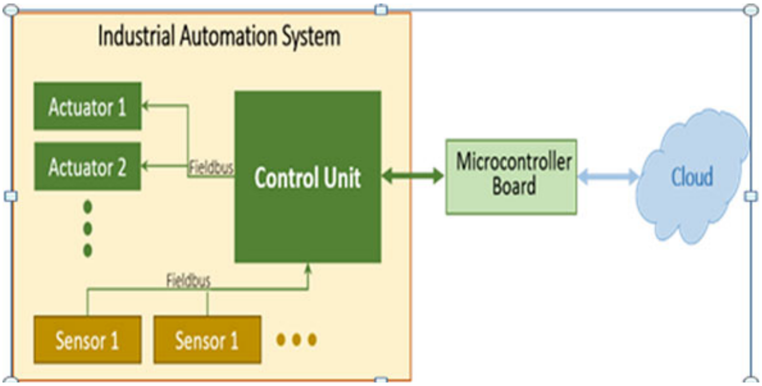

Fig. 2 System extension by the microcontroller board

platform. It's not necessary to rewrite the full code each time, but the mapping must be modified so that this variant may be easily transferred to other platforms (see Fig. 2).

C. Extension by smart actuators and sensors

Field buses connect sensors and actuators to the control unit in traditional embedded systems. This is how most of these systems work today. In these systems, the control unit performs signal processing. When using smart sensors and actuators, the sensors handle even the signal processing, and the actuators verify their present condition and correct it if necessary. Field buses, for example, can be used to send data from these sensors to a central control unit.

Additionally, the data from the sensors and actuators, that are transmitted through the field bus, might be forwarded to a cloud for processing. Smart sensors and actuators, however, produce a large stream of data, which must not be underestimated. The extension is shown in Fig. 3.

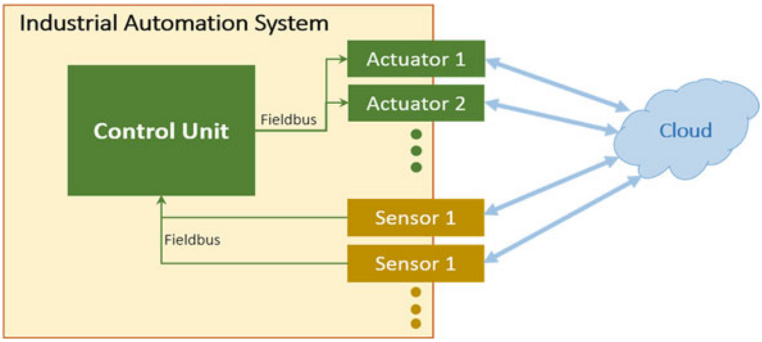

Fig. 3 Usage of intelligent actuators and sensors

1.4 Characteristics

1. **Actual framework**

This incorporates the actual framework plan, for example, the equipment plan, energy of the executives, equipment size and availability embodiment, and framework testing. Designers and researchers in this field have a profound comprehension of mechanics, gadgets, science, and science; they comprehend the specialized attributes of sensors, and they know how to handle estimation information utilizing signal handling innovation. Each actual framework has its organisational characteristics, such as a wider staggered network inclusion, a variety of difficult worldly and huge scales to satisfy few temporal needs of diverse assignments, and a huge phase of automation.

2. **Data framework**

The data in the real framework design can be transformed into product framework recommendations and models. The most essential undertaking is to arrive at equilibrium among variables, for example, ongoing framework, network framework, document framework, various levelled stockpiling framework, memory the board, particular programming plan, simultaneous plan, and formal confirmation.

3. **Coordination of heterogeneous frameworks**

CPS is a heterogeneous conveyed framework including the reconciliation and communication of data frameworks and actual frameworks.

4. **Security, constant capacity, and consistency**

Because network frameworks and actual frameworks are open, intrusions, altering, forging and other noxious assaults might happen, as well as deferrals in network transmission. Digital actual framework should have the option to offer believability, security, legitimacy, continuous ability, dynamism, and consistency. For validity, the personality of data gathering sources or control guidance shippers should be validated, and the recipient should have the option to decide the genuine character of the source to forestall duplicating. Security is required to encrypt and decrypt the data, and protection of data should be safeguarded.

For legitimacy, the exactness of handling, as well as the legitimacy and respectability of data or directions sent, should be ensured to forestall vulnerabilities and clamour in CPS handling from influencing the framework's handling precision. Continuous capacity implies that gathered data or directions should be communicated promptly to meet the constant necessities of undertaking handling. Dynamism incorporates dynamic rearrangement and reconfiguration, naturally changing principles and creating orders because of the errand necessities; it additionally remembers changes for outside conditions to dispose of predisposition and meet assignment prerequisites as per present standards. With consistency, the CPS asset portion technique can sensibly allot assets to different contending continuous errands without warning and regardless, so the constant necessities of each ongoing undertaking can be fulfilled.

1.5 Inquiry on the Design of CPS

CPS research has recently started. As this will work on various multifaceted heterogeneous frameworks, this will bring together worldwide models, CPS research is done by specialists in different regions according to the viewpoint of utilization in their field. As of now, CPS research chiefly centres around framework engineering, data handling, and programming plan.

Demonstrating can be considered as the innovation to portray an objective framework before fulfilment. CPS engineering is being explored and created, and CPS models should be altered and incorporated based on existing actual frameworks, network frameworks, and PC framework structures. Deliberation and demonstration of correspondence, calculation and actual elements on various stages which include time stages are additionally expected to foster CPS.

The 5C Architecture is divided into two major parts:

- Enhanced connection allows for real-time data capturing and information extraction from physical space.
- The foundation of cyberspace is intelligent data management, analytics, and computing power.

Figure 4 shows how the Cyber-Physical System may be seen at many levels, as shown below:

1. Level of smart connection
2. Level of data to information conversion
3. Level of cyber-warfare
4. Level of Cognitive Capacity
5. Level of configuration.

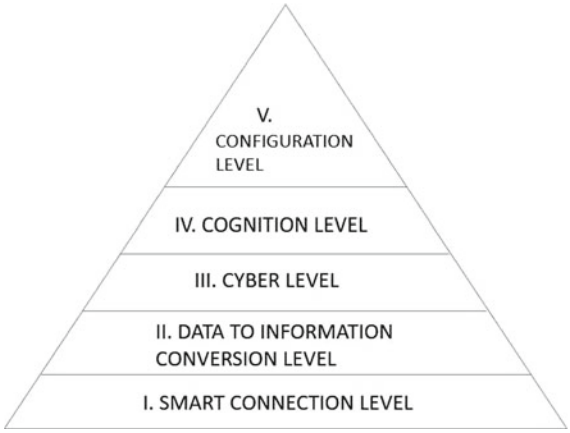

Fig. 4 5C Architecture Model

The following sections go into great depth on each of these tiers:

1. **Smart Connectivity**

At this level, the focus is on obtaining data that can be relied upon from machines and the components that make them up. Controllers and corporate production systems provide the sensors with data. Various sorts of data and sensors play a significant role in this situation.

2. **Efficiency in the Conversion of Data into Knowledge**

At this level, you'll learn how to draw conclusions from data and turn them into useful knowledge. Calculating health values, determining life expectancy, and so on are some of the uses for this.

3. **Cyber Level**

It operates as a central data hub that receives data from many sources. Special analytics are used at this level to demonstrate the capabilities of and make comparisons among several devices and systems.

4. **Level of Intelligence**

It is at this stage that a deep understanding of the system under study and an effective strategy for conveying that understanding is developed.

5. **Level of Configuration**

Cyberspace and real space are intertwined in this system, which serves as a kind of supervisory control (see Table 1).

2 Literature Review

See Table 2.

Table 1 Today's factory in comparison to Industry 4.0's factory

	Source	Today's factory		Industry 4.0	
		Attributes	Technologies	Attributes	Technologies
Component	Sensors	Precision	Smart Fault-detection sensors	Acquaintance with oneself and the ability to forecast the future	Maintaining a close eye on the environment and evaluating how much time is left
Machine	Controllers	Producibility and efficiency	Monitoring and the diagnosis based on conditions	Self-awareness, Self-predictability, and Self-comparability	Predictive health maintenance ensures uptime
Production system	Networked systems	The equipment's total efficiency and productivity	Work and waste reduction are key components of lean operations	Self-configure, Self-maintain	Productivity with no worries

2.1 Implementation of CPS Technique

The reported 5-level CPS structure lays out bit-by-bit instructions for building and sending a CPS for application assembly. The key functional components of CPS are:

1. Progressed network guarantees ongoing information obtained from the actual world and data input from the internet;
2. Smart information the board, examination and computational ability build the internet.

Notwithstanding, these prerequisites are theoretical and not explicit enough for execution. In contrast, 5C engineering defines how to create CPS in a sequential work process, from the underlying information security through the investigation to the final value production. The 5C design is framed in Fig. 5.

I. **Convenient Interaction**

The first step to create a CPS application is obtaining accurate and usable data from machines and its components. Sensors can directly estimate data, or regulators or enterprises can provide data, allowing frameworks such as ERP, manufacturing execution system (MES), supply chain management (SCM), and collaborative production maintenance to be combined into a unified platform. Two important variables should be examined at this stage.

Table 2 Summarizes the publications on Cyber-Physical Systems that have been published

S. no.	Author	Title	Context	Technique	Finding basic	Relations with the research topic
1	Olivier (2018)	Proposal of an analytical methodology for the classification of Cyber-Physical Production System applications	Cyber-physical manufacturing techniques may be classified using this paradigm	Extensive study of literature	Classifying cyber-physical systems using a novel analytical framework	Development of CPS in Industry
2	Matthew Krugh Laine (2018)	An additional foundation for Industry 4.0's cyber-physical systems, the Cyber Human Systems Framework	Human labour is the primary emphasis of Industry 4.0's renewal framework	Extensive study of literature	Continued human involvement is essential to the future of car manufacturing	Human engagement is required in the development of cyber-physical systems
3	Peter et al. (2019)	Fog computing and cloud computing are compared. Applications for Industry 4.0 that use cyber-physical interfaces for embedded machine learning in real-time	Cloud computing and new fog computing techniques are being examined to provide apps for Industry 4.0 that use real-time embedded machine learning in real-time. comparing latency and dependability	Experiment method	The cyber-manufacturing world's activities are linked to machine learning models through interfaces that connect to the cloud and fog	The cyber-manufacturing world's activities are linked to machine learning models

(continued)

Table 2 (continued)

S. no.	Author	Title	Context	Technique	Finding basic	Relations with the research topic
4	D. Mourtzis, E. Vlachou, G. Dimitrakopoulos, and V. Zogopoulos	Cyber-Physical Systems and Education 4.0 -The Teaching Factory 4.0 Concept	Industry 4.0 Revolution as a Teaching–Learning Tool	Case review	Industry 4.0 may be taught to aspiring engineers in partnership with specialists	Industrial education is entering a new era with Industry 4.0
5	Y. Liu, Y. Peng, B. Wang	Review on cyber-physical systems	Evaluating the present state of CPS research and introducing key ideas and features	Literature review	The definition and features of CPS, as well as the present state of CPS research. A discussion of CPS development is then presented, including system models, information processing technologies	Growth in the use of CPS in industry
6	B. Bagheri, S. Yang, and J. Lee	Cyber-physical systems architecture for self-aware machines in Industry 4.0 environment	CPS implementation guidelines	Literature study	CPS implementation using the 5C design principle	CPS Implementation Guidelines
7	Zhou Ji, Zhou Yanhong b, Wang Baicunc	Systems that combine humans and computers in order to produce intelligence	Examination of HCPSs for intelligent manufacturing	Literature review	Development of the cyber-physical system	The superiority of human Future businesses will need a high level of intellect

Fig. 5 5C Architecture to implement CPS

II. **Conversion of Data into Information**

Significant data should be gotten from the information. A few instruments and techniques have been created to change information over to data, with calculations planned explicitly for prognostics and resource well-being in the board applications. The second degree of CPS engineering carries attention to machines [3].

III. **Cyber**

Data is pushed to it from each associated machine at the digital level, which acts as a focal data centre. Massive amounts of data are gathered; as a result, an explicit study is required to isolate important data on the individual machine's condition. With these inquiries, a solitary machine's exhibition can be compared to others in the armada and appraised suitably. Furthermore, similarities between machine execution and the display of historical resources (authentic data) can be inferred to build predictive models [3].

IV. **Cognition**

The levels of CPS produce intensive information on the observed framework. Appropriate show of the obtained information to master clients will prompt the right choice. As similar data and single machine status are both accessible, it is feasible to decide the need for undertakings and upgrade the support interaction. Legitimate data illustrations are important to move procured information to clients [3].

V. **Configuration**

The elements are input from the internet to physical space at this level. This level serves as a foundation for administrative control or strength control. The verified framework is subjected to the machines' self-design and self-adjustment, as well as the restorative and preventive decisions made at the comprehension level [3].

2.2 Case Study: Developing Own CPS

The HAAS VF-3, a five-axis vertical milling machine, was used in this investigation. X, Y and Z axes were added to the Trunnion 160 double-cradle table, as well as two rotatory axes (A and C) (see Fig. 6).

I. **Smart connection**

An accelerometer and a network analyzer have been fitted for the accurate and dependable gathering of machine tool data, along with the machine's own global and system variables. System variables allow you to interact with control settings, whereas global variables are variables which are always available and are saved in memory even when the power is switched off.

The accelerometer (Fig. 7a) is a vibration sensor that can be used to monitor and diagnose vibrations in machinery and installations. To collect data, the accelerometer is paired with a VSE100 diagnostic electronics system (Fig. 7b).

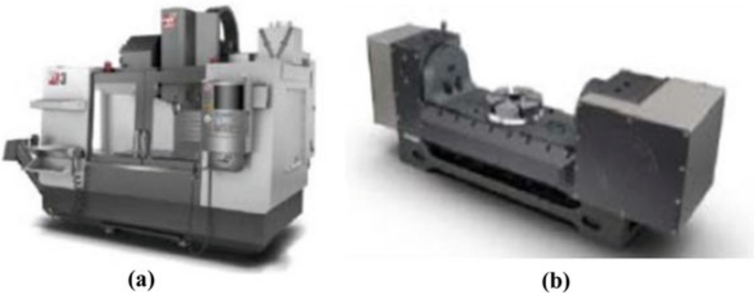

Fig. 6 **a** Haas VF-3. **b** Trunnion TR 160

Fig. 7 **a** IFM VSA005 accelerometer. **b** VSE200 diagnostic electronics

Fig. 8 CVMMINI network analyzer

A Circutor CVM-MINI network analyzer will be used for the other component (Fig. 8). An electrical network analyzer is a piece of programmed measuring equipment. The measurement settings may be stored in the sensor's internal memory, thus it can be installed in any configuration.

The CSV-MINI measurements calculate and display the essential electrical parameters of balanced and unbalanced three-phase industrial networks. This sensor can provide all electrical data via MODBUS communication, display all electrical data on a backlit LCD, show three immediate electrical parameters, max or min at overall screen jump, or display all electrical data on a backlit LCD.

These parts are linked to an industrial PC, in this case, a Beckhoff C6015, that collects and stores data in the cloud.

II. **Data to Information Conversion**

The most relevant information is extracted from the data at this second level. This can be accomplished with a variety of applications. In our situation, the data collected by the machine is automatically recorded and analyzed by a cloud-based multi-device monitoring system. Customers can use this information to query critical operational data and acquire appropriate operational indications to improve machine utilization. There are three subsystems in the system:

- Data logger (data capture hardware): this device records the machine's principal signals automatically.
- Web platform: Oracle manages and hosts the server where the web application is hosted.
- Advanced tools for analyzing, maintaining, and displaying indicators of machine operating states, such as operating time, spindle use, and so on.

Initial and foremost, the "Activity" option collects data on the machine's production during the previously set period. Within "Activity," you'll find "Timeline," that displays the major events linked to the machine's operational state during the set period.

The following settings are available in the "Timeline" (Fig. 9):

- Mode of operation: This is the current mode of operation.
- Spindle: displays the time and duration of the spindle's operation.

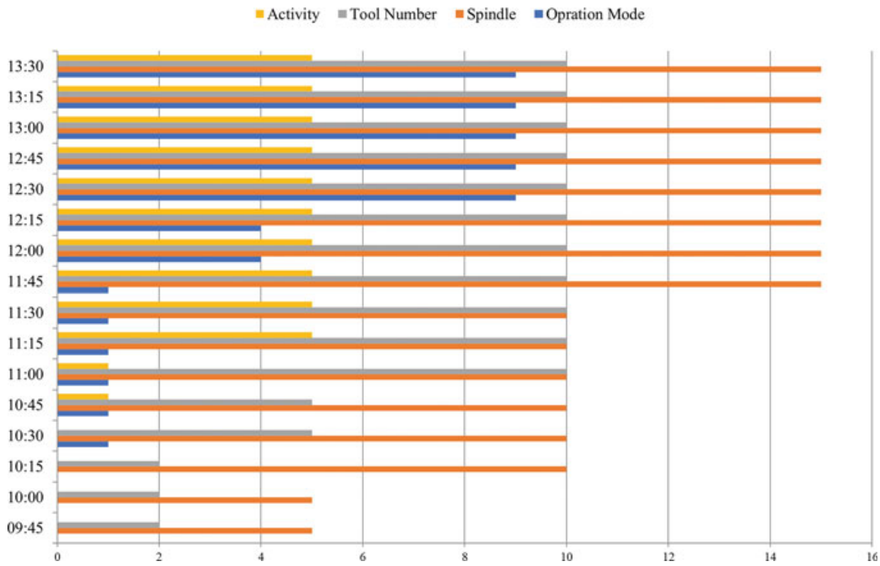

Fig. 9 Timeline

- Tool number: This identifies the type of tool that was used at the time.
- Activity: The kind of activity that the machine performs (machining, tool change, machine at rest, etc.)

III. **Cyber**

Because there is only one machine tool, this stage has not yet been completed, but it is a further level in CPS work.

IV. **Cognition**

In this stage, the purpose is to convey data in a way in which users can comprehend. The majority of our research is focused on getting KPIs (Key Performance Indicators) to offer a straightforward and global view of the machine's behaviour at the production, economic, environmental, as well as maintenance stages.

Python, a programming language that enables quick and easy software development, is used to create our applications [4]. The following case study illustrates some of the produced KPIs, which may then be seen on a dashboard on a website.

V. **Configuration**

The ultimate level is in charge of maintaining machine tracking. Because the data given at level 4 is needed to help decision-making while also providing a multi-criteria decision-making tool, this is also a priority of our study.

2.3 Case Study: KPIs Implementation

The most suited for real-time calculation of each KPI is examined, checked, and selected once the tool has been incorporated into the physical and computer system. Using Python, the software has been built to translate the information that has been obtained by the CPS into the indicators and the other information that is important to the user.

This case illustrates how to install OEE (Overall Equipment Effectiveness) and ECL (Energy Consumption Losses), as well as how to develop and deploy them further [4]. Our CPS can track machine time, energy usage, number of pieces produced (number of parts), tool number and change, and spindle rotation (rpm of the spindle). The other parameters, on the other hand, should be given as hypotheses. With the help of this scenario, you can estimate the number of reworks, rejects, maintenance time, and breakdown.

Variation among the stoppage set at five minutes. Once the data is obtained, we can estimate the time and energy related with each major loss by integrating the energy or time data with the other variables, allowing us to calculate the OEE (time variables) and ECL (energy variables) (see Fig. 10).

The installation of OEE (Overall Equipment Effectiveness) and EEE (Environmental Equipment Effectiveness) Because of this implementation and by level 4, the findings are simply displayed via graphs (cognition). The system enables the display of a range of visual data via various graphics, likewise a Pareto diagram, that can quickly notify us about the most vital data (Fig. 11a). In addition, as per level 5 (configuration), comparing our KPIs increases multi-criteria decision-making (Fig. 11b). As described in Fig. 11a, the good case of OEE (case 2) will not mesh with

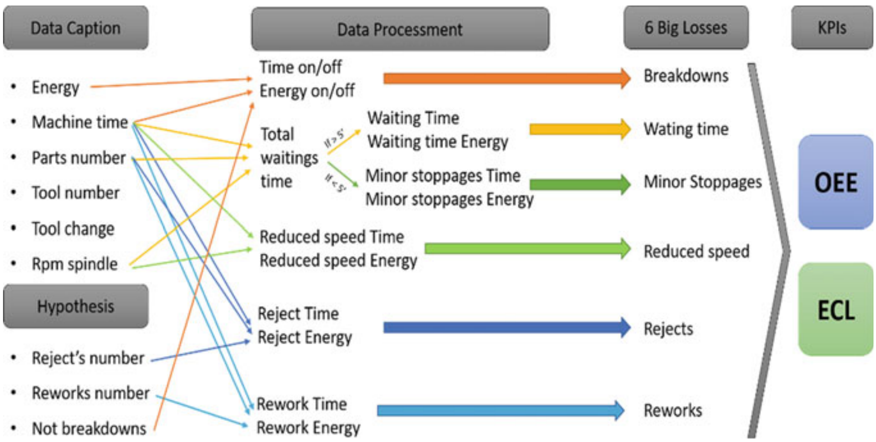

Fig. 10 Morella et al. [4]. Flow chart for Key Performance Indicator (KPI) calculation

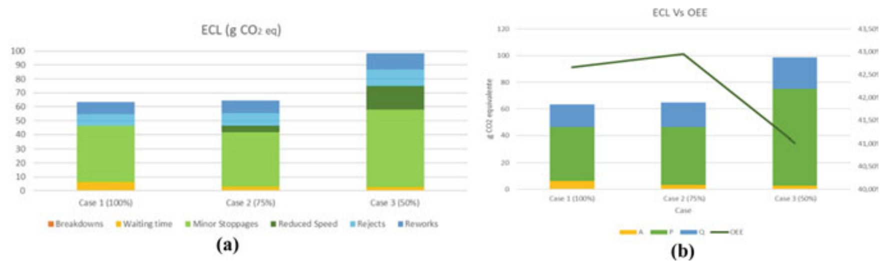

Fig. 11 **a** ECL stacked bar chart. **b** Comparing in between OEE and ECL

the less energy consumption loss as case 1. Hence the most sustainable or productive scenario must be chosen when making a multi-criteria decision (production and sustainability).

Not only are current KPIs used in this chapter, but new KPIs are also created and implemented. This dashboard includes new KPIs tied to six major losses, energy consumption, and expenses, as well as a cost model and CO_2 footprint calculations.

After the KPIs have been designed and implemented, a web application is created to display all of the elements on a dashboard (in given Fig. 12). It helps businesses make better decisions by allowing them to examine and compare all of the set KPIs in one place.

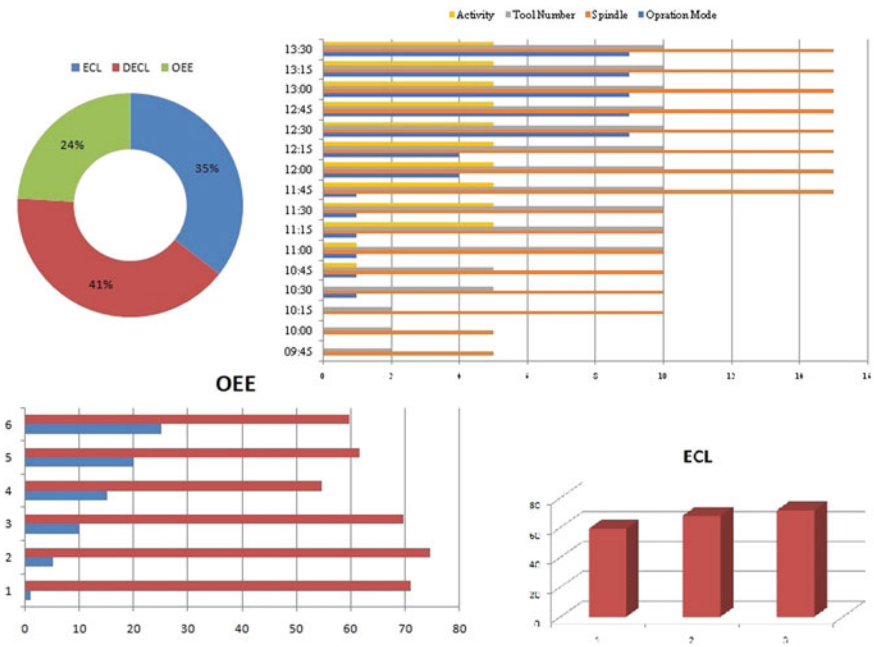

Fig. 12 Dashboard

3 Information and Operational Technology

3.1 Operational Technology Support

This feature has as of late come into somewhat boundless use and doesn't have a settled upon definition. Gartner alludes to OT as "equipment and programming that distinguish a change across the immediate checking as well as control of actual gadgets, cycles and occasions in the endeavour". It appears to have come from work to comprehend OT according to an IT perspective.

Numerous OT frameworks regularly rely upon similar server, organization, and working framework innovation as IT frameworks, driving some to consider that IT and OT are in joining directions. Nonetheless, the drivers of the frameworks' plans will quite often be focused on unexpectedly. In any case, OT frameworks had extra credits permitting them to control or screen actual cycles. Hence, their plan boundaries are frequently totally different from IT frameworks.

Instances of OT frameworks incorporate administrative control and information securing (SCADA) frameworks utilized by lattice organizations and building the executives frameworks utilized in the offices of the board business. Different models incorporate robots, CCTV, energy boards, and alarm frameworks. These need an organization and server engineering that empowers interoperability, gives strength, and provides protection.

Cost pressures have prompted moderate innovation combination, and an increment in the quantity of OT frameworks and gadgets created utilizing business off-the-rack working frameworks and organization conventions. The necessity for expanded uptime has prompted the interest for a day in and day out help, regularly satisfied through some type of remote access.

3.2 Information Technology Support

Programming apparatuses are essential to working the Industry 4.0 shrewd manufacturing plant. Figure 13 portrays the notable pyramid design of present-day creation frameworks, one with its product support.

The ERP instrument is executed on the industry phase, at the highest point of the pyramid. Undertaking asset arranging upholds venture wide arranging, for example, business arranging, SCM, deals, and dispersion, bookkeeping, human assets the executives, etc. Generally, industrially accessible arrangements are executed. The main arrangement is Applications, and Products in information handling (SAP), created by the German organization SAP SE. Many accessible ERP arrangements don't uphold quick transformation underway arranging when impromptu occasions happen.

On the second level of the pyramid, an MES is used. These productivity apps help with creation detailing, booking, dispatching, item tracking, upkeep activities,

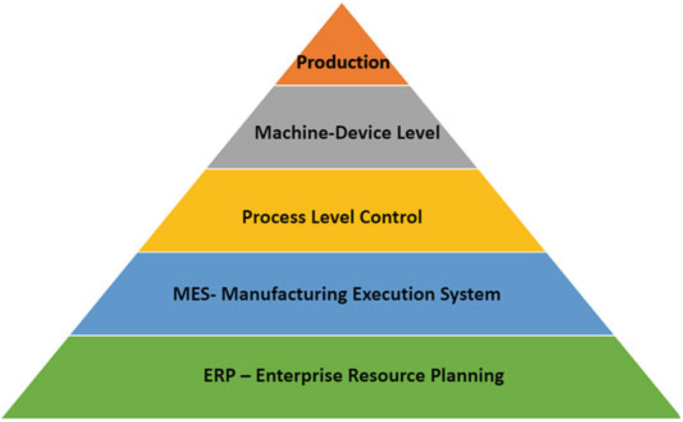

Fig. 13 The pyramid structure of modern production systems

execution investigation, labour force tracking, asset portioning, and more. Fabricating execution framework incorporates perspectives such as shop floor executives and correspondence with project (business) frameworks. The majority of the potential product configurations are brought together and not assigned to the shop floor. When adaptability is necessary due to elements of clients' needs as well as the changing creation climate, including shop floor arrangement, this is a crucial limiting factor.

The following employable phase is the interaction level control; here SCADA control framework programming is normal.

The machine or gadget phase is at the bottom of the pyramid. This layer, unlike the other two, has a normally allotted control phase [5]. PLCs, robot regulators and other regulators are all part of the programming process.

Endeavour asset arranging and MES instruments address fundamental programming in the organization and are utilized for a long time. They commonly have a particular design and are brought together in their activity; hence, they have a restricted ability for dynamic variation of the creation plan [6]. In any case, currently executed traditional ERP and MES frameworks ought not to be viewed as obstructions to the presentation of the Industry 4.0 idea. Truth be told, the presentation of a typical MES instrument requires a high-level IT foundation on the shop floor level, and it is an existing condition for additional advancement to a brilliant industrial facility.

4 Convergence of IT and OT in IIoT

The following significant problem is the joining of data accessible in ERP, MES, and other programming devices utilized in the organization, for example, client relationships the board, or business knowledge. Issues, for example, data set combination correspondence conventions actually should be settled.

Data innovation [7] or functional innovation assembly is the joining of IT frameworks utilized for information-driven figuring with OT frameworks used to screen occasions, cycles, and gadgets and make changes in big business and modern activities. Data innovation incorporates any utilization of PCs, stockpiling, organizing gadgets, and other actual gadgets, foundations, and cycles to make, process, store, secure, and trade all types of electronic information. Functional innovation, customarily connected with assembling and modern conditions, incorporates ICS like SCADA.

Since IT covers correspondences as a piece of its data scope, OT has not generally been an organized innovation. Numerous gadgets for checking or change were not modernized, and those with processing assets for the most part utilized shut, restrictive conventions and PLCs rather than advances managing the cost of full PC control.

Sensors and associated frameworks, for example, remote sensor and actuator organizations, are being coordinated into the administration of modern conditions, like those for water treatment, electric power, and plants. The joining of mechanization, correspondences, and systems administration in modern conditions is a vital piece of the developing IoT. Data innovation or functional innovation assembly empowers more straightforward control and more complete observing, with a simpler examination of information from hard frameworks anyplace on the planet.

Functional innovation's modernization via IT incorporation brings worries of safety. Numerous OT frameworks are never intended for distant availability and, subsequently, the dangers of the network were not thought of. Such frameworks may not be routinely refreshed. The weaknesses of OT frameworks can leave associations and basic foundations in danger of modern surveillance and harm.

IT and OT are uniting in various significant enterprises, for example, medical care, transportation, protection, energy, flying, fabricating, designing, mining, oil and gas, normal assets, and utilities. Data innovation pioneers who are affected by its union and OT stages ought to think about the worth and hazard of seeking after arrangement among IT and OT, as well as the possibility to coordinate individuals, devices, and assets used to oversee and uphold both innovation regions.

4.1 IT and OT Are no Longer Separate Fields of Study

The intermingling of IT and OT in IoT has been happening for some time, also there is anything but a severe division across them in reality. In numerous organizations with heaps of large equipment or different types of OT, IT offices will frequently be firmly involved in light of the basic job of innovation, as well as the continuous mechanical combination.

Notwithstanding, in certain fields, the differentiation is clear. An IT employee won't fix a cutting-edge oil drill and a specialist will not deal with the innovations to collect vehicles or sit in a gathering on utilizing prescient investigation to shield the corporate organization from digital dangers. Regardless, the lines are obscuring.

4.2 How Will IoT Embedded with IT and OT?

The connection among the IoT and OT is understood. The IoT is essentially about computerizing methods utilizing associated gadgets with an ability to accumulate, get and send data, insert knowledge and network into gadgets and set up upcycles and applications that open up a domain of additional opportunities with the appropriate devices to break down information, robotize and compose applications, giving these gadgets something to do.

The intermingling of IT and OT is inescapable in the modern Internet of Things (IIoT). Union is about innovation yet it is likewise about better approaches for thinking. It is difficult when two universes, that are performed independently and with totally various frameworks, innovations and sellers meet with regards to IIoT [8].

5 CPS Functions and Applications at a Glance

Since CPS [9] has the normal decentralized knowledge, they are themselves prepared to overview conditions, and basically choose other CPS to perform exercises when imperative. such practices are redone, and CPS are prepared to modify, henceforth adjusting, if not superseding, the moderate and vertical decision way, an indication of normal collecting for a seriously prolonged time.

Previously, parts (particularly sensors) recorded the true status of the connection and communicated all critical data to the central control unit. With the use of actuators or manual exercises, the behaviour was poor at the control unit and huge situating control system levels, decisions were formed, and cooperation was engaged.

This difference evened out and vertical correspondence isn't expected to be superseded with the aid help of CPS, yet improved.

The 3 subsystems allow CPS to recognise that its position includes sensors, actuators, and integrated structures, as well as a CPU-based, propagated knowledge base. With the help of enabled sensors, the CPS can capture what is going on in the environment. Optical sensors on a machine, for example, gives clear data regarding the condition of the work pieces to be handled. Exercises are carried out with the help of actuators. A handhold that picks the picked work pieces, for example, is widened. At the same time, the decentralised knowledge examines the sensor data and also data from other CPS. It takes decisions depending on this and communicates them to its actuators. Meanwhile, it communicates with other CPS and instructs them to move.

The purpose of the CPS virtual image isn't just to view the present status and affiliations. It also integrates data from the full lifespan. To be sure, information on computation, mechanical qualities, and reasonableness arises even during the arranging step.

Certainly, even in the arrangement stage, data arises on calculation, mechanical properties, and sensible. To be sure, even in the arrangement stage, information emerges on computation, reasonable affiliations, and sets of limits. Any excess life cycle stages, for instance, planning, fire up, and action, including backing and organization, give additional information. CPS can react to situations without hesitation if this information is taken into account. It should, in theory, be able to use previous information to adjust decision principles based on the new situation each time.

Considering this, every CPS may have any familiarity with its blend into the entire show office. That can be utilized by the CPS to plan itself during fire up, thus spread-out correspondence with its creation accessories (other CPS [10]) and as such amazingly decline the costly start up time. The improvement stage can be seen at the time of ordinary creation. Meanwhile, the different CPSs can propel themselves on account of their understanding. In all intricate cases, this can be a free disclosure of the best working edge. It may be an option between predetermined or even as of late decided procedure conditions in more sophisticated cases. Accepting difficulties can occur at any point during the creation process; for example, if a machine has broken down or essential material is lacking, there are optional philosophies that can be used to “recover” the cycle and keep it running.

Consequently, those concerns must be overlooked or, it made appear with remarkable time by CPS producing fast reprobation data, allowing for preventive maintenance by condition checking. It isn't necessary for decentralised correspondence among numerous CPS to be direct between one CPS and another. Rather, numerous educational CPS phases will employ their organisations and apps to orchestrate the interactions of people, external systems, and CPS. Two routes of contact, namely direct CPS exchange and the path through CPS stages, link one another. To offer an example, a CPS transport bearer, because it is capable of doing so, can engage in a correspondence exchange at specified times during the creation process. Any extra periods of creation that don't have access to CPS are limited by a CPS stage. As a result, the CPS transport holder can make decentralised sales for arrangements in development districts suitable to trigger errands.

6 Electronic Platform

When the experience of the client moves further into the association ethos, undertakings are checking out having a huge effect on this “new ordinary” conduct of their clients. What at first began as front-end, multichannel is at present entering the IT frameworks. Advanced stages are ending up being the platform for computerized biological systems. These stages are moulding the innovation scene and can contact each part of living souls. They span organizations, impact practices, construct networks, and can diagram a whole biological system around themselves.

This change in outlook has gotten the interest of innovation organizations and computerized pioneers. They are growing in innovation stages and forming new plans of action. While it may not be basic for an organization to possess its foundation biological system, it is fundamental to have a powerful stage technique and the business skill to execute it. Assuming saddled well, this worldwide monetary upheaval will change how business is finished for numerous years to come. Ventures used to have enormous solid stages, which filled just a couple of needs. With the appearance of versatile and computerized, they are establishing modified stages to match their industry cycle and needs, and also conveying customized and context-oriented data to their clients. The new stages required to contact the customer using cell phones, take part in item mindfulness, screen crusades, attempt steadfastness the board, and investigate information, alongside giving customized offers.

6.1 Necessity of an Electronic Platform

Frameworks and administrations are turning out to be carefully mindful, and endeavours are incorporating stages that can empower joint effort between organizations. Today, stage advancements are accessible to coordinate heterogeneous channels, frameworks, and administrations. Setting mindfulness is expanding on personalization and limitation to toss energizing open doors at organizations. The trend-setters have continued from knowing "who" their clients are to "where" they are, "how goes it with" they doing, "what" they did previously, and "what" they liable to do straightaway are. As demonstrated in Fig. 14, this knowledge empowers an association to interface with the client brilliantly, perfect spot and at the exact cost from the channel. Associations should be prepared to rebuild the organizations to jump on new open doors.

To bring change, associations are required to arrange a biological system across the entirety of their limits, adjusting promoting, deals, tasks, support, and any remaining capacities. This ability permits associations to make and keep a light-footed advanced stage where creative items and arrangements can be carried out in a productive and versatile way.

6.2 Developing a Digital Business Technology Infrastructure

- Offer an incorporated support perspective on organizations and brought together work processes.
- Consistently fuse changes like setting, personalization, and closeness.

Fig. 14 Digital links everything

- Advance consistent learning and consider client practices.
- License continuous dynamic in light of the business prospects uncovered by different frameworks.
- Shield client information, client setting, and client presence.
- Recommend advancements to tackle business issues.
- Permit numerous accomplices to organize a coordinated arrangement.
- Can run and support a fruitful tasks model.
- Comprehend and foresee clients.
- Target and arrive at clients.
- Give customized encounters.
- Sense climate and setting.
- Quickly arrange work processes.
- Bring collaboration between different client-driven subjects.

6.3 Eye on Electronic Platform

A computerized industry is upheld by innovation stages in 5 regions:

- **Data frameworks stage**: upholds the administrative centre and tasks, like ERP and centre frameworks.
- **Client experience stage**: contains the principle client situated components, like client and resident entrances, multichannel business, and client applications.
- **Information and investigation stage**: contains data on the board and scientific capacities; Information on the board programs and scientific applications fuel

information-driven independent direction and calculations mechanize revelation and activity.

- **IoT stage**: interfaces actual resources for checking, enhancement, control, and adaptation; abilities incorporate network, investigation, and joining to centre and OT frameworks.
- **Biological systems stage**: upholds the making of, and association with, outside environments, commercial centres, and networks; application programming connection point (API) the board, control, and security are its fundamental components.

7 Conclusion

A Cyber-Physical System (CPS) 5C architecture for Industry 4.0 manufacturing systems is proposed in this study. Production companies may utilize CPS to enhance product quality and system dependability by using smarter, more robust manufacturing equipment. Making a design technique that can be applied in any system, no matter how vast or complex, is the most challenging component of creating a CPS, according to those involved. As a consequence, learning factories, which are excellent for CPS owing to the superior technology utilized, must be used to produce knowledge. Test and develop various design methods at these facilities. To guarantee that the systems are constructed to be altered and updated fast in real-time, and able to communicate with other systems while maintaining dependability and security, a design process is needed. All systems must be able to interact with each other due to the need for regulators.

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Chapter 12
Machine Learning and Deep Learning Algorithms for Alzheimer Disease Detection and its Implication in Society 5.0

Nilanjana Pradhan, Shrddha Sagar, and Ajay Shankar Singh

1 Introduction

The Fifth Fundamental Plan for Science and Technology (2016–2020) was issued by the Japanese government in January 2016. Using a new cyber-physical system, the "Society 5.0" programme hopes to develop a sustainable society that enhances human safety and comfort. Society 5.0 describes a network of systems. The Internet connects a wide range of systems (such as energy management and highway transportation networks) to address both local and global societal issues (such as the reduction of carbon emissions). Think about the future in terms of the concept of "Society 5.0." An intelligent society will be created by integrating big data, IoT, AI, and people services to create digital and physical infrastructures for humans. Building the foundation for a society where anybody can generate value at anytime and anywhere, in a secure environment that is congruent with natural surroundings without the present limitations is the primary goal of this project. Networked systems (e.g., energy management and road transportation) that harness the Internet to address both local and global social issues are part of Society 5.0 (such as the reduction of carbon emissions). One of the most pressing issues in today's society is how to reconcile technological advancements like Big Data and the Internet of Things (IoT) with the needs of society as a whole. Digitalization, the ongoing technical shift known as digitization, is at the heart of this.

An overview of the four revolutions in society and industry, with an emphasis on how they were implemented to meet Society 5.0's stated goals, is provided at

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the beginning of the paper. Government and citizen viewpoints are also considered, stressing the need of sustainability in achieving a higher level of living Using the internet and physical locations, as well as IoT, big data, and AI, a framework is presented to achieve Society 5.0. From a number of viewpoints, the proposed infrastructure examines the Society 5.0 concept, following its history in practise, and analysing the extent and societal implications of its deployment in an international setting. Managers and policymakers will have a better understanding of research findings and practical issues as a result.

As neurodegenerative diseases and neuropsychiatric disorders have become more prevalent in recent decades, the need for treatment has grown. Healthcare costs connected with an ageing population have risen dramatically due to the rise in neurological illnesses including Alzheimer's, Parkinson's, and others [1–4]. A large amount of the worldwide disease burden is due to neuropsychiatric diseases such as schizophrenia, depression, and autism [4–6]. These causes have led to an upsurge in the demand for CNS drugs. When developing CNS drugs, there are a number of critical hurdles to overcome. The semipermeable blood–brain barrier (BBB), which shields the central nervous system, (CNS) from external stress and toxins, is the most important factor [1–3]. The conclusion is that CNS-targeted medications may be made ineffective by treatments that have been proved to be useful in other bodily locations. The development of CNS medications has been hindered by a lack of suitable animal models for CNS drug testing and by a lack of understanding of complicated CNS pathophysiology [2, 3, 7, 8]. Even in the field of CNS drug research, deep learning has proven to be a powerful tool for a variety of applications, from computer vision to speech recognition to reinforcement learning. Miao recently used deep learning algorithms to produce a BBB drug classification study. This study achieved a benchmark accuracy of 0.97, an AUC ROC of 0.98, and an F1 score of 0.92 for CNS drug research [33]. Miao used deep learning algorithms. There are certain interpretability issues with this model, just as other deep learning models. Scientists' understanding of CNS medication design is unaffected by this "black box" quality [9]. Although chemical data was scarce in Miao's work, it was used to build deep learning models. It is limited by the models' size in terms of breadth and applicability domains.

2 Statutory Liquidity Ratio (SLR)

An SLR's primary purpose is to summarise existing research findings in order to identify gaps in the literature and so build the framework for future research, as previously indicated. "The following are the steps involved in an SLR: Determine the necessity for SLR, develop research questions, carry out a complete search and selection of primary research studies, assess the quality of the studies and extract data from them, analyse the results, and then report on the SLR; "by Mart-Juan et al. (19). Using clinical EHR data, how are researchers using machine learning algorithms to study the course of Alzheimer's disease? In order to answer the following three research questions, the fundamental question must be disregarded. What kinds of machine learning algorithms have been used to detect the onset of Alzheimer's disease and forecast the disease's path? For predictive modelling, what types of EHR-derived data and risk variables have been used (e.g., physiological, genetics, and demographics) What are the primary research interests of the articles that employ machine learning algorithms to model and forecast the evolution of Alzheimer's disease dementia using EHR-derived data?

Your strategy for conducting a search. It is the purpose of this SLR to assess works that meet the following criteria: Modelling and forecasting the onset or progression of Alzheimer's disease (AD) dementia can be done using ML techniques, clinical indicators, and clinical data. Similar to ref. 19, we created three keyword groups, each pertinent to a different element of the review's focus: Alzheimer's, Alzheimer's disease, dementia, Alzheimer's disease, and associated dementia are all disease-related keywords. Artificial Intelligence (AI) and machine learning (ML) are some of the terminology used to define the ML technique. Pattern recognition and computer-aided diagnostics are two examples of ML applications. Data and feature keywords include EHR, clinical data, clinical evaluations, and patient health information. Using conventional manuscript notation terminologies from relevant literature databases, we selected words for each of the three keyword groupings. 19, 21 Alzheimer's disease and other forms of dementia were included in the disease category. Since "Mild Cognitive Impairment" and "MCI" are often used in the context of brain disorders other than Alzheimer's disease, we decided to exclude them from our study. A large part of our work for the ML methodology group was focused on general concepts like prediction and categorization. The third collection of data contains keywords related to clinical EHR data. There was no need to include or omit terms like "neuroimaging," "MRI," "PET," "CT," and so on in the inclusion or exclusion criteria because this study was focused on clinical EHR-derived data with and without imaging elements. To conduct our SLR, we used the following bibliographic databases: In addition to PubMed and ScienceDirect, there are also ACM Digital Library, IEEE Explore Digital Library, ScienceDirect, and arXiv/BioarXiv. It was later confirmed that the works discovered on arXiv/BioarXiv after they were identified, had been released in a peer-reviewed journal or conference.

Between January 1, 2010, and May 31, 2020, we conducted a search of journal and conference proceedings articles using each of the search engines listed above. We utilised a triplet of terms from each of the three groups in each of the online databases to limit our search to the scope of the evaluation. All possible string combinations were created by taking one term from each of the three key word groups and combining them with a "AND" symbol. The following triplets were used as questions in the search. Exclusionary criteria- The entire article search and inclusion/exclusion procedure is a cyclic process.

3 Data Set

Data characteristics- As part of our effort to better understand how academics use data in their studies, we documented the dataset's openness, human participants, and clinical aspects. We checked each manuscript to see if the authors provided instructions on how to obtain the datasets they used in their research. We discovered two main dataset types: (1) reidentified datasets that may be downloaded by the general public, and (2) limited datasets from sources such as institutional clinical datasets that are not accessible to the general public. During the late 17th and early eighteenth centuries, there occurred a phenomenon known as the First Industrial Revolution (sometimes called the Industrial Revolution). One of the most momentous social and economic shifts in human history, the First Industrial Revolution began in 1780 and lasted through 1820. Humanity's rural economy transitioned from farming to manufacturing and industrial output during this revolution. The years 2021, 13, and 6567 of sustainability were critical considerations. One-fourth (16) of the most significant inventions were mechanical in nature, such as steam-powered transportation and factory organisation. Because of this, society's rapid expansion and a new perspective on the world were brought about. As a result of this, society has gone from just surviving to thriving. 2.0.2.1. The Industrial Revolution that occurred in the twentieth century. The Second Industrial Revolution happened between 1870 and 1914 during the first phase of globalisation. Many factors contributed to its rise: the development of new energy sources like electricity and oil, automatic machinery that produced parts for other machines, the growth of land transportation, and the construction of cinema and communication networks. This resulted in new organisational growth models as a result of the acceleration of industrial and economic changes. Time and costs were considerably reduced by employing serialised approaches with these new models. As a result, internationalisation of the economy led to a significant increase in social impact. Electricity accelerated communication and transportation as robots began to replace human labour. The Third Industrial Revolution, or Fourth Industrial Revolution, began in 1970 and is frequently referred to as the Fourth Industrial Revolution. United States, Japan and the European Union were the three most powerful countries in the world. It was only lately that the term "Information Society" was coined. A significant feature of industrial automation was the integration of modern communication and energy technologies. The foundation for this new information society was created by the microprocessor and integrated electronic components, which superseded the old storage and transmission systems. Intelligent R&D and I initiatives have been highlighted by the Third Industrial Revolution. People had to adapt to a new social paradigm because of new information and communication technologies (ICTs), such as the Internet. The Fourth Industrial Revolution was born as a result of this. During the Fourth Industrial Revolution, several new industrial technologies were developed employing sensors and information systems in order to adapt and produce customised client services as a result of the Second Industrial Revolution (the second industrial revolution). New information systems based on modern digital revolution infrastructures were the focus of the project. In order to fully automate production, the Fourth Industrial Revolution relies on a number of productive axes, including big data, robotics, IoT, cloud computing, and augmented reality, for example. There are many new ways to go around and communicate thanks to the Fourth Industrial Revolution's growing technologies, which have had an impact on society. According to a historical definition of multiple revolutions, the first three industrial revolutions were characterised by mechanisation, steam engines, power, automation, and automobiles. The advancement of cyber-physical systems, smart industry, automated knowledge, deep knowledge, big data, and the Internet of Things (IoT) is accelerating at an astronomical rate. By [9, 10], industry 4.0 was defined [2]. The concept of Society 5.0 has a clear connection to the different industrial revolutions that have occurred. When it comes to the growth of technology in this day, the goal is to ensure the well-being of all people. The economy, politics, and communication all have a role in societal developments. As a result of these differences, civilizations tend to be dictated by local conditions, while industrial revolutions tend to be framed by global advances in technology and industry, depending on the setting. Sustainability 2021, 13 × 5 of 17 for peer review According to a historical definition of multiple revolutions, the first three industrial revolutions were characterised by mechanisation, steam engines, power, automation, and automobiles. By the speed with which cyber-physical systems, smart industries, automatic knowledge and deep knowledge and big data and IoT were disrupted, Industry 4.0 was described [9, 10]. Each of the past industrial revolutions is inextricably linked to Societal 5.0 [2]. It is only via strategies that focus on the well-being of all people that future technical achievements will be revived and driven. Our culture is always changing as a result of all of these interrelated factors. Industrial revolutions are defined by technology and industrial achievements rather than by the type of revolution that a country or region is experiencing. A country or region is in the midst of an industrial revolution if it is characterised by technological and industrial developments. Communities are moulded by their surroundings and are dependent on regional development.

4 Internet of Things (IoT)

It is in this direction that we are moving. In the near future, we anticipate that IoT devices like smartphones, tablets, and smart glasses will be merged into ubiquitous and pervasive IoT subsystems with significant Internet presence while in motion. An IoT ecosystem that spans a whole smart city or smart community will revolutionise people's lives by enhancing their quality of life and making it safer, more secure, and more environmentally friendly [4 and 5]. Integration of IoTs and IoPaTs into a harmonic environment is difficult. The most efficient and effective method to integrate IoTs into an ecosystem, in our opinion, is through an open, market-driven integration that places value on the services they offer. A Smart Community's IoT ecosystem is expected to be a strongly connected and smart IoT ecosystem. Through pre-aggregation of resources, the ecosystem's IoTs produce intermediate-level services and deliver intermediate-level services to the ecosystem. IoTs and IoPaT devices are encouraged to participate in the marketplace in exchange for various forms of compensation. The integration of IoTs that are owned and installed independently is a significant difficulty in research on smart communities, as mentioned in [4]. IoPaTs can be included in a well-balanced ecosystem in the same way. Sensor data from each member of the ecosystem must be of a quality comparable with the devices that make up the IoT, which is defined as an “integrated system.” For the benefit of all, the many IoPaTs may find it advantageous to participate socially in order to maximise the collective benefit. In addition to being used internally, services can be sold in the resource and service market. It would be necessary to build bespoke Smart in order to develop such a big integration between structurally and semantically varied IoT subsystems with the necessity for ongoing analysis, community platforms, when people’s lives and the health of the economy are at risk, a high level of dependability and resilience. By sharing knowledge, the IoPaTs generate value [3, 11]. By offering IoPATs the opportunity to sell their services for money, the Marketplace of Services serves as an incentive for IoPATs to share information. When it comes time to integrate these devices into an acoustically harmonious setting, as with the IoT, the challenge is enormous. There are a number of reasons why we believe the IoPaTs will benefit from integrating with other IoPaTs. To enhance people’s quality of life while transforming residents’ experiences and creating new opportunities for innovation and creativity, different IoPaT subsystems can be merged into a community-wide IoPaT ecosystem. This IoPaT integration will be decided by the Marketplace of Services, as previously announced. Individual IoPaTs’ resources and services will be valued by the marketplace based on supply and demand. Both IoPaTs can’t keep flooding the market with resources and services that aren’t in demand, thus it’s inefficient for both of them to keep producing them at the same level of quality.

5 Healthcare, Artificial Intelligences

Artificial intelligence can help doctors and other medical workers make more accurate and faster diagnoses. It is possible to use artificial intelligence in medicine to better understand the human body and produce more accurate diagnoses than clinicians. This enables medical practitioners to take immediate action in the event of potentially deadly disorders. Approximately 1 trillion pieces of data, such as DNA, blood type discoveries, and weight, can be generated by the body of an individual, according to Smarr (2016). In the future, artificial intelligence will be the primary source of information for patients around the world by swiftly obtaining essential information, such as current status, medical history and family background. Additionally, it has been used to identify abnormalities in electrocardiography, ultrasonography, X-rays, and other types of scans promptly. Using artificial intelligence to study specific diseases such as malignant melanoma and eye ailments, experts say, can guarantee precise and rapid diagnosis. As a result, clinicians are able to compare the results of a treatment plan established for a certain patient to past cases in order to determine its effectiveness. For patients, this reduces waiting times and ensures that they receive the care necessary to resolve their issues in a timely manner.

Even while AI isn't meant to replace human doctors, it's been welcomed as an evolutionary trend in healthcare in the Middle East, particularly in Kuwait where it has been implemented. According to a PwC survey, a growing number of Middle Eastern patients are eager to use modern technologies in exchange for better health outcomes and a more advanced healthcare system. Artificial intelligence and robots could solve numerous health issues, according to a survey of more than 55% of respondents from the Middle East, Europe, and Africa. This included conducting medical tests, detecting diseases, and providing suitable treatment recommendations (Bar-Cohen and Hanson, 2009). In the Middle East's evolving health care system, the use of AI and robots for disease diagnosis and treatment is becoming increasingly common. Improving access to healthcare, fast and accurate disease diagnosis, and a high level of trust in the new technology all play important roles in fostering an openness to new approaches. Artificial Intelligence and robotics are increasingly being viewed as an essential part of the healthcare experience in the Middle East, despite the fact that this technology reduces human contact.

5.1 Types of Learning

Supervised, unsupervised, and reinforcement learning18 are all forms of machine learning (Fig. 1). Machine learning algorithms that require a labelled dataset to learn from are becoming the most popular for neurodegenerative disease data. A radiologist and a neuropathologist may be required to manually or expertly review MRI scan images. M is needed to categorise post-mortem patient specimen photographs. For example, an MRI scan can show the size of a specific part of the brain, which can be used to develop a model that can be used by the machine learning approach (for example, a diagnostic category). In the future, the computer can use this model to predict the label for new, unlabeled datasets based on the new input features that have been incorporated into the database. It can be difficult to get sufficient numbers of valid labels for supervised machine learning19. Classification and regression are two supervised machine learning methods that can be applied to data. Classification algorithms m, like the one represented in this example, forecast the diagnostic category (category) output for each data set (patient). Each data sample can be used to predict a real-valued variable using regression algorithms (for example, the degree of functional impairment assessed on a continuous scale). These methods can be used to generate patient endotypes by finding patterns in the data and clustering areas of similarity together when applied to healthcare datasets. Individuals can be classified into progression endotypes based on algorithms that represent motor function deterioration, disease duration, or the slope of progression using regression techniques. For example, endotypes are defined by specific genetic mutations or the region of disease development, as opposed to regression. For classification and regression purposes, there are a variety of machine learning algorithms available. Using unsupervised

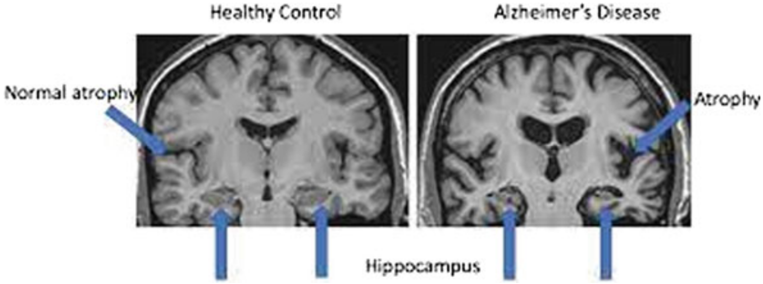

Fig. 1 Alzheimer's effected brain and healthy brain

machine learning, it is possible to group data samples or reduce the number of dimensions in datasets by presenting a simplified representation of highly intricate data20,21. Unsupervised clustering techniques can be applied to gene expression datasets22, for example, to find patient groupings with similar molecular markers. Unsupervised clustering methods such as latent variable models, which are groupings of genes that are expected to be co-regulated or connected to shared biological mechanisms or pathways, can also be used to identify gene co-expression modules. With the help of unsupervised clustering algorithms and the analysis of existing data, it is feasible to make predictions such as the life expectancy of a patient by building a model from clinical data. Supervised and unsupervised techniques can be used to provide semi-supervised learning. For example, semi-supervised approaches allow clustering (unsupervised) methods to increase classification (supervised) methods' performance while also regularising the prediction model with fresh data.... Using unlabeled data rather than shared labels24,25, transductive learning approaches avoid the problem of data leaking24,25; they can also improve performance in limited-data circumstances. Another way to use reinforcement learning is to give the learner an incentive to attain their goal. In order to determine the value of a variable, an algorithm could be utilised.

A fresh drug regimen is created taking into account the medical history of each patient. The algorithm will be punished if a new prescription or drug-drug interaction creates side effects, but it will be rewarded if the medication improves the patient's health as a result of the training. These methods are being researched rapidly, however, they are not as commonly used in the field of neurodegenerative disorders as supervised and unsupervised learning.

Health management specialists and an associate professor from Constantine 3 Salah Boubnider University's Faculty of Medicine were interviewed to help us choose the KPIs from the indicators gathered in our literature review (185). The following indications were derived from a survey of the relevant literature: 158 indicators were chosen from the experts' presentations, and 62 indicators were then categorised into the four primary areas of social, economic, technological, and internal processes for sustainability assessment. For the initial Delphi round, a questionnaire based on the identified indications was created. According to Galanis, at the second step, the Delphi approach was applied twice [30].

As part of the initial phase of research, 20 public hospitals and the management of each facility were selected to participate. Managers at primary healthcare facilities were asked to fill out questionnaires to examine the impact of KPIs on their sustainability performance. Second-round questionnaires were given to the same hospital management, and those with the lowest mean scores were excluded. There were a total of 42 KPIs in our research after we incorporated the managers' suggestions, which resulted in an overall reduction of 22 indicators. Study participants were randomly assigned to a location in either El Taref or Constantine Wilayas, where they were exposed to a variety of healthcare facilities, including university hospitals, public hospital centres, and neighbourhood health centres, beginning the week after the disease's first three cases were reported in Algeria and continuing until the end of August 2020. All 300 surveys were given between February and August 2020 to Algerian hospitals that had been designated as critical in the pandemic coronavirus framework.

There were 210 responses in total, with a 70% response rate. Gathered from medical professionals who are on the front lines of the war against this impenetrable foe. Responses were asked to rate the importance of each KPI on a scale of 1 to 5, with 1 being the least significant and 5 the most. We thoroughly evaluated the KPIs for each construct before conducting the research to ensure their validity and reliability.

El Taref contributed 41.9% of the sample's respondents (88), while Constantine contributed 122 respondents (58.1%). There were 96 females (45.7 %) and 114 males (45.7 %) in the sample (54.3 %). 21.4% of respondents were between the ages of 25 and 35, 37.6% were aged 36 to 45, 24.3% were aged 46 to 55, and 16.7% were aged 56 and beyond ($M = 2.36$; $SD = 0.9999$). More than 100 people took part in the pilot project, and all 41 KPIs were retained at their final stage since they had a loading factor over the 0.70 level (Appendix E).

IoT and IoPaT Ecosystems are on the horizon. It is anticipated that in the near future, smart IoT devices will be categorised into pervasive and ubiquitous IoT subsystems with a significant Internet presence while in motion. This includes smartphones, tablets, smart glasses, and cars. Many IoT subsystems will be merged into an IoT ecosystem that will alter individuals' lives, making them safer and more pleasurable while also making the environment cleaner [4]. It is challenging to integrate IoTs and IoPaTs into a harmonious environment [5, 6, 9]. A marketplace-driven, open integration of IoTs based on a valuation of the services provided is, in our opinion, a more practical and efficient method for IoT integration into an ecosystem than the majority of stove-pipe integration solutions that have been provided [12]. It is predicted that IoTs in a smart community will be closely integrated and create a smart IoT ecosystem inside its boundaries. Preliminary aggregation of resources by IoTs in the ecosystem provides resources and intermediate-level services to the ecosystem. IoTs and IoPaTs are incentivised to give resources to the marketplace in exchange for various types of compensation. Smart Community research faces a huge difficulty when it comes to integrating IoT devices that are owned and distributed by individuals. Incorporating IoPaTs into a well-balanced environment is no different. Each IoT component's sensor data can have a quality (such as resolution) appropriate to the devices that make up that IoT. The ecosystem is a networked system by definition. To maximise the benefit to all, several IoPaTs may find it desirable to engage in social division of labour. Internal ecosystem use or potential sale of resources and services may necessitate services' production. Smart Community platforms would be necessary to support such a large-scale IoT integration, both structural and semantically. When lives are at stake, there is a need for constant analysis, resilience, and dependability. The IoPaTs also produce value by sharing information. IoPaTs are persuaded to share information by the Marketplace of Services, which offers its services in exchange for money or other rewards. Integration into an ecosystem is just as difficult as it is for IoTs, and the same holds true for IoPATs, as well. We actually think that the IoPaTs will benefit from integrating with other IoPaTs for a number of reasons. It is our hope that the many components of the IoPaT ecosystem would be seamlessly merged into one Community-wide IoPaT ecosystem, which will enhance the quality of life for residents while also opening up new avenues for innovation and creativity. In our opinion, the Marketplace of Services is the primary arbiter of this IoPaT integration. When many IoPaTs are producing the same service, such as sensor readings at a certain resolution, it becomes inefficient for both of them to oversupply the market with resources or services because there may only be a certain amount of demand. The resources and services produced by certain IoPaTs will be valued by the market depending on supply and demand.

5.2 Importance of Deep Learning

It is important to note that while deep learning models are capable of classifying diseases with high accuracy, they are unable to explain the underlying diagnostic judgments or identify the input qualities that are linked to the predictions. Alzheimer's disease cannot be identified at the individual level, hence it is still unclear how to characterise it using computers. Our hypothesis is that the lack of external validation of single-cohort-driven models reduces the therapeutic potential of deep learning, on the basis of these features, and the rising use of opaque decision-making frameworks. Achieving these goals would not only help the medical imaging community use advanced deep learning algorithms to better serve patients, but will help establish an evidence-based approach to machine learning in the field. Around some of these restrictions, we created a novel deep learning framework that connects a fully convolutional network (FCN) to a conventional multilayer per ceptron (MLP) to produce high-resolution visualisations of Alzheimer's disease risk, which can then be used for precise predictions of Alzheimer's disease status (Fig. 1).

A model for neuroimaging Alzheimer's disease was developed and validated using the ADNI, AIBL, FHS, and NACC datasets (Table 1).

Table 1 ADNI, AIBL, FHS, and NACC datasets

Database	Exam type	Features extracted	Best classifier	Feature selection	Accuracy (%)
AIBL	sMRI	Disease probability maps	CNN	Not applied	CN versus AD-87
FHS	sMRI	Disease probability maps	CNN	Not applied	CN versus AD-77
NACC	sMRI	Disease probability maps	CNN	Not applied	CN versus AD-82
ADNI	sMRI	Statistical and textural features	Bag T	F-score	CN versus AD-93
			FGSVM		CN versus MCI-88
			QSVM		MCI versus AD-88
			SubKNN		All versus All-87

The effectiveness of the deep learning framework in relation to neuropathological results was established by model predictions and a head-to-head model performance comparison with a group of neurologists.

Participants in the study and the gathering of data Data from the cohorts of ADNI, AIBL, FHS, and NACC were used in the study (Table 1 and Supplementary Fig. 1). ADNI is an acronym for "Advanced Digital Neuroimaging." Biomarkers for Alzheimer's disease early detection and tracking are being developed in a long-term, multi-centre investigation (Petersen et al., 2010). AIBL, which was founded in 2006, seeks to identify biomarkers, cognitive traits, and lifestyle elements that influence the onset of symptomatic Alzheimer's disease in Australia (Ellis et al., 2010). The FHS has currently collected substantial clinical data from three generations of patients (Massaro et al., 2004). Because of this, the FHS has grown to include evaluations Since its founding in 1976, the programme has focused on ageing, dementia, and Alzheimer's disease. A vast repository of standardised clinical and neuropathological data collected from centres studying Alzheimer's disease worldwide in the United States is maintained by the NACC, which was founded in 1999 (Beekly et al., 2004).

Model testing, internal validation, and training all used the ADNI dataset. To train and evaluate predictions on AIBL, FHS, and NACC, ADNI data was utilised. Model testing, internal validation, and training all used the ADNI dataset. To train and evaluate predictions on AIBL, FHS, and NACC, ADNI data was utilised (Supplementary Fig. 1). Patients with brain tumours, severe traumatic brain damage, serious depression, a history of stroke, and Alzheimer's disease and other forms of dementia were also excluded. It's crucial to remember that this inclusion and exclusion criterion was created from the baseline recruiting strategy for the ADNI trial and, when appropriate, expanded to other cohorts. As a result, 102 FHS individuals, 417 ADNI cohort participants, 382 AIBL participants, and 565 NACC cohort participants were chosen to participate. A clinical diagnosis was made by selecting the most recent MRI scan if there were numerous MRI scans taken within a time frame. The MMSE score, gender, and age of most of these patients were accessible in most cases.

The creation of algorithms Using an FCN, a registered volumetric MRI scan of 181 by 217 by 181 voxels could be inputted and each location's class probability for Alzheimer's disease was estimated. An original, computationally effective patch-wise training technique was used to train the FCN model (Fig. 1). In order to estimate the output of interest using this data, 3000 volumetric patches of size 47 by 47 by 47 voxels were randomly selected from each training subject's MRI image (Supplementary Fig. 2).

The patches were the same size as the FCN's receptive field. Blocks that make up the FCN are arranged in six convolutions (Supplementary Table 1). In the first four convolutional blocks, a 3D convolutional layer is followed by 3D max pooling, 3D

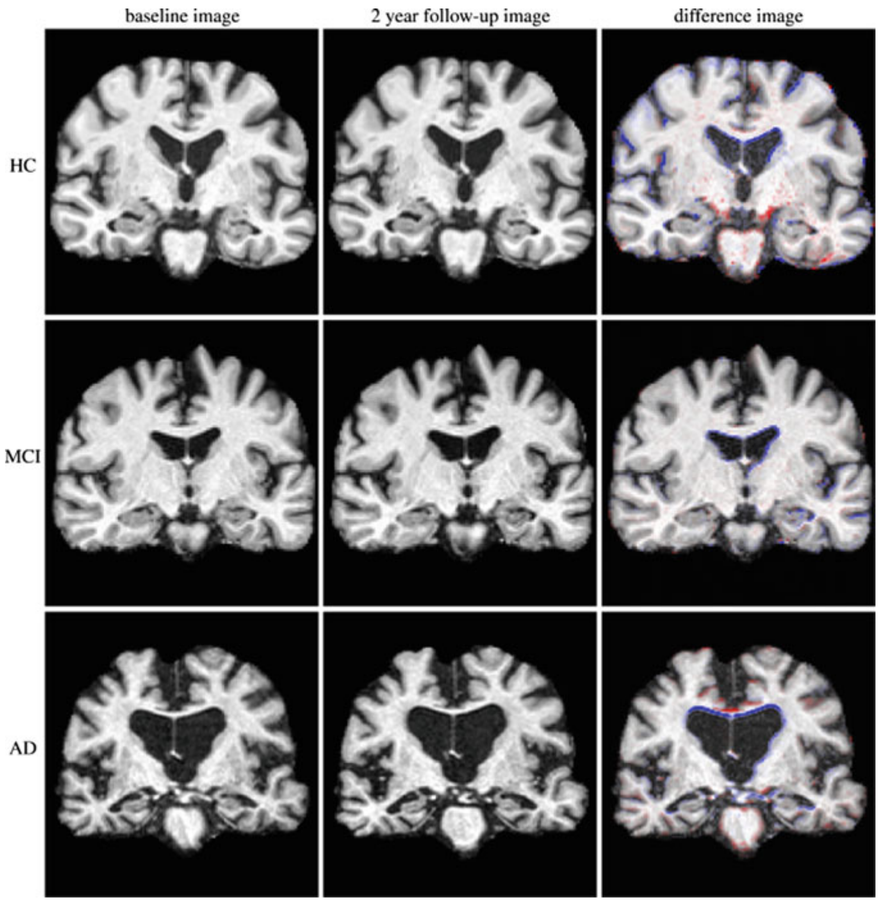

Fig. 2 MRI image of Alzheimer's disease

batch normalisation, Leaky Relu, and Dropout. In order to be classified, the final two convolutional layers function as thick convolutional layers. The importance of these two layers in boosting model effectiveness (Shelhamer et al., 2017). Random weight initialisation was used to train the network from scratch. Adam optimizer with 0.0001 learning rate was used with a mini-batch size of 10. Following the training process, the model was stored after achieving the lowest error on the ADNI validation dataset. After FCN training, we sent a single volumetric MRI scan to produce a full array of disease probabilities that we call disease probability maps. An NVIDIA Titan GPU was able to generate disease probability maps for test cases in about one second after being taught. The FCN was trained using a cuboidal patch of voxels from a volume of successive MRI scans. The form of the final output from each patch was equivalent to 2 1 1 1 after the FCN was applied to each patch during training (Supplementary Table 1), i.e., each patch generated a list of two scalar values. The bigger of these values were then used to categorise the sickness condition as either normal cognition or Alzheimer's disease after the softmax function was applied. For example, the model learned to identify patterns in brain anatomy that indicated a general state of distress. Choosing values for the likelihood of Alzheimer's disease from the maps of sickness likelihood. For binary classification, an MLP model framework was developed to forecast whether or not a subject will be given an Alzheimer's diagnosis. Using statistics from the ADNI training set's Matthew's correlation coefficient, the FCN classifier's overall performance was assessed. Based on this discovery, this selection was made.

Ten places that had strong Matthew's correlation coefficient values were selected from a total of 200. These sites' properties were used as input to an MLP model that performed binary categorization of the status of Alzheimer's disease. (MRI model in Fig. 1, Step 3). In order to predict the presence of Alzheimer's disease, one MLP model took into account the values of age, gender, and MMSE scores (non-imaging model in Fig. 1, Step 3). Age, gender, and MMSE score were used as inputs in the second MLP, which used 200 features to predict the presence of Alzheimer's disease (non-imaging model in Step 4). (Fusion model in Fig. 1, Step 3). One hidden layer and one output layer were found in all MLP models. The MLP models also incorporated non-linear operators like ReLu and Dropout.

6 Convolution Neural Network

A CNN model was utilised to identify the various phases of Alzheimer's disease (AD). Furthermore, the layers of the CNN model's design are explained. Finally, the training and evaluation of the CNN model is explained. 3.1. The source of the data accurately determining the stage of Alzheimer's disease based on patient mobility data gathered by an accelerometer is the primary goal of our proposal. An accelerometer-equipped smartphone is proposed as a data collection tool in this methodology. Wearable sensors, which can be more uncomfortable and intrusive for the patient, are not an option. Because of this, the approach should be able to prevent the patient's smartphone from being accidentally rotated in their pocket. The smartphone's accelerometer sensor provides a unique data sequence for each patient. Acceleration changes are recorded throughout time using these data sequences. Our methodology suggestion considers these three data aspects along the temporal dimension in order to forecast the stage of Alzheimer's disease (AD) There were a total of 35 individuals with three different phases of Alzheimer's disease: seven early, 18 moderate, and 10 severe. As a result, there was no initial bias in the minds of these patients. Segments of the same length are created by preprocessing data sequences. If you want to get a larger sample size for each patient, this partition is for you. It also aims to ensure that the intervals between subsequent points are as consistent as possible. An average of all data captured at a given time interval (for example, every 0.1 s) is calculated for each sample in order to homogenise the data. In order to decrease the amount of data that has to be analysed, we can just examine the average value from the accelerometer sensor's high sampling frequency. Each sample was padded with zeros to match the size of the largest one in order to ensure that all samples were the same. An accelerometer-based CNN can be built to classify Alzheimer's disease patients based on their stage of the disease, according to the proposed technique. In order to match a CNN model to a group of patients, it is required to determine their AD stage. On the basis of the Global Deterioration Scale, each participant's condition will be assessed (GDS). The following seven stages are defined by this scale: no outward signs of cognitive deterioration in GDS 1–2 However, there are no significant functional consequences to mild cognitive impairment (MCI). GDS 4: Dementia of the mild variety. Alzheimer's and other forms of dementia are characterised by deterioration in cognitive function. Dementia of the moderate variety is defined by GDS 5. Dementia with moderate severity (GDS 6). Severe dementia is classified as GDS 7 in this patient. Patients with AD are categorised into one of three stages: early, middle, and late (GDS 6 and 7). Two types of data sources are used in this manner to support a supervised learning process. I data from the accelerometer, and (ii) labels indicating the stage of AD. A method that relies on CNN Multidimensional data, such as time series, photographs, and so on, can be analysed using Convolutional Neural Networks (CNNs). In the first layer, they extract simple characteristics of the data (e.g., vertices, edges in images) and group them into more complex patterns (e.g., geometric shapes). Convolutional operations with kernels that can be trained are used to create these feature maps. Network convergence is facilitated by non-linear transformations and pooling. After that, a forecast is made based on the feature maps processed (typically by completely linked layers). ReLU transformations and average-pooling have been utilised to solve this problem. In addition, we adopted a 1-dimensional design for the CNN in order to operate with time series. It will be explained in greater detail in the next sections. The convolutional layer is 3.2.1. These are the foundational layers of this particular type of network. 'This layer's output is generated by applying the convolutional operation with different kernels to the full input using a sliding window approach to generate several feature maps that represent different characteristics of the input. We employed one-dimensional convolutions in this work because we only have one-time dimensional input. = + = Cn I f n b () I 1 (1) where I is the input channel, the filter, the size of the filter, and the bias is the convolution operation. Convolutional operations are performed for each channel separately and each filter is adjusted for the weights (e.g., if the first layer has 3 channels, the total number of parameters to change per filter will be (3 n +) 1 n +) independently. The output of the layer can be altered by other parameters, such as zero-padding, which expands the input with zeros, and stride, which determines how much the filter is shifted after each application. A stride of one and no padding was used in this situation. The sizes of the inputs and outputs of each layer are useful in determining the next layer's dimensions. The result output size is computed as follows: = output + l kps 21 (2) where the l is the input size, k is the filter size, p t is the output size.

Complicated patterns (for example, unusual or unexpected movement) in the final levels of the composition. As a result, the original information can be decoded using more direct layers such as Fully Connected to reveal a few key properties. In 3.2.2, we have ReLU (non-linear function) Convolutional operations do not provide a linear combination of the inputs, hence non-linear functions are used to bring non-linearity into the model. The Rectified Linear Unit (ReLU), which is utilised in CNNs, has been chosen for this project. Every point in the input tensor x is computed as: R x() max(0,) = x (3) Normalisation of batches in 3.2.3 For each mini-batch of training, this component [39] uses a normalisation function. This aids the model's ability to learn and generalise more quickly. For each mini-batch, the normalisation subtracts the batch's mean and divides it by its standard deviation to provide regularisation to the preceding activation layer's output. 3.2.4. Average-pooling of results In order to reduce the size of data between layers, the network uses a pooling procedure that removes some information. The filter size is divided by the received input size. The average-pooling function, which retains the average value of each cluster of inputs, was chosen in this circumstance. When dealing with time series data rather than images, the average-pooling method is more appropriate (where max-pooling obtains better results). To calculate the average-pooling operation for a given output point n, the following formula is used: = = + P () () When Everything Is Intact (FC) Based on the features detected in the convolutional layers, they are Feedforward networks. The inputs to every neuron in this form of network or layer are distributed equally among all of the nodes. The activation function is applied to the sum of the weighted inputs, which are then multiplied by the number of neurons. The training procedure teaches you how to lift these weights. Each class has a corresponding number of output neurons in the output layer (three). Scaling outputs to indicate the probability of an input being in a class, Softmax activation functions add them to one. The formula for the Softmax function is as follows: Assuming you have m outputs, the output vector y is equal to the number of outputs/classes you have. As a result, we get a probability vector for each class: the nth output shows how likely it is that the input belongs to class n. Dropout has been utilised in a complementary fashion to these convolutional layers before the fully linked layers. This layer randomly removes neurons from the network during training, ignoring them during that epoch or stage of training. Using a hyperparameter, the likelihood that a neuron will be lost is defined. This aids in the network's ability to generalise, which speeds up the learning process. 3.2.6. Description of the model- We use the CNN architecture depicted in Fig. 1 to process the various patient data. To train the network, the network receives an input in the form of 10,804 × 3 tensors, which represent the time and axis dimensions. Following batch normalisation and ReLU activation, the network includes a pooling layer. The first convolutional layer transforms the acceleration data before combining them with the various filters. While extracting significant characteristics from input, the convolutional layer set minimises the data's dimensionality. For enhanced generalisation and accuracy, a Dropout layer was included following convolutional layers of the network. Fully Connected networks next analyse the information and produce the prediction: how likely it is that input will fall into one of the three different classes. The anticipated class will be determined by the highest value. Details of the network's design are which describe the layers, operations, size and number of filters used in the Convolutional Layers, and the output of each layer in detail. In addition, the settings for each layer's parameters are displayed. Only half of the parameters in the Batch Normalisation layers, which correspond to the mean and standard deviation of each input, are not trainable (fitted in the backpropagation process). Backpropagation can only train 2,524,253 of the 2,524,953 parameters, therefore the total number is 2,524,953. The network's layers and some hyperparameters are tested in a variety of ways to ensure their applicability. We examine batch normalisation, variable dropout rates, and various pooling operations in these variations.

The early levels, and then, in the last layers, creating more complex patterns (such as a peculiar or unexpected movement). Because the original formation is encoded to a few properties that can be investigated with layers like Fully Connected, the original information may be decoded and studied. This section focuses on the ReLU algorithm (non-linear function) As a result of the use of non-linear functions, the convolutional operation's output is not just a linear combination of the inputs. The Rectified Linear Unit (ReLU), which is utilised in CNNs, has been chosen for this project. Every point in the input tensor x is computed as: R x() max(0,) = x (3) Normalisation of batches in 3.2.3 For each mini-batch of training, this component [39] uses a normalisation function. This aids the model's ability to learn and generalise more quickly. For each mini-batch, the normalisation subtracts the batch's mean and divides it by its standard deviation to apply regularisation to the activation layer's output. 3.2.4. The average-pooling method In order to reduce the size of data between layers, the network uses a pooling procedure that removes some information. The filter size is divided by the received input size. Using the average-pooling function, we've chosen to keep the average value of each cluster. When working with time series rather than images, the average-pooling method is more appropriate (where max-pooling obtains better results). Pooling operations are defined as: = = + P () () () () I n K 1 () where I is the input and K is the filter size. 3.2.5. completely linked (FC) based on the features detected in the convolutional layers, they are Feedforward networks. Every neuron receives all the inputs in this form of network or layer. To activate a neuron, the activation function is used after each input has been weighted and summed. As part of the training process, these weights are memorised. Each class has a corresponding number of output neurons in the output layer (three). Scaling outputs to represent the probability of an input being in a class, a Softmax activation function is used here. The formula for the Softmax function is as follows: Assuming you have m outputs, the output vector y is equal to the number of outputs/classes you have. It is possible to calculate the likelihood of an input belonging to a particular class by taking the nth output as an indication of the likelihood of an input belonging to class n. Dropout has been used in a complementary manner to these convolutional layers. This layer randomly removes neurons from the network during training, ignoring them during that epoch or stage of training. Using a hyperparameter, the likelihood that a neuron will be lost is defined. This aids in the network's ability to generalise, which speeds up the learning process. 3.2.6. Describe the model- We use the CNN architecture depicted in Fig. 1 to process the various patient data. To train the network, the network receives an input in the form of 10,804 × 3 tensors, which represent the time and axis dimensions. Following batch normalisation and activation of the ReLU, the network has a pooling layer of convolutional layers. The first convolutional layer transforms the acceleration data before combining them with the various filters. Convolutional layers minimise the dimensionality of the data while extracting the most important features from the input data. For enhanced generalisation and accuracy, a Dropout layer was included following convolutional layers of the network. We can then use this information to forecast how likely it is that input will fall into one of three different categories. The anticipated class will be determined by the highest score. A detailed breakdown of the network's layers, operations, size and number of filters used in the Convolutional Layers, and the output of each layer is shown in Table 1. Each layer's settings are also displayed. Batch Normalisation layers have half of the Batch Normalisation layer parameters, which correspond to the mean and standard deviation of each input, which is not trainable. There are 2,524,953 parameters in all, 2,524,253 of which can be trained via backpropagation and 700 of which cannot be trained in this way. The network's layers and some hyperparameters are tested in a variety of ways to ensure their applicability. We examine batch normalisation, dropout rates, and pooling operations in these variants.

In this post, we've developed a new way of determining the stage of Alzheimer's disease based on daily activities. First, accelerometer data is preprocessed to create shorter sequences of the same length and homogenise the intervals between data points; then, a CNN is built to forecast which stage of the disease a patient is now in. 35 Alzheimer's patients were studied in a childcare centre for a week using this method. To deploy this methodology, no additional hardware or resources (computers, motion analysis hardware, cameras, etc.) are required. Each patient in the childcare centre was assigned a unique daily data sequence by our researchers. The CNN learning process is hampered by the fact that only a small number of sequences are available for each patient. For each patient, the data sequence is varied based on the amount of time spent in daycare. Because of this, the preprocessing portion of the methodology separated each patient's data sequence into equal-sized chunks. High sampling frequencies lead to a significant volume of data being captured. Information is not lost in these short spans of time because of the low variance. It was our primary goal to develop algorithms that might automatically forecast a patient's stage of Alzheimer's disease based on their mobility data. We built a CNN using three 1-Dimensional Convolutional layers for this purpose. Local patterns in the x–y−z axis where acceleration changes are detected by these layers using fixed-length data segments. It is possible to conclude that the CNN (91%) efficiently accomplishes this purpose, but other commonly used classifiers (AdaBoost, k-Nearest Neighbors, Logistic Regression, Multilayer Perceptron and Random Forest) have a lower success rate. While the other classifiers fail to recognise early or late stages, the CNN model is able to correctly identify all three stages regardless of data imbalance. The idea is based on the accelerometer on a smartphone, which is non-intrusive and commonly used. Because of this, the methodology can be used to assess patients' daily activities. Furthermore, the CNN's predicted outputs can be used to detect an escalation of the disease and to prevent the disease from progressing to a more severe stage, and therefore to avoid complications such as falls, spatial disorientation, etc. This methodology will be used in a cloud-computing-based software system to collect accelerometer data and a service that customers can subscribe to monitor changes in the AD stage in the future. Patients' mobile devices will be used as dispersed nodes in this architecture. On the other hand, we plan to expand our first data set in order to conduct a second validation of the findings presented in this article. It is also possible to solidify and strengthen the foundation.

Transfer Learning in two dimensions. Large-scale medical images are still hard to come by, despite the fact that the Radiological Society of North America, other research institutions, and hospitals around the world have made a variety of radiologic datasets available for medical image analysis research purposes. It is common practise to use transfer learning to deal with a lack of data (10). NNs are pre-trained on a big dataset (15) before being applied to a new domain with a small amount of data (16). The basic assumption is that common low-level traits can be learned from the large-scale datasets that are available (17). For example, you can correct the lower layers and just retrain the higher ones (shallow tuning), or you can fine-tune the entire architecture (deep tuning). All or part of the pre-trained model is retrained using the domain data with a low learning rate in fine-tuning. This method aids in the transfer of learned elements to the new environment. In the course of training, you can adjust the level of fine-tuning. The domain similarity of the source and target datasets affects fine-tuning performance. Fine-tuning of the final layers is sufficient if the source and target domains are similar. Although fine-tuning more layers provides better results if the source and target domains are extremely dissimilar (10). The amount of training data is also a factor. There would be no need to fine-tune any further layers if training data were insufficient. Training data can aid with convergence even if the domain is similar, but updating additional layers' weights to the new domain will help (10).

Data Augmentation has its drawbacks. Increasing the number of training data artificially decreases overfitting, improves convergence, and improves model predictions. Altering existing data or creating new samples based on the available data distribution provides a little amount of variation. There may be instances in the data that are under or overrepresented. For rare circumstances, augmentation does not compensate for a lack of biological variability and does not capture variants that may be present in a larger sample. Limitations exist for GANs. To create realistic samples, they need a large amount of labelled data (34). Obtaining huge, high-resolution samples is also computationally expensive. The same false-positive and sensitivity results were obtained in a recent work (35) when a GAN was trained purely with synthetic data.

A comparison of MRI data (2000 synthetic volumes) versus original data. Model training performance needs to be compared to that of legitimate images, especially when abnormalities are present, and this can only be done with more use cases (36). Algorithms' performance may be severely affected by the addition of additional data. The use of data augmentation strategies may have unforeseen repercussions for algorithm performance that have not yet been well studied.

What a neuroscientist has to say about big data, machine learning, and artificial intelligence? Neurology applications images can be categorised using a variety of methods. Having the ability to extract relevant semantic information from an image is extremely valuable for search engines, social media firms, and automated vehicles. Commercial organisations have spent a lot of time developing algorithms for these kinds of jobs, and picture classification algorithms are at a more advanced stage of development than those used for most other activities. This has had a positive impact on algorithms that use clinical images to classify them. As a first step, this was used in the picture triage process to identify irregularities in enormous numbers of photos. An algorithm's role in triage reduces the overall responsibility put on the algorithm by making use of huge amounts of labelled imaging data (e.g., brain CT scans connected to radiology reports). Supervised learning algorithms are well-suited to this type of classification task. There is a true clinical advantage to flagging possibly anomalous results to a human as quickly as possible, while yet keeping the doctor in charge of the final decision. However, the risk of a significant number of false positives will have to be evaluated against any potential advantage. The screening of optical coherence tomography imaging for appropriate forward referral is an area where machine learning algorithms can have a significant impact. As a result of the extensive use of this method by opticians and other healthcare providers, a vast volume of complex data has been generated. Although the amount of data available has expanded, the ability of humans to analyse it has not. Experts' referral recommendations for a variety of eye-threatening retinal illnesses have been matched by an algorithm that learns from data. A machine learning system can analyse a large volume of scans in a matter of minutes or hours rather than days or weeks (once it has been trained). Retinal fundoscopic imaging has also been used to help determine whether a diabetic retinopathy referral is warranted. 8 Plain CT scans of the head9 10 have achieved similar improvements in the analysis of acute situations (eg, acute ischaemic stroke, subarachnoid haemorrhage, midline shift, mass effect or cal virial fractures).

7 Conclusion

In an attempt to forecast the progression of moderate cognitive impairment into Alzheimer's disease, researchers have used a semi-supervised learning system. 11 MR can be used for this purpose. 8 Dr. Auger and his colleagues published their findings in the journal Pract Neurol 2021;21:4–11. India:BMJ-PG, November 5, 2021 Sponsored. Pract Neurol: originally published as on 10.1136/practneurol-2020-002688 29 September 2020 as a protected http://pn.bmj.com/ Pract Neurol. In photos collected between one and three years before a clinical diagnosis, the learning algorithm was able to accurately predict the development of Alzheimer's disease with an accuracy of 89% sensitivity and 52% specificity using scans of persons with mild cognitive impairment. Adding additional cognitive markers to this imaging-based model increased sensitivity by 87 % and specificity by 74 %. According to new research, it may be beneficial to administer children with autism.

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Chapter 13
Deep Convolutional Extreme Learning Machine with AlexNet-Based Bone Cancer Classification Using Whole-Body Scan Images

D. Anand, G. Arulselvi, G. N. Balaji, and G. S. Pradeep Ghantasala

1 Introduction

Preliminary bone cancers are unusual with the rate of incidence being 4–7% and children and adolescents in U.S. [1], preliminary malignancies of bone cancer and joint cancer attains third rank in the patient's death cause with the cancer that are younger than 20 years [2]. The biological behaviour is widely varied by bone cancer and various management are required based on the benign or malignant or intermediate cancer classification by WHO [3]. A benign bone cancer (e.g. osteoid osteoma and osteochondroma) possesses the restricted capability for local recurrence and is cured willingly through the whole local excision/curettage. Intermediate group cancers (e.g. giant cell cancer and chondroblastoma) possesses the potentiality that is metastasize or locally aggressive in rare cases. Thus, the classification of bone cancer at the intermediate stage needs extensive margin excision comprehensive of normal tissue, and/or adjuvant therapy usage for ensuring local control [4, 5]. Chondrosarcoma and osteosarcomas are some of the malignant bone cancers that have

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the capacity of local critical growth and repetition and also carry important risk of distant metastases [6].

Various preliminary bone cancer diagnoses are mainly based on the traditional radiograph review and the patient's age. These cases are differentiated by examining the plain radiograph, whereas MRI and CT are used for some of the cases reselected [7, 8]. Also, some of the demographic data like age of patients and cancer that appears in radiography with respect to location, size, matrix type, margin, periosteal reaction and the destruction of cortex are some of the key signs used for the radiology differentiation indolent from the aggressive bone cancers [9]. As there are more appearances in a variety of bone cancers and that are comparatively unusual, some radiologists establish adequate knowledge to identify a definite diagnosis. Among common radiologists, bone lesion interpretation accuracy is low that leads to misdiagnosis and are damages the results of patients [10–12]. Several patients with benign cancers with bone biopsy are present with the problem of amplified morbidity rate and cost and are subjected to the sampling error [13, 14] or examined with improved imaging modalities that improves the costs of health care. Deep learning with convolutional neural networks is a special part of artificial intelligence that has proved to be a promising two-dimensional image classification of a few common diseases, and it is dependent on thousand databases of annotated or unannotated images [15, 16]. Predictive features are openly recognized since the images by using a back propagation algorithm in which the inner parameters of the model is recalibrated after every training round [17]. The major aim of this paper is to find the exact spotting and to grade the bone tissue as normal and abnormal using Deep Convolutional Extreme Learning Machine (DC-ELM) and identification using AlexNet operator and median filter for differentiation. The impact of this exertion is as follows:

- Construction of a simple, fast, robust Deep Convolutional Extreme Learning Machine with AlexNet classification tool used to identify bone cancer from patient's whole-body scans.

The association of chapter is as follows: Sect. 1 represents the outline of bone cancer, and application of neural networks in cancer detection; Sect. 2 portrays the present approaches for cancer prediction with its limitations. Section 3 stretches the description of materials and methods with the proposed system model. Section 4 gives a productive case study by comparing three existing methods and later, Sect. 5 concludes the chapter with a conclusion and future work.

2 Literature Review

Automatic evaluation of cell morphology in bone marrow is developed in [18] by utilizing the existing algorithms of image classification. The 171,374 images of microscopic cytology obtained from the bone marrow of 945 patients have various diseases of haematology. Model-averaged Neural Network (avNNET) is introduced in [19] to distinguish earlier metastatic diseases and to prophesy future macrometastases. This model fuses the rat's model of FDG-PET/CT and MRI functional imaging parameters [20]. MDA-MB-231 breast cancer cells are injected into an accurate epigastric superficial artery, which results in osseous metastasis progress in the right hind leg. Bone metastasis presence is determined by deep convolutional neural network developed in [7, 21]. Three sub-networks are present in this model for the extraction, aggregation and high-level feature classification in the data-driven mode. Two major improvements of this approach are joint analysis of posterior and anterior views those principals to increased accuracy. Segmentation of bone on entire-body CT utilizing convolutional neural network (CNN) is developed and evaluated in [22, 23]. Network training in the public dataset achieves 0.947 ± 0.013 as the coefficient of Dice in ten randomly produced public datasets with 15–3–9 splits. The smears of bone marrow in the digital images were chosen by the utilization of an oil immersion lens and 20MP colour CCD camera preceding a single microscope with $1000 \times$ resolution having perfect quality in illumination and white-balance settings. In this model, there is an artificial definition of every nucleated cell contour, and training/validation set and a test set are the division of cells. Novel architecture for deep convolutional neural network enthused by inception is suggested in [24]. In this, the modules of inception are replaced by depth-wise separable convolution. The performance of this method is better than V3 Inception in the dataset of ImageNet. MobileNets for mobile and embedded vision applications are presented in [25] depending on the streamlined architecture. Depth-wise separable convolutions are used for constructing light weight DNN. Two modest global hyper-parameters are presented here which establishe a trade-off between latency and accuracy. These hyper-parameters permit the model constructer to select the right model size for the applications depending on the problem constraints. Extensive resource and accuracy experiments show a robust performance as contrasted to other familiar models on the classification of ImageNet. From the existing method, it is found that numerous filters of the convolutional layers in the pre-trained network facilitate the extraction of a wide variety of features which increase the over-fitting problem by reducing the overall efficiency of the network. The aforementioned shortcomings of the literature motivated the formulation of the proposed DC-ELM + AlexNet method discussed in the forthcoming section.

3 Materials and Methods

3.1 Dataset Description

A few images of X-rays of various parts of body are required for human bone classification. Musculoskeletal Radiographs (MURA) dataset is used for that region. Seven human bone categories are present in the MURA dataset that belong to the hand, elbow, shoulder, finger, wrist, forearm and amusing. For the classification or prediction of bone category, training and testing datasets are required [26]. A few training and testing sets are present in the MURA set in 90:10 ratios. The 40,005 images of X-rays are total images and 36,808 X-ray images are considered as training set and 3,197 images of X-ray remaining are considered as images of the test set. All the cases of patients are classified into two classifications: (i) metastasis absent and (ii) metastasis present that are utilized as gold standard.

3.2 Whole-Body Scanning

To scan the patients, Siemens gamma camera Symbia S series SPECT System having two heads and low-energy high-resolution collimators is utilized [27, 28]. The scanning speed is 12 cm for a minute without pixel zooming. Radionuclides are of two kinds and are utilized for scintigraphy of bones: 99 m-Tc-HDP (TechneScan1) and 99-Tc-MDP (PoltechMDP 5 mg). Scintigraphy of the entire body was approximately obtained for 3 h subsequently after the 600–740 MBq injection of radiopharmaceutical agent, based on the type of persistent body. The injection of the communal intravenous system was 670 MBq for a radiopharmaceutical agent. In total, images of 586 planar bone scans from the patients having prostate cancer are retrospectively revised. The field of whole-body was utilized for recording the views of anterior and posterior positions having 1024×256 pixels of digital resolution. The number of Gamma decays detected is represented by images in every spatial unit having 16-bit grayscale depth.

3.3 System Model

The images of bone cancer classification problem are a complicated process and so the efficient deep learning methods like Deep Convolutional Extreme Learning Machine with AlexNet (DC-ELM + AlexNet) are used for classifier training to differentiate bone cancer images and healthy bone images. The efficient DC-ELM + AlexNet method for the classification of bone cancer is proposed in this paper, in which three processing steps are included; they are pre-processing of data to collect normalization of scanned data, DC-ELM + AlexNet learning and validation in the training phase, and the results of classification are evaluated by testing and represented in Fig. 1.

3.3.1 Data Pre-Processing and Normalization

The digital image's histogram is defined by the number of occurrences of each intensity level present in that image. In histogram equalization, each intensity level r_k is transformed into a new intensity s_k by the following transformation as indicated

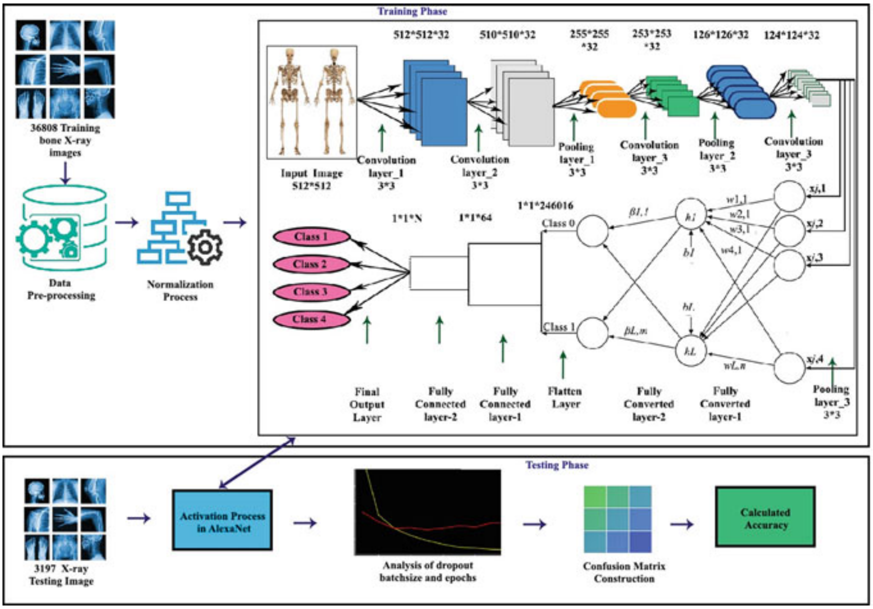

Fig. 1 System architecture for bone cancer classification process in training and testing phases

in Eq. (1):

$$sk = T(rk) = (L - 1)\sum_{j=0}^{k} p(rk) \tag{1}$$

where the number of pixels $(r_k) = n_k/n$ having the intensity r_k and the total number of pixels is n in the image. For $k = 0, 1, 2 \ldots L\text{-}1$.

Two sub-histograms of the input image are generated using mean intensity level of the breast area extracted in phase I. Let us consider $hist_{orgl}$ and $hist_{orgu}$ represent the histogram of the intensity level lower than the mean intensity, I_{mean}, and the histogram of the intensity level higher than the mean intensity, I_{mean},respectively, and $hist_u$ is the uniformly distributed histogram. The histograms $hist_{orgl}$ and $hist_{orguare}$ are modified using Eqs. (2) and (3), respectively:

$$\text{Hist(modl)} = (1 - \alpha)historgl + \alpha histu \tag{2}$$

$$\text{Hist(modu)} = \alpha historgu + (1 - \alpha)histu \tag{3}$$

where $0 \leq \alpha \leq 1$ and $hist_{orgl}$, $hist_{orgu}$, $hist_{modl}$, $\text{hist}_{\text{modu}}$, $\text{hist}_{\text{u}} \in R^{256x1}$.

When the value of $\alpha = 0$, then the modified histogram will be the same as the uniform histogram, $hist_u$ and when $\alpha = 1$ then the modified histogram will be the

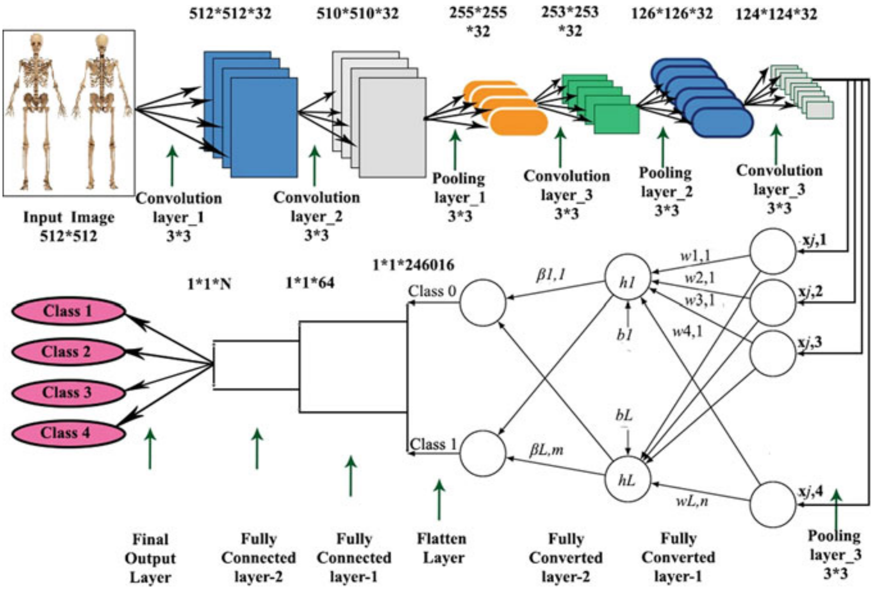

Fig. 2 Classification process using deep convolutional extreme learning machine and AlexNet (DC-ELM + AlexNet)

same as the histogram of the original image. The process of normalization in most of the machine learning procedures follows the process of normalization. The values of the dataset are normalized by the process of min–max normalization inside the range of (0,1) for ensuring all data features are in the same training and testing scale.

3.3.2 Construction of DC-ELM + AlexNet

The overlapping maximum pooling is used by AlexNet; areas of overlapping among the cell grids in the pooling layer that enhances the accuracy of features and overfitting issue are avoided to an extent. At last, the normalization layer with local response is utilized for the generation of competition among the neurons and positive feedback generation so the values of larger response become large and have values of small response; this will be small and the model's ability of generalization is improved at a similar time indicated in Fig. 2.

For over-fitting occurrence minimization, determination of regularization and dropout is used in the architecture designed. As a consequence, the 200 epoch numbers are described with 32 as batch-size, and 0.0001 is the rate of learning for Adam optimization. In addition, the function of rectified linear unit (ReLU) was utilized for every convolution layer for the prevention of vanishing gradients and the process of training is sped up [29]. The ReLU function is described in Eq. (4):

$$ReLU = \begin{cases} 0; for < 0 \\ 1; for \geq 0 \end{cases} \tag{4}$$

0.01 is the value of *L2* regularization and its value of bias is 0.01, and 30% on the fully connected layers were utilized for minimization of over-fitting. The stochastic gradient forms the basis for the Adam optimization technique in which this algorithm is highly efficient in computation. It is directly implemented and doesn't require any resource of memory and has the capability of reducing training costs [30]. In the process of training, the function of cross-entropy was utilized for obtaining the values of loss in both data training and validation. The function of cross-entropy expression is represented in Eq. (5):

$$L = -\sum_{I=1}^{c} T(i)\log(si) \tag{5}$$

where the ground truth is represented by *T(i)*, and the obtained score of CNN for every class at C is *si*. Adam optimizer is used for the optimization of the function of cross-entropy having 0.0001 of static rate of learning. Softmax is used as a function on the output layer and it is presented in Eq. (6):

$$F(xi) = \frac{e(xi)}{\sum_i e(xi)} \tag{6}$$

The numerical output of the last linear layer is converted by Softmax into the value of probability through the *e* as a natural number rising with some numeric value (xi), and it is divided by the *e's* total power for every consequence. In this function, the value expected was partitioned by each and every proportion. The function's value of highest probability is used for the predicted class representation; cancer status is determined by this classification and helps pathologists. Nowadays, the input layer's output at the *t* time step is expressed as in Eq. (7):

$$\mathrm{it} = \beta(\mathrm{wixt} + \mathrm{Riht} - 1 + \mathrm{bi}) \tag{7}$$

where the input gate with bias is *bi*. In the above equation, the forget gate and output gate are substituted with the weights and biases and the other layer's output are obtained; they are *ot* and *zt*. At last, the state of cell at t time step is stated as in Eq. (8):

$$ct = ft \cdot ct - 1 + it \tag{8}$$

and the updated hidden state is given as expressed in Eq. (9):

$$ht = ot \cdot \tanh(ct) \tag{9}$$

Given (M1, M2,…,ML), in this research L = 2; every ML is trained by $d^{tr}{}_{k}$ and every instance is predicted on $d^{te}{}_{k}$. Let the ML model be predicted by pk (x') on x' be given as expressed in Eq. (10):

$$\mathrm{Zkn} = \mathrm{Pk}\,(x\prime n) \tag{10}$$

Finally, in the whole process of cross-validation of every ML model, an ensemble from the L model results is given by the data (dcv), and it is expressed as in Eq. (11):

$$\mathrm{Dcv} = (\mathrm{yn}, \mathrm{z1n}, \mathrm{z2n}, \ldots\ldots \mathrm{zln}), \mathrm{n} = 1, 2, 3 \ldots.\mathrm{N} \tag{11}$$

where the meta-classifier $m_{mtc\,f}$ Level-1 model with the training set is d_{cv}. For finishing the training, m_L models at Level-0 are trained by the dataset d which is pre-processed, and dcv trains $m_{mtc\,f}$, and fivefold cross-validation is followed after the process.

3.3.3 Algorithm for DC-ELM + AlexNet Classification

Input: Testing data (Tes_data), training data(train_data),predicted label(pred_lab), neighbours (n),distance(d), nodes (N), leaf(l),

Output-malignant or normal

```
    Initialize the parameters Tes_data, train_data

    For

        Compute Euclidian distance (Ed)

        X(I,j)←ED

        Rank (N,l)←y

        ED<y (I,j)

        Avg (ED)←X(I,j)

        If
        P<0
           Activate randomforest

      Else
        Avg1 (ED)←X(I1,j1)

        Compute error

            Wi = max(M) – Mi

            Wi<0

            Normalize Wi =  Mi

    End for

        Mi= 0←indicates normal

        Mi= 1←indicates malignant
```

4 Case Study

The process of meticulous exploration was accomplished, where different convolutional layers, rate of drop, numerous dense nodes, epochs, size of pixels and size of batches are involved in experiments [31]. Various pixel sizes of the image with their values were evaluated like 100 × 100 × 3, 200 × 200 × 3, 256 × 256 × 3, 300 × 300 × 3 and 350 × 350x3, and also different batch size values like 8, 16, 32 and 64 were examined. Additionally, the values of variant drop rate were considered, e.g. 0.2, 0.5, 0.7 and 0.9 and a different number of dense nodes, such as 16, 32, 64 and 128 were discovered. 100, 200, 300 to 500 are the number of epochs explored. Human bones with seven categories are present in the MURA dataset belonging to the Hand, Elbow, Shoulder, Wrist, Humorous, Finger and Forearm. A particular image's grouping or class is identified in this task. The architecture model classification utilizes 4 convolutional layers, 4 pooling layers, 1 flattened layer and 2 hidden layers with 0.2 as the rate of dropout.

The experimental result is carried out and the parameters used are for the accuracy, sensitivity, specificity, F1-score and kappa score analysis. These parameters are matched with three state-of-the-art methods like Model-averaged Neural Network (avNNET), Inception V3 and MobileNets with the Deep Convolutional Extreme Learning Machine with AlexNet (DC-ELM+ AlexNet).

Accuracy presents the ability of the overall prediction produced by the model. True positive (TP) and true negative (TN) provide the capability of predicting the absence and presence of attack. False positive (FP) and false negative (FN) present the false predictions made by the used model. The formula for accuracy is given as in Eq. (12):

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{12}$$

Table 1 shows the assessment of accuracy between obtainable avNNET, Inception V3, MobileNets and proposed DC-ELM+ AlexNet method.

Figure 3 illustrates the evaluation of accuracy between prevailing avNNET, Inception V3, MobileNets methods and the proposed DC-ELM + AlexNet method where the X axis demonstrates the number of epochs used for breakdown and the Y axis shows the accuracy values attained in percentage. When compared, existing avNNET, Inception V3 and MobileNets methods achieve 92.7%, 94.72% and 96.12% of accuracy respectively while the proposed DC-ELM + AlexNet method achieves 97.04% of accuracy which is 5.74% better than avNNET, 3.72% better than Inception V3 and 1.12% better than MobileNets method.

Table 1 Comparison for accuracy

Number of epochs	avNNET [19]	Inception V3 [24]	MobileNets [25]	DC-ELM + AlexNet [proposed]
100	90.5	92.4	93.4	95.9
200	91.6	94.9	95.1	96.1
300	92.9	95.2	96.8	97.4
400	93.4	95.4	97.4	97.8
500	95.1	95.7	97.9	98

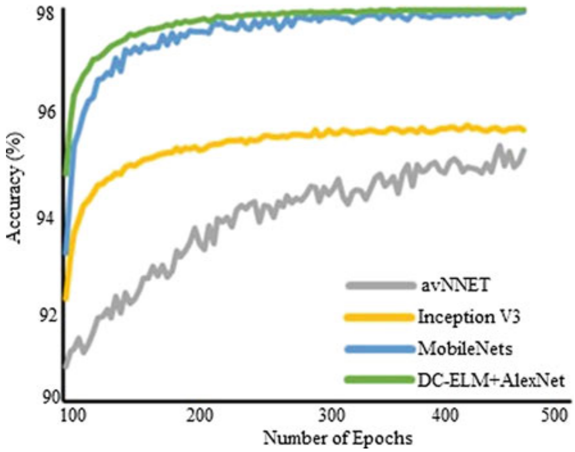

Fig. 3 Comparison of accuracy

Sensitivity estimates the efficiency of the classification model. It is the probability of positive prediction if disease is identified and is also termed as True Positive Rate (TPR) which is estimated as in Eq. (13):

$$Sensitivity = \frac{TP}{TP + FP} \tag{13}$$

Table 2 shows the association of sensitivity among remaining avNNET, Inception V3, MobileNets and proposed DC-ELM + AlexNet method.

Figure 4 illustrates the comparison of sensitivity between existing avNNET, Inception V3, MobileNets methods and the proposed DC-ELM + AlexNet method where X axis displays the number of epochs used for enquiry and the Y axis displays the sensitivity values attained in percentage. When compared, existing avNNET, Inception V3 and MobileNets methods achieve 54.62%, 55.48% and 64.96% of sensitivity respectively while the proposed DC-ELM + AlexNet method achieves 68.22% of sensitivity which is 14.4% better than avNNET, 12.24% better than Inception V3 and 1.74% better than MobileNets method.

Table 2 Comparison for sensitivity

Number of epochs	avNNET [19]	Inception V3 [24]	MobileNets [25]	DC-ELM + AlexNet [proposed]
100	54.2	55.1	59.6	65.2
200	54.4	55.3	61.5	66.4
300	54.6	55.5	65.4	67.8
400	54.8	55.6	66.8	69.4
500	55.1	55.9	71.5	72.3

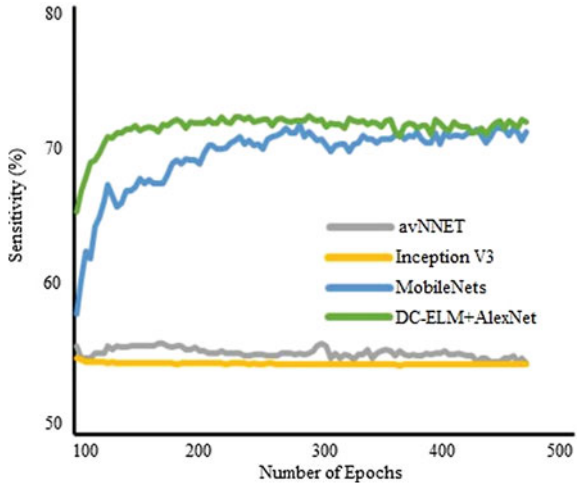

Fig. 4 Comparison of sensitivity

Specificity is the probability of true negatives aptly identified and is also termed as True Negative Rate (TNR). The formula for specificity is given as in Eq. (14):

$$Specificity = \frac{TP}{TP + FN} \tag{14}$$

Table 3 shows the comparison of specificity between existing avNNET, Inception V3, MobileNets and proposed DC-ELM+ AlexNet method.

Figure 5 illustrates the comparison of specificity between existing avNNET, Inception V3, MobileNets methods and proposed DC-ELM + AlexNet method where X axis displays the number of epochs used for breakdown and Y axis displays the specificity values attained in percentage. When compared, existing avNNET, Inception V3 and MobileNets methods achieve 71.34%, 72.26% and 81.24% of sensitivity respectively while the proposed DC-ELM + AlexNet method achieves 83.94% of specificity which is 12.6% better than avNNET, 13.26% better than Inception V3 and 4.74% better than MobileNets method.

Table 3 Comparison for specificity

Number of epochs	avNNET [19]	Inception V3 [24]	MobileNets [25]	DC-ELM + AlexNet [proposed]
100	70.9	71.1	78.2	83.1
200	71.1	71.6	79.5	83.5
300	71.3	72.4	80.1	83.6
400	71.6	72.6	83.5	84.2
500	71.8	73.6	84.9	85.3

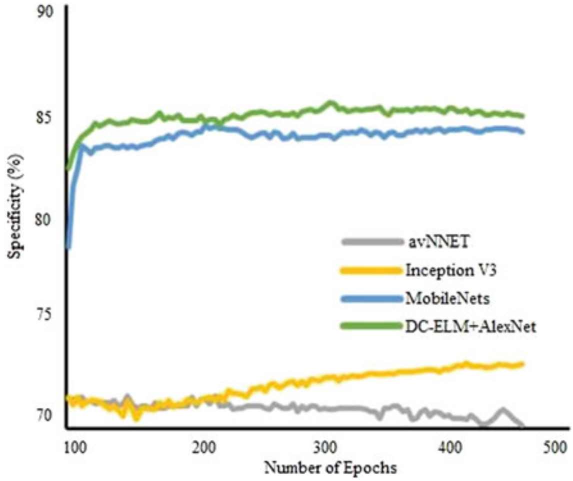

Fig. 5 Comparison of sensitivity

F1-score is utilized to determine the prediction performance. It is the weighted average of recall and precision. The value of 1 determines the best while 0 the worst. F1-score does not consider TNs and is calculated as in Eq. (15):

$$F1Score = \frac{2 * P * R}{P + R} \tag{15}$$

Table 4 displays the evaluation of F1-score between prevailing avNNET, Inception V3, MobileNets and proposed DC-ELM + AlexNet method.

Figure 6 illustrates the comparison of specificity between existing avNNET, Inception V3, MobileNets methods and proposed DC-ELM + AlexNet method where X axis displays the number of epochs used for examination and Y axis displays the F1-score values attained in percentage. When compared, existing avNNET, Inception V3 and MobileNets methods achieve 47.62%, 48.3% and 52.42% of F1-score respectively while the proposed DC-ELM + AlexNet method achieves 54.08% of F1-score which is 7.64% better than avNNET, 6.38% better than Inception V3 and 2.44% better than MobileNets method.

Table 4 Comparison for F1-score

Number of epochs	avNNET [19]	Inception V3 [24]	MobileNets [25]	DC-ELM + AlexNet [proposed]
100	40.1	41.6	42.8	45.9
200	45.2	46.8	48.1	49.8
300	46.8	48.5	50.2	51.6
400	52.4	50.1	55.9	55.9
500	53.6	54.5	65.1	67.2

Fig. 6 Comparison of F1-score

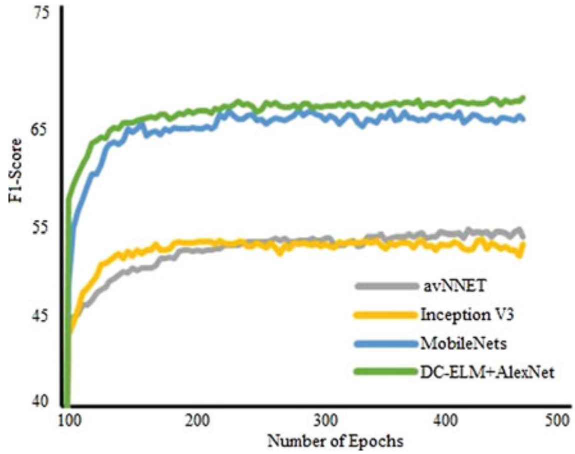

Table 5 Comparison for kappa score

Number of epochs	avNNET [19]	Inception V3 [24]	MobileNets [25]	DC-ELM + AlexNet [proposed]
100	54.9	55.4	57.9	65
200	56.4	56.5	59.4	67.8
300	58.2	58.2	60.2	68.4
400	63.5	60.9	64.9	69.6
500	67.1	68.2	69.9	70

Kappa score is employed to ensure inter-rate reliability which represents the correctness of the data collected which represents the variables measured.

Table 5 shows the comparison of kappa score between avNNET, Inception V3, MobileNets and proposed DC-ELM + AlexNet method.

Figure 7 illustrates the comparison of kappa score between existing avNNET, Inception V3, MobileNets methods and proposed DC-ELM + AlexNet method where X axis displays the number of epochs used for examination and Y axis displays the kappa score values attained in percentage. When compared, existing avNNET, Inception V3 and MobileNets methods achieve 60.02%, 59.84% and 62.46% of kappa score respectively while the proposed DC-ELM + AlexNet method achieves 68.16% of kappa score which is 8.14% better than avNNET, 9.72% better than Inception V3 and 4.3% better than MobileNets method.

Table 6 presents the overall comparison for various parameters between avNNET, Inception V3, MobileNets and proposed DC-ELM + AlexNet method.

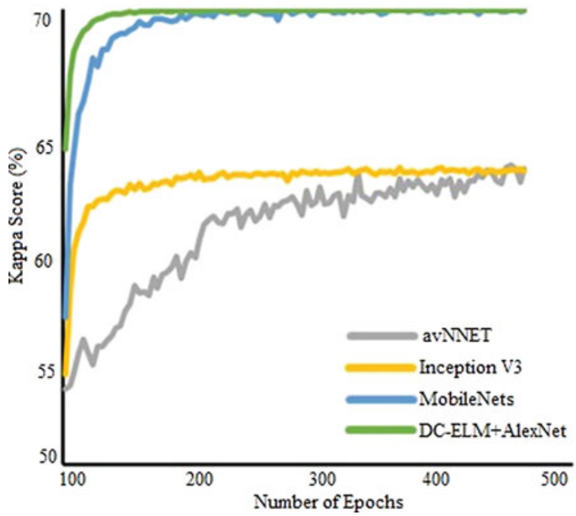

Fig. 7 Comparison of kappa score

Table 6 Overall comparison of existing and proposed methods

Parameters (%)	avNNET [19]	Inception V3 [24]	MobileNets [25]	DC-ELM + AlexNet [proposed]
Accuracy	92.7	94.72	96.12	97.04
Sensitivity	54.62	55.48	64.96	68.22
Specificity	71.34	72.26	81.24	83.94
F1-score	47.62	48.3	52.42	54.08
Kappa score	60.02	59.84	62.46	68.16

5 Conclusion

The proposed Deep Convolutional Extreme Learning Machine with AlexNet (DC-ELM + AlexNet) architecture is influentially sufficient, in each and every aspect related to the performance of computation, complex and generalization; the architectures are previously outweighed and are used in classification issue of whole-body image in the detection of bone cancer. The proposed methodology is validated of the on a trifling dataset which is measured as a probable drawback of this method as utmost of the endeavours noticed in deep learning are trained and validated typically on huge data amount. Many powerful well-known approaches like Model-averaged Neural Network (avNNET), Inception V3 and MobileNets are completely compared in terms of various parameters. As a consequence, the DC-ELM + AlexNet proposed accomplishes 97.04% of accuracy, 68.22% of sensitivity, 83.94% of specificity, 54.08% of F1-score and 68.16% of kappa score. The future work concentrates on utilizing the architecture DC-ELM + AlexNet in the classification and localization of probable bone metastasis obtained from patient's bone scans, collecting a huge number of images from patients with other cancer types.

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Chapter 14
Adaptive Clustering for Self-aware Machine Analytics

S. Karthikeyan and Putta Durga

1 Introduction

Clustering is most widely used to find similar objects in various databases. Clustering is an unsupervised learning approach that consists of a set of points into clusters and similar points belonging to the same group. In this process, data inheritance occurs in this process which causes the squared summed error, since the objects don't have class membership. The fixed-criterion technique is criticized for being overly simplistic and failing to convey the client's comprehension of the primary essence of the data. However, data is received gradually in many actual problems, such as original data-by-data in small units over unpredictably long periods. This chapter introduces adaptive clustering, a new data mining technique. The basic idea is to employ reinforcement learning (RL) algorithms to lead the search toward better clusters by incorporating feedback and previous experience. Suggest a feedback-driven adaptive clustering platform that changes the distance function based on the weights. This learning function aims to determine the weights that induce clustering that gives externally set goals.

The concept of self-aware computing incorporates a variety of characteristics that have already been studied in several computer science research fields. Self-aware computing systems that have one or more desirable traits, such as the ability to develop models about themselves and their environment, reason, plan, or provide explanations, are now a reality. Large numbers of these fields will be inseparably connected to investigation in the field of mindful registering, permitting it to remain

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on the shoulders of monsters. This chapter gives an outline of key ideas and research areas in self-aware computing. Each part presents another research point and inspects how it connects with mindful processing systems.

1.1 Clustering

Clustering is a data partitioning approach in which comparable elements in a data collection are assigned to the same cluster, while elements with differing qualities are assigned to different clusters. Clustering is a technique for finding components in data collection quickly. Clustering is very useful when dealing with multi-dimensional data that is otherwise hard to arrange. The spectrum reflectance and emittance properties of materials employed in the determination of their spectral signature are an example of such data [1]. Typically, such data is represented as a floating-point number for each characteristic, allowing for radically diverse scales to be represented. A large number of properties and the usage of distinct scales for each value make traditional data organization extremely difficult (see Fig. 1).

1.1.1 Types of Clustering

I. **Centroid-based Clustering (CBC)**

In this clustering, the data is arranged as non-hierarchical clusters. K-means algorithm (KMA) is many times utilized as a CBC algorithm. These types of algorithms are very limited and they are sensitive to default conditions and outliers. Thus KMA is a more efficient, effective, and reliable clustering algorithm (see Fig. 2).

II. **Density-based Clustering (DBC)**

DBC is most widely used and focused on high-density clusters. The arbitrary-shaped administration is possible only when the dense regions are connected [2]. These algorithms have struggled with a high range of densities and dimensions. Thus these approaches are not compatible with work on outliers to clusters (see Fig. 3).

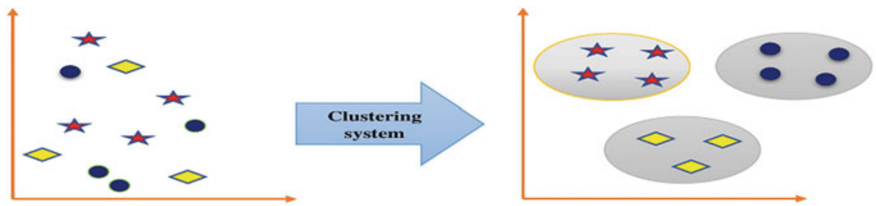

Fig. 1 Clustering

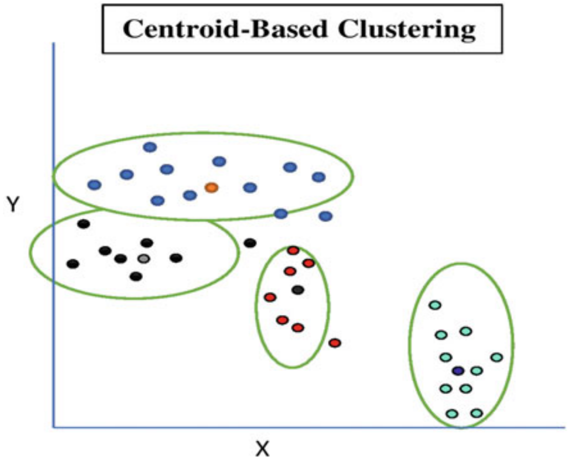

Fig. 2 Example of centroid-based clustering

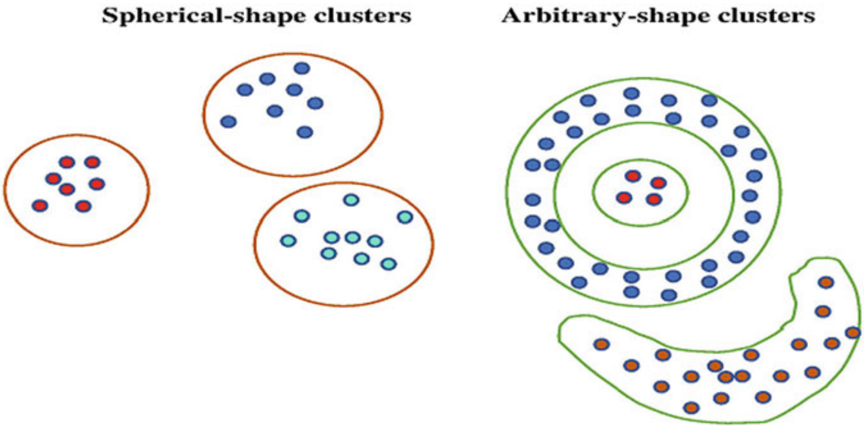

Fig. 3 Example of density-based clustering

III. **Distribution-based Clustering (Dis-BC)**

In this clustering, the data estimations are based on distributions, such as Gaussian. By using this distribution, the data is clustered into three Gaussian distributions. The similar object that belongs to this distribution decreased when the distance from the centre is increased. The drop distribution should be observed. Another algorithm should be used if the type of distribution is unknown (see Fig. 4).

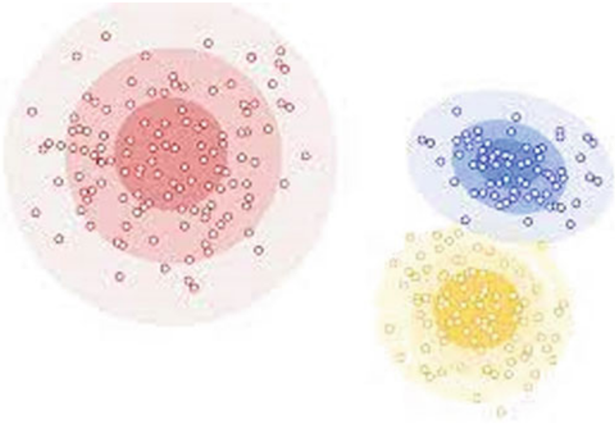

Fig. 4 Example of distribution-based clustering

IV. Hierarchical Clustering

This clustering is based on the tree structure. This clustering mainly focused on processing the hierarchical data, such as taxonomies. The most significant factor in this clustering is splitting the tree at the starting level; a total number of clusters are selected (see Fig. 5).

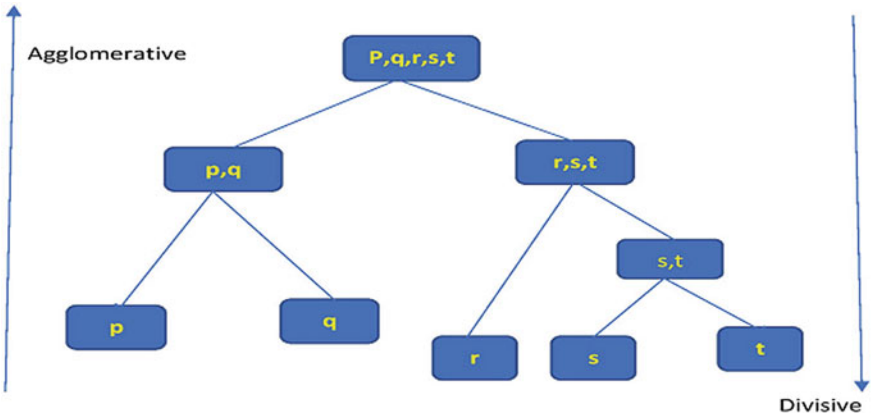

Fig. 5 Example of a hierarchical tree clustering

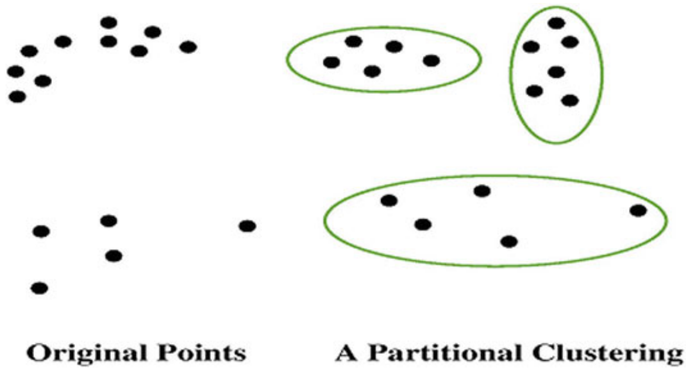

Fig. 6 An intuitive representation of a set of clusters

1.2 Cluster Analysis

This is considered an analytical classification approach that groups the items that are having same features into clusters. This is also used to classify objects that are compatible types. This analysis is also used to integrate the better patterns that should gain from data (see Fig. 6).

Because cluster analysis is implemented in so many fields, there is a lot of terminology confusion. The raw material to be clustered was referred to as a point, item, object, element, person, entity, and so on, while the characteristics of the entities examined for clustering were referred to as variables, attributes, characters, or features.

1.3 Measures of Similarity

Clustering methods are said to group related things. This necessitates a method for determining "whether an entity is more same to entity b than it is to entity c." In other words, we require a method for determining similarity, sometimes known as a similarity metric. Similarity can be calculated in two ways: by looking at the relationships between entities or by calculating the score each entity receives for a set of features.

The situation of a multi-graph relates to the first category of similarity measurement. Relationships between entities are edges in the network, while entities are nodes. Multiple edges can exist between two nodes. In statistics, the second category of similarity measurement is the most commonly utilized. Each entity is given a score based on a set of characteristics. Binary characteristics, which are qualitative variables rated on a nominal scale with only two values: 0 and 1, have received special attention due to their frequency [3]. The following formula can be used to calculate

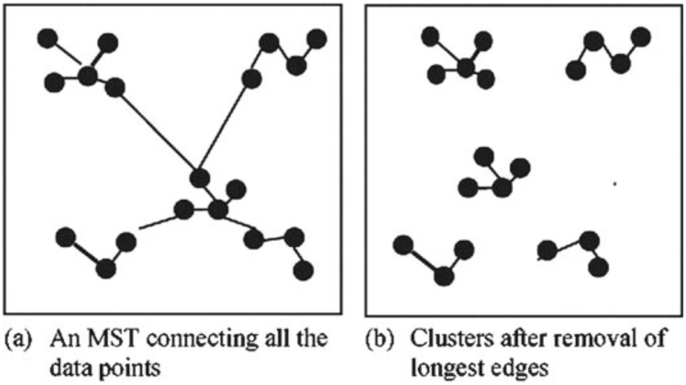

Fig. 7 Example of a minimal spanning tree clustering

the similarity measure from the dissimilarity measure:

$$\text{sim}(A,\ B) = 1 - \ \text{dis}(A,\ B)$$

where sim(A, B) and dis(A, B) is the similarity and dissimilarity measures.

1.4 Clustering Algorithms

1.4.1 Graph Theoretical Algorithms

These techniques work with graphs that have nodes that are entities. They usually employ a similarity metric based on edge costs or weights to represent inter-entity relationships. They often create specific sub-graphs, such as connected components or spanning trees, which they then employ to derive clusters. The set of entities is always partitioned by them. The MST, or Minimal Spanning Tree algorithm, is an example of a graph-theoretical algorithm. The procedure begins by generating the graph's minimal spanning forest. The clusters are then created by deleting edges from the smallest spanning forest that are regarded as "too long" (see Fig. 7).

1.4.2 Construction Algorithms

In a single pass, construction algorithms attach entities to clusters. It is not possible to relocate. Each entity is normally represented as a point in a two-dimensional plane. Then they split the plane based on predetermined criteria (geographic tactics) or look for high-density areas (density search techniques and mode analysis). The bisection algorithm is a well-known geographic approach. It operates by dividing the plain into two halves and allocating entities to clusters based on which side they are on. The fuzzy clustering algorithms are a subset of construction algorithms.

1.4.3 Optimization Algorithms

These algorithms are usually used in conjunction with other clustering approaches because they require an initial partition, which they strive to enhance iteratively based on some criteria or heuristics. The starting partition is sometimes produced at random. Hill-climbing and genetic algorithms are examples of optimization algorithms. A hill-climbing method attempts to relocate entities so that they are in the same cluster as their nearest seed point in the original partition by finding so-called seed points for each cluster in the initial partition. The seed points are frequently chosen to be the cluster's centroids or average entities. The seed points in the k-means method are recalculated after each iteration. When there are no more improvements to be made, the iterations come to an end [4].

1.4.4 Hierarchical Algorithms

Hierarchical algorithms are probably the most studied clustering approaches in the field of software engineering. They're also available in agglomerative and divisive varieties. Agglomerative algorithms use an iterative, bottom-up strategy. They begin with a partition in which each entity is assigned to its cluster. Two clusters are chosen and combined at each iteration to generate a single cluster. This process continues until all entities are contained in a single cluster. Because the series of merging operations may be described hierarchically in the form of a dendrogram, these algorithms are called hierarchical.

1.5 Structure of Adaptive Clustering

With regards to a machine armada, there is in every case a few levels of likeness between machines: machines that do equivalent positions or have comparable assistance time might have comparative execution and well-being. Machine bunches can be created as an information base addressing changed machine execution and working conditions given this likeness. Solo learning strategies like Self-Organizing Map (SOM) and Gaussian Mixture Model (GMM) can be used to make bunches independently for different working systems and machine settings. The versatile grouping approach recommended in Fig. 8 uses an online update component: the calculation looks at the furthest down-the-line contribution to the current bunch and uses multifaceted distance estimation to attempt to pick one bunch that is generally tantamount to the info test. The quest for a comparable cluster can prompt two choices.

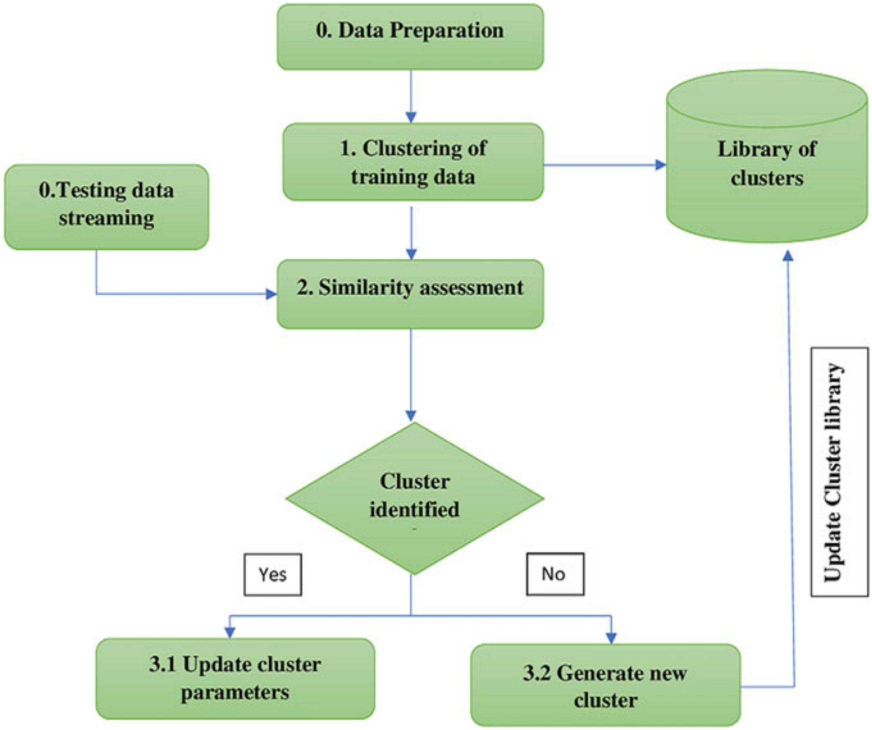

Fig. 8 Adaptive clustering for self-awareness of machine status

(1) A comparative group was found. If so, the machine from which the example was taken will be delegated having not been set in stone by the bunch. In the meantime, the calculation will refresh the current group utilizing new data from the most recent example in light of the difference between the current cluster and the new example.

(2) No comparative groups were found. In the present circumstance, the calculation will quit handling the current example until it sees an adequate number of out-of-cluster tests. At the point when the quantity of out-of-cluster tests outperforms a specific limit, the calculation will naturally assemble at least one new group to address the machine's new conduct. In the present circumstance, the grouping strategy can be incredibly versatile to evolving conditions. Besides, in the conceived internet, one developed bunch would be utilized as an information hotspot for well-being assessment. Distinctive machine execution conduct can be accumulated in the information base and utilized for future well-being assessments utilizing this methodology.

1.5.1 Algorithm

An adaptive clustering approach based on the modified k-means algorithm is developed in response to changes in vehicle density in the network.

The quantity of clusters k is converged with the vehicle thickness or the number of vehicles in the organization in this methodology. Grouping isn't needed at low densities, as recently expressed. Grouping is attempted when the vehicle thickness arrives at the limit of 1. At the point when the group's auto thickness arrives at a specific level, the bunch will be parted into numerous optional computing regions.

The following is a description of the adaptive clustering algorithm's process:

Stage 1: Determine the vehicle thickness in each RSU's executive's locale.

Stage 2: When the vehicle thickness surpasses the edge of 1, bunch the vehicles utilizing the changed k-implies calculation.

Stage 3: Determine the number of vehicles in each bunch. Stage 4 is executed on the off chance that the vehicle thickness isn't more prominent than 2; in any case, Step 5 is directed.

Stage 4: Keeping the bunch forward-thinking. All transports in the bunch have their group head determination factors determined, and the transport with the most noteworthy worth is picked as the new group head, with other standard vehicles joined to the group head given the bunching record. Get back to Step 3 after that.

Stage 5: Divide the auxiliary estimation regions. The thickness of vehicles in the bunch decides the quantity of optional registering regions. Calculation 1 portrays the versatile calculation's pseudocode.

```
Input:Cluster member set C, Cluster number K, bus member set B;
Output: CH_vector, ClusterMember_vector
        MSCN_vector, MSCNM_vector
node_den ← cal-den(C,K);
if node_den ≥ ρ1 then
K ← calculateCN(node_den);
CH_vector,CM_vector ← impkmeans(K,C,B);
end if
clusternode_den ← cal-den(CH_vector,CM_vector);
while clusternode_den< ρ2 do
CH_vector,CM_vector ← CM(CH_vector,CM_vector);
end while
if clusternode_den ≥ ρ2 then
N ←calculateCN(cluster-node_den);
MSCN_vector,MSCNM_vector ←
impkmeans(N,CH_vector,CM_vector);
end if
return CH_vector,CM_vector,MSCN_vector,MSCNM_vector
```

1.6 Types of Adaptive Clustering

I. **Adaptive K-means Clustering**

Clustering is a technique for organizing information so that it can be retrieved quickly. The identification of clusters in the given data is one of the issues with clustering. K-means clustering is a popular clustering approach in which the data is partitioned into K clusters. The number of clusters is predetermined in this procedure, and the strategy is strongly reliant on the initial identification of elements that accurately reflect the clusters. A substantial field of clustering research has concentrated on refining the clustering process so that the clusters are not reliant on the initial cluster representation identification. This is an adaptive approach that creates clusters without consideration of the cluster representation chosen at the start. As a result, the technique can find K clusters in an input data set by merging existing clusters and forming new ones while maintaining a constant number of clusters. When other effective search strategies are unavailable, the methodology has been utilized to produce an astonishing speedup of the search process [5, 6] (see Fig. 9).

II. **Adaptive fuzzy C-Means clustering**

The objective of Self Adaptive Fuzzy C-Means is to distinguish the best number of bunches and fluffy types. To assess the underlying group centroids from datasets, another clustering algorithm is used right away. The fuzzy clustering legitimacy file is then proposed as a technique for deciding the ideal number of K groups in light of conservativeness and partition. At long last, the ideal worth of the fuzzy weighting example m is resolved to utilize the kappa list [7].

$$\text{Kappa}(t) = \frac{SS_W(t)}{SS_B(t)}. \tag{1}$$

(1) **Clusters Centres**: At first, the clustering FCM result was determined by the initial cluster centers. Random selection can have a significant impact on the final clustering result. A new strategy based on the fuzzy density factor and distance is provided to overcome this problem. Its goal is to discover the best initialization for a set of data.

$$\text{f} = \rho/\text{R}. \tag{2}$$

where R shows the distance identical to the N nearest neighbors (NNN) sweep of every element, and ρ means the thickness component of every relevant informative item. Arranging in diminishing requests is finished with f. The fluffy thickness variable and distance are then used to decide the quantity of starting group habitats. Coming up next are the fundamental stages in bunch communities: We start by

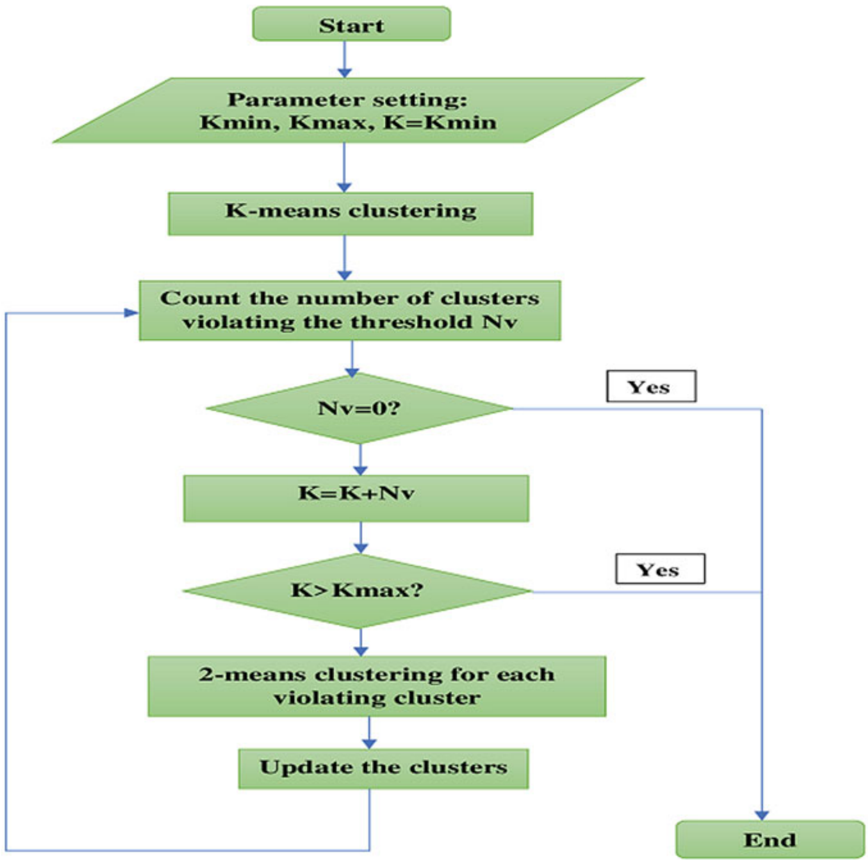

Fig. 9 Adaptive k-means for local modelling based on a threshold

ascertaining the distance between two items. The mean of all distances relating to the dataset's NNN span R and the information thickness element of every information point is then registered. Then, at that point, utilizing Eq. (2), we figure out the f-worth and sort it into a climbing request. At long last, pick the S esteems that relate to the best group place toward the beginning.

(2) **New Fuzzy Cluster Validity Index and fuzzy weighting example**: This clustering approach measures the nature of grouping outputs. This tends to utilize the better group member made by the FCM approach. Cheng et al. introduced global minimization and FCM [1, 7], and this is represented as:

$$V_B = \sum_{i=1}^{c} \frac{\sum_{j=1}^{n} U_{ji}^{m} \left\| x_j - v_i \right\|^2}{n_i \sum_{k=1}^{c} \| v_k - v_i \|^2}. \quad (3)$$

This index, like the index XB, merges the qualities of thickness, and disconnection measures the FCM. This index's value will steadily decline until it reaches 0 and, as a result, the best cluster number will be obtained. This index is a better version of the Bensaid index, and it's defined as

$$VI = \frac{\text{comp}}{\text{sep}} = \sum_{i=1}^{c} \frac{\frac{1}{n_i} \sum_{j=1}^{n} U_{ji}^{m} \left\| x_j - v_i \right\|^2 + \frac{1}{c} \| v_i - \overline{v} \|^2}{\frac{c(c-1)}{2} \sum_{k=1}^{n} \| v_k - v_i \|^2} \quad (4)$$

The numerator of the situation means the C cluster's smallness, while n_i signifies their fluffy cardinality. The subsequent thing thinks about the bunch centroids of the C group to the normal of all bunch centroids, annihilating dreariness.

III **Hierarchical Adaptive Clustering**

At the point when the list of capabilities that portrays the articles develops, we center around re-grouping a formerly bunched object assortment. Various leveled Adaptive Clustering (HAC) is a versatile bunching technique given a progressive agglomerative methodology that changes the parceling into groups that were developed before the list of capabilities changed utilizing the various hierarchical agglomerative clustering algorithm (HACA).

Hierarchical clustering techniques are widely used in a variety of fields, including biological gene classification, image processing, and network intrusion detection. Hierarchical clustering is based on the following principle:

The agglomerative (base up) approaches start with n singletons (sets with one component) and union them until the ideal number of bunches (k) is obtained, given a bunch of n objects and a number k, $k \leq n$. The most comparative two bunches are picked for converging at each progression. The troublesome (top-down) approaches start with a solitary bunch that contains all n articles and the gap until the ideal number of groups (k) is reached. We'll allude to HACA as the customary various leveled agglomerative grouping calculation so until further notice.

Following the Algorithm steps are

Input:

- the set X = {O1,...,On} of m-layered recently bunched objects;

-the set X1 = $\{O_1^1,...,O^1_n\}$ of (m+s)- layered stretched out objects to be bunched; O^1_i has similar first m parts as O_i ;

- the metric d_E between objects in a multi-layered space;

- the number p of wanted groups;

- K = $\{K_1,...,K_p\}$ the past parcel of items in X.

Output:

- the new segment $K^1 = \{K_1^1,...,K_p^1\}$ for the items in X^1.

Start

For all bunches $K_j \in$ K do

Compute $Core_j \leftarrow (StrongCore_j \neq \emptyset)?StrongCore_j : WeakCore_j$

Compute OCorej ← Kj \ Corej

EndFor

C ← ∅//the current bunch set

For i= 1 to p do

In the event that $Core_i \neq \emptyset$, C ← C ∪ $\{Core_i\}$

EndIf

For all O ∈ OCorei do

C ← C ∪ {O}//add a singleton to C

EndFor

EndFor

While | C |> p do

(Cu∗ , Cv∗) ← $argmin(C_u,C_v)d_E(C_u, C_v)$

Cnew ← Cu∗∪ Cv∗

C ← C \ {Cu∗ , Cv∗ }∪{Cnew}

EndWhile

$K^1 \leftarrow$ C

End

1.7 *The Problem of Adaptive Clustering*

For information that is known early, the bunching issue is surely known. A bunch is characterized as an assortment of information parts that share normal attributes, for example, day-by-day records of all buyers buying bread and milk. The idea of information bunching is characterized as the gathering of information parts into groups given a bunch of foreordained standards and dynamic cycles. It is a dynamic, versatile technique in our applications that arrangements with an eccentrically refreshed assortment. The framework can change the connection between any group and any record whenever, either in light of new, totally unforeseen occasions or proactively, because of inside thoughts and navigation. Versatile bunching is an issue where the best doable allotment of records to groups is kept up consistently.

Adaptive Clustering based on Multi-Agent technology [8]. Multi-specialist innovation is another kind of data aptitude that employs "calculations as communications" to tackle convoluted issues appropriately.

2 Real-Time Applications of Ada Clustering

2.1 Cargo Transportation Logistics

The issue is figuring up a close ideal timetable for assigning transportation orders to accessible assets. A savvy answer for continuous booking has the objective of evaluating customer orders, appointing assets, making an arrangement utilizing the organization's own and outsider armadas, improving the timetable, and observing. The test of versatile rescheduling of requests by assets is handled in a continuous vehicle strategies task. As a rule, the goal is like the notable test of the mobile sales rep. In all actuality, it envelops way decrease as well as a large number of different imperatives, for example, the client's level of administration, the required windowing time for getting items, the arrangement in which merchandise is stacked, the need to return void holders, etc. Indeed, even with the consideration of space specialists confusing the most common way of creating necessities for a canny asset in the executive's frameworks, it is habitually difficult to perceive which timetables are "brilliant" and which are "poor." It is possible to adopt a new strategy for this task by thinking about the authentic component of the records, past excursions, and assets. Therefore, a technique can be surveyed utilizing past information to recuperate arranging ability. For large armadas, be that as it may, the issue is more convoluted. It isn't difficult to guarantee that the last timetable is pragmatic, especially as far as cost. Different elements to consider are VIP customers, conveyance designs, favoured transporters, trip shape, plan cost, complete distance, everything being equal, client joy level for specific customers, driver happiness, etc.

2.2 Adaptive Clustering for Telecom Companies

Telecom organizations oversee a huge number of records including many client factors, determined to separate data about their clients' conduct. The issue of handling a blend of numeric and text information tended to use a bunching strategy given our multi-specialist innovation. There are multiple ways for numeric information (ROCK, DBSCAN, BIRTH, CP, CURE, etc.), yet they are altogether appropriate to representative message information and their blend. The multi-specialist motor that was constructed processes datasets with emblematic and mathematical properties. The primary approach was altered in this application to create clusters defined by their centroids. Thus, it links to centers of gravity in the case of numeric data, while it examines the most representative qualities in the case of symbolic data.

2.3 Tracing Large-Scale MPI (Message Passing Interface) Applications

Programmers with huge performance computing (HPC) applications can utilize correspondence follows to the more likely to comprehend and improve their code. The adaptability of the following apparatuses turns into an issue when utilized for a huge scope of HPC offices. Follows can be bunched into gatherings of cycles that have comparative conduct to tackle this issue. Rather than gathering follows for every individual hub, a hint of a little gathering of agent hubs, say one for each bunch, is adequate. Notwithstanding, grouping methods should be low-overhead, versatile, and versatile to application highlights. They created ACURDION, a versatile grouping calculation for enormous scope applications that follows MPI code correspondence with O(log P) time intricacy, where P is the number of cycles [9].

2.4 Application of Ontologies for Capturing the Semantics of the Problem Domain

Specialists are at present fostering a virtual market and making choices with genuine cash. Virtual cash, then again, can be utilized to control the capacity of groups and records to decide and resolve clashes. In transportation planned operations, for instance, how much cash accessible for a record can be utilized to set a cost for the request that the client should pay. The historical backdrop of VIP orders is accordingly “more extravagant” than a solitary request from a commonplace buyer. It takes into consideration the arrangement of bunches with far-off records while thinking about a changing setting and, thus, creating more gatherings.

2.5 Last-Mile Logistics Problem in Spatiotemporal Crowdsourcing

The last-mile operations period of online product exchange is basic. One of the most troublesome challenges in last-mile strategies is doling out messengers to circulate items on schedule to keep up with administration quality, particularly for new products. Since new food is hard to keep, the last-mile task issue (LMAP) for the new product gives a test to normal coordinated factors. In publicly supporting stages, the LMAP of new products is being tackled [10]. This allows everyday requests to be dispatched to accomplish a high grade of administration and helps spatiotemporal publicly support relegate messengers for the powerful conveyance of day-by-day arrangements by utilizing a versatile job mindfulness (ARA) method with job assessment.

3 Artificial Intelligence (AI)

AI is the capacity of a PC or a robot constrained by a PC to finish errands that regularly require human knowledge and wisdom.

3.1 Classification of AI

AI can be classified in a variety of ways. The most common categorizations are based on capabilities and based on AI's functionality. The flow diagram below depicts the various types of AI (see Fig. 10).

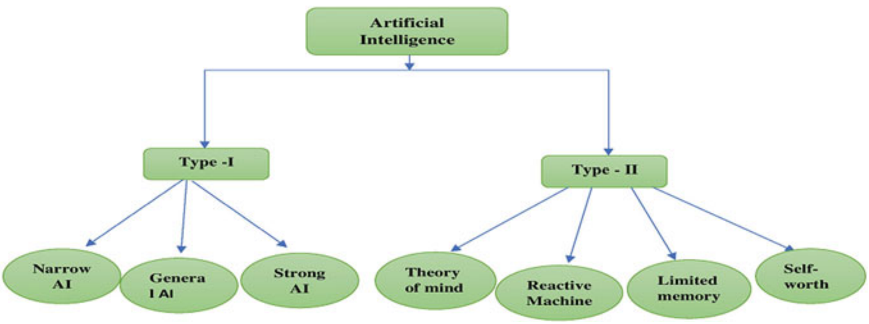

Fig. 10 Classifications of AI

4 Self-awareness

- Self-awareness Artificial Intelligence is the future. These machines will be extremely intelligent, with their consciousness, feelings, and sense of self.
- These machines will be more intelligent than humans.
- Self-Awareness AI is still a speculative idea that does not exist in reality.

4.1 Self-awareness in Software Systems

The capacity of a framework to procure information about its present status and climate is alluded to as mindfulness. Such data consider more precise reasoning in regard to the framework's versatile conduct. Thus, mindfulness is now and again considered the least degree of deliberation of self-adaptivity, and it can accordingly further develop a framework's fundamental discernments and self-adaptivity [4, 11]. Given the brain research area, we ordered a figuring framework's mindfulness into the accompanying general capacities:

- **Stimulus-aware**: "If a node knows about stimuli, it is said to be stimulus-aware. The node is unable to discriminate between stimulus sources. All other levels of self-awareness are dependent on it."
- **Interaction-aware**: "If a node knows that inputs and its actions are part of interactions with other nodes and the environment, it is interaction-aware." It understands that its actions can trigger, generate, or cause certain reactions in the social or physical environment through feedback loops.
- **Goal-aware**: "If a node knows about current goals, objectives, preferences, and limitations, it is goal-aware." It's vital to understand the difference between a goal that's implicit in a node's design and the node knowing about that objective in a way that it can reason about it. Goal awareness isn't described in the first, but it is in the second.
- **Meta-self-aware**: "This approach understands its awareness capability and the degree of intricacy with which those capabilities are used. A node can reason about the benefits and drawbacks of sustaining a given level of awareness with such awareness."

4.2 Self-adaptivity in Software Systems

The general classification of programmed and versatile frameworks expects to manage the framework's elements without human intercession; in any case, this doesn't dependably suggest vulnerability, i.e., there are changes connected with the framework, however, they are not difficult to foresee when they will happen and the size of these changes. Self-adaptivity is a sub-classification that portrays a framework's capacity to manage the two elements and vulnerability [12, 13]. Self-versatile

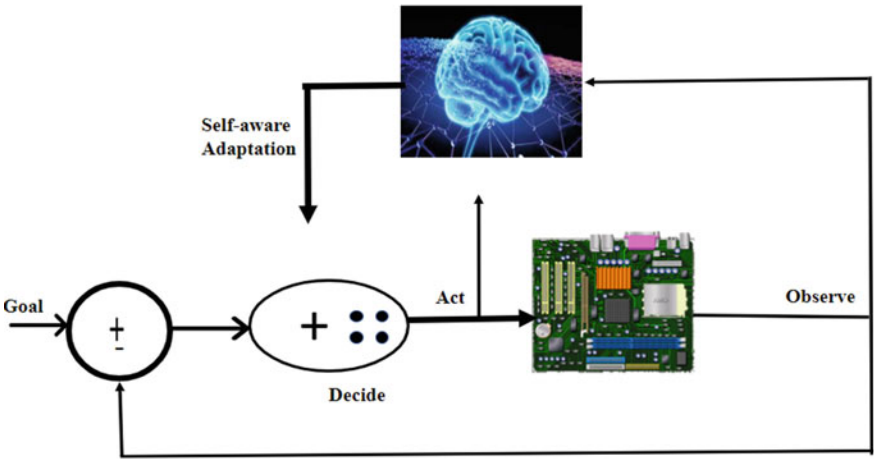

Fig. 11 Self-aware feedback loop

frameworks are those that can change their conduct because of their impression of an unsure climate and their status. Self-adaptivity in programming frameworks has stayed a fundamental and troublesome review subject to date. Self-adaptivity can be characterized as the accompanying four credits, every one of which covers a particular arrangement of objectives, as per versatile practices.

- **Self-configuring**: "The capability of installing, updating, integrating, and composing/decomposing software entities to automatically and dynamically reconfigure in response to change."
- **Self-healing**: "This refers to the ability to detect, diagnose, and respond to disruptions." It can also foresee possible difficulties and take appropriate action to avoid a failure."
- **Self-protecting**: "This is the ability to detect security breaches and recover from the consequences of those breaches. It consists of two parts: protecting the system from malicious attacks and anticipating problems and taking steps to avoid or reduce their impact" (see Fig. 11).

4.3 Perception and Learning Affordances

This is traditionally been thought of as a single observation process in robots. We feel that this method jeopardizes present agents' (i.e., robots) ability to comprehend scenes. Simultaneous perception and action necessitate interpreting the scene in terms of the agents' perceptual capability and potential actions.

Self-localization corresponding to the climate is required when thinking together on discernment and activity.

Figure 12 shows the Sensor motor approach (SMA)

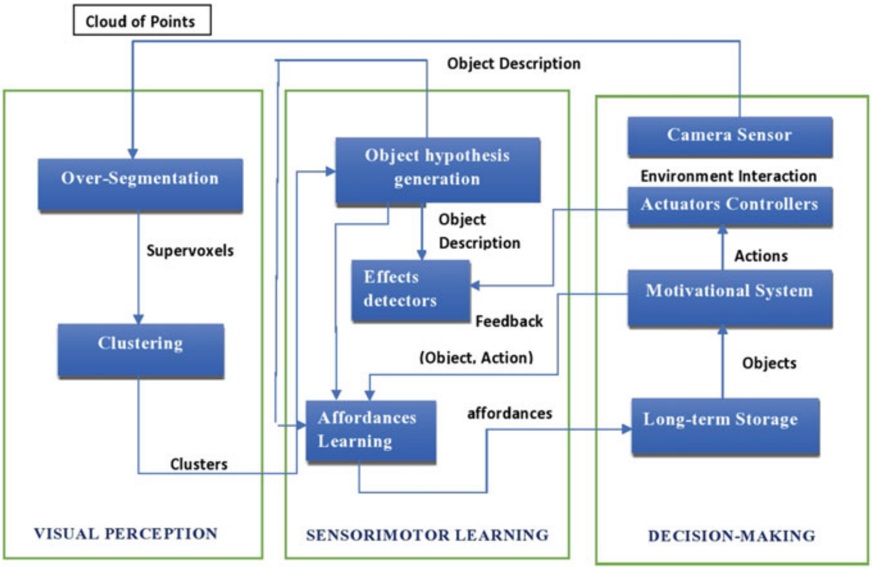

Fig. 12 Architecture of the SMA

- The approach's key inputs are measurements from the environment interaction, which include visual perception via a camera and proprioception data from joints.
- Visual perception is used to extract a set of clusters from a cloud of points. After that, clusters are tracked to build hypotheses about the substances with which the robot interacts.
- Joint and force measurements are used to obtain proprioceptive feedback. Effect detectors analyze the data from discernment and action tasks to make salient changes from the integrated process.
- SML defines the analysis of the discernment and action segments and sits at the junction of the two input processes.
- To design the predictions from a set of resource elements, the dynamic motivational system uses trained SML and the Bayesian framework.

5 Sensory-Motor Learning

Manipulating objects permits the robot to learn tactile engine relationships between the robot's essential developments A, the tangible data sources contained in the items' portrayals O, and the striking changes addressed by the impacts E [14]. At the point when an activity man-made intelligence ∈ An is set off, the objective is to gain from consistencies in the events of things in O and E. This method permits the robot to progressively establish a portrayal of the climate gathered by insight through object development identification and proprioceptive contribution while the robot is gaining from worked-in activities.

5.1 Objects

We expect that the machine has earlier non-cognitive capacities that permit it to separate the climate. These connections belong to the segmented approach. The machine has earlier mathematical origination of area, portion progression, and surface typical extraction, can recognize diverse shading esteems and can remove more significant level ascribes (e.g., as blends) for characterizing demonstrated items utilizing these perceptual capacities [15]. Shading, size, and shape can be generally found in the haze of particles that address an article.

5.2 Actions

We guess the robot has a bunch of fundamental engine abilities, or activities, that are described as far as the entertainer's morphology. These fundamental activities A = {a1, …, an} are indicated in joint space concerning their control factors:

$$a : \{Q,\ Q^{1},\ Q^{11}\}\tau$$

Q represents the combined metrics of the machine utilized in action a, and τ the time of this event. This means two factors that are unique machine compatibility and analysis do not run similar events.

5.3 Effects

This is considered as the correlation in the stage of environment that includes the employee itself. Effect learning is most widely used to design better models that are used for decision-making contains in events that show the impact in terms of feasibility and conversions to various stages of the climate.

5.4 Affordance Learning

Andries et al. [16] use the following definition of affordance: O is the set of objects, A is the set of actions, and E is the set of observable effects. The appropriate affordance αis defined as when an actor gm performs an actional on object o_k, the effect EJ is

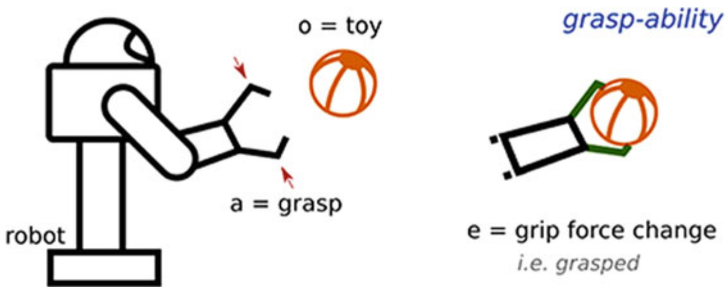

Fig. 13 This represents the grasp-ability affordance relation [17]

generated.

$$\alpha = \left((o_k, a_l),\ e_j\right),\ \text{for}\ o_k \in O,\ a_l \in A\ \text{and}\ e_j \in E$$

An affordance is defined as the relationship among the variables in O, A, and E, which are shown in the data.

Figure 13 explains the advantage of the connection between the item toy and the robot. It shows how the robot's get capacity is utilized, implying that there is the chance of creating a get handle on impact which is detected by the machine's exteroceptive and proprioceptive abilities (e.g., hold power change). We can call this connection handle capacity given its semantic importance [17].

We record the upsides of every component in the advantage sets when the robot collaborates with the surroundings. The issue of finding the connections among E, O, and A can be converted to tracking down conditions among the factors in B, i.e., P(B|D), and that implies learning the design of the related Bayesian organization B from communication information D, by regarding every component as an irregularly varying in a Bayesian organization B. The restrictive conditions between factors in B are utilized to communicate the advantage of this style. The back likelihood given the information D is utilized to work out a construction's score. To show the number of pieces needed to encode B, we made a data pressure score with a punishment determined as s(N) = log(N)/2.

5.5 Use Affordances for Problem-Solving

Shockingly, the estimations got from a probabilistic model of advantage can be used to underlie the probabilistic arranging calculation's arranging administrators. Given its tangible capacities and the apparent traits of the accessible items, a robot can design the arrangement of activities that has the most noteworthy probability of accomplishing the objectives utilizing this computational device. The capacity to see object advantage and anticipate the impacts of activities permits the robot to accomplish such objectives with adaptability (i.e., various activities might be utilized to accomplish a given objective relying upon the conditions) and heartiness (for example depending on consistent insight and thinking).

6 Learning Actions and Plans

One of the essential focuses made in this segment is that the capacity to facilitate assorted dynamic techniques and support learning (here referred to as the primary dynamic adaption process) can be an initial move toward dynamic independence.

(i) Greater automated independence and variation, just as a shift toward
(ii) The robot's capacity to evaluate the adequacy of its dynamic cycles and use that data to adjust not exclusively its conduct yet additionally the way it produces it.

6.1 Multiple Action Selection System

6.1.1 Architecture

Figure 14 shows the design. Every module (or master) is a dynamic framework that utilizes one of the accompanying techniques to create activities:

- In a model-based RL setting, the objective coordinated master, and in a sans model RL setting, the routine master. Given the prize acquired from the inspirational framework and the accomplished states and activities, these specialists advance either an undertaking model or only the nearby state-activity esteems.
- States are gotten through robot sensor information handling, and activity determination frameworks are given an assortment of discrete activities to browse. While a robot can act independently with only one dynamic framework (master here), our engineering incorporates a second part that screens the dynamic interaction.
- It executes the discretion technique that will be talked about later. This part, we propose, is needed to permit the robot to play out the main job, yet additionally to assess and provide details regarding its dynamic cycle.

6.1.2 Possible Coordination Methods

These methods are divided into two categories:

(i) These approaches are used to merge the probability distributions from every expert into a selected state, an action is selected from the last distribution and
(ii) These approaches, assess which master is generally important in the current circumstance and allow it to settle on the last activity. We've likewise proposed a reference practical dexterity approach in which every master E between N

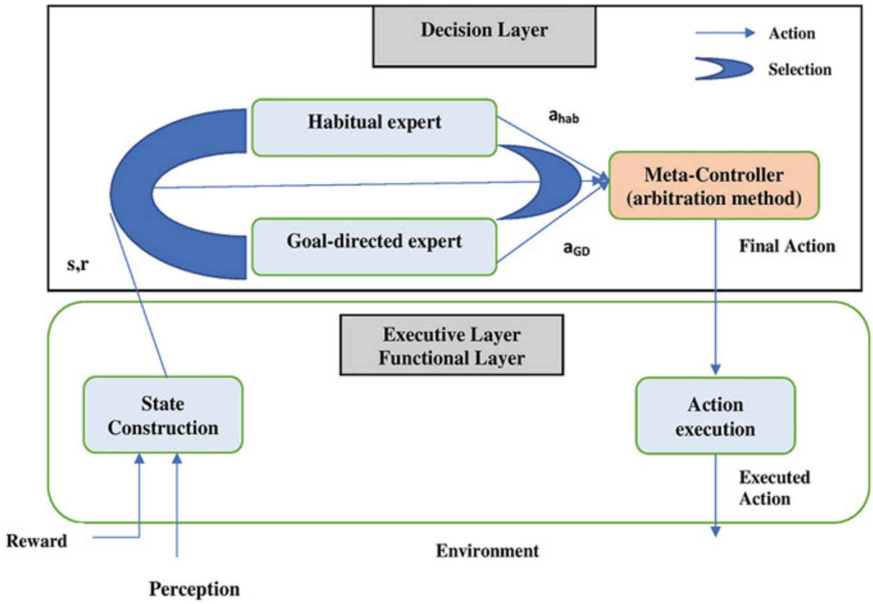

Fig. 14 Architecture of two decision systems implementing corresponding behaviors

specialists (N = 2 for this situation) has a steady and uniform likelihood P(E) of being picked: for this situation, P(E) = 1/N = 0.5. This arbitrary choice was recently used as a proof-of-idea, and it characterizes the base presentation for assessing the interest of each planning approach.

7 Human–Robot Interaction

From vision, humans can rapidly recognize the affordances (i.e. action options) of items and forecast the consequences of afforded actions on those objects. This capacity is acquired through ecological interactions with the environment and is used for action planning and issue resolution. In cognitive and social robotics, where a humanoid robot explores the world and learns probabilistic relationships between actions, objects visual features, and observed effects, endowing robots [18] with similar capacities is a basic difficulty. Several cognitive and social skills are supported by forming inferences across learned dependencies: e.g.

(I) Predicting the effects of an action on an item
(II) Choosing the optimal action to achieve the desired effect, and
(III) Emulating a human's action.

Investigating object-object cooperation permits the robot to foster the idea of hardware (for example a handheld "moderate" object that permits the robot to accomplish an ideal impact on another article) and at last utilize the procured information to design arrangements of activities to accomplish an ideal objective (for example critical thinking); curiously, this computational hardware can likewise be utilized to perform human–robot cooperative errands.

The field of human–robot cooperation has delivered a few significant commitments important to the Robotics people group on the loose for over 10 years. Here are a few experiences with a particular kind of relationship called joint activity, just as the essential degrees of mindfulness. To do such, first, clarify which cycles are engaged with the human–human joint activity, then, at that point, clarify which cycles are engaged with the human–robot joint activity, to contend that negligible degrees of mindfulness is needed for the robot to proficiently incorporate data about its belongings and the impacts of other specialists' activities into doable joint activity plans.

7.1 Human–Human Joint Action

Interfacing specialists should have the option to productively talk about and coordinate their aims, plans, objectives, and activities with different members to set up effective joint activities [19, 20]. To put it another way, it isn't enough for associating specialists to share a comparative target to build up compelling joint activity if every specialist chooses their sub-objectives and essentially forms and executes their singular activity plan. It is important to share a brought together joint activity plan, just as to organize activities and sub-plans among specialists.

7.2 Human–Robot Joint Action

Coordination issues for human–robot joint efforts are similar. The robot should have the option to address both itself and the human with whom it interfaces. It should have the option to reason how every one of these portrayals develops as the consolidated activity unfurls to do as such. To breeze through the Sally and Anne assessment, a robot should have the option to analyze viewpoint-taking capacity, just as the ability to foster a portrayal of other specialists' psychological states concerning environmental factors [21]. Then, at that point, given these psychological states, people's lead is deciphered and clarified. Notwithstanding, the robot should likewise fathom and record the effect of its exercises on the psychological conditions of its accomplices, which requires a second degree of cognizance. This is refined by having the robot play a serious game with an individual and afterwards picking its activities to control the human's psychological state according to the state of the world.

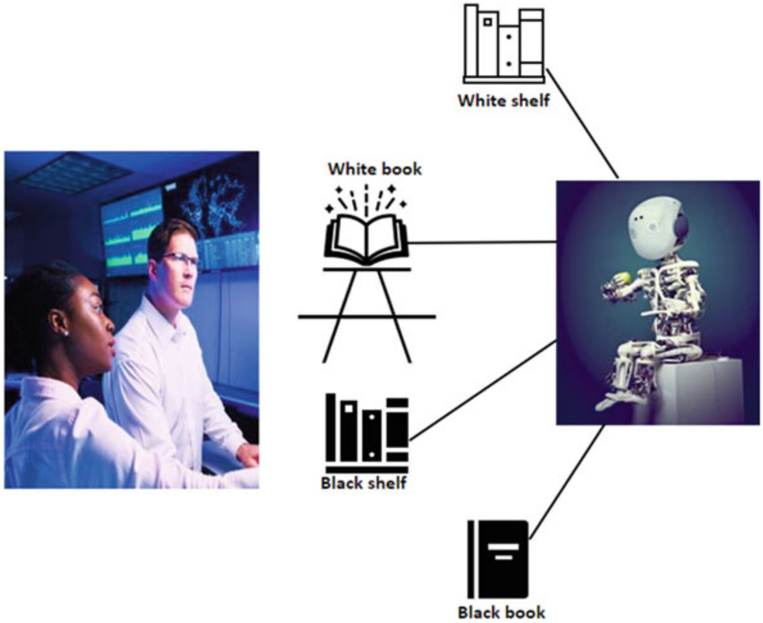

Fig. 15 Explains how a robot and a person work together to clean a table

For example, these tasks are dependent and show the impacts and abilities of each agent's activities, which are essential for cooperative action plans. Again, a person and robot must work together by placing some objects in specific locations, some of which are accessed by humans. The robot should make initialization of various sub-spaces on the table to perceive that a few things or areas are available to people. The robot attempts to survey the human and its reach-ability and reach-capacity to choose the best spots to utilize and exchange products. Likewise, the robot here can gauge the human's work to pick the main areas [22] (see Fig. 15).

8 Self-aware Decision Making

In the field of AI, arranging is commonly considered as the issue of developing a grouping of activities from a predefined set to accomplish an objective set by a client or an outer framework (Jeffrey et al., 2019 for ongoing audits) [23]. Most of the customary arranging depends on First-request Predicate Logic or its expansions. Probabilistic detailing is utilized when there are vulnerabilities in states or activity results, and MDPs/POMDPs are the principal apparatuses.

How can it decide to alter goals on the fly? These questions are crucial because the answers decide whether or not the agent is capable of volition. As a result of addressing them, a system capable of meta-reasoning was created, allowing it to reflect on its goals and how it is achieving them. In other words, the framework explained next is thinking about its inspirations and practices, a trademark we consider applies to mindfulness, to make a framework equipped for accomplishing possibly equal objectives and overseeing assets like energy and time in an unsure unique world.

8.1 Decision System

This architecture is classified into a few modules (Fig. 16):

- **The First module**, which monitors the specialist's objectives as motivations. It's essential for the thought modules. It creates an msv rundown of intentions, which contains all inspirations' present statuses. Therefore, given an MSV, all dynamic

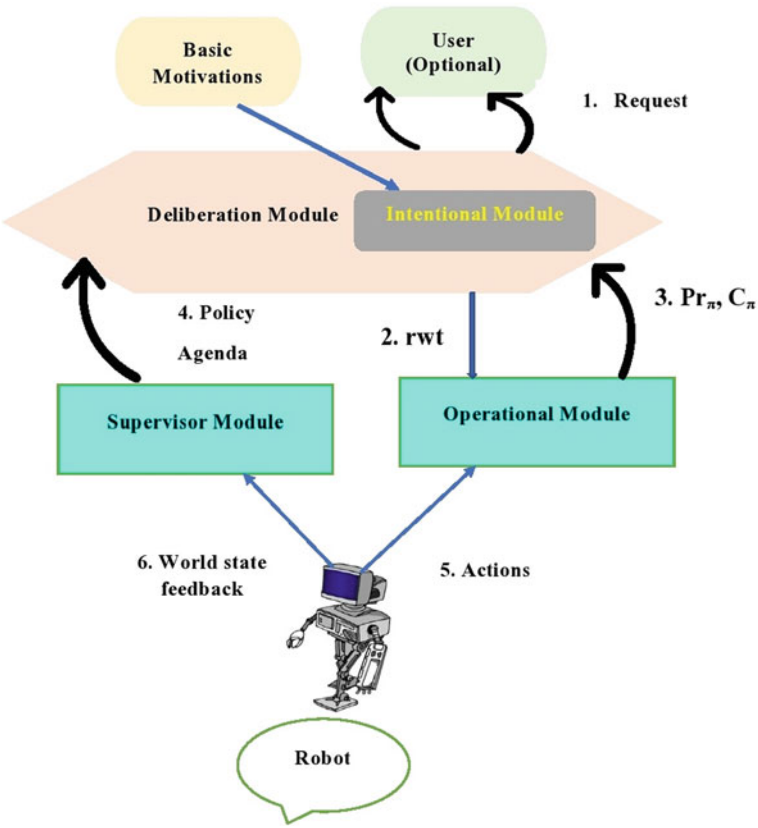

Fig. 16 Decision-making Architecture includes meta-reasoning capability used by the deliberation module

compensated inspiration changes beginning from those current states, known as accessible rmts, are not entirely settled. This module is likewise responsible for keeping intentions up to current as the world's circumstance changes.

- **The Second module**, produces approaches in light of inspiration automata and creates expectations relying upon the strategies created. It's based on top of an MDP.
- **The Third module**, Its motivation is to convey rewarded word advances wrt to the functional module, permitting it to build unsurprising arrangements that will trigger the properly compensated inspiration changes rmt. In this module, these measures show the effect of these approaches on the worldwide state and all motivations. These guidelines are utilized as large-scale activities at a restrictive significant level intend to augment the completion of motivation rewards. The robot isn't simply roused by its longings, nor is it directed by a conventional arranging capacity that chooses a strategy to achieve an objective.

9 Applications

In this section, we provide a brief overview of several common application areas:

I. Cyber-Physical Systems (CPS)
II. Autonomous Robots
III. Space Applications

I. **Cyber-Physical Systems (CPS)**

Cyber-Physical Systems (CPS) are hardware and software systems that are designed to do tasks "in the real world." For all self-demonstrating frameworks and most self-versatile frameworks, this is the authoritative model. For functional adequacy and life span, programming should make up for equipment and ecological issues like debasement, since equipment wears out or goes through at some rate, helpless development or bogus promoting when the framework doesn't act as per its determination models, lastly, "the slings and bolts of silly fortune," because the climate will do whatever it will do, and the framework has practically zero influence over what the climate will do.

II **Autonomous Robots**

These are travel to remote, complicated, hybrid, and sometimes dangerous settings when transmission time is high for direct control. If a system finds a failure in a hardware or software component in these applications, it must change the planning and allocation of resources to avoid utilizing it up to the issue should be fixed. In that sense, losing functioning is simple, but it may adversely affect the mission's success. The system will be able to decide if it is too longer suitable without outside interference due to a series of wise technical decisions [24].

III **Space Applications**

Missions to far-flung areas are one type of space use, in any case, even the more normal and general correspondence and perception satellites work at a distance. It isn't as confounded or dynamic as some, yet it is significantly more brutal and hence more perilous, and it is unreasonably costly to fix anything, so these frameworks should have sufficient assets however long the activity is relied upon to be effective. We accept that extra ability is needed for this application, and we can without much of a stretch guess that the registering frameworks will be sufficiently strong to deal with the entire scope of Wrapping highlights. Besides, because it is gathered with regards to its inside choice cycles, a Wrapping-based framework can give conduct data that is more enlightening than telemetry information. With an equal framework model running on the ground, significantly more data about the condition of the equipment, programming, and outside climate can be assembled, surmised, estimated, and recreated, and better location and reaction models can be registered and transferred, accepting the independent cycles can keep the framework alive long enough. This last limit requires an undeniably more complex idea of "SafeHold" than is regularly trusted for such expensive satellites.

10 Conclusion

Adaptive clustering develops attribute weights for grouping under the constraints of externally set goals. Several clustering algorithms work very effectively on various real-time datasets. Unfortunately, consumers frequently struggle to quantify their thoughts. External feedback is used in adaptive clustering to find better clustering that matches the user goals. In recent years, various clustering approaches change the weights of the attributes which measure distance among the users. Many techniques are needed to access the cluster with quality at a very low level of granularity. It is enough to give prising the overall team in adaptive clustering. In this chapter, the self-aware system is also integrated with adaptive clustering to get better results.

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