Chapter 15
Theories of Intelligence in Philosophy and Psychology

Basic approaches to the simulation of sensual/intellectual cognitive abilities, such as problem solving, pattern recognition, constructing knowledge representations, learning, etc. have been presented in previous parts of the book. IT systems constructed on the basis of these approaches are called *Artificial Intelligence systems*. If one is asked "What is Artificial Intelligence?", we could, therefore, answer that from a computer science point of view Artificial Intelligence is a feature of IT systems constructed on the basis of such approaches. Of course, nobody would be satisfied with such an answer, because such a definition does not explain the heart of the matter. We discuss this issue of Artificial Intelligence in this part of the monograph.

As we will see the notion of *intelligence* is defined in various ways in philosophical and psychological theories, as are related concepts such as *mind*, *cognition*, *knowledge*, etc. It seems that this is a reason for the disputes about the term *artificial intelligence*. Therefore, we present philosophical and psychological interpretations of these basic notions in this chapter.

In the first section we introduce the main philosophical approaches to issues of cognition and mind. This presentation is necessary for discussing various ideas on artificial intelligence in Chap. 17. Various definitions and models of intelligence in psychology are presented in the second section. They will be used primarily for determining a list of cognitive/mental abilities. This list will be used for presenting application areas of AI systems in Chap. 16.

15.1 Mind and Cognition in Epistemology

Issues of mind, cognition, and intelligence are studied in an area of philosophy called *epistemology*. In this section we limit our presentation of views of philosophers only to those which can form a basis for a discussion about Artificial Intelligence.

The distinction between *sense perception* and *mental perception* was introduced by Parmenides of Elea in the fifth century B.C. Plato (427 B.C.–347 B.C.) claimed that before the soul was embodied the intellect perceived perfect ideas in a direct

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way. Such an intuitive direct cognition *via* an insight into the heart of the matter is called *noesis* (*νόησις* [nóesis]). The embodied soul can recall this knowledge (during a perception of the world), which is called *anamnesis* (*ἀνάμνησις* [ánámnesis]).[1] Mathematical knowledge (*διάνοια* [diánoia]) is placed in the knowledge hierarchy at a lower level than noesis. These two types of knowledge are considered to be *justified true belief*, which together is called *episteme* (*ἐπιστήμη* [epistéme]). Contrary to episteme, the physical world is cognized via senses in an uncertain, *doxa*-type way (*δόξα* [doksa]) [228], as a *shadow* of reality (the allegory of the cave).

Contrary to Plato, Aristotle (384 B.C.–322 B.C.) denied that humans have innate ideas.[2] The *intellect (mind)* (*νοῦς* [noús], *intellectus*) is "the part of the soul by which it knows and understands". During the understanding process the intellect operates in the following way. Things are perceived through senses. On the basis of sense experience the intellect forms mental images called *phantasms*. The intellect transforms phantasms into concepts (notions) by *abstracting*. Abstraction is the act of isolating the *universal concepts* (*intelligible species, intelligibles*), which are intellectual abstracts, from the phantasms. The *active intellect* (*νοῦς ποιητικός* [noús poietikós], *intellectus agens*) *illuminates* the phantasm, and in this way the universal concept created from the phantasm is grasped by the *potential intellect* (*νοῦς παθητικός* [noús pathetikós], *intellectus in potentia*) [9].

Concepts create a hierarchy. A concept of a species is defined by giving its nearest genus (*genus proximus*) and its specific difference (*differentia specifica*), which distinguishes members of this species from other members of this nearest genus. In this way concepts create a hierarchy, which can be represented by a concept tree.[3] Linguistic representations of concepts, i.e., *terms* can be joined to form *propositions*. A proposition is a statement which is either true or false. Propositions can also create a kind of hierarchy, which is based on the relation *premise–conclusion*. An inference from a more general premise to a less general premise is of a *deductive* nature and is consistent with the logical order. Aristotle developed the theory of *syllogism* that involves deductive reasoning in which the conclusion is inferred from two premises. However, in the psychological order of cognizing reality a general proposition is derived from specific observations. Such reasoning is called *induction* [10].

St. Thomas Aquinas (1225–1274) reinterpreted and developed Aristotelian epistemology [285]. There are two great powers of the *mind* (*mens*): the *intellect* (*intellectus*), which is a cognitive power, and the *will* (*voluntas*), which is an appetitive[4] power. There are *three generic operations (acts) of the intellect* (*tres operationes rationis*). The *simple apprehension* of what something is (*indivisibilium intelligentia*), which consists of comprehending a concept by abstracting, is the first act. *Pronouncing a judgment* (*componere et dividere*), which consists of stating a proposition that is affirmed or denied, is the second operation. The third act, called *reasoning*

[1] Let us recall that the view that certain abilities are inborn is called *nativism*.

[2] Let us recall that such a view is called *genetic empiricism*.

[3] We have introduced such concept trees in the form of *semantic networks* representing *ontologies* in Sect. 7.1.

[4] Aquinas defines *appetite* as "all forms of internal inclination".

(*ratiocinare*), consists of proceeding from one proposition to another according to logical rules (principles). Thus, *reason* (*ratio*), in the sense of the abstract noun, can be defined as the reasoning function of an intellect or cognizing by discursive reasoning.

St. Thomas Aquinas distinguished, after Aristotle, the *practical mind* (*intellectus practicus*), which is used by the human being for planning, defining strategies for activities, decision making, etc. from the *theoretical mind* (*intellectus speculativus*), which allows the human being to understand and contemplate. A distinction can also be made between *dispositional intellect* (*intellectus in habitu*), which has basic universal concepts and is prepared for intellection and *actualized (achieved) intellect* (*intellectus adeptus*), which has already achieved knowledge.[5] St. Thomas Aquinas defined *intelligence* (*intelligentia*) as "*the act itself of intellect, which is understanding*"[6] [285]. In other words, intelligence means a cognitive act, which is performed by achieved intellect.

Mental perception characterized in such a way is preceded by sense perception. St. Thomas Aquinas distinguished *external senses* from *internal senses*. The external sensorium includes sight, hearing, taste, smell, and touch. There are four internal senses. *Common sense* (*sensus communis*) perceives objects of the external senses and synthesizes them into a coherent representation. *Imagination* (*imaginatio*, *phantasia*) produces a mental image of something in its absence. *Memory* (*vis memorativa*) stores perceptions which have been cognized and evaluated with respect to the interests of the perceiver. Such perceptions are called *intentions* by St. Thomas Aquinas. They can be called to mind at will. An evaluation of a perception with respect to the interests of the perceiver, i.e., whether it is beneficial (useful) or harmful, is performed by the *cogitative power*, called also *particular reason* (*vis cogitativa*, *ratio particularis*). Cogitative power thus enables human beings to react to stimuli in an adequate way, which is a necessary condition of proper behavior in the environment.[7]

William of Ockham, Occam (1288–1348) is known for the *principle of parsimony* (*lex parsimoniae*), also called *Ockham's Razor*. It states that "entities should not be multiplied beyond necessity" (*Entia non sunt multiplicanda sine necessitate*), which means that if two theories can be used to draw the same conclusions, then the simpler theory is better. According to Ockham incorrect reasoning often results from an incorrect, from a logical point of view, use of the language. Thus, logical analysis is more important than speculative discourse [213]. Therefore, he sometimes is considered a forerunner of *analytic philosophy*.

René Descartes (1596–1650) addressed the problem of the relationship between mind and matter, called the *mind-body problem*, which is one of the key issues discussed in the area of Artificial Intelligence. He claimed there is a rigid distinction

[5] This distinction was adopted by European scholastic philosophy from Islamic philosophy. Ibn Sina, Avicenna (980–1037) already used both concepts: *intellectus in habitu* (*al-'aql bi-l-malakah*) and *intellectus adeptus* (*al-'aql al-mustafâd*). Then, these concepts were adopted and reinterpreted by scholastics (St. Albertus Magnus, St. Thomas Aquinas).

[6] Adding also that sometimes "*the separate substances that we call angels are called intelligences*".

[7] An evaluation of a perception w.r.t. the interests of a perceiver is performed by animals by natural instinct. In the case of animals we talk about *(natural) estimative power* (*vis aestimativa*).

between *mind* (*res cogitans*), which is a nonmaterial substance, and *matter* (*res extensa*). Knowledge is certain, if it is clear and distinct (*clair et distinct*) [69]. Mathematical knowledge is clear and distinct. Therefore, knowledge systems should be constructed in the same way as in mathematics. Genuine knowledge is acquired by reason with the help of *innate ideas* (*ideae innatae*) and is independent of sensory experience.[8]

Thomas Hobbes (1588–1679) denied the existence of any nonmaterial substance (*materialistic monism*) [138]. According to him, a human being is a complex machine. Hobbes resolved the Cartesian mind-body problem by claiming that consciousness can be reduced to a bodily activity. Cognitive operations are of a mechanical nature, i.e., sensory experience consists of a mechanical effect on a body. *Reasoning* is a form of *computation*, i.e., it is a manipulation of symbols.

Baruch Spinoza (1632–1677) proposed another solution to the mind-body problem [284]. He defined body and mind as two aspects, attributes (*attributa*) of one universal substance (*neutral monism*). Although there is no causal interaction between mental and material phenomena, they occur in parallel, i.e., they are *programmed* in such a way that if some mental event takes place, then a *parallel* material event occurs (*psychophysical parallelism*).

As a consequence of his theory of monads, Gottfried Wilhelm Leibniz (1646–1716) claimed that all knowledge is acquired independently of any experience (*radical apriorism*) [176]. According to him, every valid proposition is an analytical proposition. So, every valid proposition can be proved. Therefore, Leibniz carried out research into defining a *universal symbolic language* (*ars characteristica, scientia generalis*), in which all valid sentences would be decidable mechanically.[9]

Contrary to the views of Descartes and Leibniz, John Locke (1632–1704) maintained that knowledge is obtained by *sensory experience* only[10] [185]. An experience can concern the external world influencing our (external) senses, and then he talks about *sensation*. It can also concern our mind, i.e., it can relate to awareness of our own intellectual activity, which is called *reflection* (inner sense) by Locke. Sensation is less certain than reflection, however the former precedes the latter. In fact, Locke pointed out an important knowledge source, which is *introspection*.

David Hume (1711–1776) defined two kinds of knowledge: *relations among ideas* and *matters of fact*. The first kind, which includes mathematics and other abstract models, is certain, however uninformative. The second kind, which concerns propositions about the nature of existing objects, so interesting for us, is not certain, unfortunately [144]. Hume was sceptical about our ability to acquire knowledge by reason. He claimed that interesting knowledge about the external world is acquired by inductive inference, which is based on our natural instinct.

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[8] Let us recall that such a view is called *methodological rationalism (apriorism)*.

[9] If Leibniz had succeeded, then philosophers, instead of disputing, would formulate their opinions with the help of *ars characteristica* and then *compute* a solution. It seems to the author that it is better that Leibniz never completed his research.

[10] Let us recall that such a view is called *methodological empiricism*.

Immanuel Kant (1724–1804) tried to bring together both empiricist and rationalist views concerning cognition. He claimed that cognition is based on both experience and a priori ideas, since *"Thoughts without content are empty, intuitions without concepts are blind."* [154]. He distinguished the following three kinds of propositions. An *analytic proposition* a priori expresses only what is contained in the concept of its subject. Thus, such propositions are used to explain knowledge already existing in our mind, since either it is contained in the definition of the subject or it can be derived from this definition. Such propositions are independent from experience and they are present in our minds (a priori).

The two remaining kinds of propositions, called synthetic propositions, expand our knowledge, because they add new attributes to their subjects. A *synthetic proposition a posteriori* is formulated on the basis of experience gained.[11] A *synthetic proposition* a priori expands our knowledge and is certain. Empiricists denied that there are such propositions. However, Kant claimed that such propositions exist.[12] In order to explain how synthetic propositions a priori are created in our mind, he developed *transcendental philosophy*.[13] According to this philosophy, *sensations* (*Empfindung*) perceived by the senses are combined with the help of a priori *pure forms of sensuous intuition* (*Anschauung*), i.e., space and time, into their mental representations (*Vorstellung*). Then, *intellect* (understanding faculty) (*Verstand*), using a priori categories of the understanding,[14] combines these representations into *concepts*. Finally, *judgment faculty* formulates propositions with the help of a priori rules.

John Stuart Mill (1806–1873) considered inductive reasoning to be more important for knowledge acquisition than deductive reasoning. General principles should be known in order to use deduction. As an empiricist, Mill claimed that experience is a source of knowledge. However, experience concerns a single event. Thus, one should use inductive reasoning in order to formulate general principles. Mill developed schemes of inductive reasoning which are helpful for defining causal relationships, called *Mill canons of induction* [202].

Franz Brentano (1838–1917) claimed that *experience* is the only source of knowledge, however, experience in the form of an *internal perception (introspection)*. He reintroduced, after scholastic philosophy, the concept of *intentionality*, which is a property of a mental act meaning directing at a certain (intentional) object (from Latin *intendere*—to direct toward something) [38]. Due to intentionality, which is a property of human minds, we can distinguish mental phenomena from physical phenomena.

To Edmund Husserl (1859–1938), a founder of *phenomenology*, *intuition* was the basic source of knowledge [145]. Intuition is a condition of both deduction and

[11] Empirical propositions in physics, chemistry, biology, etc. are synthetic propositions *a posteriori*. However, from the point of view of logic these propositions are uncertain.

[12] Kant considered mathematical propositions (e.g., theorems) to be synthetic propositions a priori.

[13] *Transcendental* means here transcending experience.

[14] Kant defined twelve such categories.

induction, since it provides these two types of reasoning with premises. Deduction and induction can be used only for indirectly deriving the truth.

Within *analytic philosophy* Ludwig Wittgenstein (1889–1951) and his colleagues forming the *Vienna Circle*[15] tried to define a formalized language that could be precise and unambiguous enough to become a language for a *unified science* (*Einheitswissenschaft*).[16] The possibility of empirically determining the *true* meaning of linguistic expressions was the basic assumption of this research. In his later works Wittgenstein claimed that the separation of the meaning of expressions from their *usage* in *live* language is impossible and notions can be meaningful, even if they are not defined precisely [316]. This results from the fact that the (natural) language used by us is a set of *language-games* (*Sprachspielen*),[17] which proceed according to specific rules and logic.

Although Kurt Gödel (1906–1978) was a logician and mathematician rather than a philosopher, his work considerably influenced epistemology. In 1931 he published his first *limitation (incompleteness) theorem* [110]. It says that if a formal system including the arithmetic of natural numbers is consistent,[18] then it is incomplete.[19] Intuitively speaking, Gödel showed that in non-trivial formal theories there exist true sentences that cannot be proved in these theories.

15.2 Models of Intelligence in Psychology

As we have seen in a previous section, there are various views concerning the nature of cognition and mind in philosophy. Where the concept of intelligence is concerned, we meet a similar situation in psychology.[20] For the purpose of our considerations about artificial intelligence, we propose a definition which is a synthesis of the scopes of definitions known from the literature. Thus, (human) *intelligence* can be defined as a set of abilities that allow one:

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[15] The *Vienna Circle* was an influential group of philosophers, mathematicians, and physicists founded in 1920s. Its best-known members were, among others Kurt Gödel, Rudolph Carnap, Moritz Schlick, and Otto Neurath.

[16] The issue of such a language had already been of great importance for William of Ockham and Gottfried Wilhelm Leibniz mentioned above.

[17] A *language-game* consists of a sequence of expressions and actions in a certain context. For example, the dialogue of a man and a woman in case he wants to pick her up or the conversation of a professor and a student during an exam at a university. Thus, our life can be treated as a sequence of language-games. Each language-game is characterized by its specific grammar, just as each game is characterized by its specific rules.

[18] A formal system is consistent if it does not contain a contradiction.

[19] A formal system is complete if for any sentence belonging to the system either the sentence or its negation is provable in this system.

[20] In this section we describe selected psychological models of intelligence. A selection is made with respect to further discussion of the concept of *artificial intelligence*. Studies of intelligence in psychology can be found e.g., in [108, 290, 291].

- to adapt oneself to a changing environment, and
- to perform cognitive activity, which consists of creating and operating abstract structures.

In the definition we have deliberately not listed such abilities, because, as we see further on, there are differences among various psychological models with respect to this aspect. We will try to identify such abilities within each succeeding model discussed below.

The second constituent of our definition has been formulated, since here we do not want to ascribe intelligence to all biological organisms which possess adaptation mechanisms. The expression *abstract structure* corresponds, in principle, to the psychological terms *abstract concept*, *mental representation*, and *cognitive structure* (in cognitive psychology). However, we assume that abstract structures do not necessarily need to be created in order to represent knowledge about an environment, since we do not want to exclude abstract constructs defined e.g., in logic and mathematics from our considerations.

There are two basic types of models of intelligence in psychology. In *hierarchical models* mental abilities are layered and create a hierarchical structure. By contrast, in *multiple aptitude models* mental abilities are treated as a set of equivalent and independent factors. Firstly, we discuss models which belong to the first approach.

The *two-factor theory of intelligence* introduced by Charles E. Spearman[21] in 1923 [282] is a generic theory for hierarchical models. In the theory one general factor g, which corresponds to *general intelligence*, and several specific factors $s_1, s_2, \ldots, s_n$, representing mental abilities that are used for solving various types of problems, are distinguished.

General intelligence (*g factor*) was characterized by Spearman with the help of three *noegenetic principles*[22] [142]. The principle of *apprehension of experience* says that the apprehension of the meaning of a received perception is the first operation of general intelligence. Basic elements which describe a problem, called *fundaments*, are created due to this operation. During the second operation, according to the principle of *eduction of relations*,[23] relations between fundaments are discovered. According to the principle of *eduction of correlates*, the third operation consists of discovering, via reasoning, further relations on the basis of the relations identified during the second operation. These further relations are not discerned directly *via* the eduction of correlates [142].

Let us notice that the operations defined by noegenetic principles can be interpreted as comprehending concepts, pronouncing judgments,[24] and reasoning (in the sense of proceeding from one proposition to another). Thus, they are analogous to

[21] Charles Edward Spearman—a professor of psychology at University College London. He is also known for his contribution to statistics (Spearman's rank correlation).

[22] Spearman used the term *noegenetic* with reference to the Platonian notion *noesis*, which was introduced in the previous section. Let us recall that *noesis* means intuitive direct cognition via an insight into the heart of the matter [142].

[23] Here, *eduction* means discovering something, from Latin: *educere*.

[24] In this case, pronouncing judgments by defining relations.

the three generic acts of the intellect (*tres operationes rationis*) defined by Aquinas, which have been presented in a previous section. According to Alfred Binet[25] pronouncing judgments is the fundamental operation [26]. We will come back to this opinion in the last chapter, in which the *issue of artificial intelligence* is discussed.

In principle, designers of AI systems do not try to simulate general intelligence.[26] Instead, methods which simulate specific mental abilities of a human being are developed. Later, we make a short survey of psychological models of intelligence which identify specific mental abilities. A discussion of a simulation of these abilities in AI systems is contained in the next chapter.

In 1997 Linda S. Gottfredson[27] performed an analysis of the mental abilities which are tested during a personnel selection process [114]. These abilities correspond to research subareas in Artificial Intelligence. The following mental skills were identified as important: *problem solving*, *reasoning decision making*, *planning*, *(verbal) linguistic abilities*, and *learning ability*.

Half a century before the research of Gottfredson, Louis L. Thurstone[28] identified a model of *primary mental abilities* [303]. This model belongs to the multiple aptitude approach. For our further considerations we choose *perception* (treated as effective pattern recognition) from the set of these abilities. Such factors as number facility, spatial visualization, and memorizing (associative memory) are implemented in *standard* IT systems. Reasoning and linguistic abilities have been identified already on the basis of the Gottfredson model. It is worth pointing out that Thurstone influenced the area of pattern recognition remarkably, mainly due to his statistical model in signal detection theory [302]. In the 1930s he identified such crucial issues of modern pattern recognition as recognition of animated patterns and 3D pattern recognition performed on the basis of various views perceived by a moving observer.

In 1947 Jean Piaget[29] identified *kinesthetic intelligence* during research into stages of a child's mental development [226]. It is related to both locomotion and manipulation abilities and their development takes place from birth to two years (the sensorimotor stage). Piaget distinguished two kinds of manipulation: *unspecific manipulation*, which is not adequate to the specificity of an object, and *specific manipulation*,[30] which involves *tuning* of movements to an object's specificity.

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[25] Alfred Binet—a professor of psychology at the Sorbonne, a director of the Laboratory of Experimental Psychology at the Sorbonne (1891–1894). He is known as the inventor of the first intelligence test (the IQ test).

[26] Apart from designers of *generic* cognitive architectures.

[27] Linda Susanne Gottfredson—a professor of educational psychology at the University of Delaware and a sociologist. She is known for the public statement *Mainstream Science of Intelligence* signed by 51 researchers, in which she claims that mental skills are different for various races (statistically).

[28] Louis Leon Thurstone—a professor of psychology at the University of Chicago and a mechanical engineer (master's in mechanical engineering from Cornell University). One of the fathers of psychometrics and psychophysics. He was the President of the American Psychological Association.

[29] A note on Jean Piaget has been included in the previous chapter, in which we have discussed notions of *assimilation* and *accommodation* and their influence on the concept of *agent*.

[30] Specific manipulation develops from 8 months.

In psychology *specific* types of intelligence are also considered. In 1920 Edward L. Thorndike[31] distinguished *social intelligence* [300]. This kind of intelligence can be defined as a set of abilities which allow one to establish interpersonal relations, to achieve social adjustment, and to influence people. These abilities can be divided into *social awareness* (e.g., the ability to interpret people's behavior) and *social facility* (e.g., the ability to generate behavior, which informs others about our internal state) [112].

Emotional intelligence is related to social intelligence. It is defined as a set of abilities which allow one to perceive others' emotions, to control ones own emotions and to use emotions in mental processes and during problem solving.

Recently research into implementing AI systems which simulate *human creativity*, such as, e.g., musical creativity or visual creativity, has been carried out as well. Such systems try to simulate *creative abilities* in order to develop original ideas, visual art, or solutions (e.g., in architecture). *Structure of Intellect theory* introduced by Joy P. Guilford[32] in 1967 [116] is one of the most important psychological models relating to creativity. The following intellectual processes are defined in this model[33]: cognition, memory operations, convergent production, divergent production, and evaluation of information. Whereas a *convergent production* consists of deriving a single valid solution for a given standard problem (i.e., *problem solving* in the sense used in AI), during a *divergent production* one draws original ideas via *creative* generation of multiple possible solutions. The quality of a divergent production can be assessed on the basis of such criteria as the number of ideas generated, the variety of approaches used for solving a problem, and the originality of the ideas.

In cognitive psychology *mental (cognitive) processes* are studied to model intelligence. This approach is interesting with respect to research into AI systems, since a *process*, interpreted as a transformation of certain information structures into other ones, is a fundamental concept of computer science. The interpretation of a mental process in psychology is analogous to the one used in computer science. A mental process is used for creating and transforming a cognitive structure, which is a mental representation of a certain aspect of an external reality. In particular, cognitive structures can represent our *knowledge*.[34] Thus, in Artificial Intelligence they correspond to *models of knowledge representation*, which will be discussed in the next chapter.

Mental processes can be divided into several basic categories, e.g., perception processes, attention processes, memory processes, and thinking processes. Apart

[31] A note on Edward L. Thorndike, a pioneer of the connectionist approach, has been included in Sect. 3.1.

[32] Joy Paul Guilford—a professor of psychology at the University of Southern California. His work mainly concerns the psychometric study of intelligence. He has carried out research for developing classification testing for the U.S. Air Force. He was the President of the Psychometric Society.

[33] Guilford's model is three-dimensional. Apart from the process dimension it contains a content dimension (types of information which are used by processes) and a product dimension (results of applying processes to specific contents). Later, Guilford extended his model, cf. Guilford J.P.: Some changes in the structure of intellect model. *Educational and Psychological Measurement 48* (1988), 1–4.

[34] In cognitive psychology, the concept of knowledge is related to the content of long-term memory.

from these categories, so-called *metacognitive factors* which are responsible for planning, supervising, and controlling mental processes are distinguished[35] in cognitive psychology. The *triarchic theory of intelligence* introduced by Robert J. Sternberg[36] in 1980 [289] is one of the best-known models based on mental (cognitive) processes.

Summing up, on the basis of a survey of important psychological theories we have identified specific mental/cognitive abilities which can be simulated in AI systems. They include perception and pattern recognition, knowledge representation, problem solving, reasoning, decision making, planning, natural language processing, learning, manipulation and locomotion, social/emotional intelligence and creativity. The issue of simulating these abilities is discussed in the next chapter.

Bibliographical Note

A good introduction to philosophy and the history of philosophy can be found in [59, 155, 255]. Epistemological issues are discussed in [33, 143, 178].

Theories of intelligence in psychology are presented in [31, 108, 290, 291].

[35] If controlling is performed with feedback, then we deal with learning.

[36] Robert Jeffrey Sternberg—a professor of psychology at Yale University, Tufts University, and Oklahoma State University, a Ph.D. student of Gordon H. Bower at Stanford University. He was the President of the American Psychological Association. Sternberg is also known for the *triangular theory of love*.