Chapter 1
Introduction

The highest activity a human being can attain is learning for understanding, because to understand is to be free.

— Baruch Spinoza

You cannot solve a problem on the same level that it was created. You have to rise above it to the next level.

— Albert Einstein

Humans have accomplished countless amazing things in our short history. We walked on the moon, created electronic devices, mastered flight, etc. With less than seventy thousand years, humankind has evolved from an insignificant animal in a corner of Africa to a species that stands on the verge of becoming a god, with the divine ability of creation. Many people have tried to use various theories and hypotheses explaining why we are the most intelligent species on the Earth. We have the sophisticated brain, nerve system, gossiping capability, language, etc.

But is it? The much less intelligent coronavirus can cause global pandemic, claiming more than 6 million intelligent human lives (as of May 2022). Ironically, the structure of most viruses is actually quite simple, nothing more than nucleic acid (DNA or RNA) wrapped around a protein subunit called a "capsid". The virus has no brain, no nerve system, even no blood, and even no complete cellular structure!

One may wonder who is more intelligent in this fighting, the coronavirus or humans? Of cause, we can design an effective vaccine to fight against the virus. However, the fact is that humans have already suffered great losses in the first round, and the virus is very likely to mutate and comeback again in the future.humans lose ground in the first round. Moreover, it is highly possible that the virus will comeback in the future.

Therefore, in this battle, who is more intelligent, the coronavirus or our humans? This is still a debatable question.

Looking back at the human history, we have seen that many large-scaled disasters were caused by viruses. The Black Death in the thirteenth century killed one-third of Europe's population, the Spanish flu in 1918 killed over 50 million people, and even today in the twenty first century, humans are still suffering from Ebola virus in

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2014 as well as the novel coronavirus which is still highly spreading now. Many lessons have been taught that the power of the virus cannot be underestimated. Viruses, the "lowest" life forms, have existed on earth for more than 4 billion years. By comparison, the short history of mankind, about 70,000 years, is but a drop in the ocean.

We may think, as a living thing, we are at least more intelligent than non-living thing. However, while human teleportation currently exists only in science fiction, teleportation is possible in tiny subatomic particles. Quantum teleportation allows two parties that are far apart to exchange information among them even in the absence of communication channel between them. Much more intelligent than humans!

One may argue that the capabilities of virus and quantum particles should not be called intelligence. Indeed, humans have been the primary focus of studying intelligence, e.g., in cognitive science and physiology of humankind. But recent studies show non-human animals and plants, even non-living things, exhibit intelligence.

What is intelligence? Although it is a concept that seems to have a concrete meaning in our daily lives, an abstract and quantifiable notion of intelligence is difficult to define. The word intelligence derives from the Latin nouns intelligentia or intellēctus, which in turn stems from the verb intelligere, to comprehend or perceive. The definition of intelligence is controversial, varying in what its abilities are and whether or not it is quantifiable.

The quest for intelligence has been around since as early as humankind coming to exist. Recently, the interest in intelligence has attracted heated attentions with the recent progress in artificial intelligence (AI).

Some people are excited to see that it is possible to create machines with human-like intelligence, helping us solve problems, such as autonomous driving, climate change and protein structure. For example, Google's Ray Kurtzweil envisions the Singularity, in which AI empowered by its ability to improve itself and learn on its own, will reach and then exceed human-level intelligence by 2040s [1].

On the other hand, some people are terrified by the progress and the advances of AI. For example, Elon Musk, founder of the Tesla and SpaceX companies, said that AI is probably "our biggest existential threat" and believes that "with AI we are summoning the demon."

Some prominent thinkers were pushing back, saying any reports of near-term superhuman AI are greatly exaggerated. Rodney Brooks, the former director of Massachusetts Institute of Technology (MIT)'s AI Lab, said that "we grossly overestimate the capabilities of machines—those of today and of the next few decades." Gary Marcus, a psychologist and AI researcher, stated that "general human-level AI has been almost no progress."

In studying human intelligence, it is usually related to the capacity for understanding, learning, reasoning, planning, creativity, critical thinking, and problem-solving.

Animal intelligence has also been studied in terms of problem solving, as well as numerical and verbal reasoning capabilities. In most cases, animal intelligence is often mistaken as biological instincts, or is determined entirely by genetics.

However, this is not always the case. Researchers have made a lot of observations and experiments to study animal intelligence.

For example, in an experiment, a banana was hanged on the top of the chimpanzee's cage, and a wooden box was put in the cage. After trying his best to catch the banana, the chimpanzee found the wooden box. After observation, he chose to put the wooden box under the banana, climbed up on the box, jumped vigorously from the box, and finally got the banana.

Plants are intelligent as well. We may naturally regard the plants as passively living things, but researchers have found that plants are not only capable of distinguish between positive and negative experiences and of learning from their past experiences, but also capable of communicating, accurately computing their circumstances, using sophisticated cost–benefit analysis and taking tightly controlled actions.

For instance, scientists have done research on semen cuscutae, a parasitic plant that does not perform photosynthesis. Scientists transplanted some semen cuscutae to some hawthorn trees with different nutritional status and found that semen cuscutae would choose to wrap around hawthorn trees with better nutritional status.

With hundreds of different definitions from psychology, philosophy, and artificial intelligence researchers, the definitions of artificial intelligence are as many as the experts trying to define it, said by Robert J. Sternberg. In general, the essence of intelligence in its general form can be referred as "an agent's ability to achieve goals in a wide range of environments" or "an agent's ability to actively reshape their existence in order to survive" [2].

In this sense, intelligence lies in not only living things, such as virus, but also non-living things, such as quantum particles. Nevertheless, it seems that, in common understanding, humans are more intelligent than non-humans, plants, and non-living things.

If you believe in Darwin's theory of evolution, you may naturally think that intelligence arises and develops through the natural selection. However, natural selection only explains *how* biological systems arise; it is difficult for natural selection to explain *what* characteristics they must possess, e.g., the active, such as the biological motivation, the end-directed purpose, the striving of living things (the "fecundity principle") and the increases in complexity in the absence of natural selection. Moreover, it cannot address the fact of planetary evolution, a special case of the problem of the population of one. Therefore, it is difficult to just simply use evolution to explain intelligence.

The Dutch philosopher Baruch de Spinoza once said, "The highest activity a human being can attain is learning for understanding, because to understand is to be free." This book originated from my research and exploration in order to understand intelligence.

I believe that intelligence is a natural phenomenon, las natural as rolling of rocks and the melting of snow and ice. Intelligence, like many other phenomena, can be studied by establishing simplified models. If intelligence is a natural phenomenon, can we answer the following questions?

- How did intelligence begin?
- Why has intelligence been evolving, from non-living things, plants, non-humans, to humans?
- Can we build machines that are more intelligent than humans?
- How to measure intelligence?
- Can we understand different forms of intelligence as completely, rigorously, simply as possible?

"You cannot solve a problem on the same level that it was created. You have to rise above it to the next level," said Einstein. We should not focus only on humans for studying intelligence. Instead, different things in the universe should be considered, and intelligence should be studied at a higher level.

If we study intelligence at a higher level, one possible hypothesis is that the natural phenomenon of intelligence, similar to other natural phenomena (e.g., rock rolling and ice melting), is *to make the universe more stable*.

I understand that the above point of view is rather dangerous, because it may offend the collective self-esteem of mankind, and knock us further off our pedestal of centrality in the universe. However, in our past history, Earth was dislodged from the center of the universe by the Copernican Revolution, and humans were yanked from the pinnacle of living things by the Darwinian Revolution. Therefore, it might not be so shocking for us to learn that human intelligence, which we all proud of, is actually similar to rock rolling.

Let me briefly explain this idea here. After the universe flashed into existence, the components in the universe are not unevenly distributed, resulting in a difference over a distance (e.g., in energy, mass, temperature, information, etc.). This difference is called *gradient*. Due to the gradient, the universe is not stable, and everything in the universe has never since been still. As stated by ecologist Eric Schneider, "nature abhors a gradient." Therefore, each component in the universe is contributing to relieving the imbalance through its own manner to the make the universe more stable. In addition, the stabilizing process of each component occurs in a distributed manner, not in a centralized one. Some simple examples include rock rolling and ice melting in our daily lives. Other sophisticated examples include living things evolution, collective intelligence, social networks, metaverse, etc.

This hypothesis can explain that all the things in the universe, including rocks, plants, animals, and humans, all have one thing in common: they contribute to the process of stabilizing the universe, and intelligence appears naturally in the process. Then, why do we have different things in the universe? In different environments, there are different constraints that limit the capability of stabilizing the universe.

Each thing (e.g., a particle, rock, person, company, or society) performs its most efficient way under the constraints to relieve the imbalance, and consequently stabilizing the universe. From this perspective, the main differences among the major categories of different things in the universe are as follows.

- Matter: Relieving the imbalance of energy to make the universe more stable.
- Non-human living things: Relieving the imbalance of energy, matter, and limited information to make the universe more stable.

- Humans: Relieving the imbalance of energy, matter, and more information to make the universe more stable.

The stabilizing process involves in a series of "phase transitions," rather than a single step. A phase transition is a holistic change in the overall arrangement of a system's structure, and consequently, its function. The timeline of different things' appearance in the universe indicates that new comers have more complex arrangements, and can contribute to the stability of the universe in more dimensions with more efficiency, compared to older things in the universe. We explain these points in the rest of this book.

Reference

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2. S. Legg, M. Hutter, A collection of definitions of intelligence, in *Advances in Artificial General Intelligence: Concepts, Architectures and Algorithms*. Frontiers in Artificial Intelligence and Applications, vol 157 (IOS Press, Amsterdam, 2007), pp. 17–24