# Three essays for the fundamental understanding of Artificial Intelligence

by Murat Durmus

(CEO AISOMA AG | https://www.aisoma.de/)

Contact:

Murat Durmus
(CEO AISOMA AG)
Thurn-und-Taxis Platz 6
60313 Frankfurt am Main
murat.durmus@aisoma.de

# Table of contents

**Artificial Intelligence: Definition and Differentiation** ..... 3

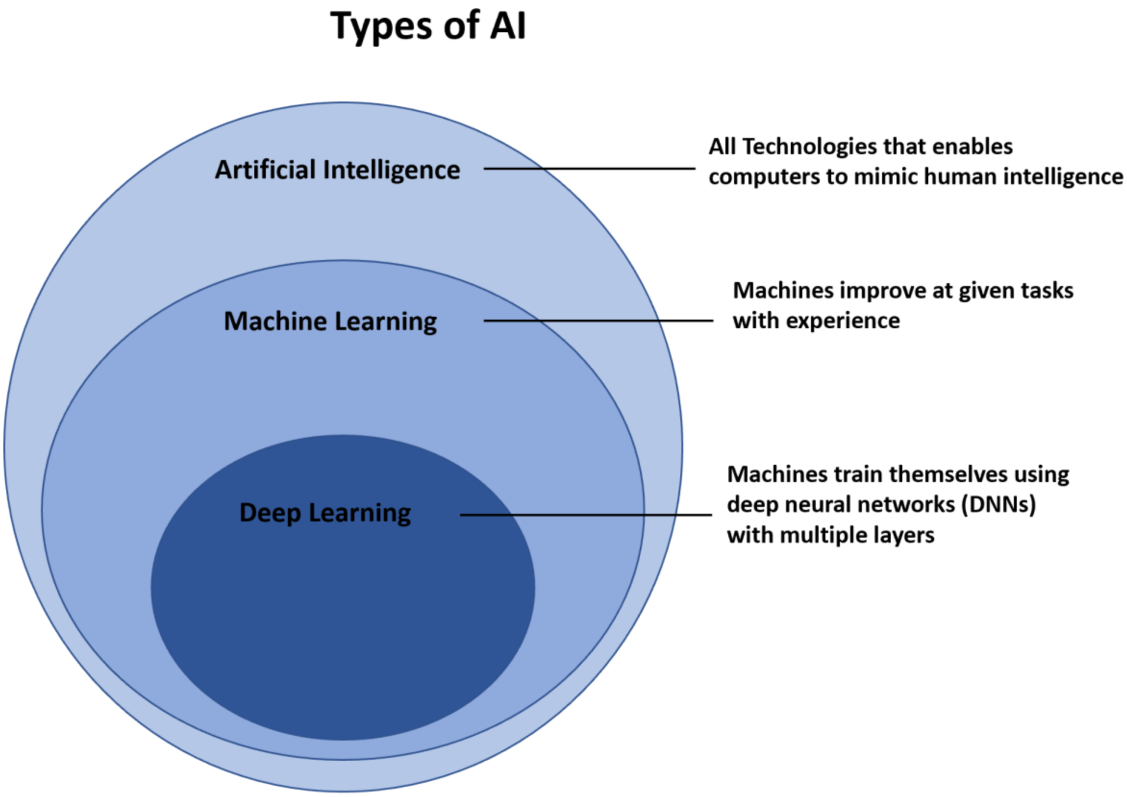
**5 Variation of Artificial Intelligence** ..... 5

**Duplication vs. Simulation** ..... 8

## Artificial Intelligence: Definition and Differentiation

The development of Artificial Intelligence can be seen as the latest wave of automation since industrialization. While in the late 19th and early 20th centuries the focus of automation was mainly on the substitution of physical human work by machines, artificial intelligence is the attempt to recreate human-like structures of perception and decision making, i.e. to enable machines to perform specific (cognitive) tasks as well as, or even better than, a human being. A clear definition of the term "artificial intelligence" does not exist until today. To distinguish between other technologies, artificial intelligence can be defined as follows:

*"The designing and building of intelligent agents that receive percepts from the environment and take actions that affect that environment."(*Russell and Norvig 1995*)*




A distinction is made between a strong and weak AI. Weak artificial intelligence (AI) aims to solve concrete, clearly defined application problems. This is done based on mathematical methods (algorithms) that are specially developed and optimized for the individual requirement. Weak AI is designed to support people in a specific activity.

These are rule-based systems that are primarily designed to perform clearly defined tasks without gaining a deeper understanding of problem-solving. This form of AI is already used in many areas, such as character and image recognition, individual control of advertising, knowledge-based expert systems, or navigation systems.

In contrast to this, a strong artificial intelligence (also known as super intelligence or strong AI or AGI Artificial General Intelligence) is characterized by the fact that it possesses the same intellectual skills as humans or even surpasses them. A strong AI no longer acts only reactively, but also intelligently and flexible on its initiative. Artificial intelligence should be enabled to generalize and abstract in addition to other cognitive abilities. To date, it has not yet been possible to develop such a strong AI. It is also not clear whether this will ever be possible to achieve this goal.

The oldest widely used artificial intelligence definition is the so-called Turing test. According to this test, artificial intelligence can be attributed to a machine if a human conversation partner in a conversation cannot identify whether the other person is a human being or a machine. AI systems also vary in terms of complexity and abilities. Simple AI systems are based on fixed codes, based on which they can solve tasks very quickly and infinitely often. An example of this is the chess software Deep Blue from IBM. Deep Blue was the first computer program that could defeat a reigning world chess champion. This simple type of AI is limited to areas with clearly defined rules and visible solutions.

The next level of AI systems is so-called machine learning. It is based on the fact that the AI learns from available data and uses this knowledge for decisions. It is possible for a system to optimize and adapt its algorithms based on experience.

Through machine learning, for example, the computer program Watson was able to defeat the human participants at the Jeopardy quiz show (more info). The challenge with Jeopardy! is that answers to mostly ambiguously formulated questions have to be found within a time limit of five seconds. Watson used several types of machine learning such as rule-based syntax analysis, knowledge bases, and logistic regression to interpret natural language, evaluate data sources, generate as many answers as possible, and then use statistical methods to select the most likely one. Other significant achievements in this area include AlphaGo and DeepStack.

The most promising discipline of machine learning is the use of artificial neural networks, also called deep learning. This involves the analysis and evaluation of vast amounts of data, the drawing of logical conclusions, and the selection of solutions. Systems based on Deep Learning can learn from experience and understand complicated contexts in the world. For example, cancer researchers at the University of California have built an innovative microscope for the automatic detection of cancer cells that provides a high-dimensional amount of data that can be used to train a deep learning application to precisely identify cancer cells.

## 5 Variation of Artificial Intelligence

According to an unofficial consensus, the birth of artificial intelligence as an independent research project can be dated to the summer of 1956, when John McCarthy at Dartmouth College (more info), where he belonged to the Mathematical Department, was able to persuade the Rockefeller Foundation to finance an investigation " The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it". In addition to McCarthy (who was a professor at Stanford University until 2000 and is responsible for the coining of the term "artificial intelligence"), several other participants took part in the historical workshop at Dartmouth: Marvin Minsky (former professor at Stanford University), Claude Shannon (inventor of information theory); Herbert Simon (Nobel Prize winner in economics); Arthur Samuel (developer of the first chess computer program at world champion level); furthermore half a dozen experts from science and industry, who dreamed that it might be possible to produce a machine for coping with human tasks, which, according to the previous opinion, require intelligence.

The Manifesto of Dartmouth (written at the dawn of the AI age) is both irritating and blurred. It is not clear whether the conference participants believed that one-day machines would actually think or just behave as if they could imagine. Both possible interpretations allow the word "simulate." Written and oral reports on the meeting support both positions. Some participants were concerned with studies of networks of artificial neurons which, they hoped, could in some sense recreate the biological neurons of the brain, while others were more interested in the production of programs that should behave intelligently, regardless of whether the principles underlying the plans bear any resemblance to the functioning of the human brain. This gap between the paradigms

Thinking = the way the brain does it,

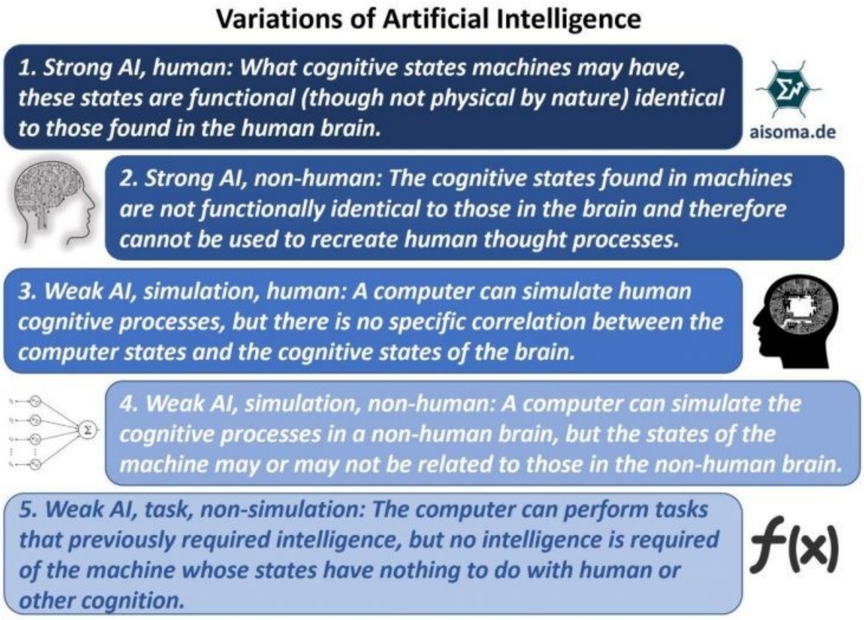
and

Thinking = the results that the brain produces.

The AI community is divided into the so-called strong and weak AI school.

To better understand what the question of whether machines can think is about, it may prove useful to differentiate the dichotomy "strong" and "weak" a little and to compare it with a scheme suggested by the philosopher Keith Gunderson. He distinguishes between the following AI "games":

5 Variations of Artificial Intelligence




It is essential that we clarify the difference between the functionally equivalent and physically identical pairs of states. The easiest way to tell the difference is to imagine that we are dealing with a correspondence between, say, the cognitive states C1, C2, C3, and three machine states M1, M2 and M3. These states are clearly not physically identical, because the machine states are merely patterns of the numbers 0 and 1 on a silicon chip, while the cognitive states are coupled to the chemical concentrations and electrical patterns in a brain. However, the two state sequences would be functionally equivalent if, for example, we found that the machine pattern M1->M3->M2 corresponds to the cognitive pattern C2->C3->C1 each time. In this case, we could say that the states M3 and C3 are functionally identical because they play the same functional role in the respective sequences; i.e., they are always the mean state of the three-part series.

As far as real machine thinking is concerned, the first category in the above overview is the only important one: strong AI, human. Everything else, although certainly technically attractive and economically rewarding, lacks any real intellectual or philosophical temptation, at least as far as the question of machines of thought is concerned. This may surprise some given the massive hype that the media (and various self-service representatives of the AI Guild) have recently been organizing. They praise the wonders of the so-called expert systems developed in the AI labs of Massachusetts, London and Tokyo, enthusiastically describe the robots and programs waiting around the corner to fulfill all our wishes (or take away our jobs), and demand that more money is thrown out of the window. Not to mention the speculation of the capitalists/entrepreneurs and their computer-fixed allies, who are romping about everywhere trying to capitalize on people's credulity in the mindset of machines. This deplorable situation can be traced back to a handful of programs that demonstrate some progress in the last and intellectually not particularly productive category: weak AI, abandonment, non-simulation.

Progress in this area says as much about thinking as the flight mechanism of birds about the development of the aircraft. So from now on, when we talk about cognitive states in machines, we are referring to the types of rules described in our first category: strong AI, human.

Of course, no one has yet put forward an unassailable argument to the effect that the inner states of an appropriately programmed digital computer are functionally identical to the rules of consciousness when they covetously eye a luxury car, examine the seemingly endless menu in a Chinese restaurant, check their account balance, enjoy a Bach fugue, or devote themselves to one of the myriads of other activities that we call thinking in a certain sense.

In the short term, AI will continue to be dominated by point 5. The most recent example is the victory of an expert system against one of the world's best Go players. (Consider the incredibly high number of 2.08 x 10 to the power of 170 different positions on a 19×19 Go board. In comparison, chess has "only "10 to the power of 43 different positions. The number of atoms in the universe is about 10 to the power of 80!). The following years (3-10) will be strongly dominated by points 4 and 3. It will come so far that we cannot always say with certainty whether we are dealing with real "consciousness" or whether it is just a brilliant simulation that is taking place right in front of us. The progressive development in the field of robotics will do the rest. AI embedded in a quasi-human body will certainly have more "effect" than text output on a screen or speech from a device such as a smartphone.

## Duplication vs. Simulation

There is still much confusion about this point in the AI community. With this article, I want to present my view on the relationship between duplication and simulation, because it is of great importance that there is clarity here.

In one of my previous articles, "Can Machines Generate Human Consciousness?", von Neumann briefly touched on the subject by expressing his skepticism about the possibility of using a computer to duplicate the activities of the human brain. Now we will try to get to the bottom of this question a little more thoroughly.

The philosopher John Searle has attached great importance to this point by explaining that a simulation is not duplication and that a machine cannot duplicate human thought, but at best, simulate it. On the point that simulation and duplication are two pairs of boots, I fully agree with him.

Suppose we have two kinds of objects in front of us, say, an Audi A4 (neither my favorite car nor do I drive it) and a second object that someone claims to be a "duplicate" or a "model" of the Audi A4. What exactly does that mean? What is a model of the A4? It means exactly what a ten-year-old who is interested in car models understands by it. Namely that there is a direct correspondence between the external stimuli, the internal states, and behavior of the A4 and the inputs, internal states, and outputs of the model. The correspondence does not necessarily have to be one hundred percent. Thus, some external stimuli, states, and behaviors of Model A4 may not be present in the model. One human brain is not the same as another. If, for example, you go to Ingolstadt and look at a model of the A4 in the wind tunnel, you will see that the seats, the navigation, etc., may be in the model... and all the other equipment details that make up many of the internal states of the "real" Audi A4 are missing - for the simple reason that they are irrelevant to the purpose of the model, i.e. testing the aerodynamic properties of the right car. Nevertheless, the external stimuli, states, and behaviors of the model are directly related to a subset of the inputs, states, and behaviors of the real engine. Such correspondence results in a model relationship between the real A4 and the object in the wind tunnel. Note that the model is more straightforward than the real object it replicates in that it has fewer states. This property is characteristic of model names: Models are always more straightforward than their originals.

What about a simulation?

Let's take a printer of the brand X, whose operating instructions assure me that I can imitate, i.e., "simulate," another type of printer, e.g., a HP Laserjet Plus. What does it mean when people say that my X machine can simulate another machine?

That means that the inputs and states of the HP machine can be encoded into the states of my machine and those same states of my machine can then be decoded into the correct outputs that a real HP printer would produce. What is important is that my machine has to be more complicated than the HP in a certain sense if such a dictionary of encryption and decryption is to be created. To be more precise: To encrypt the inputs and the states of the HP into the states of my "simulator", my machine must have more states than the HP printer, if you regard both devices as abstract machines. Therefore, the simulator (my printer) must be more complicated than the simulated object (the HP printer). **In general, simulation is always more complicated than the system it simulates.**

These short, perhaps even common and casual explanations about models and simulations can be translated into exact mathematical terms, provided, of course, that there are criteria that can be verified in principle and that we can use to distinguish a program that simulates human thought processes in the model from another that merely simulates them. In this context, it is exciting that a simulation of the brain necessarily requires a system that has more states than the brain itself. This fact justifiably makes much doubt whether the brain as a whole can ever be simulated.

The brain with its approximately 100 billion neurons has at least 2 to the power of 10 to the power of 11 possible states - a number that deserves the highest respect in every respect, because it far exceeds even the number of protons in the universe known to us (10 to the power of 79) by a factor of approximately two to the power of 100 billion. Even this number is so large that it is difficult to express it in words. Not to mention his idea. We can therefore safely assume that there will be no simulation of the human brain in the medium and long term (the Human Brain Project, funded by the EU, has a similar objective).

Brain models are an entirely different matter, and it is a good thing that the "strong AI, human" needs models and not simulations. All in all, I have the impression that the thinking machine debate is a battle between the philosophers and not the computer scientist and programmer.

My feeling tells me that in the next ten to fifteen years, we will have a genuine machine in our house. My "hopes" are mainly based on the fact that in information processing, we will work out new concepts in connection with new hardware, such as quantum computers. To name just one of the upcoming innovations in information processing. Can it then be called "strong AI, human"? Yes, that's another interesting question that will have to be answered in due course. According to what criteria, standards? Then they will have to determine philosophers, psychologists, anthropologists, etc.

However, for my part, I can conclude this brief excursion with a statement that is unambiguous and definitive: Whatever the outcome of the matter of "strong AI, human," the result will radically change our self-image and our view of our position in the cosmic order.