Chapter 2

What is Artificial Intelligence?

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Abstract

Artificial intelligence, one of the Industry 4.0 technologies, is expanding its place in our lives day by day. Artificial intelligence is used effectively in many areas of life today. It is used to make people's jobs easier, increase efficiency, solve complex problems and make new discoveries. For example, artificial intelligence is used in technology and innovation, industry, healthcare sector and education. The basis of artificial intelligence is expert systems, robotics, natural language processing, computer vision, speech and understanding. Techniques of artificial intelligence include machine learning, artificial neural networks, deep learning, expert systems, genetic algorithms and fuzzy algorithms. This study has been prepared to explain in detail the definition, foundations and techniques of artificial intelligence, which is used in almost every field today. In this context, the definition of intelligence and artificial intelligence, strong and weak artificial intelligence, the history of artificial intelligence, the basics of artificial intelligence and the techniques of artificial intelligence are explained. In the last section, a general evaluation was made.

1. Introduction

There are three major events mentioned in history. The first of these is the creation of the universe. The second is the beginning of life and the third one is the emergence of Artificial Intelligence (AI) (Pirim, 2006). AI, which is one of the main components of Industry 4.0 (artificial intelligence, internet of things, autonomous robots, cloud computing, big data, augmented reality, cyber security), is a technology that has a great importance today

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(Cioffi et al., 2020). AI is the field of science and technology that aims to imitate the human intelligence and thinking abilities of computer systems (Chen et al., 2020). Basically, AI aims to make computer systems smarter and more effective by giving them human-like abilities. The emergence of the concept of AI dates back to ancient times. The concept of AI was first used by John McCarthy at a conference at Dartmouth University in 1956 (Zhang and Lu, 2021). This conference was a prelude to studying how machines simulate human abilities. Afterwards, the development of AI continued with a great acceleration. The development of AI has benefited all aspects of life. Whether people realize it or not, AI has permeated our daily lives. AI, which can be utilized in various fields, holds significant potential in automation, data analysis, learning and prediction. By automating repetitive and routine tasks, AI enhances work efficiency while producing faster and more accurate results compared to humans. AI algorithms excel at analyzing large datasets and uncovering patterns within them, enabling the prediction of future trends and assisting in decision-making processes. Additionally, AI plays a crucial role in areas ranging from healthcare services to industrial applications, security and defense.

2. Intelligence and Artificial Intelligence

2.1. Intelligence

To define AI, the concept of intelligence needs to be explained. Intelligence refers to human cognitive abilities such as understanding, learning, thinking, problem solving, reasoning and decision making. Intelligence is the ability to process complex information, adapt to new conditions and develop strategies to achieve goals. The concept of intelligence includes different types. These include verbal intelligence, mathematical intelligence, visual intelligence, physical intelligence, musical intelligence, social intelligence, emotional intelligence and nature intelligence (Başaran, 2004). The concept of mind and intelligence are often confused. The mind and intelligence are different concepts, but they are related to each other. The mind contains the genetic characteristics of the human being. It is also shaped by the influence of the society and environment in which it is located. The mind is shaped throughout human life. It cannot be repeated because it is not fixed. While mind is a more general concept and includes thinking processes, intelligence is a more specific concept and refers to an individual's cognitive abilities. Intelligence emerges as a result of thinking processes expressed through the mind. In other words, while reason refers to the thinking processes, intelligence refers to the cognitive abilities that are the result of

these thinking processes. That is, the mind is a component that includes the thinking process necessary for intelligence.

2.2. Artificial Intelligence

There are many type of definitions for AI. According to John McCarthy, one of the pioneers of artificial intelligence, AI is to develop machines that act as if they are intelligent (Ertel, 2018). Marvin Minsky, one of the pioneers of artificial intelligence, defined AI as machines performing events performed by human intelligence (Jiang et al., 2022). Nilsson also defined AI as activities done to make machines intelligent (Nilsson, 2009). Hunt (1975), defined the capabilities of AI as a problem solving, programming, pattern recognition, composing music with a computer, processing data with natural language, playing games and making decisions. AI is modeling in a computer system by imitating the comprehension skills and behaviors of human intelligence (Yılmaz, 2022). Ginsberg (1993), on the other hand, defined AI as constructing an intelligent work.

Based on these definitions, AI can be defined as a discipline used to give computer systems the ability to have human-like intelligence. AI is concerned with algorithms and technologies that can perform complex tasks such as the ability to analyze various data, learn and make decisions. The main purpose of AI is to bring features of human intelligence such as thinking, understanding and decision making to a machine or computer.

Weak AI and Strong AI

Weak AI is an artificial intelligence system prepared to perform a specific task. Weak AI may have a human-like intelligence regarding a restricted area or task, but lack the capacity to demonstrate skills in different areas (Tizhoosh and Pantanowitz, 2018). For example, a game-playing AI program, voice assistants and text recognition systems can be examples of weak AI (Kizi, 2022). Such systems are optimized to solve a specific problem or perform a specific task.

Strong AI is an artificial intelligence system that have a human-like intelligence level or even a higher level of intelligence (Tizhoosh and Pantanowitz, 2018). Such systems may have an ability to perform a wide variety of tasks in different fields, to solve complex problems, to learn and to understand (Kizi, 2022). Strong AI has the goal of achieving a general level of intelligence and faces several challenges. Such artificial intelligences may have the potential to perform various tasks that humans can do and even activities that require creativity.

3. History of Artificial Intelligence

Although the concept of AI is widely used today, it takes place in almost all disciplines. The formation of the concept of AI dates back to ancient times. Daedalus, who is said to rule the wind during the ancient Greeks, can be given as an example of this idea with his effort to create artificial humans. Thus, we can say that the building blocks of the concept of AI extend back to the Ancient Greek period (Yılmaz, 2022). Table 1 shows the chronological order of the development of the concept of AI from past to present.

Table 1. Chronological History of Artificial Intelligence

Year	Development
1st century AD	In ancient times, Heron of Alexandria made automatons with mechanical mechanisms that could work with the power of water and steam.
1206	Automatically controlled machines working with water were made by Ebu'l İz Bin Rezzaz Al Cezeri, one of the pioneers of cybernetic science.
1623	Wilhelm Schickard invented the mechanical and four-operational calculator.
1672	Gottfried Leibniz developed the binary counting system that forms the abstract basis of today's computers.
1822 -1859	Charles Babbage built a mechanical calculator. Ada Lovelace is considered to be the first computer programmer with her work with punch cards on Babbage's machines. Lovelace's work includes algorithms.
1923	Karel Capek used the concept of robot for the first time in the theatrical show Rossum's Universal Robots (R.U.R).
1931	Kurt Gödel introduced the incompleteness theorem, which is named after him.
1936	Konrad Zuse developed a programmable computer with 64K memory called Z1.
1936	Alan Turing finished his paper on programmable numbers that paved the way for modern programming and AI.
1942	Isaac Asimov identified three laws of robotics in his book I Robot.
1943	Walter Pitts and Warren McCulloch published their paper, "The Logical Calculation of Ideas That Matter in Neural Activity", in which they describe neural networks that can learn.
1946	ENIAC (Electronic Numerical Integrator And Computer), the first computer in the size of a room with a weight of 30 tons, began to be used.
1948	The idea of a self-replicating program was introduced by John von Neumann.
1950	Alan Turing, considered the founder of computer science, introduced the concept of the Turing Test.
	The question, "Can machines think?" arose in Alan Turing's groundbreaking article, "Programmed Machines and Intelligence."
1951	The first AI programs were prepared for the device called Mark 1.
1956	The Logic Theorist (LT) program, which is used to solve mathematical problems revealed by Simon, Shaw and Newell, has been accepted as the first AI system.
	The concept of AI was first used by John McCarthy at a conference at Dartmouth University.

Late 1950's Early 1960's	A semantic web was developed for machine translation by Masterman et al.
1958	McCarthy of MIT created the LISP (List Processing Language) language.
1960	Licklider explained the connection between man and machine in his work.
1962	Unimation, the first company to manufacture robots for the industrial field, was established.
1965	ELIZA, an AI program and chatbot, was written by Joseph Weizenbaum.
1966	The first mobile robot "Shakey" was produced at Stanford University.
1973	Protocols called TCP/IP began to be developed in DARPA.
1974	The term internet was used for the first time in the work of Kahn and Cerf.
1978	Simon won the Nobel Prize for his Bounded Rationality Theory, which is one of the important studies in the field of AI.
1979	The Standford Car has been successfully tested.
1981	IBM produced its first personal computer.
1993	Robots called Cog, which look like humans, started to be produced at MIT.
1997	In the game of chess, the world-famous player Kasparov was defeated by the supercomputer Deep Blue.
1998	The first AI toy named Furby was released.
2000	A robot named Kismet emerged that can use gestures and facial expressions during communication.
2005	The robot named Asimo, which has the closest human skill and AI is introduced.
2010	The robot named Asimo was enabled to move by using the power of mind.
2011	Apple has introduced Siri, the voice-activated personal assistant that offers suggestions, answers questions and executes commands.
	In the television show Jeopardy!, IBM's supercomputer Watson defeated two human champions.
2012	Google's self-driving cars have found their way in traffic autonomously.
	Rick Rashid, head of Microsoft Research, gave a speech where his speech was automatically translated into Chinese.
2016	Google's AlphaGo defeated one of the world's successful Go players, Lee Sedol.
2017	A new type of neural network, Transformer networks, has been introduced.
2018	Google has published BERT, a transformative network-based natural language processing model.
2019	GPT-2 with 1.5 billion parameters has been published by OpenAI.
2020	GPT-3 with 175 billion parameters has been published by OpenAI.
2021	A study named DALL-E, which has the ability to create images explained by writing, has been published by OpenAI.

(Yılmaz, 2022; New Scientist, 2011)

4. The Basics of Artificial Intelligence

The foundations of AI consist of expert systems, robotics, natural language processing, computer vision, speaking and comprehension. Figure 1 shows the basics of AI. In addition to these fundamentals; AI is also associated with philosophy, mathematics, computer, control theory, psychology and biology.

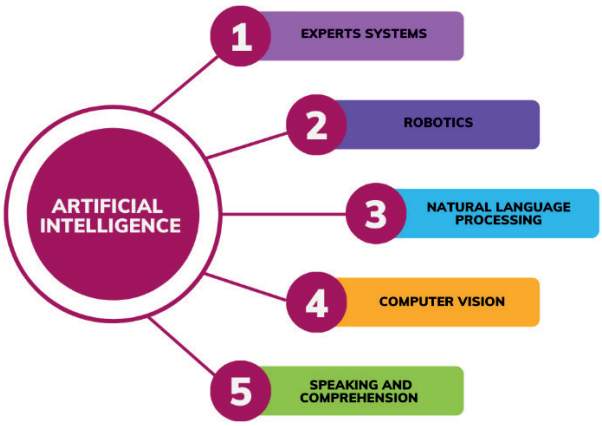

Figure 1. The Basics of AI

Expert Systems

Technology that solves problems and develops computer programs by benefiting from the knowledge and experience of an expert is called expert systems. In expert systems, the information obtained after solving a problem is stored and then used to solve a different problem (Öztürk and Şahin, 2018).

Robotics

The branch of science that emerged with the joint work of mechanical engineering, computer engineering, aerospace engineering and electronic engineering is called Robotics. AI combines with sensory and perceptual systems to reveal the branch of robotics. Robots are complex machines that are managed by software and generate work and value for a purpose (Pirim, 2006).

Natural Language Processing

Natural Language Processing (NLP) is a method that analyzes and tries to understand people's spoken languages. NLP has a wide range of

applications. The spelling correction, text-to-speech, author prediction, text summarization, information extraction, text-to-speech conversion, voice-to-text conversion, voice commands and cross-language translation can be given as an example for these applications (Yüksel and Karabıyık, 2022).

Computer Vision

Computer Vision involves acquiring, processing, analyzing and understanding digital images to obtain numerical and symbolic information. Computer Vision is an automatic extraction of important information from images (Stockman and Shapiro, 2001).

Speaking and Comprehension

The communication of the user with the machine creates the concept of speaking and understanding. This occurs in two stages. In the first step, the machine tries to recognize the speech that doesn't make the sense. In the second stage, it tries to understand the speech to work. (Yılmaz, 2022).

5. Artificial Intelligence Techniques

Let's imagine that AI is at the top of a big bubble and its techniques are listed as in the following. These techniques are machine learning, deep learning, artificial neural networks, expert systems, genetic algorithms and fuzzy logic (Uysal, 2009). AI is located at the top of the bubble as it covers all these techniques. Figure 2 shows the AI techniques.

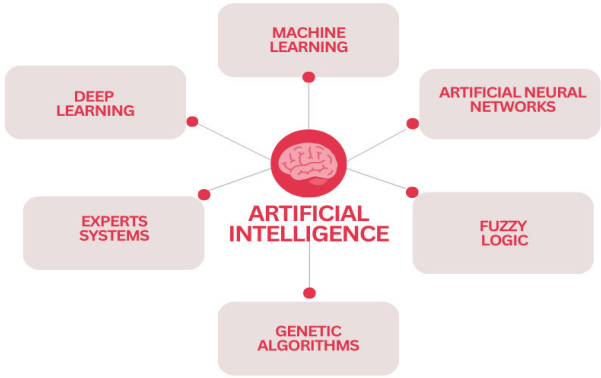

Figure 2. AI Techniques

Machine Learning

Machine Learning (ML) can be defined as a branch of science that aims to enable the computer to understand complex patterns and to give the computer the ability to make decisions by using the appropriate methods of the data obtained by different data collection techniques. Robotics, fraud detection, object recognition, natural language processing, medical diagnosis and computer games can be given as an example of usage areas of ML (Atak, 2022).

ML techniques are classified into four groups as supervised, semi-supervised, unsupervised and reinforcement learning as shown in Figure 3.

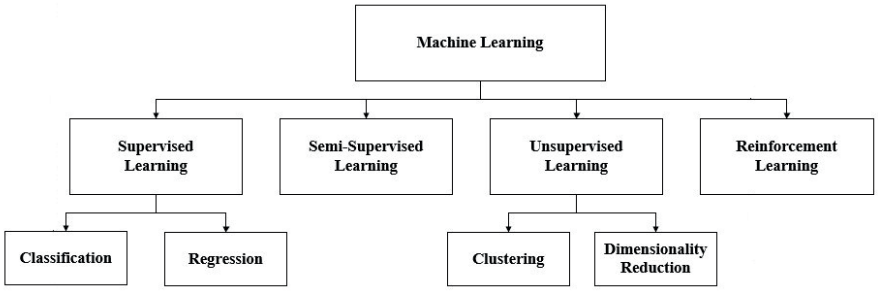

Figure 3. ML Techniques (Shobha and Rangaswamy, 2018)

Deep Learning

Deep Learning (DL) is a sub-field of ML that tries to learn high-level abstractions in data using hierarchical structures (Guo et al., 2016). DL uses many layers of nonlinear processing units for feature extraction and transformation (Şeker et al., 2017). In addition, DL is a type of ML that imitates the decision-making, analysis, observation and learning skills of human intelligence and uses large amounts of unattended data (Uludağ, 2020). The relationships between AI, ML and DL is shown in Figure 4.

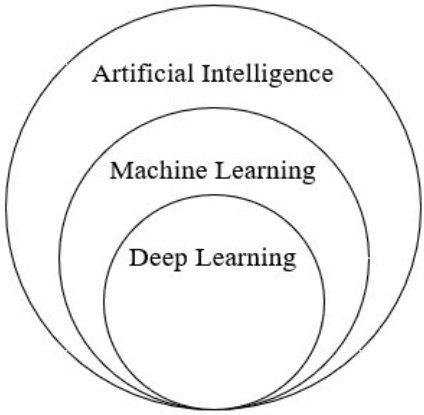

Figure 4. The Relationship Between AI, ML and DL (Mellit et al., 2020)

Detection of spam mails, autonomous tools, handwriting recognition, detection of acquisition, voice recognition, face recognition and credit card fraud detection can be given as example of deep learning applications (Doğan and Türkoğlu, 2019).

Artificial Neural Networks

Artificial Neural Networks (ANN) is an AI subfield that models and imitates the learning and information processing technique of the human brain. The main purpose ANN is to learn by oneself and to make decision by thinking like a human. In addition, it has the ability to memorize and create relationships between information (Kaynar et al., 2017).

A nerve cell in an ANN goes through the function of carrying inputs, as in biological nerve cells, and as a result, it is transmitted to the activation function. As a result of the activation function, an output value is produced and this value is transferred to another ANN (Güner, 2021). The corresponding terms in the biological neuron and the ANN cells are shown in Table 2.

Table 2. Corresponding terms in biological nerve cell and artificial neural network cell (Güner, 2021)

Biological nerve cell elements	**Artificial neural networks cell elements**
Dendrites	Sum function
Cell body	Transfer function
Axon	Activation function
Neuron	Inputs
Synapse	Weights

The structure of the ANN is shown in Figure 5.

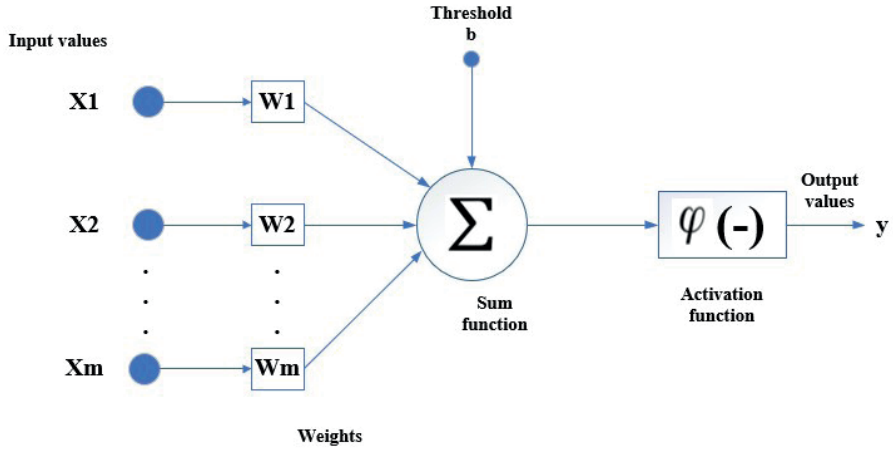

Figure 5. Structure of artificial neural network (Jin et al., 2016)

In Figure 5, the Xi values represent the input elements. All of the $\mathbf{X}_i$ input values are multiplied by $\mathbf{W}_i$. The threshold value **b** is added to the information obtained as a result of the multiplication. In the next step, the activation function is applied and the output value **y** is obtained. The working logic of ANN is as shown in the figure above (Jin et al., 2016).

Expert Systems

Expert systems solutions are systems that solve problems by pretending to be an expert in problems that require the knowledge, skills and experience of an expert. The purpose of expert systems is to save the information and to reach a solution by using this information when a similar problem is encountered later. Basic structure of expert systems consists of knowledge base, working memory, decision making mechanism, database and user interface. Information is kept in the knowledge base section and new information is tried to be produced using this information. Information is stored in the database and is in constant interaction with the knowledge base. Information such as test results and question answers about the current problem is kept in working memory. The decision-making mechanism is the unit where search and inference are made. The user interface unit is the unit where information such as system performance, summary information and results are presented (Mankad, 2015). Figure 6 shows the general structure of expert systems.

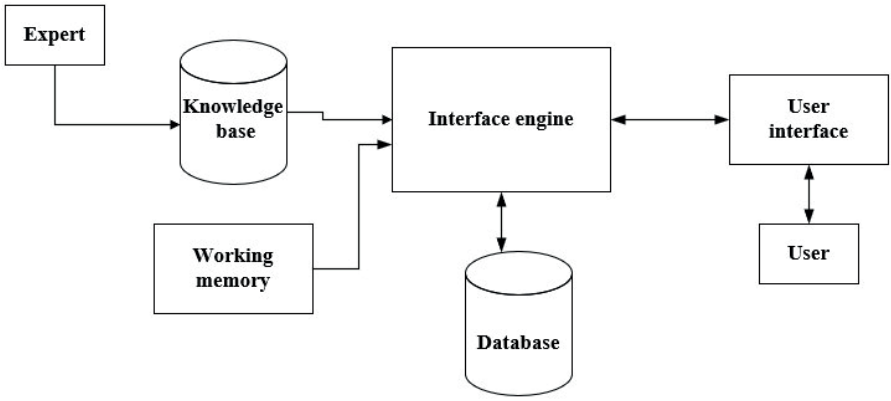

Figure 6. Structure of Expert System (Mankad, 2015)

Genetic Algorithms

All areas of artificial intelligence imitate the intelligence, brain functions and nervous system of living things. In addition, all areas of artificial intelligence imitate nature. For example genetic algorithms mimic natural selection and survival of the fittest, on which the theory of evolution is based. In other words, it aims to find the best solution among more than one solution during a problem (Atalay and Çelik, 2017). The general flow chart of genetic algorithms is shown in Figure 7.

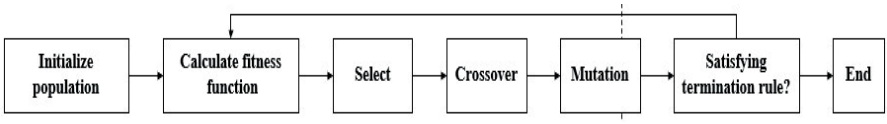

Figure 7. Structure of Genetic Algorithms (Peng, 2019)

Fuzzy Logic

In a research conducted on a subject, the researcher's lack of knowledge about the subject, insufficient or uncertain information is expressed as fuzzy (Yılmaz, 2022). Weather is an example of how fuzzy logic works. For example, in fuzzy logic, the weather is not classified as cold or hot. Classification is made according to intermediate values such as very cold, cold, warm, hot and very hot (Öztürk and Şahin, 2018). Application areas of fuzzy logic; washing machines, air conditioners, traffic lights, computer control, subway operation, vacuum cleaners, automatic brake and gear systems, object and character recognition, medical diagnosis and elevators can be given as examples. Fuzzy logic systems generally consist of 4 basic

elements. These elements are the blur interface, the inference engine, the rinse interface, and the database (Mitiku and Manshahia, 2018). The input is passed to the fuzzification interface. The fuzzy input is processed in the inference engine. The fuzzy output from the inference engine is transferred to the defuzzification interface. Then the crisp output is obtained. Figure 8 shows the general structure of fuzzy systems.

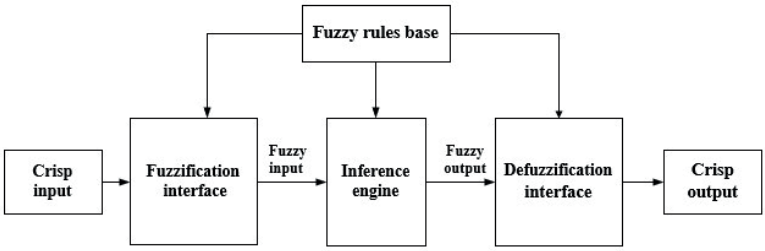

Figure 8. Structure of Fuzzy System (Mitiku and Manshahia, 2018)

6. Conclusion

Artificial intelligence (AI) development has gained momentum in recent years. AI has become a research hub in science and technology. Large companies like Google, Microsoft and IBM depend on AI and are applying it to more and more areas. AI is a rapidly developing field and is thought to have great potential in the future. Advances in areas such as ML, ANN and DL expand the capabilities and application areas of AI. In the future, AI will become more intelligent and autonomous, and its use will increase in many industries. AI will have a great impact in many areas such as disease diagnosis and treatment planning in healthcare, autonomous vehicles in transportation, smart robots in production and personalized services in the retail sector.

Human-machine interaction will become more natural and intuitive, AI systems will be able to better understand people and offer solutions more appropriate to their needs. However, the ethical, safety and social implications of AI must be considered. Issues with the use of AI include issues such as data privacy, bias, and moral responsibility. For this reason, while developing AI technologies, it is important to direct them to the benefit of humanity and to use them in accordance with ethical principles. Ethical rules and regulations are important to ensure that artificial intelligence is directed for the benefit of humanity and in line with the values of society. The future of AI will be exciting and transformative, but managing this potential in a beneficial and sustainable way is an important responsibility.

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