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Study on artificial intelligence: The state of the art and future prospects

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ABSTRACT

In the world, the technological and industrial revolution is accelerating by the widespread application of new generation information and communication technologies, such as AI, IoT (the Internet of Things), and blockchain technology. Artificial intelligence has attracted much attention from government, industry, and academia. In this study, popular articles published in recent years that relate to artificial intelligence are selected and explored. This study aims to provide a review of artificial intelligence based on industry information integration. It presents an overview of the scope of artificial intelligence using background, drivers, technologies, and applications, as well as logical opinions regarding the development of artificial intelligence. This paper may play a role in AI-related research and should provide important insights for practitioners in the real world.The main contribution of this study is that it clarifies the state of the art of AI for future study.

1. Introduction

In 1956, at a conference at Dartmouth University, scholars formally proposed the term "artificial intelligence." That moment was the first step in anew topic of studying how machines simulate human intelligent activities. In early 2016, AlphaGo defeated the world chess champion. This event immediately aroused global interest in artificial intelligence (AI) [93]. The development of artificial intelligence has brought huge economic benefits to mankind and has benefited all aspects of life, even as it has greatly promoted social development and brought social development into a new era [57]. Many scholars started AI-relevant research since the end of 20th century [92].

AI is the general term for the science of artificial intelligence. It uses computers to simulate human intelligent behaviors and it trains computers to learn human behaviors such as learning, judgment, and decision-making [94]. AI is a knowledge project that takes knowledge as the object, acquires knowledge, analyzes and studies the expression methods of knowledge, and employs these approaches to achieve the effect of simulating human intellectual activities [19]. AI is a compilation of computer science, logic, biology, psychology, philosophy, and many other disciplines, and it has achieved remarkable results in applications such as speech recognition, image processing, natural language processing, the proving of automatic theorems, and intelligent robots [20]. AI plays an indispensable role in social development, and it has brought revolutionary results in improving labor efficiency, reducing labor costs, optimizing the structure of human resources, and creating new job demands [18].

The rest of the paper is structured as follows (Fig. 1): the origin and development of AI is addressed in Section II. Section III describes enabling drivers and technologies of AI. The research fields are depicted in Section IV. Section V illustrates the application scenarios of AI. Three logical views of AI are explained in Section VI, and Section VII summarizes the paper.

2. The origin and development of artificial intelligence

Artificial intelligence is the study of how to make computers perform intelligent tasks that, in the past, could only be performed by humans [36]. In recent years, AI has developed rapidly, and it has changed people's lifestyles [37]. The development of AI has become an important development strategy for countries around the world, enhancing national competitiveness and maintaining security [69]. Many countries have introduced preferential policies and have strengthened the deployment of key technologies and talents in order to take the lead in a new round of international competition [95]. AI has become a research hotspot in science and technology; major companies such as Google, Microsoft, and IBM are committed to AI and are applying AI to more and more fields [73].

AI is a multidisciplinary technology, one with the capability of integrating cognition, machine learning, emotion recognition, human-

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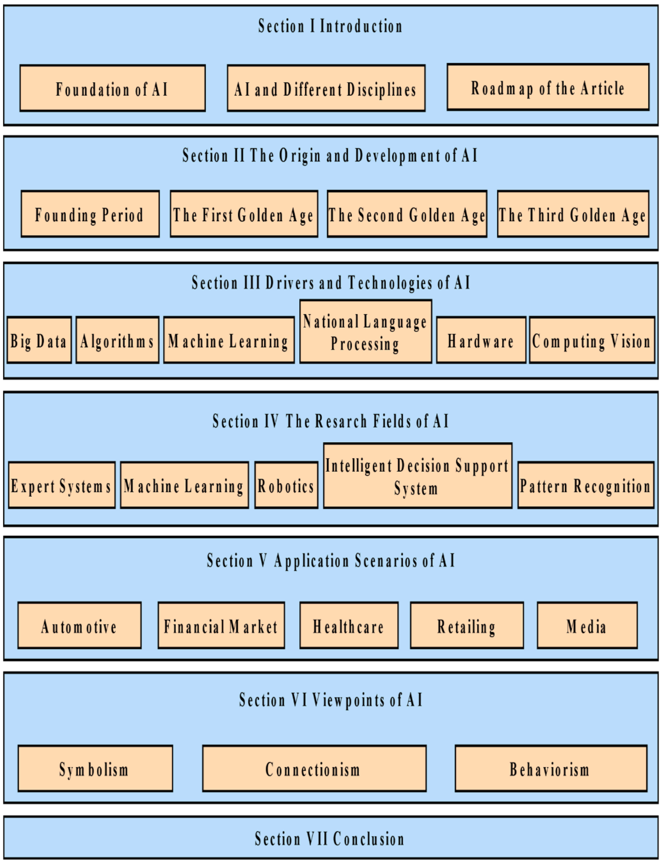

Fig. 1. Roadmap of the study.

computer interaction, data storage, and decision-making [56]. It was first proposed by John McCarthy at the Dartmouth Conference in the mid-20th century. Since 1993, AI has achieved some milestone results. Due to the wide application of the BP algorithm, the neural network has developed rapidly. In a large-scale environment, the extensive use of expert systems has saved the industry a lot of cost and has improved industry efficiency [108]. For example, the PROSPECTOR expert system successfully analyzed mineral deposits worth hundreds of millions of dollars. After that, people began to try to study general artificial intelligence programs, but they encountered serious obstacles and reached a deadlock. Artificial intelligence is at a trough again. In 1997, the success of "Deep Blue" put the development of AI on the agenda. With the improvement of computing power, the bottleneck of AI was broken, and the development of deep learning and enhanced learning based on big data continued. With the continuous development of GPUs, the successful development of custom processors has also continuously improved computing power; this has laid the foundation for the explosive development of AI [106].

Artificial intelligence has experienced a long development process, with a history of more than 70 years. Its development process can be divided into several stages: in 1943, the artificial neuron model was proposed, and this opened the era of artificial neural network research [104]. In 1956, the Dartmouth Conference was held, and the concept of artificial intelligence was put forward; this marked the birth of artificial intelligence. During this period, the trend of artificial intelligence research by the international academic community was on the rise, and academic exchanges were frequent. In the 1960s, the main types of connectionism and submissive fell into disuse, and smart technology took a downturn in development. Research on the backpropagation algorithm began in the 1970s, and the cost and computing power of computers gradually increased, which made the research and application of expert systems difficult. Moving forward became difficult, but artificial intelligence was gradually making breakthroughs. In the 1980s, backpropagation neural networks were widely recognized, algorithm research based on artificial neural networks was rapidly developed, computer hardware functions had rapidly improved, and the development of the Internet reduced the development of artificial intelligence. In the first decade of the 21st century, the development of mobile Internet brought more artificial intelligence application scenarios ([107].). In 2012, deep learning was proposed, and artificial intelligence achieved breakthrough development; the algorithm has made breakthroughs in speech and visual recognition. The following table (Table 1) addresses the events of the AI timeline.

3. Enabling drivers and technologies of artificial intelligence

3.1. Big data

Big data is a prerequisite for AI, and it is a core factor that promotes AI to improve recognition rate and accuracy. With the development and the wide application of the Internet of Things, the amount of data generated has increased exponentially, with a great increased annual growth rate. In addition to increasing the number, the dimensionality of the data has also been expanded [105]. These large amounts of high-dimensional data make the data more comprehensive and more sufficient to support the development of AI [11].

3.2. Algorithms

In traditional pattern recognition, the researchers summarized laws and methods. However, this abstraction method has great limitations and low accuracy. Researchers have been inspired by babies; no one teaches babies how to recognize objects, but they learn. Based on this, people have proposed a machine learning method that summarizes the

Table 1
The Development of AI.

Period	Events &Details
Founding period	In the summer of 1956, at an academic conference held at Dartmouth University, several distinguished scientists discussed how to make machines simulate intelligent. McCarthy first proposed the term artificial intelligence, which gave birth to artificial intelligence. This emerging discipline.
The first golden age	Since the Dartmouth Conference, the emergence of expert systems, such as the Bender Chemical Mass Spectrometry System, MTCIN Disease Diagnosis and Treatment System, and Hearsay-11 Language Understanding System, laid the foundation for the practicality of this manual. operating. intelligence. In the early days of artificial intelligence research, the Massachusetts Institute of Technology, Carnegie Mellon University, Stanford University, and other universities established artificial intelligence laboratories and received R&D funding from government agencies. In the late 1970s, Feigenbaum proposed the concept of knowledge engineering. Expert systems have developed rapidly, and their applications have also produced huge benefits. However, a series of problems such as the difficulty of obtaining knowledge from expert systems gradually emerged, and artificial intelligence entered the first trough.
The second golden period	The Hopfield neural network and BT training algorithm proposed in 1982, set off a boom in the development of artificial intelligence such as speech translation and speech recognition. However, in the late 1990s, people thought that artificial intelligence was still far from our social life. Therefore, around 2000, artificial intelligence entered a trough again.
The third golden period	From 2006 to now is a period of rapid development of artificial intelligence. The rapid development is mainly due to the widespread popularity of GPUs, and parallel processing can be faster and more powerful. Another reason is the unlimited expansion of storage capacity, which allows large-scale access to data such as maps, pictures, text and data information.

laws and methods of identifying objects [47,48,96]. For example, if you input a lot of photos of dogs into a computer, the computer can learn the characteristics of dogs through training models (such as neural networks) and can accurately recognize dogs in other photos based on these characteristics [109].

Machine learning enables computers to automatically learn and analyze big data, and then to make decisions and predictions about events in the real world. Algorithms make AI possible [8]. And beyond the application of AI-relevant algorithms in the field of pattern recognition, satisfactory results have also been achieved in other fields, among them speech recognition, search engines, semantic analysis, and recommendation systems [110]. Each of these has made considerable progress under the impetus of AI algorithms.

3.3. Machine learning

The basic idea of machine learning is the use of an algorithm that improves its performance by learning from data [64]. The four most important types of problems that need to be solved via machine learning are prediction, clustering, classification, and dimensionality reduction [23]. Considering the classification of learning methods, machine learning can be divided into four categories: supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning [3].

Supervised learning refers to the use of labeled data to train, in order to predict the type or value of new data. According to different prediction results, this can be divided into two categories: classification and regression. The typical methods of supervised learning are SVM (Super Vector Machine) and linear discrimination [62,63]. The regression problem refers to the prediction of the output of continuous values, one might analyze housing price data, fit it according to sample data input, and then obtain a continuous curve to predict housing prices. The classification problem refers to predicting the output of discrete values, such as judging whether the current photo is a dog, or a cat based on a series of features; the output value is 1 or 0 [61].

When the data has no labels, unsupervised learning is data mining. Unsupervised learning is mainly reflected in clustering. In short, data can be classified according to different characteristics without tags. Typical methods of unsupervised learning include k-clustering and principal component analysis. The important premise of k-clustering is that the difference between data can be measured by Euclidean distance. If it cannot be measured, it needs to be converted to a usable Euclidean distance. Principal component analysis is a statistical method. By using orthogonal transformation, the relevant variables are transformed into uncorrelated variables; the transformed variables are called principal components. The basic idea is to replace the original related indicators with a set of independent comprehensive indicators [2].

In its most literal meaning, semi-supervised learning can be understood to be a mixture of supervised learning and unsupervised learning. In fact, labeled data and unlabeled data are mixed in the learning process. Under normal circumstances, the amount of unmarked data is much larger than the amount of marked data. The idea of semi-supervised learning is ideal, but it is not much used in practical applications. Commonly used semi-supervised learning algorithms include self-training, graph-based semi-supervised learning, and semi-supervised support vector machines (S3VM).

Reinforcement learning is a method of obtaining rewards by interacting with the environment, judging the quality of actions by reward levels, and then training the model. The importance of exploration and development in reinforcement learning is a thorny issue: to obtain better rewards, people must choose the action that may get the highest reward, but people must also find unknown actions [12]. The foundation of reinforcement learning comes from behavioral psychology. In 1911, Thorndike proposed an effective rule: in an environment that makes people or animals feel comfortable, people or animals will continue to strengthen this action. Conversely, if a person or an animal feels uncomfortable, the person or animal will reduce its movement [13]. In other words, reinforcement learning can enhance reward behavior and weaken punishment behavior. One can train the model through the trial-and-error mechanism to find the best operation and behavior to get the greatest return. This imitates the learning model of humans or animals and does not need toguide agents to learn in a certain direction [49,68,90].

3.4. National language processing (NLP)

Natural language processing (NLP) refers to the ability of computers to recognize and understand human text language, which is an interdisciplinary subject between computer science and human linguistics. The biggest difference in natural language is that human thinking is based on language, so natural language processing also represents a goal of AI. Natural language processing is divided into seven directions: grammatical and semantic analysis, information extraction, text mining, information retrieval, machine translation, the question answering system, and the dialog system [111].

Natural language understanding (NLP) is a technology that uses natural language to communicate with computers. The key to processing natural language is to allow computers to "understand" natural language, so it is also called computational linguistics, which sits at the intersection of language information processing and artificial intelligence. As a machine, it first collects sound signals. Natural language processing technology converts sound signals into text signals and the meaning of the text. Then, machine converts sounds into words and converts words into meanings. After completing these two processes, the machine can hear and understand. The machine equipped with speech recognition and semantic understanding technology optimizes the algorithm in continuous learning, so that the machine can not only listen, but also understand – and even understand emotions [4].

3.5. Hardware

In machine learning, some "deep" neural network models are used to solve complex problems. Machine learning is a way to realize AI, and deep learning is a kind of machine learning [58]. The hardware platform that runs deep learning is mainly a GPU produced by NVIDIA. GPU acceleration is a new computing model that uses massively parallel processors to accelerate applications with parallel functions. In the past, it took a month for the CPU to obtain the training results. Now, the GPU can get results in one day. The powerful parallel computing functions of the GPU alleviate the training bottleneck period for deep learning algorithms, thereby releasing the potential of artificial intelligence [5].

3.6. Computing vision

The goal of computer vision is to enable computers to recognize and to understand the world through vision, as humans do. It mainly uses algorithms to identify and analyze images. The most widely used computer visions are facial recognition and image recognition [34].

Since 2015, image processing methods that use deep learning for classification have been widely used. The neural network is built into the network through neurons, and the model has a nonlinear fitting function through the activation function [15]. Once the need to design input and output for the model is met, the model can automatically learn the process of feature extraction and training classification. The use of deep learning simplifies the most time-consuming and laborious image classification process and improves both the effect and the efficiency of image classification. The VGG conventional neural network, ResNet (Residual Neural Network) and Startup are the most used structures in engineering. The model used in the project must consider both efficiency and effectiveness; that is, it must ensure accuracy while ensuring speed. After training the model, the model will be fine-tuned and reduced. Faster R-CNN, Mask-RCNN, and YOLO (You Only Look Once) are now commonly used network models. The common characteristics of these models are high accuracy and fast speed. In the field of facial recognition, these models can detect and obtain results in real time [14].

Computer vision divides the picture into pixels and then processes the pixels. The meaning of semantic segmentation is to understand the meaning of pixels after segmentation; this allows for the recognition, for example of people, motorcycles, cars, and streetlights in a picture. It needs to distinguish dense pixels. Convolutional neural networks promote the development of semantic segmentation algorithms [117]. The most basic method in semantic segmentation is to perform classification prediction through a sliding window. The emergence of the Fully Convolutional Network (FCN) replaced the fully connected layer of the network. Based on FCN, the Encoder-Decoder architecture was developed. Since the encoder was failure for smaller space size operations, the decoder is used to restore the space size and detailed information. After that, the pooling operation was replaced by Dialated / Atrous. The advantage of hole convolution is that the spatial resolution can be maintained. In addition to the previous method, there is a method called Conditional Random Field (CRF) that can improve the segmentation effect [118].

The following table (Table 2) address key drivers and technologies of AI (Table 3).

4. The research fields of AI

4.1. The expert system

An expert system is a knowledge system based on the existing knowledge of human experts. The expert system was the earliest field AI research. It is widely used in medical diagnosis, in geological surveying, and in the petrochemical industry. Expert systems usually refer to

Table 2
Drivers and Technologies of AI.

Driver or Technology	Explanation
Big Data	Big data refers to a collection of data that cannot be captured, managed, and processed using conventional software tools within a specific time frame. Big data requires new processing models to have stronger decision-making capabilities, insight and discovery capabilities, and process optimization capabilities and diversified information assets.
Algorithms	There are certain steps to perform any operation. The methods and steps taken to solve the problem are called algorithms.
Machine Learning	Machine learning is the science of artificial intelligence. The main research object in this field is artificial intelligence, especially how to improve the performance of specific algorithms in empirical learning. Machine learning is the study of computer algorithms, which can be improved automatically through experience. Machine learning uses data or experience to optimize the performance standards of computer programs.
National Language Processing	Natural Language Processing (NLP) is the field of computer science, artificial intelligence and linguistics. It focuses on the interaction between computers and human (natural) language. The earliest research work on natural language processing is machine translation.
Hardware	Hardware refers to the general term for various physical devices composed of electronic, mechanical, and optoelectronic components in a computer system. These physical devices constitute annuity according to the requirements of the system structure and provide a material basis for the operation of computer software. The hardware platform running deep learning is mainly GPU.
Computing Vision	Computer vision is a science that studies how to make machines "see". In addition, it refers to the use of cameras and computers instead of human eyes to identify, track and measure objects. This processing becomes an image more suitable for human observation or transmission to an inspection instrument.

Table 3
Research Fields of AI.

Fields	Explanation
Expert System	Expert system is a computer intelligent program system with professional knowledge and experience. By modeling the ability of human experts to solve problems, it uses knowledge representation and knowledge reasoning techniques in artificial intelligence to simulate complex problems that are usually solved by experts. It can reach the same level of problem-solving skills as an expert can.
Machine Learning	Machine learning is a multi-disciplinary interdisciplinary, involving probability theory, statistics, approximation theory, convex analysis, algorithm complexity theory and other disciplines. Machine learning specializes in the study of how computers simulate or realize human learning behaviors in order to acquire new knowledge or skills and reorganizes the existing knowledge structure to continuously improve its own performance.
Robotics	Robotics is the science related to the design, manufacture and application of robots. It mainly studies the relationship between robot control and processing objects.
Decision Support System	Decision support system belongs to the category of management science and has an extremely close relationship with "knowledge-intelligence".
Pattern Recognition	Pattern recognition is the study of how to make machines have perception capabilities. It mainly studies the recognition of visual and auditory patterns.

various knowledge systems [60]. This is an intelligent computer program, based on knowledge, that uses professional knowledge provided by human experts to simulate the thinking process of human experts and uses knowledge and reasoning to solve complex problems that only domain experts can solve. The expert system has a large amount of information and reasoning process in a specific field, including a large amount of professional knowledge and experience, and it can store, reason, and judge at the same time [85]. The core is the knowledge base and the reasoning engine [6].

The application method of the expert system is first to store the knowledge, experience, and research information of experts in a specific field in the database and the knowledge base, and then to call them by the interpreter and reasoning engine and provide them to the experts as needed. Users do this through a human-computer interaction interface [103]. The application advantage of the expert system in teaching does not depend on the limitation of time and space, nor on the limitation of environment and emotional influence. Expert systems should be used in education. They are, in fact, widely used, and their advantages to distance education are well known [66].

4.2. Machine learning

For a computer to possess knowledge, the knowledge must be expressed as input into the computer in a manner that is acceptable to the computer, or the computer itself has the ability to acquire knowledge, and to continuously summarize and improve knowledge in practice [101]. This method is called machine learning [52]. The research of machine learning is mainly carried out (1) to study the human learning mechanism and human brain thinking process, (2) to study the learning mechanisms of people, and (3) to study machine learning methods and to establish a learning system for specific tasks [53]. The research of machine learning is based on a variety of disciplines, such as information science, brain science, neuropsychology, logic, and fuzzy mathematics [35].

The concept of deep learning comes from artificial neural networks. Common deep learning algorithms include the Restricted Boltzman Machine (RBN), the deep belief network (DBN), the convolutional neural network (CNN), and the stacked auto-encoder ([50].). In the early artificial neural network, after the network layer exceeded four layers, there was a problem. The traditional backpropagation algorithm is trained Convergence, a multilayer perceptron with multiple hidden layers is a deep learning structure [36]. Deep learning discovers the distribution characteristics of data by combining low-level features to form high-level attribute categories or features [74,114]. Important artificial neural network algorithms include the perception neural network (PNN), back propagation (BP), the self-organizing network (SON), the self-organizing map (SOM), and learning vector quantization (LVQ) [38,102]

4.3. The robotics

A robot is a machine that can simulate human behavior. The research into robots has experienced three generations of development [51].

The first generation program controls the robot. This kind of robot can be programmed by the designer, and then is stored in the robot and works under the control of the program. Before the robot performs a task for the first time, the technician will instruct the robot to perform the operation, and the robot will perform the entire operation step by step [46,55,98]. Each operation recorded on the ground is represented as an instruction. The second generation is adaptive robots [115]. This kind of robot is equipped with corresponding sensory sensors (such as vision, hearing, and tactile sensors), which can acquire simple information (such as about the working environment and operating objects). The robot is processed by a computer to control the operation activities. The third generation is intelligent robots [75]. The intelligent robot has human-like intelligence and is equipped with high-sensitivity sensors [76]. Its sensory ability exceeds that of ordinary people. The robot can analyze the information that it perceives, control its behavior, respond to changes in the environment, and complete complex tasks [80,81].

4.4. The intelligent decision support system

The decision support system belongs to the category of management science and has an extremely close relationship with "knowledge-intelligence." In the 1980s, the expert system was successful in many ways [1]. AI, especially the application of intelligence and knowledge processing technology in decision support systems, has expanded the application scope of decision support systems and has improved the system's ability to solve problems. It becomes an intelligent decision support system [7,71].

4.5. The pattern recognition

Pattern recognition is the study of how to make machines that have perception capabilities [82]. It mainly studies the recognition of visual and auditory patterns, i.e., identifying objects, terrain, images, fonts, etc. It has a wide range of uses in daily life and for the military. In recent years, the level of application of fuzzy mathematical models and artificial neural network models has developed rapidly, gradually replacing both traditional statistical models and structural pattern recognition methods [9,99].

5. Application scenarios of ai

Based on the relatively mature development of technical conditions such as data, algorithms, and computing capabilities, AI has begun to truly solve problems and to effectively create economic benefits [116]. From an application perspective, industries with a good data foundation (such as finance, healthcare, automotive, and retail) have relatively mature AI application scenarios.

5.1. The automotive industry

In the automotive industry, let's consider autonomous driving as an example. Autonomous driving is a product of the in-depth integration of new generation information technologies such as the automotive industry, AI, and Internet of Things [45]. This is an important direction for current global transportation and for travel information and contacts. Autonomous driving uses sensors like lidar, as well as other sensors, to collect road conditions and pedestrian information and combines this information with advanced AI algorithms to continuously optimize and, ultimately, to offer the best route and control plan for vehicles on the road [16].

China is closing the gap between Europe and the United States in the field of driverless cars, and it is even achieving simultaneous development [83]. On December 21, 2014, Google announced the first driverless prototype car. Switzerland and France jointly manufactured driverless buses in 2015 and planned to conduct a two-year road test. In 2017, German Audi released its new "Audi AI" trademark and applied AI to the Olympic Games. The fixed-speed cruise automatic parking and other auxiliary drive devices installed on the car have realized automatic driving to a certain extent, and the driverless car has completely liberated human behavior when driving [17,89].

5.2. The financial markets

AI has been successfully applied in the financial markets; example uses include intelligent risk control, intelligent consulting, market forecasting, and credit rating, among others [91]. This has brought finance into a new era of innovation through AI embeddedness. Some cutting-edge Internet companies in Silicon Valley are trying to use AI algorithms to lower the threshold for users to accept financial products. Models are trained based on the knowledge and experience of financial analysts and are applied to track customer needs and to minimize costs [27,44,97]. A Japanese startup company (Alpaca) uses deep learning to analyze and recognize images, aiming to help users quickly find foreign exchange trading charts from a large amount of information [41].

In the financial sector, the AI market is growing. Through the technical means of machine learning, it can predict both risks and the direction of the stock market. Financial institutions employ machine learning methods to manage financial risks, to integrate multiple data sources, and to provide people with real-time risk warning information [10]. Also, financial institutions adopt big data to analyze the corresponding financial risks, provide real-time risk warning of corresponding financial assets, save investment and financial management manpower and material resources, establish a scientific and reasonable risk management system, and lay the foundation for the company's development [21].

5.3. The health industry

In the medical field, AI-related algorithms are used to provide medical assistance, to detect cancer, and to develop new drugs [70]. Extensive promotion of medical information is of great significance to the development of medical undertakings on a global scale [32]. One of the most famous is undoubtedly Watson, IBM's intelligent robot. The IBM technical team first input a large amount of data and information into Watson. This huge database includes medical information and reports, clinical guidelines, drug use reports, and thousands of patient medical records. Since then, AI algorithms have been used for analysis and processing, in order to provide stakeholders with medical assistance and to perform medical diagnosis more effectively and precisely [25].

5.4. The retailing industry

In the retail industry, offline physical retail stores use AI to achieve true unmanned retail, thereby reducing costs and greatly improving efficiency. AmazonGo, a smart physical retail store established by e-commerce giant Amazon, has added firepower to smart retail in a very short period of time [54]. A technology in AmazonGo called "Just Walk Out" combines machine learning, computer vision, and sensors. By distributing sensors, cameras, and signal receivers in the store, it can monitor the placement and the removal of goods on shelves, as well as monitor the goods in the virtual shopping cart. The application of AI in the recommendation system will increase online sales, achieve more accurate market forecasts, and reduce inventory costs. The recommendation system builds an online product recommendation model based on the user's potential preferences, and it has been applied on many e-commerce websites [24].

5.5. The media industry

In the media industry, content communication robots and brand communication robots offer one-click generation of content that users want, and up to 10,000 articles can be published in one minute [65]. This intelligent media platform based on artificial intelligence can combine current hot events, public opinion, and public relations marketing content, can study media delivery and delivery rules, and can automatically generate content that users want to read [59]. It can intelligently connect to mainstream media platforms and automatically send information synchronously, so as to achieve effective dissemination. In terms of brand promotion, the intelligent platform estimates and matches media products and media channels based on brand content, promotion budgets, and promotion effects, so as to bring the company the greatest communication value [31].

5.6. Smart payment systems

Nowadays, it has become a habit of many people to shop without cash. A mobile phone can easily complete the payment. If customers have not used the scan code to pay for items, another new payment method is voiceprint payment and face scanning. Shoppers don't need to bring their wallets when they go out, don't need to scan a QR code, and don't even need to enter a password [26]. They can pay through via their own voice and face. Among them, voiceprint recognition is a new technology developed based on biological characteristics [42]. For example, Alipay Pay is an AI-based payment system that applies in KFC restaurants. Two identical twins can be distinguished quickly within a few seconds, without mistake. The technique applied is the eye brushing technique. Each person's eye pattern is different. Users brush their faces for eating, brush their faces for driving, brush their faces for lodging; the application range of brushing one's face is getting wider and wider.

5.7. Smart home

Smart homes use advanced technology to integrate facilities related to daily life to create efficient residential facilities and daily family affairs management systems, in order to make life more comfortable ([28].). A smart home involves many aspects of household products; TV, bathroom, refrigerator, air conditioner, door lock and other products are all-encompassing, serving users through smart intercommunication [67]. A complete smart home system is not only a device – it is also a combination of many home products with different functions. The user in a family is not one person, but multiple users. The goal of smart home systems is to efficiently and intelligently coordinate household products and people into a unified system that is able to learn, connect, and adapt to itself [30,100].

Compared with the interactive form of buttons and touch screens, voice assistant hardware is more convenient, and currently, voice control has become an important entry point for smart homes [78,79]. Large internet companies and technology companies rely on their own advantages to enter the smart speaker market to seize market dividends. Smart speakers of various brands in the market are considered to be the gateway to the control of smart homes in the field of AI [77]. The important function of the smart speaker is to interact with the human voice. People interact with smart speakers through voice, so smart speakers can understand people's needs and perform services that people need [43].

6. Three viewpoints of AI

Symbolism, connectionism, and behaviorism represent the three main viewpoints of concepts in the field of AI research. They are the most important theoretical theorems in the development of AI disciplines, and they are the theoretical foundation for the development of AI disciplines.

6.1. Symbolism

Symbolism is also called logicism. It believes that symbols are the primitive aspect of human cognition, and the process of human cognition is the process of symbolic calculation and reasoning. Symbolism first expresses people's cognitive objects in the form of symbols through mathematical logic, and then uses the computer's own symbol processing capabilities to simulate human cognitive processes. The supporting symbol principle is mainly the assumption of the physical symbol system and the principle of limited rationality [39].

The main research content of symbolism is knowledge representation and reasoning technology, based on logic. Its main representatives are Newell, Simon, McCarthy, Robinson, and Shot field [87]. The main research results include analytical reasoning methods, heuristic algorithms, expert systems, knowledge engineering theory, and technology, among others. Symbolism has achieved great success in solving logical problems. For example, artificial intelligence solves the "four-color conjecture" problem that has not been proved by hand, as well as the successful development and application of expert systems in the 1970s [40].

6.2. Connectionism

Also known as the Bionics, connectionism's main principle is that human intelligence depends on the physiological structure and the working methods of the human brain. Connectionism believes that the basic unit of human cognition is the neurons of the human brain and that the cognitive process is the process of information processing by the human brain [29,88]. Therefore, connectionism advocates imitating the human brain from the structure and working mode, to truly realize the simulation of human intelligence on the machine. The main content of connectionism research is neural networks. Its main representatives include McCleland and Rumelhart. The main research results are brain model research and the back propagation (B-P) algorithm in the multi-layer network [22].

6.3. Behaviorism

Behaviorism is also called the evolution of cybernetics. The main principle is that intelligence depends on perception and action [72]. It does not require knowledge, representation, or reasoning. Behaviorism believes that the basic human ability is the ability to act, perceive, and sustain life and self-replication. Intelligent behavior is embodied through interaction with the real-world environment; AI should be realized through gradual evolution, like human intelligence [33]. It has nothing to do with the representation of and the reasoning of knowledge. The focus of behaviorism is to simulate various human control behaviors. Its main representative is Brooke. The main development result is the realization of intelligent control and intelligent robot systems. Behaviorism has not yet formed a complete theoretical system but, because it is completely different from the traditional AI viewpoint, it has attracted a lot of attention of the AI community [84,86].

The above three viewpoints have critical significance and far-reaching influence on the development of artificial intelligence. It can be said that it is under the guidance of these three viewpoints that various specific artificial intelligence analysis models, implementation methods, and algorithms have been born [112,113]. Even the latest data mining, knowledge discovery, and intelligent agent technologies are deeply influenced by the above viewpoints.

7. Conclusion

The study presents a systematic overview of AI that focuses on prospects and development, core techniques, applicable scenarios, and challenges. This paper conducts a state-of-the-art review of the extant and upcoming research on AI.

Artificial intelligence is an interdisciplinary subject that involves information, logic, cognition, thinking, systems, and biology. It has been used for knowledge processing, pattern recognition, machine learning, and natural language processing. Applications have been achieved across many fields, such as automatic programming, expert systems, knowledge system, and intelligent robots. AI not only requires logical thinking and imitation, but emotion is also an indispensable part of it. The next breakthrough in the field of AI can not only give computers more logical reasoning capabilities but can give them emotional capabilities. The intelligence of the machine may soon surpass that of human.

Declaration of Competing Interest

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and company that could be construed as influencing the position presented in, or the review of the manuscript entitled A review of Artificial Intelligence: The State of the Art and Future Prospects.

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