

Robotics and Automation with Artificial Intelligence: Improving Efficiency and Quality

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Abstract

*The industrial and technological revolutions are accelerating globally as a result of the widespread adoption of new information and communication technologies like artificial intelligence (AI), the Internet of Things (IoT), and blockchain technology. Government, business, and academia are all paying close attention to artificial intelligence. In this study, a selection of well-read articles on artificial intelligence from recent publications is examined. The focus of this study is to offer an analysis of artificial intelligence using integrated industry information. It provides an overview of the extent of artificial intelligence using background information, motivating factors, technological advancements, and applications, as well as rational predictions for its future. This study can contribute to the field of artificial intelligence research and offer crucial knowledge to real-world practitioners. This study's key **contribution** is its clarification of the current state of the art in AI for further research.*

Keyword: Artificial intelligence, Internet of Things, Technology

1. Introduction

In recent years, automation and robotics have completely changed the manufacturing sector, resulting in significant improvements in productivity and quality. With the introduction of sophisticated technologies and the incorporation of intelligent machines, manufacturers are now able to streamline their processes, boost productivity, and deliver top-notch products to the market. The significant influence of robotics and automation on manufacturing processes is examined in this paper, with a focus on how these technologies can boost productivity and quality [1].

Traditional assembly lines have been drastically changed by the use of robotics and automation in manufacturing. The time when human labor was the only factor in production is long gone. Robots and



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automated systems now play a major role in society, completing routine tasks with unmatched accuracy and speed [2]. This change has increased production rates while also lowering human error, which has improved efficiency all around [3].

In addition, quality control in manufacturing has been greatly improved by robotics and automation. To make sure every product satisfies exacting quality standards, sophisticated robotic systems with sensors and cameras can inspect goods at different stages of production. These intelligent machines minimize defects by spotting flaws or inconsistencies early on, producing higher-quality finished goods. Increased customer loyalty and satisfaction are the results of this quality improvement [4].

Customization in manufacturing has undergone a radical transformation thanks to the integration of robotics and automation. Flexible robotic systems enable manufacturers to meet the needs and preferences of each individual customer without sacrificing productivity. These tools enable the mass production of individualized goods because they can quickly adapt to shifting production needs. The market reach of manufacturers has increased thanks to this customization capability, which has also created new business opportunities [5].

Furthermore, workplace safety in the manufacturing sector has greatly benefited from robotics and automation. Robots have decreased the risk of injuries to human workers by taking over dangerous or physically demanding tasks. This reduces the likelihood of workplace accidents, which saves money for manufacturing companies while also enhancing the general well-being of employees.

Although there is no denying the advantages of robotics and automation in the manufacturing sector, it is important to take into account the potential drawbacks and issues that may come with these developments. To ensure a smooth transition to a more automated future, factors like job displacement, the need for retraining, and ethical issues surrounding the use of autonomous machines need to be carefully considered.

2. Artificial intelligence's genesis and advancement

The study of artificial intelligence focuses on developing computer programs that can carry out intelligent tasks that previously required humans alone. The rapid development of AI in recent years has altered people's way of life. For nations all over the world, the advancement of AI has emerged as a crucial development strategy for maintaining security and boosting national competitiveness. To win a new round of international competition, many nations have implemented preferential policies and improved the deployment of critical skills and technology. With big corporations like Google, Microsoft, and IBM dedicating resources to the area and using AI in an increasing number of fields, AI has emerged as a research hotspot in science and technology [6].

With the ability to combine cognition, machine learning, emotion recognition, human-computer interface, data storage, and decision-making, AI is a multidisciplinary technology. In the middle of the 20th century, John McCarthy made the initial suggestion at the Dartmouth Conference. Since 1993, AI has produced some significant outcomes. The BP algorithm's widespread use has accelerated the neural network's development. The extensive use of expert systems in a large-scale setting has reduced industrial costs and increased productivity [7].

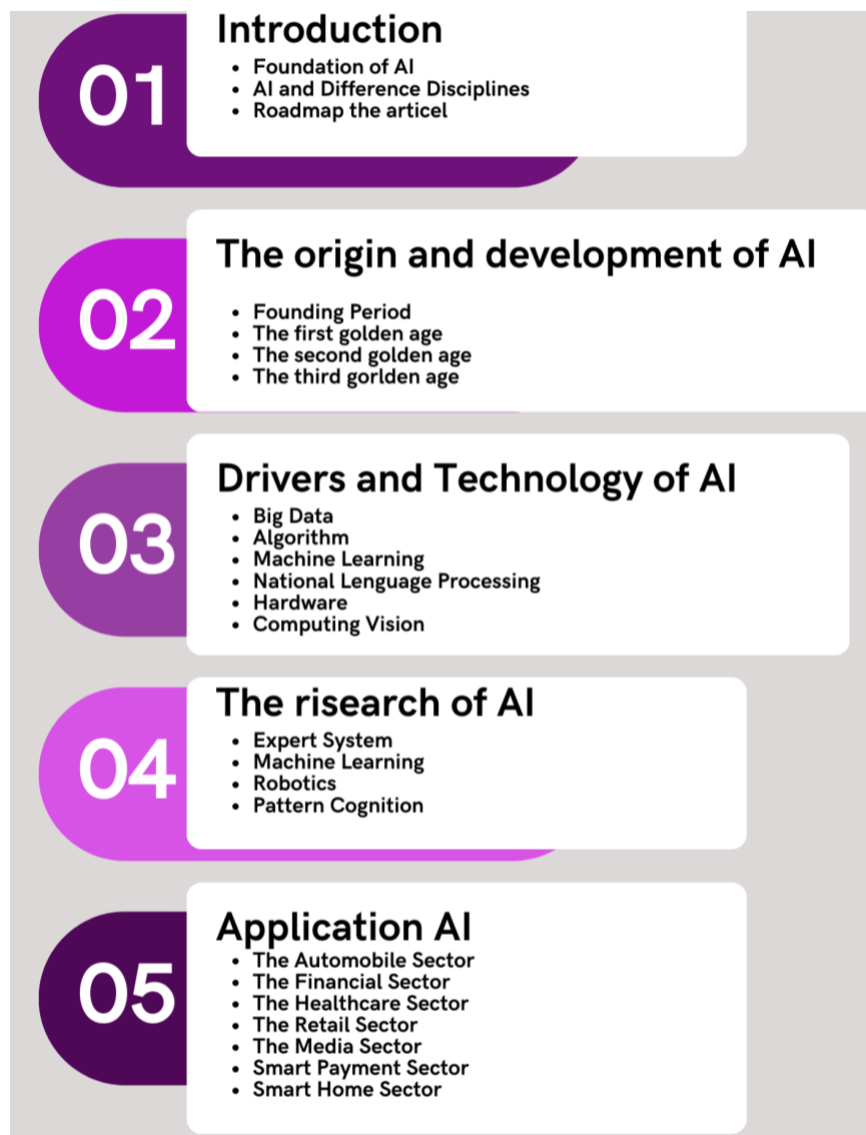


Figure 1. Roadmap of the Study

One successful analysis of mineral resources was performed using the PROSPECTOR expert system, which is worth hundreds of millions of dollars [8]. Following that, attempts to research generic artificial intelligence programs were made, but they ran into significant difficulties and came to a standstill. Once again, artificial intelligence is at a low point. The popularity of "Deep Blue" in 1997 elevated the topic of AI development. The AI bottleneck was removed with increased processing power, and big data-based deep learning and improved learning technologies continued to advance. With the successful development of custom processors and the ongoing advancement of GPUs, processing power has increased steadily, laying the groundwork for the rapid advancement of AI [9].

With a history spanning more than 70 years, artificial intelligence has gone through a protracted development process. Its evolution may be broken down into many phases. In 1943, the artificial neuron model was put forth, ushering in a new era of study into artificial neural networks. The first mention of artificial intelligence was made during the Dartmouth Conference in 1956, which is also considered to be its inception. Academic exchanges were common during this time, and artificial intelligence research was becoming increasingly popular among international academics [10]. The primary forms of connectionism and submission went out of style in the 1960s, and the advancement of smart technology slowed significantly.

Expert system research and development became challenging as work on the backpropagation method started in the 1970s and as the price and computational capacity of computers rapidly rose. Though progress was becoming challenging, advances in artificial intelligence were being made. Backpropagation neural networks gained widespread acceptance in the 1980s, algorithm research using artificial neural networks advanced quickly, computer hardware functions had much improved, and the emergence of the Internet slowed the advancement of artificial intelligence [11].

Table 1. The progress of AI.

Period	Details & Events
Founders' era	At a conference held at Dartmouth University in the summer of 1956, a number of distinguished scientists discussed artificial intelligence simulation. McCarthy is credited with coining the term "artificial intelligence," which is how the idea of artificial intelligencethis recent field of study.developed field.
era of first greatness	The Hearsay-11 Language Understanding System, MTC IN Disease Diagnosis and Treatment System, and Bender Chemical Mass Spectrometry System are a few examples of expert systems that have evolved since the Dartmouth Conference and set the stage for the applicability of this manual. operating. intelligence. The Massachusetts Institute of Technology, Carnegie Mellon University, Stanford University, and other universities established labs in the early stages of artificial intelligence research and received funding for R&D from governmental agencies. In the latter half of the 1970s, Feigenbaum introduced the concept of knowledge engineering. Expert systems have quickly developed, and their applications have produced enormous benefits. Artificial intelligence, however, entered its first trough as a result of a number of issues, including the challenge of learning from expert systems.
The second era of golden rule	Following the 1982 proposals of the Hopfield neural network and BT training algorithm, the use of artificial intelligence in speech recognition and translation saw a boom. People believed artificial intelligence was still a ways off from influencing our social lives, though, in the late 1990s. As a result, artificial intelligence hit a low point again around 2000.

The third era of gold	Artificial intelligence has developed quickly from 2006 to the present. The widespread use of GPUs, which enables parallel processing to be faster and more potent, is primarily to blame for the quick development. The unlimited capacity of storage is another factor, allowing for widespread access to data like maps, photos, text, and data information.
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The growth of mobile Internet in the first ten years of the twenty-first century led to more application possibilities for artificial intelligence. Deep learning was introduced in 2012, and artificial intelligence developed to new heights. The algorithm has improved speech and image recognition. The events in the AI chronology are covered in the following table (Table 1) [12].

3. Enabling drivers and technologies of artificial intelligence

3.1 Big Data

Big data is needed for AI and a key aspect in advancing AI's accuracy and recognition rate. With the growth and widespread use of the Internet of Things, the volume of data produced has rapidly increased, with a significantly higher yearly growth rate. The number has increased, and the data's dimensionality has increased as well. These significant volumes of high-dimensional data increase the data's breadth and sufficiency to help the advancement of AI [13].

3.2 Algorithms

The researchers outlined the laws and procedures of conventional pattern recognition. However, the accuracy and scope of this abstraction method are severely constrained. Babies are a source of inspiration for researchers since they pick up object recognition skills without being explicitly taught. On the basis of this, some have suggested a machine learning technique that condenses the rules and procedures for object identification. For instance, if you enter a lot of dog images into a computer, the computer can use training models (such neural networks) to learn the traits of dogs and can correctly identify dogs in additional photos based on these traits [14].

Computers can automatically learn from and analyze large amounts of data using machine learning, and then use the analysis to decide and predict what will happen in the actual world. AI is enabled by algorithms. Beyond the use of AI-relevant algorithms in pattern recognition, successful outcomes have also been obtained in other areas, including speech recognition, search engines, semantic analysis, and recommendation systems. Under the influence of AI algorithms, each of these has advanced considerably [15].

3.3 Machine learning

The fundamental concept behind machine learning is the application of an algorithm that enhances its performance through data learning. Prediction, clustering, classification, and dimensionality reduction are the four most significant challenges that need to be tackled using machine learning. Machine learning can be categorized into four groups based on how learning techniques are organized: supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning [16].

In supervised learning, the type or value of new data is predicted by training on labeled data. This can be divided into two categories: classification and regression, depending on the outcomes of various

predictions. The Super Vector Machine (SVM) and linear discrimination are the two most common supervised learning techniques. In order to anticipate home prices, one can examine data on housing prices, fit it using a sample of data as input, and then produce a continuous curve. This is known as the regression problem. The classification problem involves predicting discrete values' outputs, such as determining whether the current photo depicts a dog or a cat based on a number of traits; the result is a value of 1 or 0 [17].

Unsupervised learning is data mining when there are no labels in the data. Clustering is the main manifestation of unsupervised learning. In essence, data can be categorized without tags based on several properties. Principal component analysis and k-clustering are two common unsupervised learning techniques [18]. The crucial assumption underlying k-clustering is that Euclidean distance can be used to quantify data differences. It must be transformed into a useable Euclidean distance if it cannot be measured. Statistical analysis is done using principal component analysis. The pertinent variables are transformed into uncorrelated variables via orthogonal transformation; these altered variables are referred to as principal components. The fundamental concept is to swap out the initial connected indications for a collection of independent, all-encompassing metrics [19].

Semi-supervised learning can be defined most literally as a combination of supervised learning and unsupervised learning. In actuality, blended with unlabeled data during the learning process. The amount of unmarked data is typically substantially larger than the amount of marked data. Although the concept of semi-supervised learning is desirable, it is rarely employed in real-world settings. Self-training, graph-based semi-supervised learning, and semi-supervised support vector machines (S3VM) are examples of popular semi-supervised learning techniques [20].

By interacting with the environment, evaluating the quality of activities based on reward levels, and then training the model, reinforcement learning is a technique for getting rewards. It can be difficult to understand the value of exploration and development in reinforcement learning since, in order to acquire better rewards, people must select the action that may yield the highest reward while also discovering undiscovered actions. Behavioral psychology serves as the basis for reinforcement learning. Thorndike put up an insightful "People or animals will continue to strengthen this action in an environment that makes them feel comfortable."

On the other hand, if a human or an animal is uncomfortable, they will move less. In other words, reinforcement learning can strengthen conduct that is rewarded and weaken behavior that is punished. To identify the appropriate operation and behavior to acquire the best return, one can train the model using a trial-and-error mechanism. This mimics the way people or animals learn, and it is not necessary to steer agents' learning in a certain direction.

3.4. National language processing (NLP)

An interdisciplinary field combining computer science and human linguistics, natural language processing (NLP) is the study of how computers can detect and comprehend human written language. The main distinction between artificial intelligence and natural language is that human thought is language-based, hence AI also aspires to process natural language. Grammar and semantic analysis, information extraction, text mining, information retrieval, machine translation, the question-answering system, and the dialog system are the seven categories that make up natural language processing.

Table 2. Drivers and Technologies of AI.

Driver or Technology	Explanation
Big Data	Big data is a term used to describe a collection of data that cannot be managed, processed, and stored using traditional software tools in a given amount of time. New processing models are needed for big data in order to have more robust decision-making, insight and discovery, process optimization, and information asset diversity capabilities.
Algorithms	Any operation must follow a set of steps. Algorithms are the procedures and steps used to solve a problem.
Machine Learning	Artificial intelligence is a field of study known as machine learning. Artificial intelligence is the main topic of study in this area, especially how to enhance the efficacy of particular algorithms in empirical learning. Computer algorithms that can be automatically improved by experience are the subject of machine learning. To raise computer program performance standards, machine learning makes use of data or experience.
Natural Language Processing	Computer science, artificial intelligence, and linguistics are the three disciplines that make up natural language processing (NLP). It focuses on how computers and human (natural) language communicate with one another. Machine translation is the earliest type of natural language processing research.
Hardware	In a computer system, the term "hardware" refers to a broad category of physical objects made up of electronic, mechanical, and optoelectronic components. These tangible objects serve as a material foundation for the operation of computer software and constitute annuity in accordance with the specifications of the system structure. Deep learning is primarily powered by GPU hardware.
Computing Vision	Science that investigates how to "make machines see" is called computer vision. It also describes the process of identifying, tracking, and measuring objects without the use of human eyes, using cameras and computers instead. Images after this processing are made more suitable for transmission to inspection equipment or for human observation.

Table 3. Research Fields of AI

Fields	Explanation
Expert System	Expert systems are intelligent computer programs with specialized knowledge and experience. It uses artificial intelligence knowledge representation and knowledge reasoning techniques to simulate complex problems that are typically solved by experts by simulating the problem-solving abilities of human experts. It has the ability to solve issues on an expert-level level.
Machine Learning	Convex analysis, probability theory, statistics, approximation theory, algorithm complexity theory, and other fields are all involved in machine learning. The study of how computers mimic or actualize human learning behaviors in order to pick up new information or skills, as well as how they reorganize the existing knowledge structure to continuously improve their own performance, is known as machine learning.
Robotics	The science of robotics is concerned with the development, production, and use of robots. It focuses primarily on how robot control and object processing interact.
Decision Support System	The concept of "knowledge-intelligence" and decision support systems are closely related and fall under the category of management science.
Pattern Recognition	How to give machines the ability to perceive is the subject of the study of pattern recognition. It mainly studies the recognition of visual and auditory patterns.

Using natural language to converse with computers is known as natural language processing (NLP). It is also known as computational linguistics, which sits at the crossroads of language information processing and artificial intelligence. The key to processing natural language is to enable computers to "understand" natural language. It first gathers sound signals like a machine. Technology used in natural language processing transforms sound impulses into text signals and the text's meaning. Following that, a machine translates sounds into words and words into meanings. The machine can hear and comprehend after these two steps are finished. The method in continuous learning is optimized by the machine's voice recognition and semantic understanding technologies, enabling it to comprehend not only spoken language but also emotions [21].

3.5. Hardware

Some "deep" neural network models in machine learning are employed to resolve challenging issues. AI may be realized through machine learning, and deep learning is one type of machine learning. A NVIDIA GPU serves as the hardware foundation for deep learning. The use of massively parallel processors to speed up programs utilizing parallel functions is known as GPU acceleration. The CPU used to need a month to get the training results in the past. The GPU can now produce findings in only one day.

Deep learning algorithms' training bottleneck is reduced because of the GPU's formidable parallel processing capabilities, which unleashes the full potential of AI.

3.6. Computing vision

The aim of computer vision is to make it possible for machines to perceive and comprehend the environment through vision, much like people do. Algorithms are mostly used to recognize and evaluate photos. Image recognition and facial recognition are the most often utilized computer visions.

Deep learning-based image processing techniques have been in widespread usage since 2015. Neurons form the neural network, and the activation function in the model provides a nonlinear fitting function. Once the need to create the model's input and output is satisfied, the model may automatically pick up on the feature extraction and training classification processes. The most time-consuming and tedious aspect of picture categorization is made simpler with the application of deep learning, which also enhances its effectiveness and effectiveness. The most popular engineering structures are Startup, ResNet (Residual Neural Network), and VGG conventional neural networks. The project's model must take efficiency and effectiveness into account; in other words, it must guarantee correctness while guaranteeing speed. The model will be adjusted and lowered after training. Network models like YOLO (You Only Look Once), Mask-R CNN, and faster R-CNN are increasingly often utilized. These models all have the traits of great accuracy and quick speed. These models can recognize and produce results in real time in the field of facial recognition [22].

The image is divided into pixels by computer vision, which then processes the individual pixels. Understanding the significance of pixels after segmentation is the goal of semantic segmentation; doing so enables the recognition of objects in images like people, motorbikes, vehicles, and streetlights. It must be able to tell apart thick pixels. Semantic segmentation methods are encouraged to be developed by convolutional neural networks. Using a sliding window to do classification prediction is the most fundamental technique for semantic segmentation.

The completely linked layer of the network was supplanted by the advent of the completely Convolutional Network (FCN). The Encoder-Decoder architecture was created based on FCN. The decoder is used to restore the space size and detailed information because the encoder failed for lower space size activities. After that, Dilated/Atrous took over the pooling process. The ability to preserve spatial resolution is a benefit of whole convolution. A technique termed Conditional Random Field (CRF), in addition to the prior technique, can enhance the segmentation effect. The important AI drivers and technologies are covered in the following table (Table 2) (Table 3).

4. The research fields of AI

4.1. The expert system

An expert system is a body of information based on the present understanding of people. The expert system was the initial area of AI study. It is commonly used for medical diagnostics, geological surveys, and the petrochemical industry. Expert systems are a general term for a variety of knowledge systems. This is intelligent computer software that can solve complex problems that only subject-matter experts can, using knowledge and logic. It makes use of specialized knowledge provided by human professionals in order to imitate their mental processes. Due to its extensive knowledge and expertise in a certain field, the expert system can store, reason about, and make judgements all at once. The core consists of the thinking process and knowledge base.

The knowledge, experience, and research data of experts in a particular subject are first stored in the database and knowledge base via the expert system's application technique before being called by the interpreter and reasoning engine and given to the experts as needed. An interface for human-computer interaction allows users to achieve this. The application benefit of the expert system in education is independent of time and space constraints as well as environmental and emotional constraints. Education should make advantage of expert systems. They are in fact frequently utilized, and it is generally known that they provide benefits for remote learning[23].

4.2. Machine learning

When knowledge is inputted into a computer, it must be stated in a way that the machine can understand. Alternatively, a computer may have the capacity to learn, and to continually summarize and advance knowledge in practice. Machine learning is the term for this technique. The primary goals of machine learning research are to (1) understand how humans learn and think, (2) understand how people learn, and (3) understand machine learning techniques and build learning systems for particular tasks. Several academic fields, including information science, brain science, neuropsychology, logic, and fuzzy mathematics, serve as the foundation for machine learning research.

Artificial neural networks are the source of the deep learning idea. The Restricted Boltzmann Machine (RBN), the deep belief network (DBN), the convolutional neural network (CNN), and the stacking auto-encoder are examples of common deep learning methods. When the network layer in an early artificial neural network reached four layers, there was a difficulty. Training is done using the conventional backpropagation algorithm. A deep learning structure is convergence, a multilayer perceptron with many hidden layers. Combining low-level features to create high-level attribute categories or features allows deep learning to identify the distribution properties of the data. The perception neural network (PNN), back propagation (BP), self-organizing network (SON), self-organizing map (SOM), and learning vector quantization (LVQ) are notable artificial neural network techniques.

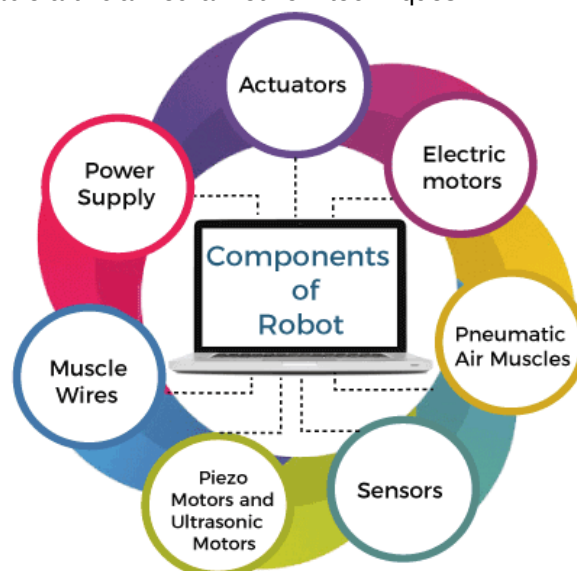


Figure 2. Components of Robot

4.3. The robotics

A machine that can mimic human behavior is called a robot. There have been three generations of advancement in robot research.

The robot is managed by a first-generation program. This type of robot may be programmed by the creator, then the program is stored in the robot, which subsequently follows the program's instructions. The technician will give the robot instructions before it does a task for the first time, and the robot will carry out the full procedure step by step. Every action that is noted on the ground is a representation of an instruction. Robots with a second generation are adaptable.

This type of robot is outfitted with the appropriate sensory equipment, such as vision, hearing, and touch sensors, allowing it to get basic data about its surroundings and the items it is manipulating. A computer processes the robot to manage operating operations. Robots with intelligence make up the third generation. The human-like intellect of the intelligent robot is combined with very sensitive sensors. It has more sensory capacity than the average person. The robot has the capacity to govern its behavior, assess the information it gathers, react to environmental changes, and carry out difficult tasks.

- **Application scenarios of AI**

AI has started to effectively solve issues and provide economic advantages based on the relatively mature development of technological circumstances including data, algorithms, and computing capabilities. Finance, healthcare, the automobile, and retail sectors, for example, have reasonably developed AI application scenarios from an application standpoint. The Automobile Sector, The Financial Sector, The Healthcare Sector, The Retail Sector, and The Media Sector, Smart Payment Sector, Smart Home Sector.

- **Three viewpoints of AI**

The three primary conceptual stances in the field of AI research are symbolism, connectionism, and behaviorism. They serve as the theoretical cornerstone for the development of AI disciplines and are the most significant theoretical theorems in the field.

4.4 Symbolism

Logicism is another name for symbolism. It holds that human cognition is based on symbols and that reasoning and computation using symbols are central to human thought. Through the application of mathematical logic, symbolism first represents people's cognitive objects as symbols before simulating human cognitive processes using the computer's built-in symbol processing power. The physical symbol system assumption and the concept of restricted rationality make up the majority of the supporting symbol principle.

Logic-based knowledge representation and reasoning technologies constitute the primary body of symbolic study. Newell, Simon, McCarthy, Robinson, and Shot field are its principal representatives. Expert systems, heuristic algorithms, expert systems, knowledge engineering theory, and technology are only a few of the primary study findings. Logical issues have been successfully resolved using symbolism. For instance, the "four-color conjecture" problem, which has never been proved manually, is resolved by artificial intelligence, as is the effective creation and use of expert systems in the 1970s.

4.5 Connectionism

The central tenet of connectionism, sometimes referred to as the Bionics, is that the physical makeup and cognitive processes of the human brain are what determine human intelligence. According to connectionism, the neurons in the human brain are the fundamental building blocks of human cognition, and the cognitive process is the way in which the brain processes information. In order to effectively simulate human intelligence on a machine, connectionism promotes mimicking the human brain's structure and functioning. Neural networks are the primary subject of connectionism studies. McClelland and Rumelhart are two of its principal representatives. The multi-layer network's back propagation (B-P) algorithm and study on brain models are the primary findings.

4.6 Behaviorism

The development of cybernetics is another name for behaviorism. The fundamental tenet is that intelligence is reliant on perception and action. It does not call for representation, knowledge, or logic. The ability to act, perceive, and sustain life and self-replication is considered by behaviorism to be the fundamental human ability. AI should develop gradually, just like human intelligence, to achieve intelligent behavior, which is embodied through interaction with the real-world environment. The representation and reasoning of knowledge are unrelated to it. Behaviorism's main goal is to mimic different human control behaviors. Brooke is its principal exemplar. Intelligent control and robot systems have been realized, which is the main development outcome. Although behaviorism hasn't developed into a complete theoretical framework yet, the AI community has taken a keen interest in it because of how drastically different it is from the conventional AI perspective.

The development of artificial intelligence is significantly impacted by the three aforementioned points of view. It could be argued that the development of various specific artificial intelligence analysis models, implementation strategies, and algorithms has been influenced by these three points of view. These ideas have a significant influence on even the most cutting-edge data mining, knowledge discovery, and intelligent agent technologies.

5. Conclusion

The study offers an organized overview of AI with a focus on prospects and development, fundamental techniques, useful scenarios, and challenges. This paper conducts a cutting-edge review of recently published and upcoming AI research.

Information, logic, cognition, thinking, systems, and biology all play a role in the interdisciplinary field of artificial intelligence. Natural language processing, pattern recognition, machine learning, and knowledge processing have all used it. Numerous fields have seen applications, including automatic programming, expert systems, knowledge systems, and intelligent robots. AI requires not only logical reasoning and imitation, but also an essential component of emotion. The next development in AI technology may enable computers to express emotion as well as increase their capacity for logical reasoning. It's possible that soon machine intelligence will surpass human intelligence.

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