

Artificial Intelligence and Its Applications

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Abstract: *The realm of Artificial Intelligence is the discipline of crafting intelligent machines and smart computer systems through science and engineering. It is connected with parallel endeavors in utilizing computers to grasp human intelligence though intelligence can transcend methods that are biologically observable. Although there is no universally agreed upon definition for Artificial Intelligence (AI), it is typically recognized as the field of computer science which can emulate human cognitive functions that include but are not limited to processes like perception, reasoning or decision-making. This research paper focuses on what artificial intelligence is all about, how we are depended onto AI in our daily life or what are the applications of AI, Different AI tools or machines powered by AI.*

Keywords: Machine Learning, Natural Language Processing, AI Tools, Neural Network

I. INTRODUCTION

Artificial Intelligence (AI) is the technology which is focuses on making machines which intelligent so that they can work without human interaction like an intelligent person. Intelligent system maximizes the success rate and minimizes the work load and cost. AI tries to solve the problem in way like a human can solve for this AI first gather the information available then uses step-by-step approaches like human to solve the problem in other words we can say AI follows some algorithms to work seems like an intelligent person. AI is the technology which is growing day-by-day on very high rate and it is useful in almost each and every field. This report aims to provide a comprehensive overview of the history, evolution, and notable examples of AI. It explores the different types of AI tools, their methods and the impact they have had on computer systems and networks. Additionally, the report discusses future trends and challenges regarding Artificial Intelligence and misuse of AI and the rise of AI and machine learning in cyber attacks.

II. HISTORY OF ARTIFICIAL INTELLIGENCE

Early Foundation (1940s-1960s)

- **1943:** McCulloch and Pitts developed the first mathematical model for neural network which is system composed of artificial neurons that can work like a neural structure of human brain.
- **1950:** Alan Turing discovered „Turing Test“ which helps to check machine intelligence.
Turing Test: The test involves 3 participants One human judge also known as a tester, a human responder and machine responder. The judge asks questions to both responders through interface. The both human and machine gives response to judge where the judge is totally unaware of which response is given by human and which response is given by machine if the judge can't differentiate between the human and machine response then the machine passes the test. In 1964 the Chabot like Eliza has been evaluated by Turing test.
- **1956:** John McCarthy has given name „Artificial Intelligence“ to the machines which are intelligent like human at the Dartmouth Conference.

Early AI Programs (1950s-1970s)

- **1951:** The early programs were developed for playing games cause in games after every step we to think for next step and term AI is given in 1956, so these programs are called as expert systems. Christopher Strachey developed a program for playing checkers and Dietrich Prinz wrote a first AI program for playing chess.
- **1964:** Joseph Weizenbaum developed ELIZA which is first Chabot and an early natural language processing program. In this time AI has been started developing widely.

Artificial Intelligence Winter and Recovery (1970s-1980s)

- **1970:** At this time interest in AI was drastically reduced and also reduced the funding for AI program therefore this phase is known as AI Winter where the development rate was slower than ever but after this the recovery of AI has been started as MYCIN was developed by Edward Shortliffe at Stanford University. MYCIN was expert system specially designed for medical diagnosis and treatment recommendations.
- **1980:** At this time the expert system like MYCIN led resurgence in AI. MYCIN was the remarkable example of how AI can be used to solve real world complex problems in particular field like healthcare.

Modern AI Development (After 1990s - 2024)

- **1997:** IBM's Deep Blue which is AI designed to play chess defeated the world champion Garry Kasparov. It was the first time AI defeated the world champion under standard chess tournament time controls. As this was rematched it is notable victory for AI. The development of IBM's Deep Blue has been started from 1980s. The initial version called as „Deep Thought“. The Deep blue is capable of analysing up to 200 million chess positions per second.
- **1990s-2024 :** In this time concepts like Machine learning, Natural Language Processing (NLP), Deep learning and Computer Vision are comes in frame with AI which helps to boost development of AI. The top companies like Google, OpenAI, Microsoft, NVIDIA, IBM, Amazon are researching and developing AI on very higher rate.

III. METHODS IN ARTIFICIAL INTELLIGENCE

3.1 Machine Learning (ML)

Machine learning is technique in which the computer programs are developed as they can access the data and use it to learn and make intelligent machines to take decisions by self like human. The primary goal of machine learning is to allow system to learn automatically without human intervention. Machine learning uses algorithms by which the machine gets able to take decision or make predictions. Types of Machine learning algorithms as follows.

- **Supervised learning:** This type of machine learning algorithm is used when data is labelled data or pre-processed data. Algorithm is used to classify or make prediction based on dataset. This algorithm mainly used to solve problems like classification and regression.
Example Algorithms: Decision Trees and Random Forests, Naïve Bayes, K-Nearest Neighbor (KNN).
- **Unsupervised learning:** This type of machine learning algorithm is used when data is unlabeled data or not a processed data. Algorithm is used to find similar patterns or relationship from data so they can be clustered. Clustering, Anomaly Detection, Association and Dimensionality Reduction are the types of unsupervised learning algorithms.
Example Algorithms: Apriori algorithm, K-means clustering, Principal Component Analysis (PCA).
- **Reinforcement learning:** The algorithm learns from interacting with the environment and take feedback. The feedback is in form of reward or penalties so algorithms can decide whether the action or decision taken is right or wrong. Model-free RL, Model-based RL, Policy Gradient Methods are the types of reinforcement learning algorithms.
Example Algorithms: Q-Learning, Deep Q-Networks(DQN), Policy Gradients.

3.2 Natural Language Processing (NLP)

Natural language processing is also field of Artificial Intelligence which focuses on the communication or interaction between human and computer. It enables computer to understand, interpret and manipulate the human language. The main aim of NLP is to make computer that can communicate with human through natural language that is both meaningful and useful. NLP also uses algorithms to make human and computer to communicate. Bag of Words (BoW), Term Frequency-Inverse Document Frequency (TF-IDF), Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM) are some of the algorithms which are used by NLP to make computer that can be naturally communicable with

human. NLP has great role of improving user experiences as it works on interaction between human and a computer.

3.3 Computer Vision

Computer Vision is also field of Artificial Intelligence which focuses mainly on visual data tries to make machines which can interact with visual data and make decision based on that. Computer vision makes computer to be able to extract the meaningful information from visual data like images, videos or environment. Computer vision is mainly used when computer needs to detect or take the decision on the basis of any objects visual appearance. Image Processing, Feature Extraction, Object Detection, Image Classification, Face Recognition, Optical Character Recognition (OCR) are some of the key concepts of Computer Vision means any system made under this uses this key concepts. Convolutional Neural Networks (CNNs), Transfer Learning, YOLO (You Only Look Once), Semantic and Instance Segmentation Networks these are some of the techniques and algorithms which are used in computer vision.

3.4 Deep Learning

Deep learning is a sub-field of machine learning which focuses on the artificial neural network. It works on many layers of neural network (hence „Deep Learning“). It used to solve problems based on complex data and tries it to solve more likely in human way. The system creates under deep learning are based on human brain processing means tries to create a system which works like a human brain. Neural network consist of many neurons (nodes) which learns the complex patterns. Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Generative Adversarial Networks (GANs), Autoencoders these are the types on neural networks on which the deep learning is based. Deep learning creates powerful AI tools which has made a revolution in industries. It has ability to work on large and complex data.

3.5 Robotics

Robotics is a field that evolving rapidly on very large scale which is also comes under AI or uses AI to create an intelligent machine which perform complex actions and wide range of tasks like a human. Innovations in AI and Robotics can create new opportunities for human and machine collaboration. Industrial Robots, Service Robots, Mobile Robots, Humanoid Robots are the types of robots which are working in different environment and fields. The Humanoid robot is main attraction as it look and also works like a human. The development in AI is developing and increasing the intelligence of these robots day-by-day. The development in AI and Robotics making evolutionary effect in every field.

3.6 Expert Systems

Expert systems are those who have been created to work like a human, but it uses the rules or knowledge (data) available to solve the problems. The system follows the predefined set of rules to solve the complex problems. The system follows rules to solve the problem of particular domain or system gather the information available and tries to solve the problem on basis of the information or data collected. Expert systems are mostly created to play games which have finite set of rules. Knowledge Acquisition, Knowledge Representation, User interface are some of the key concepts of the expert system. Expert systems have created significant tools in AI. These systems are very useful to solve complex problems across various domains.

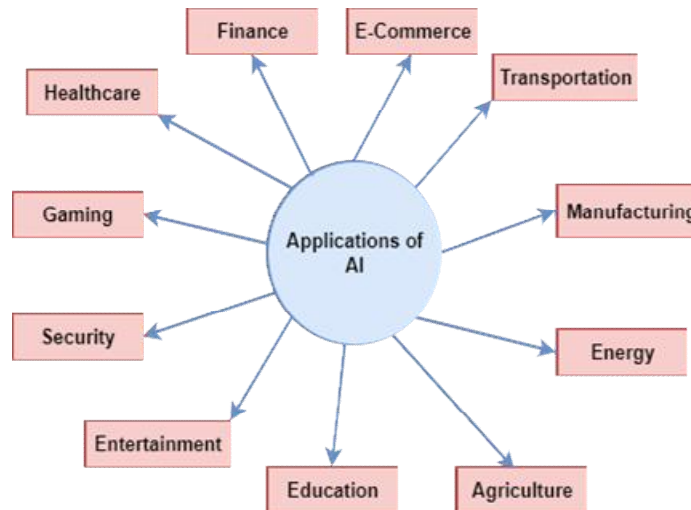
3.7 Hybrid AI Systems

Hybrid AI Systems are those AI systems which are made up of combining more than one AI Systems. Hybrid AI is powerful system which creates an effective AI system by integrating various AI tools and techniques. Rule-Based and Machine Learning, Knowledge Graphs and Neural Networks, Symbolic Reasoning and Deep Learning, Fuzzy Logic and Expert Systems these are the integration approaches which are used to create a powerful Hybrid AI system. Hybrid AI systems are created to improve performance and avoid inconsistency in AI system. Symbolic AI, Machine Learning

and Natural Language Processing (NLP) are the key concepts behind creating the Hybrid AI system. Hybrid AI Systems combine more than one AI technology which improves its strength, accuracy, adaptability, and interpretability. Hybrid AI systems can solve more complex and real world problems.

IV. APPLICATIONS OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is used in almost every field. Here are some of them. AI is widely using in every field and its usage is increasing day-by-day. The applications of AI as follows:

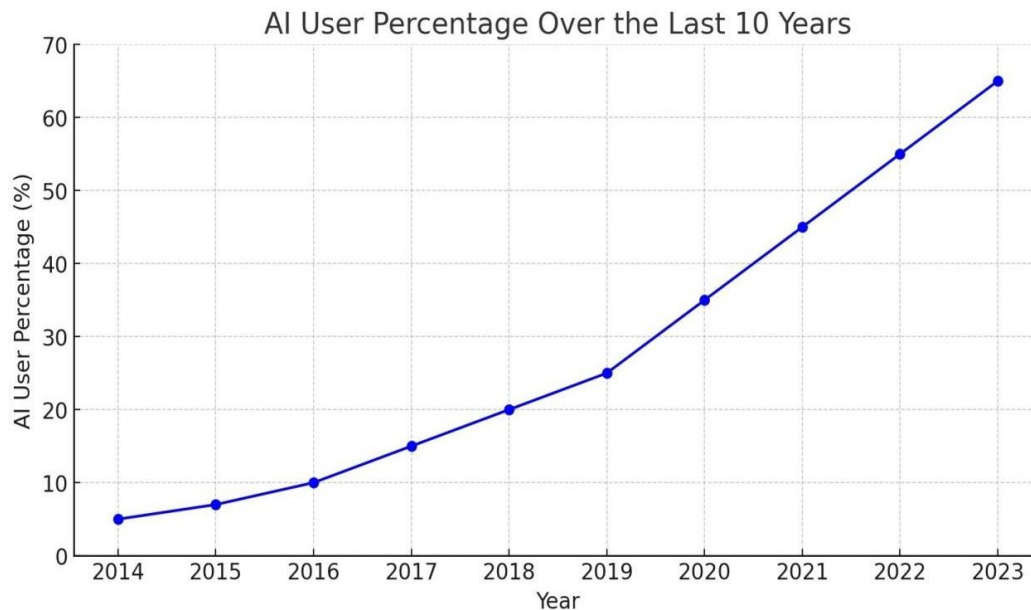


1. **Gaming:** AI is used in gaming from its beginning there are so many AI programs which are used to play strategic games like chess. AI can think large number of possible moves in game like chess. IBM's Deep Blue was specially designed to play chess and has defeated world champion in chess championship.
2. **Healthcare:** In last few years AI is significantly used in healthcare field. In this field AI is used for diagnosis purpose. AI is very useful for doctors to diagnoses of patient with accuracy and less time than usual. Robotic surgery means surgeries which are perform with the assistance of AI-powered surgical robots.
3. **Finance:** In finance sector AI is very useful as it is used fraud detection, algorithmic trading and also for customer service. AI uses ML algorithms to find pattern and identify the fraudulent transaction. AI also gives strong and highly accurate trading strategies by analysing market data. AI Chatbot helps in customer support by give right solution and advices.
4. **E-Commerce:** Price optimization tools are used to set price based on demand and also compare prices with competitor to give best price. Augmented reality (AR) is used by customer to check products visual appearance at real-time before making purchase. AI algorithms works on large volume of customer data which contains their shopping patterns, recent purchase using all this AI suggest the best product to the customer and AI customer service is also available 24 hours to solve any issue of customer.
5. **Transportation:** AI gives the best and optimize plan for deliveries by analysing the routes and traffic patterns. AI analyse traffic pattern and can handle the traffic signals to reduce the traffic. Self-driven vehicles have been invented by using the AI which can reduce the traffic flow and reduce the accidents.
6. **Manufacturing:** In manufacturing sector AI is used for maintenance, quality control and automation. AI can predict the failure of equipment which allows timely maintenance and reduce the downtime. AI inspects the products to ensure high-quality and AI-powered service robots increases efficiency.
7. **Energy:** AI optimizes the use of electricity which helps to save energy. AI predicts and works on renewable energy sources like wind and solar. AI is used to give best plan for consumption of energy.
8. **Agriculture:** In agriculture AI is used for crop monitoring, precision farming and automated harvesting. AI analyse soil conditions, weather conditions and environment to give best suggestions and optimize farming.

AI-powered drones and camera are used to monitor health of crops and drones are also used to spray pesticides Also AI-powered robots are used to work in the farm which help to reduce labour cost.

9. **Education:** In this field AI is used for personalized learning, automated grading and virtual tutors. Students used the AI generated content for better understanding and improve outcomes. AI grading system gives instant feedbacks to the students which are helpful for them. A virtual tutor helps students outside the classroom to give additional support to their study.
10. **Entertainment:** In this field AI is used for Content Creation. There are so many AI tools are available which can create music, art and stories. AI is also used as a recommendation system which recommends the best collection of movies, music and games based on our recent history. AI has enhanced the gaming experience by creating intelligent non player characters (NPC).
11. **Security:** AI is performing an important role in field of security. AI helps to improve the human safety. The Surveillance Systems used are AI-powered which detects any suspicious activity and immediately gives alert. Face recognition system helps to boost the security not only for mobile phones but this is also used at the places like airports, offices where security is important. AI also detects cyber threats by analysing network traffic and provides security to our system.

Above are the applications of Artificial Intelligence. The usage of Artificial Intelligence is increasing rapidly. The graph below shows the percentage of people using Artificial Intelligence.



The above graph is showing the percentage of AI user over the last 10 years by seeing the graph we can confirm that the usage of AI is increased significantly almost 70% people using AI now a days.

V. TOP TOOLS OF ARTIFICIAL INTELLIGENCE

1. **TensorFlow:** is an open source framework works with machine learning.
Developed by: Google Brain Team
Use Cases: Image and speech recognition, natural language processing, and time-series forecasting.
2. **PyTorch:** is an open source works with deep learning mainly used for computational graph.
Developed by: Facebook's AI Research lab (FAIR)
Use Cases: reinforcement learning, computer vision tasks and strong support to GPU.
3. **Scikit-learn:** is a free software machine learning library support to python. Built with NumPy, SciPy and matplotlib for data manipulation and visualization.

Developed by: Community-driven project

Use Cases: data manipulating and visualization, predictive analysis.

4. **Keras:** is high-level open source API. The interface of keras is written in python language. Keras is now integrated with TensorFlow 2.0 so can work on the TensorFlow.

Developed by: François Chollet

User Cases: Rapid prototyping, production ready application with deep learning.

5. **Amazon SageMaker:** is framework which provide full services to developer and data scientist to build, train and deploy any machine learning model.

Developed by: Amazon Web Services (AWS)

User Cases: Enterprise-level machine learning solutions, automated machine learning (AutoML).

VI. CHALLENGES AND FUTURE DIRECTIONS

Challenges: AI is facing so many challenges in its development phase. Privacy issue, preventing data loss and ethical considerations all this points has to be kept in the mind while developing any AI system. Transparency in decision-making is the most difficult challenge for AI systems. Like this AI system has to face so many issues and challenges but as it's developing rapidly this all issues will get resolve in the future. Cybercriminals are beginning to leverage artificial intelligence (AI) and machine learning (ML) to create smarter, more adaptive malware. These AI-powered viruses can analyse their environment and make decisions to maximize their spread and effectiveness. They might also use AI to find and exploit new vulnerabilities faster than human hackers.

Misuse of Artificial Intelligence: AI is very helpful and easy to use system in now days, but some people using these very powerful systems for malicious purpose. Usage of AI and ML is drastically increased in the field of Cyber-attacks. The hackers are also using these technologies to carry out the crime which is the biggest challenge against AI. Although development in AI is very good thing, but it depends in which way the people are using it. AI deep fake private photo or videos, AI generated voice notes, Bank frauds, device hacking are some crimes which are performed with the help of AI.

Future Directions: The future of AI is full of potential and AI will definitely deal with security concerns and challenges its facing now. The impact of AI will be positive and equitable as its continuously evolving. The next wave of AI will be full of advancements which enhance the capabilities and contribution of AI in development and shaping the future where the world is of AI technologies. AI will play a crucial role in addressing environmental challenges by optimizing resource use, monitoring ecosystems and predicting environmental changes. AI can help to optimize the effect of environmental changes. AI is also developing in new fields like Explainable AI (XAI), Edge computing, AI and Human-AI collaboration, Quantum AI, AI in Autonomous Systems, AI for Environmental Sustainability. The future is full of AI and it's developing rapidly. In the future the AI will be integral part of our life.

VII. CONCLUSION

AI has potential to evolve various industries through its advance capabilities. AI has its own history and origin that have been explored in this research paper. By understanding different AI methods and their applications can help into the development of AI in various fields. Continuous research and development will bring many new innovations and technologies in AI and make AI an integral part of our future. The research paper discussed the various application fields for AI and also discussed the challenges and future directions of AI. How the usage of AI is increasing has been shown by graphical representation. The conclusion is that AI has application in almost every field and AI is the best technologies in 21st century which will continuously get developed

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