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ARTIFICIAL INTELLIGENCE IN PHARMACY

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Abstract: Artificial Intelligence (AI) is slowly transforming the pharmaceutical sector. AI applications are expanding to achieve quality, accuracy, efficiency, high efficacy, rapid and bulk production of drug, time saving, economic growth etc. This review article covers AI technologies and their applications, Classification of AI, Future scope of AI, Milestones of AI etc. Artificial intelligence (AI) is a branch of study concerned with intelligent machine learning, primarily intelligent computer programmers that produce outcomes in a manner comparable to human attention. AI refers to a digital computers or a computer-controlled robot's ability to do tasks that are typically associated with intelligent beings. Artificial intelligence's usage in pharmaceutical technology has grown in recent years, and it can save time and money while also improving understanding of the links between various formulations and process parameters. Artificial Intelligence (AI) is concerned with the creation of intelligent models that aid in the imagining of knowledge, the solving of problems, and the making of decisions. AI is now being used in a variety of pharmacy domains, including drug discovery, drug delivery formulation development, polypharmacology, hospital pharmacy, and so on. Artificial Neural Networks (ANNs), Robotics, are used in drug discovery and drug delivery formulation development.

Key Word: Artificial Intelligence (AI), Drug Discovery, Drug Delivery, Research and Development(R&D), Robotics, Pharmacy, Machines Learning (ML),

1. INTRODUCTION

Artificial Intelligence (AI) is slowly transforming the pharmaceutical sector. It is thought to be the first AI programmed, designed by Newell and Simon in 1995. John McCarthy is considered as the father of artificial intelligence because he was the one who finally invented the term artificial intelligence. Artificial intelligence (AI) is a branch of study concerned with intelligent machine learning, primarily intelligent computer programmers that produce outcomes in a manner comparable to human attention. [1] Obtaining data, establishing effective mechanisms for using the data gained, showing definitive or approximate findings, and self-corrections/adjustments are all part of this process. In general, AI is used to analyses machine learning in order to emulate human cognitive processes. [2,3] Artificial intelligence (AI) is used to execute more accurate assessments and provide more meaningful interpretation. [3] In this case, AI technology combines several relevant statistical models as well as computational intelligence [4].

The pharmaceutical industry has seen a significant surge in data digitization in recent years. However, the challenge of gathering, evaluating, and utilizing knowledge to solve complicated healthcare problems arises with digitalization [5]. This encourages the usage of AI, which can handle massive amounts of data while also increasing automation [6]. Artificial intelligence (AI) is a technology-based system that uses a variety of advanced tools and networks to simulate human intelligence. At the same time, it does not pose a total danger to human physical presence [7,8]. AI makes use of systems and software that can read and learn from data in order to make independent judgments in order to achieve certain goals.

Classification of AI

AI can be classified in two ways: by its level of Eligibility and by its presence.[9]

- I. **Artificial Narrow Intelligence (ANI) or Weak AI:** It performs a limited set of tasks, such as facial recognition, car steering, chess practice, traffic signaling, and so on.
- II. **Artificial General Intelligence (AGI) or Strong AI:** This type of AI performs all of the tasks that humans do and is also referred to as human-level AI. It has the ability to simplify human cognitive capacities and perform new tasks.
- III. **Artificial Super Intelligence (ASI):** It is smarter than humans and engages in far more activities such as sketching, mathematics, and space exploration than humans.

AI can be categorized into the following groups based on their existence and absence:

- I. **Type 1:** It's for single-purpose programmed that don't need to remember anything because it doesn't have a memory system. The reactive machine is the name for it. Some instances of this memory include an IBM chess algorithm that can detect and anticipate checkers on a chess board.
- II. **Type 2:** It has a limited memory system that can only utilize prior experiences to solve difficulties. This system is capable of making judgments in automatic cars, and there are some recorded observations that are utilized to record subsequent actions, but these records are not kept indefinitely.
- III. **Type 3:** It is founded on the concept of "Theory of Mind." It suggests that human people' decisions are influenced by their own thinking, intentions, and desires. This is a hypothetical AI system.
- IV. **Type 4:** It has self-awareness, or a feeling of self. This is a hypothetical AI system.

1. APPLICATION OF AI IN PHARMACY

Application of artificial intelligence in the pharmaceutical industries:

- 1.1 Research and development(R&D).
- 1.2 Drug Discovery and development.
- 1.3 Patients Diagnosis.
- 1.4 Disease prevention.
- 1.5 Epidemic prediction.
- 1.6 Remote monitoring.
- 1.7 Manufacturing.
- 1.8 Marketing.
- 1.9 Drug design.
- 1.10 AI in Genetics.
- 1.11 Clinical trials.
- 1.12 Drug delivery systems
- 1.13 Robotics in Pharmacy
- 1.14 Artificial Neural Network (ANNs)

1.1 R&D

Pharma firms all over the world are using advanced machine learning algorithms and AI-powered tools to speed up the drug discovery process. These intelligence tools are designed to find nuanced patterns in vast datasets and can thus be utilized to tackle problems involving complex biological networks [10].

1.2 Drug Discovery and development.

The scale, growth, diversity, and ambiguity of data are all key data difficulties that AI must overcome. Pharmaceutical businesses' data sets can contain millions of molecules, which typical machine learning methods may not be able to handle. A computer model based on the quantitative structure-activity relationship (QSAR) can predict a large number of compounds or simple physicochemical characteristics like log P or log D in a short amount of time. These models, on the other hand, are a long way from predicting complicated biological features like a compound's efficacy or side effects.[11]

1.3 Diagnosis

Doctors can collect, analyses, and analyses large amounts of patient data using modern machine learning systems. ML technology is being used by healthcare practitioners all across the world to securely store sensitive patient data in the cloud or a centralized storage system known as EMRs (electronic medical records).[12]

1.4 Preventing disease.

AI can be used by pharmaceutical companies to research solutions for both common and rare diseases, such as Alzheimer's and Parkinson's. In general, pharmaceutical corporations do not devote time and resources to developing medicines for uncommon diseases since the return on investment (ROI) is minimal when compared to the time and cost of developing medications to treat rare disorders [13].

1.5 Epidemic prediction

Many pharmaceutical businesses and healthcare providers now utilize AI and machine learning to track and predict epidemic outbreaks around the world. These technologies use data acquired from a variety of online sources to investigate the impact of various geological, environmental, and biological elements on the health of people in different parts of the world, and to try to link these aspects to prior epidemic outbreaks. Such AI/ML models are particularly effective in developing countries that lack the medical infrastructure and financial resources to deal with an epidemic outbreak.

1.6 Remote Monitoring

It's a watershed moment in the pharmaceutical and healthcare industries. Many pharmaceutical companies have already built AI-powered factors for remotely monitoring patients with life-threatening conditions.

1.7 Manufacturing

Pharmaceutical industries can use AI in their manufacturing processes to boost productivity, efficiency, and speed up the creation of life-saving pharmaceutical products. All parts of the manufacturing process can be managed and improved by AI, including:

- 1.7.1 Quality control.
- 1.7.2 Predictive maintenance.
- 1.7.3 Waste reduction.
- 1.7.4 Design optimization.
- 1.7.5 Process automation.

1.8 Marketing

Because the pharmaceutical company is a sales-driven industry, artificial intelligence (AI) can be a helpful tool in pharma marketing. Pharma businesses are using AI to experiment with and build new marketing techniques that promise increased income and brand awareness.

1.9 Drug design.

The application of AI in the design of new drug is based on the interaction of 3D models of molecules with target locations (receptors, enzymes, etc.) that can represent possible therapies. This is accomplished through the use of deep learning techniques based on the molecules' prior behavior. In other words, just as AI learns to recognize photos by examining millions of instances, it develops potential medications based on the behavior of molecules in its database. Different programming businesses have collaborated with natural science specialists to develop an algorithm that detects medication interactions with a wide biological system, which then narrows down into smaller groupings of activities.[14]

1.10 Artificial Intelligence in Genetics

Genome sequencing is a huge, long-term project that is thought to allow scientists to investigate the origins of a variety of disorders. However, no one anticipated the massive volume of data they would receive and the time it would take someone to process it in order to extract usable information. Machine learning and technology now make it easier to access data with the help of computers, which speeds up study. It is now recognized that the origins of numerous diseases do not lay in the mutation of a single gene, but rather in the interaction of multiple genes.

1.11 Clinical trials

Drug trials are time-consuming and expensive, and machine learning has a number of potential uses in assisting with clinical trial organization. The use of advanced, predictive analysis in identifying candidates for clinical trials, determining the best sample size for increased efficiency, adjusting differences in patient recruitment sites, and reducing data errors using electronic medical records can lead to more efficient and cost-effective testing.

1.12 Drug delivery systems

In general, creating drug delivery systems has some drawbacks, such as predicting the relationship between formulation parameters and responses. [15] This is also linked to therapeutic outcomes and unanticipated events. On-demand dose adjustment or drug release rates, targeted releasing, and drug stability are all key elements in the design of many types of intelligent drug releasing systems. The appropriate algorithms are useful for controlling the quantity as well as the period of drug release in self-monitoring systems for drug release. [16,17] As a result, AI methods can be used to estimate drug dosing efficacy and drug delivery capability of drug delivery dosage forms. As a result, AI methods can be used to estimate drug dosing efficacy and drug delivery capability of drug delivery dosage forms.[18]

1.13 Robotics in pharmaceutical field: In the dispensing system, robotics plays a key part [19].

1.13.1 Safety and quality - It reduces dispensing errors and frees up dispensary workers to provide direct patient care [20,21].

1.13.2 Financial –

1.13.2.1 Stock holdings are being reduced.

1.13.2.2 Stock rotation has been improved.

1.13.2.3 Decreased wastage of expired inventory.

1.13.3 Process efficiencies –

1.13.3.1 Reduced patient wait times through a faster dispensing process.

1.13.3.2 An activity that takes place outside of normal business hours.

1.13.4 Reliability-

The FDA requires that all medicines be tracked and traced throughout the manufacturing process. Pharmaceutical businesses can meet these requirements more easily thanks to robots. Robots, on the other hand, help to reduce accidents and waste [19,22].

1.13.5 Production - As throughput speeds improve with robots, this has a direct impact on output! Robots have the potential to produce more than a human worker since they can labor at a steady speed without taking breaks, sleeping, or taking vacations [23].

1.13.6 Reduce chance of contamination - Removing individuals from the screening process decreases the risk of contamination and the possibility of dropped samples in laboratories. These jobs are much faster and more precise when performed by robots.

1.13.7 Increased efficiency - Robots can improve efficiency, lowering medicine prices. People, especially while wearing a protective gear, are not as efficient as robots when it comes to pharmaceutical manufacturing.

1.14 Neural networks and Artificial neural networks (ANNs)-

The learning algorithm for neural networks (from input data) mostly takes two forms. The following are the various types of neural networks:

1.14.1 Unsupervised learning: It means Learning without a teacher, The neural network is fed with data that has a recognized pattern. It's a tool for keeping track of things. The 'Self Organizing Map' or 'Korhonen' method is used in the unsupervised learning algorithm. [24] This is referred to as "very useful modelling" for locating relationships among complicated data sets.

1.14.2 Supervised learning: The sequences of harmonizing inputs and outputs depicted in this type of neural network are called supervised learning. It's used to figure out how inputs and outputs are connected. It demonstrates its utility in determining the cause-and-effect relationship between input and outcome in formulation. It's one of the most popular ANNs, and it's completely dependent on the back propagation learning algorithm.

2. FUTURE SCOPE OF ARTIFICIAL INTELLIGENCE

- 2.1 AI in science and research.
- 2.2 AI in cyber security.
- 2.3 AI in data analysis.
- 2.4 AI in transport.
- 2.5 AI in home.
- 2.6 AI in Healthcare

2.1 AI in science and research

In the scientific community, AI is making significant progress. Artificial intelligence is capable of handling vast amounts of data and processing it faster than human brains. This makes it ideal for studies using large amounts of data from multiple sources. In this field, AI is already making strides [25].

2.2 AI in cyber security

Another industry that benefits from AI is cyber security. The threat of hackers is getting more severe as businesses move their data to IT networks and the cloud [26].

2.3 AI in data analysis

AI and machine learning may help a lot with data analysis. AI algorithms can improve with iteration, and as a result, their accuracy and precision improve as well. Data analysts can use AI to assist them in handling and processing massive datasets [27].

2.4 AI in transportation

AI has long been used in the transportation industry. Since 1912, autopilot has been used to steer planes in the air. A plane's trajectory is controlled by an autopilot system, but the technology isn't limited to planes. Autopilot is also used by ships and spacecraft to keep them on track [28].

2.5 Home-based AI

In the guise of Smart Home Assistants, AI has found a unique position in people's homes. Amazon Echo and Google Home are two popular smart home devices that allow you to accomplish a variety of activities with only your voice.

2.6 AI in Healthcare

Before AI systems can be used in health-care applications, they must first be educated using data generated by clinical activities like screening, diagnosis, and therapy. A significant amount of AI literature evaluates data from diagnosis imaging, genetic testing, and electrodiagnosis, specifically in the diagnosis stage [29].

Milestones of AI

In 1956, the phrase "Artificial Intelligence" was coined for the first time. The notion of AI, on the other hand, has been used since 1950 with problem-solving and symbolic approaches [30].

Year	Events
1943	Walter Pitts and Warren McCulloch proved that Logical operations like “and”, or “not” can be done by neurons connected in a network
1956	The term ‘artificial intelligence’ was first appeared.
1958	Frank Rosenblatt created neuronal network called perceptron which can transmit information in one direction.
1974	Initiation of “First AI Winter”.

1986	Georey Hinton promoted Back propagation algorithm design which is widely used in deep learning.
1987	Initiation of “AI winter”.
1997	Garry Kasparov (Russian grandmaster) was defeated by IBM Deep blue.
2013	Google carried out efficient research on pictures by utilizing the British technology.
2016	In this year, the Go champion lee Sedol was defeated by Google DeepMind, software AlphaGo.

Table 1: Important milestones in the area of the AI worked [31].

Advantage

- I. The pharmaceutical business can use artificial intelligence to tackle challenges that were previously unsolvable with simple data analysis.
- II. AI can do specialized activities more correctly and efficiently, lowering costs while improving output.
- III. Artificial intelligence (AI) provides vital insights that will significantly improve clinical trial outcomes.
- IV. Deep understanding of market dynamics, customer behaviors, and how they interact.
- V. Unmet consumer needs are matched with expanded and distinctive value offers - tangible and intangible.
- VI. It boosts the development of new artificial intelligence algorithms while also improving antiviral detection performance.
- VII. It also aids in the selection of patients for clinical trials, allowing companies to detect any issues with compounds much earlier in terms of efficacy and safety. If coded correctly, AI would have a low error rate compared to humans. They'd be incredibly precise, accurate, and quick.
- VIII. Robotic radio surgery, as well as other types of surgery in the future, will be able to attain precision that humans will not be able to achieve.
- IX. Deep learning and natural language processing are being used by AI to grasp and evaluate large amounts of bioscience data, which is revolutionizing drug discovery [32].

Disadvantage

- I. Because AI lacks the ability to think, it can only work according to pre-programmed instructions. It is capable of corrupting the younger generation.
- II. Can be transformed first and principally to mass destruction.
- III. If robots begin to replace people in all industries, it will eventually result in job loss.
- IV. Building, repairing, and rebuilding can be costly in terms of both money and time.
- V. When placed in the wrong hands, machines can quickly lead to destruction. That is, at least, a common human worry.
- VI. Humans are already defendant on AI and losing their mental capacities, as demonstrated in part with cellphones and other technologies.
- VII. AI as robots has the potential to usurp humanity and enslave mankind [33].

Conclusion

The use of artificial intelligence (AI) is at the heart of a new venture to develop computational intelligence models, software. The underlying premise is that intelligence (human or otherwise) may be expressed in terms of symbol structures and symbolic operations that can be programmed into a digital computer. There is substantial disagreement over whether such a properly programmed computer would be a mind or merely simulate one, but AI researchers do not need to wait for the outcome of that debate, nor for the hypothetical computer that can model all of human intelligence. The human being is the most advanced machine that has ever existed. The human brain is striving hard to build something that is much more efficient than a human being at performing any given task, and it is succeeding to some level. Artificial intelligence (AI) techniques such as Watson for cancer and robotics have significantly altered the profession. Artificial intelligence is expanding to achieve quality, accuracy, efficiency, high efficacy, rapid and bulk production of drug, time saving, economic growth etc.

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