Artificial Intelligence in Pharmaceutical Science

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Abstract—**Artificial Intelligence (AI) concentrates on generating intelligent models that facilitate knowledge representation, problem-solving, and decision-making. Explores the transformative impact of artificial intelligence (AI) and robotics in the pharmaceutical industry. AI technologies enhance drug discovery and delivery through predictive modeling of pharmacokinetics and patient reactions, utilizing traditional expert systems and advanced artificial neural networks (ANNs) for improved efficacy and affordability in drug research. Robotics is poised to revolutionize the sector by automating processes, reducing operational costs, and facilitating rapid adaptation in drug development. The integration of machine learning allows for analyzing large datasets, supporting the creation of innovative medications while maintaining dynamic clinical trial integrations, heralding a new era in pharmaceutical advancement.**

Index Terms—**Artificial Intelligence, Artificial Neural Network, Pharmaceutical Industry, Robotics.**

I. INTRODUCTION

Artificial intelligence (AI) is the study of machine learning, computer programs that produce results equivalent to how humans focus. This usually includes gathering data, developing efficient techniques for using the data obtained, self-modification and presenting precise conclusions. It is used to analyse and simulate human thinking processes. [1] Medication development, treatment plan creation, and medical accuracy verification are some of the most important things that may be done. AI in pharmacy is used to customize dosages according to the individual characteristics of each patient. Pharmaceutical companies employ artificial intelligence (AI) techniques to expedite the drug discovery process. These days, artificial intelligence is being used more and more to evaluate adverse drug events and assess the efficacy of medications. Numerous AI-based solutions are being developed, including drug-making and dispensing robot pharmacies. The Erica robot, IBM Watson for Oncology, and molecules for each patient are examples of how artificial intelligence (AI) software has been used for research in recent years. [2] Modern artificial intelligence techniques have made extremely reliable computational tools available to the fields of pharmaceuticals and biological science. AI makes machines think like humans. Models to mimic or restore human function. [3]

II. HISTORY

AI Maturation (1943-1952) Year 1943: Warren McCulloch and Walter Pits completed the first study that is now known as artificial intelligence in 1943.They suggested a neuron model. Donald Hebb presented an update rule for altering the strength of the connections between nerve cells in 1949. We now refer to his rule as Habana learning. [4] The history of artificial intelligence has been difficult and dates back to the 1950s. Long considered a field for dreamers, perceptions began in 1997 with IBM's Deep Blue team's victory over chess champion Garry Kasparov. In 2011, International Business Machine Watson is a supercomputer that uses analytics and automation to answer questions. Afterwards, supercomputer has developed into medication development, and in 2016 Pfizer was used to treat immune cancer. In December 2016, IBM and Pfizer together unveiled International Business Machine Watson, a cloud-based medical laboratory's results and researchers to identify correlations in various sets of data through visualizations. [5]

III. CLASSIFICATION OF ARTIFICIAL INTELLIGENCE

AI is divided into two categories:
1. Based on their calibre
2. Based on their presence
1] Based on their calibre

a. Artificial General Intelligence (AGI) or Strong AI-

The term "human-level AI" is commonly used because of its ability to replicate human abilities. AI of this type is capable of handling novel tasks and streamlining human thought processes.

b. Artificial Super Intelligence (ASI)-

It surpasses human intelligence and exhibits significantly improved ability in fields like painting, mathematics, and space-related activities, including both current and emerging technologies.

c. Artificial Narrow Intelligence (ANI) or Weak AI

It concentrates on certain tasks, such as driving, chess practice, traffic signal management, and facial recognition, among others. [6]

2] Based on their presence and absence:

I) Type1: Reactive machine

It has specific uses and no memory system; therefore, it is unable to recall past events. We call it a machine that is reacting. An IBM chess program that makes intelligent predictions and can recognize the checkers on the chessboard is an example of this kind of memory.

ii) Type 2: Limited memory system

Although its memory system is small, it can tackle a variety of problems by drawing on prior knowledge. A system in automatic autos is capable of making decisions. While certain observations are documented and used to record actions that follow, these records are not permanently stored.

iii) Type 3: Based upon "Theory of Mind"

It implies that people's individual thoughts, intentions, and desires influence the decisions they make. This system is an AI that doesn't exist.

IV) Type 4: Self-awareness

It possesses self-awareness, or consciousness and self-awareness. Additionally, this system is a non-existent AI. [5]

IV. ARTIFICIAL INTELLIGENCE IN PHARMACEUTICAL SECTOR

Artificial intelligence in pharma includes drug discovery and delivery formulation development and other applications in healthcare. The application of AI models also enables the prediction of appropriate dosage, pharmacokinetic properties of the treatments, and in vivo reaction. The drug pharmacokinetic prediction is so important, silicon prototypes are utilized to improve drug research's affordability and effectiveness. Two major categories of advancements in artificial intelligence exist. First, the conventional computing techniques, such as expert systems, provide examples of findings and replicate human experiences. From the underlying ideas, such as expert systems. In the second, (ANNs) artificial neural networks is help to improve brain functions. (RNNs) recurrent neural networks and (DNNs) Deep neural networks are two examples of ANNs that specifically regulate the advancement of AI technology. Twelve DNN problems demonstrate higher productivity than the baseline machine learning approaches in the Merck Cagle and NIH Tox21 challenges. With the ability to learn with or without clear programming, machine learning uses appropriate statistical approaches. Thirteen De novo design also encourages the creation of novel medicinal compounds with respect to ideal or desired properties. [1]

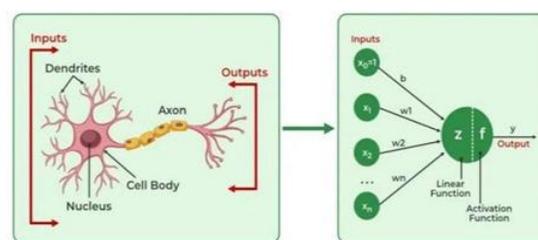AI inspired by nature – biological neuron

Fig.1 Biological neuron

V. ROBOTIC IN HEALTH CARE AND PHARMACEUTICAL INDUSTRY

What is robotic?

Robotics is multifunctional, re-programmable manipulator created to move material tools or device through numerous distinct motions for the completion of a number of tasks.

The fourth industrial revolution is about to occur, and it will change how we live, work, and even what makes us human. The world is changing. Artificial intelligence, 3D printing, robotics, big data, and some advances in the field of life sciences, such as genetics and medical imaging, are among the technologies that are currently combining to transform practically every industry, including the pharmaceutical sector. These technologies are also combining in a way that is caus-

ing a number of revolutionary changes in various industries. Automation, semi-automated machinery, and manual labour will be replaced by self-automated machinery in the pharmaceutical business.

Why Robotics?

Robots can be trained more quickly than people, are less expensive to maintain, are simpler to refuel and repair, and are less likely to get bored with monotonous work. [7]
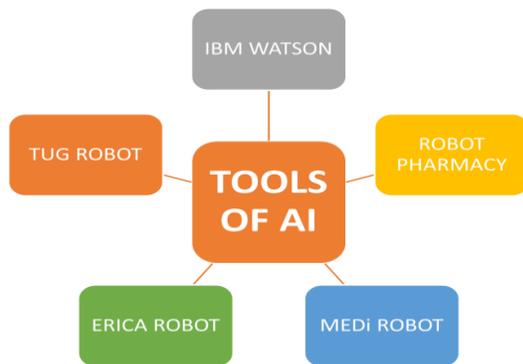
VI. ADVANCE TECHNIQUE

Fig.2 Tools of AI

1) Erica Robot: In Japan, Osaka University researcher Hiroshi Ishiguro developed the Erica robot, as shown in (fig. 4). The Kyoto University, Advanced Telecommunications Research Institute International (ATR), and Japan Science and Technology Agency collaborated to develop this robot. She speaks Japanese and has both European and Asian facial features. The robot can understand questions and respond with human-like facial expressions, even though it cannot walk on its own. Ishiguro fixed the features of thirty attractive women using the average, which is why Erica is the "most beautiful and intelligent" android. [8]

Fig.3 Erica Robot

2) Robot pharmacy: To improve patient safety, robotic technology is utilized at UCSF Medical center for tracking and preparing medications as shown in (fig.5). They claim that equipment has been used to produce 3, 50,000 doses of medication without any errors. When it comes to size and administration of medication, the robot has proven to be significantly more accurate than humans. The robot can produce oral and injectable drugs, including lethal chemotherapy medicines, among other things. Because of this, UCSF the pharmacists and nurses are capable to applying their expertise by focusing on directly caring for patients and working alongside the physicians. [8]

Fig.4 Robot pharmacy

3) Tug Robot: Anthon TUG robots are designed to roam the hospital autonomously, transporting resources, food, medicine, specimens, and heavy items like trash and linens as shown in the following(fig.6). It consists of two orders: proctected carts and permanent and an interchange support platform, and it may help to take carts, bins, and racks. The permanent carts are useful to convey laboratory specimens, medication, and responsive material, while the replace platform is designed to move supplies that may be placed on other racks. Because it can divide a large range of racks and carts, the TUG is a very flexible and serviceable source. [9]

Fig.5 Tug robot

4) Media Robot: Media stands for Engineering Designing Intelligence and medicine. Tanya Bearn, a professor of community health sciences at the University of Calgary in Alberta, oversaw the development of the pain management robot. Media got the concept while working in hospitals where children scream while receiving treatment. During a medical operation, the robot initially establishes a bond with youngsters who scream, as shown in (fig.7). It provides patients with instructions on what to do, how to breathe, and coping mechanisms throughout the medical treatment. Despite its inability to reason, plan, or think, the robot can be designed to appear to have artificial intelligence. The robot was first created to help with pain management, but over time, its applications have grown to include fundraising, physical rehabilitation, and comfort in between surgeries. [10]

Fig.6 Media robot

5) Berg: Using a large patient database, it has an AI-based drug development stage that finds and approves a variety of biomarkers connected to the onset of sickness. Based on the information acquired, medications are then selected. Berg, a Boston-based biotech company, is among the largest to use AI in its many operations. The company wants to employ AI to reduce costs and speed up drug detection since it removes the estimation required for medicine augmentation. To ascertain the exact cause of sickness, Berg uses a series of procedures that involve acquiring sequencing data from a human tissue sample, learning about protein production and metabolites, and evaluating records using AI algorithms. [9]

VII. APPLICATION OF ARTIFICIAL INTELLIGENCE

1) Product Development

The process of the development of drugs, medicines, and medications is an example of optimizations issues with several variables. It involves process and composition variable optimization. The Capacity of artificial neural networks has advantageous features of generalization. Because of these characteristics, they can be used to solve formulation optimization issues in the creation of pharmaceutical products. In studies of the influence of various factors (such as formulation and compression parameters) on tablet qualities (such as dissolution), ANN models demonstrated superior fitting and prediction capabilities in the development of solid dosage formulations. In order to minimize experimental effort, ANNs are a helpful instrument for the growth of drug-delivery systems dependent on microemulsions. [8]

2) Drug Discovery

It is a laborious and intricate procedure that includes finding possible therapeutic targets, creating and evaluating novel chemical compounds, and launching a new medication. Artificial intelligence (AI) has the ability to completely transform the drug discovery process by evaluating enormous volumes of data from several sources to find novel therapeutic targets and forecast probable toxicity and side effects. Artificial intelligence (AI) systems can reduce these time-consuming activities by evaluating vast volumes of data from many sources, such as chemical databases, scientific literature, and genetic and proteomic data. Combining information from many sources allows AI to find new targets. [11]

3) Accuracy of medicine

AI has a positive effect on genetic development and genomics. An AI system called Deep Genomics can be used to find mutations and connections to diseases by looking for patterns in genetic data and medical records. This technique tells clinicians about what happens in a cell when genetic variation changes the DNA. Craig Venter, the creator of the human genome project, created an algorithm that uses a patient's DNA to provide information about their physical attributes.

"Human Longevity" AI technology can be used to pinpoint the precise location of vascular illnesses and cancer in their early stages. [12]

4) Manufacturing

Pharma industries use artificial intelligence (AI) in their production processes to improve output, boost efficacy and provide life-saving medications more quickly. All facets of the manufacturing process, including the following, can be managed and enhanced by AI:

- Quality control
- Waste reduction
- Process automation
- Design optimization [13]

5) Clinical Trials and Design

Clinical trials are essential to the drug development process as they yield the data necessary to assess the safety and efficacy of a novel medication. AI is useful in clinical trials and design because AI increases the efficiency of the clinical trial process. It is used to evaluate patient data, including genetic, medical and demographic information and AI algorithms can determine which individuals are most likely to benefit from a new medication. [11]

VIII. ADVANTAGES

i. Robotic radio surgery and other surgical modalities in the future may achieve precision unattainable by humans.
ii. If successfully programmed, artificial intelligence would exhibit a reduced error rate compared to humans.[14]
iii. Challenging exploration.[4]
iv. Improvement of product performance and quality at a reasonable price.[8]
v. Physicians are learning about several medications and their adverse effects via AI algorithms.
vi. which are helpful to uncover novel chemical compounds and entities.[10]

IX. DISADVANTAGES

i. No Replicating Humans - Robots that have AI technology can think like human beings with the added advantage of not having any emotions and moral standards.

ii. Lack of Original Creativity: Machines lack emotional intelligence and sensitivity, in contrast to humans. Humans are creative beings, and machines cannot mimic human thought processes. Humans possess basic innate abilities that cannot be reproduced in any way.[15]
iii. High Cost: The development of smart technologies can be costly because of their complexity and the requirement for constant upkeep and repair.[16]
iv. Large-scale unemployment could result from the widespread applications of AI technology in all fields.[1]

X. FUTURE SCOPE

Machine learning methods can handle complex analyses with large, diverse, and high-dimensional sets of data without any input from a person. This has been useful in writing business applications.[5] AI and machine learning can be effectively utilized to build a robust, long-lasting pipeline of novel medications. And also using machine learning and the power of modern supercomputers, we could create drugs more rapidly and affordably. [17] Additionally, real-time data from ongoing clinical trials may be incorporated into AI systems more frequently, which would make drug development procedures more flexible and dynamic. [18]

XI. CONCLUSION

The pharmaceutical industry and the healthcare sector overall have seen a revolution thanks to artificial intelligence (AI), a potent technology. AI is employed in clinical trials, manufacturing processes, medication research, product development, and dosage accuracy because of its enormous data analysis capabilities. The application of AI in various fields has accelerated the creation of life-saving drugs and enhanced efficiency and accuracy. But there are drawbacks to AI as well, like exorbitant prices, the possibility of job displacement, and the incapacity of robots to mimic human emotions and inventiveness. The potential applications of AI in the pharmaceutical sector are numerous. As machine learning techniques evolve further, they will enable more intricate analyses and quicker medication development procedures. AI systems will more easily incorporate real-time data from clinical trials, increasing the flexibility and dynamic nature of medication development. AI has a promising future in the

pharmaceutical industry overall, with the ability to completely transform how drugs are found, created, and given to patients.

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