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Artificial Intelligence Importance and application in Pharma Industry

Rahul Sarda*, Rachappa Mahale, Sanjay Motipwar

*Deputy Manager, Par Formulation Endo India Ltd. Indore
Senior Manager, Par Formulation Endo India Ltd. Indore
Vice President, Technical Services, Par Formulation Endo India Ltd. Indore
Corresponding author email address: rahulsardam.pharm@gmail.com

Abstract The usage of artificial intelligence in pharmaceutical technology has grown over time, and it now helps us comprehend the correlations between various formulations and process factors while also saving time and money. A subfield of computer science called artificial intelligence deals with the use of symbolic programming to solve problems. It has significantly developed into a problem-solving science with numerous applications in business, medicine, and engineering. The article discusses the development of novel peptides from natural foods, the treatment and management of rare diseases, drug adherence and dosage, and challenges to the adoption of AI in pharma. It also discusses manufacturing execution systems, automated control processes systems, and AI to predict new treatments.

Keywords Drug Discovery, Tools of AI, MES, ACPS, Treatment and management of rare diseases, Drug adherence and dosage, Challenges to adoption of AI in Pharma

Introduction

A subfield of computer science called artificial intelligence (AI) focuses on using symbolic programming to solve problems. It has significantly developed into a problem-solving science with broad applications in business, medicine, and engineering [1]. This artificial intelligence's major goal is to recognise practical information processing issues and provide an abstract explanation of how to address them. A theorem in mathematics relates to such an account, which is referred to as a method. In the study of artificial intelligence, algorithms are designed and used to analyse, learn from, and understand data. A wide range of statistical and machine learning techniques, pattern recognition, clustering, and similarity-based techniques are all included in artificial intelligence [2]. AI is a rapidly developing technology with several uses in both business and daily life. The pharmaceutical industry has recently found new and inventive methods to leverage this potent technology to assist address some of the most pressing issues confronting pharma at the moment. In the pharmaceutical industry, artificial intelligence refers to the use of automated algorithms to tasks that normally require human intellect. The application of artificial intelligence in the pharmaceutical and biotech sectors has completely changed how researchers create new medications, treat diseases, and more during the last five years [3].

History

The Logic Theorist was invented by Allen Newell and Herbert A. Simon. The renowned conference was first conducted by Dartmouth College in 1956 [4], The market for artificial intelligence is expected to generate up to 10

times more revenue between 2017 and 2022. The market for natural language processing, which has several applications such as text prediction, speech and voice recognition, is expected to expand by 28.5% in 2017. Big data and business analytics generated US$ 122 billion in revenue globally in 2015, and it is anticipated that this amount would surpass US$ 200 billion by 2020 [5]. Since the 1950s, artificial intelligence has had a turbulent history. When IBM's Deep Blue computer beat chess champion Garry Kasparov in 1997, the perception that it was a field for dreamers began to shift. In 2011, IBM's brand-new Watson supercomputer was successful in taking home the $1 million prize on Jeopardy in the US. Since then, Watson has diversified into the healthcare and pharmaceutical industries, forming a relationship with Pfizer in 2016 to quicken the development of new immuno-oncology drugs. In December 2016, IBM and Pfizer unveiled IBM Watson, a cloud-based platform that provides researchers with the capacity to discover connections across various data sets using dynamic visualisations [6].

Artifical Intelligencein Drug Discovery

Testing chemicals against samples of sick cells is a time-consuming process in the drug development process. Further investigation is necessary to identify chemicals that are physiologically active and merit further study. The research teams at Novartis utilise pictures generated by machine learning algorithms to forecast which untested chemicals could be worth further investigation. As new data sets are discovered by computers far more quickly than by traditional human analysis and laboratory experimentation, novel and effective medications can be made accessible sooner while also incurring lower operational expenses than when each substance is manually investigated [3]. The leading pharmaceuticals firms' current AI initiatives include:

- Mobile platform to improve health outcomes –the ability to recommend patients by means of real time data collection and thus improve patient outcomes.
- Drug discovery- pharma companies in conjunction with software companies are trying to implement the most cutting –edge technologies in the costly and extensive process of drug discovery [7].

Figure 1: Drug discovery cycle

Tools of AI

Robot pharmacy:

The UCSF Medical Center employs robotic technology for the manufacture and monitoring of pharmaceuticals with the aim of enhancing patient safety. They claim that the system has accurately prepared 3,50,000 doses of medicine. The robot has shown to be significantly superior to humans in terms of size and its capacity to administer precise drugs. The manufacture of hazardous chemotherapy medications for oral and injectable use is one of the capabilities of robotic technology. Because of this, UCSF's pharmacists and nurses are now free to put their skills to use by concentrating on providing direct patient care and collaborating with doctors [8].

Figure 2: Robot pharmacy

MEDi Robot:

Medicine and engineering designing intelligence is abbreviated as MEDi. AI-based tools The University of Calgary in Alberta's Tanya Beran, professor of Community Health Sciences, served as the project leader for the creation of the pain management robot. After working in hospitals where children cry during medical procedures, she had the notion. Although the robot is incapable of thinking, planning, or reasoning, it may be designed to appear to have artificial intelligence (AI) [10]. The robot initially establishes a connection with the kids before explaining what to anticipate during a medical treatment.

Erica robot:

A researcher at Osaka University named Hiroshi Ishiguro created the new care robot Erica in Japan. It was created in cooperation with Kyoto University, the Advanced Telecommunications Research Institute International, and the Japan Science and Technology Agency (ATR). It speaks Japanese and possesses a fusion of facial features from Europe and Asia [11]. It enjoys watching cartoon movies, wants to go to Southeast Asia, and desires a life partner who will converse with it, just like any other typical human being.

The robot cannot walk independently; however, it has been developed with the ability to understand and answer questions with human-like facial expressions. Erica is the "most beautiful and intelligent" android as Ishiguro fixed up the features of 30 beautiful women and used the average for designing the robot‟s nose, eyes, and so on [12].

TUG robots:

Robots called Aethon TUG are made to autonomously move around the hospital and transport large items like trash and linen as well as prescriptions, meals, specimens, and resources. It features two versions, including swap base platforms that may be used to transport racks, bins, and carts, as well as fixed and secured carts. Medication, delicate items, and lab specimens are delivered using fixed carts; in contrast, commodities that may be put onto multiple racks are transported using interchange platforms. The TUG is a particularly adaptable and useful resource since it can provide many sorts of carts or racks [13].

Automated control process system [ACPS]:

The elements of [ACPS] include:

- Sensing process variables‟ value.
- Transmission of signal to measuring element.
- Measure process variable.
- Presenting the value of the measured variable.
- Set the value of the desired variable.
- Comparison of desired and measured values.
- Control signal transmission to final control element. and
- Control of manipulated value.

Berg:

One of the leading companies using AI in its numerous operations is Berg, a biotech company with headquarters in Boston. It features an AI-based drug discovery platform with a sizable patient database that is used to locate and validate the many disease-causing biomarkers before choosing treatments based on the information gathered. The company's mission is to use artificial intelligence (AI) to accelerate the drug discovery process and save costs by doing away with the element of guessing that is inherent in drug development [14].

Manufacturing Execution System (MES)

The benefits of using MES include compliance with guaranteed legal regulations, minimized risks, increased transparency, shortened production cycles, optimized resource utilization, controlled, and monitored production steps, and optimized up to batch release [15].

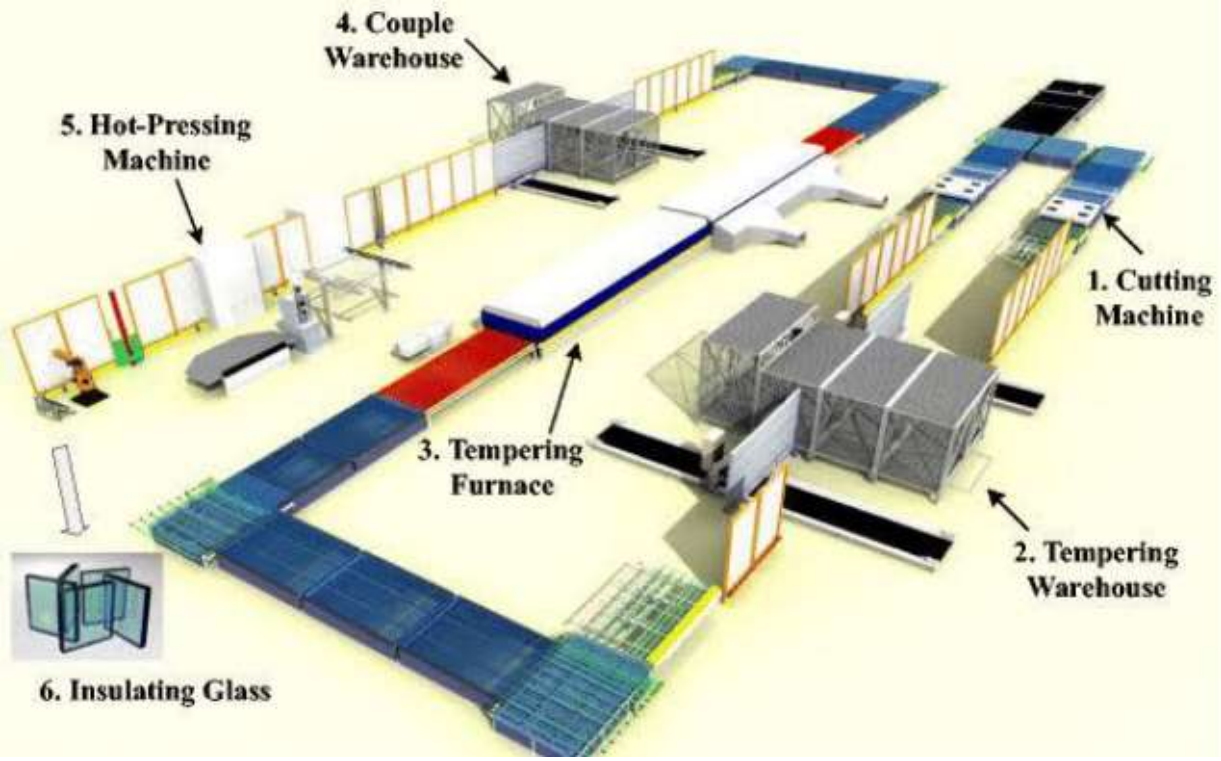

Figure 3: Manufacturing execution systems

AI to Predict New Treatments

Verge is addressing key issues in drug development by employing automated data collection and analysis. In other words, hundreds of genes that play intricate roles in brain illnesses like Alzheimer's, Parkinson's, or ALS are being mapped out using an algorithmic technique. Verge's theory is that collecting and interpreting gene data will have a good effect on the preclinical trial stage of drug research. The idea is that Verge can utilise AI to track, beginning in the preclinical stage, the effects that particular medication treatments have on the human brain. As a consequence, pharmaceutical companies may learn more quickly about a drug's impact on human cells. Verge uses artificial intelligence to keep track of the impact certain therapies on the human brain with a particular focus on the preclinical phase [3].

Development of Novel Peptides from Natural food

The Irish begin Nerites makes use of AI and other cutting-edge technology to accelerate the search for new, more robust foods and nutritious components. By utilising this collaboration, BASF (Baden Aniline and Soda Factory) will create brand-new functional peptides derived from organic foods. To forecast, examine, and validate peptides

from natural sources, BASF really makes use of Nuritas AI and DNA analysis capabilities. Discovering and bringing to market peptide-based treatments that would aid in the treatment of illnesses like diabetes is BASF's key objective.

Treatment and Management of Rare diseases

AI developments and growing interest in remedies for uncommon diseases. Over 350 million individuals worldwide suffer from one of the 7,000 uncommon illnesses that exist today. Though Heal, a UK-based biotech company, has obtained $10 million in Series A investment to employ AI to discover novel treatments for rare disorders, it's not all bad news for patients with uncommon diseases. Another Swiss biotech firm, Thera Chon, has acquired $60 million in financing to use AI to create medicines to address uncommon genetic illnesses.

Figure 4 : Treatment and management of rare disease

Drug-Adherence & Dosage

To boost treatment adherence and increase drug trial attentiveness, Abbvie teamed up with the New York-based Acura. In this partnership, Abbvie deployed the AiCure mobile SaaS platform's facial and image recognition technology to track adherence. To be more explicit, the platform powered by AI verifies that the appropriate individual did indeed consume the proper pill after the patients use their smartphones to record a video of themselves eating a pill. And the outcomes were astounding, increasing adherence by as much as 90%. Several clinical trials have changed the dose given to particular individuals in order to improve the outcomes using Genpact's AI technology. In this collaboration, Bayer makes use of Pharmacovigilance Artificial Intelligence (PVAI) from Genpact to monitor medication compliance as well as identify potential adverse effects considerably sooner.

Using AI to Make Sense of Clinical Data & to Produce Better Analytics

People may easily participate in clinical trials and studies using Apple's Research Kit without having to go through a formal physical enrollment process. It is an environment for clinical research built around its two major devices, the Apple Watch and the iPhone. For instance, Duke University employs a face recognition system powered by AI and patient data gathered from these Apple devices to detect autistic youngsters. Making sense of the gathered health data has become simple thanks to research kit.

Finding more Reliable Patients Faster for Clinical Trials

Although there is a wealth of patient data available, big pharma finds it challenging to find the suitable people for clinical trials. Clinical trials, for instance, may last an average of 7.5 years and cost between $161 million to $2 billion per medicine if the right individuals are found and enrolled. Unfortunately, clinical studies miss deadlines by 80% of the time. The $65 billion clinical trial sector requires an overhaul with over 18,000 clinical trials actively recruiting participants in the US. The biggest difficulty facing pharmaceutical firms may be obtaining relevant information from patient records. Fortunately, that's where artificial intelligence and machine learning come into play.

Challenges to Adoption of AI in Pharma

While AI has an extensive potential to help redefine the pharmaceutical industry, the adoption itself is not an easy walk in the park.

Challenges that pharma companies face while trying to adopt AI:

- The unfamiliarity of the technology — due to its youth and esoteric nature, AI still looks like a "black box" to many pharmaceutical businesses.
- Lack of appropriate IT infrastructure - this is a result of the fact that the majority of present IT applications and infrastructure were not created or designed with artificial intelligence in mind. Even worse, pharma companies must spend a lot of money on upgrading their IT infrastructure.

Since a large portion of the data is in free text format, pharmaceutical firms must go above and beyond to compile and convert this data into a format that can be examined. Despite these limits, one thing is certain: AI is already changing how the biotech and pharmaceutical industries operate.

And ten years from now, Pharma will simply look at artificial intelligence as a basic, everyday, technology.

Figure 5: Challenges to adoption of AI in pharma

Artificial Intelligence in Pharma is a good idea:

The pharmaceutical industry may speed up innovation by utilising new technologies. Artificial intelligence, the development of computer systems capable of performing activities typically requiring human intelligence, such as visual perception, speech recognition, decision-making, and language translation, would be the most recent technical development that comes to mind. According to an IBM estimate, the total amount of data in the healthcare industry was at 161 billion GB as of 2011. Due to the enormous amount of data that is accessible in this field, artificial intelligence can really assist in data analysis and result presentation that will aid in decision-making, save time, money, and human effort, and ultimately save lives. Epidermic outbreak prediction; one may research the history of epidermic outbreak utilising machine learning and artificial intelligence, analyze the social media activity and predict where and when epidermic can effect with considerable accuracy.

Apart from the a fore mentioned use-cases there are numerous others like:

- Personalizing the treatment

- Help build new tools for the patient , physicians etc.
- Clinical trials research : applying predictive analytics to identify candidates for the trial through social media and doctor vists.

Limitations:

Electronic documents that need to be streamlined must first be cleaned up since they are disorganised and dispersed over several databases.

Transparency: Given the difficulty of the artificial intelligence-based procedures, consumers require transparency in the health care they get.

Medical data is confidential and legally accessible, according to data governance. It's crucial to obtain public approval. Pharma businesses are renowned for being conservative and change-resistant. To provide the greatest treatment possible, we must eradicate the stigma.

Benefits and Issues

- Effective use of incomplete data sets,
- Rapid analysis of data,
- Ability to accommodate constraints and preferences and ability to generate understandable rules.
- Enhancement of product quality and performance at low cost,
- Shorter time to market,
- Development of new products,
- Improved customer response,
- Improved confidence and [3].
- AI would have a low error rate compared to humans, if coded properly. They would have incredible precision, accuracy, and speed.
- They won't be affected by hostile environments, thus able to complete dangerous tasks, explore in space, and endure problems that would injure or kill us.
- This can even mean mining and digging fuels that would otherwise be hostile for humans.
- Replace humans in repetitive, tedious tasks and in many laborious places of work.
- Predict what a user will type, ask, search, and do. They can easily act as assistants and can
- recommend or direct various actions.
- An example of this can be found in the smartphone.
- Can detect fraud in card-based systems, and possibly other systems in the future.
- Organized and manages records.
- Interact with humans for entertainment or a task as avatars or robots.
- An example of this is AI for playing many videogames.
- Robotic pets can interact with humans. Can help w/ depression and inactivity.
- Can fulfill sexual pleasure.
- They can think logically without emotions, making rational decisions with less or no mistakes.
- Can assess people.
- This can be for medical purposes, such as health risks and emotional state. Can simulate medical procedures and give info on side effects.
- Robotic radiosurgery, and other types of surgery in the future, can achieve precision that humans can't.
- They don't need to sleep, rest, take breaks, or get entertained, as they don't get bored or tired [16].
- Can cost a lot of money and time to build, rebuild, and repair. Robotic repair can occur to reduce time and humans needing to fix it, but that'll cost more money and resources.
- Storage is expansive, but access and retrieval may not lead to connections in memory as well as humans could.

- They could never, or, at least, seemingly never with our technological perceptions, receive creativity that humans have.
- This can prevent sympathizing with emotions for human contact, such as in being nurses.
- This can also reduce wisdom can understanding.
- This can prevent common sense occurring. Even if coded with common sense and to learn, it seems hard for them to get as much common sense that humans could.
- As seen partially with smartphones and other technology already, humans can become too dependent on AI and lose their mental capacities.
- Machines can easily lead to destruction, if put in the wrong hands. That is, at least a fear of many humans [16].

Application

(1) In Formulation:

Controlled release tablets: Hussain and colleagues at the University of Cincinnati carried out the pioneering work in the application of neural networks for modelling pharmaceutical formulations (OH, USA). They modelled the in vitro release properties of a variety of medicines distributed in matrices made from different hydrophilic polymers in separate investigations. In every instance, it was discovered that neural networks [17] with a single hidden layer had acceptable performance in the prediction of drug release. In a more recent study, researchers from the University of Ljubljana in Slovenia and the pharmaceutical company KRKA dd (Smerjeska, Slovenia) used neural networks to predict the rate of drug release and to carry out optimization using the formulation of diclofenac sodium from a matrix tablet made from cetyl alcohol [18].

Immediate release tablets: Approximately three years ago, two studies launched the field's first efforts. One study11 by Turkoglu and colleagues from the University of Marmara (Turkey) and the University of Cincinnati employed statistics and neural networks to predict different hydrochlorothiazide tablet compositions. In an effort to maximise tablet strength or choose the optimal lubricant, the networks created were utilised to construct three-dimensional plots of massing time, compression pressure, and crushing strength, or drug release, massing time, and compression pressure [19]. Despite patterns being seen, no ideal formulas were offered. The patterns matched those produced by statistical methods. Using evolutionary algorithms, comparable neural network models were created and subsequently improved. It was found that the optimum formulation depended on the constraints applied to ingredient levels used in the formulation and the relative importance placed on the output parameters. A high tablet strength and low friability could only be obtained at the expense of disintegration time. In all cases lactose was the preferred diluents and fluidized bed the preferred granulating technique [20].

(2) In Product Development:

An example of a multivariate optimization issue is the creation of medicinal products. Variables used in formulation and process optimization are involved. The capacity of artificial neural networks to generalise is one of their most advantageous traits. These characteristics make them excellent for dealing with issues relating to formulation optimization in the production of pharmaceutical products [21]. In studies of the influence of various elements (such as formulation, compression parameters), on tablet qualities, ANN models demonstrated greater fitting and forecasting skills in the production of solid dosage forms (such as dissolution). In order to build micro emulsion-based drug delivery systems with the least amount of experimental work, ANNs were a helpful tool.

Conclusion

The human body is the most advanced machine that has ever been built. The human brain is actively attempting to develop something that is much more effective than a human person at doing any given activity, and it has had remarkable success in doing so to some level. The field has seen a significant transformation because to AI technologies like the robotic pharmacy, pull robot, and Watson for cancer. The infrastructure that the healthcare industry needs will need to be increasingly sophisticated and technologically advanced as it grows. The creation and use of algorithms for data analysis, learning, and interpretation constitute artificial intelligence.

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