

Artificial Intelligence in Pharmaceutical Industry

Darshan Bapusaheb Khairnar, Mr. Yashpal Mahendra More

Loknete Dr. J.D.Pawar college of Pharmacy Manur, Kalwan.

Department Of Pharmaceutics, Loknete Dr. J.D.Pawar college of Pharmacy Manur, Kalwan.

Submitted: 01-05-2023

Accepted: 08-05-2023

ABSTRACT

Artificial intelligence and machine learning have been playing a significant role in the pharmaceutical industry and consumer healthcare business. Artificial intelligence is branch of computer science capable of analysing complex medical data. Their potential to exploit meaningful relationship with in a data set can be used in the disease identification and diagnosis, treatment, helping to identify patient for clinical trials, drug manufacturing and predictive forecasting. The most important advantage of artificial intelligence is that it reduces the costs that are related with drug developments and enhances the returns on investment and may even cause a decrease in cost for the end user. The present study describes the drug discovery, diagnosis, and prediction of new treatment, development of novel peptides from natural foods, treatment and management of rare diseases, drug adherence and dosage challenges to adoption of artificial intelligence in pharmaceutical industry.

Keywords: Artificial intelligence, machine learning, pharmaceutical industry, drug Discovery, drug manufacturing, clinical trials

I. INTRODUCTION

Artificial Intelligence (AI) is the branch of engineering science which deals with creation of intelligent machines, particularly intelligent computer programs. It is the ability of computer or a robotic computer enabled system to process the given information and produce outcomes in a manner similar to the attention process of human in learning, decision making and solving problems. AI is a branch of computer science that aims to create intelligent machines, which becomes an essential part of the technology industry. AI has brought a prominent revolution in pharmaceutical industries. It is being majorly exploited in each and every field of healthcare industry. This technology is a culmination of human intelligence and computer processing. It is an advanced version of computer aided technique that consists of collecting the information from various sources, then preparing rules accordingly to

be followed for handling the required information, and drawing possible outcomes to determine appropriate results and processes can resemble the human behaviour. It consists of subunits such as machine learning and deep learning which provide ease in working with neural works [1-3]

Basics of Artificial intelligence:

Machines can only act like humans and response like humans only if that information about activity is store in that machine. Artificial intelligence has ability to judge objects, properties, categories and relations between all with the help of information coded in it. Begin common sense; logically thinking and ability of problem-solving functions in machines is a very difficult work to develop in machine. A.I. Learning involves Machine learning as a key part with not using or giving any kind of command given need a skill to recognize patterns in run or flow of inputs, and ability of learning alongside assign control includes numerical regressions and Classification. Concludes of the category is done by classification an object belongs to and regression compact alongside acquiring a set of numerical output or input examples, thereby finding of new functions allow the creation of acceptable and satisfactory outputs from the specific inputs. [4] Theoretical computer science compact alongside mathematical analysis of machine learning algorithms and their demonstration. Machine recognition deals alongside the ability to employ sensory inputs to gather the different characteristics of the world, meanwhile computer vision is the potential to analyze visual inputs along with some sub- problems such as facial, object and motion recognition. Robotics is also a crucial field connected to AI. Robots need smart intelligence and reconnaissance to navigate tasks such as object handling and navigation, along with sub-problems of mapping, localization and motion planning. Deep learning is really just a term to express definite types of neural networks and related algorithms that absorb raw input data. Data operation is done through many layers of nonlinear transformations of

the input data in relation to calculate a target output. Unsupervised characteristic removal is also an zone where deep learning shine.[5] Feature extraction is when an algorithm is able to automatically derive or construct meaningful features of the data to be used for additional learning, generalization, and understanding. The load is traditionally on the data scientist or programmer to carry out the characteristic selection in most other machine learning approaches, along with characteristic selection and engineering. Characteristic selection usually involves some amount dimensionality reduction as well, which is reducing the amount of input features and data required to create meaningful results. This has many uses, which include simplification, computational and memory power reduction, and so on. Programmers would teach a neural network to observe an object or phoneme by wipe out the network with digitized versions of images comprises those objects or sound waves containing those phonemes. If the network is unable to correctly recognize a particular pattern, an algorithm would adjust the weights. The final goal of this training was to get the network to consistently recognize the patterns in speech or sets of images that we humans know as, say, the phoneme “d” or the image of a dog. [6] This is much the same way a child learns what a dog is by noticing the details of head shape, behavior, and the like in furry, barking animals that other people call dogs. Evolution of A.I began from early mob who took an effort to develop it, and the algorithmic approaches over the years included decision tree learning, inductive logic programming. [7] Clustering, reinforcement learning, and Bayesian networks among others. As we all know, none achieved the ideal goal of common AI, and even limited AI was mostly out of reach with early machine learning approaches. As it turned out, one of the very best application premises for machine learning for many years was computer vision, however it still need a great deal of hand-coding to get the job done. Individuals would go in and write hand-coded classifiers like edge detection filters so the program could point out where an object started and stopped; shape discernment to decide if it had eight sides; a classifier to acknowledge the letters “STOP.” From all those hand-coded classifiers they would promote algorithms to make sense of the image and “learn” to determine whether it was a stop sign. Good, but not mind-bendingly great. Mainly on a foggy day when the sign isn’t ideal visible or a tree obscures part of it. There’s rise in computer vision and image detection didn’t come close to match humans until

very recently, it was too fragile and too prone to error. Time and the right learning algorithms made all the difference. [8]

Advantages of Artificial Intelligence [9-11]

1. Reduction in Human Error

One of the biggest advantages of Artificial Intelligence is that it can significantly reduce errors and increase accuracy and precision. The decisions taken by AI in every step is decided by information previously gathered and a certain set of algorithms. When programmed properly, these errors can be reduced to null.

2. Zero Risks

Another big advantage of AI is that humans can overcome many risks by letting AI robots do them for us. Whether it be defusing a bomb, going to space, exploring the deepest parts of oceans, machines with metal bodies are resistant in nature and can survive unfriendly atmospheres. Moreover, they can provide accurate work with greater responsibility and not wear out easily.

3. 24x7 Availability

There are many studies that show humans are productive only about 3 to 4 hours in a day. Humans also need breaks and time offs to balance their work life and personal life. But AI can work endlessly without breaks. They think much faster than humans and perform multiple tasks at a time with accurate results. They can even handle tedious repetitive jobs easily with the help of AI algorithms.

Disadvantages of Artificial Intelligence [9-11]

1. High Costs

The ability to create a machine that can simulate human intelligence is no small feat. It requires plenty of time and resources and can cost a huge deal of money. AI also needs to operate on the latest hardware and software to stay updated and meet the latest requirements, thus making it quite costly.

2. No creativity

A big disadvantage of AI is that it cannot learn to think outside the box. AI is capable of learning over time with pre-fed data and past experiences, but cannot be creative in its approach. A classic example is the bot Quill who can write Forbes earning reports. These reports only contain data and facts already provided to the bot. Although

it is impressive that a bot can write an article on its own, it lacks the human touch present in other Forbes articles.

3. Unemployment

One application of artificial intelligence is a robot, which is displacing occupations and increasing unemployment (in a few cases). Therefore, some claim that there is always a chance of unemployment as a result of chatbots and robots replacing humans.

Use of Artificial Intelligence in Pharmaceutical Marketing

The process of promoting the sales of a company product and services is called marketing [16]. As per an interview with, Jon Resnick, President, Real-world & Analytics Solutions, IQVIA, he stated that “Machine learning and artificial intelligence allows global life science sales, marketing and branding team to come up with more profitable and actionable commercialization strategies from the insights uncovered from AI”. He also emphasized on the fact that AI/ML enables healthcare companies to dive deeper into granular layers of HCP, patient, and payer data to reveal previously untapped insights, show predictions on which actions can be taken, and enable better and faster decision-making²⁾.

The use of artificial intelligence systems in pharma offers additional advantages such as enhanced value proposition, optimal resource allocation for better market share gain, ability to maximize growth, customized sales, and marketing information, and channels [advanced analytics for pharma marketing efficiency and growth.]. Companies such as Google and IBM and some other companies are starting up to specialize in harnessing AI in disease diagnosis. India is employing predictive and descriptive artificial intelligence. Also in India, the companies involved in developing medical equipment and supplies are using descriptive and predictive artificial intelligence. Atop US Pharmaceutical company used physician level intelligence explored by optimizing multichannel marketing activity data to increase promotional strategy and its implementation. With the help of distinctive targeting, segmentation, and promotional campaigning plan they tried to optimize return on investment. There was a gradual increase in sales of about \$25 million in six months without having to increase in its marketing expenditure. In another case study, a Europe based pharmaceutical

company employed AI and machine learning to know the HCP’s preferences regarding digital engagement. The new insights helped the company to segment doctors and generate a digital engagement strategy as per knowledge collected from a physician. It showed an increased rate in the opening of emails sent to HCP and requests for more product details. This use and acceptance of AI can be seen at different places across the healthcare network. Artificial intelligence can help to study a person’s genome to recommend the most effective treatment option fewer side effect^[13]

Artificial Intelligence in Drug Discovery:

Drug discovery often takes a long time to test compounds against samples of diseased cells. Finding compounds that are biologically active and are worth investigating further requires even more analysis. To speed up this screening process, Novartis research teams use images from machine learning algorithms to predict which untested compounds might be worth exploring in more details. As computers are far quicker compared to traditional human analysis and laboratory experiments in uncovering new data sets, new and effective drugs can be made available sooner, while also reducing the operational costs associated with the manual investigation of each compound⁵The current AI initiative by the top biopharmaceutical companies include: [a] mobile platform to improve health outcomes –the ability to recommend patients by means of real time data collection and thus improve patient outcomes. [b] 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. The possibility of the development of a large number of drug molecules from a chemical space becomes lengthy due to lack of appropriate technologies, which can be improvised by using AI in the drug development process^[15]

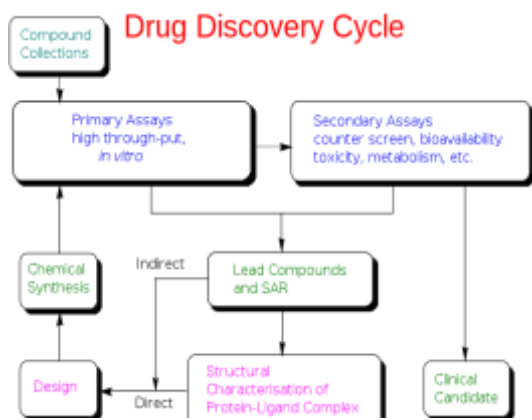


Fig no. 1– Drug Discovery Cycle

Tools of AI

1) Robot pharmacy:

The objective of improving the safety of patients, UCSF Medical Centre uses robotic technology for the preparation and tracking of medications. According to them, the technology has prepared 3, 50, 000 medication doses without any error. The robot has proved to be far better than humans both in size as well as its ability to deliver accurate medications. The abilities of the robotic technology include preparation of oral as well as injectable medicines which include chemotherapy drugs that are toxic. This has given freedom to the pharmacists and nurses of UCSF so that they can utilize their expertise by focusing on direct patient care and working with the physicians^[16].

2) MEDi Robot

MEDi is a short form for medicine and engineering designing intelligence. Tools of AI the pain management robot was developed as part of a project led by Tanya Beran, professor of Community Health Sciences at the University of Calgary in Alberta. She got the idea after working in hospitals where children scream during medical procedures. The robot first builds a rapport with the children and then tells them what to expect during a medical procedure^[16], although the robot cannot think, plan, or reason, it can be programmed such that it shows to have AI^[17].

3) TUG robots:

Nursing

TUG was designed with nurses in mind. With TUG, nurses know when meds, meals, supplies and tests are arriving. No more chasing. No more calling. No kidding. The result is higher job satisfaction and more time for patient care.

Pharmacy

TUG securely delivers medications through the hospital and directly to nursing units. It secures and automates deliveries that are normally made through pneumatic tubes or manual couriers including controlled substances and refilling carts.

Lab

TUG eliminates the headaches and restrictions associated with pneumatic tube systems. Best of all, by using biometric security and unique pin codes, TUG ensures only authorized medical personnel add or remove specimens to the secured cabinet.^[18]

Top 5 AI Companies in India Creating Solutions for Pharma Sector^[19]

Artificial Intelligence is redefining the way work is done in large corporations. With innovations in AI happening at a rapid pace, it will definitely be the technological zeitgeist in the near future. The advancements in AI has spread across all the business domains with pharmaceutical companies lately catching up in the race. In this article, we present the top five AI companies that assist in developing solutions for the ever-growing drug industry. The companies are listed in alphabetical order.

1. Indegene

Indegene is an Information Technology and Services company that assists healthcare organisations using analytics and technology. Its core agenda to its client companies are cost cutting solution for healthcare and customer engagement. The customer base for Indegene covers life science organisations, biotech companies, medical device manufacturers and similar divisions in the healthcare sector. As part of its innovation, Indegene slowly is using the potential of AI and Machine Learning (ML) to mainly address drug safety. Technically, AI would help reinforce traditional pharmacovigilance systems, with human intervention in between to supervise safety. The company has also tied up with tech titan Microsoft to come up with full stack solutions using their cloud platform Azure to enhance customer relationship management (CRM) with analytics.

2. Intuition Systems

This Bengaluru-based start-up which develops point-of-sale (POS) and billing systems using AI and ML, has collaborated with Lantern Pharma, a biopharmaceutical company which uses

precision oncology to treat cancer and its related diseases. With cancer being harder to detect and treat at initial stages, Lantern aims to alleviate this problem using its advanced genomics and AI for improved drug development. Intuition Systems will work with Lantern's team to help with AI, big data, cloud services and infrastructure to support drug development and biomarker identification. Similarly, Intuition will offer its AI-services to other pharmaceutical companies to fulfil technological needs. The POS systems brought out by the company is proprietary which primarily serves retail sectors.

3. Innoplexus

A tech company with AI and ML as its core services, Innoplexus helps customers from life science and pharmaceutical sectors make critical business level decisions using public and private relevant data to generate insights. It aims at cutting drug development costs by mainly using AI. Based in Frankfurt – Germany, Innoplexus has domestic operations in India with corporate offices in Pune. Notably, the company has a trademark product called the I Plexus — a cloud database consisting of scientific research data obtained from clinical trials, major patent offices, forums, regulatory bodies and other genuine sources

4. RxPrism

RxPrism is a digital healthcare marketing company which focuses on providing solutions specifically to pharmaceutical and life sciences organisations. With Bengaluru as its headquarters, the company extends support to even customers such as physicians, patients and health insurance providers. In its latest development, it has come up with an innovative AI solution which is powered by Amazon's Alexa. The solution mainly brings all the applications, software and documents of pharmaceutical companies under one roof. This makes it easier to interact with people hands-free such as between a doctor and patient or between a researcher and reviewer. This will enable much more convenience on board.

5. Tricog Health

Tricog Health Services Pvt. Ltd., is a healthcare start up which offers services such as electrocardiography (ECG) solutions using artificial intelligence. Founded in 2014, it has its office in Bengaluru with close to 50 employees working for the case. The company identifies itself as a medical device manufacturer with a focus on ML to

aggressively tackle heart related diseases and their drug development in India. Apart from ML, it also offers solutions such as web/app development, signal processing among others.^[19]

Future Direction

Research and development- Pharmaceutical industries have to make portfolio's in order to mitigate the requirements to satisfy the needs that ensure the proper investment of R and D funds to enable decision-making Clinical Trial Research. Clinical trial is time taking and too much expensive, to get a market approved product it takes more than 15 years. Recent trends of drug discovery process is less sustainable Clinical trials with Artificial Intelligence have tendency to enhance the safety and quality of life enhancing therapies. Drug activity prediction and precision is much higher in these methods.^[20]

APPLICATIONS

(1) **In Formulation:** Controlled release tablets: The first work in the use of neural networks for modeling pharmaceutical formulations was performed by Hussain and coworkers at the University of Cincinnati (OH, USA). In various studies they modelled the in vitro release characteristics of a range of drugs dispersed in matrices prepared from various hydrophilic polymers. In all cases, neural networks with a single hidden layer were found to offer reasonable performance in the prediction of drug release. In a more recent study involving the formulation of diclofenac sodium from a matrix tablet prepared from cetyl alcohol, personnel from the pharmaceutical company KRKA dd (Smerjeska, Slovenia) and the University of Ljubljana (Slovenia) have used neural networks to predict the rate of drug release and to undertake optimization using two- and three-dimensional response surface analysis. Immediate release tablets: Work in this area began only some three years ago with two studies. One by Turkoglu and coworkers from the University of Marmara (Turkey) and the University of Cincinnati¹¹ used both neural networks and statistics to model tablet formulations of hydrochlorothiazide. The networks produced were used to prepare three-dimensional plots of massing time, compression pressure and crushing strength, or drug release, massing time and compression pressure in an attempt to maximize tablet strength or to select the best lubricant.^[21-22]

(2) **In Product Development:** The pharmaceutical product development process is a multivariate optimization problem. It involves the optimization of formulation and process variables. One of the most useful properties of artificial neural networks is their ability to generalize. These features make them suitable for solving problems in the area of optimization of formulations in pharmaceutical product development. ANN models showed better fitting and predicting abilities in the development of solid dosage forms in investigations of the effects of several factors (such as formulation, compression parameters) on tablet properties (such as dissolution). ANNs provided a useful tool for the development of micro emulsion-based drug-delivery systems in which experimental effort was minimized.^[23]

II. CONCLUSION

Artificial Intelligence serves as marked platform in the advancement of pharmaceutical sector. AI saves time as well as provides the required set of data analysis and quality control. The various components of AI such as ANN (Artificial neural networks), deep learning, genetic programming etc. are being used for rationale design of drug molecules. The AI has also influenced the area of healthcare by playing a major role in clinical research by concluding the adverse effects. Artificial intelligence can lead to the development of various technologies and software that would help improve the pharmaceutical product development and health management strategies.

REFERENCES

- [1]. Ch. Krishnaveni. Swarupa Arvapalli, Artificial Intelligence in Pharma industry- A Review, International Journal of Innovative Pharmaceutical Sciences and Research, 2019.07.10.506
- [2]. S.S Manikaran, N.L. Prasanthi, Artificial Intelligence Milestones and Role in Pharma and Healthcare Sector, Pharma times VOL. 51-NO. 01- January 2019.
- [3]. Kamal Singh Rathore, Pooja Borisa, Impact of Artificial Intelligence on Pharma Industry, Mani pal Journal of Pharmaceutical Sciences VOL.6, Issue 1, March 2020.
- [4]. Statistical Artificial Intelligence (AI). Available from <https://www.statista.com/study/38609>. [Accessed 1 June 2019]
- [5]. Rowe R. C, Colbourn E. A, Pharm. Tech. Eur. 9 (1996)46-55.
- [6]. Qwek S.S, Lim C.P, Peh K.K, Int. J. Comp. Intel. Appl.1 (2001) 187-292.
- [7]. Goh W.Y, Lim C.P, Peh K.K, K Subari, Neural Comput. Appl. 10 (2002) 311-317.
- [8]. Holland J.H, Adaptation in Natural and Artificial Systems, the University of Michigan Press, Ann Arbor, MI, USA (1975).
- [9]. Eye for Pharma. Artificial Intelligence- A Brave New World for Pharma. Available from: <http://www.social.eyeforpharma.com/clinical/artificialintelligencebravenewworld-pharma>.
- [10]. <https://www.drugtargetreview.com/article/15400/artificialintelligence-drugdiscovery/>
- [11]. University of California San Francisco, New UCSF Robotic Pharmacy Aims to Improve Patient Safety. Available from: <https://www.ucsf.edu/news/2011/03/9510/newucsfroboticpharmacyaimsimprovedpatientsafety>.
- [12]. Myshko D, Robinson R. Artificial Intelligence: Molecule to Market. Pharmvoice website. <https://www.pharmavoice.com/article/201901pharmaai/>. Accessed April 18, 2020
- [13]. How Artificial Intelligence will Revolutionize Healthcare. Bigthink.com website. <https://bigthink.com/philip-perry/how-artificialintelligencewill-revolutionize-healthcare>. Accessed April 4, 2020.
- [14]. Ríache Brazil The Pharmaceutical Journal Dec 2007
- [15]. Bass D (2016) Oicrosoi develops AI to help cancer doctors find the right treatments. Bloomberg
- [16]. University of California San Francisco. New UCSF Robotic Pharmacy Aims to Improve Patient Safety. Available from: <https://www.ucsf.edu/news/2011/03/9510/newucsfroboticpharmacyaimsimprove-patient-safety>.
- [17]. [Last Accessed on 2017 Jun 24]
- [18]. McHugh R, Rascon J. Meet MEDi, the Robot Taking Pai Out of Kids Hospital Visits. Available from: <http://www.nbcnews.com/news/usnews/meet-medi-robot-taking-pain-out-kidshospital-visits-n363191>. [Last accessed on 2017 Jun 24]

- [19]. Trynacit K. MEDi Robot to Comfort Patients in StolleryChildren’sHospital. Available from: <http://www.cbc.ca/news/canada/edmonton/m edi-robot-to-comfortpatients-in-stollery-children-shospital-1.3919867>. [Last accessed on 2017 Jun 24].
- [20]. Aethon. TUG robots. Available from: <http://www.aethon.Com/tug/tughealthcare/>. [Last accessed on 2017 Jun]
- [21]. Russell S, Dewey D, Tegmark M. Research priorities for robust and beneficial artificial intelligence. *Ai Magazine*. 2015 Dec 31;36(4):105-14.
- [22]. Melanie M. An introduction to genetic algorithms.” A bradford book the MIT press Cambridg, Massachusetts. London, England, 1999, Fifth printing
- [23]. Hayes C., Gedeon T., Hyperbolicity of the fixed point set for the simple genetic Algorithm. *Theoretical Computer Science*, 2010; 411:24-29
- [24]. Man K. F, Tang K. S, Kwong S., Genetic algorithms: concepts and designs, chapter 1-10