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ARTIFICIAL INTELLIGENCE IN PHARMACEUTICAL AND HEALTHCARE RESEARCH

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Abstract
Artificial intelligence use in pharmaceutical technology has increased over the years, and the use of technology can save time and money while providing a better understanding of the relationships between different formulations and processes parameters. Artificial intelligence is a branch of the computer science that deals with the problem-solving by the aid of symbolized programming. It has greatly evolved in to a science of problems-solving with the hug applications in business, health care, and engineering. The article is describes the drugs discovery, tools of AI, manufacturing execution systems automated control processes systems, AI to predict new treatment, development of novel peptides from natural foods, treatment and management of rare diseases, drug adherence and dosage, challenges to adoption of AI in pharma.

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
Artificial intelligence (AI) is a branch of computer science that deals with the problem –solving by the aid of symbolic programming .it has greatly evolved into a science of problem- solving with huge application in business, health care, engineering [1]. The main objective of this artificial intelligence to identify useful information processing problems and give an abstract account of how to solve them. Such an account is called as method and it corresponds to a theorem in mathematics. Artificial intelligence as a field that deals with the design and application algorithms for analysis of learning from and interpreting data. Artificial intelligence encompasses many branches of statistical and machine learning, pattern recognition, and clustering, similarity-based methods [2]. AI is a flourishing technology which finds application in multiple aspects of life and industry. In Recent times the pharmaceutical industry discovers novel and innovative ways to use this powerful technology to help solve some of the biggest problems facing pharma today. Artificial intelligence in Pharma refers to the use of automated algorithms to perform tasks which

traditionally rely on human intelligence. Over the last five years, the use of artificial intelligence in the pharma and biotech industry has redefined how scientists develop new drugs, tackle disease, and more [3].

History

Allen Newell, Herbert A Simon. was developed the Logic Theorist .it was born in 1956 that Dartmouth college had organized the famous conference [4], It has been forecasted that the revenue from AI market will be increasing by as much as ten-fold between the years 2017 and 2022. Natural language processing market, which has several applications including text prediction, and speech and voice recognition has been said to achieve a growth of 28.5% in the year 2017. Worldwide revenue from big data and business analytics was US$ 122 billion in the year 2015 and it is being expected that the figures will rise to more than US$ 200 billion by the year 2020 [5]. Artificial intelligence has a rocky history spanning back to the 1950s. For a long time it was seen as a field for dreamers, but that started to change in 1997 when IBM‟s Deep Blue computer was able to defeat chess champion Garry Kasparov. By 2011, IBM‟s new Watson supercomputer was able to win the US$1m prize in the US game-show Jeopardy. Since then, Watson has expanded into healthcare and drug discovery, including a partnership with Pfizer in 2016 to accelerate drug discovery in immuno-oncology. In December 2016 IBM in collaboration with Pfizer introduced IBM Watson, a cloud-based such as medical lab reports and helps researchers with the ability to identify relationships between distinct data sets through dynamic visualizations [6].

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 compound [3]. The 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 [7].

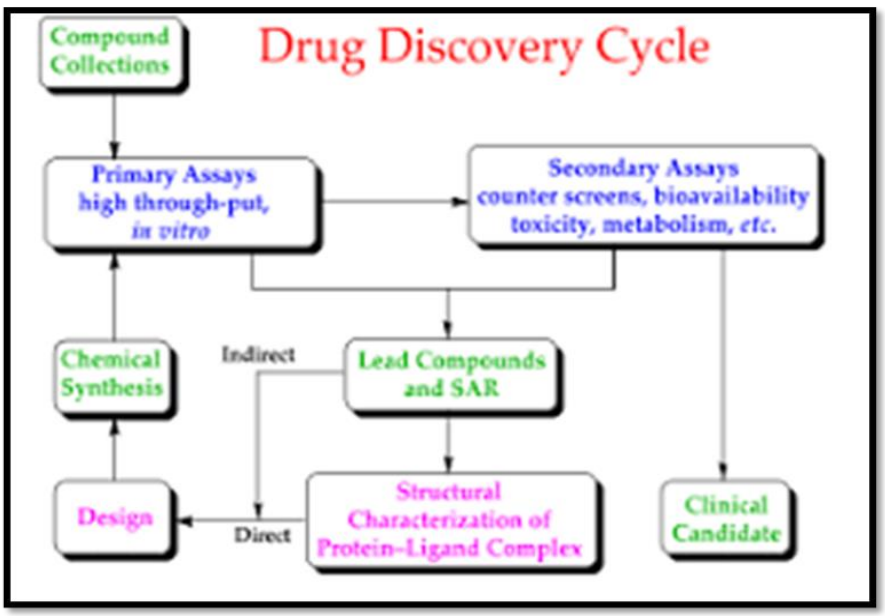

Figure: Drug Discovery Cycle

Tools of Artificial Intelligence (AI)

Robot pharmacy: The objective of improving the safety of patients, UCSF Medical Center 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 [8].

Figure: Robot Pharmacy

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 [9], although the robot cannot think, plan, or reason, it can be programmed such that it shows to have AI [10].

Erica robot: Erica is a new care robot that has been developed in Japan by Hiroshi Ishiguro, a professor at Osaka University).

It was developed in collaboration with the Japan Science and Technology Agency, Kyoto University, and the Advanced Telecommunications Research Institute International (ATR). It can speak Japanese and has a blend of European and Asian facial feature [11]. Like any normal human being, it likes animated films, desire to visit south-east Asia, and wants a life partner who would chat with it.

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: Aethon TUG robots are designed to autonomously travel through the hospital and deliver medications, meals, specimens, materials, and haul carry heavy loads such as linen and trash. It has two configurations, i.e., fixed and secured carts as well as exchange base platform that can be used to carry racks, bins, and carts.

The fixed carts are used for delivering medications, sensitive materials, and laboratory specimens, whereas, the exchange platform is employed to Vyas, et al.: Artificial Intelligence: New era in pharmacy profession Asian Journal of Pharmaceutics • Apr-Jun 2018 • 12 | 75 transport materials that can be loaded on different racks. The TUG can deliver several types of carts or racks thus making it a very flexible and utilizable resource [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.
- Control of manipulated value.

Berg: Berg is Boston-based biotech and is one of the key players employing AI in its various processes. It has an AI-based platform for drug discovery, which has a huge database of patients and this is used to find as well as validate the various biomarkers responsible for causing diseases and then decides therapies according to the obtained data. The motto of the company is to speed up the process of drug discovery and to bring about a reduction in the cost with the aid of AI as it obliterates guesswork that is involved in the process of 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].

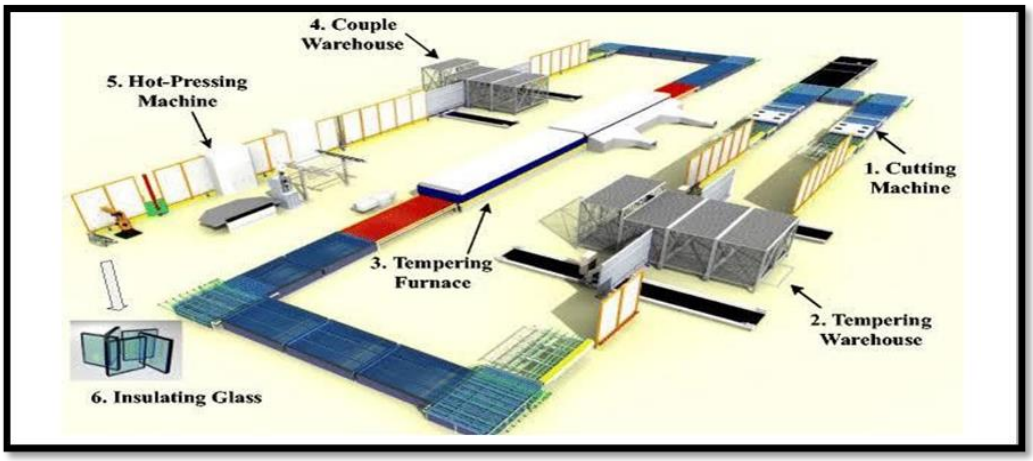

Figure: Manufacturing Execution System (MES)

Artificial Intelligence to predict new treatments

Verge is using automated data gathering and analysis to tackle main problems in drug discovery. In other words, they are taking an algorithmic approach to map out hundreds of genes that play complex roles in brain diseases like Alzheimer's, Parkinson's or ALS. Verge's hypothesis is that gathering & analyzing gene data will positively impact the drug discovery phase starting with the preclinical trials. The idea is that Verge can use AI to monitor the impact that specific drug treatments have on the human brain starting with the preclinical phase. As a result, drug manufacturers can get a better picture early on about the effectiveness of a drug on human cells.

More specifically, 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 start up Nerites leverages AI and other novel technologies facilitate the discovery of new and more robust food and healthy ingredients. BASF (Baden Aniline and Soda Factory") will take advantage of this partnership to develop novel functional peptides derived from natural foods. In practice, BASF uses Nuritas AI and DNA analysis capabilities to predict, analyze, and validate peptides from natural sources. The main goal of BASF is to discover and deliver to the market peptide-based therapies that'll help treat conditions like diabetes.

Treatment and Management of Rare diseases-

Advances in AI, renewed interest in rare disease treatments. Currently, there are over 350 million people with over 7,000 rare diseases around the world. However, it's not all gloom and doom for patients with rare diseases as Heal, a UK-based biotech firm, has secured $10 million in Series A funding to use AI to develop innovative drugs for rare conditions. Thera chon, another Swiss biotech company that leverage AI to develop drugs for the treatment of rare genetic diseases, has received $60 million in funding.

Figure: Treatment and Management of Rare Diseases

Drug-Adherence & Dosage

Abbvie partnered with New York-based Acura to enhance drug trial vigilance and improve drug adherence. In this collaboration, Abbvie used facial and image recognition algorithm of AiCure mobile SaaS platform to monitor adherence. To be more specific, the patients take a video of themselves swallowing a pill using their smartphones, and the AI-powered platform confirms that indeed the correct person swallowed the right pill. And the results were amazing, improving adherence by up to 90%. Genpact's AI solution has been used severally in clinical trials to change the dosage given to specific patients to optimize the results. In this partnership, Bayer takes advantage of Genpact's Pharmacovigilance Artificial Intelligence (PVAI) to not only monitor drug adherence but also detect potential side effects much earlier.

Using Artificial Intelligence to make sense of clinical data & to produce better analytics

Apple's Research kit makes it easy for people to enroll in clinical trials and studies without having to go through physical enrollment. It's a clinical research ecosystem designed around its two flagship products, the iPhone and the Apple Watch. Duke University, for instance, uses

patient data collected by these Apple devices and AI-driven facial recognition algorithm to identify children with autism. Research kit has made it easy to make better sense of collected

health data.

Finding more reliable patients faster for clinical trails

Although there's a lot of patient data out there, recruiting the right patients for clinical trials is a difficult process for big pharma. For instance, finding and enrolling ideal candidates can make clinical trials last an average of 7.5 years, costing between $161 million and $2 billion per drug. Unfortunately, 80 percent of clinical trials fail to make deadlines. With over 18,000 clinical studies currently recruiting candidates in the US, the $65 billion clinical trial market needs an

overhaul. Extracting useful data from patients‟ records is perhaps the biggest challenge for pharmaceutical companies. Thankfully, that's where AI and machine learning comes into the picture.

Challenges to adoption of Artificial Intelligence 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 – for many pharma companies, AI still seems like a "black box" owing to its newness and esoteric nature.
- Lack of proper IT infrastructure – that's because most IT applications and infrastructure currently in use weren't developed or designed with artificial intelligence in mind. Even worse, pharma firms have to spend lots of money to upgrade their IT system.
- Much of the data is in a free text format – that means pharma companies have to go above and beyond to collate and put this data into a form that's able to be analyzed. Despite all these limitations, one thing is for certain: AI is already redefining biotech and pharma. And ten years from now, Pharma will simply look at artificial intelligence as a basic, everyday, technology.

Artificial Intelligence in Pharma is a good idea

Pharmaceutical Industry can accelerate innovation by using technological advancements. The recent technological advancement that comes to mind would be artificial intelligence, development of computer systems able to perform tasks normally requiring human intelligence,
such as visual perception, speech recognition, decision-making, and translation between languages. An estimate by IBM shows that entire Healthcare domain has approx. 161 billion GB of data as of 2011. With humongous data available in this domain, artificial intelligence can be of real help in analyzing the data and presenting results that would help out in decision making, saving Human effort, time, money and thus help save Lives. Epidermic outbreak prediction; using machine learning /artificial intelligence one can study the history of epidermic outbreak, analyse the social media activity and predict where and when epidermic can effect with cocidarable 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 visits.

Limitations

- Streamlining electronic records; which are messy and unorganized across the heterogenous databases &are to be cleaned first.
- Transparency: people need transparency in health care they receive, which is quite a task given the complexity of the processes involving artificial intelligence.
- Data governance: medical data is private and in accessible legally. consent from the public is important.
- Hesitant to change: pharma companies are known to be traditional and resistant to change. we have to break the stigma to give the best care we can.

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 [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].

Applications

1) In Formulation:

Controlled release tablets: The first work in the use of neural networks for modelling 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 [17] 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 acetyl 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 [18].

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 [19]. Although trends were observed no optimal formulations were given. The trends were comparable to those generated by statistical procedures. Comparable neural network models were generated and then optimized using genetic algorithms. 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:

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 [21]. 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.

Conclusion

Human being is the most sophisticated machine that can ever be created. The human brain, which is working hard to create something that is much more efficient than a human being in doing any given task and it has great success to extent in doing so. The AI tools like Watson for oncology, tug robot and robotic pharmacy has change the profession considerably. The bigger the health-care sector gets more sophisticated and more technologically advanced infrastructure it will need. Artificial intelligence is the design and application of algorithms for analysis of learning and interpretation of data.

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