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Future Directions of AI In Pharma: Innovation in Pharmaceutical Industry

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ABSTRACT

Artificial Intelligence (AI) is a technology that simulates human intelligence and problem-solving processes. It encompasses human cognitive functions such as reading, observation, preparation, interpretation, reasoning, correction, speech recognition, linguistics, and other sources. AI simplifies tasks by allowing machines to learn from past experiences, map efforts and actions to results, identify errors, correct them, adjust to new and random input values, and perform human-like tasks through in-depth scenario analysis. AI simplifies work by analyzing, filtering, sorting, predicting, scoping, and determining large data volumes to follow the best implementation procedures for producing an optimal solution.

In the pharmaceutical industry, AI has several applications, including discovery and development of new drugs for complex and rare diseases such as Alzheimer's and Parkinson's, drug adherence and dosage, producing better analytics, finding more reliable patients faster for clinical trials, introducing automated robot pharmacies to fill prescriptions and dispensing, and improving marketing, logistics, and supply chain processes. AI has the potential to cut costs, create new, effective treatments, and, above all, save lives. Biotech companies should start using AI to their advantage as soon as possible. The industry has a lot to gain from embracing AI and machine learning solutions. AI can help create a strong, sustainable pipeline of new medicines faster and at reduced costs using the power of modern supercomputers and machine learning. This article exhaustively reviews the present status and future prospects of AI in pharmaceutical sciences with specific attention to the pharmaceutical industry. The literature has been collected from Pubmed, Google Scholar, and commercial websites related to this field. Overall, the future lies in cooperation between humans and machines, and alongside technological advances. Human clinical experts will need to adapt, learn, and grow. Potential experts will have to be both medical and technology experts. However, it is the evolution of medicine, not extinction.

Keywords- Artificial intelligence, pharmaceutical science, R&D, drug discovery, disease, machine learning, Therapeutics, Medicine, Clinical trials

Introduction-

The process of discovering new drugs needs to change in the 21st century to meet society's needs. Artificial intelligence (AI) and machine learning can help the pharmaceutical industry do research and development (R&D) more efficiently. AI is like when a computer acts like a human by learning from past experiences and making corrections. It can understand human communication and translate it into a code that machines can understand. AI also uses deep learning to process large amounts of data and recognize patterns. The term "Artificial Intelligence" was created in 1956 by a scientist named John McCarthy. AI is important today because we have more data and advanced technology. AI has become popular because it has demonstrated precise image recognition and autonomous driving. AI and deep learning can be used in all sectors by using big data, enhanced computing power, and cloud storage.

Differences between machine learning and artificial intelligence-

"Machine learning" is a type of artificial intelligence where a computer system learns from a set of rules and actions to achieve a goal. The system improves itself based on experience and produces accurate results. It does not involve decision-making or discretion. Machine learning is based on structured data formats and involves pattern recognition in large data sets.

On the other hand, "Artificial Intelligence" is based on a machine's ability to acquire knowledge and apply it to real-life scenarios. It involves multiple programming integrations, validations, and pattern recognition methods to behave in an expected way. The main aim is to produce a result through intelligent data analysis and deeper understanding. AI is based on the machine's response to circumstances and complex problems without a fixed algorithm in place. It involves multiple levels and forms of analysis to seek an optimal solution. AI involves smart learning by a computer through awareness of past iterations and application of alternative information processing and cognitive analysis that demand distinct capabilities. The goal of AI is to simulate human intelligence in producing realistic solutions to complex problems through better decision-making.

Current problem faced by AI –

How expensive is developing a new drug? A study published in 2020 concluded that the median research and development cost for a new treatment was $985 millionOpens a new window . A substantial part of this cost was the high trial failure rate. Roughly seven out of eight compounds that enter the clinical testing pipeline are never developed.

This is where AI comes in. AI has the potential to find previously unexplored patterns, not immediately, which can lead to a new understanding of diseases, and the drugs designed to treat them.

For example, Astra Zeneca uses machine learning models to discover more quickly which genes can cause resistance to cancer treatments and Samsung has built an app to detect early Covid-19 infection.

What stands in the Way of AI

Despite the high number of successes, there are unique challenges that need to be overcome for pharmaceutical (pharma) companies to reap the benefits of AI. Here are a few examples:

1. Smaller Datasets – Most AI algorithms need big datasets to learn from. Due to a large number of diseases and illnesses, and the relatively small number of incidences of each, creating large data for each type of medical condition is very challenging. A rule of thumb is that for machine learning models in the pharma industry to work efficiently, they need a minimum of 2 to 3 years of historical data. The high number of mergers and acquisitions can make this goal challenging, especially when the original source

of the data can no longer be available. Because pharma data sets are usually smaller with fewer patients and fewer observations per patient which makes achieving meaningful insights is more challenging.
2. Complex Data – At the same time, there can be fewer data sets there can be far more features for each dataset. Patient data may include information relating to their past and current health or illness, treatment history, lifestyle choices, and genetic data. It can also include biometric data, which is any measurable physical characteristic that can be measured by a sensor, or wearable device. As a result, patient data can include alphanumeric data, x-ray, pathological, and clinical test reports images in multiple formats like JPEG/JPG and digital imaging and communication for medicine (DICOM) format. AI systems for drug development need the ability to support varied and complex data
The pharmaceutical industry is poised to benefit significantly from the continued development and application of artificial intelligence (AI) technologies. Here are some potential future directions of AI in pharma:
1. Precision medicine: AI can help to identify subgroups of patients who are likely to respond better to a particular treatment or are at higher risk of side effects. This can allow for more targeted and personalized treatment plans for individual patients.
2. Drug design: AI can help to design new drugs or optimize existing drugs by predicting their properties and interactions with biological targets. This can lead to the development of more effective and safer drugs.
3. Clinical trial optimization: AI can help to optimize clinical trial design and execution by identifying the most promising patient populations, predicting outcomes, and minimizing trial costs and duration. This can accelerate the drug development process and reduce the costs of bringing new drugs to market
4. Real-world data analysis: AI can help to analyze real-world data from electronic health records, patient-generated data, and social media to identify new treatment approaches, adverse drug reactions, and other insights that can inform drug development and patient care.
5. Supply chain optimization: AI can help to optimize the pharmaceutical supply chain by predicting demand, reducing waste, and ensuring the timely delivery of drugs to patients.
6. Regulatory compliance: AI can help to ensure compliance with regulatory requirements by automating the analysis of data, identifying potential safety issues, and reducing the time and costs of regulatory submissions.
7. Improved patient engagement: AI can help to improve patient engagement and adherence by providing personalized education and support, monitoring patient outcomes, and facilitating communication between patients and healthcare providers.

Need of AI in the healthcare-

Al in field of Pharmacy It is one of the top technologies shaping thefuture of pharmacyPharma industries has been developing cure & treatment for centuries. Traditionally the design & manufacturing of drug requires several years, lengthy clinical trials & huge costs with the rise of 21st century technologies, this hasbeen changing. In future we will see completely different drug designs, manufacture &clinical trials. Collaboration between pharma and AI companies: The future of AI in pharma will depend on collaboration between pharmaceutical companies and AI technology providers. Partnerships between these two sectors can help to accelerate the development and adoption of AI technologies in the pharmaceutical industry. Pharmaceutical industry can accelerate innovation by using technological advancements. 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, Al can be of real help in analyzing the data & presenting results that would help out in decision making, saving human effort,time,money & thus help helps save lives.

Application of AI healthcare-

Disease Identification-	Berg, an innovative US biopharma company, is using Al to research and develop diagnostics and therapeutics in the fields of oncology, endocrinology, and neurology. Their unique Al-based Interrogative Biology platform combines patient biology and Al-based analytics to identify differences between healthy and disease environments.
Radiology and Radiotherapy-	This is an area in which Al has been speculated to play a major role in the future. Presently, Google's DeepMind Health is working on machine learning algorithms to detect differences between healthy and cancerous tissues. The goal is to improve the accuracy of radiotherapy planning while minimizing damage to healthy organs at risk.
Clinical trial Research -	Advanced predictive analytics can analyze genetic information to identify the appropriate patient population for a trial. Artificial Intelligence can also determine the optimal sample sizes for increased efficiency and reduce data errors such as duplicate entries.
Drug discovery -	A study published by the Massachusetts Institute of Technology (MIT) has found that only 13.8% of drugs successfully pass clinical trials. Furthermore, a company can expect to pay between $161 million to $2 billion for any drug to complete the entire clinical trials process and get FDA approval. With this in mind, pharma businesses are using Al to increase the success rates of new drugs while decreasing operational costs at

	the same time. Ideally, this would also translate to lower drug costs for patients, all while offering them more treatment choices
Personalizedmedicine and Rare Disease identification-	Using Al, body scans can detect cancer and other diseases early, as well as predict health issues people might face based on their genetics. Although far from perfect, IBM Watson for Oncology is currently the leader in Al for personalized treatment decisions in the oncology space.It uses each patient's medical information and history to optimize the treatment decision-making. Recently, Watson correctly diagnosed a rare form of leukemia in a patient originally thought to have acute myeloid leukemia. It reportedly examined millions of oncology research papers in 10 minutes after which it successfully diagnosed the patient and recommended a personalized treatment plan.

Scope for future Research-

Recent Al Adoptions-

1. Novartis uses Al to predict untested componentsresearchers should explore to find new cures.
2. IBM Watson helps match patients with the right drug trials.
3. Verge Genomics uses Al to predict the effect ofnew treatments for patients suffering from ALS &Alzheimer's.
4. Bayer and Merck & Co uses Al algorithms to identify pulmonary hypertension.
5. Tencent Holdings leverages Al to remotely monitor patients with Parkinson's.
6. Mission Therapeutics uses Al to develop treatments for Alzheimer's.
7. Healx uses Al to help biotech companies find treatments for rare diseases.
8. AI Cure & AbbVie use image recognition to impro drug adherence.
9. Santen and twoXAR are using Al to develop druge for glaucoma.
10. AstraZeneca and Alibaba build Al to help patients with automated cancer diagnostics.
11. Apple uses Al to screen children for autism.
12. GNS Healthcare and Genentech use Al to develop new cancer therapies.
13. Deep 6 uses Al to proactively find drug trial candidates.

Risks & Disadvantage Associated with Al

As theoretical physicist Prof. Stephen Hawking had said that human efforts to create machines that can think are a huge threat to the existence of human race & the race to develop a complete human Al could mean that the human race would come to an end in the future.

For the creation of Al requires huge costs as they are very complex machines and the cost is the main disadvantages.

Al can cause unemployment as things would be automated in this system as there is need of less human labour. And there is less need of human resources.

No Match For Human Brain Intelligence.

No Improvement With Experience.

No Original Creativity.

Programing without AI	Programming with AI
A computer program without Al can answer the specific questions it is meant to solve.	A computer program with Al can answer the generic questions it is meant to solve.
Modifications in the program leads to change in structure	Al programs can absorb new modifications by putting highly independent Pisces of information together. We can modify the information of a program without affecting it's structure.
Modification is not quick and easy. It may lead to affecting the program adversely.	Quick and easy program modification.

A Connected approach to a Pharma -

Diagnosis of disease-

Artificial Intelligence (AI) has shown great potential in improving disease diagnosis by analyzing medical data and images. AI algorithms can analyze large amounts of data and recognize patterns that may not be apparent to human doctors. AI can also help reduce errors and improve accuracy by eliminating human error and providing a standardized approach to diagnosis.

One example of AI in disease diagnosis is in the field of radiology. AI algorithms can analyze medical images such as X-rays, MRIs, and CT scans to detect and identify abnormalities that may indicate a disease or condition. AI can also assist in image interpretation by providing computer-aided detection (CAD) that highlights potential areas of concern for the radiologist to investigate further.

AI can also be used to analyze patient data such as electronic health records (EHRs) to identify patterns and risk factors for certain diseases. By analyzing a patient's medical history and other relevant data, AI algorithms can assist in making a diagnosis and predicting disease progression.

Overall, AI has the potential to revolutionize disease diagnosis by providing faster and more accurate results, improving patient outcomes, and reducing healthcare costs. However, it is important to

note that AI should not replace human doctors but rather work in conjunction with them to improve diagnosis and treatment.

Detection of disease–

Detection of diseases by AI is a rapidly growing field with potential applications in various medical areas, including radiology, dermatology, ophthalmology, and pathology. AI algorithms can be trained on large datasets of medical images, electronic health records, and genetic data to identify patterns and features that are associated with specific diseases. By analyzing these data, AI can help clinicians to make more accurate diagnoses, develop personalized treatment plans, and identify patients who are at risk of developing certain diseases.

In radiology, for example, AI algorithms can analyze medical images to detect abnormalities or lesions that may indicate the presence of a disease. In dermatology, AI can help to diagnose skin conditions by analyzing images of the skin and comparing them to a large database of similar images. In ophthalmology, AI can help to detect early signs of eye diseases, such as age-related macular degeneration, by analyzing images of the retina.

Overall, the use of AI for disease detection has the potential to revolutionize medical diagnosis and improve patient outcomes by enabling earlier and more accurate identification of diseases. However, it is important to note that AI is still in the early stages of development and requires further validation and testing before it can be fully integrated into clinical practice.

New approach in new entitiy development -

Artificial intelligence (AI) is transforming the drug development process in a significant way by offering new approaches to identify and develop new drugs. Traditionally, drug development is a time-consuming and expensive process that involves identifying a target, designing a molecule that interacts with that target, and then testing it in vitro and in vivo to assess its safety and efficacy. With AI, the process of identifying new drug candidates can be accelerated and made more efficient. One approach is to use machine learning algorithms to identify compounds that have the potential to bind to specific targets or receptors. These algorithms can analyze large amounts of data on the structure of molecules and how they interact with proteins, and use that information to generate new compounds that may be effective drugs. Another approach is to use AI to analyze large amounts of patient data to identify new targets for drug development. This can include genomic data, medical records, and even social media data. By identifying patterns in this data, AI algorithms can pinpoint potential targets for drug development and help researchers design more effective treatments. Additionally, AI can also help optimize the drug development process by predicting drug toxicity and optimizing dosing regimens. By using machine learning to analyze data from preclinical and clinical trials, AI can help identify potential safety issues earlier in the development process and help optimize dosing regimens to ensure that drugs are safe and effective. Overall, AI is offering new approaches to drug development that have the potential to accelerate the development of new treatments and improve patient outcomes.

Medical imaging-

Medical imaging with AI involves the use of artificial intelligence techniques such as deep learning algorithms to analyze medical images. Medical imaging includes a variety of techniques such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound. The use of AI in

medical imaging can help clinicians to make more accurate and timely diagnoses, and develop personalized treatment plans for patients. AI algorithms can be trained on large datasets of medical images to detect patterns and features that may be indicative of disease or other health conditions. For example, a deep learning algorithm can be trained to identify specific structures in an MRI scan of the brain, such as the hippocampus, which is often affected in patients with Alzheimer's disease. The algorithm can then be used to analyze new scans and detect any changes or abnormalities that may indicate the presence of the disease. AI can also be used to analyze medical images in real-time during medical procedures, such as during surgery or endoscopy. This can help clinicians to identify and locate areas of interest, such as tumors or lesions, with greater precision and accuracy. Overall, the use of AI in medical imaging has the potential to revolutionize the field of radiology and improve patient outcomes by enabling earlier and more accurate diagnoses, and more personalized treatment plans.

Cancer research-

AI is playing an increasingly important role in cancer research, particularly in the areas of diagnosis, prognosis, and treatment. AI algorithms can analyze large volumes of medical imaging data and assist doctors in detecting early-stage cancers, which can improve the effectiveness of treatment and patient outcomes. AI can also be used to predict a patient's prognosis by analyzing various data sources, including medical images, electronic health records, and genomic data. This can help doctors develop personalized treatment plans for their patients.

In addition, AI can assist in drug development for cancer treatment. By analyzing large amounts of genomic data, AI can identify potential new drug targets and predict the effectiveness of drugs in specific patient populations. This can accelerate the drug discovery process and bring new treatments to patients more quickly. Overall, AI has the potential to revolutionize cancer research and improve patient outcomes by assisting doctors in making more accurate diagnoses, developing personalized treatment plans, and accelerating the drug discovery process.

Genomics-

AI has revolutionized the field of genomics by making it easier and faster to analyze large amounts of genetic data. AI algorithms are used to identify patterns and mutations in genomic data, which can help in the diagnosis and treatment of genetic disorders and diseases. For example, AI can be used to analyze gene expression data to identify genes that are upregulated or downregulated in a particular disease, or to predict the likelihood of a patient developing a certain disease based on their genetic profile. AI can also help in drug discovery by identifying potential drug targets and predicting the efficacy of drugs based on genomic data. Overall, AI is helping to unlock the vast potential of genomic data for personalized medicine and disease prevention.

AI in Biotechnology-

Biotechnology is a field that involves the use of living organisms, biological processes, and biomolecules to develop new products and technologies for various applications. The use of AI in biotechnology has led to significant advancements in areas such as drug discovery, genomics, and personalized medicine.In drug discovery, AI is being used to accelerate the identification of potential drug candidates by predicting the activity of millions of compounds against specific targets. This reduces the time and cost of traditional drug discovery methods and increases the chances of success in clinical

trials. AI is also being used in genomics to analyze large volumes of genetic data and identify new disease biomarkers, understand disease mechanisms, and develop personalized treatment options. This has the potential to revolutionize healthcare by providing more accurate diagnoses and more effective treatments for patients. Additionally, AI is being used in biotechnology for process optimization in areas such as fermentation, protein production, and quality control. This improves the efficiency and productivity of biomanufacturing processes and leads to better quality products. Overall, the use of AI in biotechnology is opening up new avenues for research and development and has the potential to transform healthcare and the biotechnology industry as a whole.

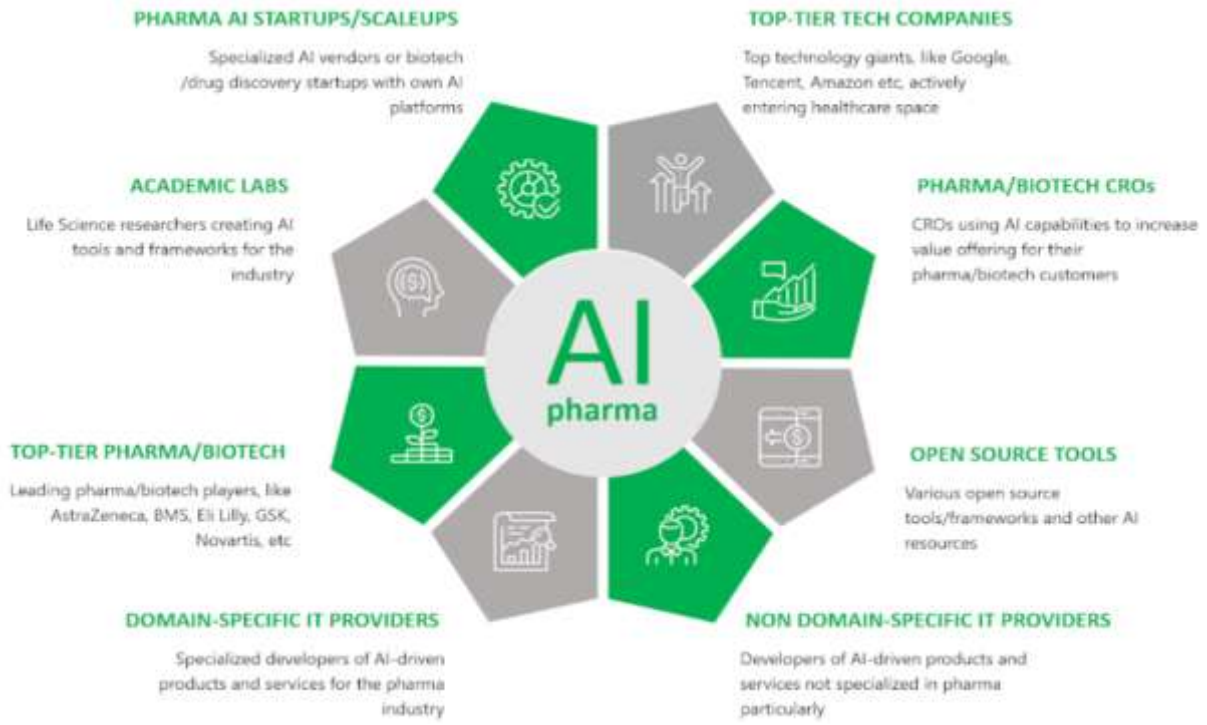
AI in Pharmaceutical Marketing-

By 2023, successful pharmaceutical brands will use Artificial Intelligence (AI) for their marketing. Nowadays, a massive amount of data is generated every minute by people, machines, sensors, and devices. Smartphones, social media platforms, and cloud computing are everywhere, and almost everyone is connected through the internet. According to McKinsey Podcast, the healthcare industry is one of the sectors where AI is likely to have the most significant financial impact, worth around $400 billion. It is predicted that the amount of data we produce will increase tenfold between 2016 and 2025, reaching 163 zettabytes. In the future, data volume will be measured in yottabytes, a number with 24 zeros. The General Data Protection Regulation (GDPR) is a European law that regulates the use of personal data.

Future of Artificial Intelligence

Companies like Google and Uber are already using AI capabilities to power self-driven cars. AI will have a great bearing on the automated transportation field by aiding handicapped drivers and preventing accidents. More evolved AI systems will support in hazardous factory-based jobs and may replace humans as well. Climatic change predictions can be made by AI systems using data sciences and environmental technologies. Around 80 percent of customer service operations will be handled by effective and timely AI systems. Personalized health management will be made easier through AI systems symptom-identification and medical data processing abilities. Cyborg technology can help patients utilize artificial prosthetics for a better living by communicating with a robotic system. In space technology, Al can study orbital paths during successful launches and suggest actions based on its observations. Coming to Pharma Industry, AI is the future of pharma but the technology is available now. Artificial Intelligence can cut costs down, create new. effective treatments and above all else, help save lives. So biotech companies should start making use of the advantages of AI at the earliest.

Terms of compound design, scope and increase given to us by AI and machine learning will mean that we can tap into a much wider chemical space, giving us a much wider and more diverse range of chemicals to better enable us to pick the best drug discovery molecules. In terms of the industry's choice of patients for clinical trials, the software will also help companies detect any problems with drugs far earlier in terms of efficacy and safety. The industry therefore has a lot to gain from embracing solutions to AI and machine learning. It can be used to create a strong, sustainable pipeline of new medicines to good effect.Using the power of modern supercomputers and machine learning would make it possible for us to produce medicines faster and at reduced costs.



Conclusion

The potential applications of AI in the pharmaceutical industry are vast and wide-ranging. Continued investment and development in AI technologies will be critical to achieving the full potential of these technologies in improving patient outcomes, reducing drug development costs, and advancing the field of medicine. With proper safeguards in place to address ethical and regulatory concerns, AI has the potential
to revolutionize the pharmaceutical industry and transform the way we approach patient care.

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