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Industrial Automation using Artificial Intelligence

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Abstract: *The pharmaceutical and consumer healthcare industries have been greatly impacted by artificial intelligence and machine learning. A subfield of computer science called artificial intelligence is able to analyze intricate medical data. The goal of artificial intelligence (AI) is to create intelligent modeling, which facilitates knowledge imagination, problem solving, and decision making. AI is becoming more and more significant in many areas of pharmacy, including drug discovery and formulation of drug delivery, process optimization, testing, and pharmacokinetics/pharmacodynamics (PK/PD) studies growth. This review focuses on the significant applications of AI in various pharmaceutical domains, including drug development and discovery, Many studies are being conducted to enhance the AI technology that is currently available in order to increase the efficiency of the pharmacy profession. Artificial intelligence and system mastery have seen a significant upsurge in recent years. It has lessened the effort required of humans to advance in their extraordinary lives. Numerous drug discovery implementations have been examined, demonstrating the technology's effectiveness in quantitative structure-property relationships (QSPR) and quantitative structure-activity relationships (QSAR).Additionally, they are employed in clinical trials to generate and interpret data gathered from patient information. The pharmaceutical industry is currently having trouble maintaining its drug development programs due to rising R&D expenses and declining productivity. In addition to helping with experimental design, machine learning algorithms can forecast the toxicity and pharmacokinetics of potential drugs. This capability lessens the need for extensive and expensive animal testing by enabling the prioritization and optimization of lead compounds. Artificial intelligence (AI) algorithms that examine actual patient data can support personalized medicine strategies, improving patient adherence and treatment outcomes.*

Keywords: healthcare industries

I. INTRODUCTION

1. Artificial Intelligence

The field of engineering science that studies the development of intelligent machines, especially intelligent computer programs, is known as artificial intelligence (AI). It is the capacity of a computer, or a robotic system with computer capability, to process input and generate results in a way that is comparable to how humans pay attention when learning, making decisions, and solving issues. The goal of artificial intelligence (AI), a subfield of computer science, is to build intelligent machines, which are becoming indispensable in the technology sector. The pharmaceutical industries have undergone a significant revolution thanks to AI.[1] It is being heavily utilized in every aspect of the healthcare sector. This technology represents the pinnacle of computer processing and human intelligence. It is a sophisticated form of computer-assisted methodology that involves gathering data from multiple sources, formulating rules to handle the needed data, and modeling potential outcomes to identify suitable outcomes and processes that can mimic human behavior. It is composed of components that make working with neural networks easier, like machine learning and deep learning.[2]

Artificial Intelligence (AI) is a branch of science that deals with intelligent machine learning, primarily with intelligent computer programs that produce outcomes that resemble the attention process of a human.[3]

1] In general, this process entails gathering information, creating effective systems to use that information, presenting precise or approximate conclusions, and making self-corrections and adjustments.[4]

Artificial intelligence is generally employed to analyze machine learning in order to simulate human cognitive tasks. AI technology is used to obtain useful interpretation and to conduct analyses that are more accurate.

From this angle, artificial intelligence (AI) technology combines a number of practical statistical models with computational intelligence.[5]

The fear of the threat of unemployment is often linked to the advancement and innovation of AI applications. But nearly every breakthrough in the use of AI technology is being hailed due to the industry's confidence, which greatly increases the technology's effectiveness. Artificial intelligence (AI) has emerged as a critical component of industry, with practical applications across a wide range of technical and scientific domains. [6]

II. HARMONY IN PHARMACEUTICAL RESEARCH USING AI

2.1 AI in manufacturing tablets with controlled release

Controlled-release formulations are designed using pharmacokinetic simulations and artificial neural networks (ANNs). Because of the ANN model inputs, formulation variables and three substitute tablet variables hardness, particle size, and moisture for 22 tablet formulations of a model drug have been used.[7] The outputs have been the in vitro cumulative percentage of drug released at ten different sampling evaluation times. With the use of Chem software, the ANN model gains sophistication and proficiency from the input and output data units. The most efficient tablet compositions are predicted by the proficient ANN model, mainly based on two desired in vitro dissolution-time profiles and two desired in profiles of vivo releases. The part of the drug absorbed in vivo that is linearly correlated with the drug's in vitro dissolution is the drug's dissolution, which is the rate-limiting step in the in vivo absorption process. The primary metrics used to observe in vitro release profiles are the similarity factor, f1, f2, and distinction factor.[8]

2.2. AI in manufacturing tablets for Instant Release:-

To increase tablet strength, Turkoglu modeled a direct compression tablet formulation that included hydrochlorothiazide. In another study, Kesavan and Peck modeled a caffeine tablet formulation in order to describe the granule and tablet characteristics (disintegration time, hardness, and friability) as well as the processing variables (kind of granulator, the approach of the addition of binder). These two tests verified that neural networks outperformed conventional statistical techniques. As such, Kesavan and Peck's data have been reexamined using a series of neural networks and genetic algorithms. This demonstrated that the optimal formulation was based on the limitations applied to each tier of the elements and processing variable, as well as the relative significance found at the output characteristics. Neuro fuzzy computing was used to study the same set of data. Beneficial rules that emphasize the most crucial components for each asset have been regularly developed.[9]

2.3 AI in the development of the hard gelatin capsule shell

Expert systems (ES) and artificial neural networks (ANN) are used as decision-making tools in the development of hard gelatin capsule formulations. Artificial Neural Networks (ANNs) are computer programs designed to mimic specific aspects of human cognition, such as learning, generalization, prediction, and abstraction from knowledge. The records and statistics that were started during the investigational work can be very easily transformed into knowledge with the help of ANNs, allowing the formulator to at least create some domain- specific guidelines for future instances or to forecast the properties of a hypothetical formulation. By growing the Expert Network and conducting analysis, Wendy I. Wilson created a capsule shell formulation of BCS class II medications in 2005. Aside from the fact that it only offers a suggested formulation, Capsugel's expert system,a centralized system for the formulation of powders in hard gelatin capsules, was utilized globally. As model drugs, medications like ibuprofen, ketoprofen, carbamazepine, naproxen, diazepam, and chlorpropamide were prepared and tested for their ability to dissolve.[10] It was discovered that the system produced a high error rate and subpar prediction abilities during the first test. $R2 \geq 70\%$ was achieved by the models after a new data set was chosen and the ANN was retrained. [11] Lastly, for the model drugs, the intelligent hybrid system predicted the amount of drug dissolved within 5%. Cross-validation was conducted using 10% of the recently generated data, and it was found that the developed system could create a formulation that satisfied its unique performance requirements. The system was shown to be appropriate for the analysis of several BCS class II [12] drugs by addressing parameters like wettability and intrinsic dissolving characteristics.[13]

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III. AI IN DRUG DISCOVERY AND DEVELOPEMENT

Drug discovery is being significantly altered by AI, which is also greatly improving efficiency, cutting costs, and raising success rates. AI is used at several phases of the drug development process (Figure 1). Employing AI's extraordinary powers in data processing, pattern recognition, and decision-making, the integration of AI technology has allowed for significant changes in pharmaceutical research.[14,15] The numerous uses of AI in the drug discovery process are covered in this section, which also explains how these technologies are being used to innovate and accelerate important drug development processes such as drug design, polypharmacology, chemical synthesis, drug repurposing, and drug screening.

Drug Design

AI greatly improves the process of identifying promising lead compounds in the field of drug design, which speeds up the drug development process considerably.[16] Traditional techniques have a number of difficulties, including expensive computing costs, unpredictable reliability, and lengthy input times, even if computer tools have transformed drug design and the approach to discovery.[17] One promising solution to these problems is artificial intelligence (AI), which can improve the usefulness and efficiency of computational methods in drug development.[18] Since many diseases are associated with protein dysfunction, studying protein architectures is an important part of therapeutic creation. Finding tiny compounds that can interact with protein targets in a selective manner is the goal of structural drug design. Historically, the process of predicting the three-dimensional (3D) structure of proteins has been expensive, time-consuming, and has had limited accuracy when done from scratch.[19] Drug design has undergone a radical change since the introduction of AI, especially deep learning and feature extraction technologies. By making it possible to map protein connections and accurately anticipate secondary protein structures, these technologies help us better understand how structure and sequence relate to one another.[20] The ultimate objective is to use deep learning to more accurately predict 3D protein structures, which will aid in the investigation of protein-protein interactions (PPI) and further the field of structural drug design. With the potential to increase the speed, cost-effectiveness, and success rates of drug development projects, this incorporation of AI into drug design is a major advancement.[21]

Drug Development

The feedback-driven drug development process begins with results that are already available and gathered from a variety of sources, including literature-based information, high-throughput compound and fragment screening, and computational modeling. The steps in this process are induction and deduction in turn. Ultimately, this cycle of induction and deduction produces compounds with optimal hit and lead contents. Merely automating certain stages of the cycle lowers error and randomness and boosts drug development productivity. For in silico compound synthesis using de novo design techniques, organic chemistry knowledge is necessary as well as virtual screening models that serve as stand-ins for biological and biochemical tests of toxicity and efficacy.[22] The identification of new or novel compounds with promising activities against a given disease target is ultimately made possible by active learning algorithms. Hit molecules are methodically altered during the lead generation process to increase their activity and selectivity towards particular biological targets while lowering toxicity and unintended effects. Hit expansion is the process of obtaining chemically related compounds from a hit, which are referred to as analogues. Medicinal chemists use tried-and-true methods from organic chemistry to expand their hits. Chemists concentrate on a particular reaction or group of reactions to swiftly put together building blocks to create a number of analogues in order to boost the synthetic throughput.[23] A compound with reactive functional group and atoms that interact with a biological target's active site is called a "building block." The biological target's active site is a particular area where the compound (or substrate) binds via interaction forces. Models known as "induced-fit" or "lock and key" can be used to visualize how a substrate binds to an active site.[24]

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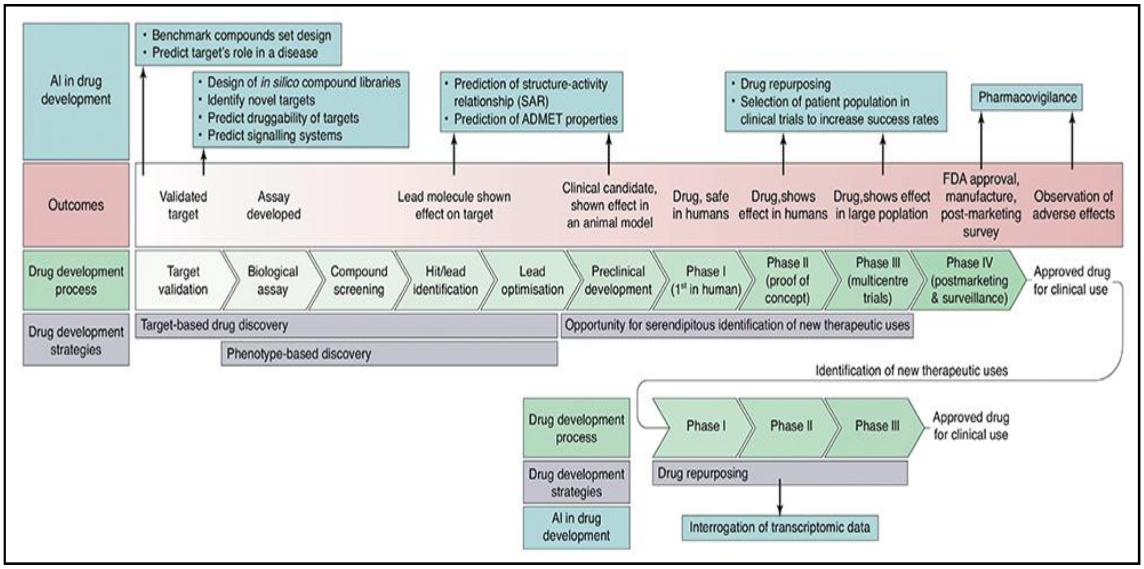

Fig no.1:- AI in drug discovery and drug development. The applications of AI at each stage of drug development are also shown.

IV. USING AI IN MEDICATION DEVELOPMENT

Finding novel, effective medications is a challenging task that is often the most challenging aspect of drug development. This is a result of the enormous extent of chemical space, which is thought to contain roughly 10^{60} molecules.[25] AI-infused technologies have evolved into flexible instruments that are widely applicable across multiple phases of drug discovery, including target validation and identification, drug design, repurposing, enhancing R&D productivity, gathering and evaluating biomedical data, and streamlining the selection process for patient enrollment in clinical trials.[26,27] These possible applications of AI offer the chance to combat the inefficiencies and uncertainties that develop in the traditional drug development techniques while reducing the need for human intervention and bias.

Predicting feasible synthetic routes for drug-like molecules, pharmacological properties, protein characteristics, efficacy, drug combination, drug-target association, and drug repurposing are some of the additional applications of AI in drug development. Additionally, the development of novel biomarkers and therapeutic targets, personalized medicine based on omics markers, and the identification of links between medications and diseases make it feasible to identify new pathways and targets using omics analysis. DL has proven to be incredibly successful at identifying promising drug candidates and correctly projecting both their characteristics and potential toxicity risks. Getting around previous issues with drug development, like analyzing big datasets and tediously screening compounds correctly estimating their characteristics and potential toxicity risks. Using AI techniques, it is now possible to avoid previous issues with drug development, such as the analysis of large datasets, the tedious screening of compounds while minimizing standard error, the need for significant R&D expenditure and time exceeding US$2.5 billion and more than a decade.[28]

Artificial Intelligence (AI) technology facilitates the identification of novel drug targets, rational drug design, and drug repurposing through the execution of new studies. AI has revolutionized the processes of pathway or target identification for the treatment of diseases by helping to understand the pathway or identify molecular targets in drug development.[29] The integration of target tractability, biochemical characteristics, and genomics data made this possible. A study established the viability of forecasting therapeutic targets using the gene-disease association data platform known as "Open Targets," a computational prediction application. It was found that the most predictive power came from animal models displaying a disease-relevant phenotype with a neural network classifier of >71% accuracy. It is suggested in to use AI in the drug-development process. The AI platform IBM Watson for Drug Discovery has discovered five novel RNA-binding proteins (RBPs) associated with the etiology of amyotrophic lateral sclerosis (ALS), a neurodegenerative disease. AI for locating the lead or hit Utilizing chemical space is a concern of using AI in the search for small drug-like molecules. Because it is possible to computationally enumerate the likely organic molecules, chemical space offers a platform for the identification of novel and high-quality molecules. Furthermore, while maximizing the safety and efficacy features, machine learning techniques and predictive model software aid in the identification of target-specific virtual molecules and the association of the molecules with their respective targets.[30] By reducing the number of synthesized compounds that are then tested in either in vitro or in vivo systems, AI systems can lower attrition rates and R&D costs. The information on small-molecule modulator probes and their structural biology that is currently available can be used with a range of in silico methods for profile selection, including virtual ligand or structure-based design approaches. When there are insufficient structural data, DL becomes helpful. Therefore, network-based algorithms based on phenotypic data, disease, biology, or molecules can be applied. While the AI techniques that are still in development must first be validated before being applied to the drug development process, the validated techniques can be used to boost the success rates in drug development. The synthesis of selected molecules is the most important step in the drug development process. Because AI can prioritize molecules based on their ease of synthesis or create tools that are efficient for the best synthetic route, it is valuable.[24]

4.1 Gene therapies and biologics

The aforementioned explanation pertains to conventional small-molecule pharmaceutical medications, which still account for roughly 90% of all medications sold. These medications are made of comparatively simple chemicals that are created through chemical reactions. After being processed into easily absorbed capsules or tablets, they are absorbed straight into the bloodstream. In recent times, there has been a growing emphasis among researchers on large-molecule biologic products and genomics. Proteins used to make large-molecule or "biologic" drugs are typically modified or synthesized from pre-existing human proteins. Usually, human cell lines are grown or genetically modified organisms like yeasts or bacteria are used to create them. When proteins attach themselves to cell receptors, they can be made to attach to sick cells like cancer cells specifically. Because they would be broken down if taken orally, they are administered by injection or infusion, and their delivery mechanism frequently makes use of virus or antibody carriers. Forty The approval process for biologic drugs in the US is the same as that for small-molecule drugs, but because of their complexity, it is more difficult to develop and test them for human use, which is one of the reasons that the total number of new drug approvals for biologics is so small.[31]

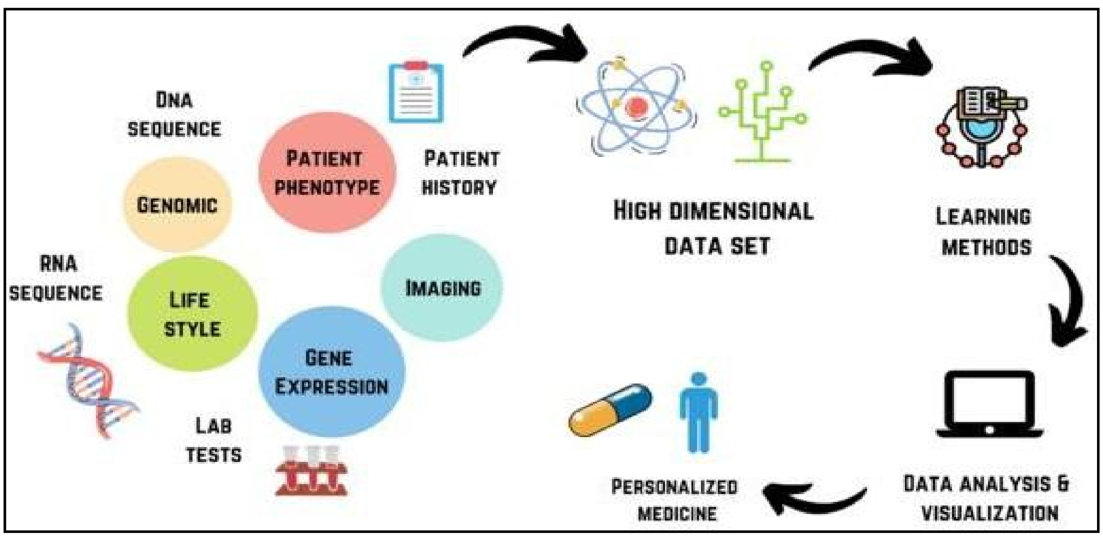

Fig no 2: Artificial Intelligence in Genetics

4.2 Research and Development:- To streamline drug research, innovation, and improvement processes, pharmaceutical companies all over the world are utilizing cutting-edge AI-powered equipment and machine learning algorithms. The purpose of these era tools is to find intricate patterns within large datasets.[32]

4.3 Artificial intelligence (AI) in the next generation of 3D printed medications: AI and the pharmaceutical 3DP pipeline can collaborate. The traditional medical "one size fits all" approach needs to bereplaced with the administration of customized medications. Pharmaceutical 3DP can provide tailored drug delivery in the clinic, but it now requires the expertise and presence of certified 3DP practitioners. There are many common process optimization tools available, such as mechanistic modeling and finite element analysis (FEA), but none of them can fully optimizing the different phases of 3DP for pharmaceuticals. On the other hand, ML can provide intelligent optimization of every stage involved in the production of 3DP medications. This will ultimately remove barriers to the clinical application of the technology by doing away with the need for continual expert input during the development of 3DP medications.[33]

4.4 Determining the Target

AI systems are able to identify possible therapeutic targets by analyzing a variety of data types, including clinical, proteomic, and genetic data. Artificial Intelligence aids in the development of drugs that can alter biological processes by identifying targets and molecular pathways linked to disease.[34]

V. ARTIFICIAL INTELLIGENCE'S FUNCTION IN MEDICATION DEVELOPMENT

- Sensor Systems:- In many industries, sensor systems play a crucial role. Sensor systems handle process instrumentation, process analytics, batching and weighting systems, vision sensors, measuring systems, conditional monitoring, and problem solving.
- Automation Systems:- In the pharmaceutical industry, artificial intelligence plays a critical role in automation systems. Numerous industries have installed cabling systems, automation software, CNC automationsystems, monitor control systems, and industrial automation systems, according to the survey.
- Operator Control and Monitoring Systems:- Devices for operator control, panel PC systems, monitors, and HMI (Human Machine Interfaces) are used in all industries. HMI programs and specially designed automations.
- Code reader:- This program is utilized for flexible verification and reading. Industries use optical character recognition (OCR), hand-held reading systems, verification systems, and stationary code reading systems
- Automatic Identification Technology:- Two identification systems are employed in the pharmaceutical industry. Code reading systems are the second type, and RFID (Radio Frequency Identification) systems are used for material handling and distribution.[34]

The gap between drug discovery and development is closing daily as the search for new drug molecules grows more challenging and laborious due to the larger chemical space.

Therefore, approaches based on the principles of artificial intelligence are very helpful at various stages of drug development; for example, determining and confirming drug targets, drug modeling and enhancing the drug-gable qualities. It is also essential in developing clinical trials for patients, which optimizes the decision-making process4. One of its applications, "Open Targets," is a brand-new strategic initiative to investigate the connections between genes and diseases as well as the relationships between drug targets and diseases. It offers a route that would direct in determining the target linked to the illness, or alternatively, the disease linked to the target 4. The Lipinski's rule of five must be followed by the drug-like molecule. In light of this, Seglar et al.'s 3N-MCTS (Monte Carlo Tree Search), a novel neural network technique, has an advantage over the retro synthesis computer assisted systems. Through this, different routes of synthesis were being devised in a short span of time with reduction in the number of steps to be followed. SPIDER is an AI approach which is being used for determining the role of natural products and their utilization in drug discovery. It was constructed to mainly predict the targets for drug molecules e.g. β- Lapachone, and hence it proved that reversible and allosteric inhibition of 5-Lipoxygenase is caused by β- Lapachone. To determine the toxicity of unknown compounds, a more advanced technique such as read across Structure Activity Relationship (RASAR) is being used. It is an eminent tool which is being developed on the basis of creating and identifying the link between molecular structure and characteristics that could make them toxic. The database for the chemicals is used to help with this. The Deep Neural Network (DNN) is a system that consists of a network of artificially connected neurons that interact with each other to perform various data transformations. It uses pharmacological and toxicological data to develop classification criteria for drugs in their respective therapeutic classes. Networks like Generative Adversarial Networks (GANs) serve as the foundation for the creation of cutting-edge AI methods. Machine learning (ML) is a crucial component of artificial intelligence. The use of statistical attributes is the foundation of this field.[35]

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VI. BENEFITS OF CONTRARY TO ARTIFICIAL INTELLIGENCE

The following are some possible benefits of AI technology:-

1. Error minimization:-Artificial intelligence helps to reduce errors and improve accuracy more precisely. The robust metal bodies of intelligent robots allow them to be capable of They are sent to explore space because they are unable to withstand the hostile atmosphere.
2. Difficult exploration:-Artificial Intelligence demonstrates its value in the mining industry. The field of fuel exploration also makes use of it. Artificial intelligence (AI) systems have the ability to overcome human error and conduct ocean research.
3. Daily application:-AI is incredibly helpful for our day-to-day actions. For instance, long drives are a common use for GPS systems. Android devices with AI installed can anticipate what a user will type. Spelling errors can also be corrected with its assistance.
4. Digital assistants:-To reduce the need for human intervention, forward-thinking companies are turning to artificial intelligence (AI) systems such as "avatar," which are models of digital assistants. The "avatar" is capable of making the proper, logical choices because they are devoid of any emotion. Artificial intelligence (AI) can be used to solve the problem of human emotions and moods impairing judgment.
5. Repeated tasks:- Generally speaking, humans are capable of completing one task at a time. Comparatively speaking, machines can do tasks that require multiple tasks at once and analyze data faster than humans. It is possible to modify different machine parameters, such as speed and time, based on specific needs.
6. Medical applications:- Generally speaking, doctors can utilize AI programs to evaluate patients' conditions and examine side effects and other health risks related to medication. With the use of AI applications, such as different artificial surgery simulators (such as those that simulate the heart, gastrointestinal tract, brain, etc.), trainee surgeons can learn a lot.
7. No breaks:- Unlike humans, who can work for eight hours a day with breaks, machines are programmed to be able to work continuously for extended periods of time without experiencing any form of boredom or confusion.
8. Accelerate the rate of technological advancement: - AI is a common component of the majorityof cutting-edge technological advancements made globally. It strives to create newer molecules and is capable of generating various computational modeling programs. Moreover, AI technology is being applied to the creation of drug delivery formulations.
9. No risk: - There is a great possibility that employees working in hazardous environments, such as fire stations, will be harmed. In the event of an accident, the machine learning programs can be used to repair damaged components.
10. Serves as an aid: Artificial intelligence technology now serves seniors and children around-the-clock, fulfilling a new role. It can serve as a resource for teaching and learning for all.
11. Limitless functions:- Because machines are limitless, they can accomplish anything. Emotionless machines are capable of performing tasks more accurately and efficiently than humans.

VII. DRAWBACKS OF AI TECHNOLOGY

1. Expensive:- AI development requires a significant financial outlay. Complex machine design, upkeep, and repair are incredibly economical. The research and development division needs a lot of time to design a single AI machine. The AI machine requires regular software programmers' updates. Reinstallations and machine recovery take a long time and cost a lot of money.
2. No human replication:-Artificial intelligence (AI)-enabled robots are said to possess human-like thought processes and emotionlessness, which confers certain benefits such as increased task accuracy and impartial performance. When unfamiliar issues emerge, robots are unable to make decisions and may give inaccurate information.

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3. Experience does not improve human resources:-Experience does improve human resources. On the other hand, AI-powered machines are incapable of learning from experience.[36] They are unable to distinguish between those who work hard and those who don't.
4. Lack of original creativity:- AI-enabled machines lack both emotional intelligence and sensitivity. People are able to see, hear, feel, and think. They are able to employ both their imagination and reasoning. Machines are not capable of achieving these features.
5. Jobless rates:-The extensive application of AI technology across all industries could result in high rates of joblessness. Due to unfavorable unemployment, employees may become less creative and dependable.[6]

VIII. DEEP LEARNING

Artificial Intelligence is a burgeoning field that finds use in many facets of society and business. The pharmaceutical business has been using this potent technology in new and creative ways lately to assist address some of the most pressing issues that the sector is currently experiencing.[12] In pharmaceuticals, artificial intelligence is the application of automated algorithms to carry out operations that have historically required human intellect. The application of artificial intelligence in the pharmaceutical and biotech sectors over the past five years has completely changed how scientists discover new medications, treat illnesses, and more. Since Dartmouth College hosted the renowned conference in 1956, that year is typically regarded as the birth year of artificial intelligence. But the year before, 1955, witnessed the development of the first artificial intelligence system, known as Logic Theorist, by Allen Newell and Herbert A. Simon. This technique was used to prove nearly forty theorems from Principia Mathematical by Bertrand Russell and Alfred N. Whitehead. Nevertheless, the system's creators were unable to get it released. The speed and memory capacities of the intelligent machines that scientists and engineers are creating have advanced to an unprecedented degree, surpassing human capabilities in numerous areas. Even the most advanced robots' cognitive mechanisms are nevertheless constrained by what a creator can initially load into them.[37]

IX. TYPES OF ARTIFICIAL INTELLIGENCE

The following classes comprise artificial intelligence:-

1. Artificial Narrow Intelligence:- sometimes known as weak intelligence, is a system that is trained and developed to carry out a certain activity, including traffic signaling, chess, driving, or facial recognition. For example, tagging in social media and Apple SIRI's virtual personal assistant.
2. Strong AI, often known as Artificial General Intelligence (AGI):-Another name for it is "Human Level AI." It has the power to make human intelligence simpler. Because of this, it has the capacity to solve problems when faced with new ones. AGI is capable of all human functions.
3. Super intelligence (ASI) that is artificial:- This mental ability is more active than that of intelligent people in areas like mathematics, sketching, space, etc. It goes from a computer that is only slightly wiser than a human to one that is trillion times smarter than a human in every subject, from science to the arts.[37]

X. ARTIFICIAL INTELLIGENCE IN PERSONALIZED/DIGITAL THERAPY AI

Has the capacity to identify significant relationships in the raw datasheets that may be used to the illness's diagnosis, management, and prevention. Numerous more recent methods utilized in this developing field of computational knowledge have the potential to be employed in nearly every area of medical study. The task of gathering, evaluating, and applying a wealth of knowledge must be met in order to solve the complicated clinical issues .The advancement of AI in medicine has aided medical professionals in resolving challenging patient issues. Healthcare professionals can receive assistance in manipulating data from systems like artificial neural networks (ANNs), evolutionary computing, fuzzy expert systems, and hybrid intelligent systems. The organic nervous system serves as the foundation for the artificial neural network (ANN). Neural networks are a type of linked computer processor network that can process input in parallel using calculations. A binary threshold function was used in the development of the first artificial neuron. The most widely used model with many layers ; input, middle, and output was the multilayer feed-forward perceptron. Every neuron is linkedby links with a numerical weight. Paul Werbos presented a novel approach called "Back propagation learning" in 1974, which has an appropriate learning algorithm. The ANN has been employed in

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diagnostic image analysis, data interpretation and waveform analysis. A branch of reasoning, thinking, and inference known as fuzzy logic is capable of identifying and applying real-world events. A continuous set of membership, with 0 denoting false and 1 true, is mostly used. Vasodilators and anesthesia have also been administered in operating rooms using fuzzy controllers. Based on the natural evolution process, which emphasizes survival of the fittest and natural evolution, is this evolutionary computation approach. The genetic algorithm is the most often used algorithm. It determines several haphazard answers to a single issue and, in the end.

10.1 Artificial Intelligence in Cancer

AI has become more important in the disciplines of cancer diagnosis and treatment due to its wide range of applications. A multilayer perceptron neural network was trained with gene expression data to predict the lymphoma subtypes of non-Hodgkin lymphoma. Lymphoma subtypes make up the output layer of the neural network, whereas 20,863 genes make up the input layer. Burkitt, diffuse large B-cell lymphoma (DLBCL), follicular lymphoma, marginal zone lymphoma, and mantle cell lymphoma (MCL) are among the subtypes of lymphoma. High accuracy lymphoma subtype predictions have been made by an AI neural network. Using gene expression data, an artificial neural network was employed to find novel MCL prognostic markers. It was found that 58 genes accurately predicted survival. , and five genes were linked to good survival and ten genes to bad survival. According to a multivariate analysis of gene expression using the Multilayer Perceptron (MLP), three genes are correlated with poor survival and four genes with favorable survival in DLBCL patients. The prognosis and overall survival of patients with follicular lymphoma (FL) were predicted using radial basis function (RBF) neural networks and machine learning (MLP) techniques. Following an analysis of 22,215 genes, it was shown that 18 genes were linked to a bad prognosis and 43 genes were connected with the prediction of overall survival. A deep learning AI method was used to classify the cell-of-origin (COO) of DLBCL based on transcriptional and genomic data gathered using RNA-Sequences on a next-generation sequencing (NGS) platform. Artificial Intelligence has made assays for categorization and future therapeutic applications more economical, efficient, and repeatable. AI reduces time while maintaining high accuracy in the detection of cancer. AI-based PET imaging for lymphomas is utilized for the assessment of tumor burden, which is then applied to the tumor's characterization, heterogeneity measurement, and treatment response prediction.

Colorectal cancer (CRC) screening technology is used to assess a patient's cancerous state when they have gastrointestinal cancer. And visual nocturnal assessment of Helicobacter pylori infection is critical factors in forecasting the course of gastric cancer. AI, appropriate blood testing, and endoscopic imaging can all help detect cancer early and slow its spread. However, only retroactive evidence can be obtained in AI because to the lack of appropriate blindfolded controlled experiments and randomization. Moreover, in certain investigations, the prognosis of tumors was not supported by the prediction models. Subsequently, a number of models have acquired several dimensions and likely predictive results, including the Multi-task logistic regression algorithm, the Cox survival regression algorithm, and the random survival forest algorithm. Thanks to these developments, gastroenterology has been able to automate the diagnosis of malignancy, not only for categorization but also for detection and magnification using endocytoscopy - a technique that has not been applied in clinical practice. AI is a flexible clinical tool for screening and early lung cancer diagnosis. Because deep learning and machine learning AI approaches can accurately describe pulmonary nodules and preserve large amounts of data, they provide a supportive measure in lung cancer screening. At the moment, Artificial Intelligence facilitates pathologists' responsibilities and helps remote institutes that are facing a pathologist scarcity. Numerous artificial intelligence (AI) applications, including those for segmenting carcinoma foci, detecting metastases from lymph nodes, counting tumor cells, and predicting gene alterations, have been proven to be beneficial in the treatment of lung cancer. Artificial Intelligence (AI) has promise for interpreting low-dose computed tomography (LDCT) images for lung cancer screening, leading to increased diagnostic precision and a reduction in false-positive rates. AI is also capable of measuring morphological changes associated with tumors and non- tumors, which is crucial for prognostication on serial imaging. The recurrent neural network (RNN), convolutional neural network (CNN), and The two algorithms' combined dual effect can be used to distinguish between benign and malignant nodules. Tools that are easy to use and don't require a degree in computational science are essential to advancing AI in healthcare and pharmaceutical research and helping to overcome its limitations in translational research. AI has shown great promise in the last ten years for the diagnosis of breast cancer. Combining quantitative and qualitative MRI data, AI-assisted

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approaches can be used to predict treatment response in patients with breast cancer, even prior to the initiation of neoadjuvant chemotherapy (NAC). Artificial Intelligence has the potential to be used in breast density evaluation, breast cancer risk assessment, and lesion recognition, segmentation, and classification. AI-based software can assist radiologists in their clinical work by helping them differentiate between benign and malignant breast lesions and by lowering the likelihood that false-negative mammograms will be interpreted. The progress made in this direction is still in its early stages and has several drawbacks, including the lack of substantial public datasets, the need for high- quality photos, the reliance on ROI annotations, issues with binary classification, and the incapacity to manage several jobs concurrently. Because there aren't enough public data sets available to train deep convolutional neural networks (DCNNs), the development of AI tools, such as DL-based CAD, is still in its early stages.

10.2 AI in Additional Chronic Illnesses:-

Based on computer programming skills, several computerized therapies are offered. The behavioral and cognitive approach—which uses joysticks or multiple-choice questions—is the main focus of the therapy. Intelligent computer-assisted instruction is a new type of computer interaction that has recently been developed. It can use other AI technologies, like natural language understanding and expert systems, to create combination therapies based on patient biopsies and to implement recommendations for n-of-1 medications. Regular monitoring is necessary for chronic diseases, and artificial intelligence (AI) can be used to create virtual medical assistants to help with this monitoring. Many businesses have implemented this kind of support, which often uses mobile applications to deliver virtual coaching through text messaging. AI is also used to make dietary suggestions that are precisely based on gut micro biota. With the use of an integrated system based on deep learning, a single-lead ECG sensor, accelerometer data from physical activity, and a smart watch, arterial fibrillation can be anticipated. Diabetes treatment makes substantial use of case-based reasoning, which is created utilizing AI techniques. The automated system recognizes issues and retains the most efficient fix for each patient. Insulin therapy optimization is already being done with it. For the treatment of diabetes, other methods like the vector regression methodology are now in vogue. In patients with type 2 diabetes mellitus, machine learning-based technologies such as clinical decision support can also predict the short- and long-term HbA1c response following the start of insulin. AI methods can also be used to determine a person's risk of contracting a specific illness. Advanced artificial intelligence methods that operate at the molecular level, including digital biomarker generation, genomics, epigenetic modifications, and molecular phenotyping, can also be applied to the treatment of many medical disorders. Patients can use web-based tools to manage their diabetes with the use of more modern techniques, such as smartphones and mobile phones.38

XI. PATENTS RELATING TO AI

Patents are used to measure a company's capacity to directly create AI technology or to leverage AI to innovate more broadly. Patents are often utilized in the biotechnology and pharmaceutical industries to assess a company's level of innovation. A single drug patent has the potential to have a significant impact on both a product and the technology utilized in drug research. Since patents are the most effective means of preventing imitations and substitutes, new pharmaceuticals are usually patented. Patents can deter intellectual property theft by discouraging reverse engineering, which is far simpler than finding a novel treatment .As a result, patents may be a useful gauge of pharmaceutical innovation. Thus, the first and third requirements for developing AIIC, tangible and intangible resources, may both be represented by patents. Due to their great portability and transferability, patents are concrete results of invention. Because they are the result of complementary processes, abilities, and business practices, patents can also approximate for intellectual assets and intangibles that are essential for future innovation and productivity. Businesses that own more intangible assets connected to artificial intelligence are more inventive and efficient than their competitors. We use both AI patent classifications and each patent's free text to locate AI-related patents. The contribution of a patent to the fundamental AI technologies may be easily measured using AI patent classes. Class 706 for "Data Processing - Artificial Intelligence" is the special patent class that the United States Patent and Trademark Office (USPTO) has designated for AI inventions. There are several subclasses within this class, such as "machine learning" and "neural networks.39

XII. USING AI TO CREATE DRUG MOLECULES

Target protein structure prediction:-

Choosing the right target for a therapeutic molecule's development is crucial for effective therapy. The development of the illness involves several proteins, some of which are overexpressed. Therefore, in order to build a therapeutic molecule that targets a disease specifically, it is essential to anticipate the structure of the target protein. Because the design is in accordance with the chemical environment of the target protein site, AI can help with structure-based drug discovery by predicting the 3D protein structure. This helps to predict the effect of a compound on the target along with safety considerations before their synthesis or production.18

XIII. AI TOOLS

13.1 Robotic pharmacy

Robotic technology is used by UCSF Medical Center to track and prepare drugs with the goal of enhancing patient safety. They claim that the system has flawlessly prepared 3,50,000 doses of medicine. The robot has shown itself to be far superior than humans in terms of both size and medicine delivery accuracy. The hazardous chemotherapy medications are among the injectable and oral medications that may be prepared using robotic technology. This has allowed the UCSF nurses and pharmacists to focus on providing direct patient care and collaborating with the doctors, allowing them to make the most of their knowledge.2

XIV. HOW AI TECHNOLOGY AFFECTS THE AVAILABILITY OF MEDICATIONS

About 40 pharmaceutical businesses are said to be utilizing and experimenting with AI technology at this time.7 Pharmaceutical firms utilize artificial intelligence (AI) to find new pharmaceuticals, and by using AI, they can find new treatments more quickly. Clinical data, theories, and academic publications will form the foundation of new drug research and be fed into AI systems. After that, AI systems will use deep learning techniques to examine the data and provide "the most promising hypotheses.40

XV. CONCLUSION

The creation and operation of pharmaceuticals, biologics, and medical devices are already being impacted by AI. With AI's help, this product convergence trend will pick up speed in the upcoming years. Within the United States, Significant progress has already been made by the FDA in integrating in silico trials and assessing the application of AI in SaMDs and other medical devices. However, there is still more the FDA could do to guarantee that AI in drugs and medical equipment adheres to "privacy by design" guidelines and is made available through open-source and open-access publishing formats. AI has the potential to drastically upend the already precarious blockbuster model of pharmaceutical research over the next several years, moving the biotech, pharmaceutical, and medical device sectors away from Silicon Valley and toward the life sciences. Congress ought to take into account. If public policy leads the way, advancements in AI could signal the start of a new era in which distributive justice goals related to global public health could be more completely fulfilled by 2050, even if there is no chance of an AI "singularity. A departure from long-standing concepts of intellectual property that can widen the already-existing gaps in the health care received by the rich and the poor. Longer term, a new international AI treaty regime that takes public health values into consideration is required. The human being represents the most advanced machine ever designed. The human brain is trying very hard to develop something that can perform any task far more efficiently than a human being, and it has been somewhat successful in this endeavor. AI cancer tools such as Watson, Robotic pharmacy and tug robots have significantly altered the profession. The infrastructure required in the healthcare industry will need to become more sophisticated and technologically advanced as it grows. The creation and implementation of algorithms for data interpretation and learning analysis is known as artificial intelligence.

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