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# Development of Pharmacy Curricula to Include AI & Machine Learning

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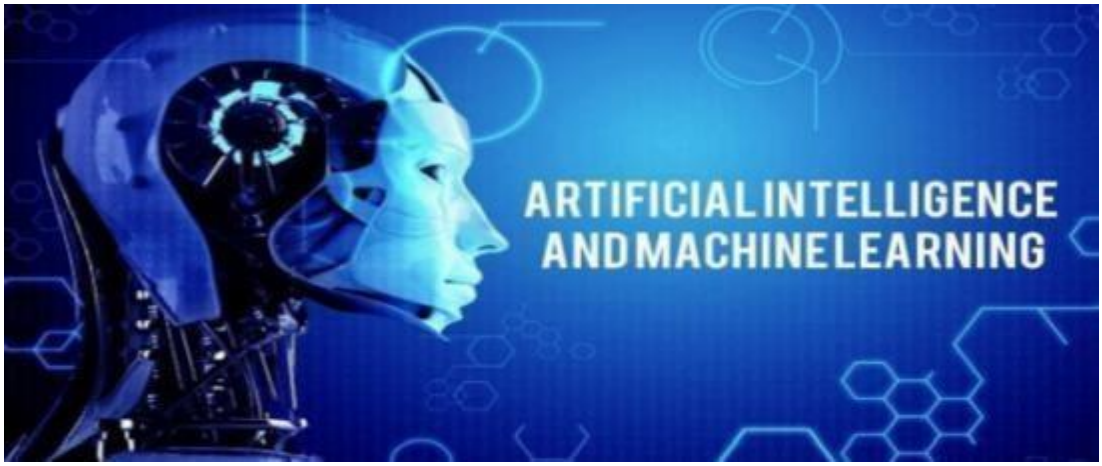
**Abstract**: *Artificial Intelligence (AI) emerged as an intervention for data and number related problems. This breakthrough has led to several technological advancements in virtually all fields from engineering to architecture, education, accounting, business, health, and so on. AI has come a long way in healthcare, having played significant roles in data and information storage and management such as patient medical histories, medicine stocks, sale records, and so on; automated machines; software and computer applications like diagnostic tools such as MRI radiation technology, CT diagnosis and many more have all been created to aid and simplify healthcare measures..*

**Keywords**: Artificial Intelligence

## I. INTRODUCTION

Intelligence (AI) is a stream of science related to intelligent machine learning, mainly intelligent computer programs, which provides results in




ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

In a similar way to human attention process. This process generally comprises obtaining data, developing efficient systems for the uses of obtained data, illustrating definite or approximate conclusions and self-corrections/adjustments. The technologies will be an integral part of the future pharmacy profession, and it may be ideal to acquire the necessary knowledge and skills and adapt to changes occurring in the field of ICT.

India is rapidly transforming into a global economy and the adoption of next-generation technologies is encouraged in the education sector, including pharmacies. The acceptance of advanced technology such as AI among the stakeholders of pharmacy education is largely influenced by the socioeconomic status of society, infrastructure support, and approval from academic regulators. However, few studies have reported the factors affecting students' perceptions of pharmacy programs regarding AI. Machine can be developed with artificial intelligence by reverse engineering human abilities and traits.


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**Table 1: Important milestones in the area of the AI uses.**

| Year | Events |
|---|---|
| 1943 | Walter Pitts and Warren McCulloch proved that logical operations like “and”, “or” or “not” can be done by neurons connected in a network |
| 1956 | The term ‘artificial intelligence’ was first appeared. |
| 1958 | Frank Rosenblatt created neuronal networks called Perceptrons which can transmit information in one direction. |
| 1974 | Initiation of “First AI Winter”. |
| 1986 | Georey Hinton promoted Back propagation algorithm design which is widely used in deep learning. |
| 1987 | Initiation of “AI winter”. |
| 1997 | Garry Kasparov (Russian grandmaster) was defeated by IBM Deep blue. |
| 2013 | Google carried out efficient research on pictures by utilizing the British technology. |
| 2016 | In this year, the Go Champion Lee Sedol was defeated by Google DeepMind, software AlphaGo. |

Principal component analysis (PCA)

PCA is another AI based model for decreasing the Dataset-dimensionality by preserving as much ‘variability’ (i.e., statistical information) as possible and at the same

Time, PCA modelling minimizes the loss of information. PCA modelling translates into searching newer variables, Which are linear functions of those in the original dataset By generating newer uncorrelated variables so that Maximize the variance, successively.30 Searching of such Newer variables, the principal components reduce the Resolving of an eigenvector or eigenvalue problem.30,31 PCA can be based on either the covariance matrix or

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The correlation matrix and the main applications of PCA Are descriptive in nature, rather than the inferential uses. Recent years, PCA is well-known for using as a 'hypothesis

Generating' AI tool generating a useful statistical mechanics Frame for modelling of biological systems without the Requirement for strong a priori theoretical assumptions, Which makes PCA of paramount significance for drug Discovery research by a systemic perspective overcoming Too narrow reductionist approaches.32

Artificial intelligence is a technology that enables computers to function independently but intelligently by reading human behavior. It is designed to create intelligent machines.

Artificial intelligence (AI):

Artificial intelligence (AI) is the capability of computational systems to perform tasks typically associated with human intelligence, such as learning, reasoning, problem solving, perception, and decision-making. It is a field of research in computer science that develops and studies methods and software that enable machines to perceive their environment and use learning and intelligence to take actions that maximize their chances of achieving defined goals.

Machine learning:

Machine learning is a branch of artificial intelligence that enables algorithms to uncover hidden patterns within datasets. It allows them to predict new, similar data without explicit programming for each task. Machine learning finds applications in diverse fields such as image and speech recognition, natural language processing, recommendation systems, fraud detection, portfolio optimization, and automating tasks.

Objectives:-

Develop the problem-solving ability

Artificial intelligence research focuses on developing efficient algorithms for solving complex puzzles that can deduce logically and simulate human reasoning. The use of probability theory in AI systems, such as stock market prediction systems, allows them to deal with uncertain situations and incomplete information.

Allow continuous learning

In AI solutions, learning implies the ability of computer algorithms to learn from past experiences and observations to improve their knowledge. A machine learning program processes a set of input-output pairs for a defined function and uses the results to predict future input outcomes.

Identify AI and ML applications relevant to pharmacy facilitate planning

By using predictive analytics, data analysis, forecasting, and optimization models, intelligent agents enable us to project the future and decide how to proceed. In robotics, autonomous systems, cognitive assistants, and cybersecurity, AI can assist us in making future predictions and determining the consequences of our actions.

Analyze the current pharmacy curriculum.

Identify AI and ML application relevant to Pharmacy.

Purpose of model curriculum with integrated AI and ML topic.

Advantages

Artificial Intelligence (AI) offers several significant advantages in the field of
pharmacy, revolutionizing everything from drug discovery to patient care. Here are the key advantages:

1. Drug Discovery and Development

Faster drug development: AI can rapidly analyze vast datasets to identify potential drug candidates, reducing the time and cost of development.

Predictive modeling: AI models can predict the efficacy and toxicity of compounds before physical testing, minimizing trial-and-error.

Target identification: AI helps identify molecular targets for new drugs by analyzing genetic and biochemical data.

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2. Personalized Medicine

Tailored treatment plans: AI can analyze a patient's genetic makeup, lifestyle, and health history to recommend personalized drug therapies.

Dose optimization: AI algorithms help in determining the optimal dosage for individual patients, reducing side effects and improving efficacy.

3. Medication Management

Error reduction: AI helps in preventing medication errors by cross-checking prescriptions with patient history and known interactions.

Adherence monitoring: AI-powered apps and smart pill dispensers remind patients to take their medications, improving compliance.

4. Pharmacy Operations

Inventory management: AI predicts stock requirements, reduces wastage, and automates restocking processes.

Workflow optimization: AI streamlines pharmacy operations like prescription filling, billing, and supply chain management.

5. Clinical Decision Support

Real-time insights: AI assists pharmacists and healthcare providers in making informed decisions using evidence-based data.

Drug interaction alerts: It can automatically alert pharmacists to harmful drug interactions or contraindications.

6. Pharmacovigilance

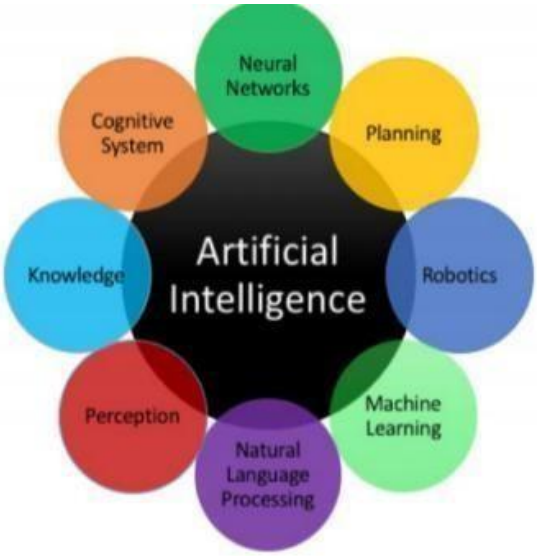
Adverse event detection: AI systems can monitor social media, medical records, and databases to detect potential side effects more quickly than traditional methods.

Signal detection: AI enhances the ability to identify patterns in adverse drug reactions, contributing to safer drug use.

7. Patient Counseling and Support

Virtual assistants: AI chatbots can provide 24/7 support for patients, answering questions about drug use, side effects, and general health.

Language translation: AI tools can help pharmacists communicate with non-native speakers more effectively.



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Classification
AI can be classified in two different ways:
a) According to caliber
b) According to the presence
Based on the caliber
Weak intelligence
Artificial narrow intelligence
Artificial general intelligence
Artificial super intelligence
Based on presence
1. Type1reactivemachine
2. Type2limitedmemorysystem
3. Type3isbasedonthetheoryof mine
4. Type4self-awareness
5. Based on their caliber, AI systems are classified as follows:
1. Weak Intelligence or Artificial Narrow Intelligence (ANI):
This system is designed and trained to perform a narrow task, such as facial recognition, driving a car, playing chess, and traffic signaling.
E.g.: Apple SIRI virtual personal assistance, tagging in social media.
2. Artificial General Intelligence (AGI) or Strong AI:
It is also called Human-Level AI. It can simplify human intellectual abilities. Due to this, when it is exposed to an unfamiliar task, it can find the solution. AGI can perform all the things as humans.
3. Artificial Super Intelligence (ASI):
It is brainpower, which is more active than smart humans in drawing, mathematics, space, etc.; in every field from science to art.

6. Based on type:
Type 1: Reactive Machine
This type of AI system is called a Reactive Machine.
E.g.: Deep Blue, the IBM chess program which beat the chess champion, Garry Kasparov, in the 1990s. It can identify checkers on the chessboard and can make predictions; it does not have the memory to use past experiences. It was designed for narrow purposes and is not useful in other situations. Another example is Google's AlphaGo.
Type 2: Limited Memory System
This type of AI system can use past experiences for present and future problems. In autonomous vehicles, some of the decision-making functions are designed by this method only. The recorded observations are used to record the actions happening in the future, such as changing the lanes by car. The observations are not in the memory permanently.

Methodology:
1. Methodology:
The methodological approach used mixes bibliometric, content analysis, and social network techniques. In this study, a state-of-the-art research was conducted through the SCOPUS and Web of Science databases. For the publication time span, the time from 1999 to 2019 was considered with the intent to understand how the level of attention towards the topic has changed before and after the introduction of Industry 4.0.
The research methodology chosen for this study was a systematic literature review [25]. The main phases of the study were as follows:
2. Phase 1: Research and Classification.
The present phase was divided into three steps:
Step 1: Identification


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Step 2: Screening
Step 3: Inclusion
In Phase 1, bibliometric data was collected (Step 1). Then, a screening of major leading pharmacy schools was conducted.
Survey/Interviews: Collect feedback from faculty, students, and professionals.
Module Design: Create sample AI/ML lesson plans and practical exercises.
Pilot Testing (Optional): Propose a trial integration in selected institutions.

Applications of AI:
AI algorithms have attracted close attention of researchers and have also been applied successfully to solve problems in engineering. Nevertheless, for large and complex problems, AI algorithms consume considerable computation time due to the stochastic feature of the search approaches.
1. Business: Financial strategies
2. Engineering: Check design, offer suggestions to create new products, expert systems for all engineering problems
3. Manufacturing: Assembly, inspection, and maintenance
4. Medicine: Monitoring, diagnosing
5. Education: In teaching
6. Fraud detection
7. Object identification
8. Information retrieval
9. Space shuttle scheduling

Additional Applications of AI:
10. Drug creation:
The development or creation of pharmaceuticals takes more than a decade and consumes billions of rupees.
"Atomwise" [28], an AI technology that uses supercomputers, is useful to find out the therapies from the database of molecular structure.
11. Treatment plan designing:
The designing of effective treatment plans is possible with the help of AI technology.
12. Maintaining of medical records:
Maintenance of the medical records of patients is a complicated task. The collection, storage, normalizing, and tracing of data are made easy by implementing the AI system.

Benefits:-
1. Preparation for future practice: Equip students with the skills and knowledge needed tothrivein an Al-driven healthcare environment.
2. Improved patient care: Enable students to apply Al and machine learning to improve patient outcomes and optimize medication therapy.
3. Interdisciplinary collaboration: Foster collaboration between pharmacy students andstudents from other disciplines, such as computer science and data science.
The ability to quickly analyse large amounts of data to produce actionable insights.
Increased return on investment (ROI) for associated services due to decreased labour costs.
Improved customer satisfaction and experiences that business owners can tailor to meet individual customer needs.

Challenges:
Curriculum Integration: Integrate AI and machine learning content into existing pharmacy curricula.
Faculty Expertise: Ensure faculty members have the necessary expertise to teach AI and machine learning concepts.
Resources: Provide students with access to necessary resources, such as computational infrastructure and software.

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## II. CONCLUSION

This project will help bridge the gap between pharmaceutical sciences and emerging AI technologies, preparing future pharmacists for tech-driven roles.

There are many different ways to define artificial intelligence, but machine learning techniques—particularly deep learning—are bringing us incrementally closer to a generalized artificial intelligence.

However, we are in the very early stages of using machine learning in real estate, and the areas that could qualify as artificial intelligence are simplistic.

Result:

The integration of AI and ML into the pharmacy curricula is essential to prepare future pharmacists for the evolving landscape of healthcare. While still in the early stages, developments are underway to equip students with the necessary skills and knowledge in this transformative field.

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