

**ANFIS-BASED RECOMMENDER SYSTEMS****Pallavi Vyas<sup>1</sup>, Dr. Ravindra Kumar Vishwakarma<sup>2</sup>, Dr. Anuj Bhardwaj<sup>3</sup>****Article History: Received: 12.12.2022****Revised: 29.01.2023****Accepted: 15.03.2023****Abstract**

Recommender Systems have become essential in personalized education information for students, as they provide relevant and useful information to students regarding specific program information and its attributes. With the rapid growth and improvement in the machine learning algorithm, the recommender systems help in finding a program that helps further in better job prospects. The system can perform more efficiently and helps in solving complex problems by using ANFIS, even with unstructured and vast datasets. In the construction of recommender systems Machine learning techniques are used which helps in academics and in the education field, discussed briefly in the research paper.

**1. Relationship between Artificial Intelligence, Data Science, and Machine Learning:** AI, machine learning, and data science falls in the same domain and are connected to each other. They each have their unique uses and meanings. Human intelligence is mimicked or replicated by artificial intelligence systems [1]. Systems now have the potential to automatically learn from their experiences and get better over time thanks to machine learning. Data analytics, data mining, machine learning, artificial intelligence, and several more related fields are all included under the general phrase "data science." We employ machine learning methods like supervised learning or unsupervised learning to extract predictions from the data set. To extract predictions from a given data set, machine learning techniques called supervised(managed) and unsupervised(unmanaged) learning are applied. A branch of machine learning called deep learning focuses on algorithms. Artificial neural networks are used, which are based on the composition and functionality of neurons in the human brain. When there isn't a clear data structure that you can simply exploit and create features around, deep learning is most effective. to learn from forecasts that are being made. Data analysis is performed in order to make predictions, which is actually the data science process. When data finally takes some kind of action, AI enters the scene. With the help of forecasts and insights, artificial intelligence blends automated and human decision-making to carry out tasks.

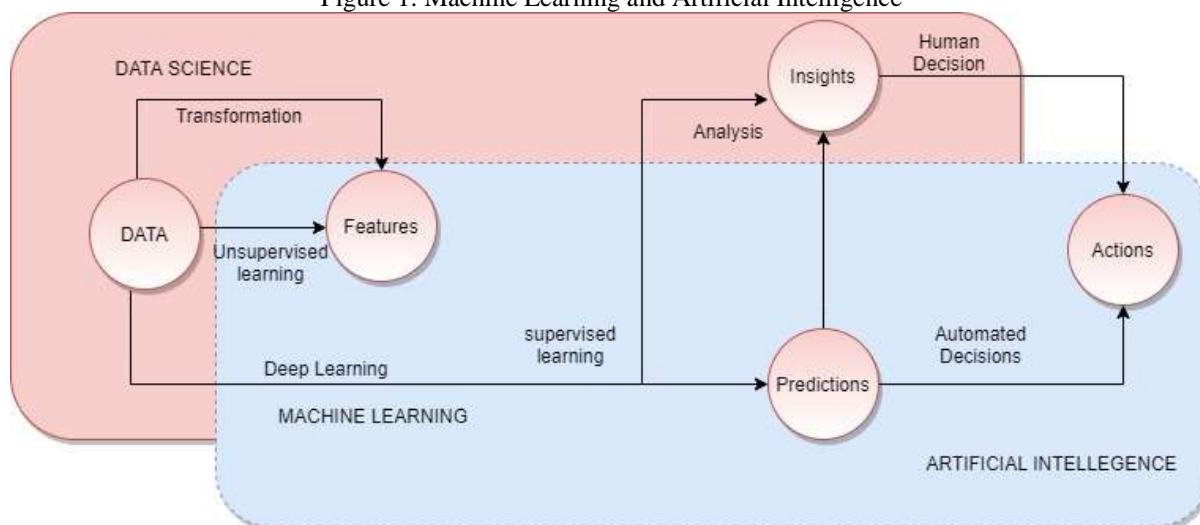
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Figure 1: Machine Learning and Artificial Intelligence

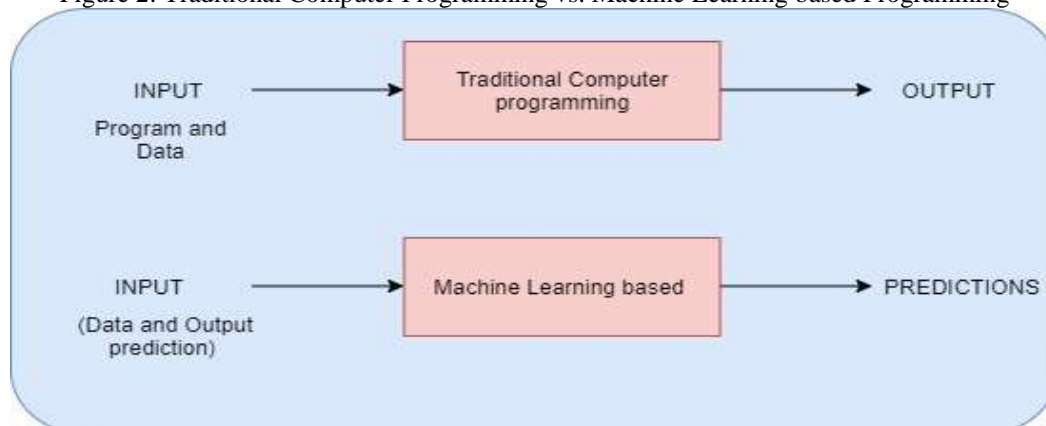


The engineering of creating intelligent robots and programmes is known as artificial intelligence. Machine learning provides systems the ability to learn from past experiences without being explicitly programmed. Machine learning allows machines to gain intelligence, thereby enabling artificial intelligence. Data science and machine learning go hand in hand. Data science helps evaluate data for machine learning algorithms. Data science covers the whole spectrum of data processing, while machine learning has algorithmic or statistical aspects. Utilising statistical techniques to identify patterns in data is known as data science. Data science employs the same methods as statistical machine learning. Pattern recognition, statistical modelling, and other approaches are all included in data science. The main goal of machine learning is to create algorithms from data by making predictions. The ability of an artificial intelligence system to learn by identifying patterns in data is known as machine learning. It typically provides faster, more precise answers to assist you in identifying lucrative opportunities or risky situations. The data is used by machine learning to identify trends in a data set and modify programme operations accordingly. Pattern detection can be defined as the classification of data based on prior knowledge or statistical data inferred from patterns. It focuses on creating computer programmes that can educate themselves to advance and adapt when they are exposed to new information using a technique known as reinforcement learning. It teaches the system to modify its internal operations

so that it can make a better guess the following time using external feedback. It allows computers to use iterative methods to discover hidden insights without having to be explicitly coded. To aid in the creation of trustworthy and repeatable conclusions, machine learning uses algorithms that learn from past data. By employing statistical and machine learning techniques to extract patterns and relationships from data and express them as mathematical equations, it automates the construction of analytical models.

The basic alteration between Machine Learning and Traditional programming is shown below in figure 2. In traditional or old-style programming data and program is provided to the computer. It processes them and gives the output. The machine learning method is pretty dissimilar, though. Algorithms are used in machine learning to process the input data and output. A learning model that aids the machine in learning from the data is produced as a result of the calculations and algorithm used. Traditional or old styles programming codes the behavior of the program, but in the machine learning approach machine learns from the data. In the new machine-learning approach, the conclusion rules are not hard coded. In order to create or learn an algorithm that best captures the relationship between the input and the output, the issue is resolved by training a model with the training data. Then test data are used to evaluate this trained model. If the results were positive, the model would be used in production; otherwise, the training would be redone with minor modifications.

Figure 2: Traditional Computer Programming vs. Machine Learning based Programming



**2. Types of applied machine learning:** There are many different types of applied machine learning, which can be broadly categorized as follows:

**-Supervised Learning:** Using labelled data, a model is trained in this type of machine learning to make predictions or categorise fresh data. By minimising a loss function, the objective is to learn a mapping between the input variables (features) and the output variables (labels).[2]

**-Unsupervised Learning:** Finding patterns or structures in unlabeled data without a clear direction on what to look for is the goal of this form of machine learning. Finding connections between data points or clustering them is the objective.[3]

**-Semi-supervised Learning:** Unsupervised learning and supervised learning are both used in this kind of machine learning. To train a model, a small amount of labelled data must be combined with a larger amount of unlabeled data.[4]

**-Reinforcement Learning:** An agent that learns to make decisions based on feedback from its surroundings is the focus of this sort of machine learning. The objective is to maximise a reward signal by making decisions that produce advantageous results.

**-Deep Learning:** This is a subset of machine learning that involves training models with multiple layers of artificial neural networks. Deep learning algorithms have shown impressive results in image and speech recognition, natural language processing, and other complex tasks.

**-Transfer Learning:** This type of machine learning involves using knowledge gained from one task to improve performance on another related task. This

is often done by reusing pre-trained models and fine-tuning them for a new task.

**-Online Learning:** This type of machine learning involves updating a model in real-time as new data arrives. This is useful in situations where the data is constantly changing or where it is impractical to store large amounts of data.

**-Bayesian Learning:** This type of machine learning involves updating the probability distribution of model parameters as new data arrives. This approach allows for uncertainty in model predictions and can be useful in decision-making applications.

### 3. Types of Supervised Machine Learning:

Two different types of supervised machine-learning techniques are there one Classification and the other is Regression supervised machine learning technique. On the basis of training sets and values, classification either predicts categorical class labels or categorises data that is used to categorise properties used in model construction. Regression graphs involve finding the best-fit straight line through the plotted points. The best-fit line is called a regression line. If the target values are continuous numeric values (1000-2000) then use a regression algorithm. In order to find continuous dependent variables from a number of independent variables.

**Recommender System:** We can see how the world is evolving in a variety of ways since it is changing rapidly. Recommender systems can be seen to be playing a significant role, especially in the field of artificial intelligence. These systems can only be operated through providing interactive systems, which is something that must be understood in order to fully comprehend these types of systems. Users must now employ interactive platforms that can reveal their preferences instead of relying on static

forms of data. Users are able to regulate the amount of data they receive on their computers in this way, according to their whims and desires.

The creation of a user recommendation system Finding certain systems that can produce accurate results is necessary in order to build an intelligent recommendation system. Recommendation systems have an intelligent foundation and can be employed in the contemporary environment. As a result, this system functions like a salesperson by providing a variety of options to the numerous users who can access it to meet their diverse demands. Understanding that these systems are designed to accommodate user preferences is crucial if we are to use them effectively. In order to help computers recognise the many types of preferences that these users value, all these recommendations are therefore installed in a system (Alpaydin, 2016).

**Program Recommender System:** Students faced many problems while selecting a program at the time of admission. Wrong program selection will lead to depression and anxiety among students. There is a need for a recommender system for students in the selection of programs based on students' past academics. This kind of recommender system helps universities in order to reduce the dropout rate of students. So, to retain students in the university it is necessary to look after their choices and interests.

The solution to this problem is *PPSRS (Personalized Program Selection Recommender System)*. In order to help students to get better job prospects PPSRS helps students with the best program recommendations. Recommender System for the program selection is based on regression-supervised machine learning techniques. This paper explains the recommender system based on ANFIS and ANN machine learning techniques.

*Adaptive Neural Fuzzy Inference System (ANFIS):* An artificial intelligence (AI) programme known as an adaptive neural fuzzy inference system (ANFIS) combines the concepts of fuzzy logic and neural networks to simulate complicated systems. Because it employs a hybrid learning strategy, it can adapt to changes in the input data and update its settings as necessary. Applications with non-linear, time-varying, or unpredictable data benefit most from ANFIS.

Each node in the ANFIS architecture represents a fuzzy rule and is connected to the others. The nodes are placed in a layered layout that enables data

propagation both forward and backward. The incoming data is first fuzzified, or transformed into fuzzy sets that the system can understand. Following the application of the rules to the fuzzed-up input data, the output is defuzzed to produce a clear output value.

The ANFIS system uses a hybrid learning algorithm that combines the least-squares method used in fuzzy systems and the gradient descent method used in neural networks. As a result, the system can react to changes in the input data and modify its settings as necessary, gradually improving accuracy. Several industries, including banking, medical, engineering, and robotics, have effectively used ANFIS.

*Artificial Neural Network (ANN):* A form of machine learning technique known as an Artificial Neural Network (ANN) is based on the structure and operation of the human brain. It is made up of layers of interconnected neurons, or nodes, that are coupled to one another. Each neuron analyses the input it receives from neurons in the layer below before sending the output to neurons in the layer above. The output of the network is produced by the last layer of neurons. By modifying the weights and biases of the neurons in response to input, the ANN is made to learn from data. A collection of input and output data, referred to as training data, are provided to the network during the training process. In order to reduce the discrepancy between the anticipated output and the actual output, the network alters its weights and biases. Backpropagation, a method of mathematical optimization, is used in this process to increase prediction accuracy by iteratively updating the weights and biases of the neurons. By modifying the weights and biases of the neurons in response to input, the ANN is made to learn from data. A collection of input and output data, referred to as training data, are provided to the network during the training process. In order to reduce the discrepancy between the anticipated output and the actual output, the network alters its weights and biases. Backpropagation, a method of mathematical optimization, is used in this process to increase prediction accuracy by iteratively updating the weights and biases of the neurons.

#### 4. Differentiate between ANFIS and ANN:

The following table explains the difference between ANFIS and ANN:

Feature	ANFIS	ANN
Type of Algorithm	ANFIS is a hybrid system that combines the principles of fuzzy logic and neural networks	ANN is a pure neural network
Learning Algorithm	ANFIS uses a hybrid learning algorithm that combines gradient descent method with the least-squares method	ANN uses backpropagation algorithm
Input Data	ANFIS requires fuzzified data	ANN uses raw data
Output	ANFIS produces crisp output	ANN produces continuous output
Complexity	ANFIS is generally less complex than ANN	ANN is more complex than ANFIS
Suitable Applications	ANFIS is suitable for applications that involve non-linear, time-varying or uncertain data	ANN is more suitable for pattern recognition and classification tasks
Advantages	ANFIS can handle imprecise or uncertain data	ANN is better at handling large amounts of data
Disadvantages	ANFIS is limited to certain types of data	ANN requires significant computational power and data to train effectively

Table1: ANFIS vs ANN

### 5. Benefits of ANFIS for creating Recommender System for Program Predictions:

A powerful technology called ANFIS (Adaptive Neuro-Fuzzy Inference System) can be utilised to build a recommender system without plagiarising. The following are a few benefits of ANFIS[6]:

- Flexibility: ANFIS is a strong tool for developing a recommender system that can handle a variety of data inputs since it can be used to describe complicated systems with non-linear and fuzzy interactions.
- Accuracy: ANFIS is renowned for its excellent level of result prediction accuracy. You may be sure that the suggestions made to users utilizing an ANFIS-based recommender system will be accurate and pertinent to their interests.
- Customizability: ANFIS enables the development of specialized fuzzy logic and rules that may be adapted to the particular requirements of your

recommender system. As a result, you can design a system that is particular to your company and its consumers.

-Lessened risk of plagiarism in a recommender system: ANFIS can be used to compare and analyse data in order to lessen the likelihood of plagiarism in a recommender system. ANFIS can assist in ensuring that recommendations are unique and original by examining trends and spotting connections across various data sources.

ANFIS is a strong tool for developing a recommender system free of plagiarism overall. Because of its adaptability, precision, customizability, and capacity to lessen plagiarism, it is the perfect option for companies and organisations wishing to develop a recommendation system that is both accurate and flexible.

#### **Proposed architectural framework using ANFIS:**

An ANFIS-based recommender system algorithm would involve the following steps:



-Collect and pre-process the data: The data may need to be cleaned, normalized and, split into a training and testing set.

-Define the fuzzy rules: Design a set of fuzzy rules that describes the relationship between user characteristics, item characteristics, and ratings or feedback. These rules will be used to make inference about user preferences and items relevance.

-Initialize the ANFIS model: Start with random values for the parameters, such as the membership functions of the fuzzy sets and the weights of the neural network.

-Fuzzify the input data: Use the membership functions to convert the crisp input values (e.g., user characteristics, item characteristics) into fuzzy sets.

-Evaluate the fuzzy sets: Use the fuzzy input sets and the associated weight values to evaluate the fuzzy rules.

-Perform the inference step: Combine the output of the fuzzy rules using a fuzzy operator (e.g., the minimum or maximum operator) to make inferences about the user-item interactions.

-Defuzzify the output: Convert the inferred output (e.g., predicted rating) back into crisp values using a defuzzification method (e.g., the centroid method).

-Learn the model: Train the ANFIS model using backpropagation algorithm, adjusting the parameters based on the error between the predicted output and the actual ratings or feedback.

-Use the trained model: Once the ANFIS model is trained, it can be used to make recommendations for new users or items by applying the fuzzification, rule evaluation, inference, and defuzzification steps.

6. **Conclusion:** This paper explains a program recommender system framework to help students to choose better programs for higher studies. It seemed that ANFIS based recommender system is much more helpful and also effective while giving recommendations
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to students which will help in the future for shaping carrier.

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