AI-Enabled E-Learning Systems: A Systematic Literature

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Abstract: Today e-learning system plays an essential role in the education system. Technology integration in teaching helps to teach content-based curriculum effectively and efficiently to build confidence among students. Personalized learning systems focus on learning behavior, interest, and design curriculum according to learners" ability and basic knowledge. It is a flexible teaching methodology to meet the individual needs of students. The personalized learning approach optimizes the needs of each learner. For an effective education system, it is necessary to understand learners and develop a plan that copes up with the individual learning needs and the interest of students". An intelligent Tutor system is an expert system to monitor the learners" performance to provide personalized coaching. E-learning applications include computer-based learning, web-based learning, digital collaboration and virtual classrooms. Artificial Intelligence can be used for automating learning activities like designing teaching tools, curriculum, training, evaluating students" performance, and using modern teaching methodology. Artificial intelligence is the most modern e-learning trend in higher education and the corporate world. AI helps to provide individual decisions using data analytics that leads to better education for personalized instruction to streamline the education process.

Key Words: e-learning system, AI, intelligent Tutor system.

1. Introduction on E-learning Trends

In India, due to the digital revolution, the number of internet users is increasing day by day. Internet technology reaches not only the urban area but also the rural landscape too. So there is tremendous demand for e-learning in India. According to the Global Industry Analysis, the e-learning market will reach $325 billion by 2025. As per the statistical report, various private universities offer e-learning courses to their undergraduate and postgraduate programs. Ministry of electronics and information technology websites motivate e-learning as an essential tool for dynamic education. The government also provides aides for research and development projects in e-learning that focus on content development, faculty training, human resource development, etc. As per the online education report in India-2021, there is growing dependability on the internet for education, leading to huge scope for the e-learning market and corresponding employment opportunities. Learners" skills and knowledge requirements are continually changing as per new trends in the learning curve that suddenly reflect e-learning practices.

It provides peer to peer communication between learner and tutor. Today e-learning plays a vital role in corporate training to provide professional training to employees without human involvement. The organization motivates to develop dedicated custom e-learning software to provide training to employees. It helps the organization to save time and money. The employees who can work from home and e-learning are a better choice to solve their problem through e-learning. E-learning software displays e-content in various formats like a graph, charts, audio-video lectures, discussion forums, etc. Many e-learning applications support customer support platforms like Android, ios devices, and mobile, laptop, tablet. In 2020 big data and AI technology significantly contribute to learner analytics to monitor learners" activities and comply with their efficiency. Machine learning algorithms can be implemented for learner"s data collection, analysis, and monitoring of learner performance to improve the efficiency of the e-learning system.

E-learning technologies are categorized into synchronous and asynchronous learning trends. Synchronous e-learning is real-time learning that includes virtual classrooms, webinars, video conferencing, instant messaging, chat, and online

discussions. Asynchronous e-learning includes delivery of e-learning material via web, email, message boards, video lectures, online PowerPoint presentation, discussion forums etc.

Artificial Intelligence has the immense power to revolutionize e-learning and saves learners time and expenses. This would not burden learners because the AI-based e- learning platform will automatically provide all education-related information. E-learning motivates the learner to acquire the knowledge, enhance the skills for better decision-making, and solve real-time problems.

Following are some famous e-learning technologies:

Blended learning: It is a modern technique of providing education to students using electronic media, e-material, and online resources for student-teacher interaction with traditional classroom methods. It is a hybrid learning approach that combines online and offline classroom tools.

Collaborative learning: It is an e-learning approach where students socially interact with other students and teachers. Students can enrich their knowledge and learning experience by interacting with other students. It is an interactive learning process that motivates learners to acquire and exchange knowledge, skills through instant messaging, forums, chats, message boards, etc., among a collaborative team of learners.

Google Classroom: It is a free web-based service provided by Google to create and share e-study material between student and teacher and grading assignments, conduct online tests, and generate performance reports of students. It is a teacher-centric online education technique for communication between students and teachers.

MOOCS: It is a social learning platform called Massive Open Online Courses for learners to learn from the web. It provides open access to e-content, a structure that promotes the reuse of existing resources. Swayam, NPTL, Coursera, edX, Uadcity, Udemy, Future Learn, Novo ED, Iversity, Canvas, Open2Study, Open learning are the top most MOOCS providers that motivate the learners for e-learning and contributes to the modern and standard education system.

Gamification: It is an informal e-learning technique to engage the learners. This method system can provide rewards, success badges or levels, and virtual currency to motivate learners". Learning performance can be analyzed from the learners" engagement and achievements. If one crafts the gamification technique in teaching, it will help to capture and retain learners" attention, skill, and challenges and motivate them to complete a learning journey with fun. According to a survey done by the e-learning industry, it is found that 80% of learners claimed that gamification is a more productive technique for learner engagement and motivation.

2. Artificial Intelligence

Artificial intelligence is the process of simulating human intelligence into a programmed machine to think like a human being for solving problems. Artificial Intelligence is a branch of computer science used to develop an intelligent machine that can think and act to solve complex problems rationally like a human being. It is powered by the technique of machine learning, deep learning, heuristic searching, rule-based system, Artificial Neural network, Support Vector Machine, Natural Language Processing, etc. There are two types of AI. Narrow AI or weak AI is an artificial intelligence technique that operates within a limited situation and is a human intelligence simulation. Narrow AI is always focused on performing a single task efficiently and effectively. These machines are intelligent systems that are operating under many constraints and restrictions even better than basic human intelligence. Strong AI or Artificial General Intelligence (AGI) is the type of artificial intelligence used in robotics, movies etc. It is a machine with general intelligence that can think and work like a human being; it can apply that intelligence to solve any problem. Artificial Intelligent can be used in various fields such as Smart assistant system like Alexa, Siri, and Cortana these are intelligent voice recognition system helps to provide knowledge as well as enhance our decision-making capability.

3. Applications of Artificial Intelligence

- In medical and health care field AI is used for symptoms mapping and predicting disease.
- AI used in manufacturing industries for performing complex tasks through drone robots.
- It is used to develop an Optimized and personalized healthcare treatment recommendations system.
- AI-based techniques are used in the advertising and marketing industries to develop conversational bots for providing efficient customer service.
- AI used to develop a Robo-advisor's intelligent technique for inverters for providing advice for stock trading.
- An artificial intelligent agent can be implemented in Spam detection and filters on email.

4. Artificial Intelligence & Education

Right from manufacturing, medical, e-commerce to education, and in every sector, AI plays an essential role in the automation of various activities. Artificial intelligent techniques help to transform learning by providing a personalized approach to the students. Artificial intelligence"s real power is to store a large amount of data about learners and analyze it and provide personalized education as per individual needs.

Artificial intelligence can fill up the gaps in the subject area in which teachers don"t have particular expertise to understand individual learner"s skills and interests.

Deep learning is a subfield of machine learning. Algorithms designed using machine learning help to analyze the brain"s function using an Artificial Neural Network. Deep learning is an intelligent technique to work on a considerable amount of data with better performance. It is used to build an intelligent computer system that can learn complex function mapping, the input to output directly from data without depending on crafted human features. A personalized e-learning system can be developed

by implementing artificial intelligence-based techniques like Fuzzy rule-based systems and artificial neural networks.

Fuzzy System

There are some problems where we can"t decides the exact solution with value as true or false. In such circumstances, the fuzzy system is useful. A fuzzy system is a mathematical technique that gives output ranges between 0 and 1. Fuzzy logic works on the level of possibilities of input to achieve actual output. A fuzzy logic-based system can work on inaccurate, distorted, and noisy data. It gives a new intuitive approach without extensive complexity. Fuzzy logic is based on human communication and based on a quantitative approach used in daily language, so it is elementary to use and understand. Fuzzy logic is a computing technology based on the amount of truth rather than the binary result true or false (1 or 0) on which the modern computer is based. The Fuzzy logic is conceptually based on the principle of fuzzy set theory. It was initially developed from infinite-valued logic. Thus there is a correspondence between classical logic and fuzzy logic concepts. In fuzzy logic, we work with linguistic modifiers and linguistic variables. A fuzzy rule-based system is an expression of type IF (antecedent) THEN (consequent). A system that represents knowledge using such rules is called a rule-based system.
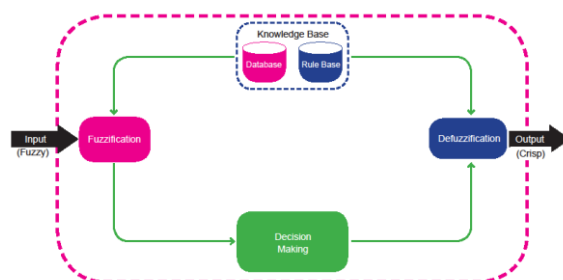

Fig.1 Block diagram of FIS

5. Components of Rule Based System

Working Memory: It consists of facts about a domain. These facts are considered while generating a rule base. It is storage medium for the rule base.

Rule Base: It stores several IF-THEN rules based on working memory. It is also called a knowledge base. Conflict resolution policies are used for the selection of appropriate rules. Conflict resolution policies like data ordering, specificity, and refractoriness of data and some data mining techniques like association, clustering techniques are used for creating rule-based. It is an iterative process that continues until expected results are obtained.

Inference Engine: It generates new information from the rule-based system and working memory to solve specific problems. It is a decision-making unit that operates on the rules.

Fuzzification: It is a technique of making a crisp set into a fuzzy set. Through this process crisp input values transforms into linguistic variables. To handle uncertainty, imprecision, ambiguity, vagueness IF-THEN rules and fuzzy sets are used, which are represented by a membership function.

Methods of Fuzzification:

There are various methods for the assignment of membership values to the fuzzy variables. These methods are listed as follows:

a. Intuition: This method is based on human intelligence. Human knowledge is used to generate a membership function based on their understanding of capability and their own intelligence. A number of linguistic functions and ranges of each linguistic function are decided based on human intelligence and experience. [23]

b. Inference: The inference technique is used to accomplish deductive reasoning. Different methods are used for the implementation of deductive reasoning. The membership functions are trapezoidal, triangular, bell-shaped, Gaussian, etc.

c. Rank Ordering: The rank method is used to assign membership values to a fuzzy variable. Rank wise comparison used to determine preferences and results in deciding the order of the membership values.

d. Angular Fuzzy: It is defined as the universe of angles that repeating the shapes 2π cycles. The angular fuzzy set represents the truth values of the linguistic variable. The membership values are true (1) and false (0). The intermediate values between 0 and 1 correlate to a preposition or statement is partially true or partially false.

e. Neural network: Neural networks can be used to obtain fuzzy membership values. For the given input dataset Fuzzy membership functions are generated for respective fuzzy classes. The input dataset is divided into testing and training dataset. The training dataset is used to train the neural network. Datasets are categorized into different classes by the conventional clustering technique. The neural network is created to use the data points and the corresponding membership values in different classes for the training itself and stimulate the relationship between coordinating locations and the membership values. The output of the neural network, which classifies data points into one respective class. The process continues until the neural

network simulates the entire set of input-output values. Neural network performance is examined using the testing dataset. The mapping between various membership functions determines the overlap between different classes. This overlapping is further used to create fuzzy membership functions.

f. Genetic algorithm: The genetic algorithm is based on Darwin‴s theory of evolution; the basic rule is "survival of fitness". The genetic algorithm is applied to decide the fuzzy membership functions. For a specific functional mapping system, similar membership functions and shapes are used to define various fuzzy variables. The selected membership functions are coded into bit strings. These bit strings are combined together to generate fitness function. This fitness function plays important role in genetic algorithm similar to activation functions in the neural networks. The accuracy or fitness of each membership function is evaluated using the fitness function. These membership functions are further used to define the functional mapping of the system.

g. Inductive Reasoning: The membership functions are generated using inductive reasoning. For inductive reasoning, database for input-output relationship should exist. It can manage static, dynamic, plentiful data and complex system. The fuzzy threshold is created among the data within various classes. Screening method for entropy minimization is used to determine the threshold value. The segmentation technique is used to create classes. Classes are partition into subclasses with the threshold value; corresponding calculations generate partition rules into several classes or fuzzy sets. Based on the shape, the membership function is determined.

Defuzzification:

It is the inverse process of fuzzification. It reduces fuzzy set to crisp single-valued result and converts fuzzy matrix to crisp matrix, and converts fuzzy values to crisp values. "Defuzzification is a process of mapping fuzzy control actions into crisp control actions in the universe of discourse." A defuzzification process can convert a fuzzy set into the crisp set or a crisp single-valued quantity, transform the fuzzy matrix into the crisp matrix, or transform a fuzzy number into a crisp number.

6. Methods of Fuzzy Inference System (FIS)

There are two important categories of methods of FIS. In Mamdani FIS the Fuzzy sets are used as rule consequents whereas in sugeon‴s method linear functions of input variables are used as rules consequents. The two methods differ from the corresponding consequent of fuzzy rules. Mamdani rules find more acceptances in all universal approximation than Sugeno‴s model.

a.   Mamdani FIS: Ebsahim Mamdani proposes this system in 1975, where output membership functions are expected to be fuzzy sets. After the aggregation process, each output variable contains a fuzzy set so at the output stage defuzzification is needed. In this method output of all fuzzy rules are combined to derive one fuzzy distribution. The crisp output is obtained from the defuzzification process by using the center of mass and mean of maxima techniques. The following fig1 shows Mamdani FIS with fuzzy input.
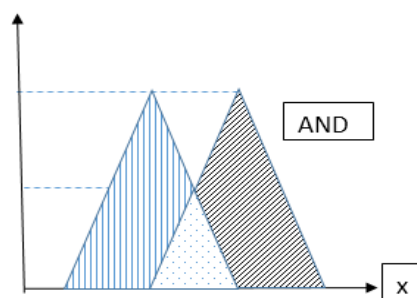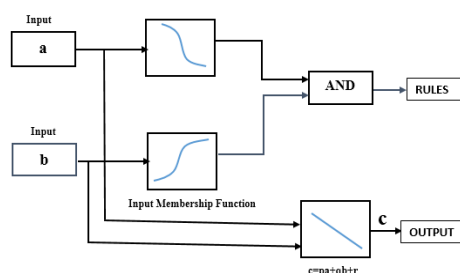

Fig 1. Mamdani FIS with fuzzy input

b.   Takagi-Sugeno Fuzzy Model: Takagi-Sugeno and Kang introduce this method of fuzzy inference system in 1985. The fuzzy rule using this model can be represented by:

$$\text{IF } a \text{ is S1 and } b \text{ is S2 THEN } c=f(a, b)$$

Fig 3. Sugeno FIS with fuzzy input

Where S1 and S2 are fuzzy sets in the antecedents and z=f(a,b) is a crisp function in the consequent. f(a,b) is a polynomial in the input variables p and q. Here we get a first-order Sugeno fuzzy model if f(a,b) is a first-order polynomial, whereas a zero-order Sugeno fuzzy model if f is constant. This model is functionally identical to a radical function network with some minor constraints. Following fig. 1.2 shows the working of Sugeno FIS with fuzzy input.

Sugeno"s method can worked as an interpolating supervisor for multiple linear controllers that are to be applied because of each rule"s linear dependence on the input variables. This is a flexible method for modeling nonlinear systems by interpolating between multiple linear models. Sugeno system provides adaptive approach for developing a fuzzy-based system. This adaptive approach is used to customize the membership function.

7. Artificial Neural Network

An artificial neural network is defined as an information processing model developed from the biological nervous system, such as the working of the human brain. It can learn by example or experience. There is no need to do specific computation or explicit programming for the working of a neural network. It is used to solve real-time problems due of its quick response and parallel architecture. The significant element of ANN is the novel structure of its information processing system. ANN is a network of strongly interconnected processing elements known as neurons working in harmony to solve a complex problem. Many neural networks designed are statistically entirely accurate but still gives errors while solving real-time problems. Output generated through the ANN might be 85-90% accurate. Specific real-world applications can tolerate the level of error. Artificial Neural Network is an AI technique for solving problems regarding classification, clustering, optimization, vector quantization, approximation, pattern matching, etc. challenging to solve using traditional computers.

Models of Artificial Neural Network

The interconnection of the different neurons forms an artificial Neural Network in the different layers where output is formed through processing between each connected weight to other processing elements or to itself. The number of layers, arrangement of neurons in each layer and formed connection pattern within and between layers is known as network architecture. There are five different types of ANN architectures as follows:

Single-layer Feed-forward network

The neural network with directed synaptic interconnections which carry weight from input layer to output layer but not vice is called a single-layer feed-forward network. It is single layer network because the neurons in the output layer alone can process the information. The neurons in the input layer can receive the input from the sensor and pass along its weight to the output layer. The following fig.1.4 shows a single layer feed-forward network.
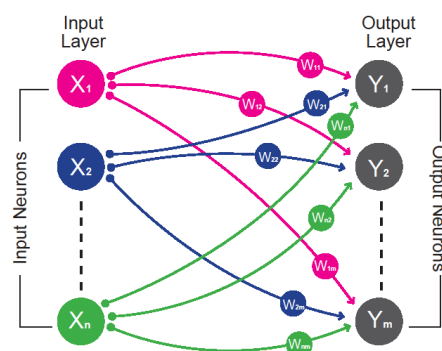

Fig. 4 Single layer feed-forward network

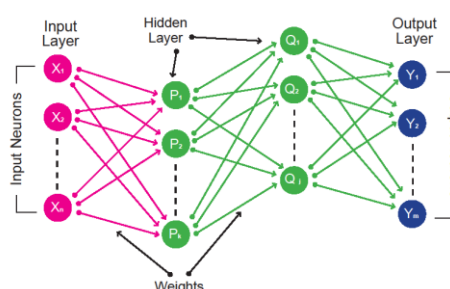**Multilayer Feed-forward Network**

Fig.5 Multilayer Feed-forward Network

The neural network is formed by connecting different neurons in two or more layers. The input layer received input data and buffered the input signal to the next level, with no direct connection with the external environment this type of network is known as Multilayer feed-forward network. It is feed-forward network with more than one intermediate layers between input and output layer called as hidden layer. Complexity of the neural network is depending on number of hidden layers. More the number of hidden layers means more complex neural network. Here the output of one layer is passed to the next level to generate the final output. Hidden layer can have any number of processing neurons and they are connected with each other through synaptic interconnections. The inputs and weights in the input layer are passed to the hidden layer where they are processed and their output is feed as the input to the next layer. This process is continuing to every layer until it reached the output layer. The following fig.5 shows Multilayer feed-forward network.

8. Advantages of Artificial Neural Network

1. Adaptive Learning: The neural network can learn from the training dataset or from the earliest experience.

2. Self-Organization: Neural network learn from training data to produce its own representation of information.

3. Real-time operation: Neural network is supported for parallel computation that can be used to solve complex real-time problems.

4. Fault-tolerant: Neural network performance may degrade due to partial faults or damage. Certain network experiences can be recovered even after major network fault or damage.

Applications of ANN:

There are various categories of neural networks are available and can be applied for variety real time applications. Successful selection and implementation of the ANN algorithm is significant for problem solving and host most of the application opportunities.

1. ANN used to develop an air traffic control system where instructions are received from parameters like location, direction, altitude, and speed of each sensor blip. Output is generated through air traffic control system in response to each blip.

2. Animal behavior, disease, predator/prey relationship, and population cycles can be predicted through ANN.

3. ANN is used for fraud detection as well as predicting cybercrime causes and incidence from event logs and cyber activities of victims.

4. ANN is used in chemical and pharmaceutical industries for predicting the result of complex physical and chemical processes.

5. The Neural network is able to optimize and predict the performance of job applicants for employee hiring in an organization.

6. ANN supports expert consultation and diagnosis of any disease in medical field.

7. The Neural network-based system is used to predict human behavior from their handwriting.

9. Conclusion

Today e-learning puts an important impact on the education system. It helps the learner to learn according to his/her needs as well as interest. It is observed that learner''s behavior, learning style, and domain knowledge is different from learner to learner. Most of the e-learning systems provide good quality of study material in various formats like audio/video lectures, reading material, discussion forums, quizzes, etc. Also, the e-learning system provides the same learning path for all learners. It is important for the learner to select e-material as per their interest, ability, learning behavior as well as existing domain knowledge. In the proposed system learners can identify their learning ability, existing knowledge level and interest area. It helps to find out learning needs of student, provide more emphasis on specific topics, suggest learners weak area, allow them to make improvement in understanding, and mostly helping students to learn at their own pace. Learners' data is provided to the machine (tutor) and artificial intelligent techniques are applied to develop personalized e-learning system. This system helps to bridge the gaps in traditional teaching-learning methodology as well as e-learning systems and motivate the learners through recommendation of appropriate methods to improve learning interest among the learners by providing better learning experience.

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