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Personalized Learning Through Reinforcement Learning: A Real-World Perspective on Education

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Abstract— Machine learning is the most significant part and area of artificial intelligence; it has emerged as a more effective tool for building intelligent systems for solving and taking action and decision-making problems enforcement learning has evolved. Reinforcement learning is developing more and more through learning by trial and error. This research paper elaborates on how reinforcement learning helps in the real world and their applications. How they work through reinforcement learning, and how they learn about the environment through trial and error.

Keywords- *Reinforcement learning, rewards, model, machine learning, education.*

I. INTRODUCTION

For the past few decades, technology has become a significant part of our everyday lives. We are becoming increasingly dependent on technology for our jobs. We live in a technological age when clever inventions are made and new technology is emerging to outperform older technology. One of the most significant developments in recent years, as the significance of new technology increases daily, is machine learning. Artificial intelligence is becoming more and more necessary every day. According to Marriot (2011), the top research and consulting firm in the world, Gartner Group, forecasted that by 2020, customers would handle 85% of their interactions with businesses without speaking to a human. The field of study known as artificial intelligence demonstrates how machines may learn exactly like people and respond to particular actions [1]. Without being specifically tailored, reinforcement learning creates a method in which computers behave like people. Machine learning methods are used to teach machines how to handle information. In particular, reinforcement learning relies on the decision-making process and the correspondence between the environment and the agent performing an action or activity. Reinforcement learning is an unsupervised learning process in which the machine learns from its mistakes.

II. BACKGROUND AND OVERVIEW OF REINFORCEMENT LEARNING

Reinforcement learning is the process of learning from the environment by making mistakes in order to accomplish specific objectives. In an attempt to optimize the benefits, interacting with the environment and executing specific activities have led to several successes and failures. The agents never give instructions, yet in this case, reinforcement learning functions similarly to how a human learns from experience. Reinforcement learning differs from both supervised and unsupervised learning, two main areas of machine learning.

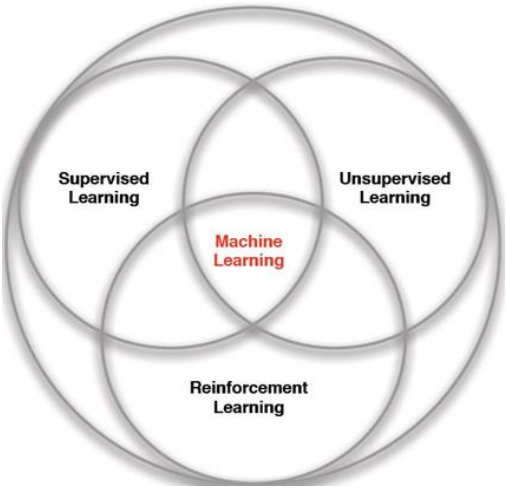


Fig. 1: Branches of Machine Learning

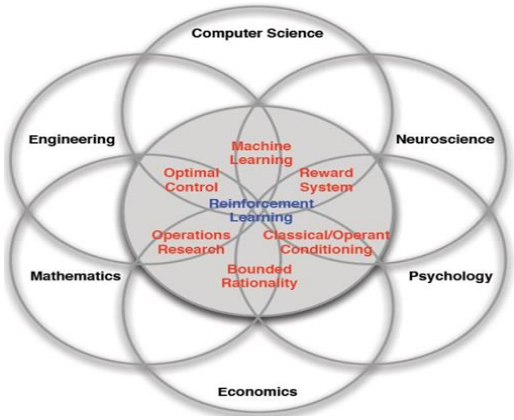


Fig. 2: Reinforcement Learning Phases

The most popular area of machine learning research is supervised learning. In supervised learning, a teacher or supervisor provides a collection of labeled data, and the machine learns from this data to decide the appropriate course of action. The goal of unsupervised learning is to uncover structure in a collection of unlabeled data. Clustering, feature learning, dimensionality reduction, and density estimation are a few instances of unsupervised learning. Since reinforcement learning does not use labeled data, it may appear to be a form of unsupervised learning, but it is distinct in that its goal is to maximize rewards rather than uncover hidden structure.

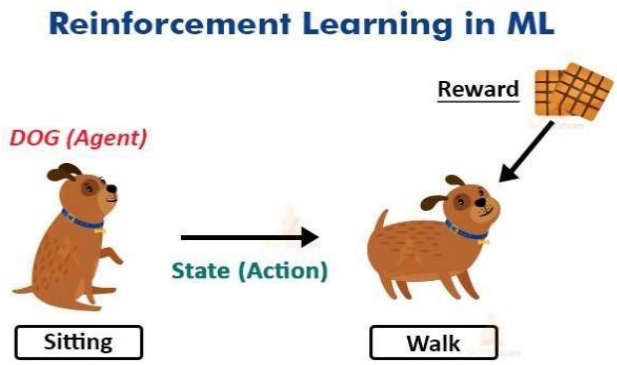


Fig..3: Reinforcement learning Example

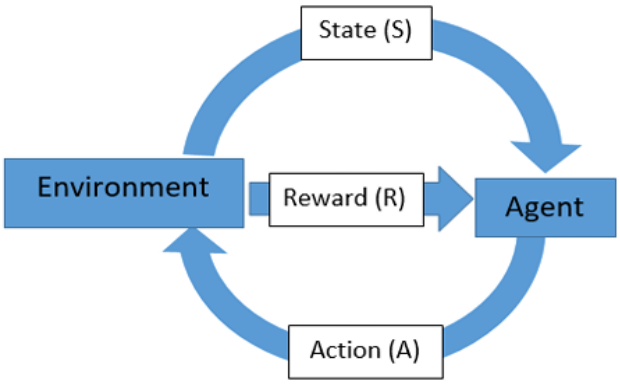


Fig. 4: Reinforcement Learning Standard Diagram

III. Main Components Of Reinforcement Learning System

A. Environment

An environment is how an agent interprets their surroundings. The objective of reinforcement learning is to determine the best policy by mapping states into actions (Fig. 4). This can be done by a search process, a lookup table, or a function.

B. Reward signal

The goal of the problem, in which the agent's objective is to maximize the overall reward received, is defined by the

reward signal (R), which shows how good or awful an event is. As a result, the primary driver behind policy updates is the reward. Both immediate and delayed rewards are possible; in the case of delayed signals, the agent must decide which activities are more pertinent to a delayed reward.

C. Action

Although this function is responsible for predicting the total future rewards, it is also responsible for evaluating the states and choosing the relevant actions. The expected return is the state value function when starting from a state.

D. State (Model)

We can forecast how the environment will behave thanks to the model. Model-based methods are those that use models and planning as an ideal component of reinforcement learning techniques. In contrast, model-free approaches rely on learners' trial and error and are employed when the agent lacks a model for the environment.

E. Agent

Games, the traffic light system, and many other real-world applications have benefited from reinforcement learning. It is more efficient since we don't have to provide our agents with labels or data to complete the next task; instead, the agent learns from its surroundings and acts accordingly, taking further action if necessary. To get more incentives, it will try different actions through trial and error. The agent then tries to be more precise and finish the process more quickly based on the rewards. Because the agent lacks the labeled data necessary to provide accurate results, the results are less accurate. It must learn on its own before producing the outcomes. Excessive reinforcement learning can cause states to become overloaded and reduce results. To continue learning, it requires enormous amounts of data and processing power.

IV. Applications of Reinforcement Learning

A. Trading

One of the most popular applications of reinforcement learning is in stock market trading. Algorithmic trading is a long-standing practice in which stocks are traded using algorithms to maximize returns, and financial systems based on reinforcement learning can further maximize stock returns.

B. Gaming

Through the use of reinforcement learning, the gaming industry has advanced farther. Humans can compete with a machine player that mimics human behavior and makes crucial decisions just like a human. A reinforcement learning backgammon game was created by IBM's Gerald Tesauro. The program developed by Gerald was able to outperform human players. But it was challenging to translate this accomplishment to more challenging games until 2016, when DeepMind used reinforcement learning to train the AlphaGo algorithm and defeated Lee Sedol, the world champion of Go. The ancient Chinese game of go was significantly more difficult for computers to learn.

C. Online recommendation

By understanding the user's historical data, machine learning has aided in online recommendations. and offering the services and goods that are suggested. Reinforcement learning is also seen to be a helpful technique for enhancing online suggestions. Both buyer and seller characteristics can be used for training purposes with reinforcement learning, and the outcomes have exceeded expectations.

D. Self-driving cars

Self-driving cars use reinforcement learning by learning the patterns through trial and error and by gaining the rewards and taking suitable actions to learn completely.

E. Education

Since students' attitudes, behaviors, and cognitive analyses are always evolving, smart learning in the classroom necessitates an efficient teaching policy. Student behavior and cognitive feature change are not the main focus of the modeling tactics, tools, and techniques now in use. In order to enhance learning skills in the classroom, an efficient learning mechanism is implemented. The Reinforcement Learning (RL.) framework is presented in order to accomplish this goal and improve learning capacity in the smart classroom. RL algorithms and methods are being extensively used in the education domain to enhance student performance, facilitate the teacher tutoring process, reduce the time needed to acquire or gain knowledge, and improve the students' graduation rate. This section illustrates the various RL techniques used in different educational applications.

V. Reinforcement Learning in Education

The primary goals of digital learning in the classroom are to enhance online learning options, motivate students to focus on their studies, increase in-person engagement, and address infrastructure issues, such as a lack of educational technology options for students who require special attention. Through digital learning, kids acquire knowledge in the classroom, and the clever learning process cultivates positive teacher-student interactions.

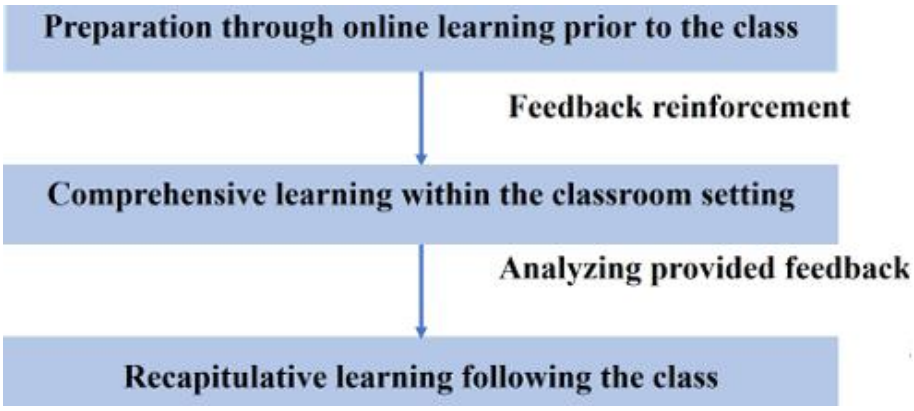


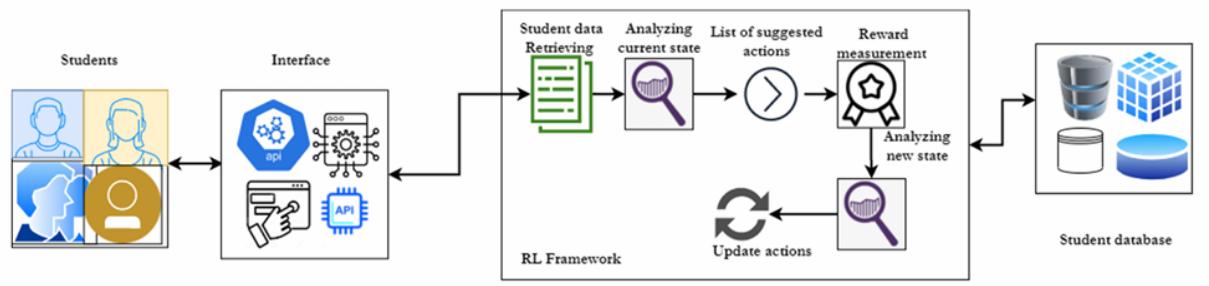
Fig 5: Blended Teaching Fundamentals using Reinforcement Learning

Working of RL in Education

The student's static details like name, gender, and course, major are collected in the initial stage. All the collected details are stored in the interface and their current state is examined to improve the overall learning process. If the data entered is first time, then the static details are assigned to the students. The student data can be retrieved by analysing the current state with the list of suggested actions. Reward measurement helps to analyse the new state with the updated actions in the RL Framework. The student's database can be stored for further use. First, the student's static details, such as name, gender, course, major, etc., need to be collected.

Several dynamic details such as interaction level, state-action related reward history and log activities are collected. After collecting the student data, their current state should be examined to improve the overall learning process. If the student enters the first time into the learning process, then static details are assigned to the student. Then the reinforcement learning process is applied for generating the digital learning pattern according to the student's state. The actions are suggested to the students for improving smart learning. Here, the suggestions depend on their requests, such as learning materials and instructor pieces of advice in the video, audio or written format. The fourth component is rewarding analysis for specific actions according to the recommended actions. Here, the student satisfaction and interactivity levels are integrated to update the reward values. Students' next state and action should be computed to enhance the overall learning activities. The student may give negative rewards and suggestions that completely affect

the quality of smart learning. The RL. framework reward-based system aims to maximize learning efficiency and improve satisfaction during learning. The successful utilization of the RL function process improves adaptive and personalized learning using the state action-reward (SAR) computation. In addition to this, the RL framework balances the relationship between the student and teachers effectively. The working process of RL is described below. Reinforcement learning (RL) works according to the biological system, interacting with surroundings and initiating learning. This work aims to maximize the rewards by providing the actions to the respective situation. The RL algorithm senses the environment to give optimal actions for the situation. The RL uses the exploration concept that effectively creates the online learning platform in an unsupervised environment.



Resources for digital Learning The resources utilized in the digital learning process help meet the student learning goals in higher education. The resources provide guidelines for maximizing the teaching qualities

A. Simulation Analysis

The digital learning framework supports the simulations because it eliminates the actual implementations and improves the students' learning ideas. Here, according to the Q-learning defined in the RL framework, the simulations are created to improve the overall learning process.

B. Quiz

The digital learning process uses the quiz to evaluate the student performance. The set of questions is utilized in a specific topic that helps investigate the student visibility, understanding, and acceptance of a particular concept.

C. E-Textbook

It is also named the digital textbook or electronic textbook. The student studying materials are published in a digitized format that includes images and texts. The materials are read-only with the help of digital devices, and devices require the software. Around 1000’s books are published in a digitized format that minimizes the material cost

Reinforcement Learning for evaluation

The reinforcement learning framework’s effectiveness is evaluated where the data is analyzed and processed using the RL characteristics. During this process, reinforcement learning uses the learning rate, and the system gives both positive and negative reward values for actions. According to the defined simulation setup, students’ details are implemented using iterations. In the learning process, students provide positive rewards that increase the iterations. The positive reward value shows that smart learning is successfully implemented in the classroom.

CONCLUSION

People in today's world are continuously searching for methods to make their lives more comfortable, which is the main reason we have always relied on technology. Although machines have been utilized to perform human tasks for the past year, their strength now surpasses that of human intelligence. One kind of machine learning that is very effective in its application is reinforcement learning, which has a larger area of control and a variety of decision issues that are typically outside the scope of supervised or unsupervised learning approaches. Because of its many features, such as self-learning, self-improving, and requiring very little programming work, reinforcement learning has emerged as a new phenomenon and is now among the most intelligent agents. Thus, using an analysis of higher education, the research examines the smart education environment. This study examines student characteristics using the reinforcement learning (RL) framework. The current circumstances and mental condition of the student are not taken into consideration by traditional teaching methods and resources. Inaccurately determining the needs of students lowers academic achievement and learning effectiveness.

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