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Algorithms Rule the Power of Artificial Intelligence - A Brief Study of Different Machine Learning Algorithms

Renjitha.P

Lecturer in Computer Engineering, Department of Computer Engineering, Government Women's Polytechnic College, Kaimanam, Thiruvananthapuram, India

ABSTRACT: This paper is a study of different artificial intelligence algorithms which empowers Artificial Intelligence through Machine Learning and Deep Learning technology for various applications and an analytical study of each of them. Here we try to explain the principles of some machine learning and deep learning algorithms used and analyses which algorithms are best suited for a particular real time application. Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. Understanding machine learning (ML), is essential to analysing these data intelligently and creating the associated intelligent and automated applications. Deep learning is a subset of a larger family of machine learning techniques and is capable of large-scale, intelligent data analysis. In this study, we provide a thorough analysis of various applicable machine learning and deep learning algorithms.. The importance of deep learning (DL) in our daily lives is growing. Voice recognition, self-driving cars, precision medicine, cancer diagnosis, and predictive forecasting are just a few of the areas where it has already made a big impact. The carefully crafted feature extractors used in traditional learning, classification, and pattern recognition systems are not scalable for large-scale data sets.

KEYWORDS: Artificial Intelligence, Machine learning, Deep learning

I. INTRODUCTION

1.1 Artificial Intelligence

Artificial Intelligence (AI) is the process of simulating human intelligence in machines so that they can carry out tasks that normally require human cognitive abilities including sensing, learning, reasoning, problem-solving, and decision-making.

Over time, AI systems improve their performance on their own by analyzing enormous volumes of data and adapting to new knowledge. The ultimate objective of artificial intelligence is to create computers that are capable of independent thought, reasoning, and action and in certain situations, surpassing human talents in a variety of fields.

1.2 Branches of Artificial Intelligence

The five most important areas of artificial intelligence are listed below.

1.2.1. Machine Learning

Machine learning (ML) is a subset of artificial intelligence (AI) in theory. Machine learning (ML) is the capacity of machines to autonomously learn from data and methods. ML makes judgments without explicit human programming by utilizing the fundamental AI components we covered before.

1.2.2. Deep Learning

Deep learning (DL) can be considered a subset of machine learning. Fundamentally, DL makes use of artificial neural networks (ANNs), which are modeled after the human brain. DL outperforms machine learning and produces representations that are frequently more potent by using these neural networks to extract abstract features from the data. Compared to ML, DL requires even less human involvement.

1.2.3. Natural Language Processing

The area of artificial intelligence that enables computers to comprehend written and spoken language is called natural language processing, or NLP. Since natural language processing (NLP) is incorporated into many of today's chatbots, virtual assistants, digital assistants, and spam detection systems, it is perhaps the most widely utilized AI. Sentiment

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analysis, which examines texts and draws out the feelings and opinions on a good or service, is another use of Natural Language Processing.

1.2.4. Robotics

AI is used in robotics to create and design devices or robots that can carry out activities either fully or partially on their own. NLP, ML, and perception are examples of other AI technology components that are typically used in robotics. AI-based robots can assist in product development and are now present in a variety of industries, including manufacturing, healthcare, and retail.

1.2.5. Fuzzy Logic

Fuzzyness results from the fact that the world is not always binary, which makes it challenging for AI systems to determine if a condition is true or false. Fuzzy logic is used to solve problems and determine whether assertions are true or not. Your autonomous braking system, for example, can use fuzzy logic to decide how hard to brake. By using linguistic variables and fuzzy rules to express and interpret imprecise or uncertain data, as well as if-then statements or rules, AI may learn this fuzzy logic.

II. ARTIFICIAL INTELLIGENCE (AI) ALGORITHMS

A wide variety of methods are included in AI algorithms, which allow machines to learn from data, spot trends, come to their own conclusions, and handle challenging issues on their own. Machine learning, data analysis, and decision-making are made possible by artificial intelligence (AI) algorithms, which are collections of guidelines or instructions. These algorithms are capable of solving problems, making decisions, identifying patterns, and interpreting natural language—tasks that ordinarily require human intelligence. The use of appropriate data for algorithm training is crucial in any discussion of AI algorithms. These algorithms are divided into groups according on their usefulness and method of learning. These include: Machine Learning Algorithms, Deep Learning Algorithms and Natural Language Processing Algorithms etc.

2.1 Machine Learning Algorithms

There are different ways an algorithm can model a problem based on its interaction with the experience or environment or whatever we want to call the input data. The algorithms are grouped based on the facts such as their learning style and their similarity in the form or in function. The main advantage of using machine learning algorithms is that, once an algorithm learns what to do with data, it can do its work automatically. Various types of machine learning algorithms such as supervised, unsupervised, semi-supervised, and reinforcement learning exists.

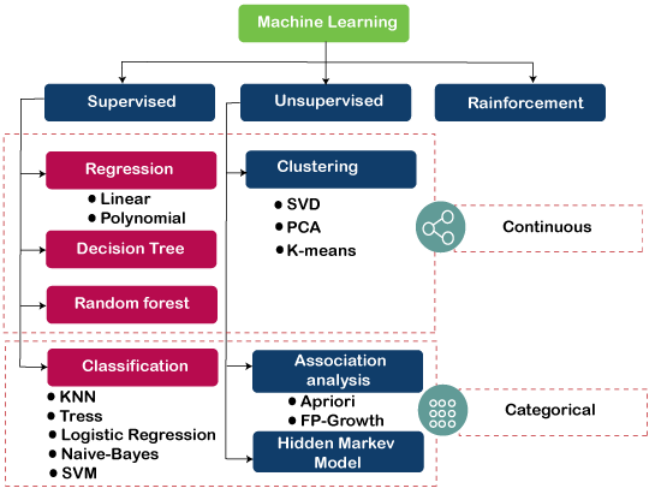

Figure 1- Machine Learning Algorithms [12]

2.1.1 Supervised Learning

In supervised learning, the model is taught with a set of input data, necessary definitions, and the proper output already linked to it. The application of supervised learning to picture categorization tasks is becoming widespread. Finding a

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mapping function to connect the input variable (x) and the output variable (y) is the goal of a supervised learning algorithm.
Supervised learning has practical applications in risk assessment, image categorization, fraud detection, spam filtering, and more.

The working of supervised learning is explained below

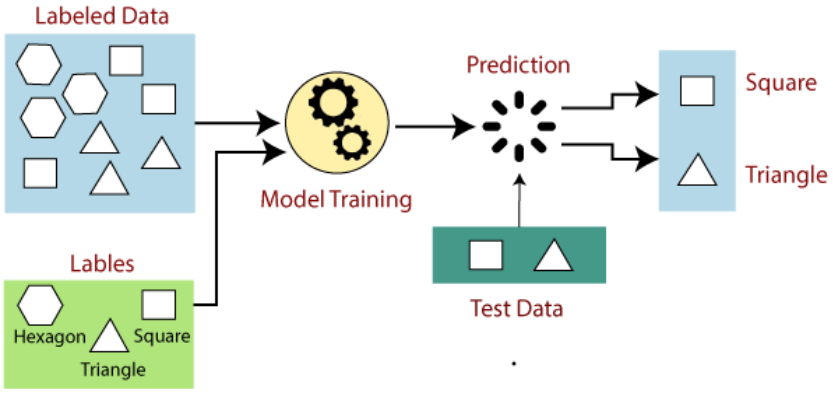

Figure 2- Working of Supervised Learning [13]

Models are trained using labeled datasets in supervised learning, where they are taught about every kind of data. After training is finished, the model is evaluated using test data, which is a subset of the training set, and it then makes predictions about the results. Classification and regression are the two primary categories into which supervised learning tasks are often divided. The most popular algorithms for supervised learning are:

2.1.1.1 Regression:
When attempting to forecast a continuous result that falls inside a range, regression is used. Predicting a home's price based on its square footage, location, number of bedrooms, and other pertinent factors is an excellent example.

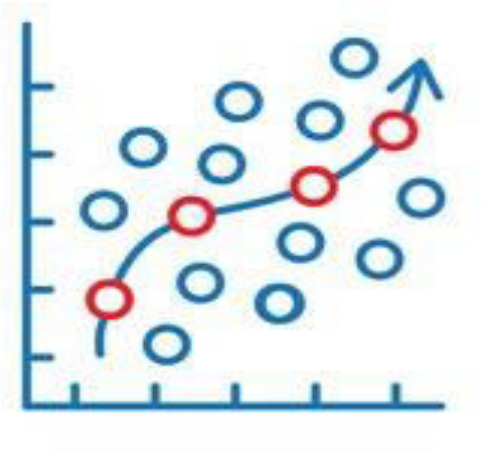

Figure 3- Regression Model [12]

2.1.1.2 Linear Regression Algorithm:
A prediction is made via a linear regression algorithm, which is among the simplest AI algorithms. The method's operator determines the independent variable. For instance, given the specific house for sale and previous local real estate data, linear regression may forecast home sale values.

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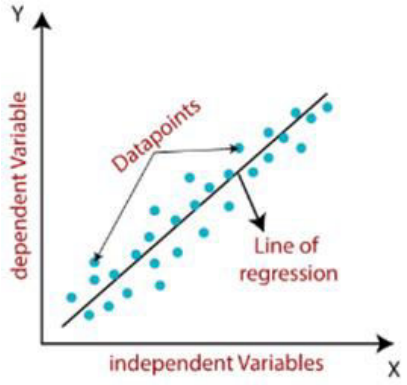

Figure 4- Linear Regression Model [21]

2.1.1.3 Decision Tree:

Each split or node in a decision tree represents a distinct categorization test, and the branching structure of the chart represents all possible outcomes.

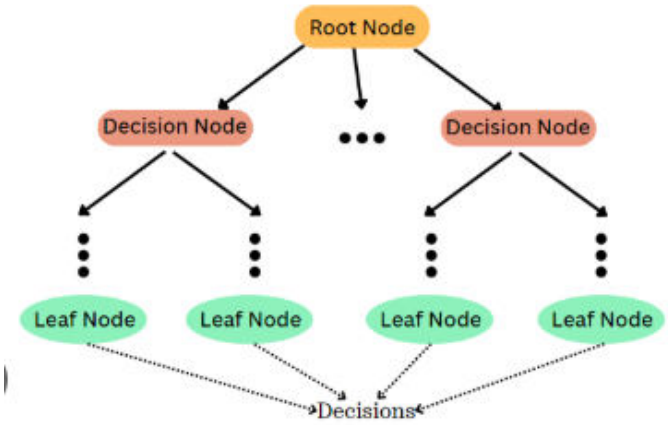

Figure 5- Decision Tree Model [20]

2.1.1.4 Random forest:

A random forest algorithm tests for a variety of inputs using a large number of decision trees. The combined outcomes of all the decision trees are used to provide a prediction.

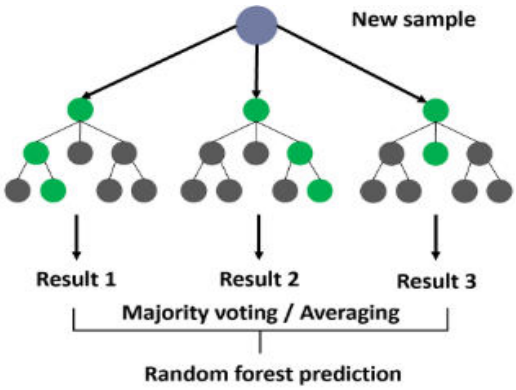

Figure 6- Random Forest Prediction Model [19]

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2.1.2 Unsupervised Learning

Unsupervised learning is where a model trains itself on data to help the algorithm to find patterns and connections. In unsupervised learning strategies, unlabeled data is given. The unlabeled data will be utilized by unsupervised learning algorithms to build models and assess the connections between various data points to provide additional information about the data.

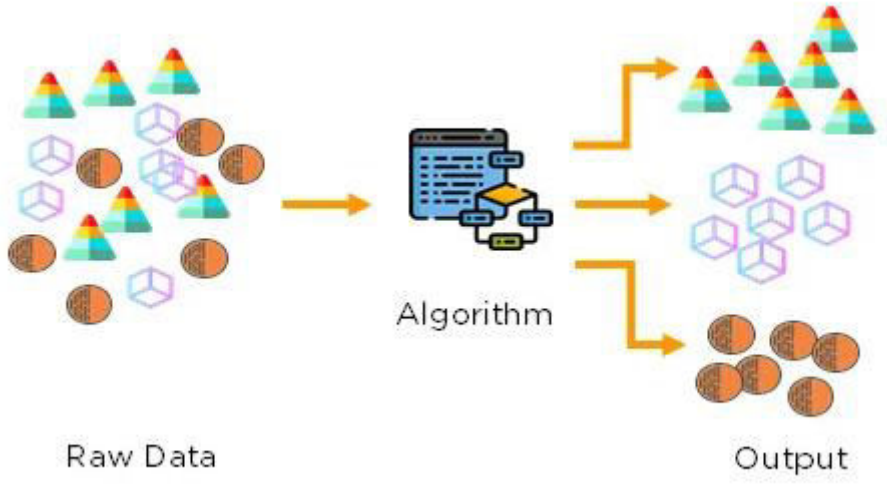

Figure 7- Working of Unsupervised Learning [18]

Here unlabeled data is fed into unsupervised machine learning models, which are then left to find patterns and insights without any direct supervision or training.

2.1.2.1 K-means clustering:

Sorting and classifying data is the goal of a K-means cluster algorithm. K is the number of groups into which the data will be sorted, and the method yields a mean variable for every group.

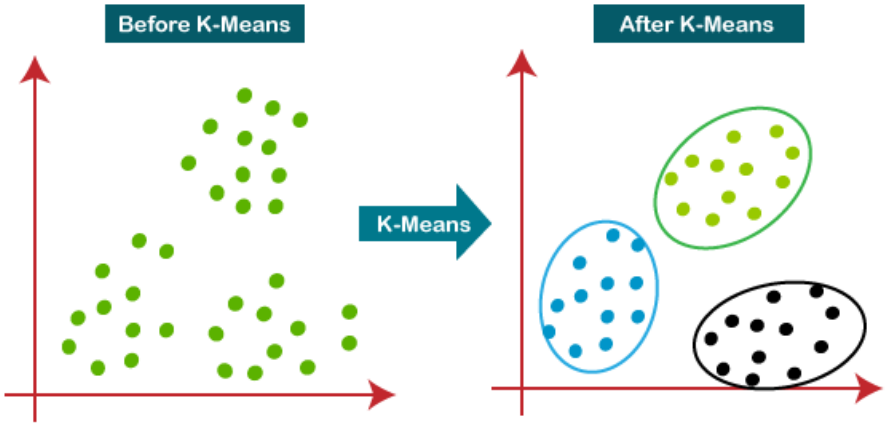

Figure 8- K- Means Clustering [17]

Following are the steps to perform K -Means Clustering Algorithms

Step 1: To determine the number of clusters, choose K.

Step 2: Choose centroids or K locations at random. Depending on the supplied dataset, it can be different.

Step 3: Create the predetermined K clusters by assigning each data point to its nearest centroid.

Step 4: Determine the variance and assign each cluster a new centroid.

Step 5: Reassign each datapoint to the cluster's new nearest centroid by repeating the third

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step.
Step 6: Proceed to step 4 if there is reassignment; if not, proceed to FINISH.
Step 7: The model has been prepared.

2.1.2.2 Gaussian mixture model:
This model clusters data in a manner similar to a K-means cluster, but with additional features. Each returned variable would represent the center of a circle of data if you were to see the K-means cluster findings on a graph. When data graphs, a Gaussian mixture model may organize them into deeper patterns.

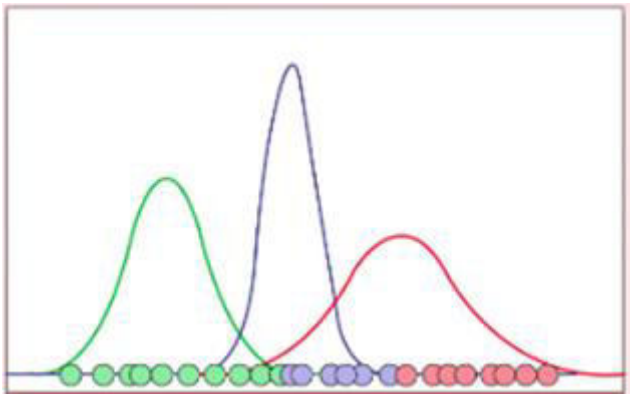

Figure 9- Gaussian Model Graph [16]

2.1.3 Semi – supervised Learning
Data sets used in semi-supervised learning include both labeled and unlabeled data. The algorithm is guided by the labels provided by the operator when deciding how best to label the remaining data. This approach combines the benefit of less training required for unsupervised learning with the accuracy of supervised learning.

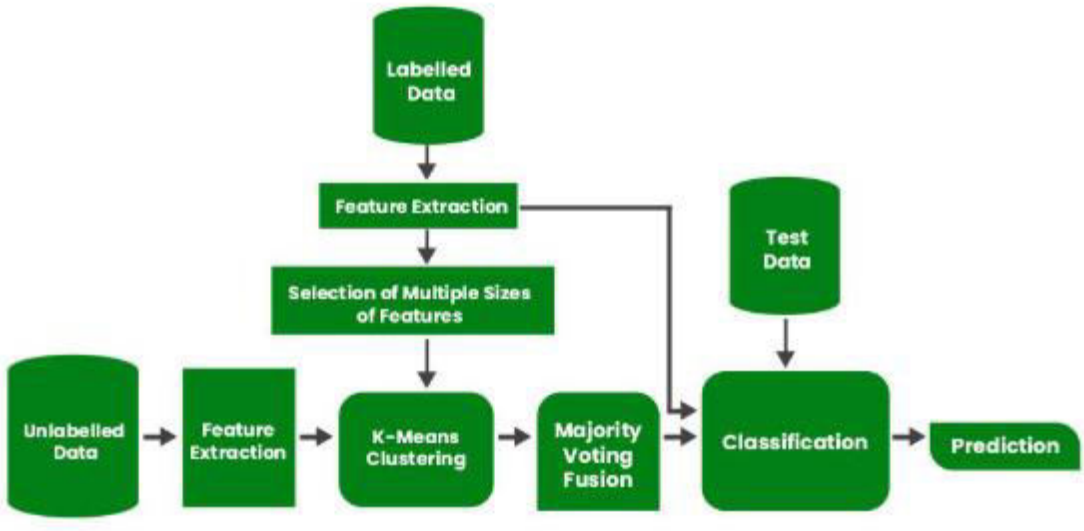

Figure 10 – Semi-supervised Learning [14]

2.1.3 .1 K-nearest neighbors (KNN):
This artificial intelligence system classifies data by examining the data on a graph that is closest to it and sorting the data into categories based on close proximity.
Working of KNN Algorithms

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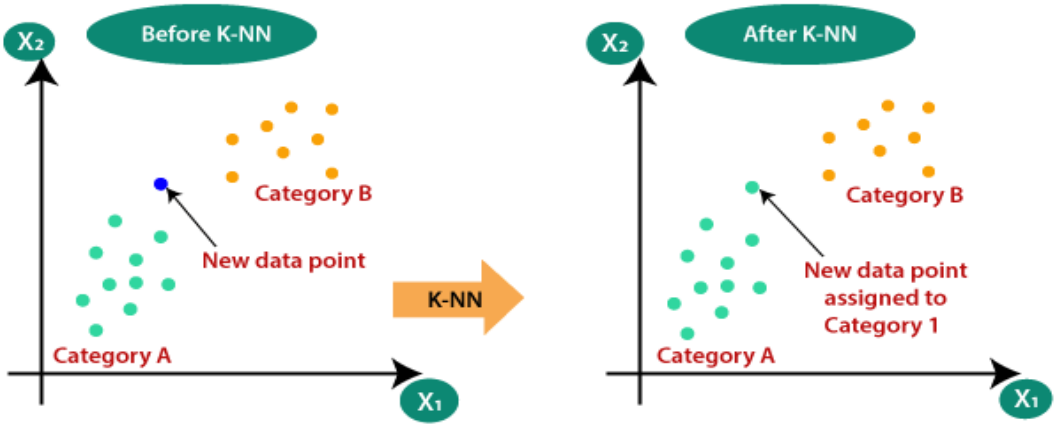

Figure 11 – KNN Algorithm [15]

Step 1: Choosing the ideal K value The number of nearest neighbors that must be taken into account while making a prediction is denoted by K.
Step 2: Distance calculation Euclidean distance is used to quantify how similar the target and training data points are. The dataset's data points and the target point's distance is computed.
Step 3: Locate Your Closest Neighbors Nearest neighbors are the k data points that are closest to the target point.
Step 4: Selecting a classification or regression average The K-NN method considers the K nearest points in the dataset when classifying a data point into a category (such as spam or not spam). We refer to these nearest sites as neighbors. After determining which category the neighbors fall under, the algorithm selects the one that shows up the most. We refer to this as majority voting.
The system continues to search for the K nearest points in regression. However, it uses the average of those K neighbors' values rather than voting for a class in classification. The algorithm's anticipated value for the new point is this average.

Example:
Let's say we have a picture of a creature that resembles a dog or cat, but we want to determine if it is a dog or a cat. The KNN method, which operates on a similarity metric, can therefore be used for this identification. In order to classify the new data set into either the dog or cat category, our KNN model will look for traits that are similar to the photos of cats and dogs.

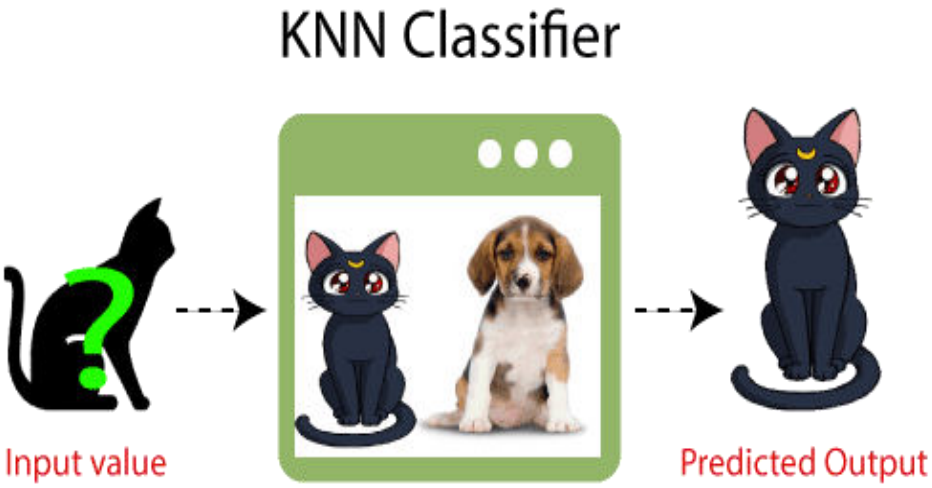

Figure 12 – KNN Algorithm Example [15]

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2.1.4 Reinforcement Learning

Reinforcement learning includes a complicated system of rules that "reward" or "punish" the algorithm's work to allow it to determine the optimal approach to complete the task on its own. This makes a trial-and-error method of problem-solving possible. When the optimal approach to a problem is unclear, this type of AI system works well. While computer programmers establish the criteria for rewards and penalties, the algorithm determines the best approach to use the data set.

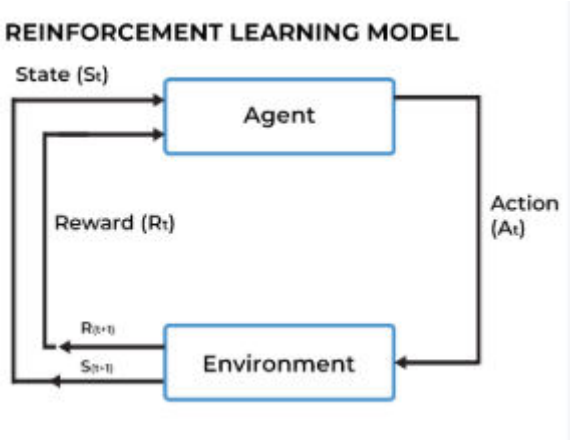

Figure 13 – Reinforcement Learning Model [21]

III. CONCLUSION

The article demonstrates the idea of algorithms used in artificial intelligence. The paper lists several kinds of machine learning algorithms, including Supervised learning, unsupervised learning, and Semi-supervised learning. Reinforcement learning, Machine learning algorithms provide a powerful tool for extracting insights from data, enabling automated decision-making and predictions across a variety of applications. However, the best algorithm to use depends heavily on the particular problem, the characteristics of the data, and the desired accuracy; factors such as supervised versus unsupervised learning, computational complexity, and interpretability are important considerations when selecting the best method. Some examples are also discussed here.

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