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Machine Learning with Applications

Dr. S. Thilagavathi[1], Rithick R Rahul[2]
[1]Assistant Professor in Computer Science, NIFT-TEA College of Knitwear Fashion, Tirupur, Tamilnadu, India
[2]III Year BE CSE, Sri Sivasubramaniya Nadar, College of Engineering, Chengalpet, Tamilnadu, India

Abstract: Machine Learning is a subset of Artificial Intelligence (AI) that focuses on the development of computer algorithms that improve automatically through experience and by the use of data. Machine Learning is all about creating and implementing algorithms that facilitate these decisions and predictions. These algorithms are designed to improve their performance over time, becoming more accurate and effective as they process more data. In traditional programming, a computer follows a set of predefined instructions to perform a task. However, in machine learning, the computer is given a set of examples (data) and a task to perform, but it's up to the computer to figure out how to accomplish the task based on the examples it's given. In this paper we have discussed various types of machine learning and its types, how does machine learning works and we have also explained machine learning method including supervised learning, unsupervised learning, and reinforcement learning.
Keywords: Machine learning, Applications, Types and Key elements of Machine Learning .

I. INTRODUCTION

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves. Machine learning (ML) is the scientific study of algorithms and statistical models that computer systems use in order to perform a specific task effectively without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as training data in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email filtering, and computer vision, where it is infeasible to develop an algorithm of specific instructions for performing the task. Machine learning is closely related to computational statistics, which focuses on making predictions using computers. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning[1][2].

II. MACHINE LEARNING

Machine learning is the way to make programming scalable.

1) Traditional Programming: Data and program is run on the computer to produce the output.
2) Machine Learning: Data and output is run on the computer to create a program. This program can be used in traditional programming.

Machine learning is like farming or gardening. Seeds is the algorithms, nutrients is the data, the gardner is you and plants is the programs.

III. APPLICATIONS OF MACHINE-LEARNING

In this paper we explained various Machine learning techniques such as supervised and unsupervised learning. Supervised learning is applied in classification problems like face recognition, medical diagnosis, pattern recognition, character recognition, web advertising Unsupervised learning can be applied in clustering, association analysis, CRM, summarization, image compression, bioinformatics. reinforcement learning is widely applied in game playing and robot control

IV. TOOLS USED IN MACHINE LEARNING

Tools makes machine learning swift and rapid. Machine learning tools provides interface to the machine learning programming language. They provide best practices for process and implementation Machine learning tools contains platforms which provides capabilities to run a module or project[3]. Examples of platforms of machine learning are:

A. KNIME Analytics Platform

KNIME Analytics Platform is a well-known online machine learning platform, which is a free open-source platform that provides end-to-end data analysis, integration, and reporting. With the KNIME Analytics Platform, data scientists can easily enable the creation of visual workflows via a drag-and-drop-style graphical interface. It will not require knowledge of coding.

To build workflows, a user gets to choose from more than **2000 nodes**. KNIME

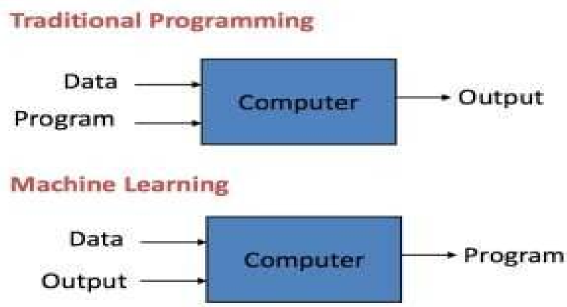

Fig 1: Traditional Programming vs Machine Learning

Analytics allows developers to perform various actions; from basic I/O to data manipulations, transformations, and data mining. The best part of KNIME Analytics is that it consolidates the entire function process into a single workflow.

B. TIBCO Software

TIBCO is a data science platform that supports the entire analytics lifecycle with capabilities to include cloud-based analytics that integrates with many open source libraries.

TIBCO data science allows the user to prepare data and do the model building, deployment, and monitoring. It is widely known for use cases, such as product refinement and business exploration.

C. Amazon Sage Maker

Amazon Sage Maker is a cloud machine-learning platform that allows developers to create, train, and deploy machine learning models. Data scientists or developers can easily deploy machine learning models on embedded systems and edge devices.

It is developed by Amazon Web Services (AWS) that offers the broadest machine and deepest set of learning services and supporting cloud infrastructure.

D. Alteryx Analytics

Alteryx is the best data science platform that accelerates digital transformation. It offers data accessibility and data science processes.Alteryx provides data scientists with a platform that helps them build models in a workflow. Their vision is to make it easy to use for companies to cultivate a data analytics culture without the requirement of data scientists. In self-service data analytics, Alteryx always leads.

V. KEY ELEMENTS OF MACHINE LEARNING

Every machine learning algorithm has three components:

1) Representation: how to represent knowledge. Examples include decision trees, sets of rules, instances, graphical models, neural networks, support vector machines, model ensembles and others.
2) Evaluation: the way to evaluate candidate programs (hypotheses). Examples include accuracy, prediction and recall, squared error, likelihood, posterior probability, cost, margin, entropy k-L divergence and others.
3) Optimization: the way candidate programs are generated known as the search process. For example combinatorial optimization, convex optimization, constrained optimization [4][5].

VI. TYPES OF MACHINE LEARNING ALGORITHMS

There are four types of machine learning algorithms: supervised, unsupervised, semi-supervised, and reinforcement.. Advanced machine learning algorithms require multiple technologies including deep learning, neural networks and natural language processing and are able to use both unsupervised and supervised learning. The following are the commonly used algorithms.

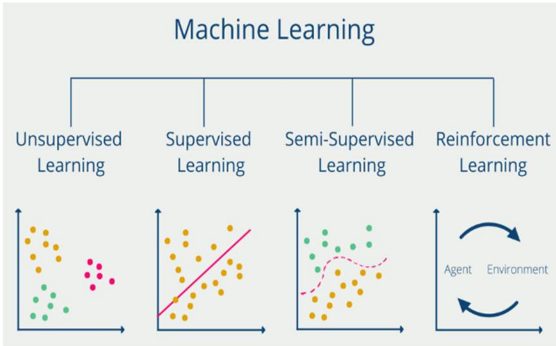

Fig 2: Machine Learning Types

A. *Supervised Learning Algorithms*

Supervised learning can be separated into two types of problems when data mining: classification and regression. ANNs, neural networks or simulated neural networks (SNNs), are a subset of machine learning techniques and are at the heart of deep learning algorithms. The learner algorithm recognizes patterns in input data using building blocks called neurons, approximating the neurons in the human brain, which are trained and modified over time[6][7].

1) Decision tree algorithms: Used for both predicting numerical values (regression problems) and classifying data into categories, decision trees use a branching sequence of linked decisions that may be represented with a tree diagram. One of the advantages of decision trees is that they are easy to validate and audit, unlike the black box of a neural network.
2) Dimensionality reduction: When a selected data set has a high number of features, it has high dimensionality. Dimensionality reduction then cuts down the number of features, leaving only the most meaningful insights or information. An example is principal component analysis.
3) K-nearest neighbor: Also known as KNN, this non-parametric algorithm classifies data points based on their proximity and association to other available data. It assumes that similar data points can be found near each other. As a result, it seeks to calculate the distance between data points, usually through Euclidean distance, and then it assigns a category based on the most frequent category or average.
4) Linear regression: Linear regression is used to identify the relationship between a dependent variable and one or more independent variables and is typically leveraged to make predictions about future outcomes. When there is only one independent variable and one dependent variable, it is known as simple linear regression.
5) Logistic regression: While linear regression is leveraged when dependent variables are continuous, logistic regression is selected when the dependent variable is categorical, meaning there are binary outputs, such as "true" and "false" or "yes" and "no." While both regression models seek to understand relationships between data inputs, logistic regression is mainly used to solve binary classification problems, such as spam identification.
6) Neural networks: Primarily leveraged for deep learning algorithms, neural networks process the input training data by mimicking the interconnectivity of the human brain through layers of nodes. Each node is made up of inputs, weights, a bias (threshold) and an output. If that output value exceeds a given threshold, it “fires” or activates the node, passing data to the next layer in the network. Neural networks learn from adjustments based on the loss function through the process of gradient descent. When the cost function is at or near zero, you can be confident in the model’s accuracy[8].
7) Naïve Bayes: This approach adopts the principle of class conditional independence from the Bayes Theorem. This means that the presence of one feature does not impact the presence of another in the probability of a given outcome, and each predictor has an equal effect on that result. There are three types of Naïve Bayes classifiers: Multinomial Naïve Bayes, Bernoulli Naïve Bayes and Gaussian Naïve Bayes. This technique is primarily used in text classification, spam identification and recommendation systems.
8) Random forests: In a random forest, the machine learning algorithm predicts a value or category by combining the results from a number of decision trees. The "forest" refers to uncorrelated decision trees, which are assembled to reduce variance and enable more accurate predictions.

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9) Support vector machines (SVM): This algorithm may be used for both data classification and regression, but typically for classification problems, constructing a hyperplane where the distance between two classes of data points is at its maximum. This hyperplane is known as the decision boundary, separating the classes of data points (such as oranges vs. apples) on either side of the plane [9].

B. Unsupervised Learning Algorithms

Unsupervised learning uses unlabeled data. From that data, the algorithm discovers patterns that help solve clustering or association problems. This is particularly useful when subject matter experts are unsure of common properties within a data set. Common clustering algorithms are hierarchical, K-means, Gaussian mixture models.

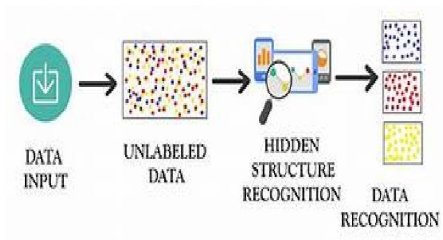

Fig 3: Unsupervised Machine Learning

C. Semi-supervised Learning Algorithms

In this algorithms when only part of the given input data has been labeled giving the algorithm a bit of a "head start." This approach can combine the best of both worlds improved accuracy associated with supervised machine learning and the ability to make use of cost-effective unlabeled data, as in the case of unsupervised machine learning.

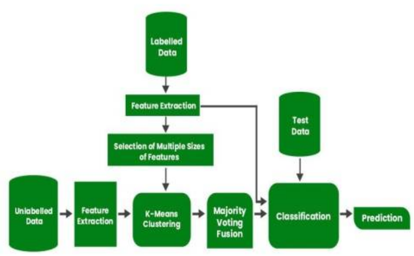

Fig 4: Semi-Supervised Learning Algorithms

D. Reinforcement Algorithms

In this algorithms are trained just as humans learn through rewards and penalties which are measured and tracked by a reinforcement learning agent which has a general understanding of the probability of successfully moving the score up vs. moving it down.

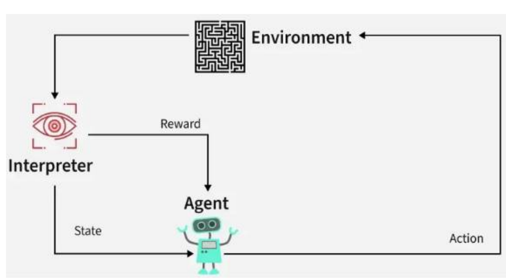

Fig 5: Reinforcement Learning

Reinforcement Learning revolves around the idea that an agent (the learner or decision-maker) interacts with an environment to achieve a goal. The agent performs actions and receives feedback to optimize its decision-making over time[10].

- Agent: The decision-maker that performs actions.

- Environment: The world or system in which the agent operates.
- State: The situation or condition the agent is currently in.
- Action: The possible moves or decisions the agent can make.
- Reward: The feedback or result from the environment based on the agent's action.

VII. CONCLUSION

Machine learning (ML) has emerged as a transformative force across a wide range of industries, From supervised and unsupervised learning methods to more complex techniques like reinforcement learning and deep learning, ML has provided tools that are not only efficient but increasingly capable of human-level decision-making.

The techniques employed such as decision trees, neural networks, support vector machines, and ensemble methods each offer unique advantages and are selected based on the problem at hand. Applications span numerous domains including healthcare, finance, transportation, marketing, and cyber security, where ML enhances automation, personalization, predictive analytics, and operational efficiency.

Machine Learning continues to evolve and drive innovation, its future success depends on responsible development, cross-disciplinary collaboration, and the continuous refinement of both algorithms and ethical standards. Only by addressing its challenges head-on can the full benefits of machine learning be realized in a sustainable and equitable manner.

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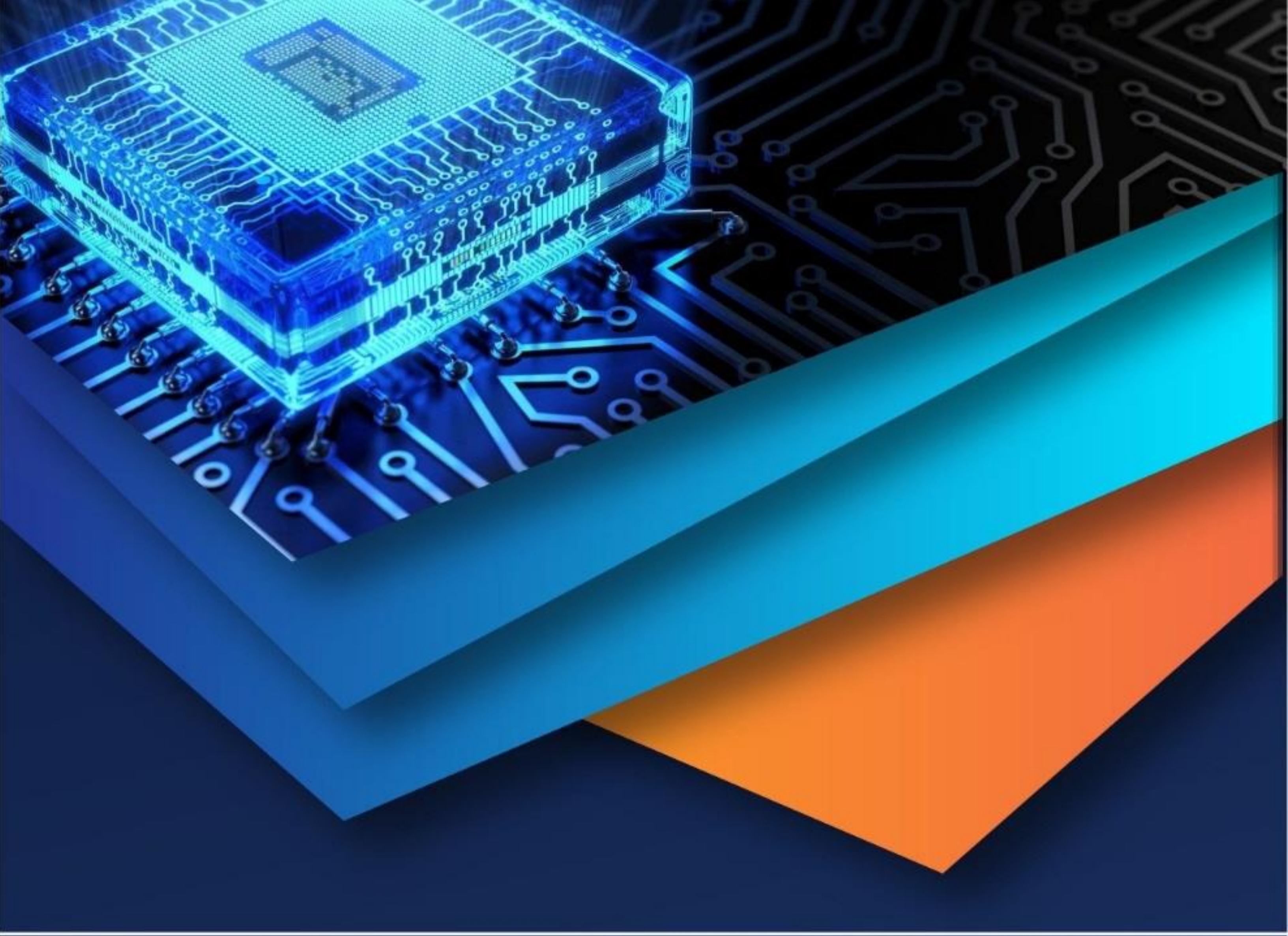

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