PW SKILLS

Lesson Plan

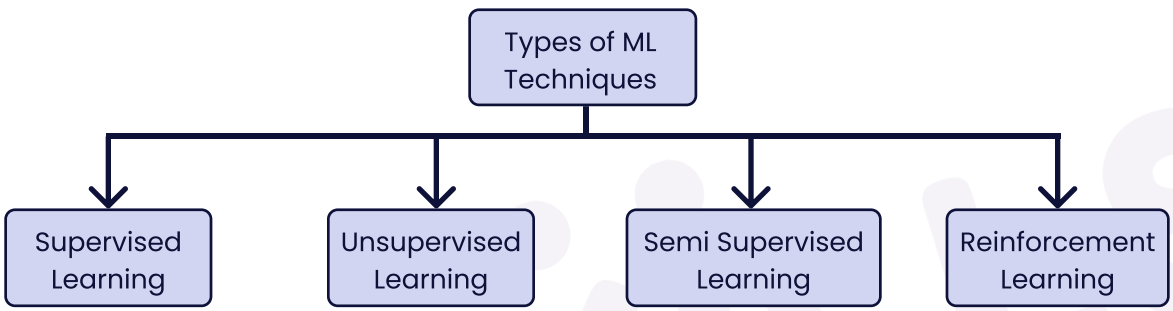
Supervised, Unsupervised, Semi-Supervised, Reinforcement Learning

Topics Covered:

- **Types of ML Techniques**
  - Supervised Learning
  - Unsupervised Learning
  - Semi-Supervised Learning
  - Reinforcement Learning

Types of Machine Learning Techniques:

Supervised, unsupervised, semi-supervised, and reinforcement learning are the four main types of machine learning techniques.



1. Supervised Learning : In supervised learning, the algorithm is trained using labelled data, where the input features are already mapped to the output labels. The goal is to learn a function that maps new inputs to their correct output labels. Supervised learning is used in applications such as classification, regression, and object detection.

dependent variables or responses). The goal of the model is to learn a mapping between the input features and the output labels, such that it can make accurate predictions on new, unseen data.

Here's how supervised learning works in detail:

- **Data Collection:** The first step in supervised learning is to collect a dataset that consists of labeled examples. The labeled data is generated by manually annotating the data or by using some automatic labeling process.
- **Data Preprocessing:** Once the labeled data is collected, the next step is to preprocess the data. This step involves data cleaning, data normalization, and data transformation to prepare the data for modeling.
- **Model Training:** In supervised learning, the model is trained on the labeled data to learn the mapping between the input features and the output labels. The goal of the training process is to minimise the difference between the predicted output of the model and the true output labels in the training data.
- **Model Evaluation:** After training, the model is evaluated on a separate set of data called the validation set. The validation set is used to estimate the model's performance on new, unseen data. The performance metrics such as accuracy, precision, recall, F1-score, or ROC curve are used to evaluate the model.

- **Hyperparameter Tuning:** The performance of the model can be further improved by tuning the hyperparameters of the model. Hyperparameters are the configuration settings of the model, such as the learning rate, regularisation parameters, or number of hidden layers. Hyperparameter tuning is an iterative process of adjusting the hyperparameters and evaluating the model's performance on the validation set.

- **Model Deployment:** Once the model is trained and evaluated, it can be deployed in real-world applications to make predictions on new, unseen data.

Examples of supervised learning include classification problems, such as spam detection or image recognition, and regression problems, such as predicting housing prices or stock prices.

2. Unsupervised Learning: In unsupervised learning, the algorithm is trained using unlabeled data, where there are no predefined output labels. The goal is to identify patterns and structures in the data, such as clustering or dimensionality reduction. Unsupervised learning is used in applications such as anomaly detection, recommendation systems, and data compression.

Unlike supervised learning, there are no output labels in unsupervised learning, and the model learns the underlying structure of the data by discovering patterns and relationships in the data.

Here's how unsupervised learning works in detail:

- **Data Collection:** The first step in unsupervised learning is to collect a dataset that consists of unlabeled examples. The unlabeled data can be obtained from various sources such as customer behavior, website logs, or sensor data.

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- **Data Preprocessing:** Once the unlabeled data is collected, the next step is to preprocess the data. This step involves data cleaning, data normalization, and data transformation to prepare the data for modelling.

- **Model Training:** In unsupervised learning, the model is trained on the unlabeled data to discover patterns and relationships in the data.

The goal of the training process is to find a representation of the data that captures its underlying structure.

- **Model Evaluation:** Unlike supervised learning, there is no validation set in unsupervised learning, and the model's performance is not evaluated on any specific task. Instead, the model's performance is evaluated by visualizing the learned patterns and relationships and by inspecting the quality of the learned representations.

- **Clustering:** Clustering is a common technique used in unsupervised learning to group similar data points together. Clustering algorithms such as K-means or hierarchical clustering can be used to find the natural clusters in the data.
- **Dimensionality Reduction:** Dimensionality reduction is another common technique used in unsupervised learning to reduce the number of features in the data. Dimensionality reduction algorithms such as PCA or t-SNE can be used to find a lower-dimensional representation of the data that captures most of its variation.

Examples of unsupervised learning include clustering problems such as customer segmentation or anomaly detection, and dimensionality reduction problems such as data visualisation or feature extraction.

3. **Semi-Supervised Learning:** Semi-supervised learning is a combination of supervised and unsupervised learning, where the algorithm is trained using both labeled and unlabeled data. The goal is to improve the accuracy of the model by leveraging the additional unlabeled data. Semi-supervised learning is used in applications where labeled data is scarce, and acquiring additional labeled data is expensive.

   In semi-supervised learning, we have both labelled and unlabeled data, where labelled data is a small fraction of the overall dataset. The percentage of labelled and unlabeled data can vary depending on the application, the availability of labelled data, and the size of the dataset.

   There is no fixed rule for the percentage of labeled and unlabeled data in semi-supervised learning. However, a common practice is to use a small percentage of labeled data, such as 1% to 10%, and the rest of the data is used as unlabeled data. The choice of the percentage of labeled data also depends on the complexity of the problem, the amount of data available, and the desired accuracy of the model.

   In general, having more labeled data will lead to better performance, but acquiring labeled data can be costly and time-consuming. Therefore, semi-supervised learning can be a useful technique to leverage the unlabeled data to improve the model's performance while minimizing the need for labeled data.

4. **Reinforcement Learning:** Reinforcement learning is a type of machine learning where the algorithm learns to make decisions based on trial and error. The algorithm interacts with the environment and receives rewards or penalties based on its actions. The goal is to learn a policy that maximizes the cumulative reward over time. Reinforcement learning is used in applications such as game playing, robotics, and autonomous driving.

In reinforcement learning, the input and output processes involve the following components:

- **Environment:** The environment is the external world in which the agent interacts. It provides input to the agent in the form of sensory information or observations. The environment also receives output from the agent in the form of actions.

- **State:** The state is the current configuration of the environment, as perceived by the agent. It is derived from the input provided by the environment.

- **Action:** The action is the output of the agent that is sent to the environment. The agent selects an action based on the current state and the policy that it has learned.

- **Reward:** The reward is the feedback that the agent receives from the environment based on the action it has taken. It is a scalar value that represents the quality of the action. The goal of the agent is to maximise the reward over time.

- **Policy:** The policy is the strategy that the agent uses to select actions based on the current state. It is a mapping from states to actions and is learned through trial and error.

The input and output process in reinforcement learning can be summarised as follows: the agent receives an observation of the current state of the environment, it selects an action based on its learned policy, and sends this action to the environment. The environment responds with a reward signal that the agent uses to update its policy. This process is repeated over time, and the agent learns to optimise its actions to maximise the expected reward.

Note: The choice of the learning technique depends on the problem domain, the available data, and the desired outcome. Supervised learning is used for prediction tasks, unsupervised learning is used for exploratory data analysis, semi-supervised learning is used for situations where labelled data is scarce, and reinforcement learning is used for decision-making in dynamic environments.

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THANK YOU !