Machine Learning

What is machine learning?

Machine learning (ML) is a branch of computer science that focuses on using data and algorithms to enable artificial intelligence to mimic the way humans learn, gradually improving its accuracy.

How does machine learning work?

breaks out the learning system of a machine learning algorithm into three main parts.

1. A Decision Process: In general, machine learning algorithms are used to make a prediction or classification. Based on some input data, which can be labeled or unlabeled, your algorithm will produce an estimate about a pattern in the data.
2. An Error Function: An error function evaluates the prediction of the model. If there are known examples, an error function can make a comparison to assess the accuracy of the model.
3. A Model Optimization Process: If the model can fit better to the data points in the training set, then weights are adjusted to reduce the discrepancy between the known example and the model estimate. The algorithm will repeat this iterative “evaluate and optimize” process, updating weights autonomously until a threshold of accuracy has been met.

Machine learning versus deep learning versus neural networks

Since deep learning and machine learning tend to be used interchangeably, it’s worth noting the nuances between the two. Machine learning, deep learning, and neural networks are all sub-fields of artificial intelligence. However, neural networks is actually a sub-field of machine learning, and deep learning is a sub-field of neural networks.

The way in which deep learning and machine learning differ is in how each algorithm learns. "Deep" machine learning can use labeled datasets, also known as supervised learning, to inform its algorithm, but it doesn’t necessarily require a labeled dataset. The deep learning process can ingest

unstructured data in its raw form (e.g., text or images), and it can automatically determine the set of features which distinguish different categories of data from one another. This eliminates some of the human intervention required and enables the use of large amounts of data. You can think of deep learning as "scalable machine learning"

Classical, or "non-deep," machine learning is more dependent on human intervention to learn. Human experts determine the set of features to understand the differences between data inputs, usually requiring more structured data to learn.

Neural networks, or artificial neural networks (ANNs), are comprised of node layers, containing an input layer, one or more hidden layers, and an output layer. Each node, or artificial neuron, connects to another and has an associated weight and threshold. If the output of any individual node is above the specified threshold value, that node is activated, sending data to the next layer of the network. Otherwise, no data is passed along to the next layer of the network by that node. The “deep” in deep learning is just referring to the number of layers in a neural network. A neural network that consists of more than three layers—which would be inclusive of the input and the output—can be considered a deep learning algorithm or a deep neural network. A neural network that only has three layers is just a basic neural network.

Deep learning and neural networks are credited with accelerating progress in areas such as computer vision, natural language processing, and speech recognition.

Machine learning methods

Supervised Machine Learning

- **Definition**: This method uses labeled datasets to train algorithms to make classifications or predictions.
- **Process**: During training, input data is provided with correct output labels, allowing the algorithm to learn the correlation between input features and target labels.
- **Applications**: Examples include email spam detection (where spam vs. non-spam is labeled) and diagnostic tools in healthcare.

- **Algorithms Used**:
    - Neural Networks: Mimic human brain structure with layers (input, hidden, output) to handle complex tasks.
    - Naïve Bayes: A probabilistic model based on Bayes' theorem, especially effective for text classification.
    - Linear Regression: Models the relationship between variables with a straight line, ideal for predictions.
    - Logistic Regression: Predicts binary outcomes (like true/false) with logistic functions.
    - Random Forest: Combines multiple decision trees to improve prediction accuracy and prevent overfitting.
    - Support Vector Machine (SVM): Creates boundaries between classes, suitable for text and image classification.

Unsupervised Machine Learning

- **Definition**: Uses unlabeled data to explore patterns or group similar data points without predefined categories.
- **Process**: The model identifies natural clusters within data or reduces the data's complexity through feature reduction.
- **Applications**: Ideal for customer segmentation, recommendation engines, and image recognition.
- **Algorithms Used**:
    - Principal Component Analysis (PCA): Reduces dimensions by highlighting key features.
    - Singular Value Decomposition (SVD): Decomposes matrices to simplify the data structure, often for recommendation systems.
    - K-Means Clustering: Partitions data points into clusters based on proximity.
    - Probabilistic Clustering: Models data as distributions (such as Gaussian) to find likely groupings.

Semi-Supervised Learning

- **Definition**: A middle ground that uses a small amount of labeled data to guide feature extraction and classification in a larger, unlabeled dataset.
- **Applications**: Used when labeling data is costly or impractical, such as in natural language processing and video analysis.
- **Benefits**: Increases the model's effectiveness without needing extensive labeled data, combining the structure of labeled and unlabeled data for efficient learning.

Reinforcement machine learning

Reinforcement machine learning is a machine learning model that is similar to supervised learning, but the algorithm isn't trained using sample data. This model learns as it goes by using trial and error. A sequence of successful outcomes will be reinforced to develop the best recommendation or policy for a given problem.

Common machine learning algorithms

Neural networks

Neural networks simulate the way the human brain works, with a huge number of linked processing nodes. Neural networks are good at recognizing patterns and play an important role in applications including natural language translation, image recognition, speech recognition, and image creation.

Linear regression

This algorithm is used to predict numerical values, based on a linear relationship between different values. For example, the technique could be used to predict house prices based on historical data for the area.

Logistic regression

This supervised learning algorithm makes predictions for categorical response variables, such as "yes/no" answers to questions. It can be used for applications such as classifying spam and quality control on a production line.

Clustering

Using unsupervised learning, clustering algorithms can identify patterns in data so that it can be grouped. Computers can help data scientists by identifying differences between data items that humans have overlooked.

Decision trees

Decision trees can be used for both predicting numerical values (regression) and classifying data into categories. Decision trees use a branching sequence of linked decisions that can 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 the neural network.

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.

In the end the steps is :

1. **Data Collection and Preparation**
2. **Model Selection**
3. **Training the Model**
4. **Feature Implementation in the App**
5. **Deployment and Continuous Learning**