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Computational Robotics

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Implementation for Perceptron

Introduction

Perceptron is an artificial neuron which performs binary decisions, such as classifying inputs into one of two categories. The main objective of Perceptron is to detect features or patterns in the input data. It is an algorithm which is mostly used in Supervised Learning of binary classifiers.

Development

Intuition behind Perceptron

The Perceptron algorithm is a simple but foundational algorithm in machine learning used for binary classification tasks. Its core intuition is based on the idea of learning a linear decision boundary that separates data points belonging to two different classes. It seeks to identify a linear decision boundary, akin to a hyperplane in the feature space, capable of effectively distinguishing between positive and negative instances.

To accomplish this, the Perceptron leverages the concept of a weighted sum. It processes input features, such as attributes or variables associated with a data point, and calculates their weighted sum. Each feature is assigned a weight, reflecting its significance in the classification process. After the calculation of the weighted sum, an activation function is applied. The Perceptron employs the step function or Heaviside step function. The choice of activation function determines the final output of the Perceptron. If the weighted sum exceeds a predefined limit, which is usually set to 0, the Perceptron classifies the input as positive class 1; otherwise, it categorizes it as negative class 0.

Perceptron's learning process involves adjusting the initial weights. Initially, these weights are usually set to small random values. As the algorithm processes data and makes classification decisions, it monitors its errors. When it misclassifies a data point, it updates its weights to minimize the error. This iterative weight adjustment continues until the Perceptron makes no errors or until it reaches a predefined limit on the number of training iterations. Through this learning process, the Perceptron adapts to the data and becomes capable of accurately classifying new, unseen instances.

Algorithm Pseudocode

These are the steps to follow when making a Perceptron Algorithm Pseudocode.

1. Initialization: Initialize weights and bias to small random values.
2. Define Hyperparameters: Set the learning rate (η) and the maximum number of training iterations (max_iter).
3. Training Loop:

For each training example (x, y):

- Compute the weighted sum (z) and apply the activation function.
- Calculate the error (e) as the difference between the true label (y) and the predicted label.
- Update weights and bias based on the error and learning rate.

4. Prediction:

Given a new input feature vector (x_new):

- Compute the weighted sum (z_new) and apply the activation function.
- Output the predicted class based on the activation function result.

Loss Function and Optimization function identification

A standard Perceptron model doesn't typically involve a loss function or optimization function because it uses a simple update rule based on errors for weight adjustments. However, if you want to introduce a loss function and an optimization function, you can modify the Perceptron code to make it more like a modern machine learning model. these factors

Conclusion

The Perceptron is a fundamental machine learning algorithm, especially suitable for binary classification tasks. Its basic principles revolve around creating a linear decision boundary, using weighted inputs and applying an activation function for decision making. Training a Perceptron involves iteratively updating the weights using the Perceptron learning rule, with the ultimate goal of achieving accurate classification. The simplicity of the Perceptron and its clear decision-making process make it an invaluable starting point for understanding binary classification algorithms.

References

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