
Lesson 10: Self-Organizing Networks**Table of Contents**

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10.1 Introduction

In this lesson, we will be discussing self-organizing networks, a type of neural network that is capable of organizing and structuring data on its own without the need for supervision. These networks are based on the principles of unsupervised learning, which is a type of machine learning where the network is not provided with labeled data. Instead, the network must learn to classify or cluster the data on its own.

We will explore two main types of self-organizing networks: unsupervised Hebbian learning and competitive learning without supervision. Unsupervised Hebbian learning is a type of learning that is based on the Hebbian rule, which states that neurons that fire together will wire together. Competitive learning without supervision is a type of learning where the neurons in the network compete with each other to represent a specific input pattern. We will learn how these networks are able to learn and classify data on their own, and the advantages and disadvantages of using self-organizing networks in various applications. By the end of this lesson, you will have a better understanding of self-organizing networks and their capabilities in unsupervised learning.

10.2 Unsupervised Hebbian Learning

Unsupervised Hebbian learning is a type of learning algorithm that is based on the principle of Hebb's rule, which states that "neurons that fire together wire together." In other words, it is a learning mechanism in which the strength of the connection between two neurons is increased if they are activated at the same time.

Hebbian learning is typically used in unsupervised learning scenarios, where the input data is not labeled and the goal is to discover patterns or structure in the data. It is often used for tasks such as feature extraction, dimensionality reduction, and clustering. The basic idea of unsupervised Hebbian learning is to adjust the weights of the connections between neurons in such a way that the neurons are activated in a coordinated manner. This is typically done by updating the weights based on the correlation between the activities of the neurons.

There are several variations of Hebbian learning, including the Oja's rule, which is a modified version of Hebb's rule that is designed to prevent the weights from becoming too large. Another variation is the "anti-Hebbian" learning, which decreases the weights between neurons that are active at the same time. In summary, Unsupervised Hebbian learning is a type of learning algorithm that uses the principle of Hebb's rule to adjust the connections between neurons based on the correlation of their activities, and it's used in unsupervised learning scenarios to discover patterns or structure in the data.

10.3 Competitive learning without supervising

Competitive learning is a type of unsupervised learning algorithm that is based on the principle of competition between neurons. The idea is that each neuron competes with other neurons to be the one that best represents a particular pattern or feature in the input data.

In competitive learning, a set of neurons is typically arranged in a layer, and each neuron is connected to the input data. The input data is presented to the network, and the activity of each neuron is calculated based on the input. The neuron with the highest activity is considered the winner, and its weights are updated to better represent the input pattern. The process of competitive learning is often used for tasks such as feature extraction, dimensionality reduction, and clustering. It is particularly useful for discovering patterns or structure in data that is not labeled or supervised.

One of the most popular competitive learning algorithms is the Kohonen Self-Organizing Map (SOM). SOM is a type of neural network that is trained using unsupervised learning to produce a two-dimensional map of the input data. Each neuron in the SOM represents a different feature or pattern in the input data, and the neurons are arranged in a grid, with similar neurons being grouped together.

Another popular competitive learning algorithm is the Adaptive Resonance Theory (ART) algorithm. ART is a neural network that is trained using unsupervised learning to classify input data into different categories or clusters. The ART algorithm uses a competition between neurons to determine which neuron best represents the input data, and the weights of the winning neuron are adjusted to better represent the input pattern.

10.4 Lesson 10 Questions

1. What is the principle behind unsupervised Hebbian learning?
2. In what types of scenarios is unsupervised Hebbian learning typically used?
3. How does unsupervised Hebbian learning adjust the connections between neurons?
4. What is the difference between Hebbian learning and Oja's rule?
5. What is "anti-Hebbian" learning and how does it differ from Hebbian learning?
6. What is competitive learning and how does it differ from supervised learning?
7. In what types of tasks is competitive learning particularly useful?
8. Can you explain the Kohonen Self-Organizing Map (SOM) algorithm and its applications?
9. What is the Adaptive Resonance Theory (ART) algorithm and how does it classify input data?
10. How do competitive learning algorithms Kohonen Self-Organizing Map (SOM) and Adaptive Resonance Theory (ART) compare to each other?
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