Implementation of a Self-Organizing Map

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OVERVIEW

What is a SOM ?

Definition

It is a neural network of just one layer : the output layer.

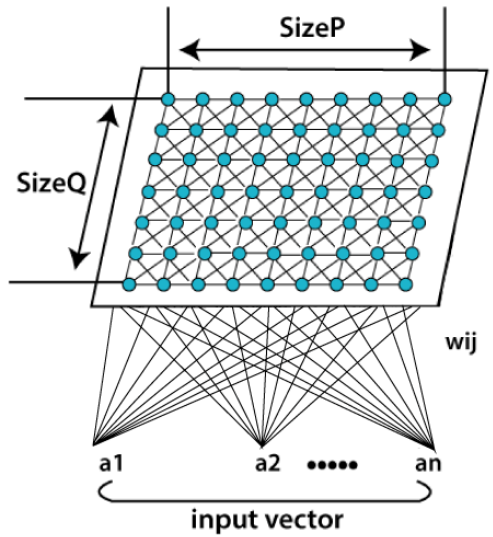


Figure: SOM Architecture (see 2 of Bibliography).

Wikipedia

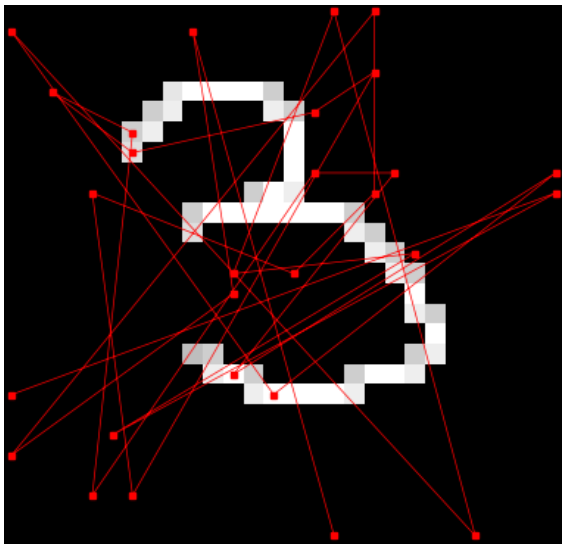
A self-organizing map (SOM) is used to produce a low-dimensional (typically two-dimensional) representation of a higher dimensional data set, while preserving the topological structure of the data.

Motivation

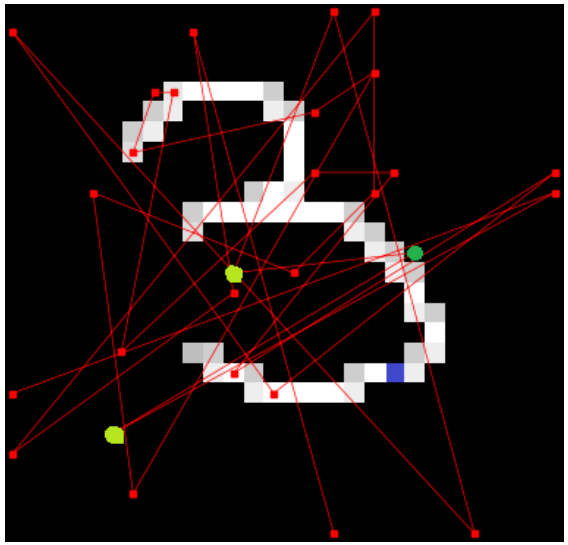
The Self-Organizing Maps permit to :

- Analyse and visualise the data. It represents complex data on a map of only two or three dimensions (see Convergence slide).
- Detect patterns from the data. Clustering (see K-means slide).
- Improve a deep neuronal network by sorting the data at the beginning.

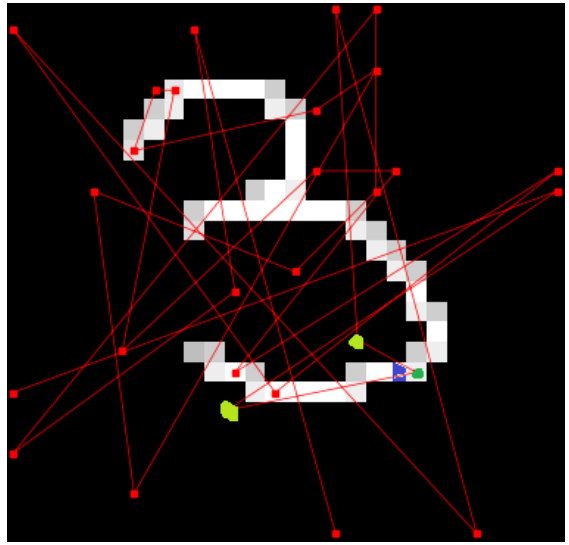
Example



Step 1



Step 2



Step 3

1. Initialize the weight vectors (randomly or not) in red.
2. **Competition** : Select a data vector(blue), then chose the closest weight vector(green) to it.
3. **Adaptation** : Update the winner and its neighbors (all green ones).
4. repeat the process till reach max_iteration

Similarities with the Perceptron

Perceptron

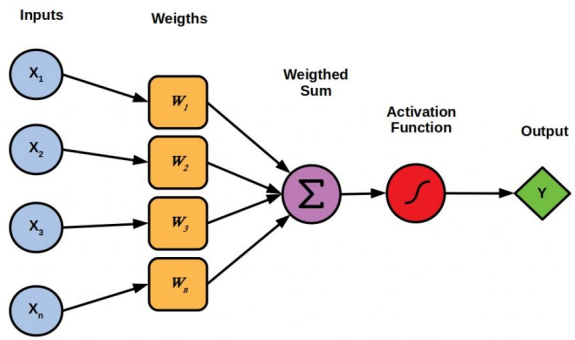


Figure: Diagram of a Perceptron.

It is also a one-layer neuronal network. However, this one is used to separate two different classes. The output is actually a binary one.

This is a supervised learning algorithm.

SOM

The SOM can gather vectors due to their similarities.

The SOM is an **unsupervised learning algorithm**.

Similarities with K-means algorithm

K-means algorithm is an unsupervised learning technique that can automatically gather data by creating **clusters**, which are subsets of data elements that share common characteristics.

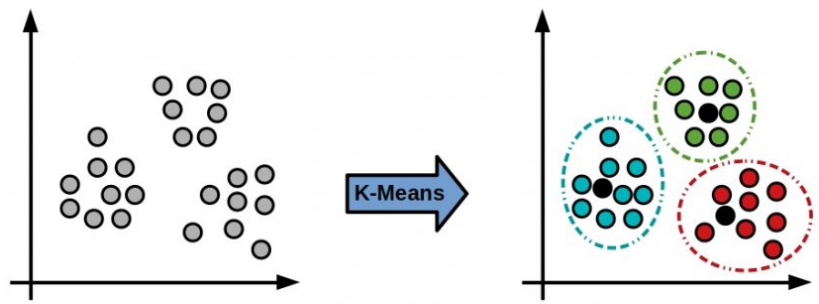


Figure: Process of K-means algorithm

The user must define the number of clusters **K**. However, The SOM does not require this, it guesses the right amount of clusters.

Convergence

The convergence of the SOM algorithm is not guaranteed (1). There are actually 2 errors that can appear.

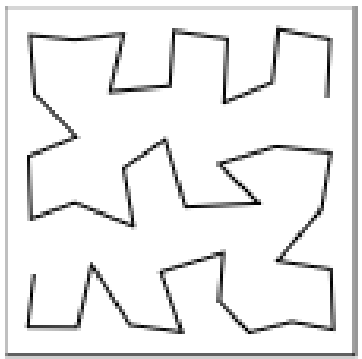


Figure: **Dimension Error**.
It happens when the number of neurons does not fit with the data.
The ideal number of neurons is $5\sqrt{N}$ where N is the number of data vectors.

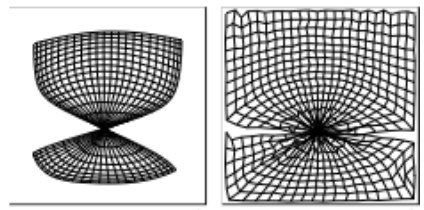


Figure: **Topological Error**.
It happens when a node is created. It looks like a butterfly.

ALGORITHM

Different Phases

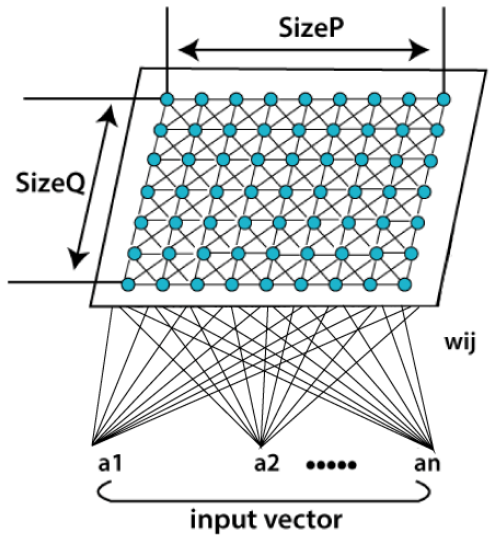
Initialisation

The weights w_i of neuron connections are randomly initialized.

Competition

Cooperation

Adaptation



Algorithm

BIBLIOGRAPHY

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2. https://www.baeldung.com/cs/som-algorithm

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