Unsupervised learning

Part 3: Self-organising map

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Self-organising map (SOM)

- A **self-organising map** (**SOM**) is a common type of unsupervised artificial neural network (ANN).
- It is trained using unsupervised learning.
- It produces a low-dimensional (usually 2D) discretised representation of the input space of the training data.
- This representation is called a **map.**
- Also known as Kohonen maps.

Self-organising map

- Used for dimensionality reduction, clustering, analysis and visualisation of high-dimensional datasets
- SOMs do not perform error-correction learning (e.g. backpropagation with gradient descent)
- They apply competitive learning
- They preserve the topological properties of the input space by using a neighborhood function

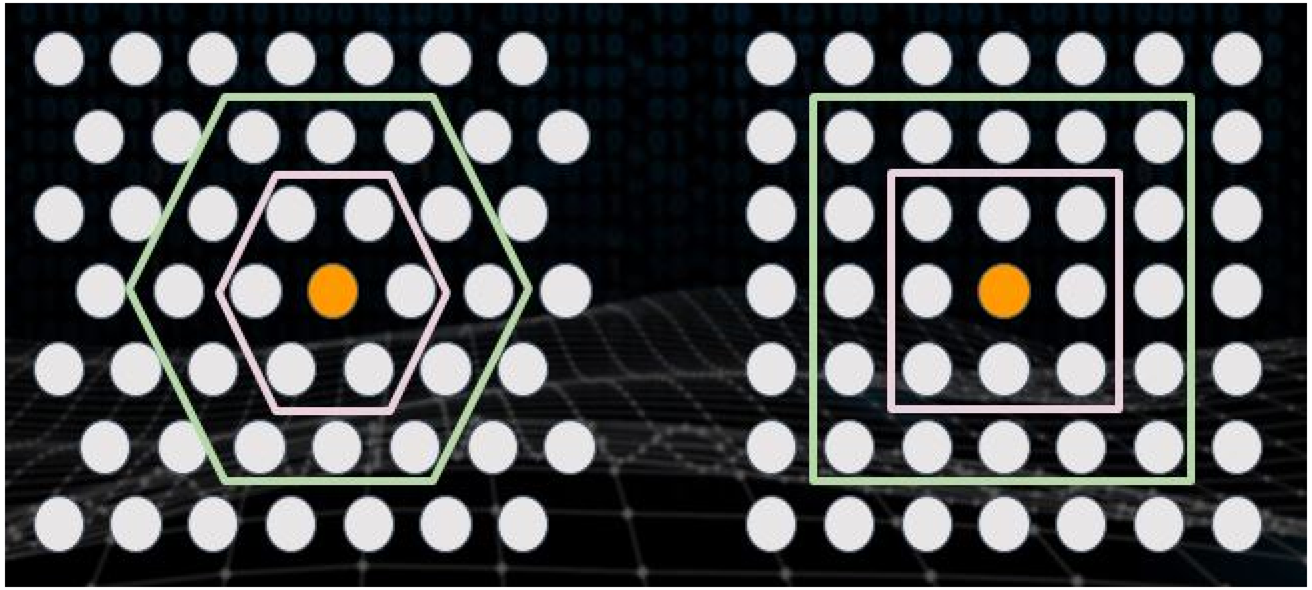
SOM grid

Feature 1	Feature 2	Feature 3	Feature 4
33.6	25.7	21.4	19.5
29.1	26.9	31.8	22.6
23.8	30.4	28.4	33.1

The algorithm 1/5

1) Initialise a grid of neurons (can be a rectangular or hexagonal lattice).

- Neurons are connected to their neighbouring neurons.
- Neighbours are levelled as shown on the right.



http://docs.unigrafia.fi/publications/kohonen_teuvo/

The algorithm 2/5

2) Initialise random weight values for each neuron (between 0–1).
    - Remember each column in the data is connected to each neuron.
3) Randomly select a row (i.e. vector) from the training data.
4) Compute the distance between this row and all the neurons to find **the nearest neuron** (which is called the Best Matching Unit, **BMU**).
    - Euclidean is often used (see below).

$$Distance = \sqrt{\sum_{i=1}^{n} (V_i - W_i)^2}$$

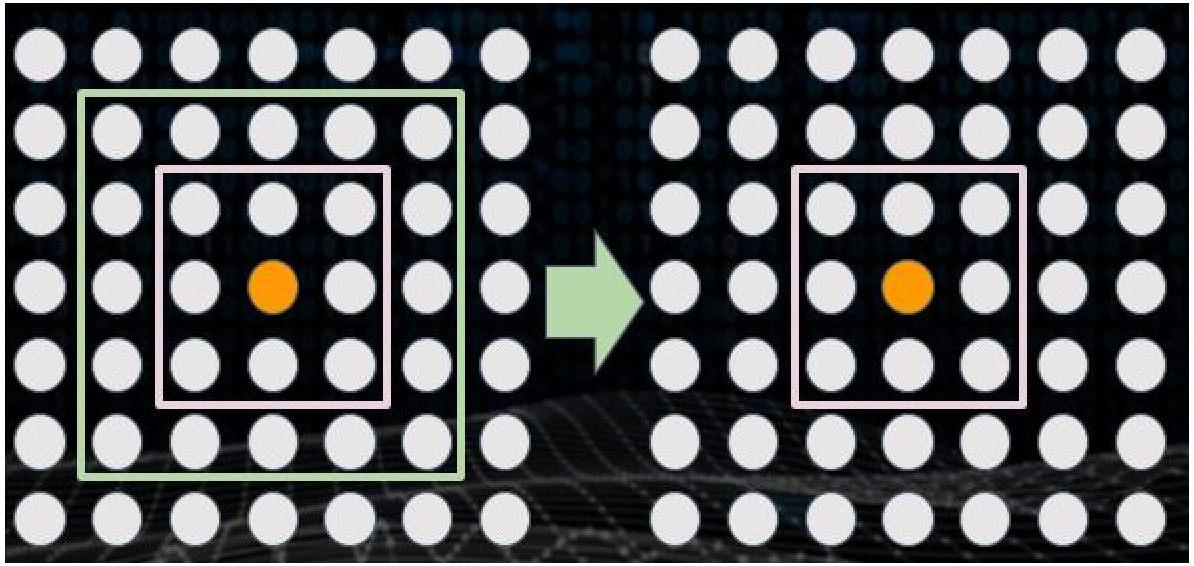
V = The current input vector

W = The neuron’s weight vector

The algorithm 3/5

5) The size of the neighbourhood around the BMU is calculated.

- It shrinks over time (i.e. in each iteration) with an exponential decay function until it becomes link the BMU.
- The closer a neuron is to the BMU, the more its weights are adjusted and vice versa (see step 6).

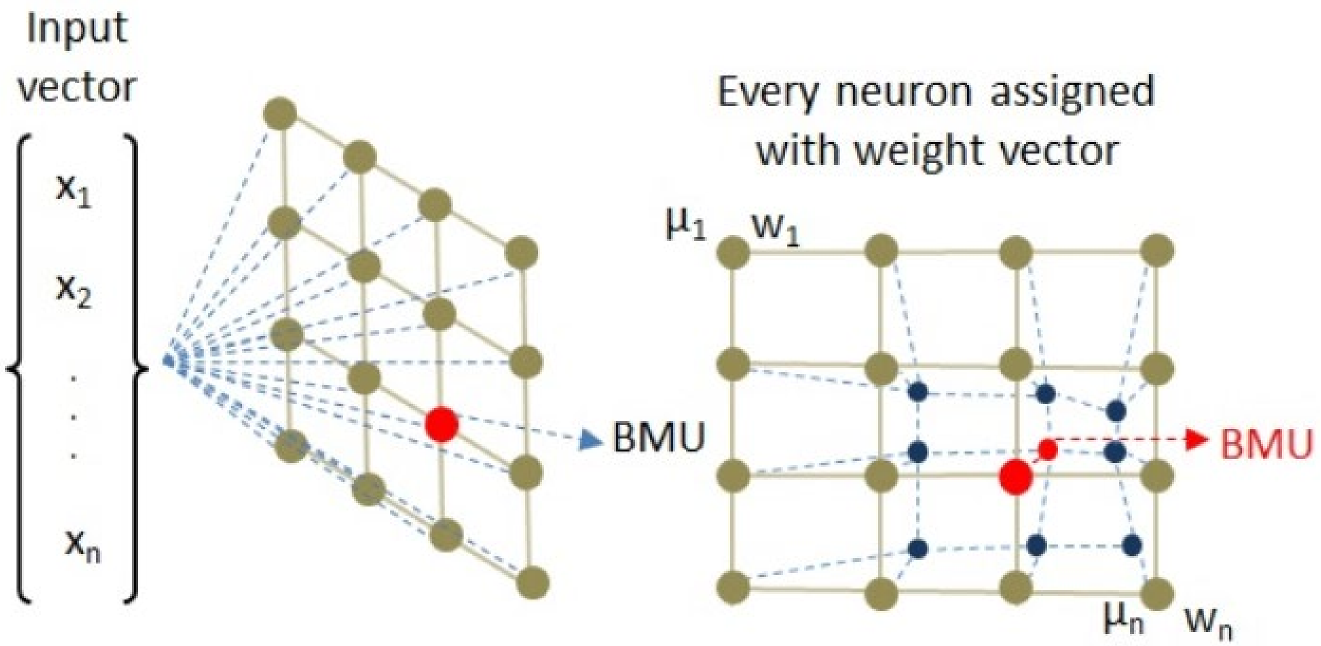


Size of the neighbourhood around the BMU shrinks over time.

The algorithm 4/5

6) The weights of the BMU neuron and its neighbouring neurons are modified so that the BMU is closer to the input vector in the input space:

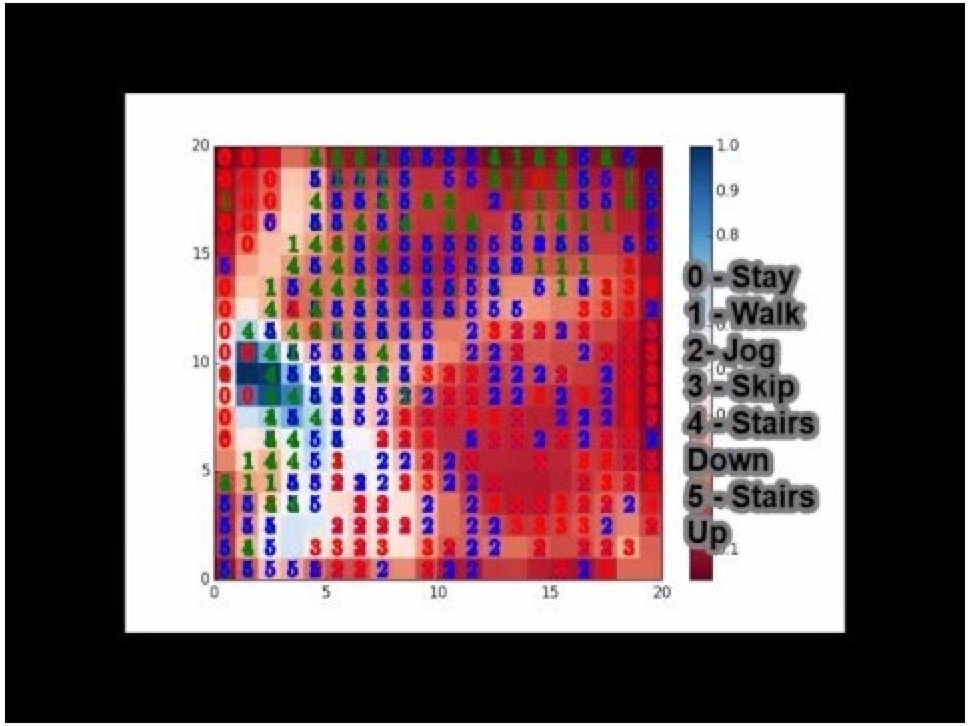
- i.e. its weights are more similar to the weight of the input vector.



Source: Senzio-Savino, B. et al. ‘An Online Synchronous Brain Wave Signal Pattern Classifier with Parallel Processing Optimization for Embedded System Implementation’, *International Journal of Advanced Computer Science and Applications* 8(1) 2017, https://bit.ly/37hHo81

The algorithm 5/5

Now steps 2 to 6 are repeated N number of iterations.



www.youtube.com/watch?v=niMC9x5-9OU