Self-organizing map (SOM)

Presented by

Sasinee Pruekprasert 48052112

Thatchaphol Saranurak 49050511

Tarat Diloksawatdikul 49051006

Department of Computer Engineering, Faculty of Engineering, Kasetsart University

Title

- What SOM?
- Unsupervised learning
- Competitive learning
- Algorithm
- Dimensionality Reduction
- Application
- Coding

What is SOM?

- **The self-organizing map** also known as a Kohonen map.
- SOM is a technique which reduce the dimensions of data through the use of self-organizing neural networks.
- The model was first described as an artificial neural network by professor Teuvo Kohonen.

Unsupervised learning

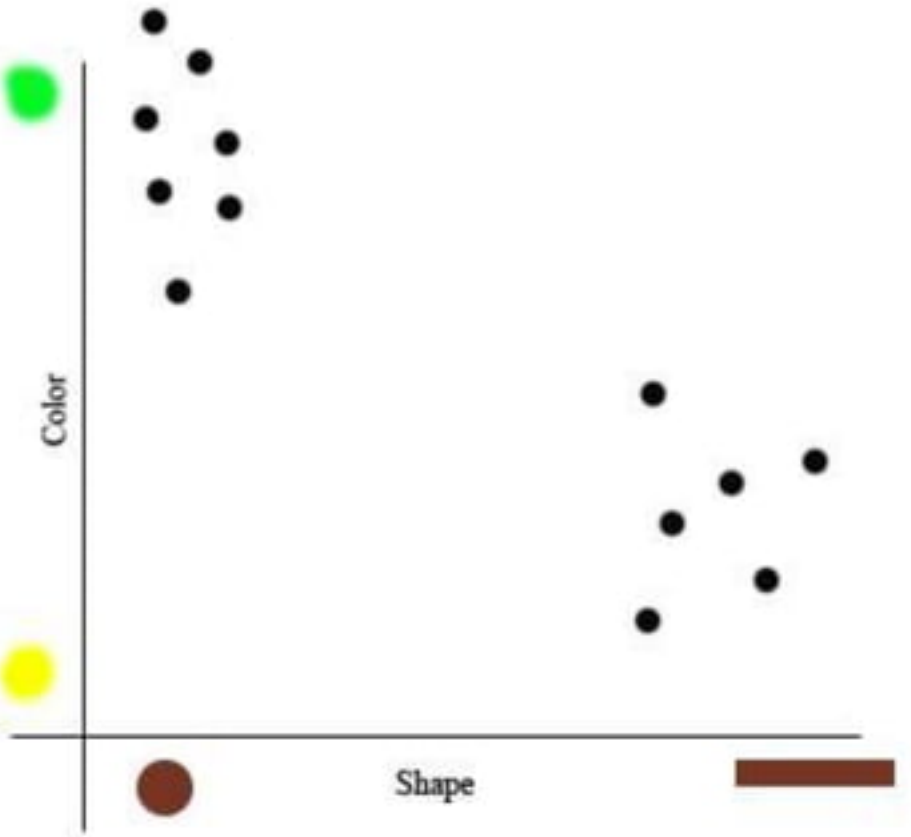
- Unsupervised learning is a class of problems in which one seeks to determine how the data are organized.

- One form of unsupervised learning is clustering.

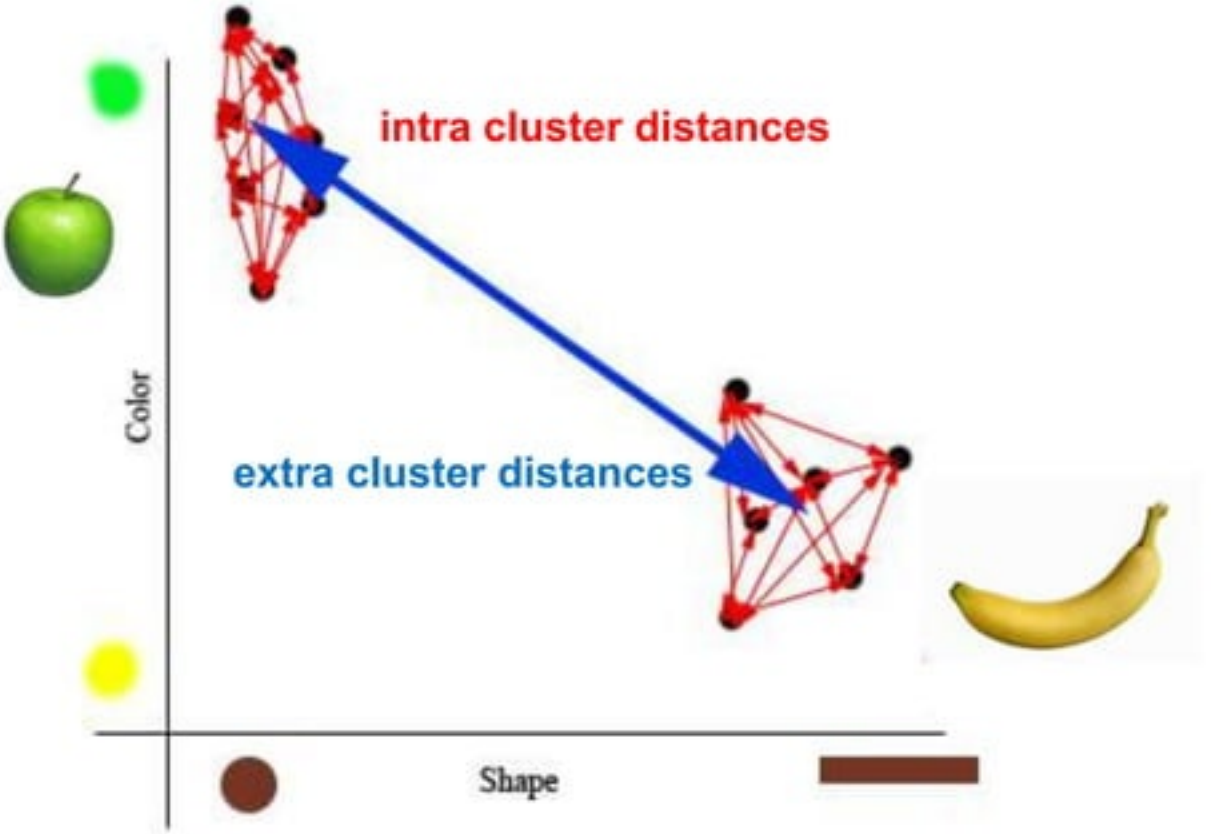
Unsupervised learning

- How could we know what constitutes "different" clusters?
- Green Apple and Banana Example.
  - two features: shape and color.

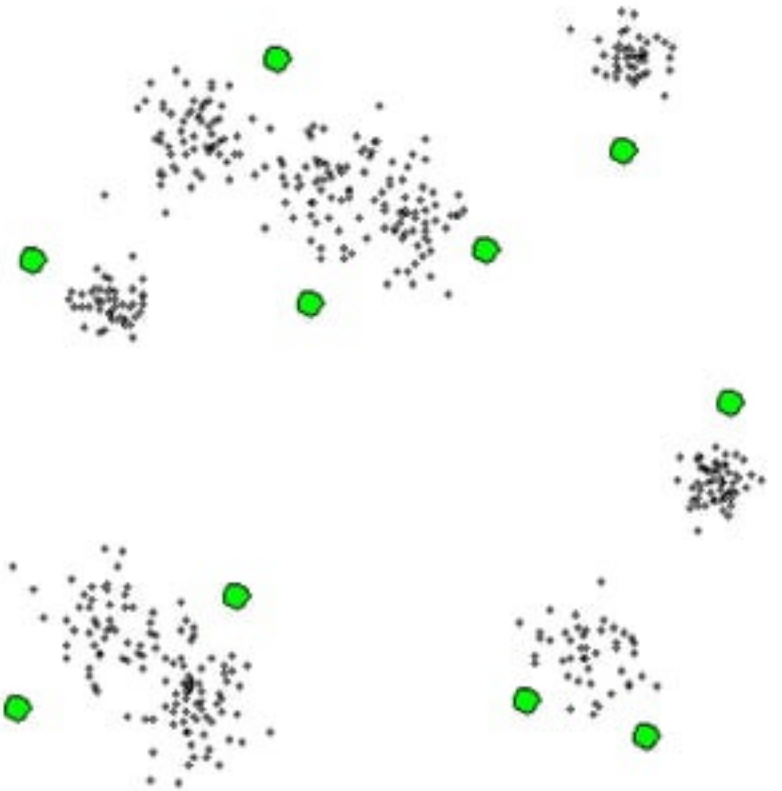
Unsupervised learning



Unsupervised learning



Competitive learning



Unit

- Unit, also called artificial particle and agent, is a special type of data point.
- The difference between unit and the regular data points is that the units are dynamic

Competitive learning

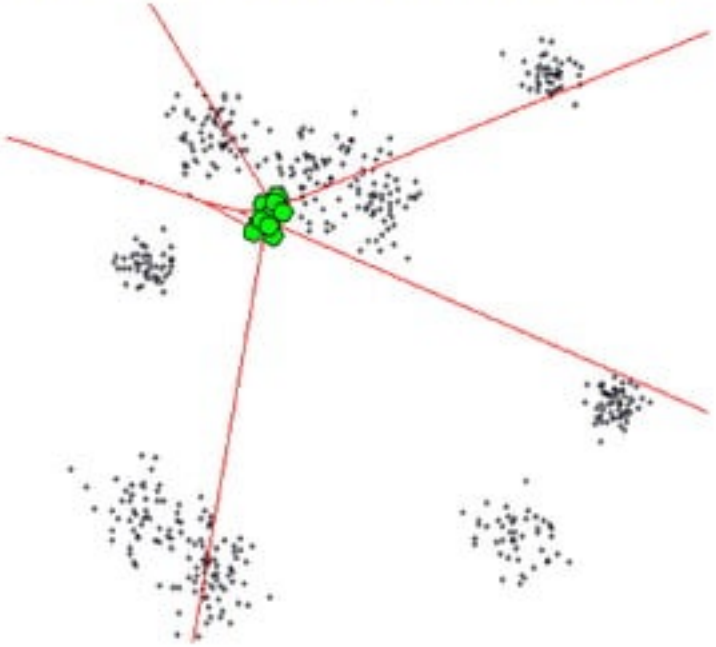
- the position of the unit for each data point can be expressed as follows:

$$p(t+1) = a(p(t)-x)\, d(p(t),x)$$

- a is a factor called learning rate.
- d(p,x) is a distance scaling function.

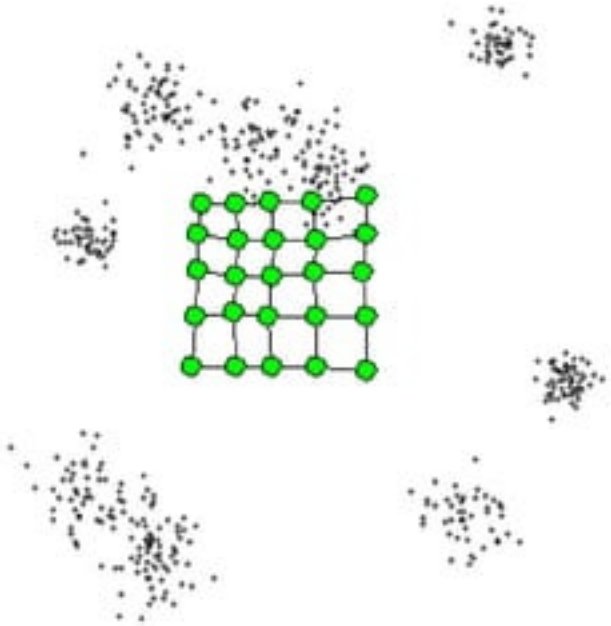
Competitive learning

- Competitive learning is useful for clustering of input patterns into a discrete set of output clusters.



The Self-Organizing Map (SOM)

- SOM is based on competitive learning.
- The difference is units are all interconnected in a grid.



The Self-Organizing Map (SOM)

- The unit closet to the input vector is call Best Matching Unit (BMU).
- The BMU and other units will adjust its position toward the input vector.
- The update formula is

$$W_v(t+1) = W_v(t) + \Theta(v, t)\,\alpha(t)(D(t) - W_v(t))$$

The Self-Organizing Map (SOM)

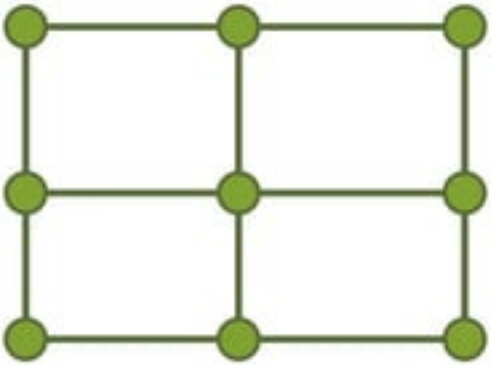
$$Wv(t + 1) = Wv(t) + \Theta(v, t)\,\alpha(t)(D(t) - Wv(t))$$

- **Wv**(t) = weight vector
- α(t) = monotonically decreasing learning coefficient
- **D**(t) = the input vector
- Θ (v, t) = neighborhood function

This process is repeated for each input vector for a (usually large) number of cycles **λ**.

Algorithm

1. Randomize the map's nodes' weight vectors



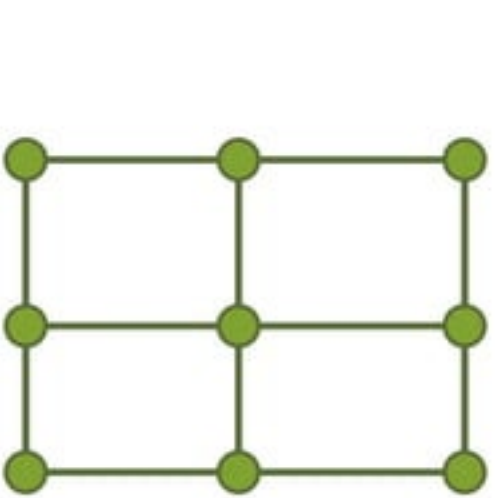
Algorithm

2. Grab an input vector

$$\boldsymbol{x} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ . \\ . \\ . \\ x_n \end{bmatrix}$$

Algorithm

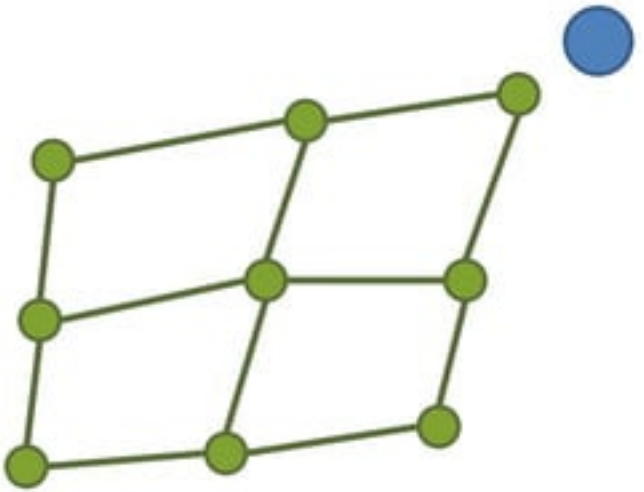
3. Traverse each node in the map



Algorithm

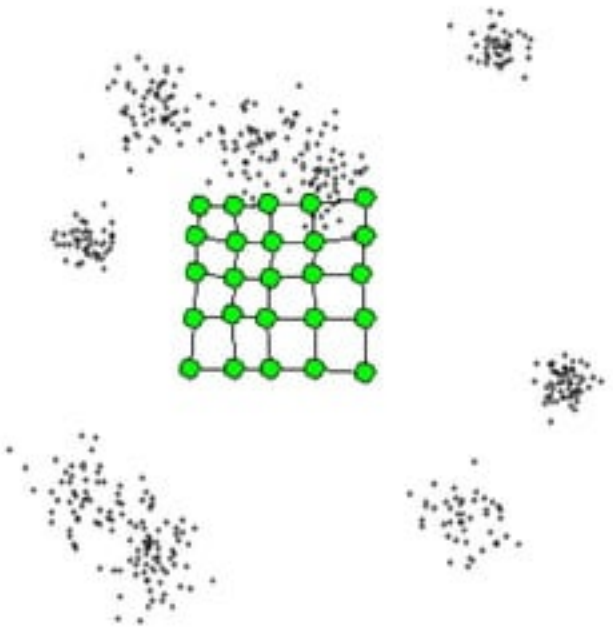
4. Update the nodes in the neighbourhood of BMU by pulling them closer to the input vector

$$Wv(t + 1) = Wv(t) + \Theta(t)\alpha(t)(D(t) - Wv(t))$$

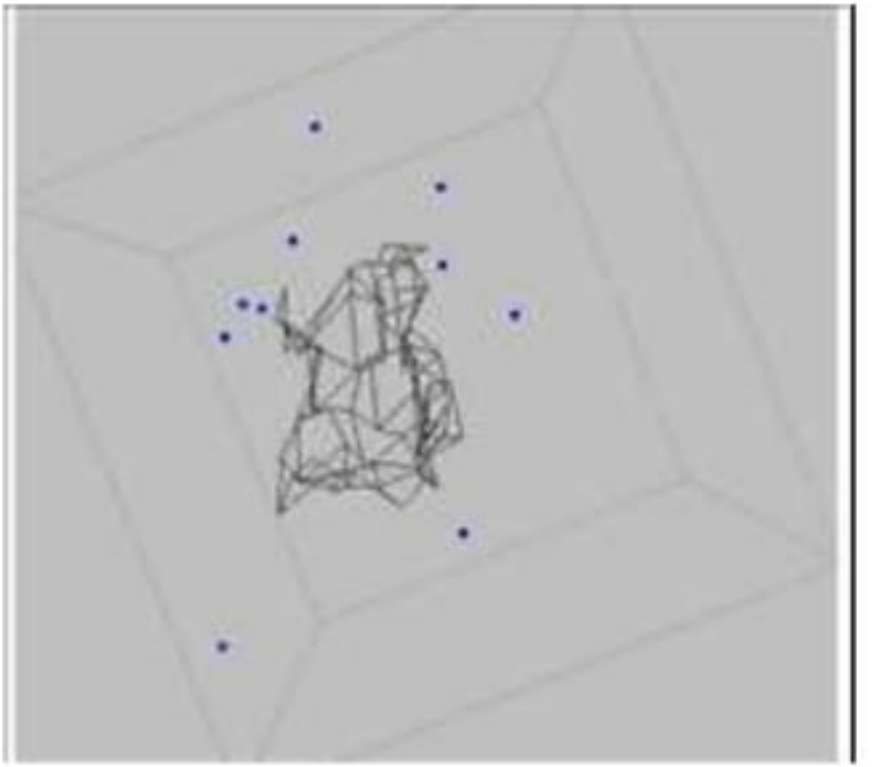


Algorithm

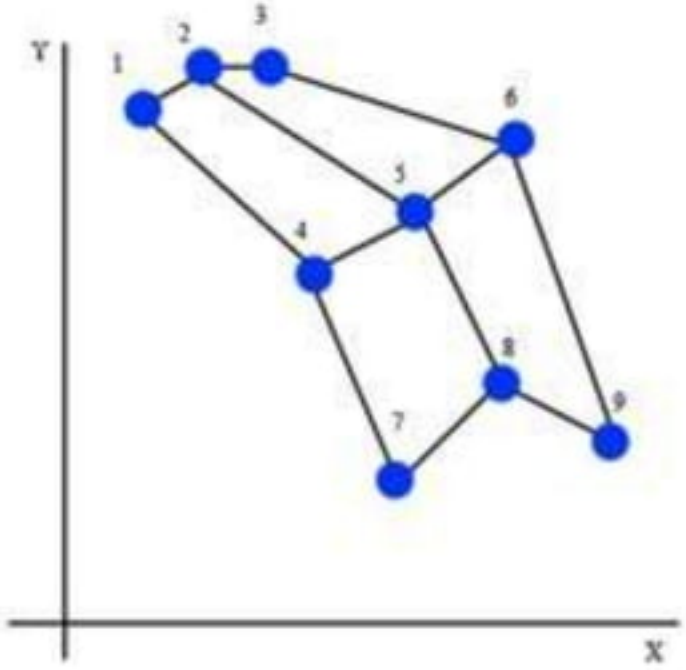
5. Increment t and repeat from 2 while $t < \lambda$



SOM in 3D



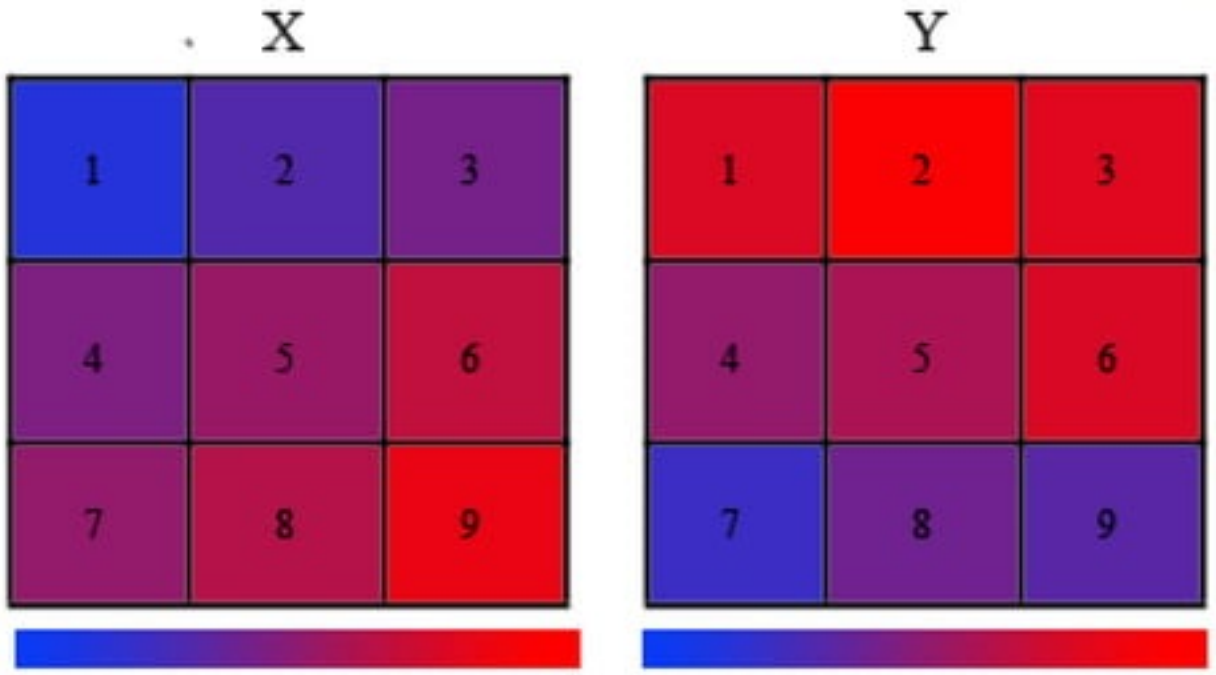
Visualization with the SOM



1	2	3
4	5	6
7	8	9

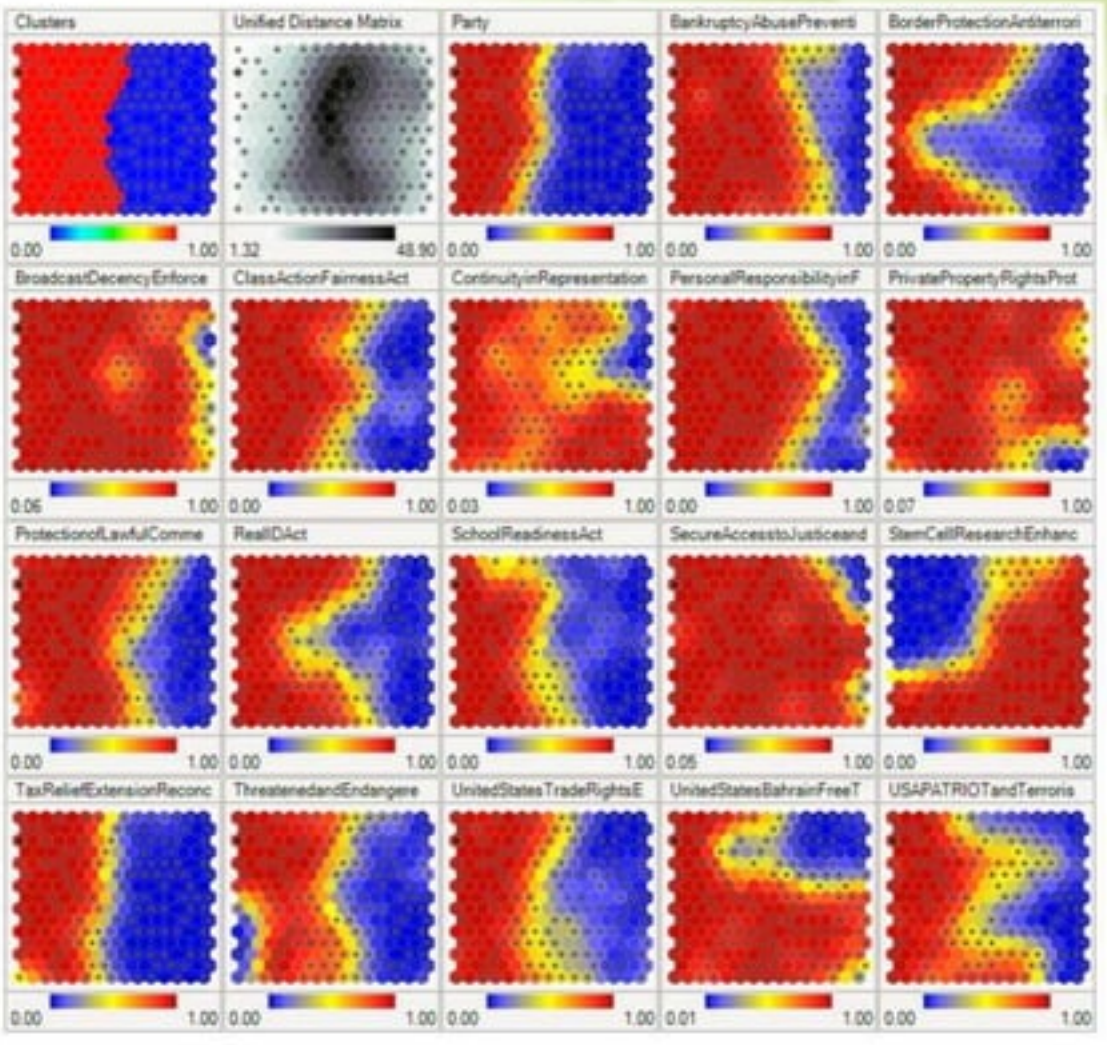
Maplet

Visualization with the SOM

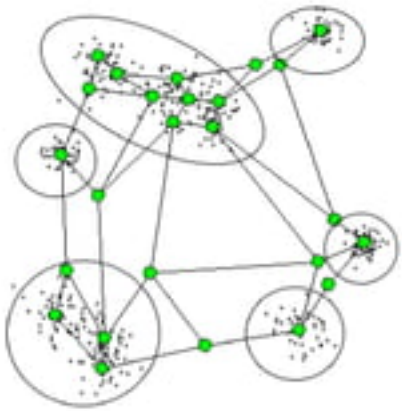


Blue color -> low value **Red color -> High value**

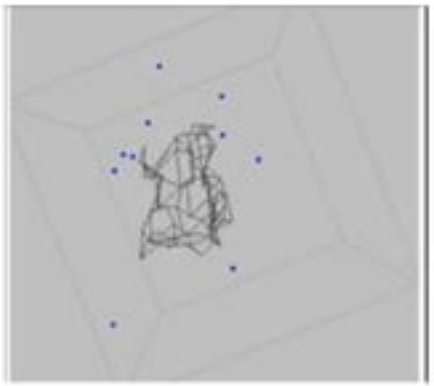
SOM showing US congress voting results



Dimension Reduction



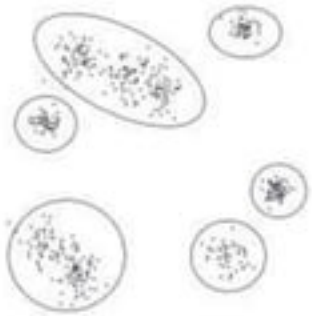
2D



3D

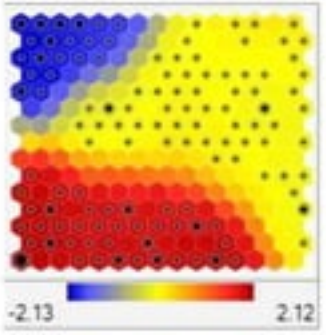
Dimension Reduction

Input vector



BMU

Unit 2D



$$x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ . \\ . \\ . \\ x_n \end{bmatrix} \rightarrow BMU = \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ . \\ . \\ . \\ u_n \end{bmatrix} \rightarrow U = \begin{bmatrix} u_x , u_y \end{bmatrix}$$

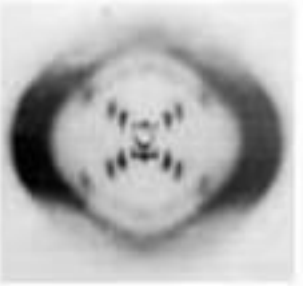
Application

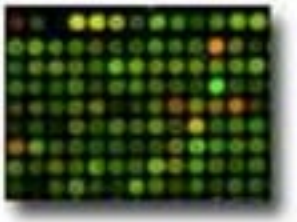
- Dimensionality Reduction using SOM based Technique for Face Recognition.
- A comparative study of PCA, SOM and ICA.
- SOM is better than the other techniques for the given face database and the classifier used.
- The results also show that the performance of the system decreases as the number of classes increase

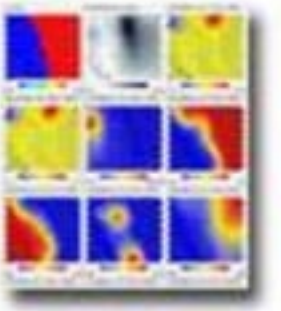
Journal of Multimedia, May 2008
by Dinesh Kumar, C. S. Rai, Shakti Kumar

Application

- Gene functions can be analyzed using an adaptive method – SOM.
- Clustering with the SOM Visualizer - create a standard neural network based classifier based on the results.

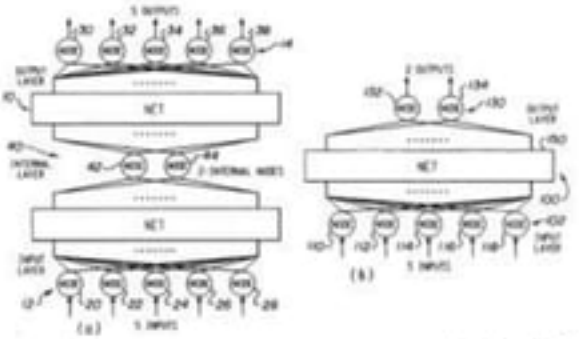


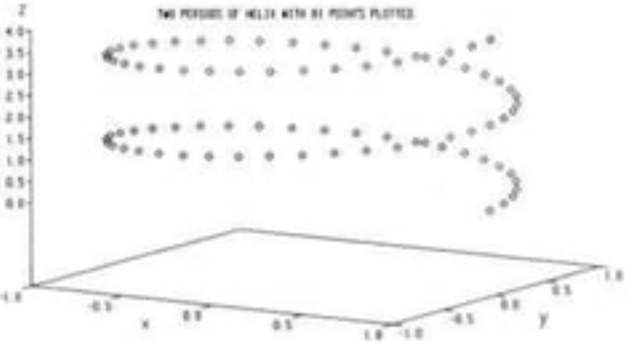




Application

- A neural network comprised of a plurality of layers of nodes.
- A system for organization of multi-dimensional pattern data into a two-dimensional representation comprising
- It allows for a reduced-dimension description of a body of pattern data to be representative of the original body of data.





US Patent 5734796 Issued on March 31, 1998
Yoh Han Pao,Cleveland Heights,Ohin

References

- http://en.wikipedia.org/wiki/Self-organization
- http://blog.peltarion.com/2007/04/10/the-self-organized-gene-part-1
- http://www.freepatentsonline.com/5734796.pdf
- http://www.britannica.com/bps/additionalcontent/18/32480508/Dimensionality-Reduction-using-SOM-based-Technique-for-Face-Recognition
- http://www.cis.hut.fi/projects/somtoolbox/documentation/

Q & A