

Tutorial 5

(Neural Computing)

Artur S. d'Avila Garcez

Department of Computer Science, City, University of London

EXERCISE 11

Consider the *Discrete Hopfield Network* of Figure 1 with 0/1 states. For any initial state, we randomly select a node among $\{1, 2, 3\}$, evaluate its activation (Act) in the normal way, and output “1” if $Act \geq 0$ or “0” otherwise. The network will either be in the same state as before, or in a new state which is at *Hamming distance* one from its previous state. We then choose a new node at random and repeat the process over many times.

- (a) What is the behaviour of the network (give your answer in the form of a *state transition diagram*)?
- (b) Which is the *Energy Function* of the network?
- (c) Which are the *memories* stored by the network?

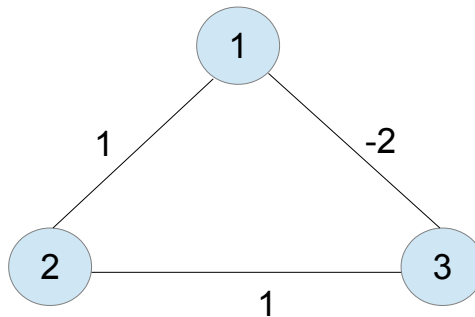


Figure 1: Hopfield network

EXERCISE 12

Explain the concept of unsupervised learning. Give two examples of what can be achieved with unsupervised learning in general.

EXERCISE 13

Using self-organizing maps for clustering and dimensionality reduction:

Run file `som1.m` and inspect the result in comparison with the original data.

Run `som2.m`; change the uniform distribution and inspect the result, e.g. compare with `som3.m`.

Run `som.m` on the well-known iris dataset; see en.wikipedia.org/wiki/Iris_flower_data_set. Notice how in this case a 4-dimensional data set is mapped onto 2 dimensions. Is it possible to interpret the result?

EXERCISE 14

Support Vector Machines. Read the specification of *fitcsvm* in Matlab at:

<https://uk.mathworks.com/help/stats/fitcsvm.html>

Inspect and run the SVM code for the Iris (flower classification) data set provided in the above link as an example of how to use *fitcsvm*.

How would you adapt the above code to try and solve the XOR (exclusive-OR) problem using an SVM?

EXERCISE 15 Think about the following questions:

- What is a neural network (NN)?
- What can you do with an NN and what not?
- What are some applications of NNs?
- What is backpropagation?
- How does backpropagation work?
- What learning rate should be used for backpropagation?
- How should categories be coded?

- Why use a bias/threshold?
- Why use activation functions?
- What does unsupervised learning learn?
- Should I normalise/standardise/rescale the data?
- What are the main objectives of Self-Organising Maps?
- How do Self-Organising Maps work?
- How is generalisation possible?
- How does noise affect generalisation?
- What is overfitting and how can I avoid it?
- How many hidden layers should I use?
- How many hidden units should I use?
- How can generalisation error be estimated?
- What are cross-validation and bootstrapping?
- What are attractor nets?
- What are stable states? How does the energy relate to stable states?