# SOM – Hopfield - RBF

**Question 1.** Which of the following statements is NOT true for a self-organizing feature map (SOM)?

A. There are two phases during training: soft competitive learning and fine tuning.

B. The topological mapping in a well-trained SOM preserves the probability distribution of the training data.

C. The units are arranged in a regular geometric structure such as a 2-dimensional square or a 1-dimensional ring.

D. The number of cluster units can be increased by adding new units if the distribution of the input data changes over time.

E. The learning rate for the neighbors is a decreasing function of the distance from the winning unit in the geometric structures.

**Question 2.** Consider a self-organizing feature map (SOM), in which an input vector x and two prototype vectors $p_1$ and $p_2$ are given by

$$x = [-1.40, 2.30, 0.20]^T \qquad p_1 = [-1.00, 2.20, 0.10]^T \qquad p_2 = [-4.00, 7.00, 0.60]^T$$

a) Which prototype is nearest to x in terms of squared Euclidean distance, $p_1$ or $p_2$?

b) Adapt the weight vector of the winning prototype in the above question according to the competitive learning algorithm with a learning rate of 0.5. What is the new weight vector?

A. $p_{winner} = [-0.80, 2.15, 0.05]^T$

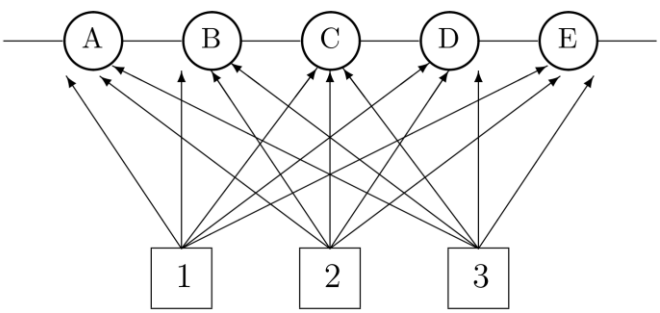
B. $p_{winner} = [-1.20, 2.25, 0.15]^T$

C. $p_{winner} = [-2.70, 4.65, 0.40]^T$

D. $p_{winner} = [-5.30, 9.35, 0.80]^T$

**Question 3.** A self-organizing feature map (SOM) has 8 input units, and 100 output units arranged in a two-dimensional grid. How many weights $w_{ij}$ does this network have?

**Question 4.** Below is a diagram of a self–organizing map (SOM)



By looking at the diagram answer the following questions:

a) How many input nodes does this SOM have?
b) How many output nodes does this SOM have?
c) The input to an SOM can be represented by a point in an m–dimensional space (or m–dimensional vector). How many dimensions are in the space that this SOM is analyzing?
d) How many weights does each of the output nodes have?
e) How many output nodes can fire simultaneously?
f) Is it important what value the output node sends when it fires?
g) Is there any limit on how many data points (input patterns) this SOM can analyze?
h) How many clusters can this SOM detect in the input data?
i) If node D is the winner, which output nodes are its immediate neighbors?

**Question 5.** A Hopfield network has 20 units. How many adjustable parameters (i.e., weights $w_{ij}$) does this network contain?

**Question 6.** Which of the following statements is NOT true for a Hopfield network?

A. The output of the units is often specified by a bipolar step function.
B. The weight matrix is symmetric — that is, $w_{ij} = w_{ji}$ for all units i and j.
C. A unit can be connected to itself — that is, $w_{ii} \neq 0$ for all units i.
D. The Hopfield network minimizes an energy function during recall

**Question 7.** Consider a Hopfield network.

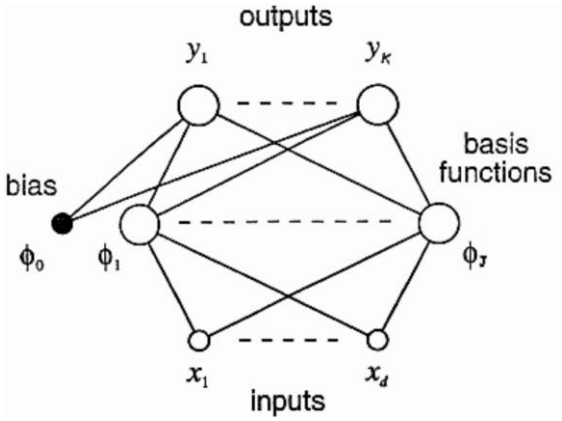
a) Calculate the weight matrix to store the pattern [1 −1 1 −1]
b) Calculate the weight matrix to store two patterns [1 −1 1 −1] and [−1 −1 −1 1]
c) The trained Hopfield network in b) is used for recall. A pattern [−1 −1 1 −1] is presented to the network, then the nodes of the network are updated until a steady state is reached. What is the final state of the network?

**Question 8.** A radial basis function (RBF) network has 1 input unit, 10 radial basis function units and 5 output units. How many adjustable parameters does this network have?

**Question 9.** The below figure shows a two-layer radial basis function (RBF) network with Gaussian radial basis functions in the hidden units defined by

$$\phi_j(x) = \exp\left(-\frac{\|x - m_j\|^2}{2\sigma_j^2}\right)$$

where $m_j$ is the mean vector and $\sigma_j^2$ is the variance for hidden unit $j$, x is the input vector, and $\|a - b\|$ refers to the Euclidean distance between two vectors $a$ and $b$.




The following are steps of a training procedure for the given RBF network.

(i) Decide the number of basis functions.

(ii) Calculate the variance σj2 from the training data for each cluster j.

(iii) Calculate the mean vectors mj using an unsupervised learning algorithm such as the SOFM.

(iv) Train the weights for the output units using a supervised learning algorithm such as the Delta rule.

What is the correct sequence for training this network?

A. (i), (ii), (iii), (iv).

B. (i), (iii), (ii), (iv).

C. (ii), (i), (iii), (iv).

D. (ii), (iii), (iv), (i).

**Question 10.** Which one of the following statements is NOT true in the comparison of RBF networks and multi-layer perceptrons (MLP)?

A. The decision boundaries formed by the hidden units are hyper-planes for the MLP and hyper-spheres for an RBF network.

B. The supervised training is highly non-linear with problems of local minima for the MLP, but linear for an RBF network.

C. All the parameters in an RBF network are determined at the same time using a global training strategy, but a MLP network is often trained in two stages (supervised and unsupervised learning).

D. The training of an RBF network is usually faster than that of a MLP.

E. RBF and MLP networks are both able to approximate arbitrary non-linear functions.