Questions 5

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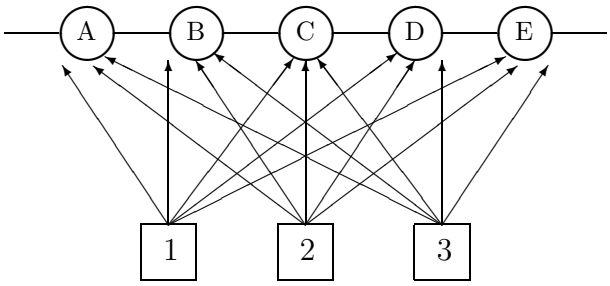
Question 1

Below is a diagram of a self–organising map:



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 analysing?

d) How many weights does each of the output nodes have?

e) The output nodes are organised in a lattice. How many dimensions does the output lattice of this SOM have?

f) How many output nodes can fire simultaneously?

g) Is it important what value the output node sends when it fires?

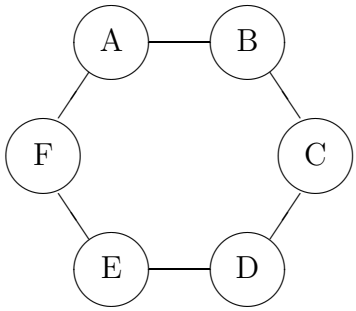
h) Is there any limit on how many data points (input patterns) this SOM can analyse?

i) How many clusters can this SOM detect in the input data?

j) If node D is the winner, which output nodes are its immediate neighbours?

Question 2

Consider the following self–organising map:



The output layer of this map consists of six nodes, A, B, C, D, E and F, which are organised into a two–dimensional lattice with neighbours connected by lines.

Each of the output nodes has two inputs x_1 and x_2 (not shown on the diagram). Thus, each node has two weights corresponding to these inputs: w_1 and w_2. The values of the weights for all output in the SOM nodes are given in the table below:

Node	A	B	C	D	E	F
w_1	-1	0	3	-2	3	4
w_2	2	4	-2	-3	2	-1

For an input pattern $\mathbf{x} = (x_1, x_2)$ the winner is determined using Euclidean distance:

$$\|\mathbf{x} - \mathbf{w}\| = \sqrt{(x_1 - w_1)^2 + (x_2 - w_2)^2}$$

a) Calculate which of the six output nodes is the winner if the input pattern is

$$\mathbf{x} = (2, -4) \ ?$$

The answer should contain all the working.

b) After the winner for a given input $\mathbf{x}$ has been identified, the weights of the nodes in SOM are adjusted using adaptation formula:

$$\mathbf{w}' = \mathbf{w} + \alpha\, h[\mathbf{x} - \mathbf{w}] \ ,$$

where $\mathbf{w}'$ is the new weight vector, α is the learning rate, h is the neighbourhood function. Let $\alpha = 0.5$ and the neighbourhood be defined as:

$$h = \begin{cases} 1 & \text{if the node is the winner} \\ 0.5 & \text{if the node is immediate neighbour of the winner} \\ 0 & \text{otherwise} \end{cases}$$

Adjust the weights in the SOM.

Question 3

What are the main similarities and differences between feed–forward neural networks and self–organising maps?

Question 4

Suppose that the SOM, shown in Question 1, is used to classify types of airplanes based on three parameters: Size, speed and passenger load. The weights of the output nodes are shown in the table below:

Node→	A	B	C	D	E
w_1	3	5	1	2	5
w_2	2	1	5	3	2
w_3	5	1	1	2	5

Each of the three parameters is assessed on a scale from 1 to 5. For example, small airplanes have size 1, while huge planes would have value 5. Each plane is represented as a three–dimensional vector with coordinates corresponding to these three parameters. Answer each of the following questions justifying your answers:

a) How many types of planes can this SOM classify?

b) Which node will be the winner, if a vector representing a fighter jet is fed into the input?

c) Which of the output nodes can represent a jumbo passanger jet?

d) Suppose you were asked to change the design of the SOM in order to take into account two additional parameters: Price and fuel consumption. What would you need to change in this SOM?

e) Is it possible to classify ships using this SOM? Explain your answer.

Question 5

An insurance company with several thousands of customers has decided to analyse its customers in order to unsertand better why they buy the policy. The company collected data about its customers for the last 2 years. Each customer's profile was stored electronically in a database and fed into a data warehouse, where it was assessed on 50 parameters. Discuss in a form of essay how a self–organising map (SOM) could be used for this analysis. Why would the results, produced by an SOM, be particularly useful for the reports presented to strategic managers?

Question 6

What are the main features of an SOM that can help to analyse the business data in a data warehouse?

Question 7

In which phase of decision making would a self–organising map be most useful? Explain your answer referring to important features of SOMs.