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Monash University
Semester Two Examination 2004
Faculty of Information Technology

EXAM CODES: CSE5301
TITLE OF PAPER: NEURO-FUZZY COMPUTING

INSTRUCTIONS TO CANDIDATES:

1. This is an open-book exam.
2. Calculators are permitted.
3. **Exam duration:** 120 minutes writing time
4. **Reading time:** 15 minutes
5. This paper comprises 5 questions and 2 figures printed on 5 pages.
6. Attempt all questions.
7. Marks for questions are as shown.
8. Total marks are 100.
9. The examination paper must be returned.
10. **Question 5 should be answered in the examination paper. Answer the remaining questions in the script book.**

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1. A neural network generates its output according to the following equation

$$y = \sigma \left(U \cdot \begin{bmatrix} \mathbf{h} \\ 1 \end{bmatrix} \right), \quad \mathbf{h} = \sigma \left(W^h \cdot \begin{bmatrix} \mathbf{x} \\ 1 \end{bmatrix} \right)$$

where σ is a suitable step function (a hard limiter),

$$W = \begin{bmatrix} -2 & 4 & 1 \\ 6 & -4 & 1 \end{bmatrix}, \quad U = \begin{bmatrix} 3 & 4 & -1 \end{bmatrix}.$$

- Sketch a dendritic diagram of the network.
- calculate the network output y for the following input vectors:

$$X = \begin{bmatrix} 0.5 & 0 & 0 & 1 & 1 \\ 0.25 & 0 & 1 & 0 & 1 \end{bmatrix}$$

- Plot the decision plane/line for every neuron in the network
- If the step functions σ are removed from the network, what function does the network perform?

(7 + 7 + 7 + 5 = 28 marks)

2. In Adaline, the performance index is given in the following form:

$$J(w_1, w_2) = 4w_1^2 + 6w_1w_2 + 5w_2^2 + 2w_1 - 3w_2 + 2$$

- Determine the cross-correlation and input correlation matrices.
- Assuming that the current weight vector $w = [1 \ -1]$ calculate the gradient of the performance index.
- In the steepest descent learning law, what would be the next value of the weight matrix?
- Assuming that the next values of the input vector $\mathbf{x}(n+1)$ and the desired output $d(n+1)$ are

$$\mathbf{x}(n+1) = \begin{bmatrix} 2 \\ 1 \end{bmatrix}, \quad d(n+1) = 0.5;$$

calculate the next values of the cross-correlation and input correlation matrices.

(5 + 6 + 5 + 7 = 23 marks)

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3. In Generalised Hebbian learning

(a) the current values of the input vector and the weight matrix are as follows:

$$\mathbf{x} = \begin{bmatrix} -2 \\ -1 \\ 1 \end{bmatrix}, \quad W = \begin{bmatrix} 1 & 0 & 2 \\ -1 & 1 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

Calculate the weight update ΔW . Assume $\eta = 1$.

(b) At the conclusion of the learning process, what do the weight matrix, W , and the output vector, y , represent?

(10 + 4 = 14 marks)

4. Consider a Kohonen Self-Organizing Map where dimensionality of the input and feature spaces are 2 and 1, respectively. The number of neurons is 8.

(a) Sketch a structure of the network.

(b) Assuming the contents of the weight and neuronal position matrices is as follows:

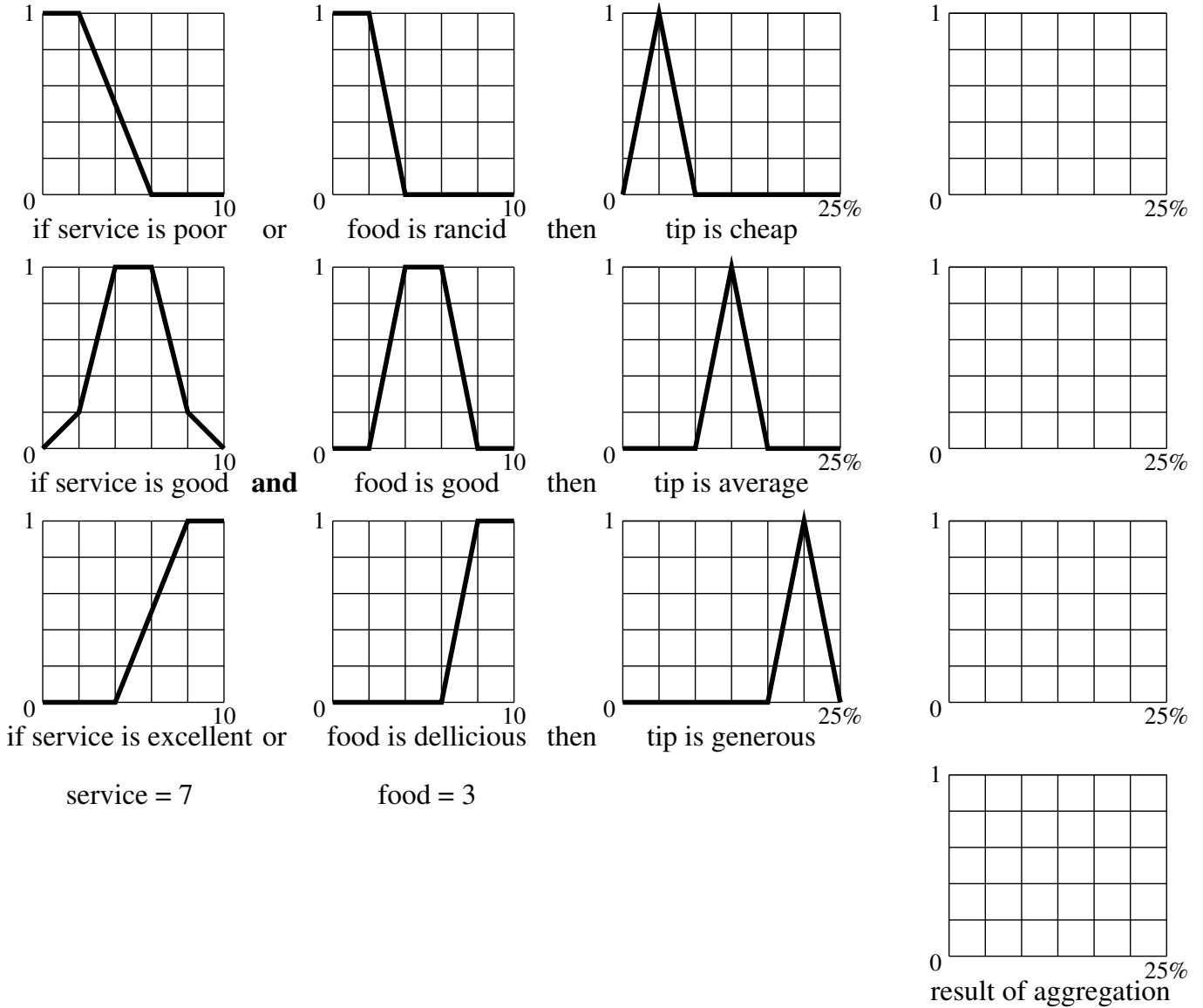
W		V
4	3	5
1	3	1
5	4.5	7
2	1	3
1.5	2	2
4.5	5	6
3	2.5	4
5.5	3	8

Sketch the resulting feature map.

(10 + 5 = 15 marks)

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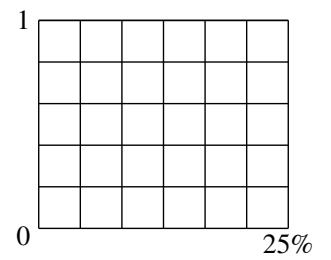
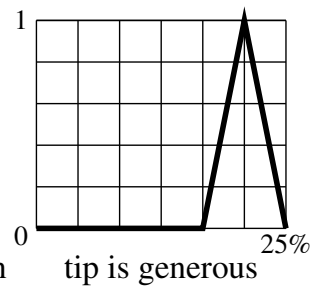
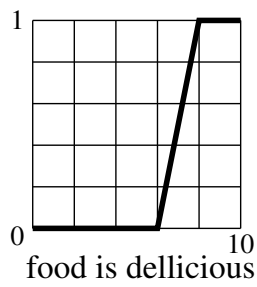
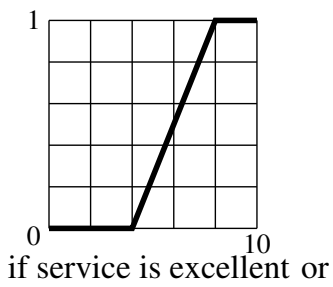
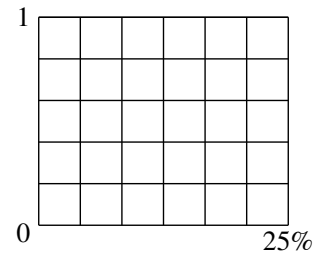
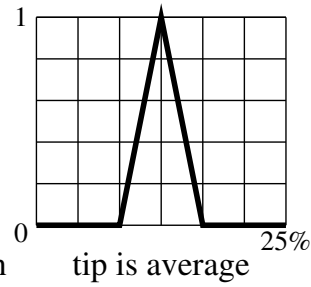
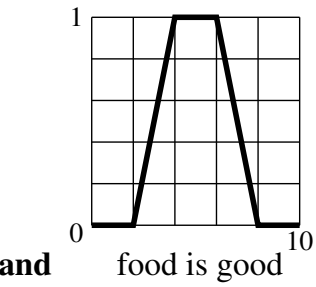
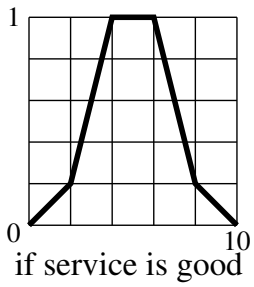
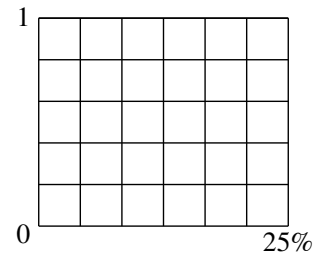
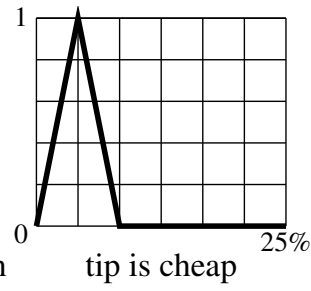
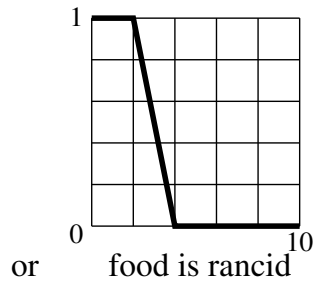
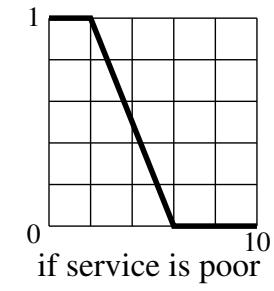
5. Complete the following Fuzzy inference diagram. Another copy of the diagram is available on the next page. Use it as a draft.



(20 marks)

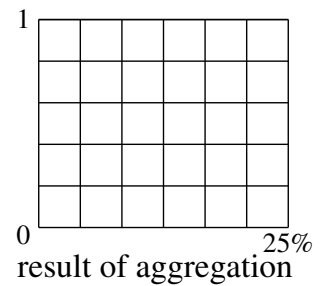
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service = 7

food = 3



result of aggregation