GALWAY-MAYO INSTITUTE OF TECHNOLOGY

SEMESTER 2 EXAMINATIONS 2016/2017

MODULE: COMP08016 - ARTIFICIAL INTELLIGENCE

PROGRAMME(S):
GA_KSOFG_H08 BACHELOR OF SCIENCE (HONOURS) IN SOFTWARE DEVELOPMENT

YEAR OF STUDY: 4

EXAMINER(S):

JOHN HEALY	(Internal)
Mr. Tom Davis	(External)
Dr. Des Chambers	(External)

TIME ALLOWED: 2 Hours

INSTRUCTIONS: **Answer 4 questions. All questions carry equal marks.**

PLEASE DO NOT TURN OVER THIS PAGE UNTIL YOU ARE INSTRUCTED TO DO SO.
The use of programmable or text storing calculators is expressly forbidden.
Please note that where a candidate answers more than the required number of questions, the examiner will mark all questions attempted and then select the highest scoring ones.

There are no additional requirements for this paper.

1. (a) Using examples where appropriate, describe each of the following terms as they apply to ***artificial neural networks***:

- Activation Functions **(5 Marks)**
- Perceptrons **(5 Marks)**

(b) Discuss how ***backpropagation*** can be used to train a multi-layered neural network. Your answer should include a diagram and explain each step in the process.

(15 Marks)

2. **Figure 1** below depicts a semantic network of nodes interconnected by edges. The starting node is node '**A**" and "**I**" is the goal node. Each node is labelled with a letter in the upper compartment and a heuristic estimate of distance to the goal node in the lower compartment. The actual distance between two nodes is shown as a number along their connecting edge.

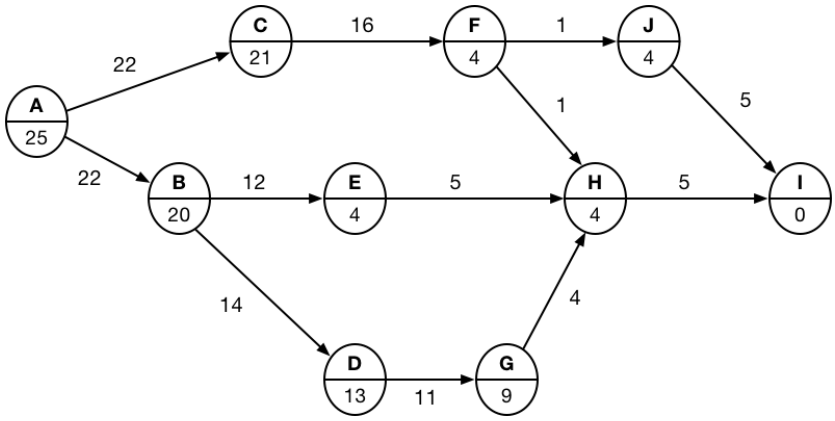

Fig. 1

(a) Show how the ***A* algorithm*** can find the optimal path from the initial node (A) to the goal node (I). Your answer should show the state of the ***OPEN*** and ***CLOSED*** queues for each iteration of the algorithm and how the path evaluation function, *f(n)*, is computed.

(13 Marks)

(b) Discuss the factors that impact on the ***space complexity*** of the A* algorithm and explain, using examples, how ***iterative deepening*** can reduce the memory overhead whilst preserving both optimality and completeness.

(12 Marks)

3. (a) Discuss each of the following topics as they relate to semantic networks:

- Branching Factor **(6 Marks)**
- Brute Force Search **(6 Marks)**

(b) Describe the structure and function of a ***Radial Basis Function (RBF)*** neural network. Your answer should include a diagram explaining the role of each layer in the network topology.

(13 Marks)

4. **Figure 2** below depicts a 4-*ply* full game tree having leaf nodes decorated with a score that represents a goal state. You may assume that node 'A' is a MAX node.

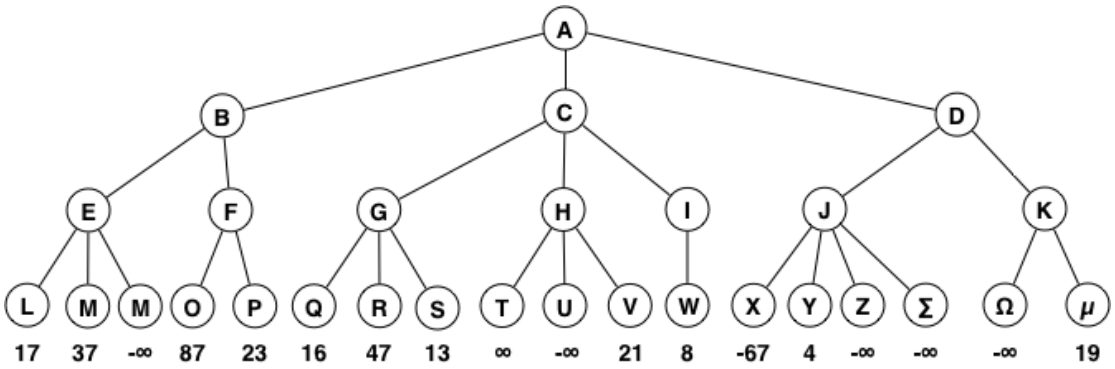

Fig. 2

(a) Show, using labelled diagrams, how the ***minimax*** algorithm can determine the best move to make from node 'A'. Your answer should also illustrate how MAX and MIN values are computed at each level.

(10 Marks)

(b) Describe how ***alpha-beta pruning*** can be applied to the game tree in **Figure 2** to reduce the number of nodes to be generated and examined. Your answer should show the pruned game tree, indicate the alpha and beta cut-off points and address the effectiveness of alpha-beta pruning.

(15 Marks)

5. (a) Explain the ***fuzzy set operations*** that underpin fuzzy logic and explain how they relate to Boolean logic. Include diagrams with your answer where appropriate.

(10 Marks)

(b) **Figures 3, 4 and 5** below depict fuzzy sets that describe the variables ***growth***, ***tax-take*** and ***spending*** respectively. The universe of discourse ranges from 0 - 10% for the variables ***growth*** and ***tax-take*** and from 0-25% for the variable ***spending***. The following three rules describe the reasoning used by a fuzzy inference system to compute the increase in government spending for the inputs ***growth*** and ***taxtake***:

1. if growth is very strong and taxtake is not small then spending is high
2. if growth is weak or taxtake is not normal then spending is low
3. if growth is moderate and taxtake is somewhat normal then spending is balanced

Compute, using the ***Sugeno inference method***, the crisp value of spending for the inputs *growth=7.5 and taxtake=3*. Your answer should clearly show each step in the fuzzy inference process and how the output values are computed.

(15 Marks)

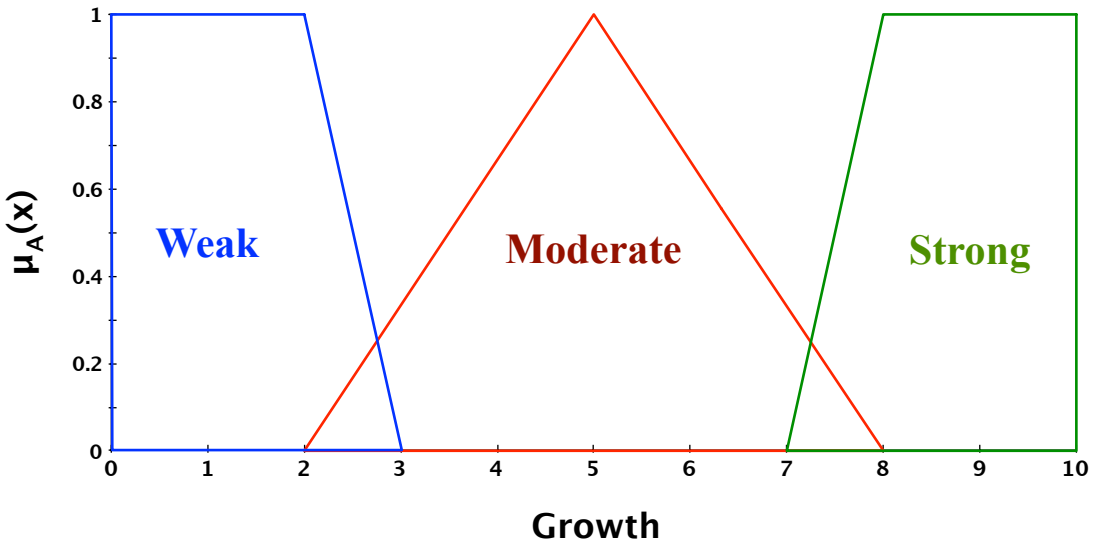

Fig. 3. Fuzzy Sets for Economic Growth

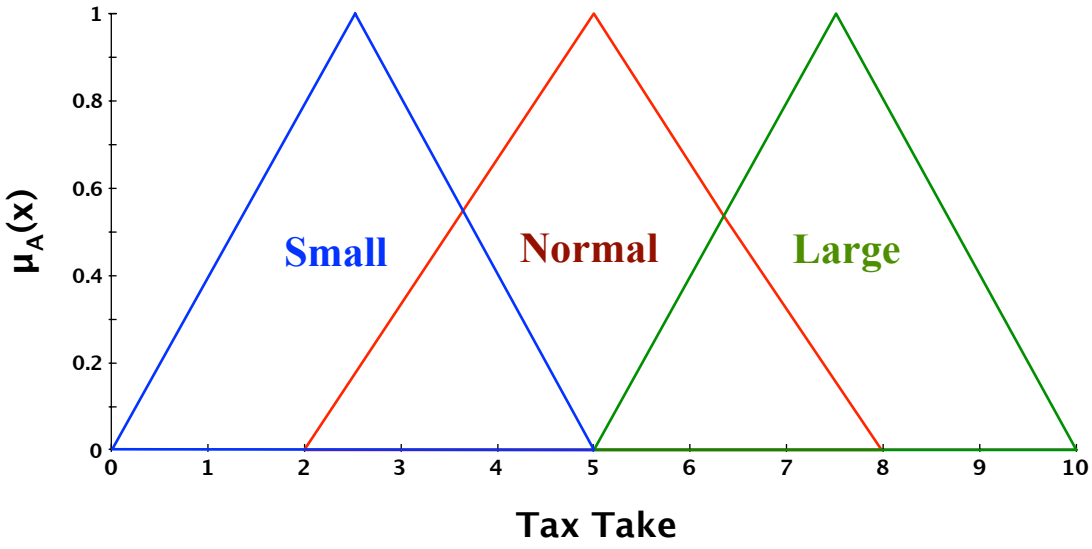

Fig. 4. Fuzzy Sets for Tax Take

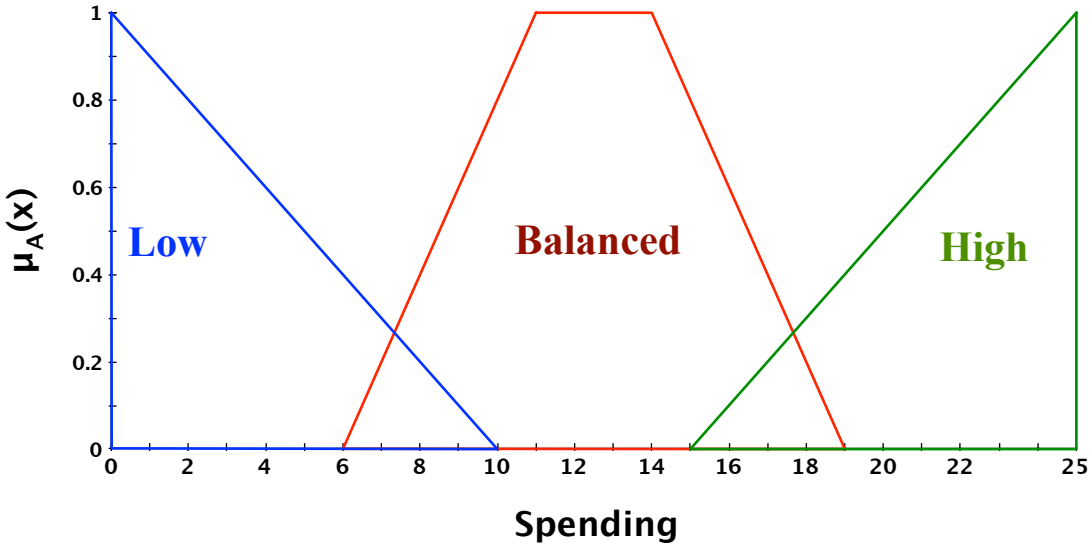

Fig. 5. Fuzzy Sets for Spending