GALWAY-MAYO INSTITUTE OF TECHNOLOGY

SEMESTER 2 EXAMINATIONS 2017/2018

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.

Requirements for this paper:
1. Non-Programmable Calculators Allowed

1. (a) Describe, using examples where appropriate, how an Artificial Neural Network (ANN) can be ***trained to learn classification*** tasks. Include a fully labelled diagram in your answer, showing the structure of both a ***neuron*** and a ***perceptron***.

(15 Marks)

(b) Discuss the structure and function of a ***multilayer back-propagation neural network***. Your answer should include a diagram that illustrates the direction of information flow through the network and address techniques for choosing the network ***topology***.

(10 Marks)

2. **Figure 1** below depicts a 4-*ply* game tree having leaf nodes decorated with a score that represents the computation of a static evaluation function:

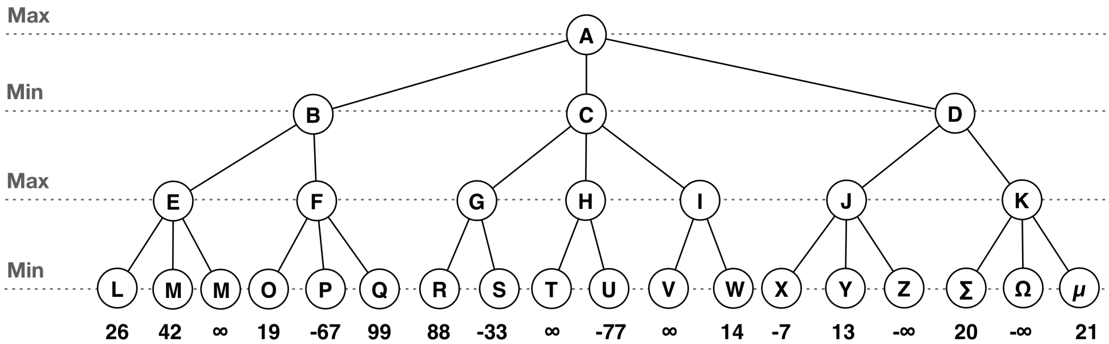

Fig. 1

(a) Show, using labelled diagrams, how the ***minimax*** algorithm can determine the best move to make from node 'A'. Your answer should clearly 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 1** 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 computational effectiveness of alpha-beta pruning.

(15 Marks)

3. (a) *"Branching factor is the one characteristic of an algorithm, more than any other, that will determine the effectiveness of a search strategy on a semantic network."*

Discuss this statement and evaluate implications of ***branching factor*** for the computational efficiency of a search strategy.

(12 Marks)

(b) Discuss the limitations of the ***basic hill-climbing algorithm*** and how they may be mitigated by ***steepest-ascent*** and ***simulated annealing*** techniques. Use diagrams and pseudocode or Java snippets to illustrate your answer.

(13 Marks)

4. **Figure 2** below depicts a semantic network of ten nodes interconnected by edges. The starting node is node '**A**" and "**J**" 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.

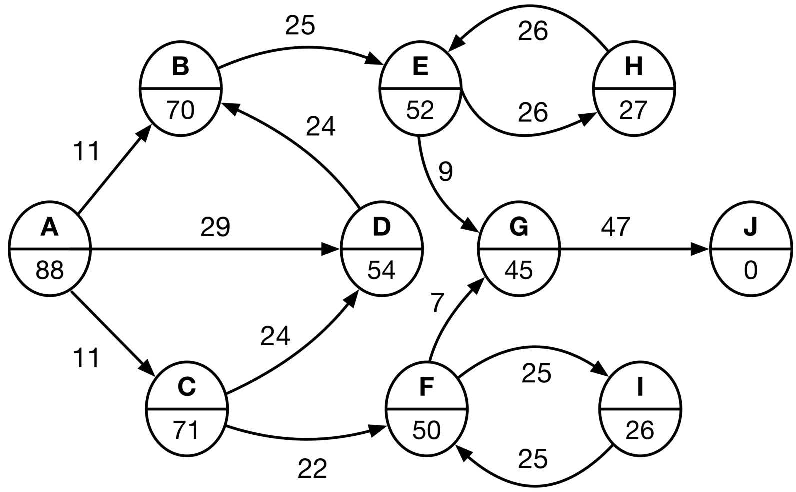

Fig. 2

(a) Show how the ***A* algorithm*** can find the optimal path from the initial node (A) to the goal node (J). Your answer should clearly 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.

(11 Marks)

(b) Discuss the efficiency of the A* algorithm and the parts of the algorithm that contribute most to the computational complexity of the search of a semantic network. Your answer should also address how different types of graph topologies may impact the performance of A*.

(6 Marks)

(c) Using a diagram and code snippets where appropriate, discuss how ***iterative deepening*** can be applied to A* to reduce computational complexity without compromising algorithmic optimality and completeness.

(8 Marks)

5. (a) Explain the following terms as they apply to ***fuzzy logic***:

- Membership Functions **(4 Marks)**
- Hedges **(4 Marks)**

(b) A college has created a result forecasting system based on fuzzy logic that computes a percentage based on input values of course difficulty and CAO points. **Figures 3, 4 and 5** below depict fuzzy sets that describe the linguistic variables *course*, *points* and *result* respectively that are used by the forecasting system. The universe of discourse ranges from 0 – 10 for the variable *course* and from 200 – 600 for the variable *points*. The linguistic variable *result* has a universe of discourse spanning the range 0-100%.

The following three rules describe the reasoning used by a fuzzy inference system for computing a percentage *result* for the inputs *course* and *points*:

- If *course* is *difficult* and *points* is *not high* then *result* is *poor*
- If *course* is *easy* then *result* is *good*
- If *course* is *normal* and *points* is *average* then *result* is *mediocre*

Compute, using the **Mamdani** inference method and a **Right-Most-Max** defuzzifier, the predicted result for a student with **450** points that has taken a course rated with a level of difficulty of **6.5**. Your answer should clearly show each step in the fuzzy inference process.

(17 Marks)

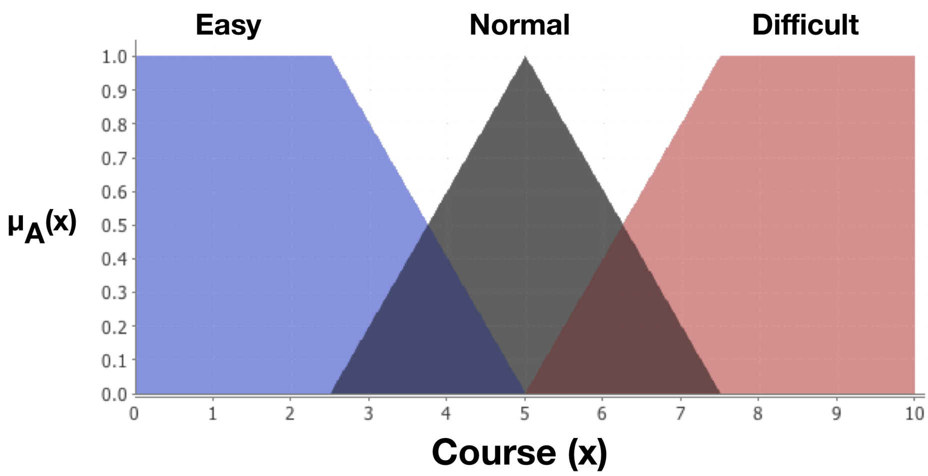

Fig. 3: *Fuzzy sets for the variable Course*

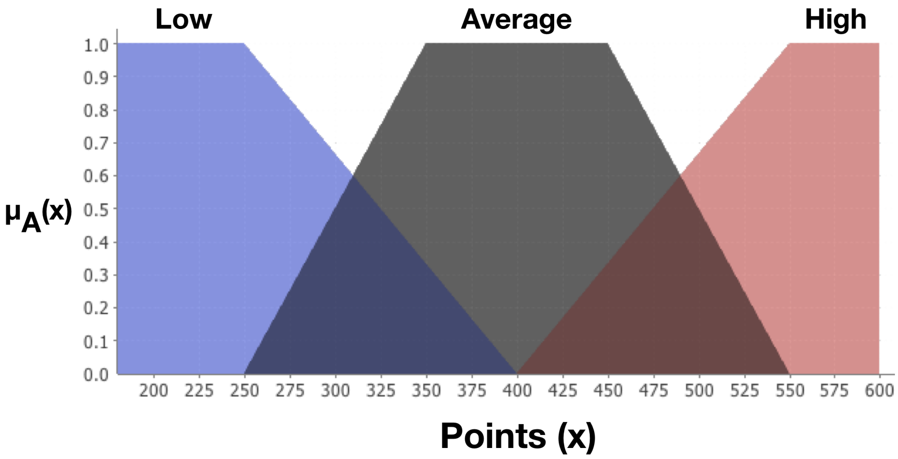

Fig. 4: *Fuzzy sets for the variable Points*

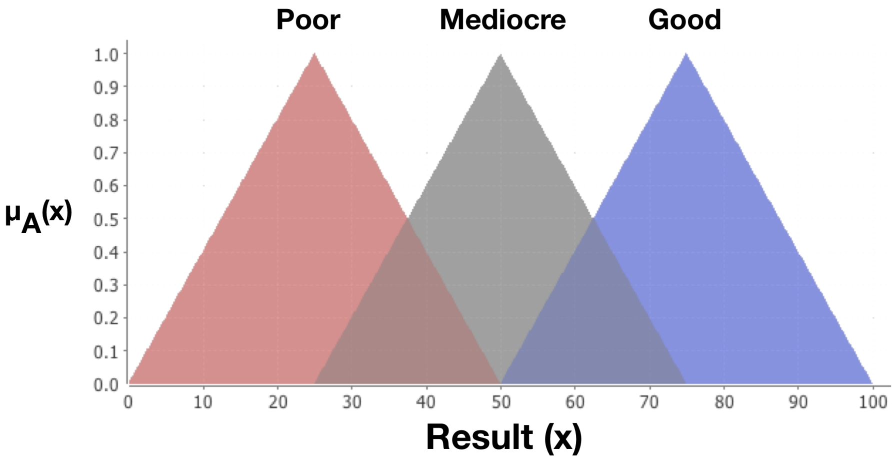

Fig. 5: *Fuzzy sets for the variable Result*