GMIT
INSTITIÚID TEICNEOLAÍOCHTA NA GAILLIMHE-MAIGH EO
GALWAY-MAYO INSTITUTE OF TECHNOLOGY

GALWAY- MAYO INSTITUTE OF TECHNOLOGY

SEMESTER 2 EXAMINATIONS 2015/2016

MODULE: COMP08016 – ARTIFICIAL INTELLIGENCE

PROGRAMME(S):

GA_KSOFG_H08 BACHELOR OF SCIENCE (HONOURS) IN SOFTWARE DEVELOPMENT

YEAR OF STUDY: 4

EXAMINERS:

Dr. John Healy	(Internal)
Dr. Michael Schukat	(External)
Mr. Tom Davis	(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
Programmable or text storing calculators, smart phones/watches or any other electronic devices are expressly forbidden in the Examination Hall

---

Requirements for this paper (Please mark (X) as appropriate)

	Log Tables		*Thermodynamic Tables*
	Graph Paper		*Actuarial Tables*
	Dictionaries		*MCQ Only – Do not publish*
	Statistical Tables		*Attached Answer Sheet*
	Bible		

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

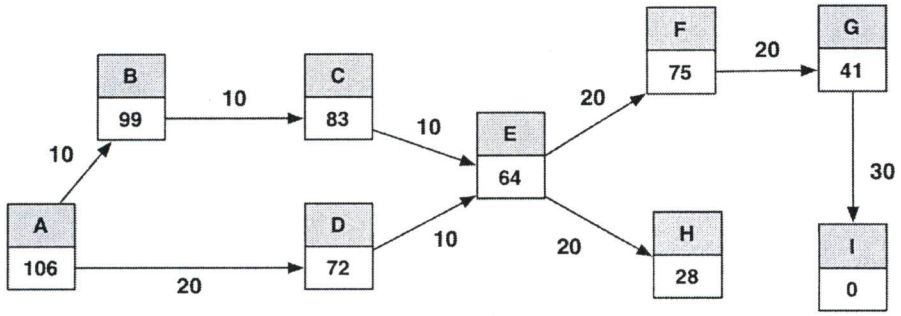

Fig. 1

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

(12 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.

(13 Marks)

2. (a) Explain, using examples, the following terms has they apply to heuristic search:

- Foothills **(4 Marks)**
- Plateaux **(4 Marks)**
- Ridges **(4 Marks)**

(b) Discuss how **steepest-ascent** can overcome the limitations of the basic **hill-climbing** algorithm and contrast hill-climbing with a **best-first** approach. Use diagrams and pseudocode or Java snippets to illustrate your answer.

(13 Marks)

3. **Fig. 2** is an illustration of the state of a tic-tac-toe game board after n alternating plays:

O		X
		O
	O	X

Fig. 2

(a) Assuming that our opponent has made the previous move, **draw the full game tree** showing the combinations for the remaining moves in the game.

(7 Marks)

(b) Label the diagram to show how the **minimax** algorithm can determine the best move to make from the sate in Fig. 2. Your answer should illustrate how MAX and MIN values are computed at each level using the following static evaluation function:

$f(n)$**=[#3-lengths open for MAX] - [#3-lengths open for MIN]**

where a 3-length is a complete row, column or diagonal.

(6 Marks)

(c) Discuss, using an example, how **alpha-beta pruning** can be applied to reduce the number of nodes to be evaluated in a game tree. Your answer should also address the effectiveness of the alpha-beta pruning algorithm and the factors that influence its performance.

(12 Marks)

4. (a) Explain, using a fully labelled diagram, the structure and function of a **neuron** and a **perceptron**.

(12 Marks)

(b) Explain the difference between **supervised** and **unsupervised** learning in a neural network and discuss how a perceptron can be **trained** to learn basic tasks.

(13 Marks)

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

- Membership Functions **(5 Marks)**
- Hedges **(5 Marks)**

(b) **Figures 3, 4 and 5** below depict fuzzy sets that describe the variables **salary**, **mortgage** and **tax** respectively. The universe of discourse ranges from 0 – 10 for the variables salary and mortgage and from 0-100% for the variable tax. The following three rules describe the reasoning used by a fuzzy inference system for computing the rate of tax to be paid for the inputs salary and mortgage:

1. IF **salary** IS NOT **high** AND **mortgage** IS VERY **large** THEN **tax** IS **low**

2. IF **salary** IS **high** THEN **tax** IS INDEED **high**

3. IF **salary** IS NOT **average** OR **mortgage** IS EXTREMELY **large** THEN **tax** IS MORE OR LESS **low**

Compute, using the **Sugeno inference** method, the crisp value of tax rate to be paid for the inputs Salary=6 and Mortgage=9. Your answer should clear show each step in the fuzzy inference process.

(15 Marks)

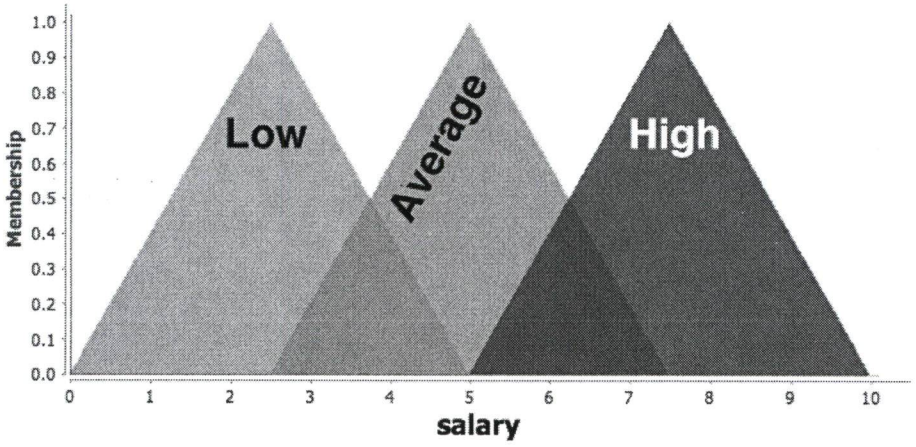

Fig. 3

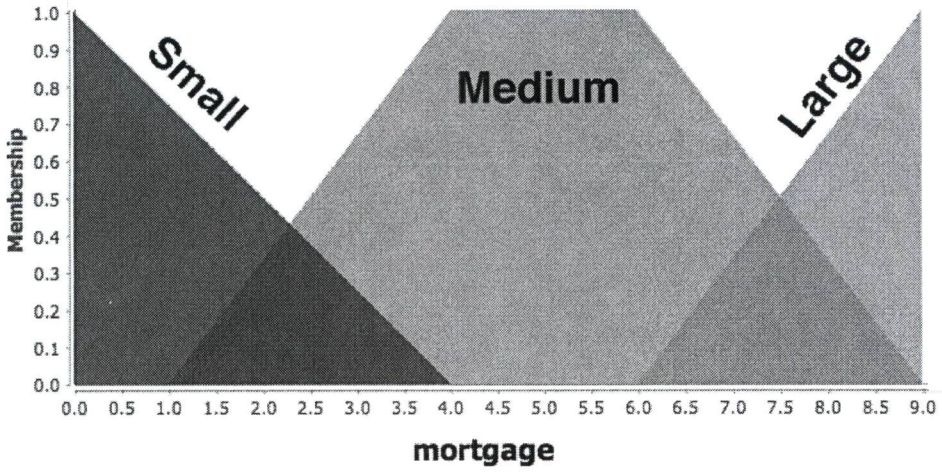
Small
Medium
Large
Membership
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0
mortgage

Fig. 4

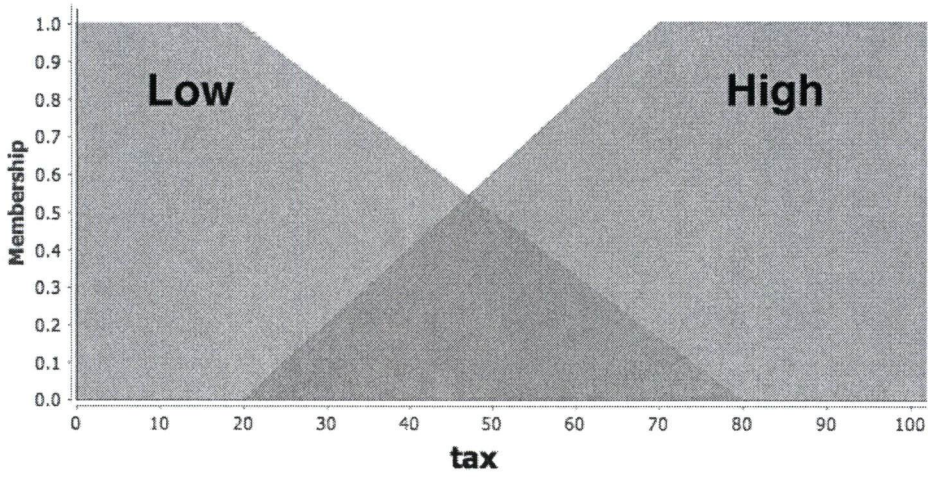
Low
High
Membership
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 10 20 30 40 50 60 70 80 90 100
tax

Fig. 5