UNIVERSITY *of* LIMERICK

OLLSCOIL LUIMNIGH

COLLEGE *of* SCIENCE *and* ENGINEERING

Department of Computer Science
and Information Systems

End of Semester Assessment Paper

Academic Year:	2007/2008	Semester:	Spring
Module Title:	Intelligent Systems	Module Code:	CS4006
Duration of Exam:	2½ Hours	Percent of Total Marks:	80
Lecturer(s):	Dr. M. Eaton	Paper marked out of :	80

Instructions to Candidates:

- Answer any FOUR questions.
- All questions carry equal marks.
- 20% in-term assessments 80% this exam

Q1. a) Specify the components of the ***Threshold Logistic Unit***, and the components of a natural neuron that they model. Illustrate how a TLU can be used to compute the following Boolean Functions

1. P AND Q
2. NOT Q
3. (P OR Q) AND NOT R

10 Marks

b) What is a genetic algorithm? What are the basic operators associated with genetic algorithms? Outline the mathematical foundations of the field of genetic algorithm research, demonstrating that short defining length, low order, above average schemata receive exponentially increasing trials as generations progress. What is this fundamental result known as?

10 Marks

Q2. a) Briefly describe the operation of the best-first search algorithm. By generating the values of f(n) for each state as specified below, perform a best-first search of the 8-puzzle graph going from the given start state to the goal state, showing the successive stages of open and closed states that generate this graph.

f(n) = g(n) + h(n) where

g(n) = level of the search tree
h(n) = number of tiles out of place

Start state:

2	8	3
1	6	4
7		5

Goal state:

1	2	3
8		4
7	6	5

14 Marks

b) Is the heuristic h(n) used in the previous section admissible? Why?

Briefly outline a proof that all A* algorithms are admissible.

6 Marks

Q3. a) Describe the POE model of bio-inspired intelligent systems explaining the function of each of the three axes in this model. Outline how POE axes can be combined in order to create novel bio-inspired systems.

7 Marks

b) Using the heuristic function E(n) = M(n) - O(n) where

M(n) = 3A + B, and O(n) = 3C + D

where

A = number of lines with two X's (and no O)
B = number of lines with one X (and no O)
C = number of lines with two O's (and no X)
D = number of lines with one O (and no X)

e.g. for the position

	O	
X	X	

A=1, B=3, C=0, D=1 and E(n) = 5

Apply two-ply minimax (your move and the response of your opponent) to the opening move of tic-tac-toe (noughts and crosses) to obtain your first move and the expected response. Ensure that all nodes on your graph are clearly and correctly labelled.

13 Marks

Q4. a) What is an Expert System? Outline and describe its components. Describe the ways in which inferences can be drawn in an Expert System, and how the designers of expert systems try to cope with *uncertainty* in the data and inference rules used by these systems.

12 Marks

b) Given the facts

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suckles young, warm-blooded, lives in sea, hind flippers
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And the following rules:

1. *eats meat* → ***carnivore***

2. *suckles young* ***and*** *warm-blooded* → ***mammal***

3. *hind flippers* → ***pinniped***

4. *pinniped* ***and*** *mammal* → ***seal***

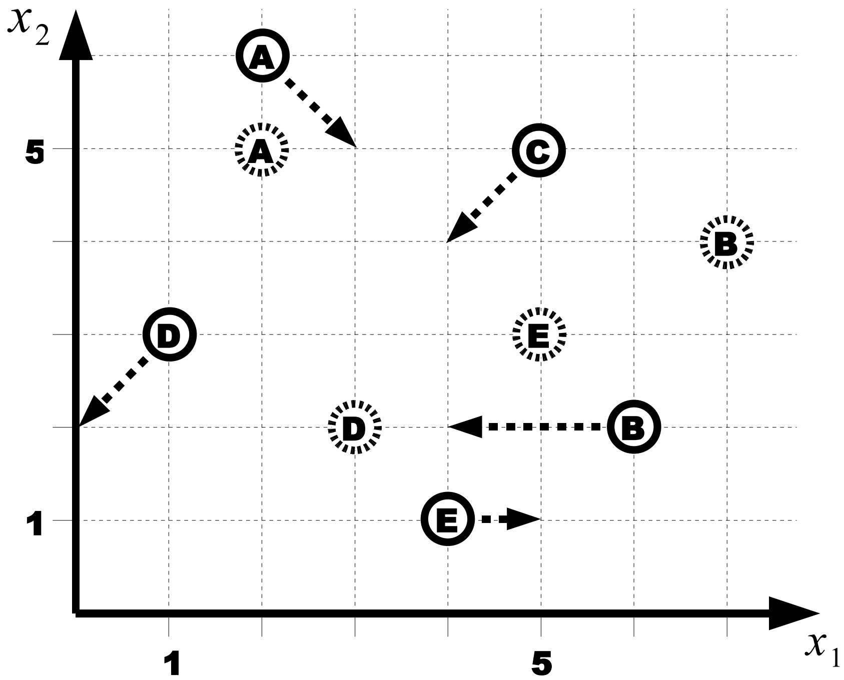
5. ***not*** *warm-blooded* ***and*** *lives in sea* → ***fish***

Apply the inference mechanism you have described in the previous section in a forward fashion to establish the identity of the facts

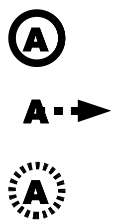
8 Marks

Q5. We want to find the minimum of the function $f(x,y)=(x-2)^2+(y-2)^2-xy$ with a particle swarm optimization algorithm.

We consider a swarm of 5 particles A,B,C,D, and E. After a few iterations, the swarm state is shown on the figure below (note that the best position seen by particle C is the same as its current position).



Reading information on particle A:



Current position (2 ; 6)

Current velocity (1 ; -1)

Best position (2 ; 5)

The parameters of the swarm are:

$w = 0.5$

$c_1 = c_2 = 2$

The (pseudo) random numbers generated by the computer are given in the following order:

$r_1 = [0.1; 0.6; 0.8; 0.9; 0.3; 0.2; 0.5; 0.4; 0.1; 0.8; 0.0; \ldots]$

$r_2 = [0.5; 0.4; 0.7; 0.2; 0.6; 1.0; 0.4; 0.1; 0.5; 0.7; 0.2; \ldots]$

The update rule, in case you forgot, is for the *i*-th component of particle A:

$$v_{i,new}^A = w v_{i,old}^A + r_1 c_1 (\overline{x^A}_i - x_i^A) + r_2 c_2 (\overline{x^G}_i - x_i^A)$$

$$x_{i,new}^A = x_{i,old}^A + v_{i,new}^A$$

where:

x_i^A is the *i*-th component of the current position of particle A

$\overline{x^A}_i$ is the *i*-th component of the best position of particle A

v_i^A is the *i*-th component of the velocity of particle A

G is the best neighbour of particle A

a) Find the new position of the particle B in case of a global-best model, i.e. when every particle knows the best position of all others. Detail the calculation.

7 Marks

b) Find the new position of the particle B in case of a local-best model, with ring topology*.

(* the particles are connected this way: E<->A<->B<->C<->D<->E<->A)

7 Marks

c) This function is unimodal, should the global-best algorithm perform better than the local-best, why?

6 Marks