



**UNIVERSITY OF COLOMBO, SRI LANKA**



**UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING**



**DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)**  
*Academic Year 2006/2007 – 3<sup>rd</sup> Year Examination – Semester 5*

***IT5302: Intelligent Systems***  
***Structured Question Paper***  
**25<sup>th</sup> March 2007**  
**THREE HOURS**

**To be completed by the candidate**

BIT Examination Index No: .....

**Important Instructions:**

- The duration of the paper is **3 (Three) hours**.
- The medium of instruction and questions is English.
- This paper has **4 questions** and **16 pages**.
- **Answer ALL questions. Each of the four questions carries 25 marks.**
- **Write your answers** in English using the space provided **in this question paper**.
- Do not tear off any part of this answer book. Under no circumstances may this book, used or unused, be removed from the Examination Hall by a candidate.
- Note that questions appear on both sides of the paper.  
If a page is not printed, please inform the supervisor immediately.

**Questions Answered**

Indicate by a cross (X), e.g.  the question numbers of the questions answered.

<b>To be completed by the candidate by marking a cross (X).</b>	1	2	3	4	
To be completed by the examiners:					

1) (a) Briefly describe what is meant by Strong AI.

(02 marks)

**ANSWER IN THIS BOX**

Strong AI is a school of thought which claims that machines can be made to think.

For example, a machine that exhibits intelligent behavior is regarded as having real understanding.

(b) Name the experiment that was used to promote the idea of strong AI.

(01 mark)

**ANSWER IN THIS BOX**

Turing test

(c) Define the term 'performance measure'.

(02 marks)

**ANSWER IN THIS BOX**

This is the criteria used to judge how well an agent acts with respect to time, space, optimality and completeness.

(d) Why is a human not an ideal rational agent?

(02 marks)

**ANSWER IN THIS BOX**

**Because humans make mistakes**

(e) Naughts and crosses (tic-tac-toe) can be described as having an accessible, deterministic, static and discrete environment. What does this mean?

(08 marks)

**ANSWER IN THIS BOX**

**Accessible – The squares that have been marked are visible to the players.**

**Deterministic – A move effects the decision of the next move by the opponent.**

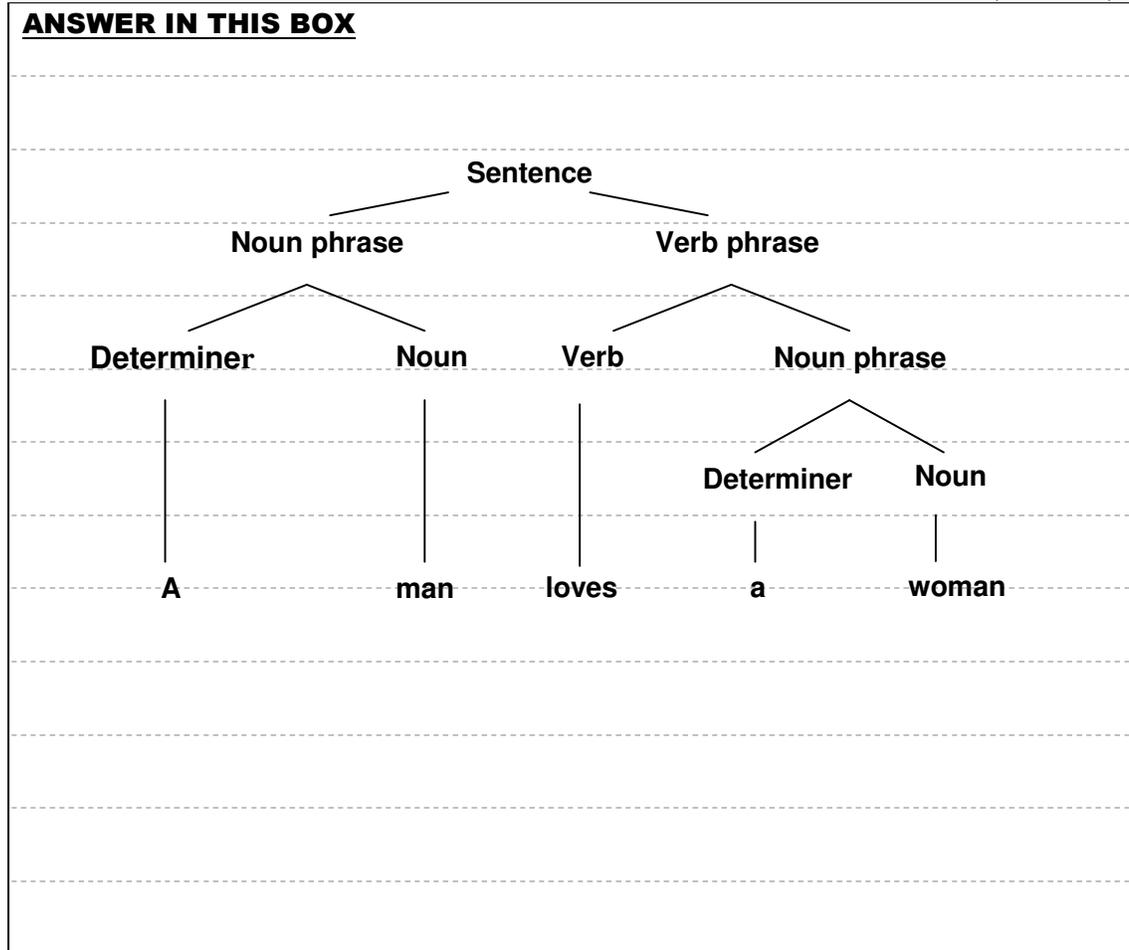
**Static – Except by a move, the configuration of the symbols placed in the squares do not change.**

**Discrete – Each player takes turns in independent time slots.**

(f) Draw a parse tree for the sentence 'A man loves a woman' using the following grammar:

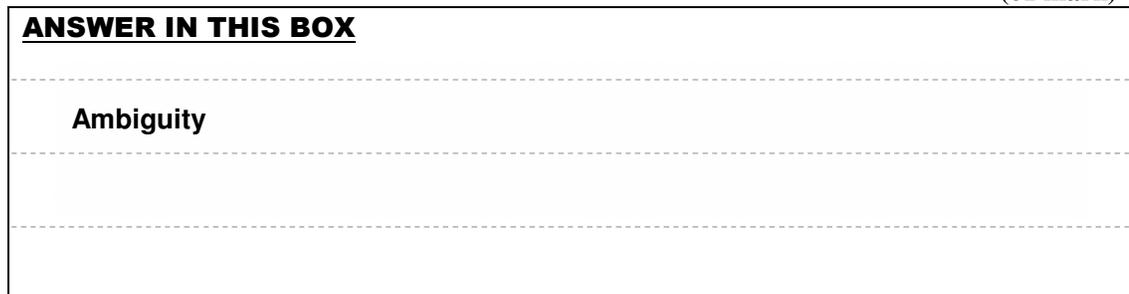
- sentence → noun phrase + verb phrase
- verb phrase → verb + noun phrase
- noun phrase → determiner + noun
- determiner → a
- noun → woman
- noun → man
- verb → loves

(03 marks)



(g) Consider the sentence 'Flying planes are dangerous'. What is the problem with representing this in natural language?

(01 mark)



(h) Justify your answer in part (g) above using examples.

(02 marks)

**ANSWER IN THIS BOX**

Two interpretations are possible:

(1) The act of flying planes is dangerous.

(2) Planes which fly are dangerous.

(i) How can we overcome this problem in artificial intelligence?

(02 marks)

**ANSWER IN THIS BOX**

By using a formal language to represent the semantics of the expression

(j) Define the term 'context free grammar'.

(02 marks)

**ANSWER IN THIS BOX**

A formal grammar in which every production rule is of the form  $V \rightarrow w$

where  $V$  is a non-terminal symbol and  $w$  is a string consisting of terminals

and/or non-terminals

2) (a) Represent the following first order logic statements in Prolog.

*Likes ( Mala, Sumana)*  
*Mother ( Mala, Kamala)*  
 $\forall x, y \text{ Mother } (X, Y) \rightarrow \text{Likes } (X, Y)$   
 $\forall x, y \text{ Mother } (Y, X) \rightarrow \text{Likes } (X, Y)$

(04 marks)

**ANSWER IN THIS BOX**

**likes (mala, sumana).**

**mother\_of (mala, kamala).**

**likes (X,Y) :- mother\_of (X,Y).**

**likes (X,Y) :- mother\_of (Y,X).**

(b) Consider the following Prolog code fragment.

`fun1([],[]).`  
`fun1([H|T],L2):- fun1(T,L),fun2(L1,[H],L2).`  
  
`fun2([],L,L).`  
`fun2([H|T],L2,[H|Y]):- fun2(T,L2,Y).`

What will be the output produced for the following input?

Q : `fun1([0,1,2,3,4,5,6,7,8,9],X).`

(03 marks)

**ANSWER IN THIS BOX**

**X = [9, 8, 7, 6, 5, 4, 3, 2, 1, 0].**

(c) Consider an airliner which flies between certain pairs of cities. Following are the distances between certain pairs of cities.

Route	Cities		Distance (km)
1	P	U	11,520
2	Q	U	3,520
3	Q	R	10,400
4	R	P	12,480
5	R	T	12,960
6	P	T	12,800
7	S	Q	8,800
8	S	R	8,640

Assuming that the airliner uses an expert system for route planning, what is the search technique the route planner should be using if the goal is to minimize the distances traveled?

(02 marks)

**ANSWER IN THIS BOX**

Uniform cost search

(d) Justify your answer in part (c) above.

(02 marks)

**ANSWER IN THIS BOX**

Because uniform cost search is optimal and complete

(e) Define the term 'heuristic'.

(02 marks)

**ANSWER IN THIS BOX**

A rule of thumb/general guideline that can be used to solve a problem

- (f) State a suitable heuristic that can be used to solve the problem in part (c) more efficiently. **(02 marks)**

<b><u>ANSWER IN THIS BOX</u></b>
Estimated distance to the destination from every city.

- (g) The following table provides the estimated cost to city P from every node.

City	Cost
P	0
Q	16000
R	12480
S	20000
T	12800
U	11520

- (i) Can we use cost as a heuristic to perform A\* search?  
 (ii) Specify a suitable heuristic function.  
 (iii) Find the optimal route from S to P using the A\* search method.

**(10 marks)**

<b><u>ANSWER IN THIS BOX</u></b>
(i) Yes
(ii) $f(n) = g(n) + h(n)$ , where $g(n)$ is the distance to an adjacent city and $h(n)$ is the estimated cost to the destination from that city
(iii) The algorithm proceeds by evaluating Q and R, which yield the following results: $Q = (8800 + 16000)$ and $R = (8640 + 12480)$ .
R is chosen because $g(n) + h(n)$ is minimum with respect to R.
The algorithm proceeds by evaluating P, T and Q, which yield the
Continued ....

following results: P = (21120 + 0), T (21120 + 12800) and Q (21120 + 16000).

P is chosen as it gives the minimum cost.

Path taken: S, R, P.

- 3) (a) Considering the following description.

*'A student has come to a teacher's place to study. The teacher starts the lesson when he/she is ready. When the teacher finishes the lesson he/she will give some home work.'*

Complete the following script using the information given in the description above.

(06 marks)

**ANSWER IN THIS BOX**

Entry conditions	<b>teacher present, student ready to learn</b>
Result	<b>student learns, teacher gets tired, student gets tired</b>
Props	<b>desk, books, pen</b>
Roles	<b>student, teacher</b>
Scenes	<b>student arrives, teacher teaches, student learns</b>
Tracks	<b>student has to do home work</b>

(b) Express the following first order logic expressions in natural language.

(i)  $\exists X(\text{dog}(X) \rightarrow \sim \text{bark}(X)) \wedge \forall X(\text{dog}(X) \wedge (\text{male}(X) \vee \text{female}(X)))$

(ii)  $\exists X \exists Y [(\text{love}(X,Y) \rightarrow \text{love}(Y,X)) \vee (\text{love}(X,Y) \rightarrow \sim \text{love}(Y,X))]$

**(06 marks)**

**ANSWER IN THIS BOX**

**(i) Although some dogs do not bark they are either male or female.**

**(ii) When someone loves another person that person may or may not love him.**

(c) Define the term 'expert system shell'.

**(02 marks)**

**ANSWER IN THIS BOX**

**Artificial intelligence software which contains general purpose reasoning/explanation techniques, a knowledge-base editor and an user interface.**

(d) If you are given an expert system shell what should be your first step in order to develop an expert system?

(01 mark)

**ANSWER IN THIS BOX**

Construct the knowledge-base

(e) What is the difference between a decision support system and an expert system?

(04 marks)

**ANSWER IN THIS BOX**

A decision support system merely facilitates decision making whereas an expert system solves problems by mimicking an expert while giving explanations.

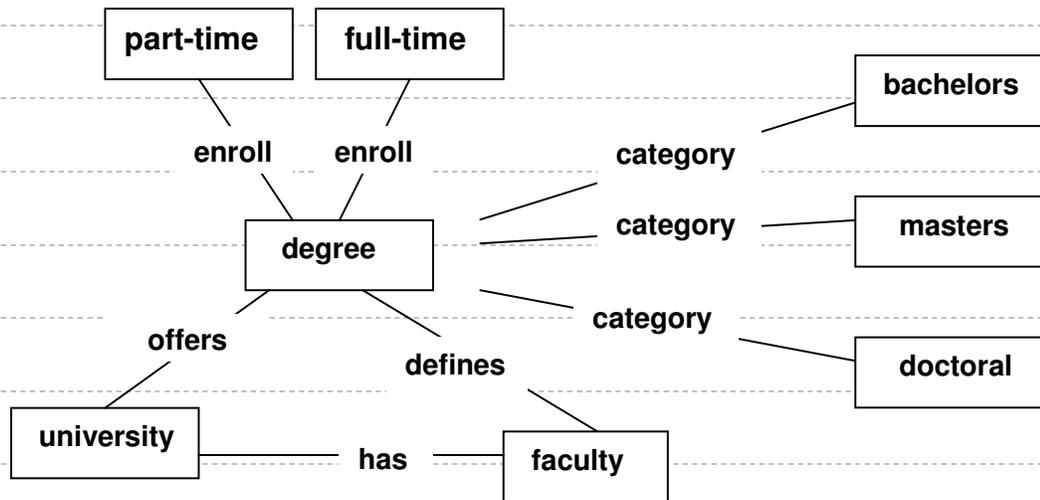
(f) Consider the following scenario.

*'A university offers 3 types of degrees, namely bachelors, masters and doctoral. Generally enrollment is full time, but it could also be part-time. The university has several faculties and these define disciplines for degree programmes.*

Draw a semantic network to represent the above scenario.

(06 marks)

**ANSWER IN THIS BOX**



- 4) (a) In what characteristics are Artificial Neural Networks (ANNs) different from other artificial intelligent tools?

**(04 marks)**

**ANSWER IN THIS BOX**

**(a) Artificial Neural Networks are**

- used to deal with uncertainty.
- used for pattern classification.
- flexible and capable of adjusting to changing environments, i.e. they are able to classify previously unseen patterns, using the knowledge gained through training and learning.
- trained and tested using historical data before being put into use.
- able to disseminate (i.e. use) knowledge gained through the learning and training similar to the function of the human brain.

**(b) Other AI Tools**

- use algorithms (or rule bases), databases (or knowledge bases).
- cannot deviate from the rules defined on them.

(b) Briefly explain the Supervised and Unsupervised Training of ANNs.

(06 marks)

**ANSWER IN THIS BOX**

**Supervised Training**

- Number of classes are known
- Trained for a Target
- Weights are randomly set initially
- For a given input, network output and the target are compared and if they are different the error is calculated
- Weights are updated to minimize the error.

**Unsupervised Training**

- Number of classes is generally not known
- Network itself adjusts to determine the number of classes for a given set of (training) data
- Weights are randomly set and the input is applied
- Strength of each output node is calculated and the highest is determined and trained for the applied input pattern

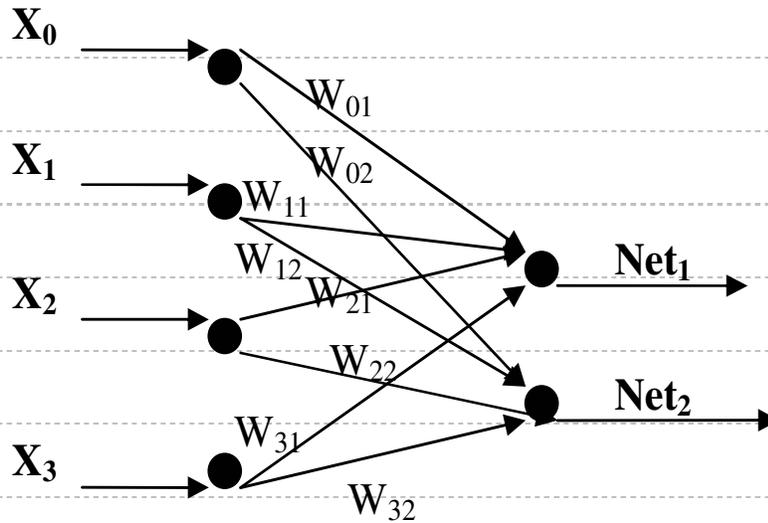
(c) An Unsupervised Neural Network (i.e. a Self Organising Map - SOM) is perfectly trained for the following two input patterns after normalization.

- [0, 1, 1, 0] - Class 1
- [1, 0, 0, 1] - Class 2

(i) Draw a suitable network structure for the above set up.

(06 marks)

**ANSWER IN THIS BOX**



No. of Input Nodes = 4

No. of Output Nodes = 2

8 weights in two vectors

(ii) Determine the weights associated with the two classes after training.

(05 marks)

**ANSWER IN THIS BOX**

Normalized Inputs

$$[0, 1, 1, 0] - [0, 1/\sqrt{2}, 1/\sqrt{2}, 0] = [0, 1/1.4142, 1/1.4142, 0]$$

$$= [0, 0.707, 0.707, 0]$$

$$[1, 0, 0, 1] - [1/\sqrt{2}, 0, 0, 1/\sqrt{2}] = [1/1.4142, 0, 0, 1/1.4142]$$

$$= [0.707, 0, 0, 0.707]$$

Assume inputs 1 and 2 mapped to node 1 and node 2 respectively.

Therefore, trained weights of

$$\text{node for class 1} = [0, 0.707, 0.707, 0],$$

$$\text{node for class 2} = [0.707, 0, 0, 0.707].$$

(iii) To which class patterns will  $[0, 0, 0, 1]$  and  $[1, 1, 1, 0]$  be classified by this network?

(04 marks)

**ANSWER IN THIS BOX**

$$[0, 0, 0, 1]$$

$$\text{Normalized Input} = [0, 0, 0, 1]$$

$$\text{Strength of Output Node 1} = 0$$

$$\text{Strength of Output Node 2} = 0.707$$

Therefore, input belongs to – Node 2 i.e. Class 2

Continued ....

**[1, 1, 1, 0]**

**Normalized Input =  $[1/\sqrt{3}, 1/\sqrt{3}, 1/\sqrt{3}, 0]$**

**= [0.577, 0.577, 0.577, 0]**

**Strength of Output Node 1 =  $0.707 \times 0.577 \times 2$**

**Strength of Output Node 2 =  $0.707 \times 0.577$**

**Therefore, input belongs to – Node 1**

**i.e. Class 1**

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