UNIVERSITY OF COLOMBO, SRI LANKA

UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)
Academic Year 2005/2006 – 3rd Year Examination – Semester 5

IT5302: Intelligent Systems

Structured Question Paper with Model Answers
26th March 2006
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 **19 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 (✕), e.g. [✕] the question numbers of the questions answered.

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

Index No: ……...

1) (a) Name the experiment that promotes the idea of weak AI.

(01 mark)

ANSWER IN THIS BOX

Searle's Chinese Room experiment.

(b) What is the name given to the type of agents which does the correct thing always?

(01 mark)

ANSWER IN THIS BOX

Omniscient.

(c) Can such an agent be implemented? Why?

(03 marks)

ANSWER IN THIS BOX

No, because capturing complete knowledge for every outcome is exhaustive.

(d) Name the 5 types of environment pairs an agent can operate in.

(02 marks)

ANSWER IN THIS BOX

(1) accessible/inaccessible.

(2) deterministic/non-deterministic.

(3) episodic/non-episodic.

(4) static/dynamic.

(5) discrete/continuous.

(e) List the environments of the following applications:

(i) chess
(ii) medical diagnosis

(05 marks)

ANSWER IN THIS BOX

(i) accessible, deterministic, static(semi-static when played with a clock) and discrete.

(ii) inaccessible, non-deterministic, non-episodic, dynamic and continuous.

(f) What characteristic of natural language does formal languages try to avoid?

(01 mark)

ANSWER IN THIS BOX

Ambiguity.

(g) Consider the sentence "John saw the girl with a telescope". How many different interpretations of this sentence are possible? What are they?

(03 marks)

ANSWER IN THIS BOX

2.

John used a telescope to see a girl.

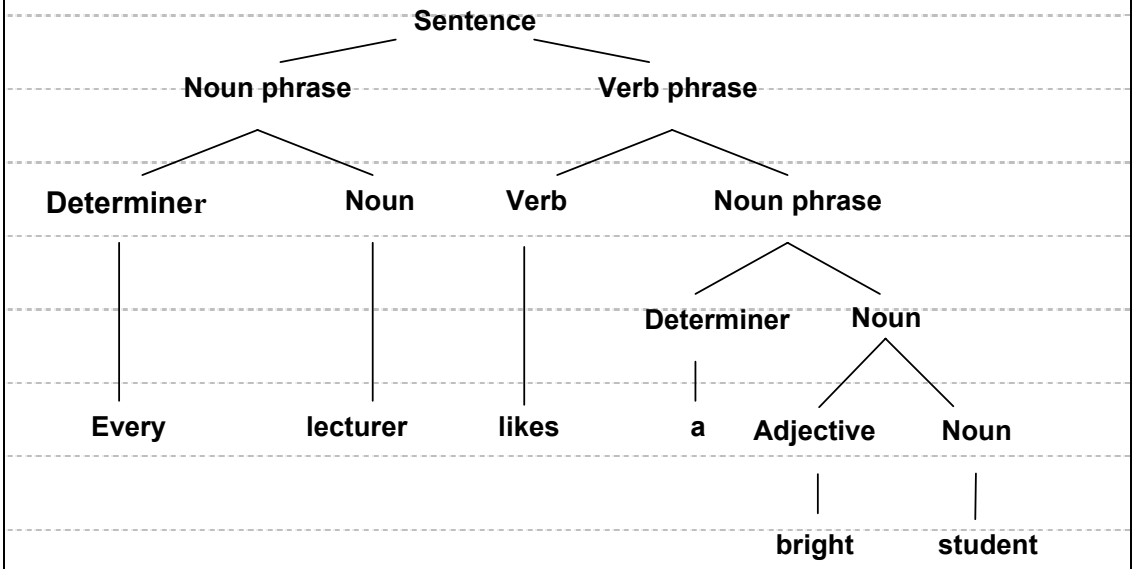
John saw a girl carrying a telescope with her.

(h) Draw the parse tree for the sentence '**Every lecturer likes a bright student',** using the following grammar:

sentence → noun phrase + verb phrase.
verb phrase → verb + noun phrase.
noun phrase → determiner + noun.
noun → adjective + noun.
determiner → a.
determiner → every.
noun → lecturer.
noun → student.
noun → course.
adjective → bright.
verb → teaches.
verb → likes.

(06 marks)

ANSWER IN THIS BOX



(i) At what level of natural language processing does the different interpretations arise?

(01 mark)

ANSWER IN THIS BOX

Semantic analysis.

(j) What is the class of automata needed to pass sentences of the form $a^n b^n c^n$? To what category of grammar does this type of sentences belong?

(02 marks)

ANSWER IN THIS BOX

Linear bound automata.

Context sensitive.

2) (a) Consider the following set of facts and rules in Prolog.

```
likes(mala,sunil).
mother_of(mala,amal)
likes(X,Y) :- mother_of(X,Y).
likes(X,Y) :- likes(Y,X).
```

What will be the output of the following query?

likes(amal,mala)

(01 mark)

ANSWER IN THIS BOX

Yes.

(b) Trace the steps followed by the Prolog interpreter to derive the answer for part (a) above.

(06 marks)

ANSWER IN THIS BOX

Suppose,

F1 = likes(mala,sunil).

F2 = mother_of(mala,amal).

R1 = likes(X,Y) :- mother_of(X,Y).

R2 = likes(X,Y) :- likes(Y,X).

Match with F1 fails.

Match with F2 fails.

Match with the R2 fails with substitution likes(X = amal,Y = mala) :- mother_of(X = amal,Y = mala).

Match with R2 fails with substitution likes(X = amal,Y = mala) :- likes(Y = mala,X = sunil)

but succeeds with substitution likes(X' = mala,Y' = amal) :- mother_of(X = mala,Y = amal).

(c) What is the search mechanism used in Prolog?

(01 mark)

ANSWER IN THIS BOX

Depth first search.

(d) Consider the following Prolog code.

```
fun([], L, L).
fun([H|T], L2, [H|Y]) :- fun(T, L2, Y).
```

What will be the output produced for the following input?

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

(06 marks)

ANSWER IN THIS BOX

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

(e) Suppose a robot is about to enter a maze about which it has no information. The robot has the goal of finding the EXIT of the maze starting from the ENTRANCE with minimum effort. What is the best searching technique the robot should utilize if it wants to save fuel? Justify your answer.

(03 marks)

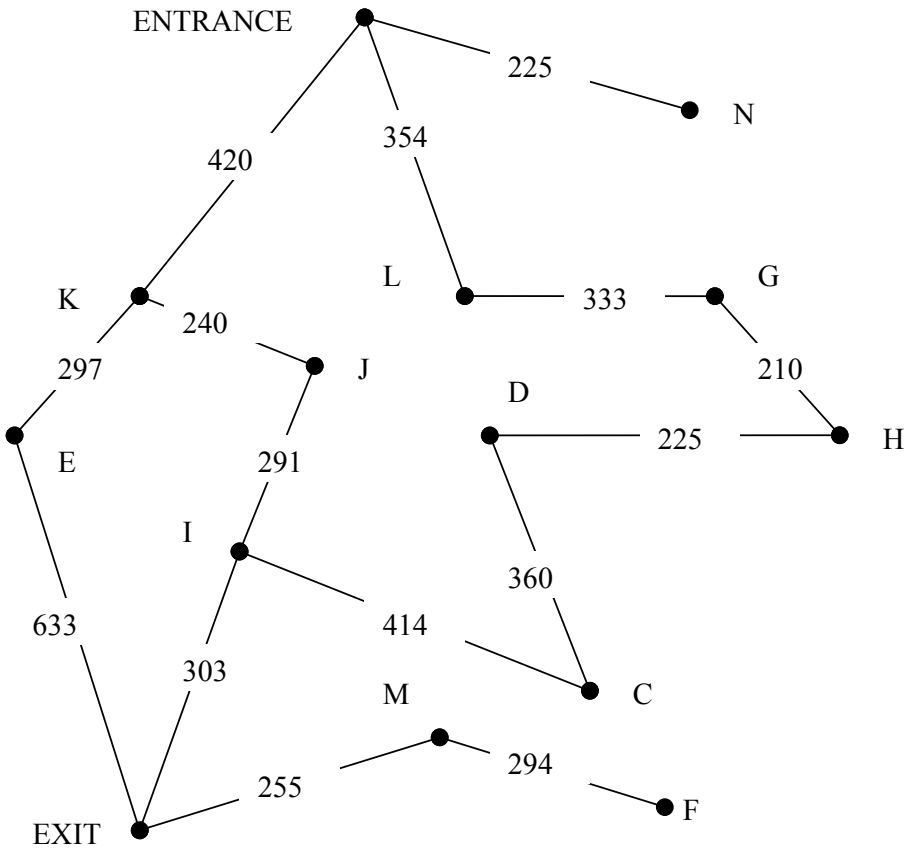
ANSWER IN THIS BOX

Depth first search.

This is because it avoids repeating moves through the maze.

(f) Consider the following tabulated information about the distances between the junctions of the maze and the corresponding roadmap illustrated graphically.

Route	Junctions		Distance in meters between junctions
1	ENTRANCE	N	225
2	L	G	333
3	H	D	225
4	C	I	414
5	EXIT	M	255
6	ENTRANCE	K	420
7	E	EXIT	633
8	J	I	291
9	ENTRANCE	L	354
10	G	H	210
11	D	C	360
12	I	EXIT	303
13	M	F	294
14	K	E	297
15	K	J	240



What is the most optimal search technique the robot can use?

(01 mark)

ANSWER IN THIS BOX
Uniform cost search.

(g) Is the search you gave as the answer for part (f) above optimal?

(01 mark)

ANSWER IN THIS BOX
Yes.

(h) Is the search you gave as the answer for part (f) above complete?

(01 mark)

ANSWER IN THIS BOX
Yes.

(i) Show how greedy search finds the route from ENTRANCE to EXIT, considering the estimated straight-line distances given below as a heuristic.

Straight-line distances from EXIT point to all the other junctions:

Junction	Distance
ENTRANCE	274
C	120
D	181
E	133
F	113
G	183
H	180
I	73
J	144
K	189
L	246
M	60
N	280

(5 marks)

ANSWER IN THIS BOX

Junction K is chosen to visit next, since min_distance{K(189), L(246), N(280)} = 189.

Junction E is chosen to visit next, since min_distance{E(133), J(144), ENTRANCE(274)} = 133.

Finally EXIT is chosen, since min_distance{EXIT(0), K(189)} = 0.

Path = ENTRANCE, K, E, EXIT.

3) (a) (i) State the technique that is used to represent stereotypical information of a scenario?

(ii) Represent the following scenario using the technique you mentioned in part (i) above?

"A mother takes her child to the doctor"

(06 marks)

ANSWER IN THIS BOX

(i) scripts.

(ii)

Entry conditions	**child ill, mother has money, doctor available.**
Result	**child gets well, mother loses money, doctor earns a profit.**
Props	**medicine, medical instruments, examination bed.**
Roles	**mother (brings child, describes illness, pays, takes child out)** **doctor (examines, prescribes medicine, receives payment)**
Scenes	**arriving at reception, waiting in room, examination, paying.**
Tracks	**child needs medicine.** **child needs to get a blood report.**

(b) Express the following two natural language sentences in logic.

(i) Everyone loves everyone who loves them.
(ii) Saman cares for everyone but no one cares for him.

(02 marks)

ANSWER IN THIS BOX

(i) $\forall X \exists Y (love(X,Y) \rightarrow love(Y,X))$.

(ii) $[\forall X (saman(Y) \wedge cares(Y,X))] \wedge [\sim\forall X((saman(Y) \wedge cares(X,Y))]$.

(c) Express the three following logic expressions in natural language.

(i) $\exists X(student(X) \rightarrow \sim bright(X))$
(ii) $\forall X(human(X) \wedge (male(X) \vee female(X)))$
(iii) $[\forall X(god(Y) \wedge loves(Y,X))] \wedge [\exists X(god(Y) \wedge \sim loves(X,Y))]$

(03 marks)

ANSWER IN THIS BOX

(i) Some students are not bright.

(ii) Humans are either male or female.

(iii) God loves everyone but everyone does not love god.

(d) Consider the following argument:

"*An interesting teacher keeps me awake. I stay awake in the maths class. Therefore my maths teacher is interesting.*"

(i) Is this a valid argument?
(ii) Justify your answer for part (i) above using a truth table.

(05 marks)

ANSWER IN THIS BOX

(i) No.

(ii) Consider the following representations for the propositions which follow.

t - My teacher is interesting.

a - I stay awake.
m - I am in maths class.

Continued …

t	a	m	t → a	a ^ m	(t → a) → (a ^ m)	m ^ t	[(t → a) → (a ^ m)] → (m ^ t)
T	T	T	T	T	T	T	T
T	T	F	T	F	F	F	T
T	F	T	F	F	F	T	T
T	F	F	F	F	F	F	T
F	T	T	T	T	T	F	F
F	T	F	T	F	F	F	T
F	F	T	T	F	F	F	T
F	F	F	T	F	F	F	T

(e) Define the term '**expert system'** using one short sentence.

(02 marks)

ANSWER IN THIS BOX

It is a system that emulates the knowledge and the reasoning process of an expert.

(f) Name the 3 basic components of an expert system.

(03 marks)

ANSWER IN THIS BOX

(i) knowledgebase

(ii) interpreter

(iii) user-interface

(g) Using Prolog, construct a knowledgebase to represent the following information.

The mother or father of someone is a parent of that person. Someone's parents or grandparents are his or her ancestors. If some person X is a parent of either the mother or the father of some person Y, then X is a grandparent of Y. Two people are siblings if both have the same mother and the same father.

(04 marks)

ANSWER IN THIS BOX

```
parent(X,Y) :- mother(X,Y).
parent(X,Y) :- father(X,Y).

ancestor(X,Y) :- mother(X,Y).
ancestor(X,Y) :- father(X,Y).

grandparent(X,Z) :- parent(X,Y), parent(Y,Z).

sibling(X,Y) :- mother(M,X), mother (M,Y), father(F,X), father(F,Y).
```

4) (a) What are the similarities and differences between the functions of the human brain and those of an Artificial Neural Network?

(03 marks)

ANSWER IN THIS BOX

Similarities

ANN	Human Brain
• Ability to gather knowledge	
• Knowledge Acquisition through learning and training	
• Knowledge Dissemination	
• Ability for both Supervised and Unsupervised learning/training	
• Ability to behave in changing environments	

Differences

ANN	Human Brain
• Consistent behavior	Consistency not guaranteed
• No decay of memory	Memory decay can happen
• Task Specific	non-task specific

(b) Explain why Artificial Neural Networks (ANNs) are widely used in pattern recognition and classification applications.

(04 marks)

ANSWER IN THIS BOX

Strength of computer vision is characteristic to a human and animal brain which has been evolved over millions of years. Ability of human brain for knowledge acquisition and dissemination through learning and training has no match to

Continued…

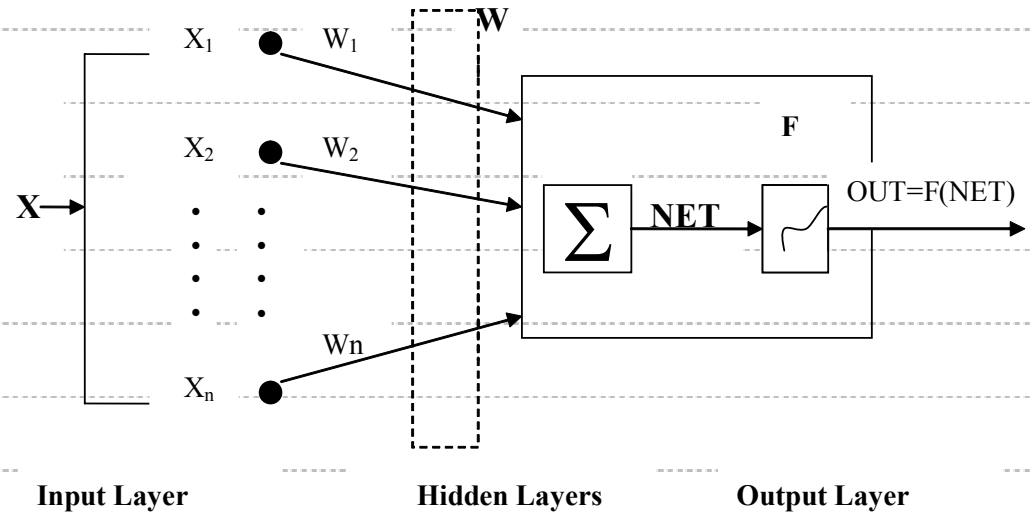
conventional programming techniques. ANNs have been designed to simulate the ability of human brain for knowledge acquisition and dissemination to which computer vision and pattern recognition is closely associated.

(c) A food dispensing machine accepts different currency notes inserted through a slit and releases different types of food depending on the user's selection and the total amount inserted. If a balance is due to the user, a collection of currency notes and coins amounting to the balance is released. In this machine, a scanner captures the image of a currency note and it is identified by a trained ANN. The value of the currency note is then added to the total amount being inserted.

(i) In a clearly labeled block diagram, indicate the function of the ANN component of this device.

(03 marks)

ANSWER IN THIS BOX



(ii) Justify the use of an ANN to identify/classify currency notes in this device.

(03 marks)

ANSWER IN THIS BOX

Even two currency notes which have never been used are not identical. Due to the problems with worn out, deformed and fake notes, recognition of currency notes is a typical pattern recognition application which needs artificial intelligence in automation. Therefore, ANN is a competitive tool, which could be used for the purpose.

(iii) Explain what is meant by a 'Trained ANN'.

(03 marks)

ANSWER IN THIS BOX

Once an ANN is designed, it should be trained to be used for the purpose using a fair sample of data selected from the actual population of data it is going to cope with. Training may be supervised (which is intended for a specific target) or unsupervised (where the network is allowed for self-learning). Once the network is trained, it should be tested to ensure that it performs the classification up to an acceptable accuracy. Such a network, which is ready to be used in the actual environment is known as a trained ANN.

(iv) There are occasions when some currency notes inserted through the slit are rejected. Explain possible reasons for this.

(03 marks)

ANSWER IN THIS BOX

The image of the currency note which is being inserted is captured through a scanner, to which such image should be produced in a standard format. Severely crumpled notes may be rejected. Also notes inserted up-side-down, with wrong end etc. are rejected.

(v) There are extremely rare occasions when some currency notes are misclassified after acceptance through the slit. Explain possible reasons for this.

(03 marks)

ANSWER IN THIS BOX

Although a trained network should be able to recognize its inputs and classify them to the correct class, there may be cases where overlapping between two classes occurs. This is common with the human brain also. When the features extracted from a certain currency not overlaps with those of a currency note from a different class, uncertainty occurs and misclassification may take place.

(vi) Even with the issues such as (iv) and (v) above, how do you justify the continuing usage of such a machine when compared with an equivalent total manual process?

(03 marks)

ANSWER IN THIS BOX

Even the human brain is not guaranteed to perform at 100% accuracy in pattern recognition and classification. Due to various reasons such as strong similarity between two inputs from two different classes and mental status of a human being, errors can occur in human vision. Therefore, errors have to be tolerated to some extent in the performance of the automated system.

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