



UNIVERSITY OF COLOMBO, SRI LANKA



UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING



DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)
Academic Year 2010/2011 – 3rd Year Examination – Semester 5

IT5303: Intelligent Systems
Structured Question Paper with Model Answers
13th March 2011
TWO HOURS

To be completed by the candidate

BIT Examination Index No: _____

Important Instructions:

- The duration of the paper is **2 (Two) hours**.
- The medium of instruction and questions is English.
- This paper has **4 questions** and **16 pages**.
- Each question carries equal marks.
- **Answer all 4 questions.**
- **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.
- **Calculators are not allowed.**

Questions Answered

Indicate by a cross (X), 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:					

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

(02 marks)

ANSWER IN THIS BOX

The school of AI philosophy which claims that machines however smart they are, do not and will not ever have real understanding.

(b) Name and briefly describe the famous experiment which promotes the philosophy of weak AI.

(03 marks)

ANSWER IN THIS BOX

Searle's Chinese Room Experiment

A man who does not understand Chinese provides Chinese answers to Chinese questions using a rule book. The man still passes the Turing Test even though he really does not understand Chinese. As such, mere symbol manipulation does not generate real understanding.

(c) Define the term 'Ideal Rational Agent' using an example.

(02 marks)

ANSWER IN THIS BOX

An Ideal Rational Agent tries to optimize its performance subject to its capabilities.

For example, an expert system which provides medical advice to the best of its perceived knowledge and reasoning capabilities can be considered as an Ideal Rational Agent.

(d) Consider an intelligent agent involved in playing chess. Define the environment of the agent using relevant *environment variables*.

(10 marks)

ANSWER IN THIS BOX

Accessible – The board configuration is visible to the players.

Deterministic – A move determines the move of the opponent.

Static – Except by a move, the configuration on the board does not change.

Discrete – Each player take turns in independent time slots.

Episodic – Each move can be seen as an episode in a continuous time space.

(e) (i) What is meant by a context free grammar? What is its use?

(04 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**

**Context free grammars can be used to parse sentences when processing natural
language.**

(ii) Draw the parse tree for the sentence 'Every man loves a pretty woman', using the following grammar:

sentence \rightarrow noun phrase + verb phrase.

verb phrase \rightarrow verb + noun phrase.

noun phrase \rightarrow determiner + noun.

noun \rightarrow adjective + noun.

determiner \rightarrow a.

determiner \rightarrow every.

noun \rightarrow man.

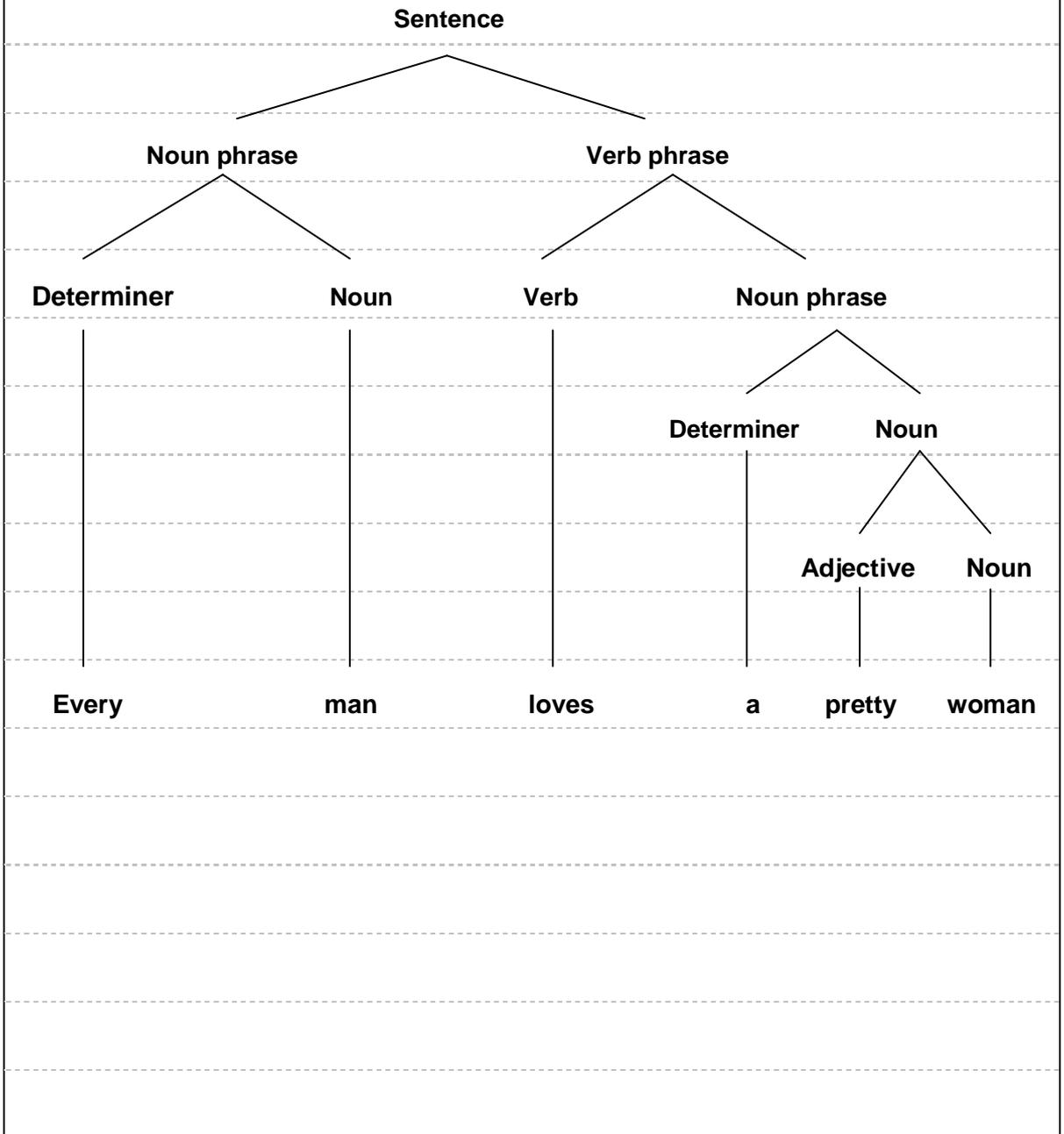
noun \rightarrow woman.

adjective \rightarrow pretty.

verb \rightarrow loves.

(04 marks)

ANSWER IN THIS BOX



2) (a) Code the following statements in Prolog.

- (i) John loves Mary.
- (ii) Mary loves John if Mary is the mother of John and John loves her.
- (iii) Some one is an ancestor of another if he or she is either a parent or a parental predecessor of the other.

(06 marks)

ANSWER IN THIS BOX

(i) `love(john, mary).`

(ii) `love(mary, john) :- mother(mary, john), love(john, mary).`

(iii) `ancestor(X,Y) :- parent(X,Y).`

`ancestor(X,Y) :- parent(Z,Y), ancestor(X,Z).`

(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 by the above program to the following query?

Q : `fun1([a,b,c,d,e,f,g],X).`

(04 marks)

ANSWER IN THIS BOX

`X = [g,f,e,d,c,b,a].`

(c) Name and briefly explain the 4 criteria which define the performance of a search algorithm.

(04 marks)

ANSWER IN THIS BOX

(1) **Completeness** – Algorithm’s ability to find a solution if there is a solution

(2) **Optimality** – Algorithm’s ability to find the best solution

(3) **Time complexity** – Algorithm’s time utilization

(4) **Space complexity** – Algorithm’s memory utilization

(d) Consider a bus service where busses travel between towns. The distances between the towns where the bus service operates are tabulated below.

Towns		Distance in km
A	F	7
B	E	3
B	C	10
C	A	12
C	E	8
A	E	6
D	B	9
D	C	9

(i) Name a suitable search technique to find the least distance route from A to D given the information above.

(01 mark)

ANSWER IN THIS BOX

Uniform Cost Search

(ii) Explain why you think the search technique you named in part (i) above is the best to be used.

(03 marks)

ANSWER IN THIS BOX

The distances between some of the cities are given. As such, an Informed Search Technique has to be used. This rules out all the Uninformed Search Techniques such as Breadth First, Depth First, Depth Limited, Iterative Deepening and Bidirectional. Yet, information that can be used as heuristics is not available. This rules out any use of Heuristic Search Techniques such as Best First and A*.

(iii) Use the search technique you named in part (i) above to find the cities to be visited for a bus from A to D.

(02 marks)

ANSWER IN THIS BOX

From A, E is visited as distance from A to E is the shortest of distances from A to C, E and F. Out of B and C, B is visited because distance $(E+B) < \text{distance } (E+C)$.
From B, D will be chosen as it gives the shortest distance.

(iv) What extra information do you think would have assisted the search for a better route?

(02 marks)

ANSWER IN THIS BOX

If direct distances from each town to D have been given, that information can be used as a heuristic to find a better route.

(v) Name a search technique that can be used to find a better route provided the extra information you stated in part (iv) above has been given.

(01 mark)

ANSWER IN THIS BOX

A*

(vi) Explain how a better solution could have been found using the search technique you named in part (v) above.

(03 marks)

ANSWER IN THIS BOX

A* is an optimal search technique which can be used when the distances between the towns as well as a heuristic such as the direct distance from each node to D is given. A* operates by visiting the town having the minimum $f(n)$ value. $f(n)$ is calculated for each adjacent town by summing the distance with the direct distance.

3) (a) Scripts are a knowledge representation technique that can be used to represent eventual knowledge.

Consider the following description and complete the script that follows.

‘A lecturer enters for a class to deliver a lecture. The class is equipped with desks, chairs, a white-board, marker, computer and projector. The students are provided handouts and are ready to follow the lecture. Before attending the lecture, the students have to register for the lecture by paying a registration fee to the registrar. The students must have completed several prerequisite lectures before following the lecture.’

(06 marks)

<u>ANSWER IN THIS BOX</u>	
Entry Conditions	Students have completed the prerequisites, Students have registered for the course
Result	Student learns, Lecturer completes lecture
Props	Desks, Chairs, Lecture notes, Projector, Computer, Software, White-board, Marker
Roles	Lecturer, Student, Registrar
Scenes	Student registers, Student comes to class, Lecturer come to class, Lecturer provides handouts, Lecturer delivers the lecture, Student learns, Lecturer exits, Students exit
Track	Registration

- (b) List 2 advantages and 2 disadvantages of using Predicate Logic as a knowledge representation technique.

(04 marks)

ANSWER IN THIS BOX**Advantages****Quantification is possible****Logical conclusions can be made****Disadvantages****Can not represent temporal knowledge****Can not represent probabilistic knowledge**

- (c) Express the following sentences in predicate logic.

- (i) All mammals drink milk.
 (ii) There is a fortune behind every successful man.
 (iii) Not all birds may sing but they all do fly.

(06 marks)

ANSWER IN THIS BOX

i. $\forall X (\text{mammal}(X) \rightarrow \text{drink}(X, \text{milk}))$

ii. $\forall X \exists Y [\text{man}(X) \wedge \text{successful}(X) \rightarrow \text{fortune}(Y)]$

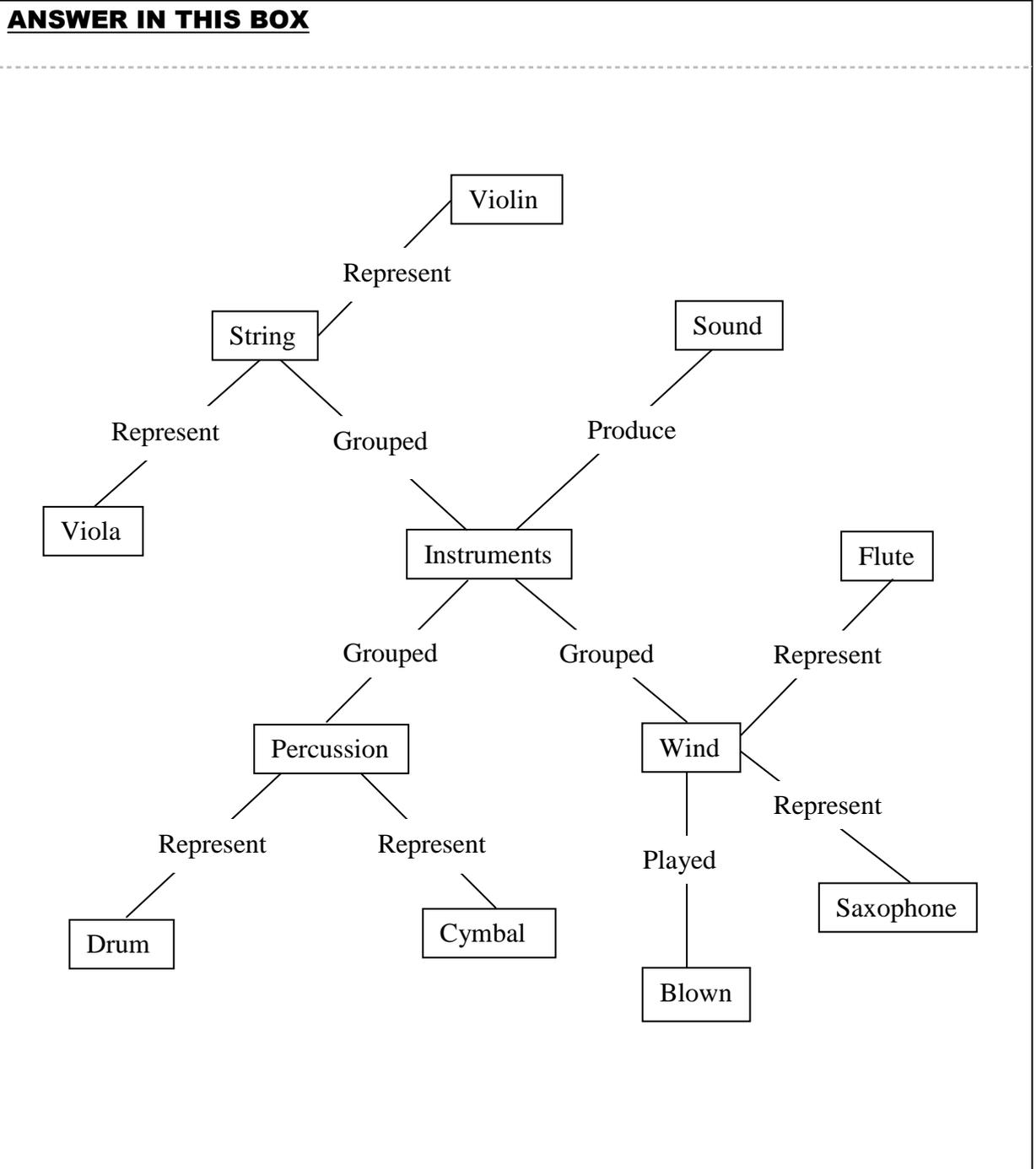
iii. $\exists X (\text{bird}(X) \rightarrow \sim \text{sing}(X)) \wedge \forall X (\text{bird}(X) \rightarrow \text{fly}(X))$

(d) A Semantic Network is a knowledge representation technique used to code factual knowledge.

Draw a Semantic Network to represent the following facts.

“Musical instruments which produce different sounds can be categorized into different groups. The Percussion Family is one such group which represents instruments such as drums and cymbals. The String Family is another such group which represents instruments such as the violin, viola and cello. The Wind Family represents instruments such as flutes and saxophones which are blown to produce sounds.”

(04 marks)



(e) Define the term **Expert System** using a suitable example.

(02 marks)

ANSWER IN THIS BOX

An Expert System mimics the expertise of a human expert.

Examples: An Expert System to diagnose nerve problems using EEG patterns, An Expert System to predict volcanic activity based on sensor readings, An Expert System to schedule flights of a commercial airliner

(f) Briefly describe the 3 main components of an Expert System.

(03 marks)

ANSWER IN THIS BOX

(i) Knowledgebase – The knowledge has to be engineered and stored in some form such as predicates so that the reasoning can function based on it.

(ii) Interpreter – This is the reasoning module. The reasoning is usually based on some search technique. For example, in an Expert System coded in Prolog, Depth First Search is used by its interpreter in a process called Unification.

(iii) User Interface – Through this, the user interacts with the system. The user will be able to issue queries so that the Interpreter can find answers.

- 4) (a) Compare and contrast the most fundamental features that are common to the human brain and Artificial Neural Networks (ANNs).

(05 marks)

<u>ANSWER IN THIS BOX</u>
Similarities: ANN and Human Brain
Ability to gather knowledge
Knowledge acquisition through learning and training
Knowledge dissemination
Ability to both supervised and unsupervised learning/training
Ability to behave in changing environments
Differences: ANN and Human Brain
Consistent behavior, Consistency not guaranteed
No decay of memory, Memory decay can take place.
Task specific, Non-task specific

- (b) Outline the role of the activation function in the error back-propagation algorithm and state any properties that it should have in order to be used in the above algorithm.

(05 marks)

<u>ANSWER IN THIS BOX</u>
Transforms neuron's inputs into output
It can be a hard limiting threshold function or sigmoid function. To use in the back-propagation algorithm, the first derivative of the activation function should exist.

- (c) Explain how an unsupervised learning algorithm learns a concept or updates its knowledge about a domain using training data.

(05 marks)

ANSWER IN THIS BOX

It learns through a clustering process. Each input will be mapped to a closest neuron whose weight value is closer to the input features of the presented pattern.

In an iterative manner, all the input patterns are presented to the unsupervised network and finally neurons will try to map the input space to a output space.

- (d) Explain how Kohonen's self-organizing map (SOM) algorithm can be used as a classification tool.

(05 marks)

ANSWER IN THIS BOX

SOM algorithm cannot be directly used as a classification tool. After unsupervised training, it will cluster the input patterns in the output map and then, one has to use some labeled data and needs to label the output neurons to different classes based on the hit ratio. Once the SOM network is labeled, it can be used as a classification tool.

(e) What is meant by generalization ability of a neural network, and why is it important?

(05 marks)

ANSWER IN THIS BOX

Generalization ability refers to how a network can be trained from a given set of data to predict/classify unseen data samples. The importance here is that, one can get a classification, which is not biased, on the training data
