UNIVERSITY OF COLOMBO, SRI LANKA

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UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)
Academic Year 2009/2010 – 3rd Year Examination – Semester 5

IT5303: Intelligent Systems
Structured Question Paper
28th March 2010
TWO HOURS

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 **15 pages**.

- **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.

- **Non-programmable Calculators may be used**

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).	Question numbers				
	1	2	3	4	
To be completed by the examiners:					

1) (a) State the four categories of Artificial Intelligence.

(04 marks)

> **ANSWER IN THIS BOX**
>
> - Thinking humanly
> - Thinking rationally
> - Acting humanly
> - Acting rationally

(b) Briefly describe the Turing Test.

(04 marks)

> **ANSWER IN THIS BOX**
>
> A human judge engages in a natural language conversation with one human and one machine, each of which tries to appear human. All participants are placed in isolated locations. If the judge cannot reliably tell the machine from the human, the machine is said to have passed the test.

(c) State to which category of AI does the "Turing Test" fall into.

(01 marks)

> **ANSWER IN THIS BOX**
>
> Acting humanly

(d) State the two paradigms/approaches of Artificial Intelligence.

(02 marks)

> **ANSWER IN THIS BOX**
>
> Symbolic AI
> Connectionist AI

(e) Compare and contrast the following two paradigms/approaches of Artificial Intelligence.

(03 marks)

ANSWER IN THIS BOX

	Connectionist AI	**Symbolic AI**
Search	Parallel relaxation	State space traversal
Knowledge representation	Very large number of real valued connections Structures stored as distributed patterns of activation	Predicate logic Semantic networks Frames scripts
Learning	Back propagation Boltzmann machines Reinforcement learning Unsupervised learning	Micro operators Version spaces Explanation based learning discovery

(f) Briefly describe the concept of Weak AI and the concept of Strong AI.

(03 marks)

ANSWER IN THIS BOX

Weak AI:
The weak AI hypothesis states that a machine running a program is at most only capable of simulating real human behaviour and consciousness.

Strong AI:
Strong AI, on the other hand, states that the correctly written program running on a machine actually is a mind -- that is, there is no essential difference between a (yet to be written) piece of software exactly emulating the actions of the brain, and the actions of a human being, including their understanding and consciousness.

(g) State the three main arguments against Weak AI.

(03 marks)

ANSWER IN THIS BOX

- Argument from disability
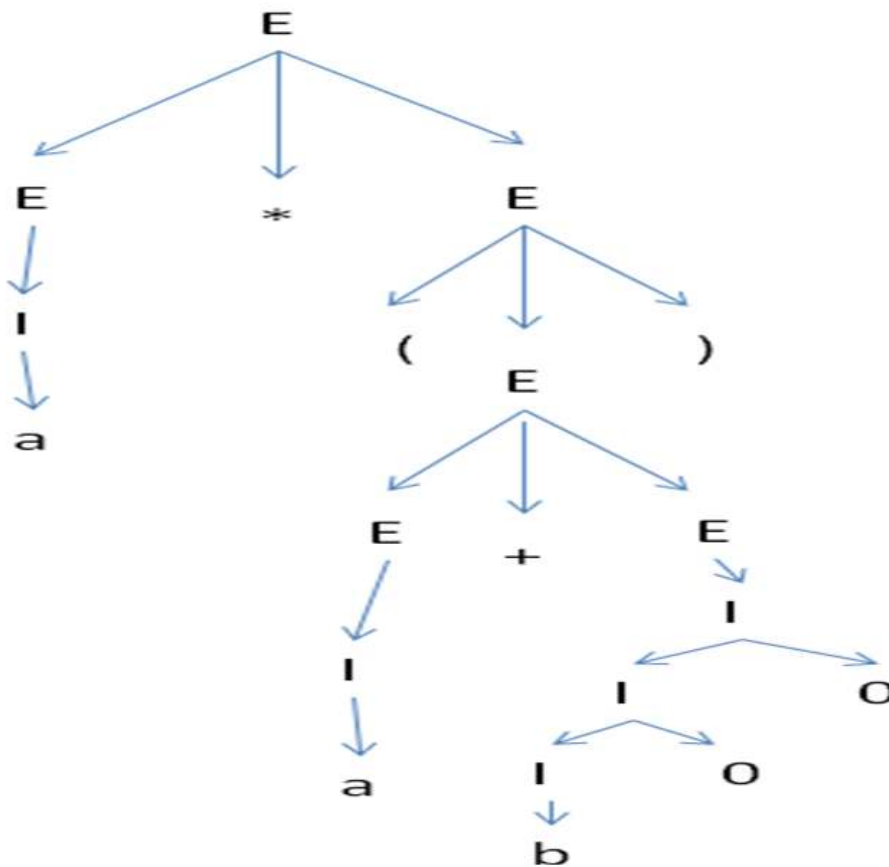- Argument from mathematics
- Argument from informality

(h) Consider the grammar stated formally as G = ({E,I}, T, P, E), where, T is the set of symbols {+,*,(,),a,b,0,1} and P is the set of productions stated below.

$$E \longrightarrow I$$
$$E \longrightarrow E + E$$
$$E \longrightarrow E * E$$
$$E \longrightarrow (E)$$
$$I \longrightarrow a$$
$$I \longrightarrow b$$
$$I \longrightarrow Ia$$
$$I \longrightarrow Ib$$
$$I \longrightarrow I0$$
$$I \longrightarrow I1$$

Derive a parse tree for the string a*(a+b00).

(05 marks)

ANSWER IN THIS BOX

2) (a) Represent the following statements in Prolog.
      (i) Nimal owns a car.
      (ii) X is rich if he/she owns a car.
      (iii) X is the daughter of Y if X is female and Y is a parent of X.

(05 marks)

ANSWER IN THIS BOX

    (i) owns(nimal, car).

    (ii) rich(X) :- owns(X,Y), car(Y).

    (iii) daughter(X,Y) :- female(X), parent(Y,X).

(b) Which of the following are syntactically correct Prolog objects? State whether they are *an atom, a number, a variable or a structure*.
      (i) _x44
      (ii) 'Test_Data'
      (iii) two(Nice (Girls))
      (iv) persondata(name(kamal, perera), date(28, june, 1983))
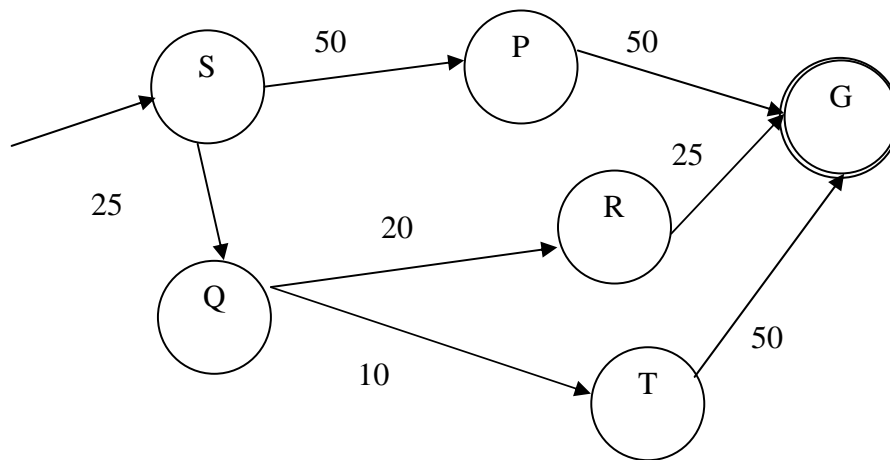
(04 marks)

ANSWER IN THIS BOX

    (i) a variable

    (ii) an atom

    (iii) Syntax error

    (iv) a structure

(c) Consider the following search space where we want to find a path from start state (S) to goal state (G). According to Uniform Cost Search, what is the solution path? Clearly write down the sequence of node expansion.
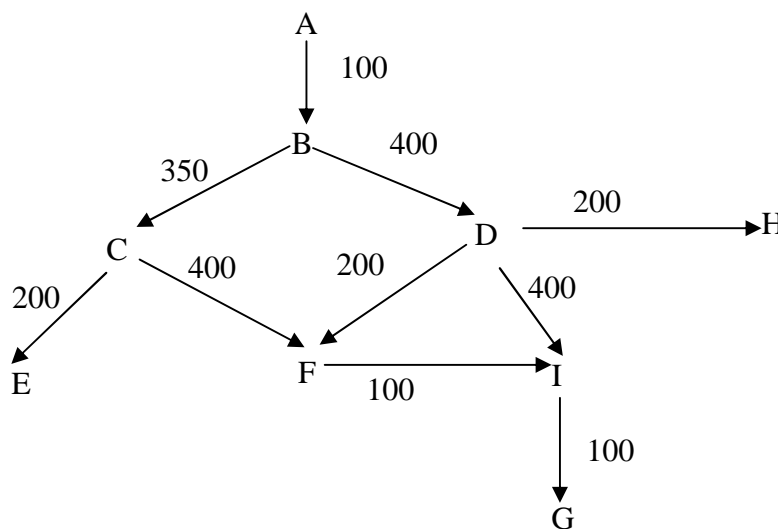

(06 marks)

ANSWER IN THIS BOX

Solution Path: S, Q, R, G

Sequence of nodes expanded: S, Q, T, R, P, G

(d) Consider the flowing graph which shows the distances (in kilometers) between cities on a map.

Estimated cost to town G from every town is given in table 1.

6

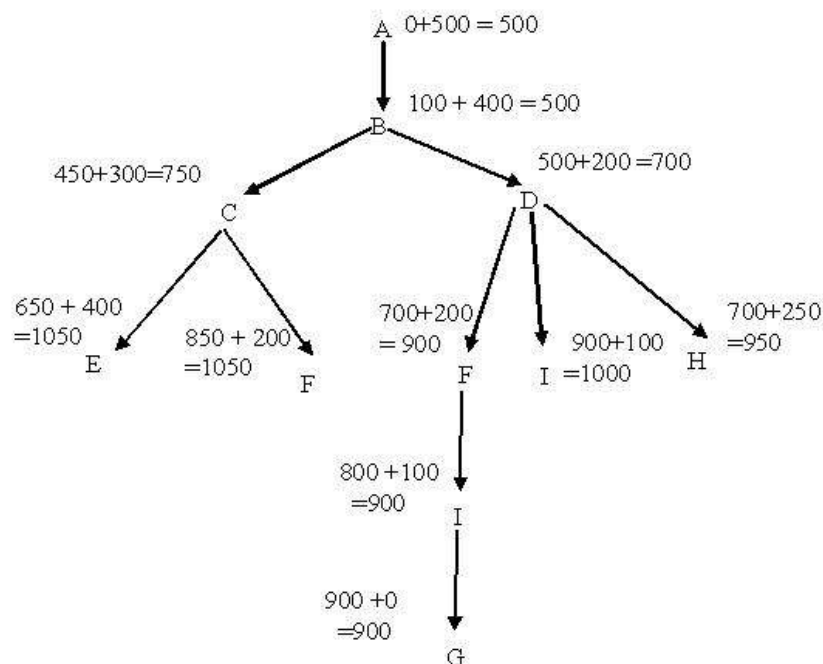| Town	Estimated Cost to Town G (Unit of currency)
A	500
B	400
C	300
D	200
E	400
F	200
H	250
I	100
G	0

Table 1

(i) Define a suitable cost function to perform A* Search.

(ii) Using the A* algorithm, workout a route from A to G using the cost function defined in part (i). Clearly draw the search tree that is produced, showing the cost function at each node.

(iii)Write down the order of node expansion.

(08 marks)

ANSWER IN THIS BOX

(i) $f(n) = g(n) + h(n)$ where $g(n)$ is the distance from the start node to node n and $h(n)$ is the estimated cost from node n to goal state .

(ii) Route : A,B,D,F,I,G

A 0+500 = 500

B 100 + 400 = 500

450+300=750 C

500+200 =700 D

650 + 400 =1050 E

850 + 200 =1050 F

700+200 = 900 F

900+100 I =1000

700+250 =950 H

800 +100 =900 I

900 +0 =900 G

(iii) A, B, D, C, F, I, G

(e) Explain the relationship between Uniform Cost Search algorithm and A* Search algorithm.

(02 marks)

ANSWER IN THIS BOX

Uniform Cost Search (UCS) expands the node n with the lowest path cost g (n).
UCS is complete and optimal, but can be very inefficient. In A* search, we combine
this path cost g(n) with a heuristic h(n) (the cost to get from the node to the goal) to
come up with a evaluation function f(n) i.e.; the estimated cost of the cheapest
solution through n where, $f(n) = g(n) + h(n)$. A* is optimal and complete given that
the heuristic does not overestimate the cost to the goal.

3) (a) *"A customer enters in to a restaurant for lunch. The waiter brings the menu and the customer orders food. Waiter serves the customer and customer eats. If necessary, customer orders take-away. Customer pays the bill and exits"*

Complete the following script using the above description.

(06 marks)

ANSWER IN THIS BOX

Entry Conditions	Customer hungry, customer has money
Result	Customer is not hungry, customer is satisfied, customer has less money
Props	Menu, food, money
Roles	Customer, Waiter
Scenes	Customer enters into the restaurant, waiter brings menu, customer orders food, waiter serves food, customer eats, customer pays the bill, customer exits
Track	Customer orders take-away

(b) State two limitations of propositional logic.

(02 marks)

ANSWER IN THIS BOX

- Cannot represent at sub-sentence level
- Cannot generalize

(c) Express following sentences in predicate logic.
  (i) All students who are doing sports are smart.
  (ii) There is a teacher who gives handouts only to students who are not late to the class.
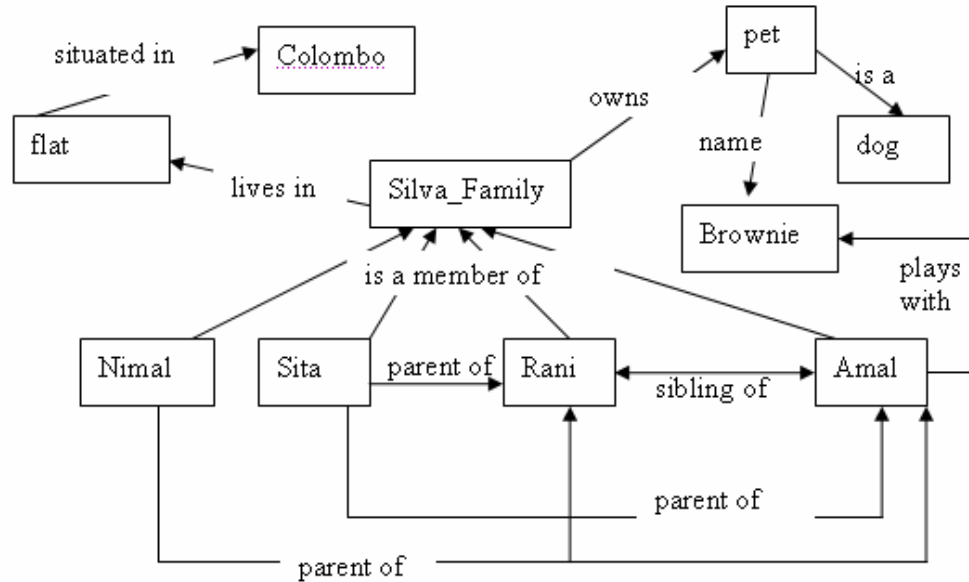
(04 marks)

ANSWER IN THIS BOX

  (i) $(\forall x)$ (student(x) $\wedge$ doing_sports(x)) => smart(x)

  (ii) $\exists x$ teacher(x) $\wedge$ $\forall$ y,z handout (y) $\wedge$ gives(x,y,z) => (student(z) $\wedge$ ~late_to_the_class(z)).

(d)   Draw a semantic network to represent the following scenario.

  "Nimal, Amal, Sita and Rani are members of the Silva family. Amal and Rani are siblings. Nimal and Sita are the parents of Amal and Rani. Silva family lives in a flat situated in Colombo. They own a pet dog whose name is Brownie and Amal plays with Brownie very often."

(06 marks)

ANSWER IN THIS BOX

(e) Define the term *"frame"* in the context of knowledge representation.

(01 marks)

ANSWER IN THIS BOX

"Frame" is the data Structure that includes all the knowledge about a particular object.

(f) What kinds of problems are appropriate for expert systems? Give an example.

(03 marks)

ANSWER IN THIS BOX

Problems which typically require human expertise to solve are appropriate for expert systems.

Example: Medical diagnosis.

(g) State three limitations of an expert system.

(03 marks)

ANSWER IN THIS BOX

- Do not learn by experience
- Cannot easily adapt to new/unusual situations
- Domain experts not always able to explain their logic and reasoning
- Errors may occur in the knowledge base, and lead to wrong decisions
- Cannot refine own knowledgebase

4) (a) List the main differences between an Artificial Neural Network (ANN) and a Human Brain.

(03 marks)

ANSWER IN THIS BOX

ANN	Human Brain
Consistent behaviour	Consistency not guaranteed
No decay of memory	Memory decay can happen
Task specific	Non-task specific

(b)

(i) Briefly explain as to what is meant by linear separability.

(02 marks)

ANSWER IN THIS BOX

Linear separability refers to the property that classes of patterns with n dimensional vector

$X = (x_1, x_2, x_3... x_n)$ can be separated with a single decision surface.

(ii) Sate whether the following problems are linear separable or not.

      (a) Logical AND
      (b) Logical OR
      (c) Logical XOR

(03 marks)

ANSWER IN THIS BOX

      (a) Separable

      (b) Separable

      (c) Not Separable

(c) Consider the four variables p, q, r and s having values within the given ranges.

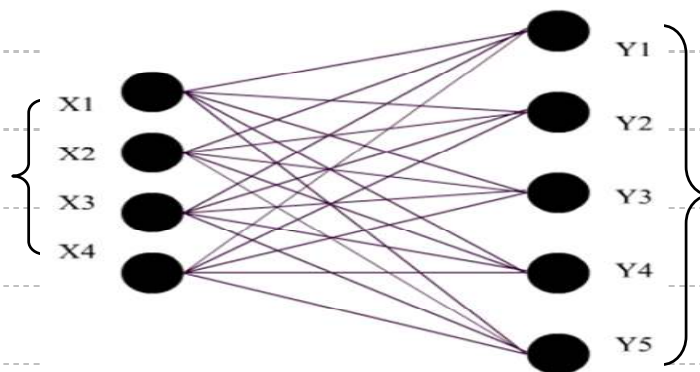$1.0 < p < 1.2$ $1.4 < q < 1.7$ $1.8 < r < 2.0$ $0.7 < s < 1.0$

Suppose that there exist five classes C1, C2, C3, C4 and C5 which can be described as follows.

Class C1	Class C2	Class C3	Class C4	Class C5
p	q	r	s	s
q	r	s	p	r
r	s	p	q	q
s	p	q	r	p

Draw a suitable setup for a neural network if an unsupervised ANN (Self Organizing Map) is used for the classification of the classes mentioned above.

(05 marks)

ANSWER IN THIS BOX

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

 (i) Determine the weight vectors for each class.

- [1 0 0 1] : class C1
- [0 1 0 1] : class C2
- [0 1 1 0] : class C3

(03 marks)

ANSWER IN THIS BOX

Node that recognizes class C1 : [0.7 0 0 0.7]

Node that recognizes class C2 : [0 0.7 0 0.7]

Node that recognizes class C3 : [0 0.7 0.7 0]

(ii) Determine as to which class patterns will the following be classified by this network.

[1 0 0 0]

(01 marks)

> **ANSWER IN THIS BOX**
>
> C1

(e)

(i) Suppose you are given a set of images representing characters in the English alphabet to be recognized using a supervised neural network. Briefly explain the pre processing steps which are necessary.

(03 marks)

> **ANSWER IN THIS BOX**
>
> Make all images the same size.
>
> Bring all images to the same colour (make them black and white)

(ii) List down a set of features which could be used to train a neural network so that it could recognize the given characters of the English alphabet.

(03 marks)

> **ANSWER IN THIS BOX**
>
> Height to width ratio of a character
>
> Black pixel to white pixel ratio

(iii) Comment on the following statement.

"Inserting the whole image of the character to the neural network is much better than trying to select a specific feature and then inserting only that feature into the network"

(02 marks)

> **ANSWER IN THIS BOX**
>
> A feature related to character recognition could be inserted in to the network using very few input nodes whereas, if we use to insert the whole image as pixels to the network, then the network may need a large number of input nodes. Therefore, when the number of input nodes increases it will be very difficult to train the network due to the complexity of the network.

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