UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING
(Successor to the Institute of Computer Technology (ICT))

DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)

Academic Year 2004/2005 – 3rd Year Examination – Semester 5

IT5301: Intelligent Systems

13th March, 2005
(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 **15 pages**.

- **Answer all 4 questions**. All questions carry **equal 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 numbers of the questions answered.

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

1) (a) Describe how the **Turing test** promotes the idea of strong AI.

(08 marks)

> **ANSWER IN THIS BOX**
>
> **Strong artificial intelligence believes that machines could be made to pose real understanding and cognition.**
>
> **The Turing test suggests that irrespective of the mechanism, intelligence could be produced. An entity is regarded as intelligent if it reasons the given problem using accessible knowledge. The mechanism that produces intelligent behavior is not of a concern in this case.**
>
> **Thus, a machine that behaves intelligently by solving given problems is indeed intelligent and possesses understanding according to Turing.**
>
> **This is in fact, the idea that is put forward by strong artificial intelligence.**

(b) What is meant by the term **ideal rational agent** in the context of AI?

(03marks)

> **ANSWER IN THIS BOX**
>
> **An ideal rational agent is one who optimizes performance for every possible percept sequence within its knowledge and the allowable set of actions (Ideal mapping).**

(c) How does a **rational agent** differ from an **ideal rational agent**?

(03 marks)

ANSWER IN THIS BOX

A rational agent does not behave optimally like an ideal rational agent but would behave more intelligently than an agent acting randomly.

(d) Is a human being an ideal rational agent?

(02 marks)

ANSWER IN THIS BOX

No

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

(03 marks)

ANSWER IN THIS BOX

Humans do act intelligently but their performance may not always be optimal.

(f) 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

(g) Neural networks have been established as powerful pattern recognition paradigms in recent years. Draw a labelled diagram of an artificial neuron.
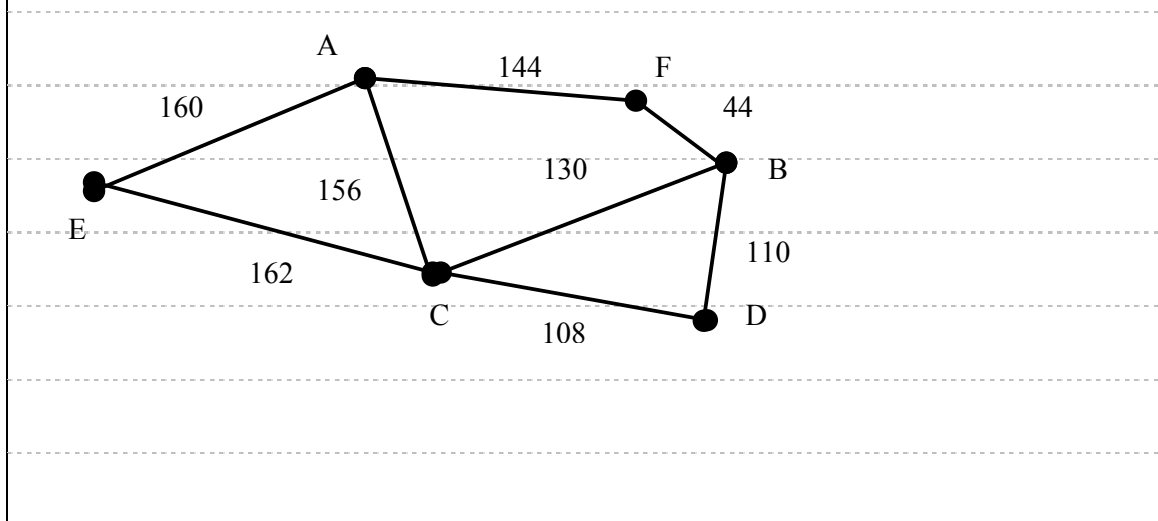
(04 marks)

ANSWER IN THIS BOX

Inputs (X) → | **Input function** $? [X_i]$ | **Activation Function** $Y = F ? [X_i]$ | → **Output (Y)**
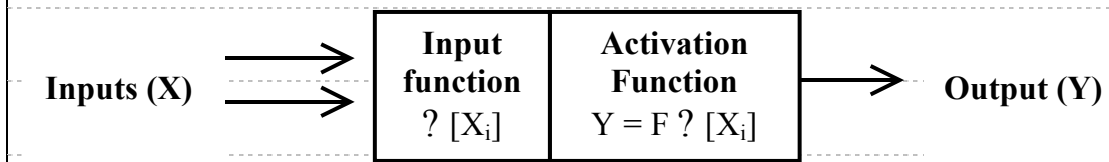
2) (a) The following table shows the distances between pairs of certain cities in a country measured along the routes indicated.

Route	Cities		Distance (km)
1	A	F	144
2	B	F	44
3	B	C	130
4	C	A	156
5	C	E	162
6	A	E	160
7	D	B	110
8	D	C	108

Draw the road map corresponding to the above table.

(03 marks)

ANSWER IN THIS BOX

(b) What would be the most appropriate search technique to plan routes if the objective is to minimize distance?

(02 marks)

ANSWER IN THIS BOX

Uniform cost search

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

(04marks)

ANSWER IN THIS BOX

Because uniform cost search finds the optimal path from start state to the final state given, the cost function is monotonically non decreasing.

(d) Show how your search mechanism in part (b) finds the route from D to A considering distance.

(04 marks)

ANSWER IN THIS BOX

Path taken : D, C, B, F, A

From D, C is chosen because distance (D, C) < distance (D, B). From C the algorithm chooses B because out of the distances (C, E), (C, A) and (C, B), the distance (C, B) has the minimum value. To move forward from B, there are 2 alternatives, D and F. Since distance (B, F) < distance (B, D) the algorithm chooses path (B, F). From F, finally A is chosen making the algorithm to terminate.

(e) List and briefly explain the factors used to evaluate search techniques.

(04 marks)

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ANSWER IN THIS BOX

(1) Completeness (Is the algorithm capable of finding a solution when there is one?)

(2) Optimality (Does the algorithm find the best solution?)

(3) Time complexity (How much time does the algorithm consume?)

(4) Space complexity (How much space does the algorithm consume?)

</div>

(f) Suppose minimizing distance is not an issue in finding a route. List the cities encountered when breadth first search is applied to the problem in (part d) above

(02 marks)

<div style="border:1px solid">

ANSWER IN THIS BOX

D, B, C, F, A or D, C, B, E, A depending on the paths taken.

</div>

(g) The following table provides the estimated cost to town A from each node.

Town	Cost
A	0
B	200
C	156
D	250
E	160
F	144

(i) Can one use cost as a heuristic to perform A* search?
(ii) Specify a suitable queing function for (a).
(iii) Solve the problem using the A* search method.

(06 marks)

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ANSWER IN THIS BOX

(i) Yes

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

Where

</div>

Continued..

h(n) is the heuristic function that estimates to reach goal from node n in the state space and

g(n) is the cost function to reach node n from start node in the state space.

(iii) The algorithm proceeds by evaluating B and C, which yields the following results : B = (110 + 200) and C = (108 + 156) .

C is chosen because g(n) + h(n) is minimum with respect to C.

The algorithm proceeds by evaluating A, E and B, which yields the following results : A = (164 + 0), E (164 + 160) and B (164 + 200).

A is chosen as it gives the minimum cost.

Path taken : D, C, A

3) (a) Giving examples, explain what is meant by a proposition.

(02 marks)

ANSWER IN THIS BOX

A proposition is a statement that is either true or false.

Examples : (1 + 3 is 5, Every human will die) are propositions.

('Sit down') is not a proposition.

(b) Name 3 knowledge representation schemes used in developing expert systems.
What is the most common scheme?
Justify.

(03 marks)

ANSWER IN THIS BOX

(1) Production systems

(2) Frame systems / Semantic networks

(3) Logic

The most common scheme is " production rule-based system" since it is easy to produce and rules are human understandable.

(c) Express the following natural language sentences in predicate logic.

(i). Some mammals can fly.
(ii). Everybody is some woman's child but nobody is every woman's child.
(iii). Kids love animals who are their pets.

(06 marks)

ANSWER IN THIS BOX

(i) ∃X (mammal (X) ^ fly (X))

(ii) [∀X ∃Y (child (X,Y) ^ woman (Y))] ^ [~∀X ∀Y (child (X,Y) ^ woman (Y))]

(iii) ∀X ∃Y (love (X,Y) ^ kid (X) ^ animal (Y) → pets (X,Y))

(d) Fill in the blank boxes in the following truth tables for the indicated sentences of propositional calculus.

(02marks)

ANSWER IN THIS BOX

a	b	(a → b)	(a → b) → a	(b → a)	a → (b → a)
T	T	**T**	**T**	**T**	**T**
T	F	**F**	T	T	T
F	T	**T**	T	F	T
F	F	**T**	**F**	T	T

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(e) Draw the parse tree for the sentence '**The monkey ate the banana'** using the following grammar:

sentence → noun phrase + verb phrase

noun phrase → determiner + noun

verb phrase → verb + noun phrase

determiner → the

noun → monkey

noun → banana

verb → ate

(03 marks)

ANSWER IN THIS BOX
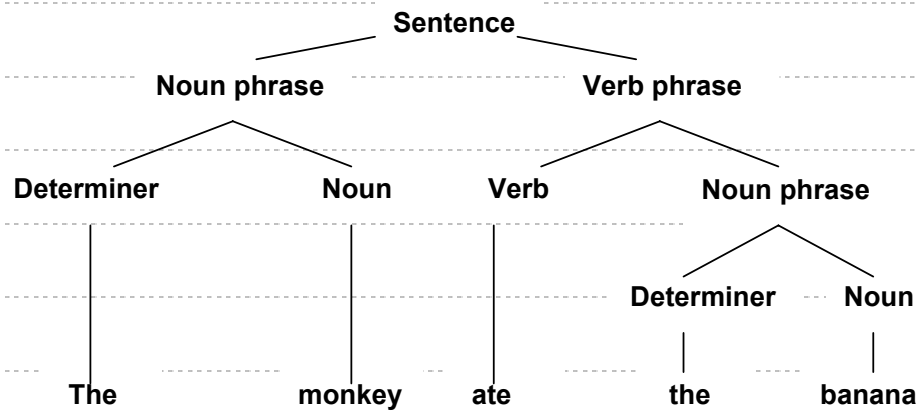
(f) Giving reasons, explain to which category of the Chomsky grammar hierarchy this grammar belongs.

(03 marks)

> **ANSWER IN THIS BOX**
>
> **Context free grammar / Type 2**
>
> **Justification : Because the left hand side consists of a single non terminal symbol**
>
> **and each rule licenses is rewriting that non terminal symbol as the right hand side**
>
> **of it in any context**

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

Vehicles can be categorized into buses, lorries, cars and bikes. Each vehicle possesses an engine and a set of tires. Vehicles like buses, lorries and cars have four tires each, while   bikes have two. Vehicles come in different colors like blue, gray and silver. They consume fuel, which may be either petrol or diesel.

(06 marks)

> **ANSWER IN THIS BOX**
>
>
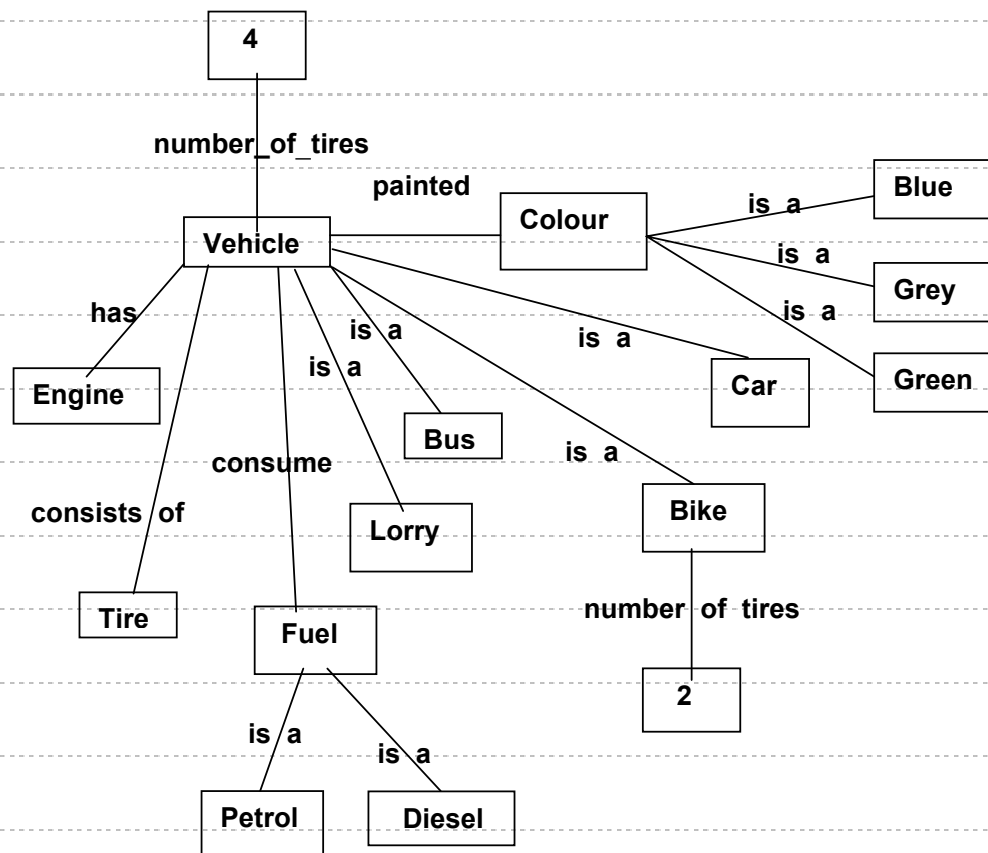
4) *(a)* Most vision systems consist of two sub-systems namely, the low-level processing sub-system and the high-level processing sub-system. Consider a vision system used in the food industry where quality of rice is checked for impurities. Explain the potential functions of the low-level and high-level vision components respectively in the given food quality control application.

(04 marks)

ANSWER IN THIS BOX

Low level subsystem in given rice quality control vision system:

The image of each rice sample may be acquired using a digital camera and preprocessing of the image is done to enhance its qualities and extract features such as shapes and sizes of individual objects.

High level subsystem in given rice quality control vision system.

This sub system accepts the features such as shapes of objects extracted from the low-level sub system, then uses domain knowledge such as expected shape and size of rice samples and then provides an interpretation of the contents in the image.

(b) Boundary detection is an important aspect in many computer vision systems. <u>Briefly</u> describe the following:

Searching near an approximate location

Graph Searching

(04 marks)

ANSWER IN THIS BOX

Boundary detection method	Description
Searching near an approximate location	**Method for refining a boundary given an initial estimate**
Graph Searching	**This method represents the image of edge elements as a graph. The boundary is a path through a graph.**

(c) Computer vision systems use 'region growing' and 'region splitting' as two main approaches for extracting planes and other surfaces from grey scale images. Briefly explain these two surface extraction techniques.

(04 marks)

ANSWER IN THIS BOX

(I) Region Splitting:

initially, the scene is considered as a whole scene and Region Splitting

recursively splits the image into smaller regions until the sub division

produces regions which meet some terminating criteria for belonging to a

single surface. Divide and conquer or top down approaches are used in

Region Splitting.

(ii) Region Growing:

This is a bottom up approach where each pixel is grouped with neighboring pixels to form larger regions while the composite neighborhood continues to satisfy some similarity constraint. e.g. pixels on the same plane, same texture etc.

(d) Give two computer vision applications which can be used in the automobile (car manufacturing) industry. Explain how computer vision can be used to improve quality and productivity.

(04 marks)

ANSWER IN THIS BOX

(i) **A quality control system based on computer vision to identify the dimensions of high precision objects such as engine parts.**

(ii) **Computer vision can be used for robots in a vehicle assembly system, spray painting system etc.**

(e) A computer vision system is needed to be developed to detect motor vehicles which travel at high speeds along Baseline Road in Colombo. The system needs to install appropriate speed sensors capable of detecting each vehicle exceeding the speed limit and capture images of those vehicles. Once the images are captured, the vision system needs to identify the vehicle numbers. Assume that a database is already available with the vehicle number, vehicle details and owner's information. The system needs to automatically generate a letter specifying the fines. The letter will be sent to the owner's address by the Police. Identify a suitable processing technique for each of the processing stages given in the following table and complete the table. Assume that all the vehicle registration numbers are of the following format.

(09 marks)

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ANSWER IN THIS BOX	
Processing stage	Technique
Image capturing	**Still Camera installed at several points along the road. The data needs to be automatically transferred to a central system using wireless technology.**
Preprocessing	**The image can be enhanced using sharpening, smoothing and histogram equalization techniques selecting the appropriate techniques.**
Feature extraction	**The Vehicle number needs to be extracted from the image of the vehicle.**

Continued..

Feature representation	**A thinning algorithm may be used to identify the letters/numbers of the vehicle registration number**.
Interpretation of the registration number from the vehicle number plate	**Neural network based techniques can be used to train the system for recognizing the letter and number to identify the vehicle registration number.**

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