

**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**  
**FACULTY OF APPLIED SCIENCE**  
**COMPUTER SCIENCE DEPARTMENT**  
**JUNE EXAMINATIONS 2004**

**SUBJECT:** EXPERT SYSTEMS&DSS  
**CODE:** SCS4207

**INSTRUCTION TO CANDIDATES**

Answer any five questions.  
Each question carries 20 marks  
Total marks 100

**Time: 3 hours**

**QUESTION ONE**

a) A poor farmer wants to take his goods, a goat and a bag of cabbages, to market. In order to do so he must cross a river using a small boat. Unfortunately the little party is being chased by a wolf. The wolf wants to eat the goat, and the goat wants to eat the cabbages. While the farmer is with the goat he can protect it from the wolf, and can stop it eating the cabbages. However, if ever the wolf is left alone with the goat, or the goat with the cabbages, disaster will ensue. The farmer's problem is that the boat is only big enough to hold him and one other thing, either wolf, goat, or bag of cabbages, so he has to plan a sequence of crossings that will get him and his goods safely to the other side of the river. Luckily, he has invested in a portable computer and a Prolog program that can do this planning for him. It is your job to write this program and save the farmer's livelihood.

i) Let the farmer, goat, cabbages and wolf be initially on bank *a*, and the bank to which the farmer is trying to cross be bank *b*. Show how the *state* of the system can be represented as a Prolog list of four elements, and, using this representation, write down the initial and goal states of the system, explaining what they mean. [5]

ii Write a Prolog procedure that detects "disastrous" states, that is, states where the goat is eaten or the cabbages are. Explain clearly how this works. [5]

- b) What is an expert system shell ?. Explain why the use of an expert system shell can dramatically reduce the development time of an expert system. [2]
- c) Distinguish clearly between forward and backward chaining inference processes. [5]
- d) State any four advantages and two disadvantages of rule-based expert systems. [3]

## QUESTION TWO

- a) Given the fact :

"Simba eats waffles "

Write the following as facts in propositional logic .

- i. "Simba likes waffles or Simba eats waffles"
- ii. "Simba likes waffles and Simba eats waffles"
- iii. "Simba doesn't eat waffles"
- iv. "If Simba likes waffles then Simba eats waffles" [2]

- b) Represent the following facts in the language of predicate logic .
  - i. "There is some table that doesn't have 4 legs"
  - ii. "No macintosh is a real computer " or "if something is a macintosh then it is not a real computer"
  - iii. "All Hararians support either dynamos or caps"
  - iv. "There is something small on the table"
  - v. "There exists some bird that doesn't fly"
  - vi. "Every person has something that they love" [3]
- c) "Herbert is a small hippopotamus who lives in Chipangali zoo. Like all hippopotamuses he eats grass and likes swimming ".

Represent the above :

- i. as a semantic net [4]
- ii. in predicate logic [3]
- d) Basing on c) above give two new facts about Herbert that are :
  - i. easier to represent in a semantic net than in predicate logic. [4]
  - ii. Easier to represent in logic than in a semantic net. [4]

### QUESTION THREE

- a) A rule requires three (3) separate pieces of data to be fireable . One datum has confidence 900, one has confidence 800, and the third 700. What is the antecedent confidence of the rule instance created? Support your answer with explanations. [2]
- b) The rule-firing threshold has been set to 800. Is the rule instance in a) above fireable? . Support your reasoning with explanations. [2]
- c) Consider the MYCIN rule in the Fig . below .

*If 1) the stain of the organism is gran-positive , and  
2) the morphology of the organism is coccus , and  
3) the growth conformation of the organism is chain  
THEN there is suggestive evidence (0.7) that the identity of the  
organism is streptococcus.*

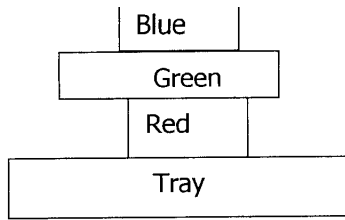
**Fig 3.1 A MYCIN ORGRULE for drawing the conclusion streptococcus**

Suppose that the conditions of the rule are satisfied with the following degrees of uncertainty :

condition 1: 0.8  
condition 2: 0.2  
condition 3: 0.5

What certainty will MYCIN associate with the conclusion that the identity of the organism is streptococcus? . Support your answer with explanations. [4]

- d) Imagine that a robot arm hovering over a tray of toy blocks can move a block , B, from one location, L , to another, M , using the operator table given in the Fig below .



**Fig 3.2 An operator table for move**

Preconditions: on (B, L) , clear(B) , clear (M)

Delete list: on (B, L) , clear (M)

Add list: on (B, M) , clear(L) , clear(tray)

on(B,L) means that B is resting directly on L. L may be another block or the tray itself. Only one block can rest on another block, but by convention any number of blocks can rest upon the tray .

A robot 's goal in life is to stack the blocks portrayed in the Fig above into a tower , with the blue block on the red block , and the red block on the green block resting on the tray . Thus its final goal should contain the following representations :

on (green,tray) ,on(red,green) , on (blue, red)

- i. Describe a plan for achieving this goal . [4]
- ii. Show how the database is modified as the plan is executed by the robot's operator table. [3]
- iii. Why do we need to add the formula: **clear(tray)** after every application of the operator table . [2]
- iv. Can we use the operator table for **move** to achieve negative goals , for example , achieve the goal that the green block is not on the red block?. Support your answer with explanations. [3]

#### QUESTION FOUR

- a) Give any three types of decisions that can be recorded on the **blackboard** of an expert system. [3]
- b) Draw a diagram showing the general architecture of an expert system .Give the function of each component part . [7]

- c) Consider a simple knowledge –based expert system for diagnosing problems in an automobile . Describe this proposed system for each stage of the **linear model** of expert system development. Assume that there are many people working on the project and consider the coordination of their efforts. Explain any assumptions you make. [10]

#### **QUESTION FIVE**

- a) Distinguish between conventional software systems and expert systems. [5]
- b) Explain any three advantages derived from the use of expert systems in a commercial environment [3]
- c) Define the following terms
- i) conflict set [1]
  - ii) conflict resolution [2]
- d) Describe any three possible conflict resolution strategies in a production system. Explain why more than one conflict resolution strategy is usually needed. [7]
- e) What is a production rule? What do you think is the relationship between a set of production rules and a decision tree? [2]

#### **QUESTION SIX**

- a) Describe any one alternative technique for dealing with uncertainty in expert systems. [3]
- b) The following information is an extract from a frame-based expert system
- 1.Bongani is a fine Arts major.
  - 2.Nothando is a CS major.
  - 3.Fine Arts majors and CS majors are students
  - 4.Students are people and have 2.0s GPAs (General point averages).
  - 5.Arts majors have 3.0 GPAs
  - 6.People are right handed.
  - 7.CS majors are left handed.
- i. Represent the information given above in a **generalization** hierarchy. [5]

- ii. What are Bongani and Nothando's GPA's. [2]
- iii. Is Nothando left or right handed. Support your answer with explanations. [2]
- c) What is a decision support system?. [2]
- d) Write brief notes on the following decision support system technologies:
  - i. Intelligent decision support systems (IDSSs). [3]
  - ii. Group decision support systems (GDSSs) [3]

**END OF QUESTION PAPER**

**GOOD LUCK!**

