

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering



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| Study Programme | : Bachelor of Technology Honours in Engineering |
| Name of the Examination | : Final Examination |
| Course Code and Title | : EEX6540- Knowledge Engineering |
| Academic Year | : 2020/21 |
| Date | : 02 nd February 2022 |
| Time | : 1400-1700hrs |
| Duration | : 3 hours |

General Instructions

1. Read all instructions carefully before answering the questions.
 2. This question paper consists of **Seven (7) questions** in **Five (5) pages**.
 3. Answer any **five(5)** questions only. All questions carry equal marks.
 5. Answer for each question should commence from a new page.
 6. This is a Closed Book Test(**CBT**).
 7. Answers should be in clear hand writing.
 8. Do not use Red colour pen.
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Question 1

- (a) A house owner is thinking of upgrading her house. When she discussed her requirements with a property developer she was given 3 options as given below to choose from.

Option1

A large-scale investment to improve the house with a total investment of Rs.1,400,000. At the end this will considerably increase the value of the house. After extensive market research the property developer indicated to her that there is a 40% chance that a profit of Rs. 2,500,000 will be obtained, but there is a 60% chance that it will be only Rs. 800,000.

Option2

A smaller scale investment to re-decorate the house with a less cost around Rs. Rs.500,000. This is less costly but will produce a lower profit. After extensive market research the property developer has identified that there is a 30% chance of a gain of Rs.1,000,000 profit but a 70% chance of it being only Rs.500,000.

Option3

No investment and improvement to the house. It will have a zero cost and there will be no profit.

Based on the above 3 scenarios answer the below questions.

- (i) Draw the decision tree representing the options open to the house owner. (5 marks)
- (ii) Add the chance nodes, the probabilities and the outcomes. (4 marks)
- (iii) Calculate the expected values and based on the net expected value decide the most suitable option for the house owner. (3 marks)
- (iv) Write three(03) decision rules in the form of IF THEN ELSE rules for this scenario. (5 marks)
- (b) Turing Test and Chinese Room argument proposes two opposing arguments. Compare and contrast the two arguments using an example. (3marks)

Question 2

- (a) For each of the queries below write the output (true, false or a variable binding) that will be given by Prolog when executed.

- (i) `?- X = 5+3.` (ii) `?- X is 5+3.`
 (iii) `?- X =5, X is X+3.` (iv) `?- first\==second.`
 (v) `?-att(cup1, X) = att(Y, white).`
 (vi) `?- [cup, bench, kitchen] = [X|Y].`
 (vii) `?- [c1, on(Y,Z), in(b,k)] = [X, on(X,b)|W].`

(10 marks)

- (b) Consider the following prolog program.
`in(t0, bathroom).`
`in(f1, bedroom).`

```
in(f2, bathroom).
in(f3, bathroom).
in(f4, bathroom).
```

```
towel(t0).
frock(f1).
frock(f2).
frock(f3).
frock(f4).
```

```
clean(t0).
dirty(f1).
clean(f2).
dirty(f3).
clean(f4).
```

```
toWash(X):-in(X, bathroom),      format("~n In: ~w", [X]),
          frock(X),              format("~n Frock: ~w", [X]),
          dirty(X),             format("~n Dirty: ~w", [X]),
          fail.
```

(i) What is the output of the following query? (6 marks)
 |?-toWash(X).

(ii) Suppose a cut were added to the toWash predicate (on the second line)
 toWash(X):-in(X, bathroom), format("~n In: ~w", [X]),
 frock(X), format("~n Frock: ~w", [X]), !,
 dirty(X), format("~n Dirty: ~w", [X]), fail.

(iii) What would the output of the following query be? (4 marks)
 |?-toWash(X).

Question 3

(a) Write the following sentences in Predicate logic.

- (i) Some students at OUSL are very smart.
- (ii) All dogs are adorable.
- (iii) Happy people have healthy lives. (2×3= 6 marks)

(b) Convert the following predicate logic expressions into Conjunctive Normal Forms.

- (i) $\forall x \forall y (\neg(R(x,y) \wedge \neg R(y,x)))$
- (ii) $\exists x \forall x \exists y P(x,y,z)$
- (iii) $\forall x \forall y \exists z (\neg R(x,z) \vee \neg (R(y,z)))$ (2×3= 6 marks)

(c) Derive by resolution an empty clause from the following clauses (where x, y, z are variables and a and b are constants)

```
C1: [-R(x,x)]
C2: [-R(x,y), R(y,x)]
C3: [-R(x,y), -R(y,z), R(x,z)]
C4: [R(a,b)]
```

(8 marks)

Question 4

- (a) Assume that you are going to play a two-player game called "power-pack". The game starts with a single stack of 09 cards. At each move a player selects one stack and divides it into two non-empty, non-equal stacks. A player who is unable to move loses the game.
- (i) Draw the complete search tree for the game power-pack. (8 marks)
- (ii) Assume two players, min and max, play the game as explained above. Min plays first. If a terminal state in the search tree developed above is a win for min, then a zero is assigned to that state. If max wins a particular state then 1 is assigned for max for that state. Apply the min-max algorithm to the search tree to assign values for all states in the search tree. (5 marks)
- (b) Apply the alpha-beta pruning algorithm to the search tree created in part(b). Make sure that you show where the alpha and beta cuts are applied and which parts of the search tree are pruned as a result. (7 marks)

Question 5

- (a) "A multi-agent system is a computerized system composed of multiple interacting intelligent agents within an environment."
- (i) Briefly explain what is an "Intelligent Agent". (2 marks)
- (ii) Identify 3 characteristics of a Multi Agent System. (3 marks)
- (iii) Multi Agent systems are giving less performance for some systems. Briefly explain such a system with an example. (3 marks)
- (b) Assume that you are required to design a Multi Agent system for a food and grocery delivery company. There is a main distribution centre in each district and under each main distribution centre there are several sub-centres. There are delivery vehicles attached to each centre and all the centres are monitored from the main centre located in the Colombo district.
Using Multi Agent approach, answer the questions given below.
- (i) Identify different kinds of agents suitable for the above scenario with justifications. (4 Marks)
- (ii) Briefly describe relevant tasks of each agent. (3 marks)
- (iii) Draw a block diagram to show the agent-based system you proposed for the above scenario. (5 marks)

Question 6

Consider the below given search space diagram, where S is the initial state and G1 and G2 are the goal states. The cost of moving from one state to the other is given along the edge between the states. The value of the heuristic evaluation function h applied to the state is the number written inside the state. In the event if a tie occurs choose the state according to the alphabetical order.

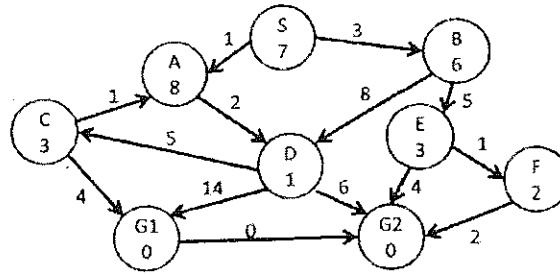


Figure 1- state space diagram

List the nodes of the state space shown in figure 1 in the order of expansion for the following Search algorithms.

- (a) Depth-first search method. (5 marks)
- (b) Hill climbing with $f(s) = g(s) + h(s)$ visits. (7 marks)
- (c) A* visits if it uses $f(s) = g(s) + h(s)$ and give the total cost. (8 marks)

Question 7

- (a) There are several knowledge representation mechanisms. Out of those compare and contrast Rule Base systems, Semantic Networks and Frame systems with each other using appropriate examples.
- (b) Represent the following scenario as a semantic network.

It is considered that any individual studying or conducting research at a university to be an academic. Within the academic community, there are two categories: students and staff.

Students get some form of funding and staff gets a salary. Students who are studying for their primary degree are called undergraduates, and attend particular degree programme (e.g. Software Engineering, Electrical etc.). All other students are called post-graduates and have a primary degree. They also have some research area (e.g. Artificial Intelligence).

Three categories of staff exist: lecturers, demonstrators, and researchers. Lecturers teach a course (e.g. AI, mathematics etc.), and demonstrators provide support for those courses. On the other hand, researchers conduct research into a particular research area.

Varuni is a student studying Software Engineering degree programme. Malkanthi is a lecturer in Software Engineering.

- (c) Assume that you have to perform the task of a Knowledge Engineer to elicit the knowledge/experience for the scenario "How to pass your *Artificial Intelligence and Agent Technology*" exam from the student who obtained the highest marks in the previous year final exam.
- Describe three(03) difficulties that you will face as a Knowledge Engineer.
 - Assuming that an expert system is to be developed for the above scenario code the knowledge elicited into a rule based system with five(05) rules.
 - Using an example from the above scenario explain how you can resolve a conflict.

End of the Paper

