B.Sc. Engg. CSE 6th Semester

23 October 2019

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

SEMESTER FINAL EXAMINATION **SUMMER SEMESTER, 2018-2019**

DURATION: 3 Hours **FULL MARKS: 150**

CSE 4617: Artificial Intelligence

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **8 (eight)** questions. Answer any **6 (six)** of them.

Figures in the right margin indicate marks.

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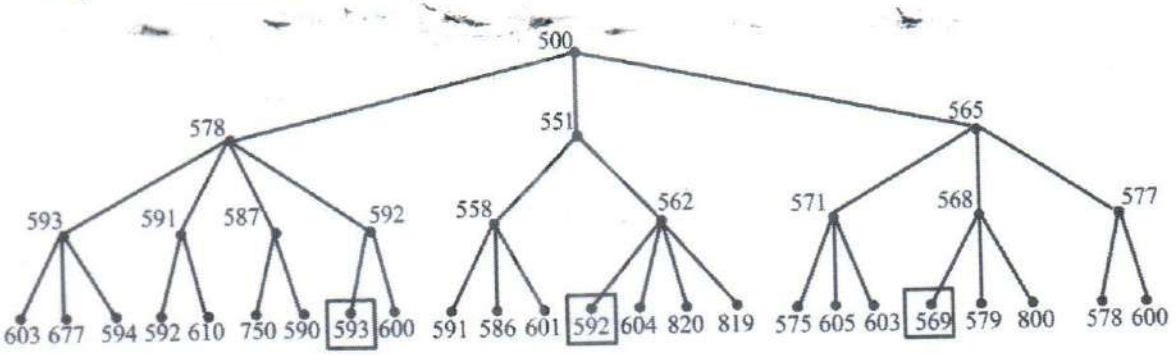
1. a) Distinguish between programming with and without AI. What abilities are required for an agent to be intelligent? 7

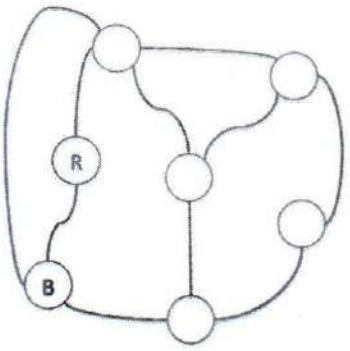
   b) How can a doctor rostering problem be an optimisation problem? Explain the constraints and objective function with respect to the following optimisation problem – "A toy manufacturer must determine how many bicycles, B, and tricycles, T, to make in a 40 hr week given that (i) the factory can produce 200 bicycles per hour or 140 tricycles, (ii) the profit for a bicycle is $25 and for a tricycle it is, $30 (iii) no more than 6,000 bicycles and 4,000 tricycles can be sold in a week. 8

   c) "Iterative deepening is the preferred uninformed search method when the search space is large and the depth of the solution is not known." – Justify the statement with an example. 10

2. a) How can you prove the optimality of A* search? In the following search tree, the numbers by the nodes denote the sum of some path cost and heuristic. The boxed nodes are goals. Describe in detail the way in which the RBFS algorithm searches this tree. Your answer should indicate the order in which nodes are expanded, the reason that this order is used, and should state which of the three goals is found and why. Note that smaller numbers represent more desirable nodes. 12



   b) Which variable should be assigned next in order to improving backtracking efficiency in a constraint satisfaction problem? Consider the following graph coloring constraint satisfaction problem, where each circle denotes a variable with domain R, G, B, and an edge between two circles denotes the binary constraint that the corresponding variables must be assigned different values. Suppose the two leftmost variables have already been assigned the values R and B as shown. Show the result of applying arc consistency checking to this instance. You should write the resulting domain of each variable next to the corresponding circle. 13



3. a) Compare and contrast between large and small neighborhoods of a local search. How can you exploit a local search to find a low-cost tour that starts from a city, visits all cities en-route exactly once and ends at the same starting city. 7

b) What is the working principle of simulated annealing meta heuristic? How Tabu search avoids local minima? 10

c) Distinguish among population, chromosomes, gene, and allele with regards to genetic algorithms. Given the following parents, P_1 and P_2, Show how the following crossover operators work. 8

i. one point (middle) crossover

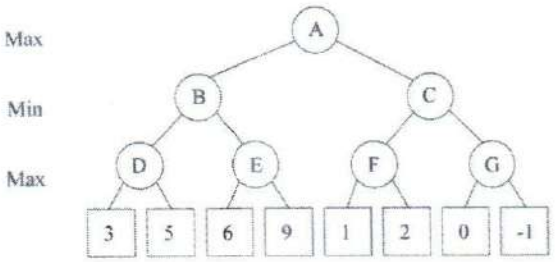
ii. uniform crossover

P_1	A	B	C	D	E	F	G	H	I	J
P_2	E	F	J	H	B	C	I	A	D	G

4. a) Given a set of seven coins, a player takes a set and divides it into two unequal sets. The player who cannot do uneven split, looses. Illustrate how two players, MIN and MAX starting from MIN taking turns, will use search tree to find next move in the state space. 8

b) How a evaluation function heuristic can be measured in a state of tic-tac-toe game? Distinguish between deterministic adversarial games having perfect information and games of chance having imperfect information. 7

c) "Good move ordering improves effectiveness of alpha-beta pruning algorithm" – Justify the statement. Given the following search tree, apply the alpha-beta pruning algorithm to it and show the search tree that would be built by this algorithm. 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. 10



5. a) What is the contraposition law of equivalence? Explain the following entailment formula with regards to propositional logic with an example. 8

$KB \models \alpha$ *iff* $M(KB) \square M(\alpha)$

b) How validity and and satisfiability are connected to inference? For each of the following propositions, indicate whether it is valid, satisfiable, or unsatisfiable. Use a truth table to decide. 8

1. $((A \rightarrow B) \wedge (B \rightarrow \neg A)) \rightarrow A$
2. $(\neg B \rightarrow \neg A) \rightarrow ((\neg B \rightarrow A) \rightarrow B)$

c) How can an inference procedure be sound or complete? Briefly explain the criteria for a knowledge base to be in horn form with an example. 9

6. a) Explain the advantages of first-order logic (FOL) over propositional logic (PL). Illustrate the common mistakes to avoid in universal and existential quantifications. 8

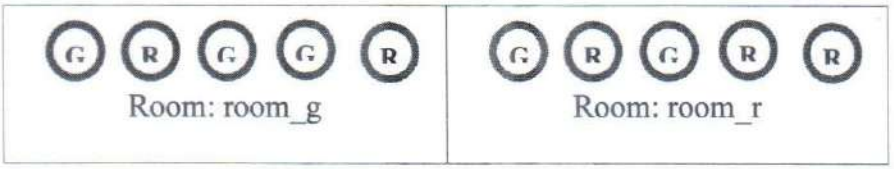
b) Given the following sentences. 17

i. John likes all kinds of foods.
ii. Apples are food.
iii. Chicken is food.
iv. Anything anyone eats and remains alive is food.
v. Bill eats peanuts and is alive.
vi. Paul eats everything that Bill eats.

Now, write them in first-order logic (FOL), convert the FOL sentences into Conjunctive Normal Form (CNF), and finally prove, by resolution refutation (contradiction), that *John likes peanuts*.

7. a) What is the purpose of causal links in partial plan representation? How is a causal link protected during partial plan generation? 8

b) What is the advantage of backward chaining algorithm over forward chaining algorithm in classical planning? Consider the following problem from the gripper domain: There is a robot agent with two grippers (left and right), two rooms (room_g and room_r), and a number of red (marked as 'R') and green (marked as 'G') balls in each room. The initial distribution of the balls are shown below. The goal is to move all the red balls to room_r and green balls to room_g. 17



i. Describe the problem in classical planning representation by writing a domain file and a problem file in PDDL.
ii. Write a solution (as sequence of actions) according to your domain action descriptions, and prove the correctness of the solution by showing that successively applying that action sequence leads the initial state to a goal state.
iii. Describe an admissible heuristic for this problem that could be applied by a planner for state space search.

8. a) Distinguish between qualification and ramification problem in planning problem representation. 5

b) What is Sussman anomaly? How does a partial order planning algorithm find a plan of the following problem – "Go to a shop from home, buy two products, and then return back to home."? 10

c) Consider a nurse rostering problem. Each nurse is scheduled for each day as either: on day shift, on night shift, or off. In each four day period a nurse must have at least one day off, and no nurse can be scheduled for 3 night shifts in a row. Model the problem in MiniZinc to find a 10 day schedule for 7 nurses, requiring 3 on each day shift and 2 on each night shift, with a minimum 2 night shifts per nurse. 10