National University of Computer & Emerging Sciences, Karachi
Spring2017 CS-Department
Midterm 2
29th March 2017, 11:00 am – 12:00Noon

Course Code: CS401	Course Name: Artificial Intelligence
Instructor Names: M. Rafi, S. Ali Naqvi and Farrukh Hassan	
Student Roll No:	Section No:

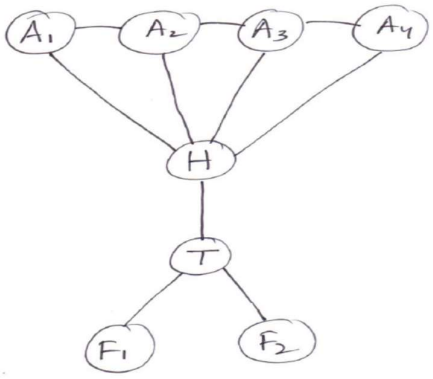
Instructions:

- Return the question paper.
- Read each question completely before answering it. There are **3 questions and 2 pages**.
- In case of any ambiguity, you may make assumption. But your assumption should not contradict any statement in the question paper.
- All the answers must be solved according to the sequence given in the question paper.
- Attempt all questions. Be to the point, there is a penalty for wild guesses. Draw neat and clean diagram/code where necessary.

Time: 60 minutes. **Max Marks:** 50 points

Question No. 1 [5+5+5] [Time: 20 Min.]

a. Consider the graph with 8 nodes A1, A2, A3, A4, H, T, F1, F2. Ai is connected to Ai+1 for all i, each Ai is connected to H, H is connected to T, and T is connected to each Fi. Find a 3-coloring of this graph by dry run of the algorithm using the variable order A1, H, A4, F1, A2, F2, A3, T, and the value order R, G, B. You can use simple backtracking in term of reaching a dead end.



A1	R G B		R G B
H	R G B	(Select B now)	R G B
A4	R G B	(no value left) -> H	R G B
F1	R G B	(no change for this variable) -> A4	R G B
A2	R G B	(no value left) ->F1	R G B
F2	R G B	(no change for this variable) -> A2	R G B
A3	R G B	=> (Dead end) -> F2	R G B
T	R G B		R G B

b. If we allow backtracking with conflict-directed back jumping in term of reaching a dead end. What will be the output if the same variable order and value order is used as in part (a).

Assignment to A3 initially a dead end. We will backtrack to A2 as it is most constrained, see from the solution of general backtrack. Conflict set for A2 before back jumping is {H, A1}, after back jumping the conflict set {A4, H, A1}

A1	R G B	R G B
H	R G B (Select B now)	R G B
A4	R G B (no value left) -> H	R G B
F1	R G B	R G B
A2	R G B (no value left) ->A4	R G B
F2	R G B	R G B
A3	R G B => (Dead end) -> A2	R G B
T	R G B	R G B

We have got same solution with only 3 back jumps. Much quicker than the general backtracking which tried all values of F1 and F2.

c. Differentiate between Backtracking and Backjumping?

Backtracking	**Back jumping**
-Backtracking handles an implicit tree - At the dead end, backup to the any recent level or variable (generic return point) - Backtracking approach is generally informed.	-Back jumping is an intelligent backtracking approach. -At the dead end, backup to a point where variables possible leads to a solution, more quickly. - it is also an informed approach; it also need to keep track of points where it need to perform jump.

Question No. 2	[5+10] [Time: 20 Min.]

a. Consider the following sentences {P = "John is healthy", Q = "John is wealthy", R = "John is wise"} Represent the following in propositional Logic:

   i. John is healthy and wealthy but not wise.
   P Λ Q Λ ~ R
   ii. John is not wealthy but he is healthy and wise.
   ~Q Λ P Λ R
   iii. John is neither healthy nor wealthy nor wise.
   ~P Λ ~Q Λ ~R

b. Given the following facts in the database:

   If a triangle is equilateral then it is isosceles
   If a triangle is isosceles then two sides are equal
   If two sides are equal then opposite angles are equal
   ABC is an equilateral triangle (assuming standard notations for ΔABC from elementary geometry)

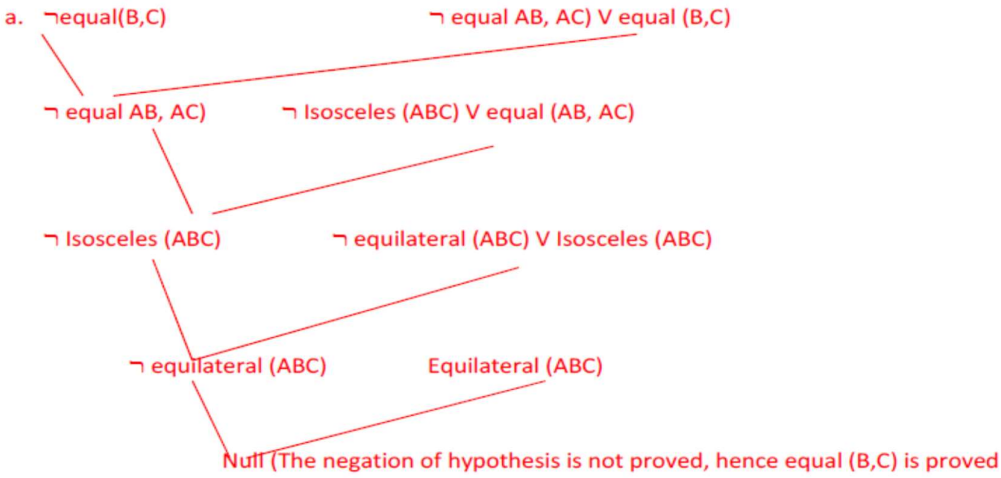
   Proof by contradiction that angle B and C are equal Using Resolution. Show all working to get full marks.

a. Equilateral (ABC) → Isosceles (ABC)
b. Isosceles (ABC) → equal (AB, AC)
c. Equal (AB, AC) → equal (B, C)
d. Equilateral (ABC)

Remove implications:

a. ¬ equilateral (ABC) V Isosceles (ABC)
b. ¬ Isosceles (ABC) V equal (AB, AC)
c. ¬ equal AB, AC) V equal (B,C)
d. Equilateral (ABC)

In order to prove equal (B, C), prove that its negation ¬equal (B,C) is false.



Question No. 3	[5X4] [Time: 20 Min.]

a. Explain why it is a good heuristic to choose the variable that is most constrained but the value that is least constraining in a CSP search.

In CSP search the solution is a complete assignment of all variable with values from the possible set of domain values and obeying all the constraints. Any selection of the order of variables may fail and it is an important heuristic to select variable in some specific order. The very first choice is to select a variable that is most constrained, it is also called minimum remaining value (MRV) heuristic. This is to choose the variable which has the fewest legal values remained. This will ensure that we will fail first in searching the complete assignment, and hence the early failure will save us from fruitless searches. Once a variable has been selected, the algorithm must decide on the order in which to examine its values. For this, the least-constraining-value heuristic can be effective in some cases. In general, the heuristic is trying to leave the maximum flexibility for subsequent variable assignments. For value ordering, the trick is that we only need one solution; therefore, it makes sense to look for the most likely values first. It is very effective if we only looking for a single solution.

b. What do we mean by a problem is commutative in term of CSP? Explain.

A problem is commutative if the order of application of any given set of actions has no effect on the outcome. CSPs are commutative because when assigning values to variables, we reach the same partial assignment regardless of order. Therefore, we need only consider a single variable at each node in the search tree. For example, at the root node of a search tree for coloring the map of Australia, we might make a choice between SA=red, SA=green, and SA=blue, but we would never choose between SA=red and WA=blue. With this restriction, the number of leaves is d^n, as we would hope.

c. Why a logical Agent is required? How the working (achievement of goal) is different from state space search and constraint satisfaction problem for a logical agent?

Most of the practical problems have partial observable environment. A Logical Agent are equipped with Knowledge base and hence they are keeping the most relevant information about the environment. The Logical agent achieved its goal by using logical reasoning over the facts that are available in the KB. This logical reasoning gives a great advantage over the simple state space search and constraint satisfaction problem both may search a large portion of fruitless/non-relevant state space hence are less efficient as compared to logical agent.

d. How the interaction of a Knowledge Based (KB) - Logical Agent is performed from a KB? What are the benefits of separating a KB from control strategies (Search Algorithms)?

In a Logical Agent (Knowledge Based Logical Agent), there are two abstract layers one for Knowledge based and other is for algorithms. A generic knowledge-based agent. Given a percept, the agent adds the percept to its knowledge base, asks the knowledge base for the best action, and tells the knowledgebase that it has in fact taken that action. The sequence of tell-ask-tell to interact with KB give a generic procedure for making a logical decision. The separation of KB from search routines make sure we can change KB for some other domain problem hence our agent can work on various environments.

BEST OF LUCK!