CSCI 561 - Introduction to Artificial Intelligence

Exam-1, July 5, 2016. Total Time: 120 minutes (2 hours)

This exam counts for 30% of the course grade.

Student ID | | | | | | | | | | |

USC-email | | | | | | | | | @usc.edu

First Name _____

Last Name _____

Instructions:

1. Date: **7/5/2016 from 4:00pm – 6:00 pm in SGM124**
2. Maximum credits/points/percentage for this midterm: 100
3. The percentages for each question are indicated in square brackets [ ] near the question.
4. **No books** (or any other material) are allowed.
5. **Write down your name, student ID and USC email address.**
6. **Your exam will be scanned and uploaded online.**
7. **Answers must be written in the provided boxed only.** Please make sure NOT to write the answer to one question in the box for another one.
8. **Do NOT write on the 2D barcode.**
9. **The back of the pages will NOT be graded.** You should use the back of the pages only for SCRATCH PAPER, not the actual answers.
10. No questions during the exam. **If something is unclear to you, write that in your exam.**
11. **Be brief: a few words are often enough if they are precise and use the correct vocabulary studied in class.**
12. When finished, raise completed exam sheets until approached by proctor.
13. **Adhere to the Academic Integrity code.**

1. Multiple Choice Questions (10 points)

Write down the **best** answer for each question in the provided boxes [2pts each]:

1. This is the form of sound inference:
   A. Resolution
   B. Inheritance
   C. Generalized modus ponens
   D. All of the above
   E. None of the above

2. What is AI?
   A. Systems that think like humans
   B. Systems that think rationally
   C. Systems that act like humans
   D. Systems that act rationally
   E. All of the above

3. What does Prolog sacrifice for efficiency?
   A. Inheritance
   B. No Occurs-check
   C. No infinite recursion check
   D. All of the above
   E. None of the above

4. Which of the followings is/are of central importance for genetic algorithms?
   A. Cross over
   B. Fitness-proportion reproduction
   C. Selection
   D. All of the above
   E. None of the above

5. Which of the followings is/are stochastic games?
   A. Chess
   B. Battleship
   C. Bridge
   D. All of the above
   E. None of the above

2. True/False Questions (10 points)

For each of the statements below, fill in the box 'T' if the statement is always and unconditionally true, or fill in the box 'F' if it is always false, sometimes false, or just does not make sense. [1 pt each]

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Text

1) DFS has lower asymptotic time complexity than BFS.

2) A complete search algorithm will always find a solution.

3) The best Go programs in the world play Go optimally.

4) Forward chaining is complete for FOL.

5) A truth table will grow exponentially with the number of variables.

6) Uniform Cost search algorithm is complete and optimal.

7) A* search with a heuristic that is not completely admissible may still find the shortest path to the goal state.

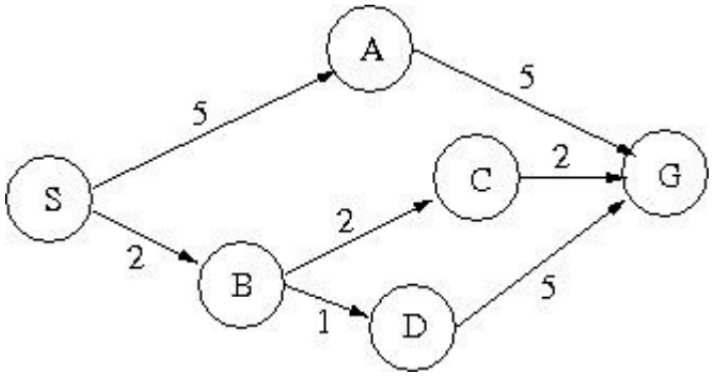
8) Every CSP with higher order constraints can be rewritten as a binary CSP with the same number of variables.

9) A logical agent can behave rationally even in partially observable environment.

10) In CSP, any algorithm for establishing n-consistency is exponential in n in worst case.

3. Search (20 points)

Consider the following search space where we want to find a path from the start state S to the goal state G. The table shows three different heuristic functions *h1*, *h2*, and *h3*.



Node	*h1*	*h2*	*h3*
S	0	5	6
A	0	3	5
B	0	4	2
C	0	2	5
D	0	5	3
G	0	0	0

(a) [3pts] What solution path is found by Greedy Best-First search using *h2*? Break ties alphabetically.

(b) [3pts] What solution path is found by Uniform-Cost search? Break ties alphabetically.

(c) [9pts] Give the tree solution paths found by algorithm A* using each of the three given heuristic functions in the table above, respectively. Break ties alphabetically.

(d) [5pts] Given two arbitrary admissible heuristics *h1 & h2*, which composite heuristic is **better** to use, max(h1, h2), (h1+h2)/2, or min(h1,h2)? Explain briefly why.

4. Constraint Satisfaction Problem (20 Points)

You offer to help incoming freshmen set up their course schedules. One particular freshman comes to you with four classes as well as an availability schedule (grayed out boxes represent reserved times).

Course	Lecture Times Offered
CSCI-1	MWF 11, 12
CSCI-2	MWF 12, 1
CSCI-3	MWF 10, 11, 12, 1, 2, 3
CSCI-4	MTWRF 10, 11

Time	MWF	TR
10		
11		
12		
1		
2		
3		

You also device the following set of constraints:

- Each class must be assigned to exactly one time slot.
- Each time slot can be assigned to maximum of one class.
- No classes can be scheduled during the greyed out time periods.
- The TR selection for CSCI-4 must occur at the same time as the MWF selection.

a) [5pts] Using the courses as variables, formulate this problem as a constraint satisfaction problem (CSP) showing variables, domains, and constraints. (Enforce any unary constraints)

b) [5pts] Draw a constraint graph associated with your CSP.

c) [5pts] Show the domains of variables after running arc-consistency on this initial graph.

d) [5pts] Give one solution to this CSP.

5. Propositional Logic (20 points)

5.1 [12 points] Consider the KB given below:
(1) ExamNextWeek => Study
(2) HomeworkDueNextWeek ^ HighWeightageOfHomework => WorkOnHW
(3) Study => GoodGrades
(4) ¬ GoodGrades
(5) StudyBreak => ExamNextWeek
(6) HomeworkDueNextWeek
(7) HighWeightageOfHomework

Are the following statements true? Mention which inference rule is used and to which sentences it was applied. If you need to perform intermediate steps, you can number the intermediate result and use it in your next step.

a) [4pts] (8) ¬ Study

b) [4pts] (9) WorkOnHW

c) [4pts] (10) ¬ StudyBreak

5.2 [8pts] Use resolution and proof by contradiction to prove W from the following knowledge base:

(1) P

(2) ¬ Q

(3) P → R

(4) ¬ Q ∨ W

(5) W → P

(6) R ∨ W

Please show the complete resolution proof, including all substitutions used.

6. First Order Logic (20 Points)

6.1 [10pts] Consider the given domain, and formalize the following sentences:

Color(x, y)	Object x has the color y
On(x, y)	Object x is on top of object y
Expensive(x)	Object x is expensive
Block1, Block2, Block3, Block4	Constants denoting objects
Red, Blue	Constants denoting colors

a) [2pts] Block2 or Block3 is blue.

b) [2pts] Everything red is on top of something blue.

c) [2pts] Block3 is not on top of any red object.

d) [2pts] Block4 has something on top of it, but that thing has nothing on top of it.

e) [2pts] Only 2 blocks are expensive.

6.2 [10pts] Consider the following 8 sentences that are added to KB. Enrolled, Classmate, hasHelp, IsWillingToLearn, Passes are predicates. Bob, Alice, Susan and AI are constants. x, y, z are variables. Assume all sentences are universally quantifies over all variables.

- HasHelp(x) ∧ IsWillingToLearn(x,y) ⇒ Passes(x,y)
- Classmate(x,y) ⇒ HasHelp(x) ∧ HasHelp(y)
- Classmate(x,y) ∧ Classmate(y,z) ⇒ Classmate(y,z)
- Enrolled(x,y) ∧ Enrolled(z,y) ⇒Classmate(x,z)
- Enrolled(Bob, AI)
- Enrolled(Alice, AI)
- Classmate(Alice, Susan)
- IsWillingToLearn(Bob,AI)

Given the KB above, show how backward chaining with GMP can be used to infer whether Bob passes AI (ie. Passes(Bob, AI). Draw a backward chaining inference tree. Be sure to show all the substitutions used in unification at each stage, as relevant.