CS444 - Artificial Intelligence- Sample Exam 2
February 2019

James MadisonUniversity
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Abidement by the Honor Code:

I abide by the guidelines of the honor code at JMU.

Signature: _____

Instructions:

- Do not proceed with the exam until directed to do so.
- You have a total of 70 minutes (2:05 pm - 3:15 pm).
- The exam is closed book.
- Write your answers in the space provided. If you need more space, you can write on the back of the page. Should you need more space, blank pages are provided for you at the end.
- Do not spend a lot of time on a particular problem. Read all problems first. Then, attack them in the order that you think allows you to accumulate most points.
- You will be graded on both correctness and clarity. Show your work but be concise!
  Points will be deducted for rambling.

Name: _____

1. CSPs (good summary of points in section 6.6)

   (a) You are going to Europe for the summer and are super excited. You only have a limited budget, so, you want to see all the cities without visiting any of them twice. A famous problem in computer science is the **Hamiltonian tour**. Given a network of cities connected by roads, choose an order to visit all cities without revisiting any city along the way. You can imagine the cities as nodes and the roads as undirected edges in graph.

   Knowing that this problem is NP-complete, you are eager to exploit AI methods to see if they perform well. In this case, solve means return a Hamiltonian tour or indicate that one does not exist. How would you setup this problem as a CSP? State the variables, domains of the variables, and the constraints for this problem.

   (b) Describe the methods in your own words: backtracking, min-conflicts. Be as specific as you can in how methods assign variables are resolve conflicts.

   (c) What is a cutset cycle? Are they easy to find? Discuss the implications on CSP problems.

2. Propositional Logic

(a) Using a truth table, enumerate all models to show if the following clauses are (simultaneously) satisfiable:

$$\neg(p \vee q), \quad \neg p \wedge \neg r, \quad p \vee \neg q$$

(b) Convert the following sentences into clausal forms (i.e., a disjunction of literals):

i. $(p \wedge q) \Rightarrow (r \vee s)$

ii. $(p \Leftrightarrow q)$

(c) Consider the sentence "Heads I win, tails you lose". We can represent this sentence plus associated domain knowledge in propositional logic using the following proper axiams, Where (H) Heads, (T) tails, (W) I will, and (L) you lose.

$$H \Rightarrow W, \quad T \Rightarrow L, \quad \neg H \Rightarrow T, \quad L \Rightarrow W$$

i. Convert each axiom into a disjunction of literals, and indicate whether the resulting clause is a horn clause

ii. Determine if it is possible to prove W using resolution with the 4 created disjunctions

3. First-Order logic

   (a) Sam, Clyde and Oscar are rabbits. We know the following facts about them:

      i. Sam is pink

      ii. Clyde is gray and likes Oscar.

      iii. Oscar is either pink or gray (but not both) and likes Sam.

      Use resolution refutation to prove that a gray rabbit likes a pink rabbit, that is, prove:

$$(\exists\, x, y)\, [Gray(x) \wedge Pink(y) \wedge Likes(x, y)]$$

   (b) In first order logic, convert the sentence:
   There exists a monkey that got all of its bananas from Kevin.
   You can assume a predicate Receive(x,y,z) which means that money x received object y from person z.