CSci 4511 Spring 2019

Final Exam

Thursday May 9
120 minutes – Open book and notes

Name: Student ID:

1. *15 points*
   You are given the following English sentence: "Anyone who owns a pool owns a house" and these translations into predicate calculus:

   (a) $\forall x \forall y \forall z\ [[Pool(y) \wedge Owns(x, y) \wedge Owns(x, z)] \rightarrow House(z)]$
   (b) $\exists x \exists y \exists z\ [Pool(y) \wedge House(z) \wedge Owns(x, y) \wedge Owns(x, z)]$
   (c) $\forall x \forall y\ [[Pool(y) \wedge Owns(x, y)] \rightarrow [\exists z House(z) \wedge Owns(x, z)]]$

   (a) Is there a statement that represents well the English sentence? If yes, specify which one it is. If no, please write the correct logical sentence.

   (b) For each of the logical sentences above write in English what the logical sentence is actually saying.

2. *10 points* Write the following sentences in predicate calculus using predicates such as $Student(x), Building(x), Room(x), Visited(x, y)$ and convert them to CNF:

   (a) Every student has been in at least one room of every building on campus.

   (b) There is a student who has been in every room of at least one building on campus.

3. *15 points*
Express each of the following statements in first-order logic and convert to CNF, skolemizing as needed.

   (a) All computer science majors own a Mac or a PC.

   (b) Everyone who owns a Mac owns an IPOD.

   (c) All except one student in Stats 101 are Math majors.

   (d) IPOD owners love music.

   (e) John is a CS major who does not like music.

   Prove by resolution with refutation that "John owns a PC"

4. *15 points*
Prove by resolution with refutation that the following set of expressions in CNF is unsatisfiable. Assume that upper case arguments are constant, lower case arguments are variable:

   (a) $\neg Bar(x) \vee \neg Zip(x)$

   (b) $\neg Bar(w) \vee \neg Foo(w, y) \vee Bar(y)$

   (c) $Foo(A, B)$

   (d) $Foo(A, C)$

   (e) $Bar(A)$

   (f) $Zip(C)$

5. *20 points*
You are given the following action schema to transfer object o from location x to location y:
Action $(Transfer(o, x, y)$,
PRECOND: $At(Robot, x) \wedge At(o, x)$
EFFECT: $\neg At(Robot, x) \wedge \neg At(o, x) \wedge At(Robot, y) \wedge At(o, y)$

(a) Create new action schemas by decomposing the action schema given into three schemas, one to grasp the object, one to move it to the destination, and one to drop it at the destination.

(b) Describe in general how action schemas can be created by splitting existing schemas. Explain when this would be a good idea and when it would not.

6. *25 points*
Answer these questions explaining your reasoning briefly but precisely.

(a) Can you construct a graph in which A* (with an admissible heuristics) will expand more nodes than uniform cost? if yes, show an example, if not, explain why not.

(b) Does iterative deepening depth-first search use less memory than breadth-first search? Why (or why not)?

(c) How does the number of variables and the size of the domain affect the complexity of solving a CSP problem using backtracking search?

(d) Explain why dropping negative effects from every action schema results in a relaxed problem.

7. Extra Credit *10 points*

   Suppose you decide to use simulated annealing but you do not want to reduce the initial temperature. How will the algorithm behave? Be precise.