CSci 5511 Spring 2008

Final Exam

Tuesday May 13

120 minutes == 120 points

Open book and notes

1. *15 points*
   Prove by resolution that the following set of clauses (in predicate calculus) is unsatisfiable. Assume that upper case arguments are constant, lower case arguments are variable:

   1. $G(B)$
   2. $\neg G(x) \vee H(x)$
   3. $\neg H(z) \vee I(z)$
   4. $\neg H(w) \vee J(w, D)$
   5. $\neg I(B) \vee J(C, B)$
   6. $\neg I(q) \vee \neg J(q, y)$

2. *25 points*
   Write the following sentences in predicate calculus, using appropriate predicates:

   1. An object is clear if nothing is on it
   2. If a block is on the table it is not on top of any other block
   3. There is no one taller than Bill
   4. All employees who earn more than $1400 per year pay taxes
   5. Every car has an engine

3. *20 points*
   You are given the following problem and STRIPS operator schemata:

Initial State	$Garbage \wedge Cleanhands$
Goal:	$Dinner \wedge \neg Garbage$
Operators	$Op($ACTION:$Cook$,
	PRECOND:$Cleanhands$
	EFFECT: $Dinner$
	$Op($ACTION:$Carry$,
	PRECOND:$Garbage$
	EFFECT: $\neg Garbage \wedge \neg Cleanhands$

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1. Draw the first three levels (S0, A0, and S1 as in the textbook) of the planning graph. Mark ALL the mutex and indicate for each the type of mutex.
2. Is the problem solved at level S1? if not, why not?

4. *40 points*
You are given the following STRIPS operator schemata for a robot that can move, pickup, and drop objects.

$Op($ACTION: $Go(x, y)$,
PRECOND: $At(Robot, x)$,
EFFECT: $\neg At(Robot, x) \wedge At(Robot, y))$

$Op($ACTION:$Pick(o)$,
PRECOND:$EmptyHand(Robot) \wedge At(Robot, x) \wedge At(o, x)$,
EFFECT: $\neg EmptyHand(Robot) \wedge \neg At(o, x) \wedge Holding(Robot, o))$

$Op($ACTION:$Drop(o)$,
PRECOND:$At(Robot, x) \wedge Holding(Robot, o)$,
EFFECT: $EmptyHand(Robot) \wedge At(o, x) \wedge \neg Holding(Robot, o))$

1. Suppose you want to allow the robot to carry two objects at once, one in its right hand and one in its left hand. Do you need to add new predicates? if yes, what predicates do you want to add? if not, how will you handle carrying more than one object?
2. Modify the STRIPS operators given above to enable the robot to carry one object per hand. Use the predicates you decided to add, if any.
3. If you were to rewrite the operators given above using the successor-state formulation instead of STRIPS, how many axioms will you need?
4. Rewrite the operator schemata given above using the successor-state formulation.

5. *20 points – 5 each* Answer the following questions briefly but precisely. Justify your answers.

1. Can multiple totally ordered plans be obtained from a single partially ordered plan?
2. Is it possible for alpha-beta and minimax to choose different moves when used on the same problem?
3. Can you say that semantics networks are more expressive than predicate calculus because they allow exceptions to default values? can exceptions to default values be expressed in predicate calculus?
4. Suppose you decide to use simulated annealing without ever reducing the initial temperature. How will the algorithm behave?

YOU REACHED THE END OF THE EXAM