

Final Exam
Tuesday December 16
120 minutes == 120 points
Open book and notes

1. *15 points*

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

1. $Foo(A, B)$
2. $Foo(A, C)$
3. $Bar(A)$
4. $Zip(C)$
5. $\neg Bar(x) \vee \neg Zip(x)$
6. $\neg Bar(w) \vee \neg Foo(w, y) \vee Bar(y)$

2. *30 points*

Write the following sentences in predicate calculus, using appropriate predicates:

1. John loves all his dogs.
2. Everyone who loves one of his cats is happy.
3. Not all vegetarians hate hunters.
4. Everyone except butchers likes vegetarians.
5. There is a student whose grade in Bio is lower than his grade in Math
6. Not every student takes history and biology but every student takes Composition.

3. *20 points*

You are given the following STRIPS action schema to move a block.

OpACTION: $Move(b, x, y)$,

PRECOND: $On(b, x) \wedge Clear(b) \wedge Clear(y)$

EFFECT: $On(b, y) \wedge Clear(x) \wedge \neg On(b, x) \wedge \neg Clear(y)$

1. If you were to rewrite the action given above using the successor-state formulation instead of STRIPS, how many axioms will you need? Explain briefly why.

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- Rewrite the action given above using the successor-state axiom formulation.

4. *25 points*

You are given the following STRIPS action schemas, initial state, and goal:

Actions	$Op(\text{ACTION:}MakeDrink,$ $\text{PRECOND:}CleanCup \wedge HaveMilk$ $\text{EFFECT:} HaveDrink \wedge \neg CleanCup \wedge \neg HaveMilk$
	$Op(\text{ACTION:}Drink,$ $\text{PRECOND:}Thirsty \wedge HaveDrink$ $\text{EFFECT:} \neg Thirsty \wedge \neg HaveDrink$
Initial State	$Thirsty \wedge CleanCup \wedge HaveMilk$
Goal:	$\neg Thirsty$

- Draw the planning graph. Mark all the mutexes between action instances and between propositions, and indicate for each the type of mutex.
 - at what level is the problem solved? why?
5. *30 points – 5 each* Answer the following questions briefly but precisely. Justify your answers.

- Is the Minimum Spanning Tree an admissible heuristic for the Traveling Salesman Problem? Why?
- Given a finite state-space, is the search space always finite? Explain your reasoning.
- Can minimax be used for games with more than two players? If yes, how? If not, why not?
- Suppose you are trying to prove by resolution a sentence in first-order logic which is not entailed by the knowledge base. What result do you expect to obtain? explain your reasoning.
- Describe briefly one advantage of using successor state axioms instead of STRIPS actions, and one advantage of using STRIPS actions instead of successor state axioms.
- The concept of optimal plan is not commonly used in planning. Why? How would you define what an optimal plan is?

YOU REACHED THE END OF THE EXAM
