CSCI 561

Foundations of Artificial Intelligence

Exam #2 – Spring 2014

4:00-5:20pm

Friday, March 28, 2014

Instructor: Prof Tejada

(This exam is closed book, closed notes, closed everything.
No "cheat sheet" allowed.
No calculators, cell phones, or any electronic gadgets.)

Notes. As grading criteria, you will get full marks for each question that has the right answer (with appropriate reasoning or show of steps). You may be assigned a partial credit for question if deemed appropriate. If you face difficulty, or if things are unclear, write down your assumptions and proceed accordingly.

Logical Reasoning (50pts)
Convert from English to FOL (20pts)

Circle True or False. For sentences in English make your judgment of the meaning of the sentence, i.e., you may want to translate it in FOL to conclude.

1. [2pts] [] "Bert and Ernie are brothers" is equivalent to "Bert is a brother and Ernie is a brother"

2. [2pts] [] " p and q are not both true" is equivalent to " p and q are both not true"

3. [2pts] [] "Neither p nor q" is equivalent to "both p and q are false"

4. [2pts] [] "Not all A's are B's" is equivalent to "$\exists x (A(x) \wedge \neg B(x))$ "

5. [2pts] [] "MS students and PhD students are welcome to apply." is equivalent to "$\forall x [(M(x) \wedge P(x)) \Rightarrow Apply(x)]$"

Convert from English to FOL continued

Circle True or False. For sentences in English make your judgment of the meaning of the sentence, i.e., you may want to translate it in FOL to conclude.

Questions 6 to 9: Attract is a relation from x to y, i.e., A(x,y) says that x attracts y.

6. [2pts] [] "Everything attracts something", where "something" means "something or other", is equivalent to "$\forall x \, \exists y \, A(x, y)$"

7. [2pts] [] "Something is attracted by everything", where "something" means "something in particular", is equivalent to "$\exists y \, \exists x \, A(x, y)$"

8. [3pts] [] "Everything is attracted by something" ", where "something" means "something or other", is equivalent to "$\exists x \, \forall y \, A(x, y)$"

9. [3pts] [] "Something attracts everything", where "something" means "something in particular", is equivalent to "$\exists x \, \exists y \, A(x, y)$"

Resolution (20pts)
From the sentence "Heads I win, tails you lose," prove using resolution that "**Iwin**."

1. [10 pts] First build the KB, from the sentence "Heads I win, tails you lose," using the true or false variables **Heads, Tails, IWin, YouLose** and write the sentence in terms of disjunctions clauses. Add to KB the general knowledge that the outcome of a coin toss must be **Head** or **Tails** and the general knowledge that if **YouLose** then **IWin** and, if **IWin** then **YouLose**.

Resolution continued

2. [10 points] Prove the Goal sentence: "**IWin**" via the Resolution method.

Unification and Prolog (10pts)

Answer the questions below given these two rules in Prolog for appending two lists to produce a third:

append([],Y,Y).
append([X|L],Y,[X|Z]) :- append(L,Y,Z).

1. [4pts] Given the query append(A, B, [[1], [2, [3]]]) list all possible □ for A and B:

Unification and Prolog continued
Answer the questions below given these two rules in Prolog for appending two lists to produce a third:

append([],Y,Y).
append([X|L],Y,[X|Z]) :- append(L,Y,Z).

2. [6pts] When L=[A], Y=[B, C], X=[[D]] then what are the values for:
   a. [3pts] Z= [A, B, C]

   b. [3pts] [X|Z]= [[[D]] , A, B, C] or [[[D]] | [A,B,C]]

Knowledge Representation (20pts)

Circle the letter that corresponds to the best answer for the question:

1. [4pts] This is a form of sound inference:
   a. Resolution
   b. Inheritance
   c. Generalized modus ponens
   d. All of the above
   e. None of the above

2. [4pts] The closed world assumption helps to address this problem:
   a. Frame problem
   b. Ramification problem
   c. Qualification problem
   d. All of the above
   e. None of the above

3. [4pts] This is a type of ontology:
   a. Semantic Network
   b. WordNet
   c. Facebook
   d. All of the above
   e. None of the above

4. [4pts] This is **not** part of Situation Calculus:
   a. Atemporal predicate
   b. Fluent
   c. Frame axiom
   d. All of the above
   e. None of the above

5. [4pts] A PartOf hierarchy allows this type of reasoning:
   a. Individual vs stuff
   b. Inheritance
   c. Transitivity
   d. All of the above
   e. None of the above

Planning (30pts)

Planning representation (10pts)

The monkey-and-bananas problem is faced by a ***monkey*** in a laboratory with some ***bananas*** hanging out of reach from the ceiling. A ***box*** is available that will enable the monkey to reach the bananas if he climbs on it. Initially, the monkey is at ***A***, the bananas at ***B***, and the box at ***C***. The monkey and box have height ***Low***, but if the monkey climbs onto the box he will have height ***High***, the same as the bananas. The actions available to the monkey include ***Go*** from one place to another, ***Push*** an object from one place to another, ***ClimbUp*** onto or ***ClimbDown*** from an object, and ***Grasp*** or ***Ungrasp*** an object. The result of a ***Grasp*** is that the monkey holds the object if the monkey and object are in the same place at the same height.

    a [4pts] Write down the initial state description.

    b. [6pts] Write the six action schemas with preconditions and effects (you must define).)

Partial order planning (20pts)

The problem is to plan the transportation of the bird Tweety from the Lincoln Park Zoo in Chicago using the O'hare airport (ORD) to the Bronx Zoo in New York using the JFK airport and the transportation of apples from Los Angeles to New York. Use the PDDL actions given

below to create the plan:

$Init(At(C_1, SFO) \land At(C_2, JFK) \land At(P_1, SFO) \land At(P_2, JFK)$
$\land Cargo(C_1) \land Cargo(C_2) \land Plane(P_1) \land Plane(P_2)$
$\land Airport(JFK) \land Airport(SFO))$
$Goal(At(C_1, JFK) \land At(C_2, SFO))$
$Action(Load(c, p, a),$
  PRECOND: $At(c, a) \land At(p, a) \land Cargo(c) \land Plane(p) \land Airport(a)$
  EFFECT: $\neg At(c, a) \land In(c, p))$
$Action(Unload(c, p, a),$
  PRECOND: $In(c, p) \land At(p, a) \land Cargo(c) \land Plane(p) \land Airport(a)$
  EFFECT: $At(c, a) \land \neg In(c, p))$
$Action(Fly(p, from, to),$
  PRECOND: $At(p, from) \land Plane(p) \land Airport(from) \land Airport(to)$
  EFFECT: $\neg At(p, from) \land At(p, to))$

Figure 10.1   A PDDL description of an air cargo transportation planning problem.

1.[4pts] Given the initial and goal states of this problem as:

Initial State: *At(Tweety, ORD), At(apples, LAX), At(P1, LAX), Cargo(Tweety),*
                 Cargo(apples),   Plane(P1),   Airport(LAX),   Airport(JFK),
                 Airport(ORD)
Goal State: *At(Tweety, JFK), At(apples,JFK)*

Write an efficient and consistent total order plan that starts at the initial state and
achieves the goal state.

Partial order planning continued
2. [4pts] Draw the first action that will be inserted into the initial plan by a partial order planner
(POP) shown below. Include solid arrows to represent causal links between action effects and
preconditions or dotted arrows to represent ordering constraints.

Partial order planning continued

3. [4pts] Draw the first and second actions that will be inserted into the initial plan by a partial order planner (POP) shown below. Include solid arrows to represent causal links between action effects and preconditions or dotted arrows to represent ordering constraints.

Partial order planning continued

4. [4pts] Draw the first, second, and third actions that will be inserted into the initial plan by a partial order planner (POP) shown below. Include solid arrows to represent causal links between action effects and preconditions or dotted arrows to represent ordering constraints.

Partial order planning continued

5. [4pts] Draw all actions that will be inserted into the initial plan by a partial order planner (POP) shown below. Include solid arrows to represent causal links between action effects and preconditions or dotted arrows to represent ordering constraints.