Practice Midterm Examination

CSCI 561 FALL2014: Artificial Intelligence

Student ID: _____

Last Name: _____

First Name: _____

USC email: _____

Instructions:

1. Date: **11/3/2014 from 5:00pm – 6:20 pm**
2. Maximum credits/points for this midterm: 100 points.
3. Credits/points for each question is indicated in the brackets [ ] before the question.
4. **No books** (or any other material) are allowed.
5. Attach extra sheets (available upon request) if required (write full name on each extra sheet).
6. **Write down name, student ID and usc email address.**
7. No questions during the exam.
8. **Be brief: a few words are often enough if they are precise and use the correct vocabulary studied in class.**
9. When finished raise completed exam sheets until approached by proctor.
10. **Adhere to the Academic Integrity code.**

1. Concepts in Logic (10%)

Match each keyword to its meaning by writing the letter of the definition below:

Keywords:

1. _____ Syntax
2. _____ Semantics
3. _____ Model
4. _____ Entailment
5. _____ Inference
6. _____ Soundness
7. _____ Completeness
8. _____ Equivalence
9. _____ Validity
10. _____ Satisfiability

Definitions:

A. sentences are true in the same models
B. determine whether sentence entailed by KB
C. a possible world that defines truth values for all sentences
D. truth of sentences with respect to models
E. necessary truth of one sentence given another
F. sentence is true in all models
G. sentence is true in some model
H. produce only entailed sentences
I. formal structure of sentences
J. can produce all entailed sentences

2. Convert to CNF (10%)

Convert sentence to CNF using some of the basic manipulation rules below. Write down which rule number used for each step in the conversion.

$B <=> (P_1 \text{ V } P_2)$

1. (2%) Eliminate ⇔ using which rule ___

2. (2%) Eliminate => using which rule __

3. (3%) CNF requires ¬ to only appear in literals using which rule ____

4. (3%) Flatten to have conjunction of disjunctive clauses using which rule ____

A. ¬(¬A) = A Double negation
B. ¬(A ^ B) = (¬A) V (¬B) Negated “and”
C. ¬(A V B) = (¬A) ^ (¬B) Negated “or”
D. A ^ (B V C) = (A ^ B) V (A ^ C) Distributivity of ^ on V
E. A V (B ^ C) = (A V B) ^ (A V C) Distributivity of V on ^
F. A => B = (¬A) V B by definition
G. ¬(A => B) = A ^ (¬B) using negated or
H. A <=> B = (A => B) ^ (B => A) by definition
I. ¬(A <=> B) = (A ^ (¬B))V(B ^ (¬A)) using negated and & or

3. Convert from English to FOL (20%)

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. [2%] [True/False] "Bert and Ernie are brothers" is equivalent to "Bert is a brother and Ernie is a brother"

2. [2%] [True/False] " p and q are not both true" is equivalent to " p and q are both not true"

3. [2%] [True/False] "Neither p nor q" is equivalent to "both p and q are false"

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

5. [2%] [True/False] "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" or equivalently that "y is attracted by x".

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

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

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

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

4. Resolution (20%)

From the sentence "Heads I win, tails you lose," prove using resolution that "**Iwin**."

1. [10%] 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%] Prove the Goal sentence: "**IWin**" via the Resolution method.

Unification and Prolog (10%)

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. [4%] Given the query append(A, B, [[1], [2, [3]]]) list all possible θ 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. [6%] When L=[A], Y=[B, C], X=[[D]] then what are the values for:
   a. [3%] Z=

   b. [3%] [X|Z]=

Knowledge Representation (20%)

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

1. [4%] 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. [4%] 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. [4%] Knowledge Engineering is expensive because:
    a. Encoding knowledge in a formal system is hard
    b. It is an iterative modeling process
    c. Domain experts don't know what they know
    d. All of the above
    e. None of the above

4. [4%] 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. [4%] 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 (10%)

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. [4%] Write down the initial state description.

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