Midterm 2 Examination

CSCI 561 Summer 2015: Artificial Intelligence

Student ID: | | | | | | | | | | | |

Last Name: _____

First Name: _____

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Instructions:

1. Date: **7/7/2015 from 4:00pm – 6:00 pm in SLH200**
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. **Write down name, student ID and USC email address.**
6. **Your exam will be scanned and uploaded online.**
7. **Write within the boxes provided for your answers.**
8. **Do NOT write on the 2D barcode.**
9. **The back of the pages will not be graded. You may use it for scratch paper.**
10. No questions during the exam. **If something is unclear to you, write that in your exam.**
11. **Be brief: a few words are often enough if they are precise and use the correct vocabulary studied in class.**
12. When finished raise completed exam sheets until approached by proctor.
13. **Adhere to the Academic Integrity code.**

Problems	**100 Points total**
1- General Concepts	20
2- Truth Tables	10
3- Propositional Logic	30
4- First Order Logic	30
5- Planning	10

1) General Concepts (20 points)

a) (1pt each) For each of the statements below, fill in the bubble T if the statement is always and unconditionally true, or fill in the bubble F if it is always false, sometimes false, or just does not make sense:

1	T	F
2	T	F
3	T	F
4	T	F
5	T	F
6	T	F
7	T	F
8	T	F
9	T	F
10	T	F
11	T	F
12	T	F

1- In FOL, constant symbols refer to objects, while predicate symbols refer to relations.

2- The truth table method of inference is complete for propositional logic.

3- Not every sentence of propositional logic can be converted to CNF.

4- ∀ is often used with ∧

5- Propositional logic is not monotonic but First order logic is.

6- Propositional logic has 2 quantifiers: for all and there exists.

7- Forward checking algorithm is sound but it is not complete for knowledge bases of definite clauses.

8- Cyc is an example application of a knowledge engineering.

9- The Semantic Web solves all of the problems of knowledge sharing

10- An upper ontology can be used for knowledge sharing.

11- Inheritance can occur from any subclass

12- Reification represents a category as an object

b) (1 pt each) Fill in the blank for each sentence with the appropriate word or phrase.

13- A _____hierarchy allows for an inference process called Inheritance.

14- An inference algorithm is sound if it_____.

15- An inference algorithm is complete if it_____.

16- A sentence is _____ if it is true in all models.

17- α entails β if and only if _____is unsatisfiable.

18- Generalized modus ponens requires sentences to be in _____ form.

19- Prolog does inference using _____ chaining.

20- _____ is a sentence that is necessary true in all models.

2) Truth Tables (10 points)

a) (8 points) Enumerate the truth table to discuss whether the sentence α is entailed by the knowledge base or not? Draw your table in the space below. There should be one row for each model. There should be columns for each propositional symbol. There should be sufficient number of additional columns to prove entailment.

$\alpha = (A \wedge B) \vee C$

$KB = (A \vee \neg C) \wedge (B \vee C)$

b) Does your table prove the entailment relationship? Explain how one can tell by examining your table.(2 points)

3) Propositional Logic (30 points)

a) Convert the following propositional sentence into CNF. Your answer must be as simplified as much as possible and must exactly match the CNF form. (10 points)
~((A => B) => (((P^B) => Q) v R))

b) Consider the KB given below:

(1) ExamNextWeek => Study

(2) HomeworkDueNextWeek ^ HighWeightageOfHomework => WorkOnHW

(3) Study => GoodGrades

(4) ~GoodGrades

(5) StudyBreak => ExamNextWeek

(6) HomeworkDueNextWeek

(7) HighWeightageOfHomework

Are the following statements true? Mention which inference rule is used and to which sentences it was applied. If you need to perform intermediate steps, you can number the intermediate result and use it in your next step. (10 points)

(8) ~Study

(9) WorkOnHW

(10) ~StudyBreak

c) Use resolution and proof by contradiction to prove W from the following knowledge base:

1. P
2. $\neg Q$
3. $P \rightarrow R$
4. $\neg Q \vee W$
5. $W \rightarrow P$
6. $\neg R \vee W$

Please show the complete resolution proof, including all substitutions used. (10 points)

4) First-Order Logic (30 points)

1- Consider the following predicates:
Student(x) : x is a student.
Course(x) : x is a course.
Semester(x) : x is a semester.
Takes(x,y,z) : student ‘x’ has taken course ‘y’ in ‘z’ semester
Failed(x,y,z) : student ‘x’ has failed course ‘y’ in ‘z’ semester

Using the above predicates translate these English sentences into logic expressions (15 points)

a) Every student takes at least two courses in each semester.

b) Only one student failed History in Spring2015.

c) No student failed Chemistry in Spring2015 but at least one student failed History (in Spring2015).

d) Every student who takes Analysis also takes Geometry.

e) No student has Analysis and History simultaneously in one semester

2- Consider the following 8 sentences that are added to KB. Enrolled, Classmate, hasHelp, IsWillingToLearn, Passes are predicates. Bob, Alice, Susan and AI are constants. x, y, z are variables. Assume all sentences are universally quantifies over all variables.

- HasHelp(x) ∧ IsWillingToLearn(x,y) ⇒ Passes(x,y)
- Classmate(x,y) ⇒ HasHelp(x) ∧ HasHelp(y)
- Classmate(x,y) ∧ Classmate(y,z) ⇒ Classmate(y,z)
- Enrolled(x,y) ∧ Enrolled(z,y) ⇒ Classmate(x,z)
- Enrolled(Bob, AI)
- Enrolled(Alice, AI)
- Classmate(Alice, Susan)
- IsWillingToLearn(Bob,AI)

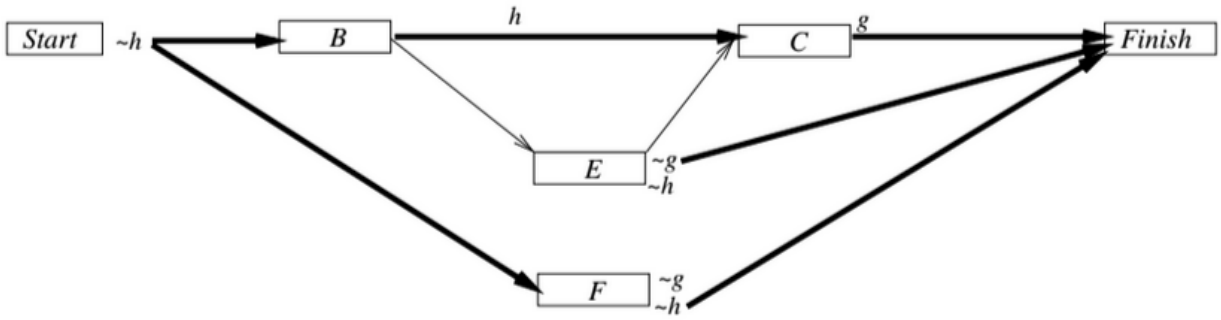
Given the KB above, show how backward chaining with GMP can be used to infer whether Bob passes AI (ie. Passes(Bob, AI). Draw a backward chaining inference tree. Be sure to show all the substitutions used in unification at each stage, as relevant. (10 points)

3- Is backward chaining a complete algorithm? If yes, why? If no, how can we make it complete? (3 points)

4- What does it mean to say that entailment for first-order logic is semidecidable? (2 points)

5) Planning (10 points)

Consider the following partial-order plan (a step followed by e.g. ~g means that the steps deletes g):



1- How many possible total-order plans does this partial-order plan have? (2 points)

2- Which step(s) may threaten the causal link between action B and action C? (2 points)

3- Which step(s) necessarily threaten the causal link between action B and action C? (2 points)

4- How can the plan be refined (by a standard partial-order planner) to remove a possible threat to the causal link between action B and action C ? (2 points)

5- Is g necessarily true at the finish step? Justify your answer. (2 points)