Assignment 5

Written Assignment - Propositional and Predicate Logic

Max points:

- CSE 4308: 100
- CSE 5360: 100

The assignment should be submitted via Blackboard.

Instructions

- The answers can be typed as a document or handwritten and scanned.
- Name files as assignment5_<net-id>.<format>
- Accepted document format is .pdf.
  - If you are using Word, OpenOffice or LibreOffice, make sure to save as .pdf.
  - If you are using LaTEX, compile into a .pdf file.
  - Please do not submit .txt files.
- If you are scanning handwritten documents make sure to scan it at a minimum of 600dpi and save as a .pdf or .png file. Do not insert images in word document and submit.
- If there are multiple files in your submission, zip them together as assignment3_<net-id>.zip and submit the .zip file.

Problem 1

10 points.

Two logical statements A and B are logically equivalent if A <=> B. We have two knowledge bases, KB1 and KB2.. Write a function CHECK_EQUIVALENCE(KB1, KB2) that:

- returns true if KB1 and KB2 are logically equivalent.
- returns false otherwise.

Your pseudocode can use or modify any code from the textbook or slides, and can call any of the functions given in the textbook or slides, as long as such code and functions are used correctly, with correct names for the functions, and with well-specified values for all variables and arguments.

Problem 2

10 points.

A	B	C	KB	S1
True	True	True	True	True
True	True	False	False	True
True	False	True	True	True

True	False	False	False	True
False	True	True	False	False
False	True	False	False	False
False	False	True	False	False
False	False	False	False	False

KB and S1 are two propositional logic statements, that are constructed using symbols A, B, C, and using various connectives. The above truth table shows, for each combination of values of A, B, C, whether KB and S1 are true or false.

Part a: Given the above information, does KB entail S1? Justify your answer.

Part b: Given the above information, does statement NOT(KB) entail statement NOT(S1)? Justify your answer.

Problem 3

10 points.

Suppose that some knowledge base contains various propositional-logic sentences that utilize symbols A, B, C, D (connected with various connectives). There are only two cases when the knowledge base is **false**:
- First case: when A is true, B is true, C is true, D is true.
- Second case: when A is true, B is false, C is true, D is false.

In all other cases, the knowledge base is true. Write a conjunctive normal form (CNF) for the knowledge base.

Problem 4

25 points.

Consider the KB

A <=> B
B => C
D => A
C AND E => F
E
D

Show that this entails C by

i. Forward Chaining
ii. Backward Chaining
iii. Resolution

Problem 5

15 points.

On April 20, 2017, John and Mary sign the following contract:

- If it rains on May 1, 2017, then John must give Mary a check for $10,000 on May 2, 2017
- If John gives Mary a check for $10,000 on May 2, 2017, Mary must mow the lawn on May 3, 2017.

What truly happened those days is the following:
- it did not rain on May 1, 2017
- John gave Mary a check for $10,000 on May 2, 2017
- Mary mowed the lawn on May 3, 2017.

Part a: Write a propositional-logic statement to express the contract. Make sure that, for each symbol that you use, you clearly define what that symbol stands for.

Part b: Write a logical statement to express what truly happened. When possible, use the same symbols as in question 4a. If you need to define any new symbols, clearly define what those new symbols stand for.

Part c: Was the contract violated or not, Justify your answer

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Problem 6

10 points.

Consider a knowledge base with these facts:

- There is a dog called Shadow.
- John gave Shadow to Mary.
- If Shadow is male, Mary gave a smartphone to John.
- If Shadow is female, Mary gave John a laptop.
- John only gives male dogs to people.
- Mary gave John a laptop.

Convert the above knowledge-base to a first-order logic knowledge base. For each predicate, function, constant, or variable that you use, explicitly state:

- What type of entity it is (is it a predicate, function, constant, or variable).
- What its semantics are (what it means).

Problem 7

15 points.

Consider this first-order logic knowledge base:

```
taller(John, Bill)
(∀x) taller(x, Bill) => tall(x)
```

In this first-order logic knowledge base, `taller` and `tall` are predicates, `x` is a variable, and `John`, `Bill` are constants. Convert this first-order logic knowledge base into a propositional logic knowledge base, by performing the following two steps:

1. Define symbols for the propositional-logic version of the knowledge base, and specify what their equivalents are in the original first-order logic knowledge base.
2. Define the statements that should be stored in the propositional-logic version of the knowledge base.

The symbols you define should be comprehensive enough to allow us to translate any well-defined inference problem in the original knowledge base to an equivalent problem for the propositional knowledge base. Anything that we can infer from the original first-order logic knowledge base we should also be able to infer from the propositionalized knowledge base, and vice versa.

Problem 8

5 points

Try and unifiy the following predicates(if possible)

```
taller(John, y), taller(x, Son(x))

taller(y, Barry), taller(Barry, x)

taller(x, Jane), taller(Bob, Jane)

taller(Son(x), Jane), taller(Bob, Jane)

taller(Barry, John), taller(x, y)
```
