CSC520 Fall 2020 Homework 3
Due October 7th at 11:59pm EST

This assignment includes both conceptual and code questions. It must be completed individually. You may not collaborate with other students, share code, or exchange partial answers. Questions involving answers or code must be emailed to the instructor or TAs directly or discussed during office hours. Your answers to the conceptual questions must be uploaded to Moodle as a pdf file titled `Assign3-<unityid>.pdf`. Your source code must be submitted as a self-contained zip called `Assign3-<unityid>.zip` All code must be clear, readable, and well-commented. You may only use libraries to provide standard data structures or file parsing. All third party library use must be checked with Dr. Lynch or the TA *before* submission. For all questions you must show your work.

Note: The code will be tested on the NCSU VCL system. You are advised to test your code there before submission.

Question 1 (10 points)

Using the given lexicon represent the following sentences in propositional logic, convert them to CNF and use resolution or a truth table to derive a contradiction or show a satisfactory model. Show your work.

Lexicon:

p Sally is reading

q Sally wants to publish

s Sally wants to rest.

a It is Tuesday

t Sally will write

Sentences:

Sally will write if and only if she wants to publish it. If it is Tuesday, Sally wants to rest. If Sally is reading, she either wants to rest or publish. If Sally is not reading, then it is not Tuesday. Sally is reading.

Question 2 (15 points)

Using the following lexicon represent the following sentences in FOL. Use resolution and unification to determine if you can derive a contradiction for the target sentence.

Lexicon:

WiCS(x) x is a member of WiCS

Phy(x) x is a Physics major

Com(x) x is a CS major

enroll(x, y) x is enrolled in y

Sentences:

Michelle, Sheryl and Berne are the members of WiCS. Each member of WiCS is either a Physics major, CS major or both. None of the CS majors study Mechanics and all the Physics majors take Scientific computing. Michelle is enrolled in courses that Sheryl is not, and is not in the courses that Sheryl is enrolled in. Sheryl is not enrolled in Mechanics and Scientific Computing.

Target:

There is a WiCS member, who is a CS major but not a Physics major

Question 3 (25 pts)

Listed below is a set of statements. Represent the knowledge using a frame representation with generalized relationships as described in class. Then implement that representation as a Prolog database called `q3.pl`. This code should support general queries of the form: `isa(X, Y)` and `compatible(X, Y)`. Use comments in your code to explain your translation process.

There are two OS-linked manufacturers. Apple and Microsoft. Apple makes Macbooks, iPads, and iPhones, the first two of which are computers. Microsoft makes the Surface series of computers, as well as the Zune music player. The Macbooks come in 15 and 13 inch models and are laptops not touchscreens. The iPad is a tablet. The Surfaces are both and come in the Pro and Go models. All Apple products are compatible with one-another. Microsoft products are not. The Surface Pro is compatible with an iPad, and an iPhone, the Zune is not.

Question 4 (25 pts)

The following Prolog program counts the number of occurrences of the symbol a in a list and its nested lists. Implement this code and additional code as necessary to answer the following questions and save your code in a file called `q4.pl`.

Clause	Code
1	`c([H|T],X):-c(H,N),c(T,M),X is N + M,!.`
2	`c(a,1):-!.`
3	`c(_,0).`

Given the above program and the following query: `c ( [ a , [ a ] , b ] ,X )`.

1. What are the answer(s) to this query?

2. List step by step how the answer is obtained by Prolog interpreter. In each step, state the subgoal list, the line number of the clause matched, and the substitutions. For example, the first two steps should be:

Subgoal List	Matched Clause	Substitutions
c([a, [a], b], X)	1	{a/H, [[a], b]/T }
c(a, N 1), c([[a], b], M 1), X is N 1 + M 1	2	{1/N1}

Note: In above example, when the first clause is expanded, variables N and M are renamed to N1 and M1 correspondingly, this is done to avoid name duplication in case of a clause is expanded multiple times.

3. If we remove the cut term from the second line yielding a statement with no subclauses, Do the answer(s) change? if so Why?

4. What will happen if we subsequently remove the cut term of the first line? Why?

Question 5 (25 pts)

You have been given a prolog database describing a network of roads on a map with distances called `map.pl`. Write code to find the *shortest* path between any pair of cities using the predicate `isShortest(X,Y,Path)`. You may assume that all roads are two-way roads. Name your submitted file `q5.pl`.

Question 6 (10 pts extra credit)

Building on the above code, write code to find the *longest* path with no loops between two cities using the predicate `isLongest(X,Y,Path)`. Name your submitted file `q6.pl`.