CSCE 420 - Fall 2014
Homework #1
due: Tuesday, December 2, 2014 (in class)

1. Convert the following set of propositional sentences to CNF and trace the DPLL algorithm on them to show it is satisfiable by finding a model.

- Number your clauses.
- Mark which clauses are satisfied on each iteration.
- Indicate when you use a **choice** point, or the **Pure** Symbol or **Unit** Clause heuristics.
- Indicate when **backtracking** occurs, and which clause is violated.

$\neg A \vee \neg B$

$A \vee B$

$B \rightarrow D$

$\neg A \vee D$

$\neg B \vee \neg C$

$B \vee C$

$C \rightarrow (\neg A \wedge \neg B)$

$(\neg A \wedge \neg B) \rightarrow C$

2. Paraphrase these FOL sentences in English.

- $\forall x \; \text{IsAStudent}(x) \wedge \text{IsTakingAI}(x) \Rightarrow \text{IsASenior}(x)$
- $\forall a \; (\text{IsADog}(a) \Rightarrow \text{Rules}(a)) \wedge (\text{IsACat}(a) \Rightarrow \text{Drools}(a))$

3. Translate the following sentences into FOL.

- A poodle is a small, fluffy dog.
- Tomatos are either a fruit or vegetable.
- Nobody can light a fire with a wet match.
- Every king has a crown and some subjects.
- You shouldn't eat wild mushrooms, as some are poisonous. (hint: replace 'You' with 'People')
- Someone from the post-office is at the front door of John’s house.

- All laptops sold by Dell in 2012 have at least 4 gigabytes of memory.
- Phillip is eating Raman noodles on his couch. (hint: an "eating event")

4. Convert the following sentences to CNF:

- $P \rightarrow [(A \rightarrow B) \wedge \neg (C \rightarrow D)]$
- $\forall x\ P(x) \rightarrow [\ \forall y\ P(y) \rightarrow P(f(x,y))\ ] \wedge [\neg \forall y\ Q(x,y) \rightarrow P(y)\ ]$

5. Determine whether or not the following pairs of predicates are unifiable. If they are, give the most-general unifier and show the result of applying the substitution to each predicate. If they are not unifiable, indicate why. Variables are in capital letters; constants and function names are lowercase.

a)	P(a, X, f(g(Y)))	P(Z, f(Z), f(U))
b)	Q(f(a), g(X))	Q(Y, Y)
c)	R(f(Y), Y,X)	R(Z, f(a), f(V))
d)	P(a, Y, f(X))	P(Z, f(b), f(b))
e)	Q(g(f(a)), g(X), Z)	Q(Y, Y, f(W))
f)	P(x,f(X),X)	P(Y,f(a),b)
g)	Q(f(a,a), V ,Z)	Q(X, f(X,X), Y)

6. Translate the following sentences into First-Order Logic using Event Calculus. Note that football games are *events*, the interval (time-span) of the game is broken up into 4 quarters plus half-time (other *intervals*).

In all football games...

- The band of the home team marches during halftime. (there is a marching event such that...)
- The winner of the game is the team that has the most points at the end.

For the game g_1 played by TAMU and SMU on 9/20/14...

- The game was played in Gerald Ford stadium in Dallas, and SMU was the home team.
- Nobody left the stadium before halftime.
- TAMU scored a touchdown during the fourth quarter. (hint: another event)
- The score of the two teams was never tied (except when it was 0-to-0).

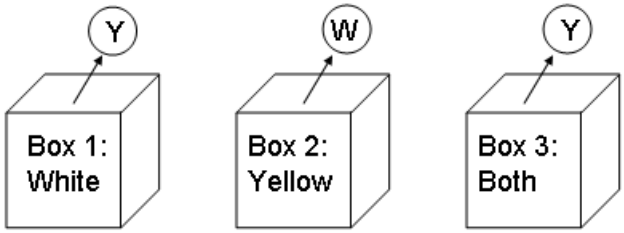
7. Consider the following situation: *Marcus is a Pompeian. All Pompeians are Romans. Ceasar is a ruler. All Romans are either loyal to Caesar or hate Caesar (but not both). Everyone is loyal to someone. People only try to assassinate rulers they are not loyal to. Marcus tries to assassinate Caesar.*

a) Translate these sentences to First-Order Logic.

b) Re-write the sentences as Horn clauses (facts and conjunctive rules).

c) Prove that *Marcus hates Caesar* using backward chaining. Label all derived sentences with prior sentences and unifier used.

8. You are the proprietor of Sammy's Sport Shop. You have just received a shipment of three boxes filled with tennis balls. One box contains only yellow tennis balls, one box contains only white tennis balls, and one contains both yellow and white tennis balls. You would like to stock the tennis balls in appropriate places on your shelves. Unfortunately, the boxes have been labeled incorrectly; the manufacturer tells you that you have exactly one box of each, but that each box is definitely labeled wrong.



a) Write down a complete knowledge base describing all facts and rules for this problem in First-Order Logic (not just the rules needed for the proof, but all the constraints). Use predicates like this: *observe(1,Y), label(3,B), contains(2,W).* (As a hint: you might be tempted to use = or ≠ in your sentences, but there is a way to express the constraint of this problem without using equality.)

b) Convert all your sentences to CNF.

c) Prove *contains(2,W)* using Resolution Refutation in FOL. Number all your sentences, and label each derived sentence with the sentences it was derived from and the unifier used.