Languages for AI
January XX 2020

Time: 2 hours.

1. Consider the language of propositional logic and use natural deduction to prove that the following holds, or find a counter-example to show that it does not hold
   - $B \vee (A \wedge C) \vdash (A \wedge B)$
   - $A \rightarrow (B \wedge C) \vdash (A \rightarrow B) \wedge (A \rightarrow C)$
2. Transform the following propositional logic fomulae into equivalent formulae in Conjunctive (Disjunctive) Normal Form
   - $(\neg A \rightarrow B) \rightarrow (C \rightarrow \neg D)$
3. Prove that the following propositional logic fomulae are logically equivalent or find a counter example to show that they are not.
   - $(A \wedge B) \rightarrow (C \vee D)$ and $(\neg C \wedge \neg D) \rightarrow \neg(A \wedge B)$
   - $(A \wedge B) \rightarrow (C \vee D)$ and $(\neg C \wedge \neg D) \rightarrow \neg(A \vee B)$
4. Let us consider a propositional logic language where
   - A= "Anna goes to the Florence",
   - B = "Bob goes to the Florence",
   - C = "Charlie goes to the Florence",
   - D ="Debora goes to the Florence".

   Formalize in propositional logic the following sentence: Anna, Bob and Charlie go to the Florence if and only if Debora doesn't go, but if neither Anna nor Bob go, then Debora goes only if Charlie goes".
5. Analogous of exercises 2, 3 and 4 for First Order Logic.
6. Write a logic program (or Prolog program, or CLP program) which:
   - given an input list L produces in output the reverse of L (for example, the reverse of the list (a, b, c, d) is (d, c, b, a);
   - given an input list L checks whether it is a palindrome;
   - given an input list L containing integer numbers computes the sum of the elements of the list;
   - given a binary tree T where the labels of the nodes contain integer numbers, compute the sum of all the labels of T;
   - ....
7. Given the (logic, Prolog, CLP) program

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p(a,b):-p(a,b).
p(Z,Y):-q(Z),r(Y).
q(a).
q(b).
r(b).
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   what is the result of the evaluation of the goal $p(X, X)$? Provide a short motivation for the answer.
8. Open and closed questions on the theory done in the course.