# CS 724 Assignment Two: Game Playing & Propositional Logic

*Dues on Feb 25, 11:59pm*

*Total points: 80.*

**1.** [25] This problem exercises the basic concepts of game playing, using tic-tac-toe (noughts and crosses) as an example. We define $X_n$ as the number of rows, columns, or diagonals with exactly n X's and no O's. Similarly, $O_n$ is the number of rows, columns, or diagonals with just n O's. The utility function assigns +1 to any position with $X_3$=1 and -1 to any position with $O_3$ =1. All other terminal positions have utility 0. For non-terminal position, we use a linear evaluation function defined as:
$Eval(s)=3X_2(s) + X_1(s) –(3O_2(s) + O_1(s))$.

a. Show the whole game tree starting from an empty board down to depth 2 (i.e., one X and one O on the board), taking symmetry into account.
b. Mark on your tree the evaluations of all the positions at depth 2.
c. Using the minimax algorithm, mark on your tree the backed-up values for the positions at depths 1 and 0, and use those values to choose the best starting move.

2. [15] Represent each of these sentences in propositional logic.
a) If you take Chemistry, you cannot take Physics.
b) You must take either Chinese or French but not both.
c) You must take at least two of CSci724, CSci617, and CSci764.

3. [20] For each of the following, use truth tables to show whether it is *valid*, *satisfiable*, or *unsatisfiable*.
a. $(P \rightarrow Q) \wedge (P \rightarrow \neg Q)$
b. $(P \rightarrow Q) \wedge (P \rightarrow R) \wedge (\neg Q \wedge \neg R) \wedge P$
c. $(P \rightarrow Q) \vee (Q \rightarrow P)$
d. $((P \rightarrow Q) \rightarrow (Q \rightarrow R)) \leftrightarrow (P \rightarrow R)$

4. [10]
Given: 1) $P \wedge Q \rightarrow R$
2) $\neg X \vee \neg Y \vee R$
3) $Q \wedge Y \rightarrow W$
4) Q
5) $\neg (\neg X)$
6) Y
prove: 7) $R \wedge W$

5. [10] Put the following in *clausal form(CNF)*.
a. $(P \rightarrow Q) \wedge (X \rightarrow Y)$
b. $(P \wedge Q \rightarrow Z) \vee (X \wedge Y)$