**COMP2411 Tutorial 5**

1. Which of the following are Horn clauses (in either the book’s notation or as a disjunction of literals)? Which are definite Horn clauses? Which are equivalent to a set (i.e., conjunction) of Horn Clauses?

   (a) \((A \rightarrow B) \rightarrow C\)
   (b) \((A \lor B) \rightarrow C\)
   (c) \(A \lor B \lor \neg C\)
   (d) \(\bot\)
   (e) \(A \lor A\)
   (f) \(A \land A \rightarrow A\)
   (g) \(\neg(A \land B)\)

2. For each of the following sets of Horn clauses, apply the two techniques for determining unsatisfiability discussed in lectures in Week 5: the algorithmic technique and SLD resolution with leftmost selection rule and a depth first search. When there exists a choice of which clause to use, try the possibilities from top to bottom in the following lists. Comment on the outcome.

   (a)
   \[
   \begin{align*}
   \top &\rightarrow p \\
   p &\rightarrow r \\
   p \land r &\rightarrow s \\
   s \land r &\rightarrow t \\
   a &\rightarrow c \\
   c &\rightarrow f \\
   c &\rightarrow h \\
   c &\rightarrow k \\
   t &\rightarrow \bot
   \end{align*}
   \]

   (b)
   \[
   \begin{align*}
   \top &\rightarrow b \\
   a \land z &\rightarrow x \\
   c \land d &\rightarrow a \\
   c \land f &\rightarrow a \\
   b &\rightarrow a \\
   r &\rightarrow c \\
   b \land q &\rightarrow z \\
   r &\rightarrow q \\
   x &\rightarrow \bot
   \end{align*}
   \]

   (c) The clauses of the previous problem, plus \(q \rightarrow r\) (at the bottom of the list.)
(d) The clauses of the problem (b), plus

\[
\begin{align*}
q \rightarrow r \\
b \land f \rightarrow z \\
\top \rightarrow f
\end{align*}
\]

(add these clauses at the bottom of the list.)

Optional Advanced Questions

1. A two-clause is a clause containing at most two literals. (Some two-clauses are not Horn clauses, since there could be two positive literals.) Show that there is an efficient (non-exponential) algorithm that computes whether a set of two-clauses is satisfiable. Does your approach work for clauses with up to three literals?