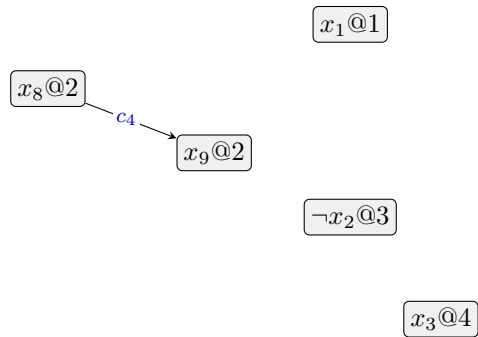


Problem 1: UIPs and their corresponding learned clauses

Consider the CNF formula F with clauses

$$\begin{aligned} c_1 &= \neg x_4 \vee x_6 & c_2 &= \neg x_6 \vee \neg x_7 \vee \neg x_1 \\ c_3 &= \neg x_3 \vee x_2 \vee x_4 & c_4 &= \neg x_8 \vee x_9 \\ c_5 &= \neg x_5 \vee \neg x_6 \vee x_7 & c_6 &= \neg x_4 \vee \neg x_1 \vee x_5 \end{aligned}$$

Consider the decisions in the following figure.



- (a) Draw a contradiction through elimination.
- (b) What are the unique implication points (UIPs)?
- (c) Determine the asserting clause and the backjump level for each UIP.

Problem 2

Consider the CNF formula F with clauses

$$\begin{array}{ll} c_1 = \neg x_2 \vee \neg x_7 \vee x_1 & c_2 = x_5 \vee x_6 \vee \neg x_4 \\ c_3 = x_4 \vee \neg x_1 \vee \neg x_7 & c_4 = \neg x_6 \vee \neg x_3 \vee x_5 \\ c_5 = \neg x_4 \vee \neg x_2 \vee \neg x_6 & c_6 = x_7 \vee x_4 \\ c_7 = \neg x_4 \vee \neg x_5 & c_8 = x_1 \vee \neg x_7 \\ c_9 = \neg x_4 \vee x_1 & c_{10} = \neg x_6 \vee x_2 \end{array}$$

Decide the smallest unassigned variable, set to *true*.

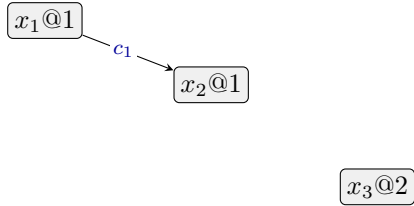
- (a) Run CDCL until the first conflict, do the backjump. What happens?
- (b) Continue until the algorithm reports UNSAT. Extract the resolution refutation (i.e. the proof of unsatisfiability based on binary resolution): list the clauses used in order, from the original clauses to $\perp$ (i.e. false).

Problem 3: Clause Optimization

Consider the CNF formula F with clauses

$$\begin{aligned} c_1 &= \neg x_1 \vee x_2 & c_2 &= \neg x_3 \vee \neg x_1 \vee x_4 \\ c_3 &= \neg x_4 \vee \neg x_2 \vee x_5 & c_4 &= \neg x_4 \vee \neg x_5 \vee \neg x_1 \end{aligned}$$

Consider the decisions made in the following figure.



- (a) Draw a conflict and learn an asserting clause from the first UIP.
- (b) Can the clause be shortened? How?