Tutorial 13

Exercise 1

Show that all the usual boolean operations ($\neg t$, $t_1 \wedge t_2$, $t_1 \vee t_2$, $t_1 \Rightarrow t_2$ and $t_1 \Leftrightarrow t_2$) can be expressed using only the if-then-else construct.

Exercise 2*

- Use Shannon's expansion law to translate the following boolean expression

  $$(\neg x_1 \vee x_2) \wedge \neg(x_3 \vee x_1) \wedge \neg x_3$$

  into if-then-else normal form (assume the ordering $x_1 < x_2 < x_3$).

- Draw the resulting if-then-else expression as a decision graph and apply the reduction rules in order to achieve ROBDD.

Exercise 3

Construct the ROBDD for $\neg x_1 \wedge (x_2 \Leftrightarrow \neg x_3)$ with ordering $x_1 < x_2 < x_3$ using the function **Build** and show its internal representation as an array (table T).

Exercise 4

Construct two ROBDDs for x_1 and $x_1 \Rightarrow x_2$ with ordering $x_1 < x_2$ and compute their conjunction using the function **Apply**.

Exercise 5 (optional)

Recall the notion of *conjunctive/disjunctive normal form* as defined e.g. in "An introduction to Binary Decision Diagrams" on page 7.

- Describe a polynomial time algorithm for determining whether a formula in DNF is satisfiable.
- Describe a polynomial time algorithm for determining whether a formula in CNF is a tautology.