CSC2108: Automated Verification
Assignment 2, part 2
Due: Wednesday, October 24, classtime.
Do not work on this part of the assignment in groups.

1. Let the following two expressions be given:
\[ x_1 = (x_2 \land (x_3 \lor x_4)) \quad (exp_1) \]
\[ (x_2 \lor \neg x_3) \land (x_1 \land x_4) \quad (exp_2) \]
Let the order of variables \( x_1 < x_2 < x_3 < x_4 \) be given.
(a) Build BDDs for the two expressions, referring to them as \( BDD_1 \) and \( BDD_2 \).
(b) Compute \( \text{Apply}('\land', BDD_1, BDD_2) \). You may compare your answers with computing \( exp_1 \land exp_2 \) and building a BDD from it (this is not part of the assignment – it is for your benefit only).
(c) Compute \( \text{Apply}(\lor, BDD_1, BDD_2) \).
(d) Compute \( \text{Quantify}(x_1, BDD_1) \), i.e., compute \( \exists x_1 \cdot exp_1 \).

2. Prove the duality
\[ \mu Z. f(Z) = \neg \nu Z. \neg f(\neg Z) \]

3. Prove that \( AF\varphi = \mu Z. \varphi \lor AXZ \), i.e., prove
(a) \( \varphi \lor AXAF\varphi = AF\varphi \)
(b) \( \forall Y \cdot (Y = \varphi \lor AXY) \Rightarrow (Y \supset AF\varphi) \)

4. Consider this model:
(a) Compute the transition relation \( R \) for this model.
(b) Symbolically, compute the value of \( AGEFy \). Check that the computation is correct by executing the explicit-state model-checking algorithm.
(c) Symbolically, compute \( EGY \).