Section: Master 1 SIGL

Faculty of Mathematics and Computer Science
Department of Computer Science

Formal Verification and Specification
Lab Session (TP) 04

1. **LTL equivalence:**

   - Express $\Box p$ with the operators $\neg$, $\Diamond$ and p.
   - Express $\Diamond p$ with the operator U.
   - Can we express $\bigcirc$ using other operators ?
   - Can we express U using other operators?

2. **LTL Buchi automaton:**
   Transform the following LTL formulae into Buchi automaton with the alphabet $p, \neg p$:
   p, $\neg p$, Xp, Fp, Gp, pUq.

3. **LTL Buchi automaton:**
   Express in LTL the following properties:

   - in the future state, if p is true, q is never true
   - p will be true one time at most
   - p will be true Exactly two times

Answers

1. **LTL equivalence:**

   - Express $\Box p$ with the operators $\neg$, $\Diamond$ and p.
   - Express $\Diamond p$ with the operator U.
   - Can we express $\bigcirc$ using other operators ?
   - Can we express U using other operators?

   Answer:
   - $\Box p \equiv \neg F \neg p$
   - $\Diamond p \equiv trueUp$
   - NO, the other connectors are looser. $\bigcirc$ is exact
   - No, U is mainly used between two subformulas

2. **LTL Buchi automaton:**
   Transform the following LTL formulae into Buchi automaton with the alphabet $p, \neg p$:
   p, $\neg p$, Xp, Fp, Gp, pUq.

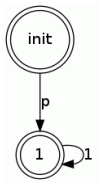

Figure 1: p

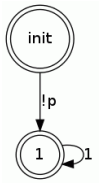

Figure 2: p

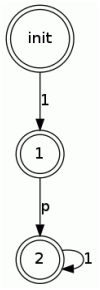

Figure 3: X p

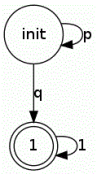

Figure 6: p U q

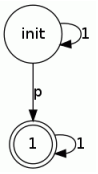

Figure 4: F p

Figure 5: G p

Answer:

3. **LTL Buchi automaton:**
   Express in LTL the following properties:

   - in the future state, if p is true, q is never true
   - p will be true one time at most
   - p will be true Exactly two times

   Answer:
   - $X(p \implies G\neg q)$ or $((Xp) \implies (XG\neg q))$
   - $((G\neg p) \vee (\neg pU(p \wedge X(G\neg p))))$
   - $(\neg pU(p \wedge X(\neg pU(p \wedge X(G\neg p)))))$