Tutorial for Cyber-Physical Systems - Discrete Models
Exercise Sheet 13

Exercise 1: Positive normal form 1 Point
Transform the following LTL formula into an equivalent LTL formula in PNF.

\[ \neg \left( (\Box a) \rightarrow ((a \land \neg c) \lor \neg (\Diamond b)) \right) \]

Exercise 2: From LTL to NBA 3 Points
Provide an NBA for each of the following LTL formulas:

(a) \( \Box (a \lor \neg \Diamond b) \)  
(b) \( \Diamond a \lor \Box (a \leftrightarrow b) \)  
(c) \( \Diamond \Diamond (a \lor \Diamond \Box b) \)

You do not have to apply the algorithm from the lecture (which often produces large automata).

Exercise 3: From LTL to GNBA using elementary sets 3 Points
Consider the LTL formula \( \varphi := \neg a \lor a \) over the set of atomic propositions \( AP = \{ a, b \} \). Apply the algorithm from the lecture to obtain a GNBA \( G_{\varphi} \) whose language is \( \text{Words}(\varphi) \) by executing the following steps.

(a) Construct \( \text{closure}(\varphi) \).
(b) Construct the elementary sets w.r.t. \( \text{closure}(\varphi) \).
(c) Construct the GNBA \( G_{\varphi} \).