Prof. Bernd Finkbeiner, Ph.D.
Peter Faymonville, M.Sc.
Michael Gerke, B.Sc.

Verification

Please write the names of all group members on the solutions you hand in.

Problem 1:

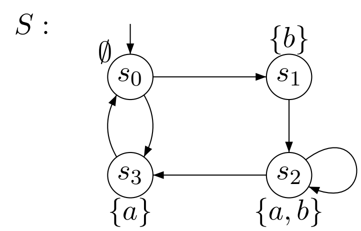
Prove or disprove the following equivalences of LTL–formulas:

$$\Box\varphi \to \Diamond\psi \equiv \varphi\,\mathcal{U}(\psi \vee \neg\varphi) \qquad \Box\Diamond\varphi \to \Box\Diamond\psi \equiv \Box(\varphi \to \Diamond\psi) \qquad \Diamond\,(\varphi\,\mathcal{U}\psi) \equiv \Diamond\psi$$

For disproving, a counterexample for one direction of the equivalence suffices. For proving, show both directions by applying already known equivalences for LTL or giving an argument using the LTL semantics.

Problem 2:

We consider the LTL formula $\varphi = \Box(a \to (\neg b\ \mathcal{U}\ (a \wedge b)))$ over the set $AP = \{a, b\}$ of atomic propositions and want to check $S \models \varphi$, where S is the state graph shown on the right.



(a) Come up with an NBA $\mathcal{A}_{\neg\varphi}$. You don't need to use the algorithm from the lecture for this.
Hint: Four states suffice!

(b) Construct $S \otimes \mathcal{A}_{\neg\varphi}$.

(c) Use the nested DFS algorithm from the lecture to check $S \models \varphi$. Sketch the algorithm's main steps and interpret its outcome.

Problem 3:

Consider the LTL formula $\varphi = \Box\Diamond p$.

(a) Convert φ into an equivalent formula ψ containing only $p, \mathit{true}, \neg, \wedge, \mathcal{U}$.

(b) Give the elementary sets wrt. $\mathit{closure}(\psi)$.

(c) Construct the GNBA $\mathcal{G}_\psi$ using the algorithm given in the lecture.

Problem 4:

Prove that there is an LTL formula φ over $AP = \{p\}$ such that no NBA $\mathcal{A}$ with only a *single* accepting state satisfies $\mathcal{L}(\mathcal{A}) = \mathit{Words}(\varphi)$.