Formal Verification WS 2024/25 Monday 28th October, 2024

Exercise sheet 1

Submission deadline: Friday 8th November, 2024

Submission: via StudOn or in person. Feel free to ask questions!

Equivalences in LTL — 10 points

1. Show that the following equivalences hold in LTL:

$$\mathsf{G}a \equiv a\mathsf{U}\mathsf{G}a \qquad\qquad \mathsf{GF}a \equiv \mathsf{XGF}a$$

2. Which of the following four equivalences hold in LTL? For each of them, give either a proof or a counterexample.

$$(a_1 \wedge a_2)\mathsf{U}b \equiv (a_1\mathsf{U}b) \wedge (a_2\mathsf{U}b) \qquad (a_1 \vee a_2)\mathsf{U}b \equiv (a_1\mathsf{U}b) \vee (a_2\mathsf{U}b)$$
$$a\mathsf{U}(b_1 \wedge b_2) \equiv (a\mathsf{U}b_1) \wedge (a\mathsf{U}b_2) \qquad a\mathsf{U}(b_1 \vee b_2) \equiv (a\mathsf{U}b_1) \vee (a\mathsf{U}b_2)$$

River puzzle II — 10 points

Three actors and their three agents want to cross a river in a boat. The boat is capable of holding up to two people, and there must be at least one person in the boat to operate it. Additionally, there is the constraint that no actor can be in the presence of another agent unless their own agent is also present, because each agent is worried their rivals will poach their client. How should they cross the river with the least amount of rowing?

Model this scenario in Promela and find an *optimal* solution (i.e. a solution using the least possible number of crossings) by writing down an LTL formula that claims its nonexistence. Add short instructions on how to find a solution trace and how to run your model to show the solution in human-readable form (add `printf` statements for that purpose).