Universität Leipzig
Institut für Informatik
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Exercises

# Introduction to Verification

## Exercise Sheet 4 (for 2.5.2023)

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### Exercise 4.1

Prove that the language noncontainment problem for finite automata ("Given two finite automata $\mathcal{A}$ and $\mathcal{B}$, does $L(\mathcal{A}) \not\subseteq L(\mathcal{B})$ hold?") is PSPACE-hard.

### Exercise 4.2

Prove that the language nonequivalence problem for finite automata ("Given two finite automata $\mathcal{A}$ and $\mathcal{B}$, does $L(\mathcal{A}) \neq L(\mathcal{B})$ hold?") is PSPACE-complete.

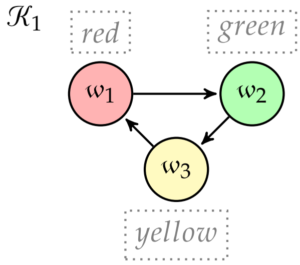
### Exercise 4.3

Consider the following regular properties for *finite paths* of the Kripke structure $\mathcal{K}_1$ shown below.

(i) When the traffic light is green, then it will *finally* be red.

(ii) When the traffic light is green, then it will be red *after exactly two steps*.

(iii) Everytime the traffic light is red, it was *preceded* by a yellow phase.




(a) For each of the properties (i), (ii), and (iii), give a corresponding finite automaton over the alphabet $\mathcal{P}(\mathbb{P})$ that expresses the property, where $\mathbb{P} = \{red, green, yellow\}$.

(b) Can you give an algorithm that decides whether some finite path of $\mathcal{K}_1$ starting in $w_2$ satisfies these properties?

(c) Do all finite paths of $\mathcal{K}_1$ starting in $w_2$ satisfy these properties?

## Exercise 4.4

Consider the Kripke structure $\mathcal{K}_3$ over $\mathbb{P} = \{p, q, r\}$ depicted below. For the following statements, can you give an algorithm that decides whether $\mathcal{K}_3$ satisfies them?

(i) In every path of $\mathcal{K}_3$, the propositional variable $p$ *always* holds true.

(ii) There is some path in $\mathcal{K}_3$, where $p$ is as often true as $q$ is true.

(iii) It is *always possible* to reach a world where $r$ holds in $\mathcal{K}_3$.