# Languages and Automata

**Assignment 2, Tue 13th Nov, 2018**

**Exercise teachers.** The student groups are supervised by the following teachers:

| Teacher | E-Mail | Room | Time |
|---|---|---|---|
| Menno Bartels | `m.m.bartels@student.ru.nl` | HG00.065 | 8:30 – 10:15 |
| Maris Galesloot | `m.galesloot@student.ru.nl` | HG00.086 | 8:30 – 10:15 |
| Leon Gondelman | `lgondelman@gmail.com` | HG00.114 | 8:30 – 10:15 |
| Ellen Gunnarsdóttir | `E.Gunnarsdottir@student.ru.nl` | HG00.308 | 8:30 – 10:15 |
| Toine Hulshof | `T.Hulshof@student.ru.nl` | HG00.633 | 8:30 – 10:15 |
| Alexis Linard | `A.linard@cs.ru.nl` | HG00.310 | 8:30 – 10:15 |
| Jan Martens | `j.martens@student.ru.nl` | HG01.028 | 8:30 – 10:15 |
| Serena Rietbergen | `serena.rietbergen@student.ru.nl` | HG01.029 | 8:30 – 10:15 |
| Bas Steeg | `bas.steeg@student.ru.nl` | HG01.028 | 10:30 – 12:15 |
| Nienke Wessel | `N.Wessel@student.ru.nl` | E1.09 | 10:30 – 12:15 |
| Bas Hofmans | `B.Hofmans@student.ru.nl` | HG00.308 | 15:30 – 17:15 |
| Amber Pater | `A.Pater@student.ru.nl` | HG00.310 | 15:30 – 17:15 |

Postboxes are located in the Mercator building on the ground floor. There will be boxes labelled with *LnA* and the corresponding group teacher's name. There will be 1 box, the *Uitleverbak*, for work that hasn't been picked up at the exercise hours.

**Handing in your answers:** There are two options:

1. E-mail: Send your solutions by e-mail to your exercise class teacher (see above) with subject "**L&A: assignment 2**". This e-mail should only contain a single PDF document as attachment (unless explicitly stated otherwise). Before sending an e-mail make sure:
   - the file is a PDF document
   - your name is part of the filename (for example MyName_assignment-2.pdf)
   - your name and student number are included in the document.
   - please do not submit photographs (scans of handwritten notes are fine).
2. Post box: Put your solutions in the appropriate post box (see above). Before putting your solutions in the post box make sure:
   - your name, student number, and IC, KI, Wiskunde or Science are written clearly on the document.

**Deadline:** Tue 20th Nov, 2018, 8:30 (in Nijmegen!)

**Goals:** After completing these exercises successfully you should be able to construct an automaton from a description of a language, describe the language of a basic automaton, perform the complement and product constructions, and compute a regular expression from an automaton.

There are 3 exercises, worth **10 points** in total.

## 1 DFAs and Their Languages

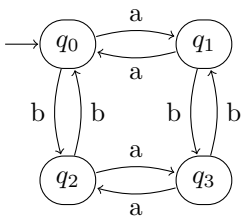
**a)** Let $L$ be the following language over $A = \{a, b\}$. **(3pt)**

$$L = \{w \in A^* \mid |w|_a \text{ is } \textit{not} \text{ divisible by 3 and } w \text{ ends with } a\}$$

Use the constructions for product and complement automata, given in the lecture, to construct an automaton $M$ with $\mathcal{L}(M) = L$.

**b)** Which of the words $abaa$, $ba$ are accepted by your automaton from the previous answer? Justify your answer with accepting or rejecting computations. **(1pt)**

**c)** We define a family of DFA over the alphabet $A = \{a, b\}$ by letting the states $Q$, the transition map $\delta$ and the initial state $q_0$ be as in the following graph.




Describe explicitly the languages $L_1, L_2, L_3$ accepted by the automata $M_i = (Q, q_0, F_i, \delta)$ with accepting states $F_1 = \emptyset$, $F_2 = \{q_0\}$ and $F_3 = \{q_1, q_2\}$, respectively. **(3pt)**

## 2 DFAs and Regular Expressions

Let $M$ be the DFA given by:

- set of states $Q = \{q_0, q_1, q_2\}$
- initial state $q_0$
- set of final states $F = \{q_0, q_2\}$
- transition function $\delta$ given by

| $\delta$ | $a$ | $b$ |
|---|---|---|
| $q_0$ | $q_1$ | $q_0$ |
| $q_1$ | $q_0$ | $q_2$ |
| $q_2$ | $q_0$ | $q_1$ |

**a)** Draw a state/transition diagram for the automaton $M$. **(1pt)**

**b)** Construct a regular expression $e$ such that $\mathcal{L}(M) = \mathcal{L}(e)$. **(2pt)**