Languages and Automata

Assignment 4, Tue 27th 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	leon.gondelman@gmail.com	HG00.114	8:30 – 10:15
Ellen Gunnarsdóttir	E.Gunnarsdottir@student.ru.nl	HG00.308	8:30 – 10:15
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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 4**". 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-4.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 4th Dec, 2018, 8:30 (in Nijmegen!)

Goals: After completing these exercises successfully you should be able to recognise a regular language and, if it is not, then show this by using non-regularity of other languages or by using distinguishable words. Further, you should be able to minimise an automaton.

There are 3 mandatory exercises, worth **10 points** in total. There is 1 more, extra hard, exercise. Be aware that this exercise is just for fun, you cannot earn any points with it.

1 Non-regular Languages

Let A be the alphabet $\{a, b, c\}$, and let

$$L_1 = \{a^m b^n \in A^* \mid m \text{ is even if and only if } n \text{ is even}\}$$
$$L_2 = \{c^n a^p c^m b^p \mid n, m, p \in \mathbb{N}\}$$
$$L_3 = \{a^n b^m \mid n \neq m\}$$

Decide the following statements. Give in each case an appropriate explanation, in which you may use languages that have been shown to be non-regular in the lecture, and the techniques that have been presented there (see last slide). Tip: Try to use simpler techniques first.

a) Is L_1 regular? **(1pt)**

b) Is L_2 regular? **(1pt)**

c) Is L_3 regular? **(2pt)**

2 Non-Regular Languages via Distinguishable Words

Show the following languages over $\{a, b, c\}$ to be non-regular using infinite collections of distinguishable words.

a) **(2pt)**

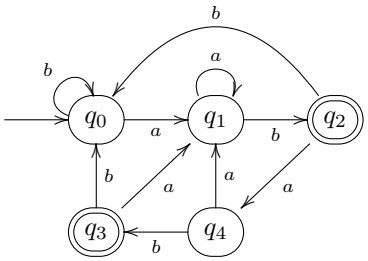
$$L = \{a^m b^n \mid m, n \in \mathbb{N}, n < m\}$$

b) **(2pt)**

$$L = \{ucv \mid u, v \in \{a, b\}^*, \, u \text{ appears as subword in v}\}$$

3 Minimisation

Consider the following automaton: **(2pt)**



Minimise this automaton, using the construction from the lecture.

4 Fun Exercises

1. Show that the following language L over $A = \{a, b\}$ is not regular.

$$L = \{a^n b^m \mid n = km, \text{ for some } k \in \mathbb{N}\}$$

2. Show that the following language L over $A = \{a\}$ is not regular.

$$L = \{a^{n^2} \mid n \in \mathbb{N}\}.$$