

Talen en Automaten

Assignment 4, Tue 5th Dec, 2017

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

Teacher	E-Mail	Room	Time
Michiel de Bondt	M.deBondt@math.ru.nl		8:45 – 10:30
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Tom van Bussel	tom.van.bussel@student.ru.nl		8:45 – 10:30
David Venhoek	david@venhoek.nl		8:45 – 10:30
Alexis Linard	A.linard@cs.ru.nl		8:45 – 10:30
Bas Steeg	bas.steeg@student.ru.nl		10:45 – 12:30
Ties Robroek	ties.robroek@student.ru.nl		10:45 – 12:30
Jan Martens	j.martens@student.ru.nl		15:45 – 17:30
Nienke Wessel	N.Wessel@student.ru.nl	HG00.310	15:45 – 17:30

Postboxes are located in the Mercator building on the ground floor. There will be boxes labelled with *Talen en Automaten* 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 "**T&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 (they will be printed).
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 or Wiskunde are written clearly on the document.

Deadline: Tue 19th Dec, 2017, 8:45 (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 the pumping lemma.

There are 2 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 Pumping Lemma for Regular Languages

Show the following languages over $\{a, b, c\}$ to be non-regular by means of the pumping lemma.

- a) (3pt)
- $$L = \{a^m b^n \mid m, n \in \mathbb{N}, n < m\}$$

- b) (3pt)
- $$L = \{vca^n \mid v \in \{a, b, c\}^* \text{ with } |v| < n, \text{ for some } n \in \mathbb{N}\}$$

3 Fun Exercises – Pumping Lemma

1. Show, again by appealing to the pumping lemma, 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, again by appealing to the pumping lemma, that the following language L over $A = \{a\}$ is not regular.

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