Talen en Automata
Assignment 4, Tuesday 29$^{\text{th}}$ November, 2016

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

Teacher	E-Mail	Room	Time
Michiel de Bondt	`M.deBondt@math.ru.nl`	HG00.058	10:45 − 12:30
Bas Steeg	`steegbas@gmail.com`	HG02.032	10:45 − 12:30
Demian Janssen	`wd.janssen@student.ru.nl`	HG01.058	10:45 − 12:30
Jan Martens	`jan-martens@hotmail.com`	HG01.139	10:45 − 12:30
Ties Robroek	`ties.robroek@student.ru.nl`	HG02.028	10:45 − 12:30
Sjoerd Hemels	`sjoerd0707@live.nl`	HG03.632	10:45 − 12:30
Rick Erkens	`rjarickerkens@gmail.com`	HG02.028	**13:45 − 15:30**

Postboxes are located in the Mercator building on the ground floor. There are 7 boxes labelled with *Talen en Automaten* and the corresponding group teacher's name. There is 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: Tuesday 6$^{\text{th}}$ December, 2016, 13:30 (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 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

$$L_1 = \{a^m b^n \in A^* \mid m = n \pmod 2\}$$
$$L_2 = \{c^n a^p c^m b^p \mid n, m, p \in \mathbb{N}\}$$
$$L_3 = \{ww^R \mid w \in A^*\}.$$

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