Formal languages, grammars, and automata

Assignment 7, Wednesday, Jan. 14 2015

Exercise teachers. Recall the following split-up of students:

teacher	lecture room	email	students
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The delivery boxes are located in the Mercator 1 building on the ground floor (where the Computer Science department ICIS is located).

Handing in your answers. The exercises marked with **points** should be handed in:

1. Delivery box (default): Put your solutions in the appropriate delivery box (see above). Before putting your solutions in the box make sure:
   - your name and student number are written clearly on the document.
2. E-mail (in case your exercise class teacher approves): Send your solutions by e-mail to your exercise class teacher (see above) with subject '*assignment 7*'. This e-mail should only contain a single PDF document as attachment. Make sure:
   - the file is a PDF document that is well readable
   - your name is part of the filename (for example MyName_assignment-7.pdf)
   - your name and student number are in the document (since they will be printed).

Deadline: Monday, January 19, 16:00 sharp!

Goals: After completing these exercises you should understand all material for this course. The total number of points is 40.

1. **(5 points)** Draw 4 iterations of the following Lindenmayer system with start symbol S.

$$S \to F[+S][X]$$
$$X \to F[-X][S]$$

   Here + stands for a 45° rotation clockwise, and - stands for a 45° rotation counter-clockwise, F stands for a step forward.

2. Consider the following context sensitive grammar G_2

S	$\to$	$XSY \mid a \mid b$
Xa	$\to$	aa
Xb	$\to$	bb
Y	$\to$	a

   (a) **(5 points)** Describe the language generated by G_2 using set notation.

   (b) **(5 points)** Is $\mathcal{L}(G_2)$ context-free? If so, give a CFG.

   (c) **(5 points)** Is $\mathcal{L}(G_2)$ deterministic context-free, if so, prove it by giving a deterministic PDA.

3. Consider the languages
   - $L_1 = \{a^n \mid n \text{ is prime}, n \leq 10\}$.
   - $L_2 = \{w \mid w \text{ does not contain } bb\}$.
   - $L_3 = \{wb^n \mid |w|_b = n, n \geq 0\}$

(a) **(5 points)** One of L_1, L_2, L_3 is not regular, the other two are. Show this by giving regular expressions for these two languages.

(b) **(5 points)** Show that the other language is not regular using the pumping lemma.

(c) **(5 points)** Construct a context-free grammar for the language that is not regular.

(d) **(5 points)** Is $L_2 \cap L_3$ regular? If so, give a regular *grammar* for it.