Oblig 2

IN2080

Deadline: March 25, 2022

Hand-in and deadline

Hand in a single PDF file (containing your answers to Problems 1 and 2) and 3 text files (containing your answers to Problem 3) in Devilry. The deadline is **March 25, at 23:59**.

We recommend LaTeX, but all major text editors allows exporting to PDF. You can get help with LaTeX at the group sessions. You can also download the LaTeX source (`.tex`) for this assignment at the assignments page.

Problem 1: Context-free languages

Consider the languages

$$L_1 = \{\mathsf{a}\mathsf{b}^n\mathsf{c}^n \mid n \geq 0\}$$

and

$$L_2 = \{\mathsf{a}^i\mathsf{b}^j\mathsf{c}^k \mid i, j, k \geq 0 \text{ and } i + j = k\}.$$

Problem 1a

Construct a CFG which generates L_1.

Problem 1b

Give the state diagram for a PDA which recognizes L_1.

Problem 1c

Show that L_2 is context-free.

Problem 2: Pumping lemmas

Problem 2a

Consider the language L_2 from problem 1. Prove, using the pumping lemma for regular languages, that L_2 is not regular.

Problem 2b

Let $L_3 = \{\mathsf{a}^i\mathsf{b}^j\mathsf{c}^k \mid i, j, k \geq 0 \text{ and } i \times j = k\}$.

Prove, using the pumping lemma for context-free languages, that L_3 is not context-free.

Problem 3: Turing machines

In this problem you will give implementations of Turing machines using the Turing machine simulator found on https://github.com/torenord/universaltm and following the format specified there. Hand in one text file for each problem, giving your description of the specific Turing machine, which can be run using that simulator.

Problem 3a

Create a Turing machine M_1 deciding the language from chapter 3: $\{w\#w \mid w \in \{0,1\}^*\}$. Deliver a text file named M1.txt containing the description of the Turing machine.

Problem 3b

Create a Turing machine $M_{3.8a}$ deciding the language from exercise 3.8a: $\{w \in \{0,1\}^* \mid w$ contains an equal number of 0s and 1s$\}$. Deliver a text file named M3-8a.txt containing the description of the Turing machine.

Problem 3c

Create a Turing machine $M_{3.8b}$ deciding the language from exercise 3.8b: $\{w \in \{0,1\}^* \mid w$ contains twice as many 0s as 1s$\}$. Deliver a text file named M3-8b.txt containing the description of the Turing machine.