

CS-275 – Coursework Part 2

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- This is an individual assignment, and you must not collaborate with others or share solutions.
- If you are using sources other than the lecture material, cite them.
- You submit your solutions by uploading a single pdf file on Canvas.

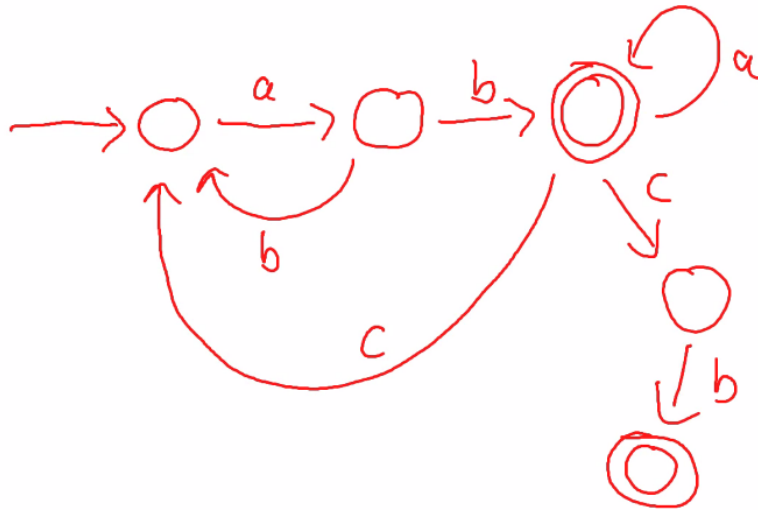


Figure 1: A non-deterministic automaton

Exercise 1 (Easy, 1 mark). Consider the grammar $S \rightarrow aTS$, $S \rightarrow T$, $T \rightarrow b$, $T \rightarrow bcc$, $T \rightarrow TT$. Explain why the word $abbbcc$ belongs to the generated language by writing out the derivation steps (ie a path in the \leftrightarrow relation).

Exercise 2 (Medium, 2 marks). Draw an automaton that accepts the language $\{aa, bb\}^*$.

Exercise 3 (Medium, 2 marks). Use the powerset construction to find a deterministic automaton accepting the same language as the non-deterministic one in Figure 1. (Omit unreachable states. You may also omit dead ends.)

Exercise 4 (Medium-advanced, 2 marks). Prove that the language

$$\{a^x b^y a c^z \mid x, y, z \in \mathbb{N} \ x > 3 \wedge y \text{ is prime}\}$$

is not regular using the pumping lemma.

Exercise 5 (Advanced, 6 marks). Given two words w, u of the same length, let their interleaving be $\langle u, w \rangle$ defined as $|\langle u, w \rangle| = 2|u|$, $\langle u, w \rangle(2n) = u(n)$ and $\langle u, w \rangle(2n + 1) = w(n)$. Thus, we put the symbols from u at the even positions in $\langle u, w \rangle$ and the symbols from w at the odd positions. Recall that we start numbering positions by 0.

Given two languages L_1, L_2 , let $\langle L_1, L_2 \rangle = \{\langle u, w \rangle \mid u \in L_1 \wedge w \in L_2 \wedge |u| = |w|\}$.

Prove that if L_1 and L_2 are regular, then so is $\langle L_1, L_2 \rangle$ by showing how to construct a finite automaton for $\langle L_1, L_2 \rangle$ from finite automata for L_1 and L_2 .

Hint: Have a look at the product automaton construction and get creative with the transition relation.