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INFO-F-403 – Introduction to language theory and compiling
First session examination

January, 23rd, 2017

Instructions

- This is a closed book test. You are not allowed to use any kind of reference.
- You can anwser in French or in English.
- Write your first and last names on each sheet that you hand in.
- Write clearly: you can use a pencil or a ballpen or even a quill as long as your answers are readable!
- Always provide full and rigourous justifications along with your answers.
- This test is worth 12 points out of 20. The weight of each questions is given as a reference.
- In your answers (diagrams representing automata, grammars,...), you can always use the conventions adopted in the course, without recalling them explicitely. If you deviate from these conventions, be sure to make it clear.

Question 1 — 4 points

In the course, we have seen that all regular languages are also context-free, but that there are some context-free languages which are not regular (i.e., the inclusion is proper).

1. Define *formally* the notions of *regular language* and *context-free language*.
2. *Prove* that all regular languages are context-free. Start by outlining the main steps of your proof, then prove each step as formally as you can.
3. Give a context-free language which is not regular, and explain why it is not regular.

Question 2 — 2 points

What are the six phases of compiling? Give their names, explain their different functions, and explain how they communicate with each other.

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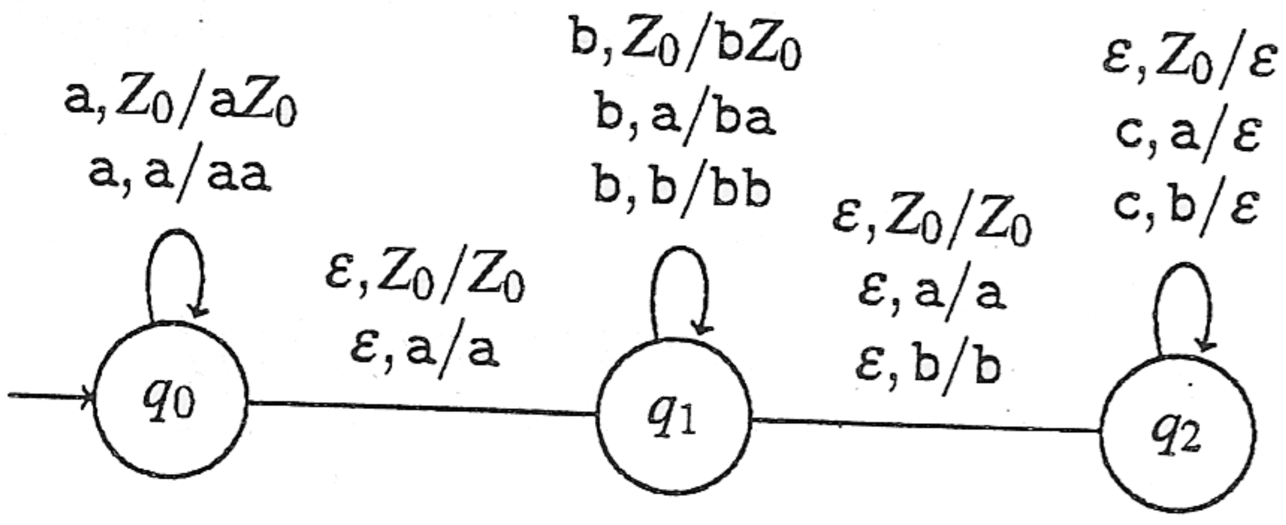
Question 3 — 3 points

1. Given a PDA $P = \langle Q, \Sigma, \Gamma, \delta, q_0, Z_0, F \rangle$, define the following notions: (i) *configuration* of a PDA; (ii) *configuration change* of a PDA; and (iii) the *accepted language by empty stack*, also denoted $N(P)$.
2. Then, consider the following PDA on $\Sigma = \{\mathtt{a}, \mathtt{b}, \mathtt{c}\}$:



and the three following words:

(a) ε,

(b) aabccc,

(c) abaccc.

For each of those words, determine whether the above PDA accepts it (by empty stack). When the PDA *does* accept the word, prove it using the definitions you have given above (i.e., give an accepting sequence of configurations for the word).

Question 4 — 3 points

Give the LR(0) canonical finite state machine (CFSM) of the following grammar (where the set of variables is $\{S', S, A, B, C\}$ and the set of terminals is $\{\mathtt{a}, \mathtt{b}, \mathtt{c}, \mathtt{d}\}$):

(1)	S'	$\rightarrow$	$S\$$
(2)	S	$\rightarrow$	aAb
(3)		$\rightarrow$	aB
(4)		$\rightarrow$	c
(5)	A	$\rightarrow$	dA
(6)		$\rightarrow$	a
(7)	B	$\rightarrow$	BC
(8)		$\rightarrow$	b
(9)	C	$\rightarrow$	c

Is the grammar LR(0)? Is it SLR(1)? Justify your answers by giving action tables without conflicts when your answer is positive, or by pointing out the conflict(s) when your answer is negative.