Automi, Linguaggi e Traduttori. 16 September 2008. Precision and clarity are important. Document your program of Exercise 1 and motivate your constructions and answers. Exercise 1 is compulsory.

1. (6) Write a C++ or Java program for testing whether or not a word in $\{a, b, c\}^*$ is generated by the grammar with axiom S and the following productions:

$\quad S \to A S \mid a \qquad A \to a A b \mid \varepsilon$

Determine the time complexity and space complexity of your program.

2. (4) Define a notion of "the power of a pushdown automaton" and show that for that notion of power, the *deterministic* pushdown automata have strictly less power than the *nondeterministic* pushdown automata.

3. (3) Construct the Greibach normal form of the grammar with axiom T and the following productions:

$\qquad T \to F \mid T \times F \qquad F \to (T) \mid a$

4. (3) Construct an $LALR(1)$ parser, if any, for the context-free grammar with axiom S and the following productions: $\quad S \to aA \mid bB \qquad A \to \varepsilon \mid cAd \qquad B \to \varepsilon$

5. (4) Find *all* (not *some*) formulas $P(x, y)$, which may depend on x and y, such that the Hoare's triple

$\quad \{y > 1\}\ x := 0;\ \text{while } y > x \wedge P(x, y)\ \text{do } x := y - 1\ \{x = 0 \wedge y > 1\}$ holds.

6. (3) Define a set $\mathcal{C}$ of context-free languages which has more than three languages and $\mathcal{C}$ is a boolean algebra with respect to the three operations: (i) $\_ \cup \_$ as lub, (ii) $\_ \cap \_$ as glb, and (iii) $\Sigma^* - \_$ as complement.

7. (3) Define a problem (that is, a set of words) P such that P is not semidecidable and the negation of P is semidecidable. (For instance, given the problem $\{x \mid x$ is a prime number$\}$, its negation is $\{x \mid x$ is not a prime number$\}$.)

8. (4) Illustrate a parsing algorithm for operator precedence grammars.

Nota. Tra parentesi sono indicati i punti per ogni esercizio. Le due prove in itinere valgono, di norma, 4+4 punti. Per la prova orale, si presenti: (i) il programma fatto da solo/a di cui all'Esercizio 1 con alcune prove di esecuzione, (ii) un elaborato con la soluzione degli altri esercizi fatti da solo/a e (iii) se possibile, si venga con un portatile ove siano istallati e pronti per l'esecuzione i programmi relativi alle due prove in itinere.

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