

Formal Languages and Automata Theory, SS 2017. Homework 1 (due Week 3, respectively 4)

1. Give examples of NP-hard problems. Explain.
2. Extend the example grammar given in the class such that the programming language generated with the help of it contains also lists of statements and real constants.
3. Specify the language generated by the grammar $G = (V_N, V_T, S, P)$:

- (a) $V_N = \{A\}, V_T = \{a, b\}, S = A, P = \{A \rightarrow aA|b\}$
- (b) $V_N = \{x_0, x_1, x_2\}, V_T = \{A, B, \dots, Z\}, S = x_0, P = \{x_0 \rightarrow Ex_1, x_1 \rightarrow Nx_2, x_2 \rightarrow D\}$
- (c) $V_N = \{A\}, V_T = \{0, 1, 2\}, S = A, P = \{A \rightarrow 0A0|1A1|2A2|\lambda\}$
- (d) $V_N = \{S, A\}, V_T = \{0, 1, \dots, 9, .\}, P = \{S \rightarrow A.A, A \rightarrow 0A|1A|\dots|9A|0|1|\dots|9\}$
- (e) $V_N = \{S\}, V_T = \{USR, PNL, PSD, ANR\}, P = \{USR|PNL|PSD|ANR\}$
- (f) $V_N = \{A, B, C\}, V_T = \{0, 1\}, S = A, P = \{A \rightarrow 0A|1B|1, B \rightarrow 0C|1A, C \rightarrow 0B|1C|0\}$
- (g) $V_N = \{S, A, B, C\}, V_T = \{0, 1, \dots, 9, +, -\}, P = \{S \rightarrow +A|-A|A, A \rightarrow 0A|1A|\dots|9A|0|\dots|9\}$
- (h) $V_N = \{S\}, V_T = \{(\cdot), \cdot\}, P = \{S \rightarrow S(S)S|\lambda\}$
- (i) $V_N = \{E, T, F\}, V_T = \{(\cdot), \cdot, i, +, *\}, S = E, P = \{E \rightarrow E + T|T, T \rightarrow T * F|F, F \rightarrow (E)|i\}$
- (j) $V_N = \{S, A, B\}, V_T = \{a, b, c\}, S = E, P = \{S \rightarrow abc|aAbc, Ab \rightarrow bA, Ac \rightarrow Bbcc, bB \rightarrow Bb, aB \rightarrow aaA|aa\}$
- (k) $V_N = \{S, A, B, C, D, E\}, V_T = \{a\}, P = \{S \rightarrow ACaB, Ca \rightarrow aaC, CB \rightarrow DB|E, aD \rightarrow Da, AD \rightarrow AC, aE \rightarrow Ea, AE \rightarrow \lambda\}$
- (l) $V_N = \{S, A, B, C, D, E\}, V_T = \{a, b\}, P = \{S \rightarrow ABC, AB \rightarrow aAD|bAE, DC \rightarrow BaC, EC \rightarrow BaC, EC \rightarrow BbC, Da \rightarrow aD, Db \rightarrow bD, Ea \rightarrow aE, Eb \rightarrow bE, Db \rightarrow bD, AB \rightarrow \lambda, C \rightarrow \lambda, aB \rightarrow Ba, bB \rightarrow Bb\}$

4. Devise grammars generating the following languages:

- (a) $L = \{\lambda\}$
- (b) $L = \emptyset$
- (c) $L = \{0^n | n \in \mathbb{N}\}$
- (d) $L = \{a^i b^j a^i b^j\}$
- (e) $L = \{awbbw' | w, w' \in \{0, 1\}^*\}$
- (f) $L = \{w | w \text{ real constant in C programming language}\}$
- (g) $L = \{w \in \{0, 1\}^* | w \text{ contains maximum 2 zeros}\}$
- (h) $L = \{wa\tilde{w} | w \in \{0, 1\}^*\}$
- (i) $L = \{w | w \text{ is a byte representing an even number}\}$
- (j) $L = \{A, B, \dots, Z\}$