

Formal Languages and Automata Theory, SS 2019. Homework 1 (due Week 2)

1. Give examples of NP-hard problems. Explain.

2. 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) $V_N = \{S\}$, $V_T = \{USR, PNL, PSD, ANR\}$, $P = \{USR|PNL|PSD|ANR\}$. Why don't we have a starting point specified?
- (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) $V_N = \{S\}$, $V_T = \{(\cdot,)\}$, $P = \{S \rightarrow S(S)S|\lambda\}$
- (i) $V_N = \{E, T, F\}$, $V_T = \{(\cdot,), i, +, *\}$, $S = E$, $P = \{E \rightarrow E + T|T, T \rightarrow T * F|F, F \rightarrow (E)|i\}$
- (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) $V_N = \{S, A, B, C, D, E\}$, $V_T = \{a, b\}$, $P = \{S \rightarrow ABC, AB \rightarrow aAD|bAE, DC \rightarrow BaC, EC \rightarrow BbC, Da \rightarrow aD, Db \rightarrow bD, Ea \rightarrow aE, Eb \rightarrow bE, Db \rightarrow bD, AB \rightarrow \lambda, C \rightarrow \lambda, aB \rightarrow Ba, bB \rightarrow Bb\}$