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3. Exercises for the Course „Automata and Logic“

Exercise 11:

Describe the language accepted by the Turing machine $M := (Q, \Sigma, \Gamma, \delta, q_0, q_{acc}, q_{rej})$ defined as follows:

$$\begin{aligned}
Q &:= \{q_0, \ldots, q_3, q_{acc}, q_{rej}\} \\
\Sigma &:= \{a, b\} \\
\Gamma &:= \{a, b, \sqcup\} \\
\delta(0, a) &:= (q_1, \sqcup, R) \\
\delta(0, b) &:= (q_{rej}, b, R) \\
\delta(0, \sqcup) &:= (q_{acc}, \sqcup, R) \\
\delta(1, a) &:= (q_1, a, R) \\
\delta(1, b) &:= (q_1, b, R) \\
\delta(1, \sqcup) &:= (q_2, \sqcup, L) \\
\delta(2, a) &:= (q_{rej}, a, L) \\
\delta(2, b) &:= (q_3, \sqcup, L) \\
\delta(2, \sqcup) &:= (q_{rej}, \sqcup, L) \\
\delta(3, a) &:= (q_3, a, L) \\
\delta(3, b) &:= (q_3, b, L) \\
\delta(3, \sqcup) &:= (q_0, \sqcup, R)
\end{aligned}$$

Exercise 12:

Develop Turing machines that accept the following languages:

- $\Sigma = \{a\}$ and $L_u := \{a^n \mid n \text{ is a power of 2 }\}$;
- $\Sigma = \{0, 1\}$ and $L_b := \{\widehat{n} \mid n \text{ is a power of 2}\}$, where $\widehat{n}$ denotes the binary representation of n.

Here and in the next exercise, Use a graphical notation for the transition table.

Exercise 13:

In the lecture, a Turing machine was sketched that accepts the following language:

$$L := \{\#\widehat{n}\#\widehat{m}\#\widehat{n+m}\# \mid n, m > 0\}$$

Work out the details for the part of this TM that checks whether the sum is correct (assuming that the input is guaranteed to be in the required form).