

Finite Automata Theory and Formal Languages

TMV027/DIT321 – LP4 2015

Turing Machines

Week 8

Basic exercises

1. Given the alphabet $\Sigma = \{I\}$, the Natural number n can be represented in a tape as n consecutive occurrences of I .

Give both a high-level description and a transition diagram of a Turing machine computing the following operations on Natural numbers:

- (a) Successor and predecessor;
- (b) Addition and subtraction;

Consider the input numbers on the tape separated by a blank symbol (\square).

2. For each of the languages below, give both a high-level description and a transition diagram of a Turing machine accepting the language.

In each case, state whether your Turing machine is also a Turing decider or not.

- (a) $\{\#w\#w \mid w \in \{0, 1\}^*\}$;
- (b) $\{\#w_1\#w_2 \mid w_1, w_2 \in \{0, 1\}^* \text{ and } w_1 \neq w_2\}$;
- (c) $\{\#w_1\#w_2 \mid w_1, w_2 \in \{0, 1\}^* \text{ and } \text{length}(w_1) < \text{length}(w_2)\}$;
- (d) $\{\#w_1\#w_2 \mid w_1, w_2 \in \{0, 1\}^* \text{ and } \text{length}(w_1) = \text{length}(w_2)\}$;

Additional exercises

1. Give a Turing machine for the multiplication of numbers given as in exercise 1) above.
2. Do as in exercise 2) above for the following languages:

- (a) $\{0^n 1^n 2^n \mid n \geq 0\}$;
- (b) $\{0^i 1^j 2^k \mid k = i * j\}$;
- (c) $\{0^i 1^j \mid j = i^2\}$.

Programming exercises

1. Write a program that runs/simulates a Turing machine.