Tutorial 2

Exercise 1 (compulsory)

Can 3-tape Turing machines recognize a larger class of languages than 2-tape Turing machines?

- If your answer is positive, then provide an example of a language recognizable by a 3-tape Turing machine but not recognizable by any 2-tape Turing machine.
- If your answer is negative, give a short but complete argument supporting your claim.

Exercise 2 (compulsory)

One can imagine an extension of the Turing machine model such that the transition function is of the type

$$\delta : Q \times \Gamma \to Q \times \Gamma \times \{\mathrm{L}, \mathrm{R}, \mathrm{V}\}$$

where V denotes that the head is to be immediately (in one step) moved to the leftmost tape-cell. Is this extension more powerful than the original Turing machine model? Give precise arguments for your claim, at least on the implementation level description (see the text on page 170-171 after 'Examples of Turning machines').

Exercise 3 (compulsory)

Which of the definitions of nondeterministic Turing machines given below is correct? Read them carefully before you answer.

1. A nondeterministic Turing machine M accepts input x if there exists more than one computation of M on x such that M halts in the state q_{accept}.
2. A nondeterministic Turing machine M accepts input x if no computation of M on x halts in the state q_{reject}.
3. A nondeterministic Turing machine M accepts input x if there exists a computation of M on x such that M halts in the state q_{accept}.
4. A nondeterministic Turing machine M accepts input x if there is exactly one accepting computation of M on x.
5. A nondeterministic Turing machine M accepts input x if for every computation of M on x we have that M halts in state q_{accept}.

Complete the definition below and be as precise as possible:

A nondeterministic Turing machine M is called *decider* if ...

Exercise 4 (compulsory, write down your solutions)

A *lexicographical enumerator* E is a two-tape TM with a special state q_{print} that prints strings on the second tape (by entering the state q_{print}) in the lexicographical order, meaning that once a string w is printed, all other strings that are printed afterwards are in lexicographical order strictly larger than w, in particular implying that their length is at least $|w|$.

Prove that the class of languages that are generated by lexicographical enumerators is equal to the class of decidable languages.

Exercise 5 (compulsory)

What is the statement of Church-Turing Thesis?

Exercise 6 (optional but recommended)

- Problem 3.18 on page 189 (in international edition) or Problem 3.11 on page 189 (in standard edition) (easy).
- Problem 3.20 on page 189 (in international edition) or Problem 3.13 on page 189 (in standard edition) (medium difficult).
- Problem 3.17 on page 189 (in international edition) or Problem 3.10 on page 188 (in standard edition) (hard).