Theoretical Computer Science II

Dr. M. Helmert, Dr. A. Karwath   University of Freiburg
G. Röger   Department of Computer Science
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Exercise Sheet 11
Due: January 20, 2010

Exercise 11.1 (TM computation, $0.5 + 0.5 + 1$ marks)
Consider the TM M_1 on page 12 from the slides on Turing machines (Example 3.5).

(a) Give the sequence of configurations for the input string 1#1.

(b) Give the sequence of configurations for the input string 10#00.

(c) After how many steps does the TM halt on input string 10#10 and what is the final config-
uration?

Hint: To keep the state diagram on the slide readable, all transitions that lead to the state
q_{reject} (which is not shown) are omitted. You can assume that whenever there is no transition
shown for a tape symbol s at a state q_i, the TM has a transition $\delta(q_i, s) \mapsto (q_{reject}, s, R)$. As an
alternative definition, you can assume that the TM rejects an input string whenever it halts in a
state different from q_{accept}.

Exercise 11.2 (TMs, 2 marks)
Describe a TM that decides the language $\{a^n b^n c^n \mid n \geq 0\}$.

Exercise 11.3 (PDAs and TMs, 3 marks)
How would one simulate a PDA on a Turing machine? Please do not write the Turing machine
itself, but rather write the key idea in plain English.

Exercise 11.4 (TM with two-way infinite tape, 3 marks)
A Turing machine with a two-way infinite tape is similar to a normal Turing machine except that
its tape is infinite in both directions. So, it can move left at the start postion. The infinite tape
left of the input string is initially filled with blanks. Show that for every TM with a two-way
infinite tape there is an equivalent TM with a one-way infinite tape.