CS 334 - Homework 3 (Regular Languages) ←[0-indexed!]
Due 4/26/2016

Construction of a Turing Machine

1. Provide a diagram for a single-tape, deterministic Turing Machine which decides the language {s#w | s is a subsequence of w}, where w is a string over the alphabet $\Sigma = \{0, 1\}$.
   You may define the tape-alphabet Γ to include whatever additional symbols that you so choose.

   Ex: "#", "001#0101", "#00", "0#11101".

2. Trace the computation of the string "01#001" through the machine, provided as the sequence of configurations that it passes through from its start state, to its accept-state.

Proving Turing-Decidability

1. Prove that the set $\{s^n \mid s \in \Sigma^*\}$ where $\Sigma:=\{0,1\}$ is Turing-decidable. You may utilize any of the computational models equivalent to Turing machines that were learned in class, in the construction of your proof.

Computing non-decision-problems with Turing Machines

1. Given the alphabet $\Sigma:=\{a, b, c\}$, describe a Turing machine which takes as input a string over Σ^*, and enters the accept state only after sorting the individual symbols of the input string, on the tape. This machine should accept all of Σ^*.

   Ex: Given "abcbca", the halting tape-state would be "aabbcc".
   Ex: Given "", the halting tape-state would be "".
   Ex: Given "abcaab", the halting tape-state would be "aaabbc".

Musings on the Finiteness of DFAs

1. Previously in the course, we defined a Deterministic Finite Automaton to be a 5-tuple, $(Q, \Sigma, \delta, q_0, F)$, such that Q is a finite set of states and Σ is a finite alphabet.

   a. Consider an alternative formulation of DFAs, in which Q is allowed to be an infinite set of states. How does this alter the computational power of the formalism? Can this new model accept more or less languages than a Turing Machine? Why?

b. Alternatively, consider an alternative formulation of DFAs in which Σ is allowed to be an infinite alphabet of symbols (but Q is a finite set of states). How does this alter the computational power of the formalism? Can this new model accept more or less languages than a Turing Machine? Why?