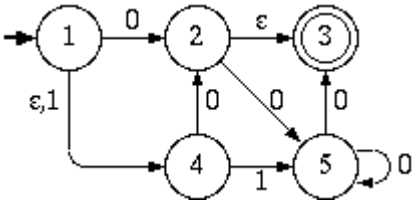
ARSDIGITA VNIVERSITY

Month 8: Theory of Computation

Problem Set 2 - Prof. Shai Simonson

1. Minimizing FSM's

Consider the Finite Automaton below. Construct the smallest Deterministic Finite Automaton which accepts the same language. Finally, draw a regular expression that represents the language accepted by your machine and draw a Regular Grammar that generates it.



2. Regular or Not?

You must prove that your choice is correct

a. The set of strings that have an even number of double zeros in them. (Note that three zeros in a row count as 2 double zeros).
b. The set of strings over the alphabet {0} of the form 0^n where n is not a prime.
c. The set of all strings of the form xwx^R where x and w are non-empty strings over the alphabet {0,1}, and the big R over the x means the reverse of x.
d. The set of all strings over the alphabet {0} whose length is n! for some n > 0.
e. The set of all binary strings that read backwards the same as forwards (pallindromes).
f. 1.17 a,b,c in the text
g. 1.18 in the text
h. 1.23 a,c in the text
i. 1.37 in the text

3. Decision Algorithms

Give decision algorithms to determine if a Regular set

a. Contains all strings of the form 0*1*.
b. Is co-finite. (its complement is finite).
c. 4.14 in the text

4. Regular Grammars

a. Write down a regular (also called left-linear) grammar to generate the set of strings that are evenly divisible by 5 when interpreted as a binary string.
b. A right-linear grammar is a context-free grammar where each production must

be either in the form A->Ba, or A->b, where a and b are terminal symbols and A and B are non-terminals. (The regular grammars we did in class are called left-linear). Right-linear grammars are also equivalent to finite state machines. Explain how to convert a given finite state machine, to an equivalent right-linear grammar. You may use an example to illustrate.

5. Single Symbol Regular Languages

   a. Prove that every language of the form 0^{mx+b}, where m and b are positive integer constants and x ranges from 0 to infinite, is regular.
   b. Describe a regular set over the alphabet {0} that is NOT of the form from part (a).
   c. Extra Credit: Characterize all regular sets over the alphabet {0}, and prove your answer. That is, prove that every regular set over the alphabet {0} is of some particular form.

6. Triple Extra Credit: Minimizing FSM's

   Describe a method to implement the FSM minimization algorithm that runs in O(n log n) time, rather than $O(n^2)$. Write a program implementing your method.