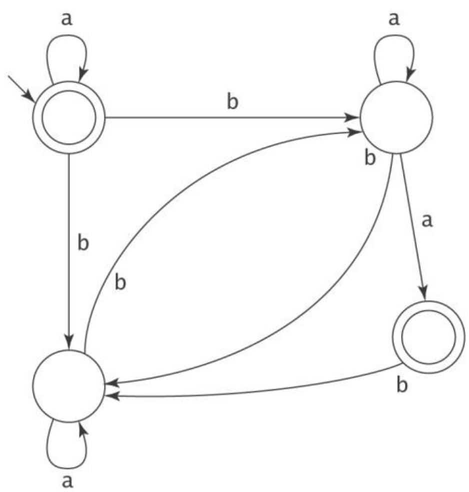
COMP2270/6270 – Theory of Computation
Fourth week

School of Electrical Engineering & Computing
The University of Newcastle

Exercise 1) Let L be a language for which there exists a NDFSM that accepts L, is it true that there exists at least one such a language for which there does not exist any DFSM (Deterministic FSM) that accepts it? Justify your answer

Exercise 2) (Chapter 5, Exercise 5 of Ref. [1])
Consider the following NDFSM M



For each of the following strings *w*, determine whether $w \in L(M)$:

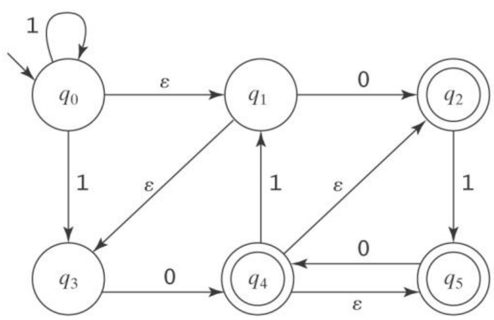
a) aabbba.
b) bab.
c) baba.

Exercise 3) (Chapter 5, Exercise 6 of Ref. [1]) Show a possibly nondeterministic FSM to accept each of the following languages:

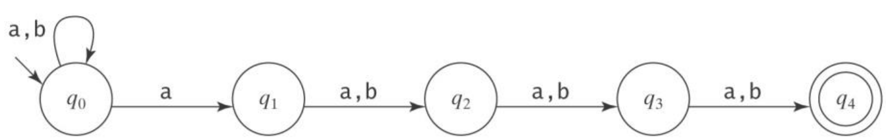
a) L= $\{a^n b a^m : n, m \geq 0, n \equiv_3 m\}$.
b) L= $\{w \in \{0, 1\}^* : w$ corresponds to the binary encoding of a positive integer that is divisible by 16 or is odd$\}$.
c) L = $\{w \in \{0, 1\}^* : w$ contains both 101 and 010 as substrings$\}$.

Exercise 4) The algorithm *ndfsmtodfsm* (Ref. [1] , pages 75-76) allows you to receive as input a non-deterministic Finite State Machine (NDFSM) and construct another *equivalent* deterministic finite state machine.

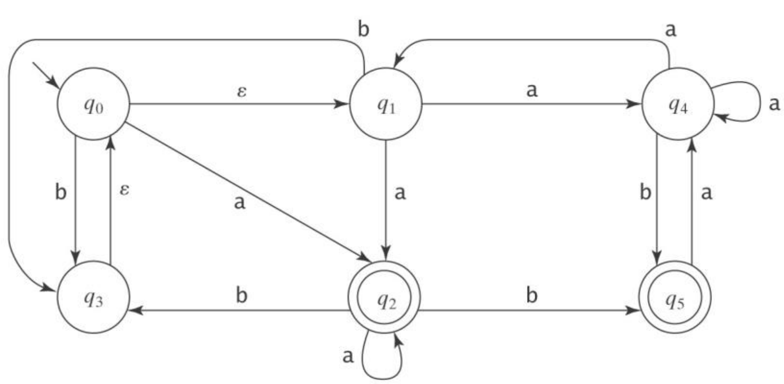
a) What does “equivalent” refers to in the previous sentence ?
b) Follow Example 5.20 (pages 76-77).
c) Solve at least one case of Chapter 5, Exercise 9 of Ref. [1]. Choose one of the following NDFSMs, use *ndfsmtodfsm* to construct an equivalent DFSM. Begin by showing the value of *eps*(q) for each state q



(a)



(b)



(c)

Exercise 5) From Chapter 6, Exercise 1 of Ref. [1]). 1) Describe in English, as briefly as possible, the language defined by each of these regular expressions

a) (b ∪ ba) (b ∪ a)* (ab ∪ b).
b) (((a*b*)*ab) ∪ ((a*b*)*ba))(b ∪ a)*.

Exercise 6) From Chapter 6, Exercise 2 of Ref. [1]). 1)
2) Write a regular expression to describe each of the following languages:

a) {*w* ∈ {a, b}* : every a in *w* is immediately preceded and followed by b}.
b) {*w* ∈ {a, b}* : *w* does not end in ba}.
c) {*w* ∈ {0, 1}* : ∃*y* ∈ {0, 1}* (|*xy*| is even)}.
d) {*w* ∈ {0, 1}* : *w* corresponds to the binary encoding, without leading 0's, of natural numbers that are evenly divisible by 4}.

Exercise 7) From Chapter 6, Exercise 3 of Ref. [1]). 1)
Simplify each of the following regular expressions

a) (a ∪ b)* (a ∪ ε) b*.
b) (∅* ∪ b) b*.
c) (a ∪ b)*a* ∪ b.
d) ((a ∪ b)*)*.
e) a ((a ∪ b)(b ∪ a))* ∪ a ((a ∪ b) a)* ∪ a ((b ∪ a) b)*.

Exercise 8) (Chapter 6, Exercise 4 of Ref. [1]). 1) For each of the following expressions *E*, answer the following three questions and prove your answer:

(i) Is *E* a regular expression?
(ii) If *E* is a regular expression, give a simpler regular expression.
(iii) Does *E* describe a regular language?

a) ((a ∪ b) ∪ (ab))*.
b) $(a^+ a^n b^n)$.
c) ((ab)* ∅).
d) (((ab) ∪ c)* ∩ (b ∪ c*)).
e) (∅* ∪ (bb*)).

Exercise 9) ((Chapter 6, Exercise 5 of Ref. [1]). 1)
Let $L = \{a^n b^n : 0 \leq n \leq 4\}$.

a) Show a regular expression for *L*.
b) Show an FSM that accepts *L*.

REFERENCES

[1] Elaine Rich, Automata Computatibility and Complexity: Theory and Applications, Pearson, Prentice Hall, 2008.