

# Formal Languages Homework 3

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## 1 Problem 2.5.2

Consider the following  $\epsilon$ -NFA

	$\epsilon$	$a$	$b$	$c$
$\rightarrow p$	$\{q, r\}$	$\emptyset$	$\{q\}$	$\{r\}$
$q$	$\emptyset$	$\{p\}$	$\{r\}$	$\{p, q\}$
$r$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$

1.1 a) Compute the  $\epsilon$ -closure of each state

$$ECLOSE(p) = \{p, q, r\}.$$

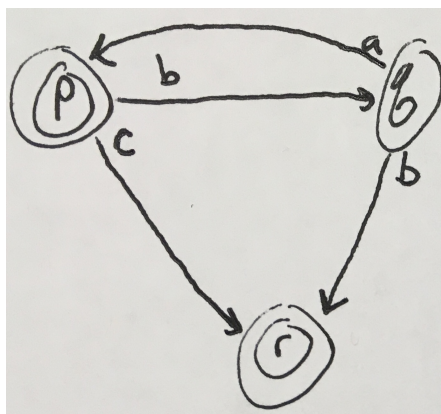
$$ECLOSE(q) = \{p, q, r\}.$$

$$ECLOSE(r) = \emptyset.$$

1.2 b) Give all strings of length three or less accepted by the automaton

$\{\epsilon, b, c, ab, cb, bb, bc, aab, bab, abb, cbb, bcb, ccb, cab, acb\}.$

1.3 c) Convert the automaton to an NFA



## 2 Problem 3.1.1

Write regular expressions for the following languages:

- 2.1 a) The set of strings over alphabet  $\{a, b, c\}$  containing at least one  $a$  and at least one  $b$
- 2.2 b) The set of 0's and 1's whose tenth symbol from the right end is 1
- 2.3 c) The set of strings of 0's and 1's with at most one pair of consecutive 1's

## 3 Problem 3.1.2

Write regular expressions for the following languages:

- 3.1 a) The set of all strings of 0's and 1's such that every pair of adjacent 0's appears before any pair of adjacent 1's
- 3.2 b) The set of strings of 0's and 1's whose number of 0's is divisible by five

## 4 Problem 3.1.4

Give English descriptions of the languages of the following regular expressions:

- 4.1 a)  $(1 + \epsilon)(00^*1)^*0^*$ .
- 4.2 b)  $(0^*1^*)^*000(0 + 1)^*$ .
- 4.3 c)  $(0 + 10)^*1^*$ .