

CSC416 - Homework 1

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Regular Languages

1. Write English descriptions for the languages generated by the following regular expressions:

4 (a) $(0|1|\dots|9|A|B|C|D|E|F)^+(x|X)$
Any combination of hexadecimal digits (0-9, A-F) one or more times, followed by either an uppercase or a lowercase **x**.

4 (b) $(a|b)^*(a|b|\epsilon)$
A lowercase **a** or lowercase **b** zero or more times, followed by either a lowercase **a**, lowercase **b**, or nothing.

2. Write regular expressions for each of the following.

4 (a) All strings of lowercase letters that begin and end in **a**.
 $a[a-z]^*a$

4 (b) All strings of digits that contain no leading zeros.
 $[1-9][0-9]^*$

4 (c) All strings of digits that represent even numbers.
 $([1-9][0-9])^*(0|2|4|6|8)$

4 (d) Strings over the alphabet $\{a,b,c\}$ with an even number of **a**'s.
 $(a(b|c)^*a)|((aa)^*|b^*|c^*)$

4 (e) Strings over the alphabet $\{a,b\}$ that contain an odd number of **a**'s or an odd number of **b**'s (or both).
 $a(aa)^*|b(bb)^*|a(bb^*)b(aa)^*$

3. For each of the following regular expressions determine which of the strings **cc**, **ababb**, **bbcab**, and **ccbbaab** matches it:

4 (a) $(ab)^*c|a^*b^*c^*$

cc ✓
ababb ✗
bbcab ✗
ccbbab ✗

4 (b) $(ab|bc^*)^+$

cc ✗
ababb ✓
bbcab ✗
ccbbab ✗

4 (c) $[ab]^*cc?(ab)^*$

cc ✓
ababb ✗
bbcab ✓
ccbbab ✗

Lexical Specifications

3 4. Given the string `abbbaacc` and alphabet $\{a,b,c\}$ what tokenization will the following lexical specification produce?

Token Class	Regex
-----	-----
A	b^+
B	ab^*
C	ac^*

<B, abbb>

<B, a>

<C, acc>

3 5. Given the string `babac` and alphabet $\{a,b,c\}$ what tokenization will the following lexical specification produce?

Token Class	Regex
-----	-----
A	$a(ba)^*$
B	$b^*(ab)^*$
C	<code>abc</code>

D c+

<B, bab>

<A, a>

<D, c>

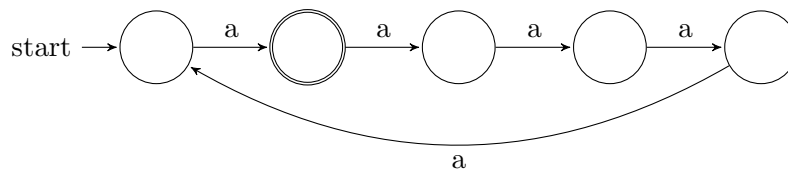
6. Given the following lexical specification and alphabet $\{0,1\}$, which of the below strings will be successfully tokenized?

Token Class	Regex
A	$(11)^*$
B	01^+
C	10^+

1. 1000001 ✓
2. 1110010 ✓
3. 01100100 ✓
4. 10011001 ✓

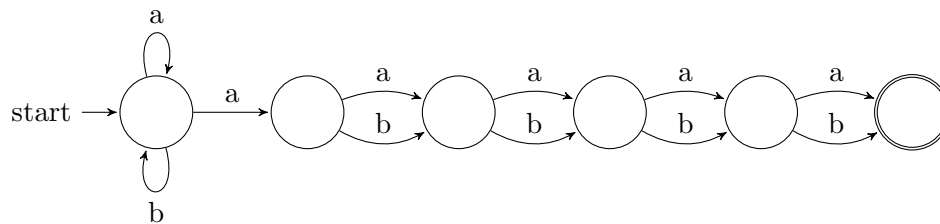
Finite Automata

7. Explain in informal English what each of these finite-state automata recognizes.



- (a)

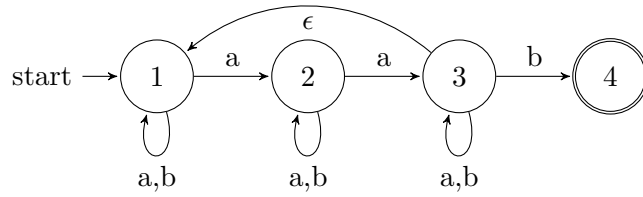
A single **a**, optionally followed by any number of sequences consisting of 5 **a**'s.



- (b)

Any number of **a**'s or **b**'s, followed by an **a**, followed by a combination of 4 **a**'s and **b**'s.

- 6 8. Write a regular expression whose language is equivalent to the following NFA.

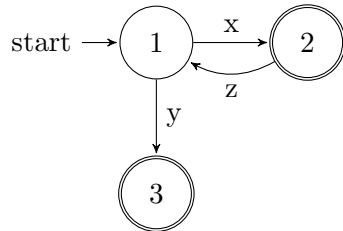
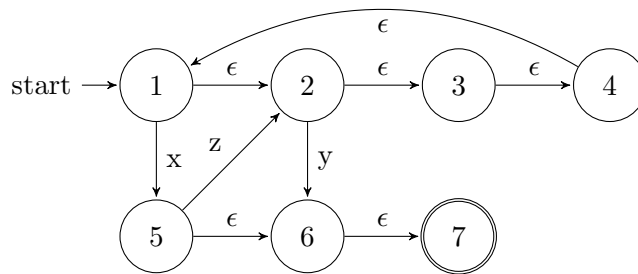


$$((a|b)^*a(a|b)^*a(a|b)^*)^+b$$

9. Convert these NFAs into DFAs.

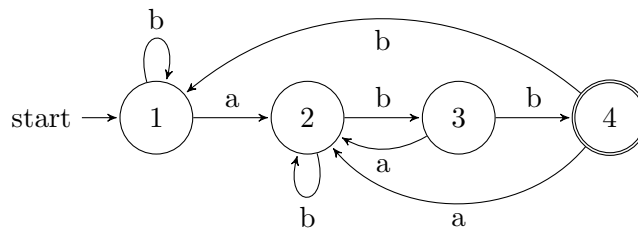
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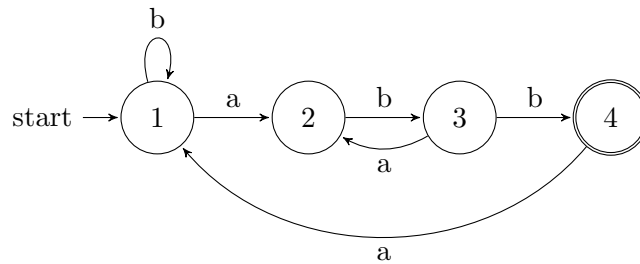
(a)



6

(b)





10. Construct DFA's for each of the following regular expressions. Do it in two steps: construct the NFA using Thompson's construction, then the DFA from the NFA. Let the alphabet be $\{a,b\}$.

6 (a) $a^*|b^*$

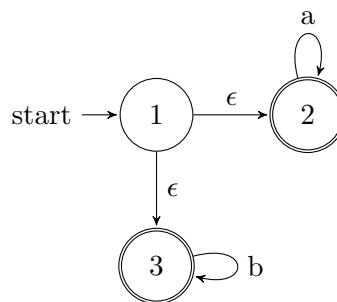


Figure 1: NFA

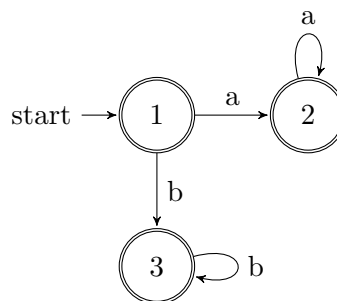


Figure 2: DFA

7 (b) $a^*(ab)^*a^*$

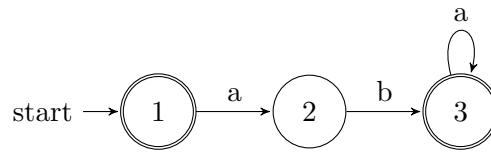


Figure 3: NFA

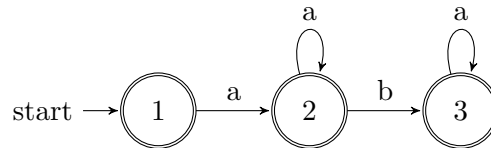


Figure 4: DFA

7

(c) **CSC416 ONLY:**

$[ab]^*abab$

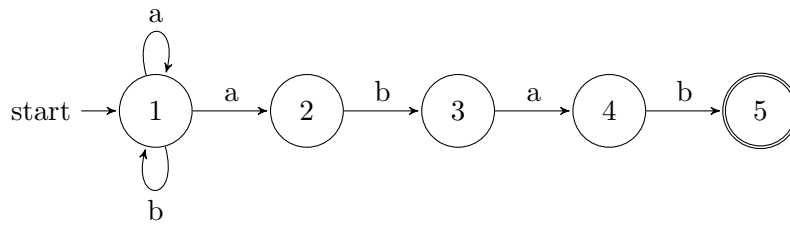


Figure 5: NFA

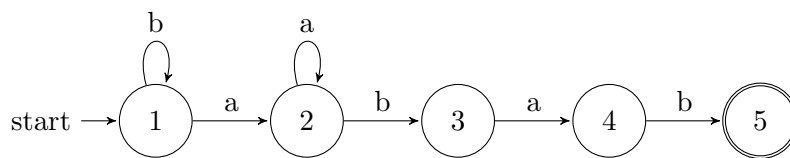


Figure 6: DFA

CSC565 ONLY:

$[ab]^*abab[ab]^*$

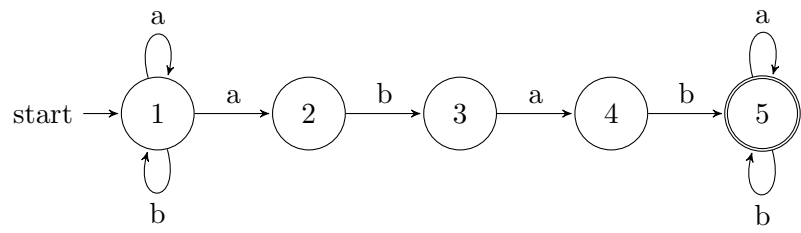


Figure 7: NFA

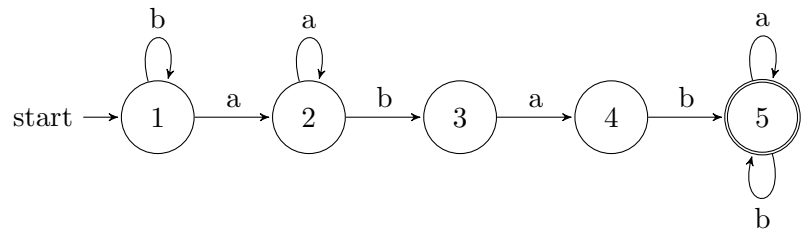


Figure 8: DFA