

CMPE 350 - Spring 2019

PS 2 - 25.02.19

1.7 Give state diagrams of NFAs with the specified number of states recognizing each of the following languages. In all parts the alphabet is $\{0, 1\}$.

- b) $\{w \mid w \text{ contains the substring } 0101 \text{ i.e. } w = x0101y \text{ for some } x \text{ and } y\}$
- c) $\{w \mid w \text{ contains an even number of 0s or contains exactly two 1s}\}$

1.12 Let $D = \{w \mid w \text{ contains an even number of } a\text{'s and an odd number of } b\text{'s and does not contain the substring } ab\}$. Give a DFA with five states that recognizes D and a regular expression that generates D . (Suggestion: Describe D more simply.)

1.14 a) Show that if M is a DFA that recognizes language B , swapping the accept and nonaccept states in M yields a new DFA recognizing the complement of B . Conclude that the class of regular languages is closed under complement.

b) Show by giving an example that if M is an NFA that recognizes language C , swapping the accept and nonaccept states in M doesn't necessarily yield a new NFA that recognizes the complement of C . Is the class of languages recognized by NFAs closed under complement? Explain your answer.

1.18 Give regular expressions generating the languages of Exercise 1.6.

- b) $\{w \mid w \text{ contains at least three 1s}\}$
- g) $\{w \mid w \text{ the length of } w \text{ is at most 5}\}$
- l) $\{w \mid w \text{ contains at least two 0s and at most one 1}\}$

1.20 For each of the following languages, give two strings that are members and two strings that are not members—a total of four strings for each part. Assume the alphabet $\Sigma = \{a, b\}$ in all parts

- b) $a(ba)^*b$
- c) $a^* \cup b^*$
- e) $\Sigma^* a \Sigma^* b \Sigma^* a \Sigma^*$
- h) $(a \cup ba \cup bb) \Sigma^*$

1.31 For any string $w_1 w_2 \dots w_n$ the reverse of w , written w^R , is the string w in reverse order, $w_n \dots w_2 w_1$. For any language A , let $A^R = \{w^R \mid w \in A\}$. Show that if A is regular, so is A^R .

- For languages A and B , we define the Even operation as $\text{Even}(A, B) = \{w = uv \mid u \in A, v \in B \text{ and } |w| = 2k \text{ for some } k \geq 1\}$.

Is the set of regular languages closed under the Even operation? Prove your answer.

- The REMOVETHIRD operation on a language L creates a new language by taking all strings of L which have length three or more, and then by deleting the third symbol in those strings. For instance, $\text{REMOVETHIRD}(\{ab, ababa, babbbb\}) = \{abba, babbb\}$.

Prove or disprove the following statement:

For any language A , $\text{REMOVETHIRD}(A) \neq A$.