CSE 331: Automata & Computability
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Practice Sheet (Regular Expression)

1. Extended definition of Regular Language.

2. Derived the strings from the following expressions:
a) (0+1)* **b)** (00)* **c)** 0*1* **d)** (0*1*)* **e)** 0*1* + (ab)* **f)** (0+1) **g)** a (0+1) b **h)** a (0+1)* b
i) 1*01* + ab

3. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w contains “101” as a substring.}

4. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w starts with “101”.}

5. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w ends with “101”.}

6. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w contains “00” or “11”.}

7. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w contains exactly two 1s.}

8. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w contains at least two 1s.}

9. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: w contains at most two 1s.}

10. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: The length of w is even or multiple of 2.}

11. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: The length of w is odd.}

12. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: The length of w is multiple of 3.}

13. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: The length of w is **not** multiple of 3.}

14. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: The number of 1's in w is a multiple of 3.}

15. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: w starts and ends with different symbols.}

16. Construct a Regular Expression that generates the language L = { w ∈ $\{0,1\}^*$: w starts and ends with the same symbols.}

17. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w doesn't end with 01.}

18. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: 0's and 1's alternates in w.}

19. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w doesn't contain 00.}

20. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w doesn't contain 11.}

21. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w doesn't contain 111.} [Practice]

22. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w doesn't contain 10.}

23. Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w doesn't contain 00 and 11.} Or, **Similar to Question:** 18

24. a) Construct a Regular Expression that generates the language L = { w ∈ {0,1}*: w contains 0 in every third position.}

b) Regular language for $\overline{L}$

25.

Consider the following languages over $\Sigma = \{0, 1\}$.

$$L_1 = \{w : w \text{ does not contain } 11\}$$
$$L_2 = \{w : \text{every } 1 \text{ in } w \text{ is followed by at least one } 0\}$$
$$L_3 = \{w : \text{the number of times } 1 \text{ appears in } w \text{ is even}\}$$

Now solve the following problems.

(a) **Give** a regular expression for the language L_1. (2 points)

(b) Your friend claims that $L_1 = L_2$. **Prove** her wrong by writing down a five-letter string in $L_1 \setminus L_2$. Recall $L_1 \setminus L_2$ contains all strings that are in L_1 but not in L_2. (2 points)

(c) **Give** a regular expression for the language $L_1 \setminus L_2$. (2 points)

(d) **Give** a regular expression for the language L_3. (2 points)

(e) **Give** a regular expression for the language $L_2 \setminus L_3$. (2 points)

26.

Let $\Sigma = \{0, 1\}$. Consider the following languages over Σ.

$$L_1 = \{w : w = 1^m 0^n, \text{where } m, n \geq 0\}$$
$$L_2 = \{w : 1 \text{ does not appear at any even position in } w\}$$
$$L_3 = L_1 \cap L_2$$

Now solve the following problems.

(a) **Give** the state diagram for a DFA that recognizes L_1. (3 points)

(b) **Give** the state diagram for a DFA that recognizes L_2. (3 points)

(c) If you were to use the "cross product" construction shown in class to obtain a DFA for the language L_3, how many states would it have? (1 point)

(d) **Find** all four-letter strings in L_3. (1 point)

(e) **Give** the state diagram for a DFA that recognizes L_3 using only three states. (2 points)