

Languages \rightarrow "set"

Regular operation:

- 1) Union (OR):
- 2) Concatenation (\cdot):
- 3) Kleene Closure ($*$):

Languages \rightarrow "set"

Regular operation:

- 1) OR ($|$):
- 2) Concatenation (\cdot):
- 3) Kleene Closure ($*$):

$$L_1 = \{0, 1\} \quad L_2 = \{00, 11\}$$

$$L_1 \cdot L_1 = \{00, 01, 10, 11\}$$
$$(0|1) \cdot (0|1)$$

0^* = 0's for any number of times

$$= \{\epsilon, 0, 00, 000, 0000, 00000, \dots\}$$

$$\therefore \quad 01^* = \{0, 01, 011, 0111, \dots\}$$

$$(01)^* = \{\epsilon, 01, 0101, 010101, \dots\}$$

$(0|1)^*$

Regular Expressions

$$\Sigma = \{0, 1\}$$

$$(0|1)^0 = \{\epsilon\}$$

$$(0|1) = \{0, 1\}$$

 \sum^*

$$(0|1)^* = \{\epsilon, 0, 1, 00, 01, 10, 11, 000, \dots\}$$

$$(0|1)(0|1) = \{00, 01, 10, 11\}$$

$$(0|1)(0|1)(0|1) = \{000, 001, 010, 011, 100, 101, 110, 111\}$$

Activate Windows
Go to Settings to activate Windows.

 $(0|1)^*$

Regular Expressions

$$\Sigma = \{0, 1\}$$

$$(0|1)^0 = \{\epsilon\}$$

$$(0|1) = \{0, 1\}$$

 \sum^*

$$(0|1)^* = \{\epsilon, 0, 1, 00, 01, 10, 11, 000, \dots\}$$

all possible binary strings

$$(0|1)(0|1) = \{00, 01, 10, 11\}$$

$$(0|1)(0|1)(0|1) = \{000, 001, 010, 011, 100, 101, 110, 111\}$$

meet.google.com is sharing your screen. [Stop sharing](#) [Hide](#)

$0 \mid 1^{(OR)} 0+1$

0011

$0^* \Sigma^*$

1) Strings starting with "01".

$01 \Sigma^*$

2) Strings ending with "01".

$\Sigma^* 01^I$

3) Strings having "100" as a substring

$\Sigma^* 100 \Sigma^*$

3) Strings having "100" as a substring

$\Sigma^* \underline{100} \Sigma^*$

4) Strings having "100" as a subsequence

$\Sigma^* 1 \Sigma^* 0 \Sigma^* 0 \Sigma^*$

$\boxed{0010010} \Sigma \boxed{110010000} \Sigma \Sigma \Sigma$ $0^* 1^* 0^* 1^* 0 \Sigma^*$

3) Strings having "100" as a substring

$\Sigma^* \underline{100} \Sigma^*$

4) Strings having "100" as a subsequence

$\Sigma^* 1 \Sigma^* 0 \Sigma^* 0 \Sigma^*$

$\boxed{001\underline{110110}11001000} \Sigma$ $0^* 1^* 0^* 1^* 0 \Sigma^*$

"RegEx"

5) Strings having even no. of 1's
 $(0^* 1 0^* 1)^* 0^*$

$0^* 1 0^* 1 0^* 1 0^* 1 0^* 1 0^* 1 0^* 1 0^*$

"RegEx"

5) Strings having even no. of 1's
 $(0^* 1 0^* 1)^* 0^*$

$0^* 1 0^* 1 0^* 1 0^* 1 0^* 1 0^* 1 0^* 1 0^*$

$0^* (1 0^* 1 0^*)^*$

Strings that end in three consecutive 1's

$$(0|1)^* 111 \quad \not\in^* 111$$

Strings that have at least one 1.

$$\not\in^* 1 \not\in^* \quad 0^* 1 \not\in^* \quad \not\in^* 10^*$$

Strings that have at most one 1.

$$0^* 1 0^*$$

Activate Windows
Go to Settings to activate!

Strings that end in three consecutive 1's

$$(0|1)^* 111 \quad \not\in^* 111$$

Strings that have at least one 1.

$$\not\in^* 1 \not\in^* \quad 0^* 1 \not\in^* \quad \not\in^* 10^*$$

Strings that have at most one 1.

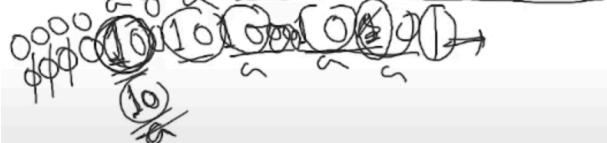
$$0^* 1 0^* | 0^* \quad 0^* (1|\epsilon) 0^*$$

Activate Windows
Go to Settings to activate!

Strings that contain the substring “101”.

$$\sum 101 \sum$$

Strings that do not have consecutive 1s.



$$O^*(10^+)^*(1|e)$$

$$(0|1_0)^* (1|e)$$

Strings that do not contain the substring 11.

Strings that have neither consecutive 1s, nor consecutive 0s.

1010101010101

$$\left. \begin{array}{c} (10)^* (1|e) \\ (01)^* (0|e) \end{array} \right\}$$

Strings that have neither consecutive 1s, nor consecutive 0s.

10101010101

$$(0| \epsilon) (10)^* (1| \epsilon)$$

01

Strings that may have consecutive 1s, or consecutive 0s, but not both.

$$(0|10)^* (1|e)$$

$$(1|01)^*(0|\epsilon)$$

Strings in which the number of 0s is even. $\Sigma = \{0, 1\}$

$$(1^* 0^* 1^*)^*$$

$$\left| \begin{array}{l} \Sigma = \{0, 1\} \\ (00)^* \end{array} \right.$$

Strings in which the number of 0s is odd.

$$(1^* 0^* 1^*)^* 1^* 0^* 1^*$$

Strings in which the number of 0s is divisible by four.

$$(1^* | 0^* 1^* 0^* 1^* | 0^* 1^*)^*$$

Activate Windows
Go to Settings to activate Win

Monday, January 30, 2023 3:16 PM

a) $1^? (01)^* 0^? / \underline{0^?} \underline{(10)^*} \underline{1^?}$

b) $0 \Sigma^* 0 / 1 \Sigma^* 1 / 0 / 1$

c) $1^* (0(1)^*)^* 0^* 1^* / 1^*$

CSE331 Assignment 1 Spring 2023

Deadline: 12th February, 2023 11:59 pm
Total Marks: 20 marks
[Submit your assignment here]

Q1: Write down regular expressions for each of the following languages. Assume $\Sigma = \{0, 1\}$ [6 marks]

- The language containing strings where 0s and 1s are alternate
- The language containing strings which starts and ends with same character
- The language containing strings in which the number of 1s between every pair of consecutive 0s is odd.

$L_1 \quad (\Sigma \Sigma \Sigma)^*$

$L_2 \quad (\Sigma 0)^* \Sigma ?$

$(\Sigma 0 \Sigma 0 \Sigma 0)^* (\Sigma 0 \Sigma | \epsilon)$

CSE331 Assignment 1 Spring 2023

$\Sigma = \{0, 1\}$ [6 marks]

- The language containing strings where 0s and 1s are alternate
- The language containing strings which starts and ends with same character
- The language containing strings in which the number of 1s between every pair of consecutive 0s is odd.

Q2: Write a regular expression for the language $L_1 \cap L_2$ [4 marks]

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

$L_1 = \{w : \text{the length of } w \text{ is divisible by three}\}$
 $L_2 = \{w : \text{every second letter in } w \text{ is a } 0\}$

Q3: [3 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1, 2\}^* : \text{the last letter of } w \text{ appears at least twice in } w\}$

Q4: [3 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1, 2\}^* : w \text{ contains at least one } 1 \text{ and one } 0\}$

$$\Sigma = \{0, 1, 2\}$$

$\overbrace{\varepsilon^* 0 \varepsilon^* 0} \mid \overbrace{\varepsilon^* 1 \varepsilon^* 1} \mid \overbrace{\varepsilon^* 2 \varepsilon^* 2}$

$$\Sigma = \{0, 1, 2\}$$

$\overbrace{\varepsilon^* 1 \varepsilon^* 0 \varepsilon^*} \mid \overbrace{\varepsilon^* 0 \varepsilon^* 1 \varepsilon^*}$

$1^* (01^*)^* 00 (1^* 0)^* 1^*$

File Edit View Insert Format Tools Extensions Help Last edit was 9...

$\Sigma = \{0, 1\}$ [6 marks]

- The language containing strings where 0s and 1s are
- The language containing strings which starts and ends
- The language containing strings in which the number of 1s between every pair of consecutive 0s is odd.

Q2: Write a regular expression for the language $L_1 \cap L_2$ [4 marks]

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

$L_1 = \{w : \text{the length of } w \text{ is divisible by three}\}$

$L_2 = \{w : \text{every second letter in } w \text{ is a } 0\}$

Q3: [3 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1, 2\}^* : \text{the last letter of } w \text{ appears at least twice in } w\}$

File Edit View Insert Format Tools Extensions Help Last edit was 9...

$\Sigma = \{0, 1\}$ [6 marks]

- The language containing strings where 0s and 1s are
- The language containing strings which starts and ends
- The language containing strings in which the number of 1s between every pair of consecutive 0s is odd.

Q2: Write a regular expression for the language $L_1 \cap L_2$ [4 marks]

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

$L_1 = \{w : \text{the length of } w \text{ is divisible by three}\}$

$L_2 = \{w : \text{every second letter in } w \text{ is a } 0\}$

Q3: [3 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1, 2\}^* : \text{the last letter of } w \text{ appears at least twice in } w\}$

Q4: [3 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1, 2\}^* : w \text{ contains at least one } 1 \text{ and one } 0\}$

File Edit View Insert Format Tools Extensions Help Last edit was 9...

- The language containing strings in which the number of 1s between every pair of consecutive 0s is odd.

Q2: Write a regular expression for the language $L_1 \cap L_2$ [4 marks]

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

$L_1 = \{w : \text{the length of } w \text{ is divisible by three}\}$

$L_2 = \{w : \text{every second letter in } w \text{ is a } 0\}$

Q3: [3 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1, 2\}^* : \text{the last letter of } w \text{ appears at least twice in } w\}$

Q4: [3 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1, 2\}^* : w \text{ contains at least one } 1 \text{ and one } 0\}$

Q5: [4 marks]

Write down a regular expression that generates the following language.

$L = \{w \in \{0, 1\}^* : \text{exactly one occurrence of } 00 \text{ appears in } w\}$

Activate Windows
Go to Settings to activate Windows.

$$\Sigma = \{0, 1\}$$

- The language containing strings where 0s and 1s always appear in pairs. For example - 001100, 1100110011001100 etc.
- The language containing strings which starts and ends with different characters.
- The language containing strings in which the number of 1s between every pair of consecutive 0s is even.
- The language containing strings having equal number of "01" and "10" substrings
- The language containing strings whose parity of 0 and 1 are different.
- The language containing strings where every 0 is followed by at least three 1's.

$$(00 \mid 11)^*$$

$$(00)^* \mid (11)^*$$

$$0 \in 1 \mid 1 \in 0$$

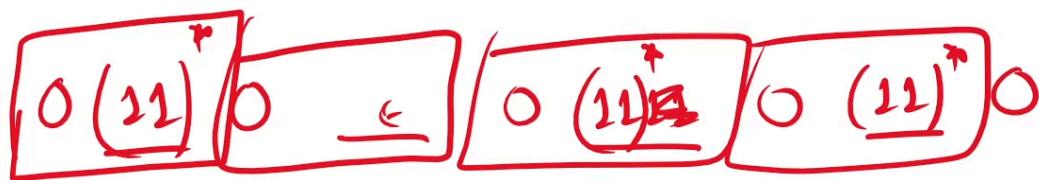
same

$$0 \in 0 \mid 1 \in 1 \mid 1 \mid 0$$

- The language containing strings in which the number of 1s between every pair of consecutive 0s is even.
- The language containing strings having equal number of "01" and "10" substrings
- The language containing strings whose parity of 0 and 1 are different.
- The language containing strings where every 0 is followed by at least three 1's.

U V W

$$(00)^* \mid (11)^*$$

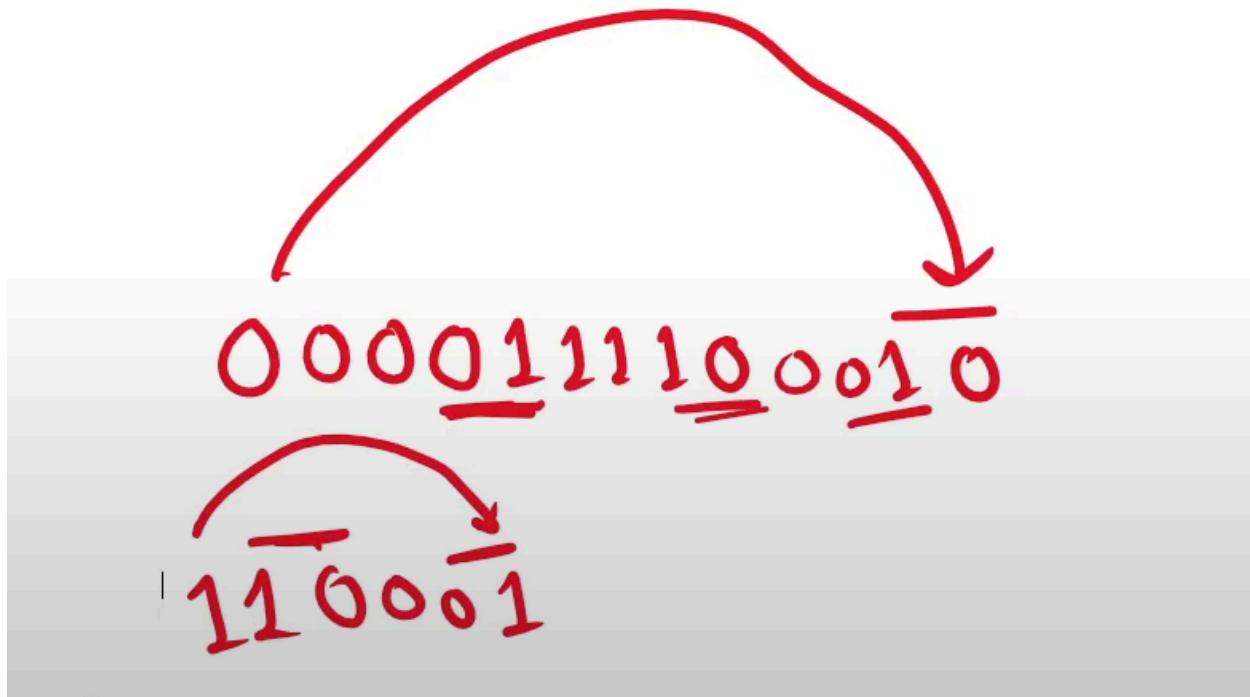


- The language containing strings in which the number of 1s between every pair of consecutive 0s is even.
- The language containing strings having equal number of “01” and “10” substrings
- The language containing strings whose parity of 0 and 1 are different.
- The language containing strings where every 0 is followed by at least three 1's.

$$1^* \left(0 (11)^* \right)^* 1^*$$

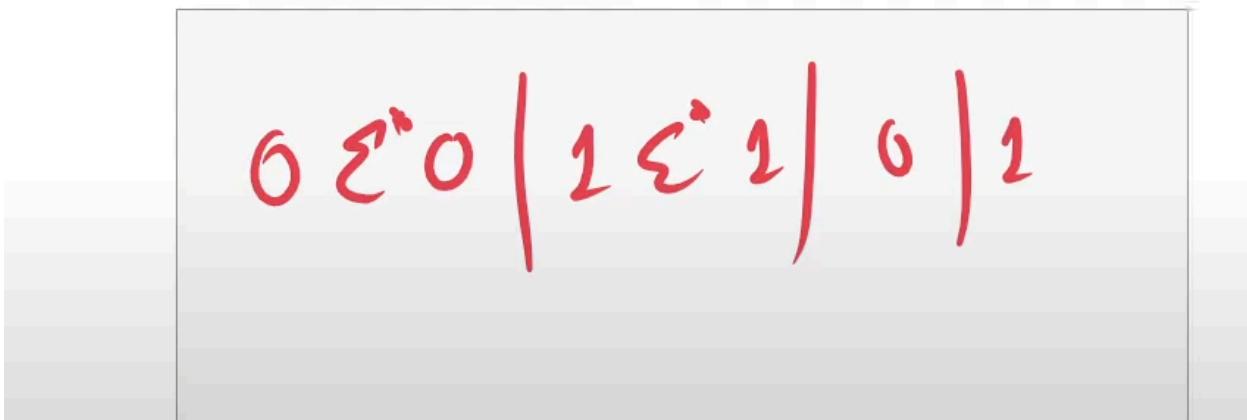
pair of consecutive 0's is even.

- The language containing strings having equal number of '01' and '10' substrings
- The language containing strings whose parity of 0 and 1 are different.
- The language containing strings where every 0 is followed by at least three 1's.



Example - 001100, 11001100 etc.

- The language containing strings which starts and ends with different characters.
- The language containing strings in which the number of 1s between every pair of consecutive 0s is even.
- The language containing strings having equal number of "01" and "10" substrings
- The language containing strings whose parity of 0 and 1 are different.
- The language containing strings where every 0 is followed by at least three 1's.



$$\Sigma = \{0, 1\}$$

- The language containing strings where 0s and 1s always appear in pairs. For example - 001100, 1100110011001100 etc.
 - The language containing strings which starts and ends with different characters. ~~Same~~
 - The language containing strings in which the number of 1s between every pair of consecutive 0s is even.
 - The language containing strings having equal number of '01' and '10' substrings
 - The language containing strings whose parity of 0 and 1 are different.
 - The language containing strings where every 0 is followed by at least three 1's.

<u>length</u>	<u>diff pairs</u>	<u>same pairs</u>	<u>length</u>
<u>always odd</u>	0 <u>even</u> , 1 <u>odd</u>	0 even, 1 even	<u>even</u>
	1 <u>even</u> , 0 <u>odd</u>	0 odd, 1 odd	

$$\Sigma = \{0, 1\}$$

- The language containing strings where 0s and 1s always appear in pairs. For example - 001100, 1100110011001100 etc.
 - The language containing strings which starts and ends with different characters.
 - The language containing strings in which the number of 1s between every pair of consecutive 0s is even.
 - The language containing strings having equal number of "01" and "10" substrings
 - The language containing strings whose parity of 0 and 1 are different.
 - The language containing strings where every 0 is followed by at least three 1's.

<u>length</u>	<u>diff pairs</u>	<u>same pairs</u>	<u>length</u>
always odd	0 even, 1 odd	0 even, 1 even	even
	1 even, 0 odd	0 odd, 1 odd	

- \hookrightarrow ~~pair of consecutive 0's or 1's~~
- The language containing strings having equal number of "01" and "10" substrings
 - The language containing strings whose parity of 0 and 1 are different.
 - The language containing strings where every 0 is followed by at least three 1's.

$$(\Sigma\Sigma)^*$$

$$(\Sigma\Sigma)\Sigma$$

- \hookrightarrow substrings
- The language containing strings whose parity of 0 and 1 are different.
 - The language containing strings where every 0 is followed by at least three 1's.

$$\Sigma^* (01111^*)^*$$

- \hookrightarrow substrings
- The language containing strings whose parity of 0 and 1 are different.
 - The language containing strings where every 0 is followed by at least three 1's.

$$\Sigma^* (01111^*)^*$$



$$\Sigma^* 0 (\epsilon | 1 | 11) (\epsilon | 0 \Sigma^*)$$

The set of strings that end with 11.

L₁

$$\Sigma^* 11$$

$$(0|1)^* 11$$

L̄

The set of strings that do not end with 11.

$$\Sigma^* (00|01|10)$$

L₁

The set of strings that end with 11.

$$\Sigma^* 11$$

$$(0|1)^* 11$$

L̄

The set of strings that do not end with 11.

$$\Sigma^* (00|01|10) \quad | \quad (0|1|\epsilon)$$

The set of strings that contain 01 as a substring.

$\Sigma^* 01 \Sigma^*$

The set of strings that do not contain 01 as a substring.

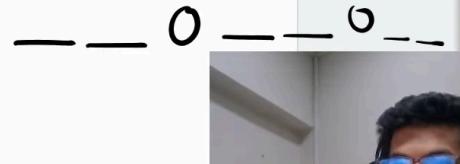
$1^* \overset{\text{0}}{\underset{\text{*}}{\mid}} *^*$

The set of strings having 0 at every odd position.

$$(0(01))^*(0|\epsilon) \quad \underline{0} \underline{(01)} \underline{0} \underline{(01)} \underline{0} \dots \underline{0}$$
$$(00|01)^*(0|\epsilon)$$

The set of strings having 0 at every third position.

$$(\Sigma \setminus \{0\})^* (0|1|\epsilon) (0|1|\epsilon)$$



The set of strings having 0 at the third position.

$$\Sigma^* 0 \Sigma^* \quad (0|1)(0|1) 0 \Sigma^*$$

The set of strings having 0 at the third last position.

$$\Sigma^* 0 \Sigma^2$$

