

lecture 4:- 2) Recursive definition.

- 1- Some basic words are specified in language.
- 2- Rules for constructing more words.
- 3- No string except those constructed above are allowed in the language.

$$\Sigma = \{-, 0, 1, \dots, 9\}.$$

Language of INTEGER.

- 1- 1 is in INTEGER.
- 2- if x is in INTEGER then $x+1$ & $x-1$ is in INTEGER.
- 3- -----

$$\begin{aligned} 4+1 &= 5 \\ 3+1 &= 4 \\ 2+1 &= 3 \in \text{INTEGER.} \\ 1+1 &= 2 \in \text{INTEGER.} \end{aligned}$$

$$1-1=0 \text{ INTEGER.}$$

Language of EVEN.

- 1- 2 is in EVEN.
- 2- if x is EVEN then $x+2$ & $x-2$ is also EVEN.
- 3- -----

$$\begin{aligned} 8+2 &= 10 \\ 6+2 &= 8 \\ 4+2 &= 6 \\ 2+2 &= 4 \in \text{EVEN.} \end{aligned}$$

Language of ODD.

Language of PALINDROME. $\Sigma = \{a, b\}.$

- 1- a and b are in PALINDROMES.
- 2- if x is in PALINDROME then
 $S \times \text{Reverse}(S) \in \text{PALINDROME}$.
 $xx \in \text{PALINDROME}$.
 $S \in \Sigma^*$.

$x = a$

$$= \frac{a \ a \ a}{S \ x \ S^R} \in P$$

$S = a$.

$$\text{reverse}(S) = a.$$

$$\overbrace{a \ a \ a \ a}^x$$

$$\overbrace{b \ a \ b \ b \ a \ b}^x$$

Language of $\{a^n b^n, n = 1, 2, 3, \dots\}$ $\Sigma = \{a, b\}$.

- 1- ab is in $\{a^n b^n\}$
- 2- if x is in $\{a^n b^n\}$ then $axb \in \{a^n b^n\}$.
- 3- - - - -

$$\begin{array}{c} \uparrow \\ \overbrace{a \ a \ b \ b}^1 \in \{a^n b^n\}. \\ \overbrace{a \ x \ b} \\ \overbrace{a \ x \cdot b} \\ x \end{array}$$

A language L that begins & ends in same letter
 $\Sigma = \{a, b\}$.

1. a, and b are in L.
2. if x is in L then $axa \in L$ and $bxb \in L$.
3. - - - - -

$a \ b \ b \ a \ a \ a \in L$. think.

3- Regular Expression. (Regex).

$$\leftarrow \text{?} \quad \leftarrow * \quad (\text{ } \dots \text{ })$$

5- Regular Expression. (Regex).

$$\Sigma = \{a\}$$

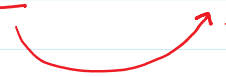
$$\Sigma^* = \{ \epsilon, a, aa, aaa, \dots \}$$

$$\Sigma^+ = \{a\}^+ = \{a, aa, \dots\}$$

$$a^+ = a, aa, aaa, \dots$$



$$a^* = \epsilon, a, aa, aaa, \dots$$



$$a^* = 0, 1, 2, \dots \text{ of } a\text{'s}$$

$$a^+ = 1, 2, 3, \dots \text{ of } a\text{'s}$$

$$(ab)^* = \epsilon, ab, \underline{abab}, ababab, \dots$$

Ex. $(ab)^* \neq a^*b^* \quad ? \quad abab.$

$$a^*b^* = \epsilon, b,$$

Ex. $\underline{a^+} \text{ (or } \textcircled{+} \text{)} \underline{b^*} = \epsilon, a, aa, \dots$
 $\epsilon, b, bb, bbb, \dots$

Ex. $a^+b^* \neq (a+b)^* \quad \text{Not Equal.}$

$$\Sigma^* = (a+b)^* = (a+b)^0 = \epsilon.$$

$$(a+b) = a, b.$$

$$(a+b)(a+b) = aa, ab, ba, bb.$$

$$(a+b)(a+b)(a+b) = \dots$$

Ex. $(a+b^*)^* \neq (a+b)^* \quad \checkmark$

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

$$(a+b^*)^0 = \epsilon \quad (a + \{ \epsilon, b, bb, bbb, \dots \})^*$$

$$(a+b^*)^1 = a, b^*$$

Ex. $L = \{ab, bc\}$

$$L = \{abb, bcb\}$$

$$(ab+bc)b = abb, bcb.$$

$$(ab+bc) =$$

$$L = \{a, b\}^* = (a+b)^*$$

$$L = \{ac, c\} = (a+\epsilon)c \rightarrow$$

$$L = \{ac, c\} = (a + \Lambda)c =$$

$$L = \{\Lambda, a, b, ab\} = (a + \Lambda)(b + \Lambda) = a, ab, b, \Lambda.$$

Define Regex for a language which start with "a" followed by anything - $\Sigma = \{a, b\}$.

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

$(a+b)^*b$ ends with b followed by anything.

$$a(a+b)^* \text{ - at least one "a"}$$

$$(a+b)(a+b)^* \text{ Even length strings.}$$

$$(a+b)(a+b)^*(a+b) = \text{odd length.}$$

$$aa(a+b)^*bb \text{ - Starting with aa \& ending in bb.}$$

$$a(a+b)^*b + b(a+b)^*a \text{ - Starting \& ending in diff letters.}$$

$$a(a+b)^*a + b(a+b)^*b \text{ - Same letters.}$$