

Tutorial 2: Languages

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1. Let $x = \{\overset{00}{\cancel{00}}\}$, and $y = \{w \mid w \in \Sigma^*, |w| = 2\}$ are languages over $\Sigma = \{0, 1\}$

(a) List the members of set $y = \{00, 01, 10, 11\}$ *

(b) How many strings of length 4 are there in x^* ?

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

$$4 = \{\cancel{00000}, 100001\}$$

= 1 strings of length 4 *

(c) yx

$$= \{00, 01, 10, 11\} \times \{\overset{00}{\cancel{00}}\}$$

$$= \{0000, 0100, 1000, 1100\} *$$

2. Let $\Sigma = \{a, b\}$, $L_1 = \{x \in \Sigma^* : |x| < 3\}$ and $L_2 = \{aa, aaa\}$. List the elements in each of the following languages L :

a) $L_3 = L_1 \cup L_2$ $L_1 = \{\epsilon, a, b, aa, ab, ba, bb\}$

$$L_3 = \{\epsilon, a, b, aa, ab, ba, bb, aaa\}$$

(b) $L_4 = L_1 \cap L_2$

$$L_1 = \{\epsilon, a, b, aa, ab, ba, bb\}$$

$$L_2 = \{aa, aaa\}$$

$$L_4 = \{\cancel{\epsilon}, \cancel{a}, \cancel{b}, \cancel{ab}, \cancel{ba}, \cancel{bb}\}$$

$$= \{aa\} *$$

(c) $L_5 = L_1 L_4$

$$L_1 = \{\epsilon, a, b, aa, ab, ba, bb\}$$

$$L_4 = \{a, a\}$$

$$= \{\epsilon, aa, ba, aaa, aba, baa, bba, a, aa, ba, aaa, aba, baa, bba\}$$

$$= \{\epsilon, aa, ba, aaa, aba, baa, bba\} *$$

$$(d) L_0 = L_1 - L_2$$

$$= \{ \epsilon, a, b, ab, ba, bb \}$$

3. Let $w = abbaaababb$

aab abab baba abbaa bba babb bab bbb abb abbaaababb

Substing	Prefix	Suffix	Palindrome	None
aab	abbaa	babb	abbaa	baba
abab	abb	abb	babb	bbb
abbaa	abbaaababb	abbaaababb	bab	
bba			bab	
babb				
bab				
abb				
abbaaababb				

4. S^* $S = \{a, ab, bb\}$

a, b, aa, bb, abb, aabb, aaba, aabb, abaa, abab, abba, abbb, baaa, baab, baba, bobb, bbaa, bbab, bbba, bbbb.

IN the language	NOT IN the language
a, bb, abb, aa, aab, aabb, abaa, abab, abbb,	b, ab abba, baaa, baab, baba, babb, bbba, bbbb

5.

Language	Three Valid Strings			Three Invalid Strings		
(b) $\{a^m b^n c^p d^q \mid m+n=p+q\}$	$a^1 b^1 c^1 d^1 = abcd$	$a^2 b^1 c^1 d^2 = aab cdd$	$a^1 b^2 c^2 d^1 = abbccd$	$a^0 b^3 c^1 d^1 = bbbcd$	$a^3 b^1 c^1 d^1 = aaabcd$	$a^2 b^1 c^1 d^1 = aabcd$
(c) $\{a^m b^n c^p d^q \mid m=n+p+q\}$	$a^3 b^1 c^1 d^1 = aaabcd$	$a^2 b^1 c^1 d^0 = aabc$	$a^1 b^2 c^1 d^2 = aabbaabb cdd$	$a^1 b^2 c^1 d^1 = abbcd$	$a^0 b^1 c^1 d^1 = bcd$	$a^2 b^1 c^2 d^1 = aabcccd$

6.

Language	$m=1, n=1$	$m=1, n=0$	$m=0, n=1$	$m=1, n=2$	$m=2, n=1$
(b) $\{a^m b^n c^n d^n \mid m, n \geq 0\}$	$a^1 b^1 c^1 d^1 = abcd$	$a^1 b^1 c^0 d^0 = ab$	$a^0 b^0 c^1 d^1 = cd$	$a^1 b^1 c^2 d^2 = abccdd$	$a^2 b^2 c^1 d^1 = aabbcd$
(c) $\{a^m b^n c^{m+1} \mid m, n \geq 0\}$	$a^1 b^1 c^3 = abccc$	$a^1 b^0 c^2 = acc$	$a^0 b^1 c^1 = bc$	$a^1 b^2 c^2 = abbcc$	$a^2 b^1 c^3 = aabccc$
(d) $\{a^{m+n} b^n c^m \mid m, n \geq 0\}$	$a^2 b^1 c^1 = aabc$	$a^2 b^0 c^1 = aac$	$a^1 b^1 c^0 = ab$	$a^3 b^2 c^1 = aaabbc$	$a^3 b^1 c^2 = aaabcc$