Theory of Computation

النظرية الاحتسابية
المحاضرة الرابعة

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REGULAR EXPRESSIONS

EXAMPLE

Another expression that denotes all the words with at least two a's is:

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

We scan through some jungle of b's (or no b's) until we find the first a, then more b's (or no b's), then the second a, then we finish up with anything.

In this set are *abbbabb* and aaaaa.

We can write:

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

where by the equal sign we do not mean that these expressions are equal algebraically in the same way as

$$\boxed{x+x=2x}$$

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

Are they equal ?

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

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

1- $a^*\ a\ a^*\ a\ a^*$.

2- $a^*\ a\ a^*\ a\ b^*$.

3- $a^*\ a\ b^*\ a\ a^*$.

4- $a^*\ a\ b^*\ a\ b^*$.

5- $b^*\ a\ a^*\ a\ a^*$.

6- $b^*\ a\ a^*\ a\ b^*$.

7- $b^*\ a\ b^*\ a\ a^*$.

8- $b^*\ a\ b^*\ a\ b^*$.

$2^3 = 8$

1- $(a + b+c)^*a\ (a + b)^*\ a\ (a + b+c)^*\ (a+b)^*$

2- $(a + bc^*)^*a\ (a + b)^*\ a\ (a + b)^*\ (a+b)^*$

REGULAR EXPRESSIONS

We could write
language $((a + b)^*a\ (a + b)^*a\ (a + b)^*)$
$= \text{language } (b^*a\ b^*\ a\ (a + b)^*)$
= all words with at least two a's.

To be careful about this point, we say that two regular expressions are equivalent if they describe the same language.

$$\mathbf{(a + b)^*\ \underset{\substack{\uparrow \\ \text{next to} \\ \text{last } a}}{a}b^*\ \underset{\substack{\uparrow \\ \text{last } a}}{a}b^*}$$

and

$$\mathbf{b^*\underset{\substack{\uparrow \\ \text{first } a}}{a}(a + b)^*\underset{\substack{\uparrow \\ \text{last } a}}{a}b^*}$$

REGULAR EXPRESSIONS

EXAMPLE

If we wanted all the words with *exactly* two a's, we could use the expression

b*ab*ab*

which describes such words as *aab, baba,* and *bbbabbbab.*

To make the word *aab,* we let the first and second b* become Λ and the last becomes b.

b*ab*a b*

Prove is these one of the solutions and how?

AaAa b = aab

baba A=baba

and <u>***bbb***</u> ***a bbbab***

REGULAR EXPRESSIONS

EXAMPLE

The language of all words that have at least one a and at least one b is somewhat trickier. If we write

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

$$= (\text{arbitrary})\ a(\text{arbitrary})\ b(\text{arbitrary})$$

we could define this set by the expression:

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

Here we are still using the plus sign in the general sense of disjunction (or). We are taking the union of two sets, One a and one b always

1-(a + b)*a(a + b)* b(a + b)*

Are they equal ?

2-(a+b)*a(a+b)*b(a+b)* + (a+b)* a (a+b)*b (a+b)*

3-(a+b)*a(a+b)*b(a+b)* + (a+b)* b (a+b)*a (a+b)*

REGULAR EXPRESSIONS

يمكن التعبير عن الصيغ بصيغ اخرى مشابهة

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

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

$$(a+b)^* = a(a+b)^* + b(a+b)^* + \Lambda$$

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

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

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

$(a+b)^* = a(a+b)^* + b(a+b)^* + \Lambda$

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

Check these?