Theory of Automata

&

Formal Languages

Handouts 06

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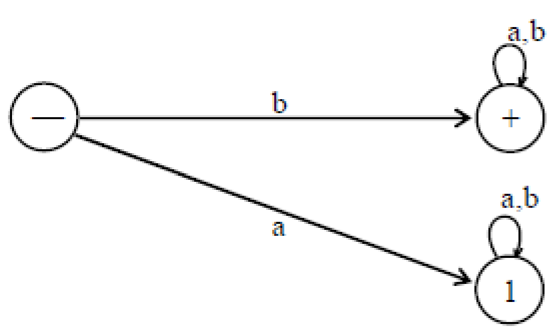
Finite automata examples

Consider the language L of strings, defined over Σ={a, b}, **starting with b.** The language L may be expressed

by RE b(a + b)* , may be accepted by the following FA

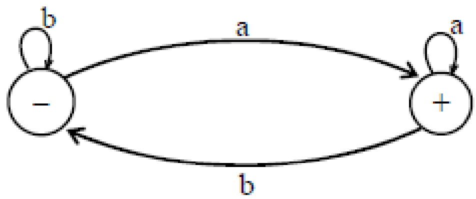


Example

Consider the language L of strings, defined over Σ={a, b}, **ending in a. T**he language L may be expressed by RE (a+b)*a.

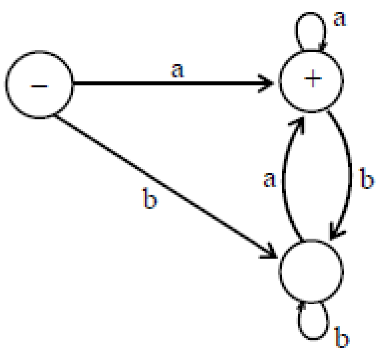
This language may be accepted by the

FA shown below



There may be another FA

corresponding to the given language, as shown below



Note

It may be noted that corresponding to a given language there may be more than one FA accepting that language, but for a given FA there is a unique language accepted by that FA.

It is also to be noted that given the languages L1 and L2 ,where

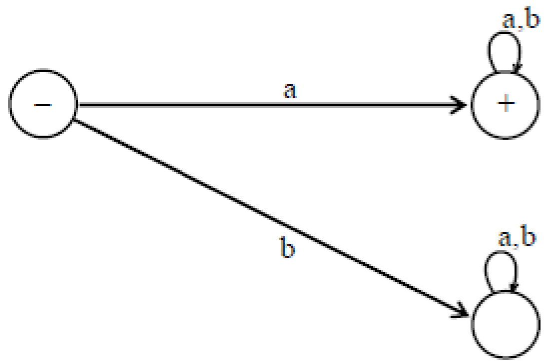
L1 = The language of strings, defined over Σ ={a, b}, **beginning with a.**

L2 = The language of strings, defined over Σ ={a, b}, **not beginning with b**

The Λ does not belong to L1 while it does belong to L2 . This fact may be depicted by the corresponding

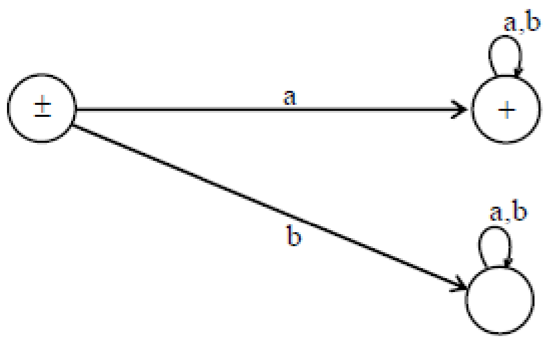
transition diagrams of L1 and L2.

FA$_1$ Corresponding to L$_1$



The language L$_1$ may be expressed by the regular expression $a(a + b)^*$

FA$_2$ Corresponding to L$_2$



The language L2 may be expressed by the regular expression a(a + b)* + Λ

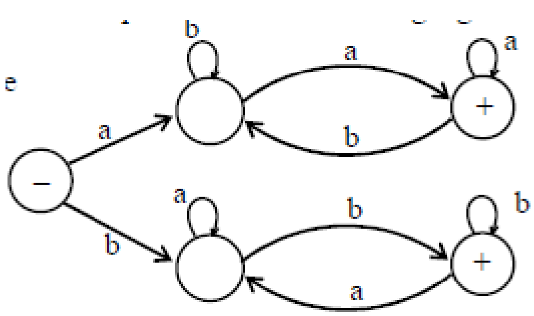
Example

Consider the Language L of Strings of **length two or more**, defined over Σ = {a, b}, **beginning with and ending in same letters.**

The language L may be expressed by the following regular expression a(a + b)*a + b(a + b)*b

It is to be noted that if the condition on the length of string is not imposed in the above language then **thestrings a and b will then belong to the language.**

This language L may be accepted by the FA as shown below

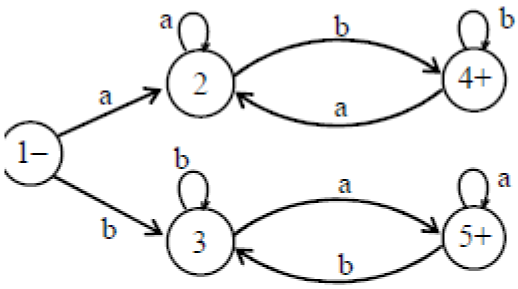


Example

Consider the Language L of Strings, defined over Σ = {a, b}, **beginning with and ending in different letters.**

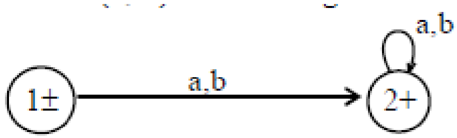
The language L may be expressed by the following regular expression a(a + b)*b + b(a + b)*a

This language may be accepted by the following FA

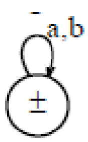


Example

Consider the Language L, defined over Σ = {a, b} of **all strings including Λ**. The language L may be accepted by the following FA



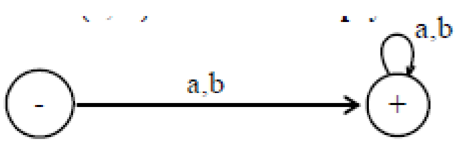
The language L may also be accepted by the following FA



The language L may be expressed by the regular expression (a + b)*

Example

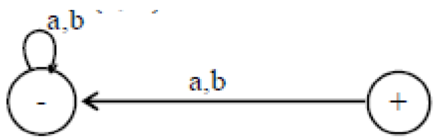
Consider the Language L , defined over Σ = {a, b} of **all non empty strings**. The language L may be accepted by the following FA



The above language may be expressed by the regular expression $(a + b)^+$

Example

Consider the following FA, defined over Σ = {a, b}

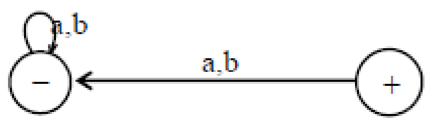


It is to be noted that the above FA **does not accept any string,** even it does not accept the null string; as there is no path starting from initial state and ending in final state.

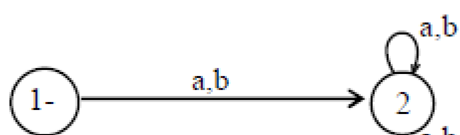
Equivalent FAs

It is to be noted that two FAs are said to be equivalent, if they accept the same language, as shown in the following FAs.

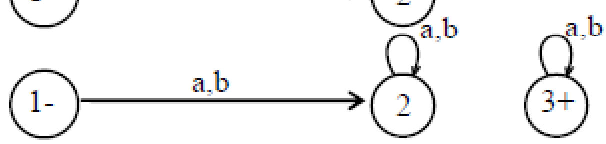
FA1:



FA_2



FA_3



Note

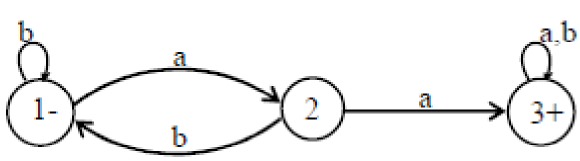
FA1 has already been discussed, while in FA2, there is no final state and in FA3, there is a final state but FA3 is disconnected as the states 2 and 3 are disconnected.

It may also be noted that the language of strings accepted by FA1, FA2 and FA3 is denoted by the empty set *i.e* { } OR ϕ

Example

Consider the Language L of strings , defined over Σ = {a, b}, **containing double a.**

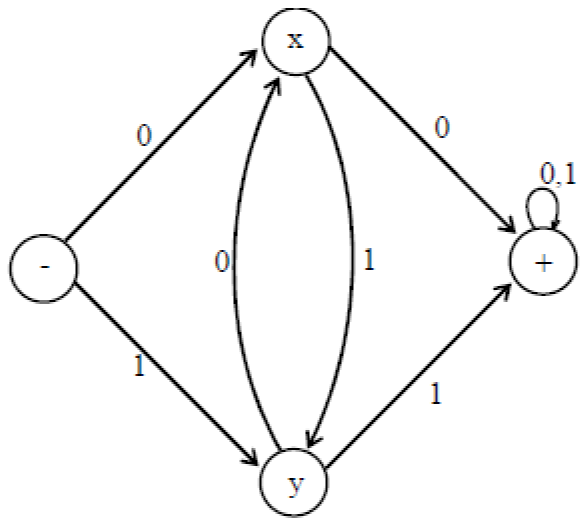
The language L may be expressed by the regular expression (a+b)* (aa) (a+b)*. This language may be accepted by the following FA.



Example

Consider the language L of strings, defined over Σ={0, 1}, **having double 0's or double 1's,** The language L may be expressed by the regular expression (0+1)* (00 + 11) (0+1)*

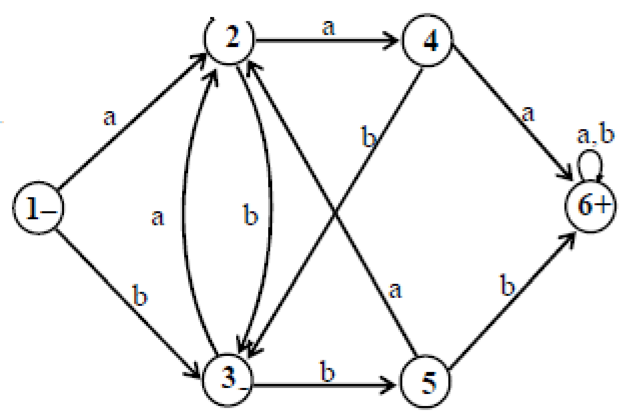
This language may be accepted by the following FA



Example

Consider the language L of strings, defined over Σ={a, b}, **having triple a's or triple b's.** The language L may be expressed by RE (a+b)* (aaa + bbb) (a+b)*

This language may be accepted by the FA as shown below



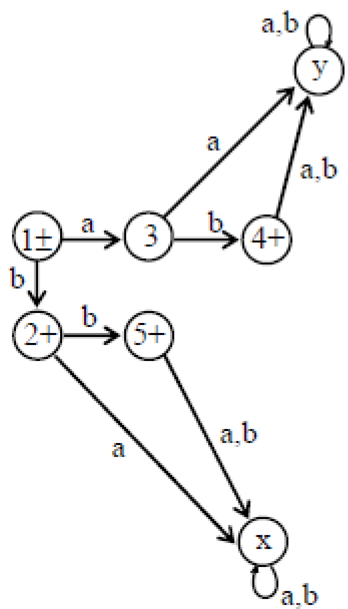
FA corresponding to finite languages

Example

Consider the language

L = {Λ, b, ab, bb}, defined over Σ ={a, b}, expressed by Λ + b + ab + bb OR Λ + b (Λ + a + b).

The language L may be accepted by the FA as shown below



It is to be noted that the states x and y are called **Dead States, Waste Baskets or Davey John Lockers,** as the moment one enters these states there is no way to leave it.