EXPERIMENT - IV
ϵ-CLOSURE OF ALL STATES OF NFA

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AIM

To write a program to find ϵ-closure of all states of any given NFA with ϵ transitions.

THEORY

Non-Deterministic Finite Automata

A non-deterministic finite automata (NFA) A over an alphabet set Σ is a structure of the form:

$$A = (Q, S, \Delta, F)$$

where,

- Q is a set of finite states.
- S ⊆ Q is the set of start states.
- Δ : Q X Σ → 2^Q is the transition function.
- F ⊆ Q is the set of final states.

NFAs can be extended with ϵ-transitions. An ϵ-transition allows the NFA to make a move without consuming any input.

ϵ-Closure of a State

ϵ-closure for a given state X is the set of all states which can be reached from the state X with only ϵ-moves. The ϵ-closure of a state includes the state itself. In other words, ϵ-closure of a state can be obtained by union operation of the ϵ-closure of the states which can be reached from X with a single ϵ-move in a recursive manner.

ALGORITHM

Algorithm 1 Algorithm to find ϵ-closure of all states of an ϵ-NFA

```
Start
Input the ϵ-NFA (enfa).
for each state in enfa do
    Let the current state be k.
    Initialize a list t containing state k only.
    Initialize an iterator to the first element of list t.
    while iterator has not crossed the last element of the list t do
        Append all the states (not present in t) in the ϵ-transition of NFA to the list t.
        Set the iterator to the next element of the list t.
    end while
end for
Stop
```

SOURCE CODE

```
def epsilon_closure(enfa):
        eclosure=[]
        for k in range(n):
                t=[]
                t.append(k)
                if enfa[k][s]=="-":
                        eclosure.append(t)
                        continue
                for i in t:
                        if enfa[i][s]=="-":
                                continue
                        x=enfa[i][s].split(",")
                        for a in x:
                                if a not in t:
                                        t.append(int(a))
                eclosure.append(t)
        print()
        print("State\tEpsilon-Closure\t")
        for i in range(len(eclosure)):
                print(i,"\t",eclosure[i])

global s
global n
n=int(input("Enter number of states in the NFA:"))
s=int(input("Enter number of input symbols:"))
print("State",end="\t")
x=('a','b','c','d','e','f','g','h','i','j')
for i in range(s):
        print(x[i],end="\t")
print("epsilon")
enfa=[]
for i in range(n):
        print(i,end="\t")
```

```
        t=input().split()
        enfa.append(t)
epsilon_closure(enfa)
```

SAMPLE OUTPUT

```
user@adithya-d-rajagopal:~/s7/cd$ python3 p4.py
Enter number of states in the NFA:3
Enter number of input symbols:2
State   a       b       epsilon
0       0       1       2
1       1,2     2       -
2       0       1       -

State   Epsilon-Closure
0        [0, 2]
1        [1]
2        [2]
user@adithya-d-rajagopal:~/s7/cd$
```

RESULT

A program to find the ϵ-closure of all states of an NFA with ϵ-transitions has been implemented using Python and the outputs have been verified.