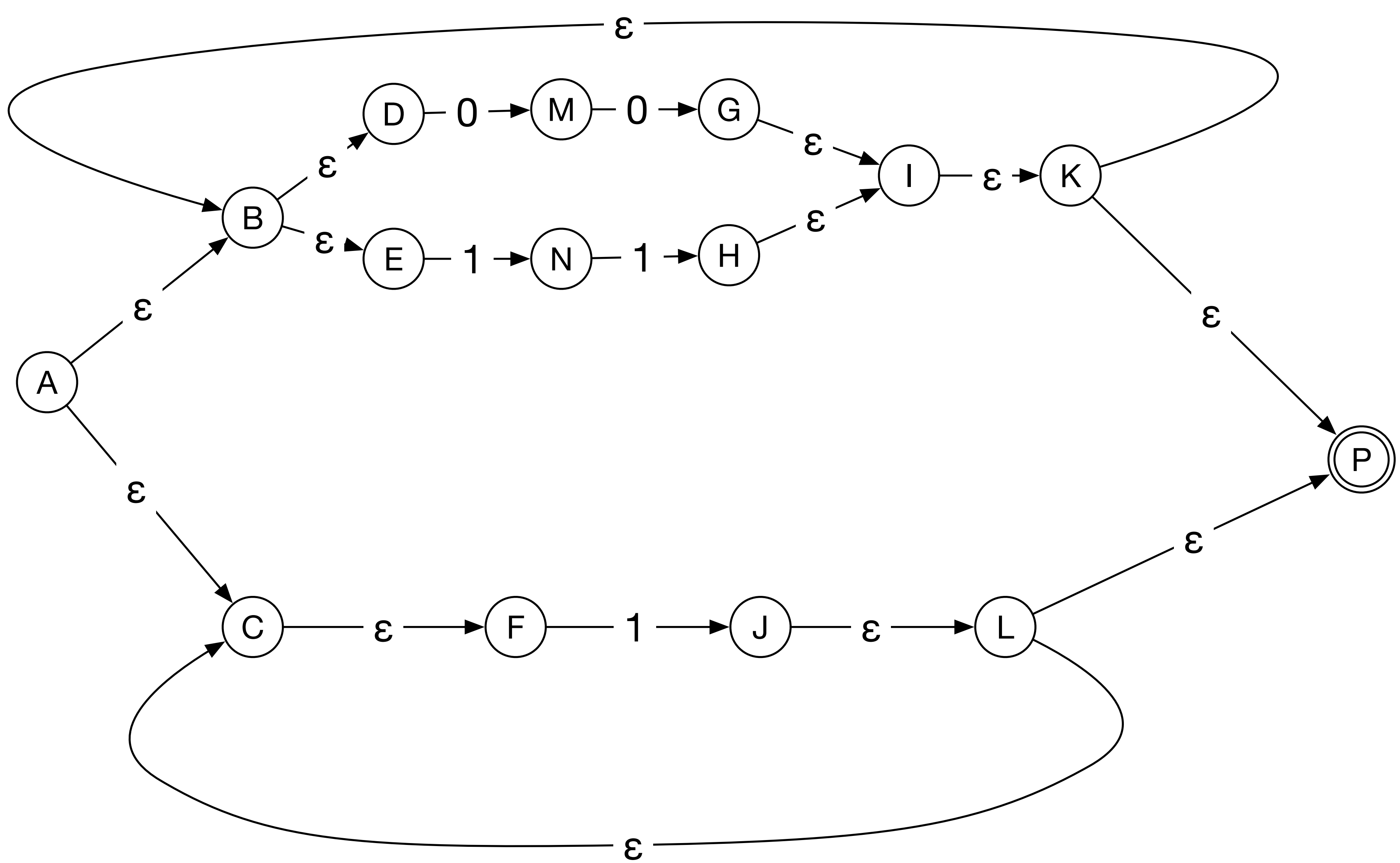
ε-Closure

Thomas Schwarz

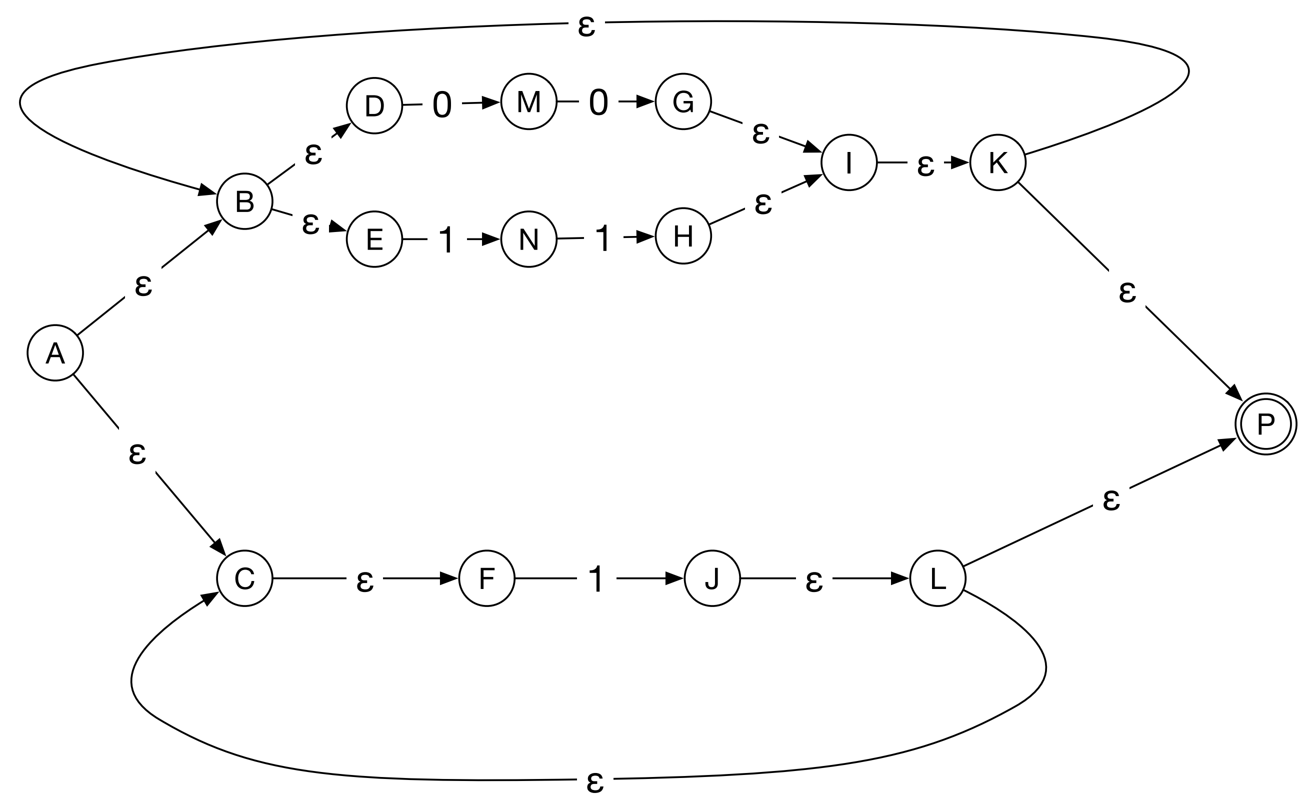
ε-Closure

- Transform the following NFA with ε-moves to an NFA without ε-moves (start state is A)



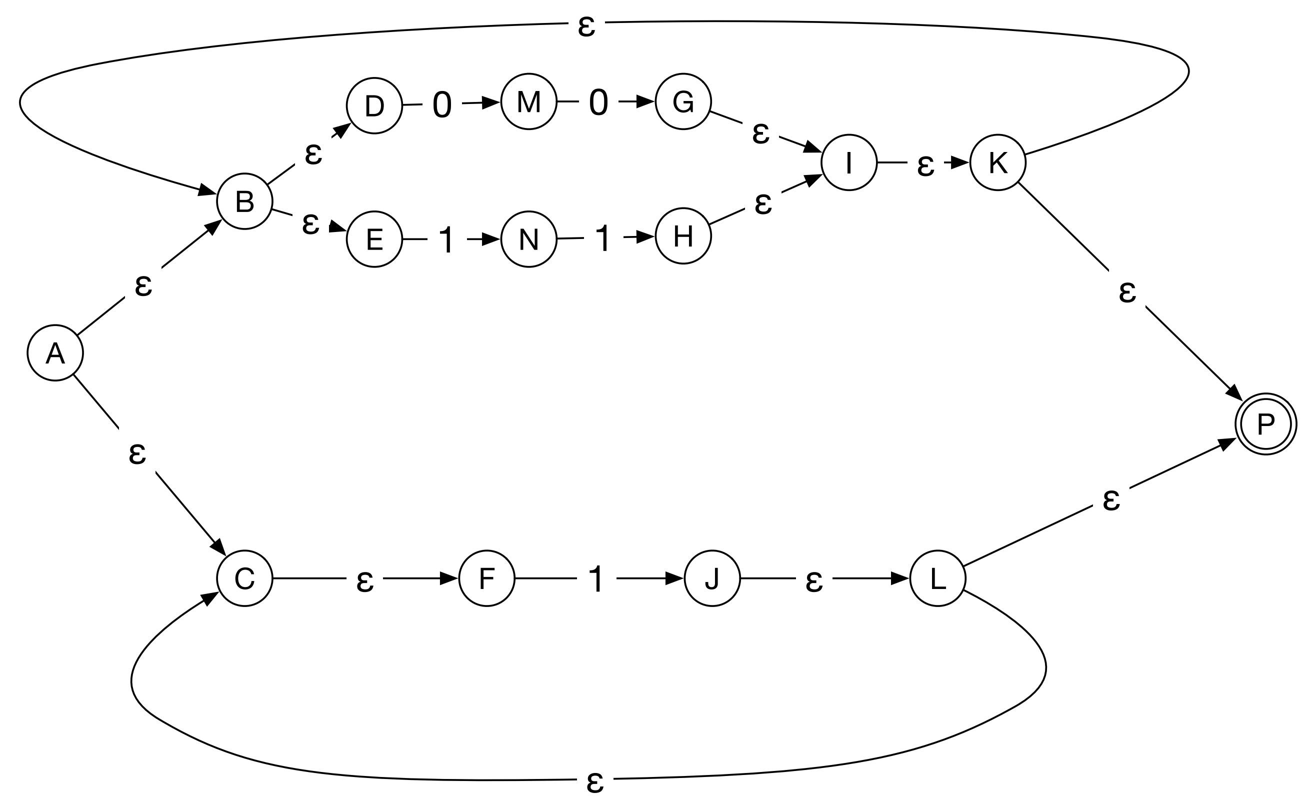
ε-Closure

- ε-closure of A
  - Insert A
  - Insert all states reached from A with an ε-transition
  - Repeat with all states in the ε-closure
- $\{A, B, C, D, E, F\}$

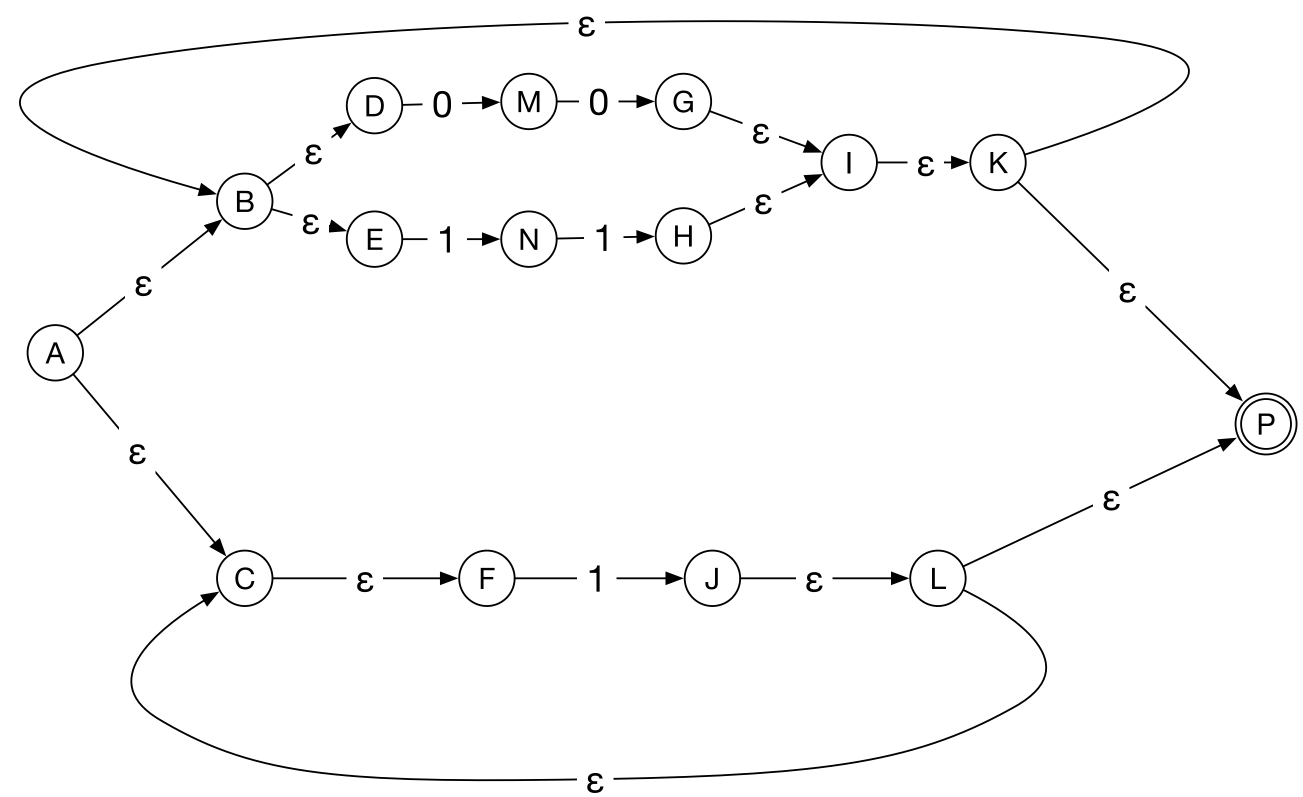


ε-Closure

- ε-closure of B
  - $\{B, D, E\}$
- ε-closure of C
  - $\{C, F\}$
- ε-closure of D
  - $\{D\}$



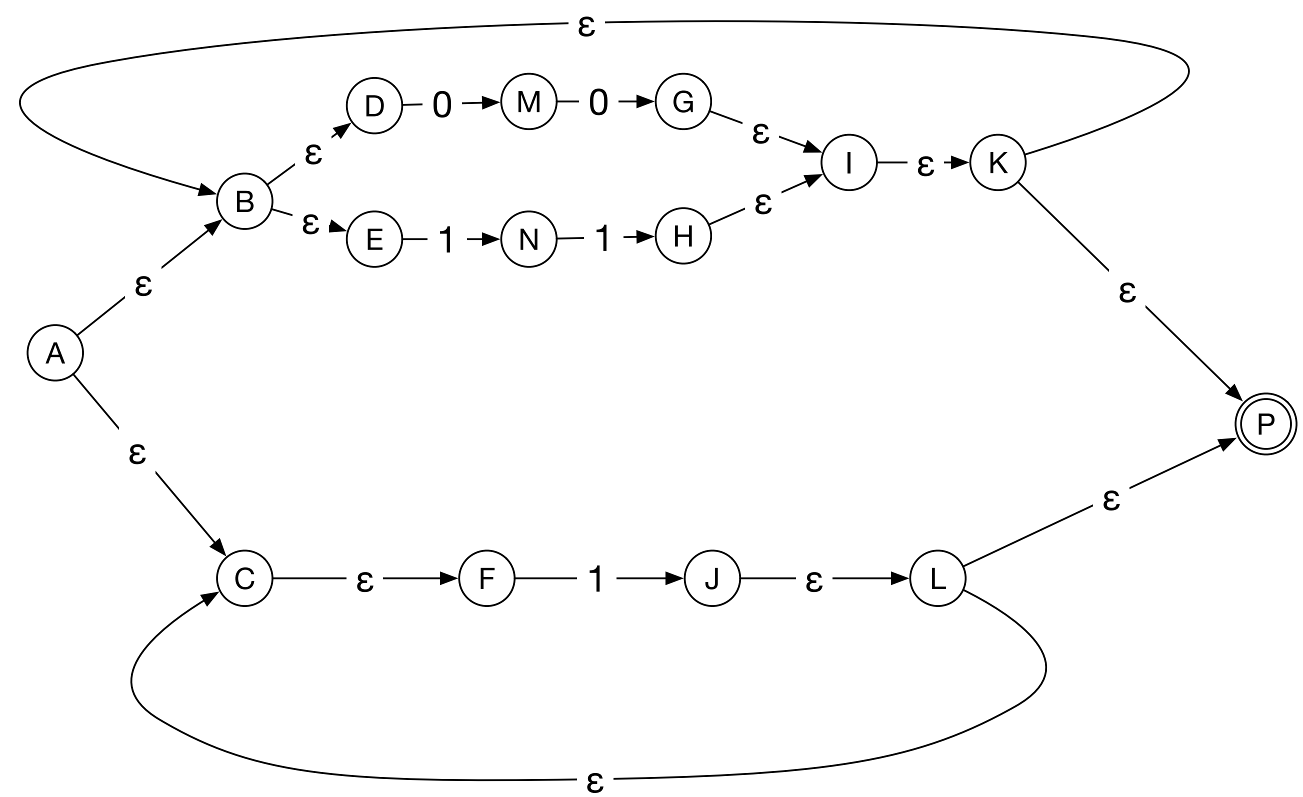
ε-Closure



- ε-closure of E
  - $\{E\}$
- ε-closure of F
  - $\{F\}$
- ε-closure of G
  - $\{G, I, K, P, B, E, D\}$

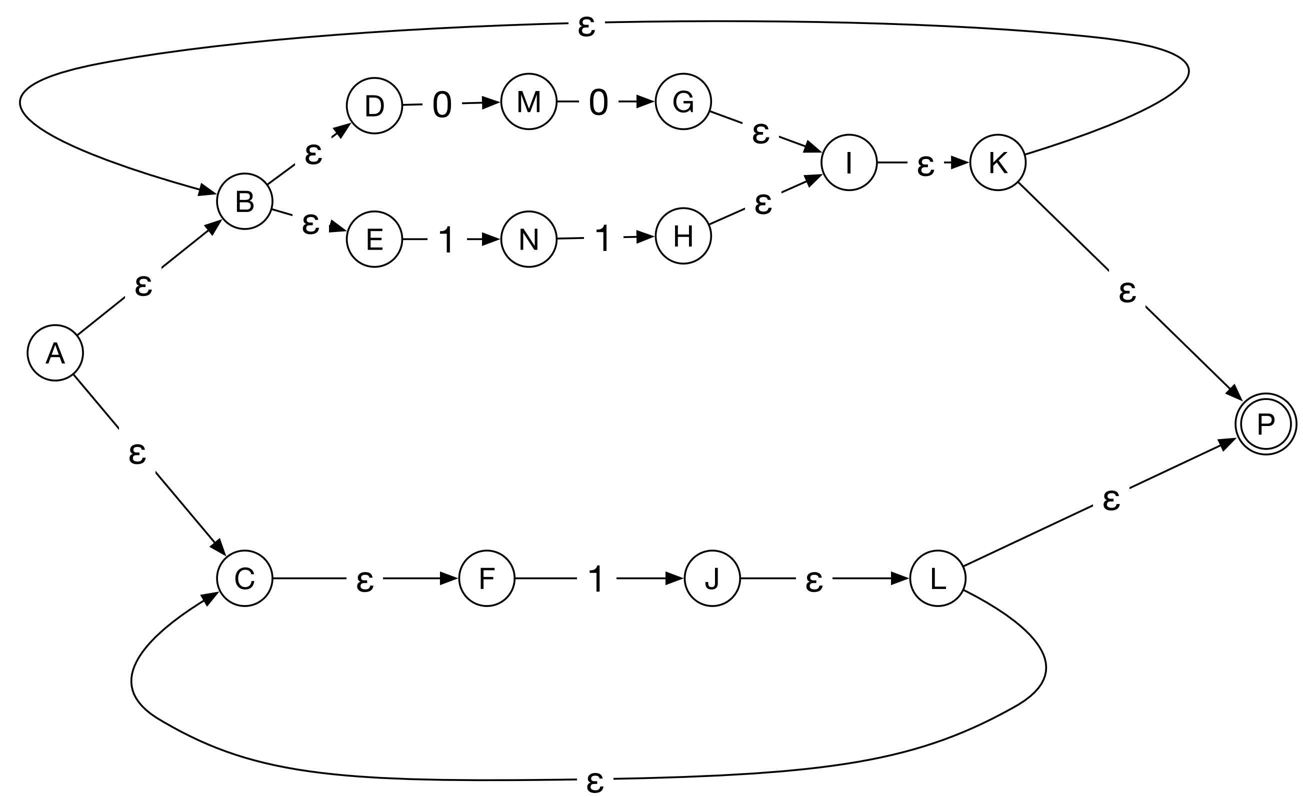
ε-Closure

- ε-closure of H
  - $\{H, I, K, P, B, D, E\}$
- ε-closure of I
  - $\{I, K, P, B, D, E\}$
- ε-closure of J
  - $\{J, L, C, F, P\}$

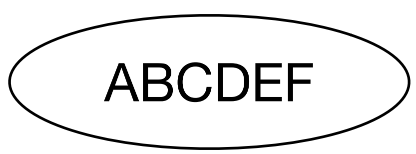


ε-Closure

- ε-closure of K
  - $\{K, P, B, D, E\}$
- ε-closure of L
  - $\{L, C, F, P\}$
- ε-closure of P
  - $\{P\}$

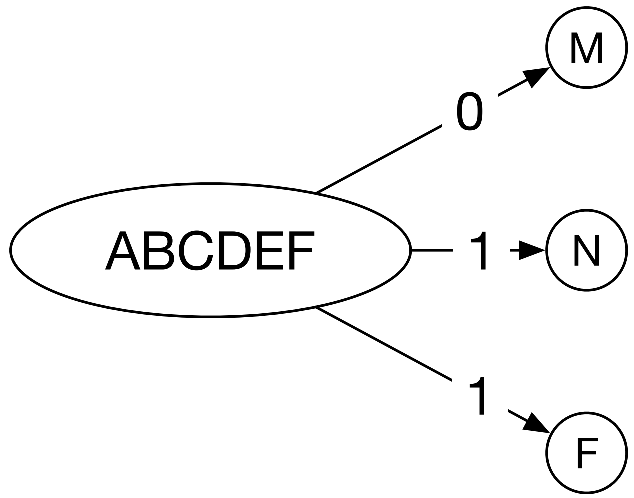


Equivalent NFA

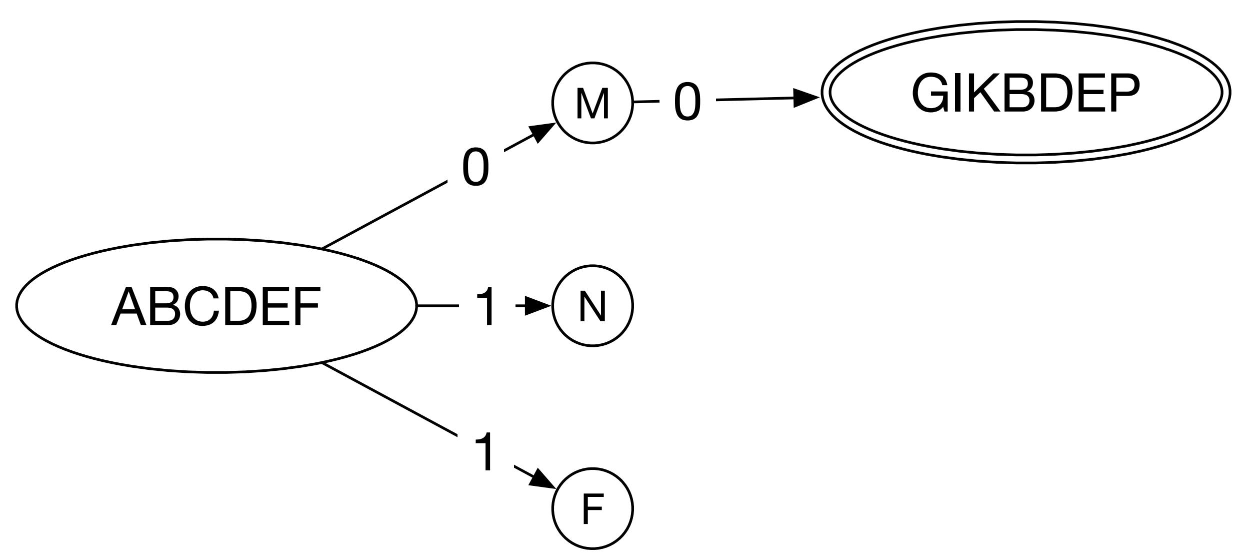
- Replace each state with its ε-closure
  - Start with A
  - 

  - Use any non-ϵ transition to another state, which gets replaced with its ϵ-closure
  - We have D to M on 0, E to N on 1, C to F on 1
  -

Equivalent NFA

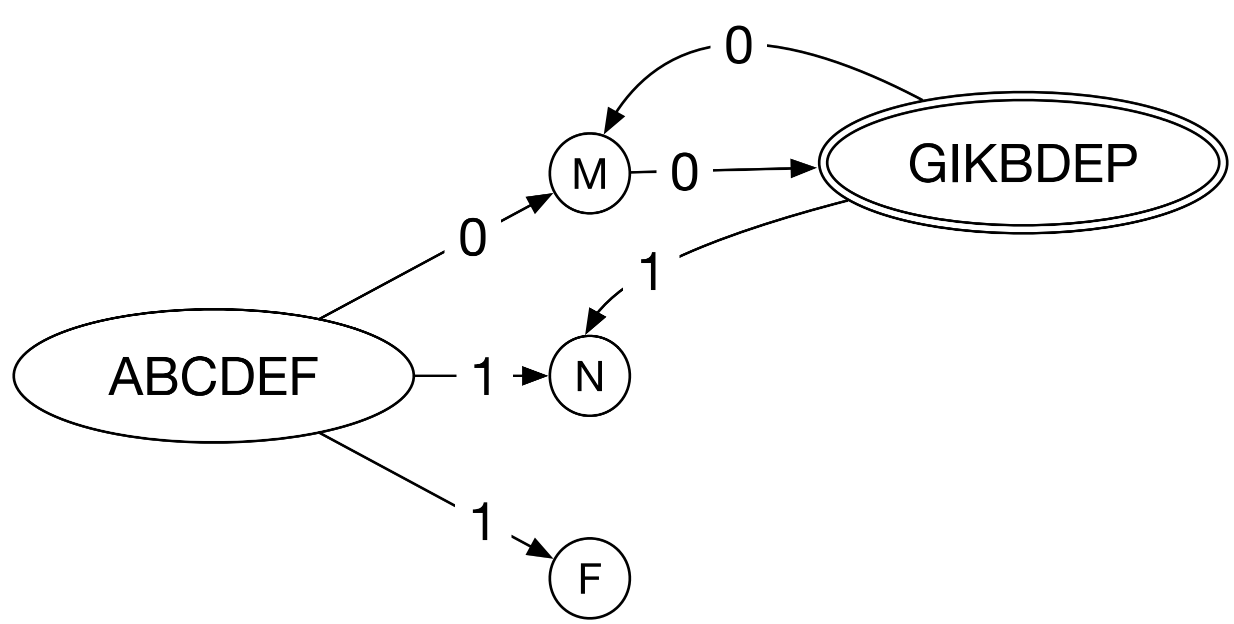
- 

- We have a transition in M to G on 0.
  - Replace G with its closure (which is accepting since it contains P



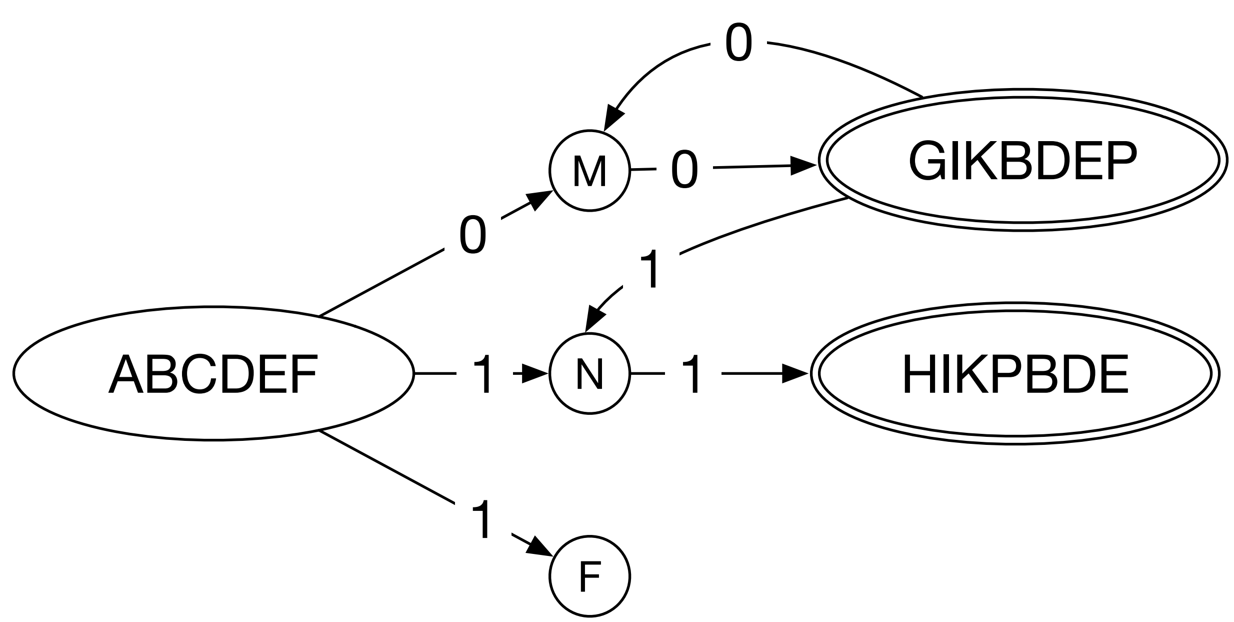
Equivalent NFA

- GIKBDEP has:
  - transition from D to M on 0
    - So we add a transition to M
  - transition from E to N on 1
    - So we add one to N on 1



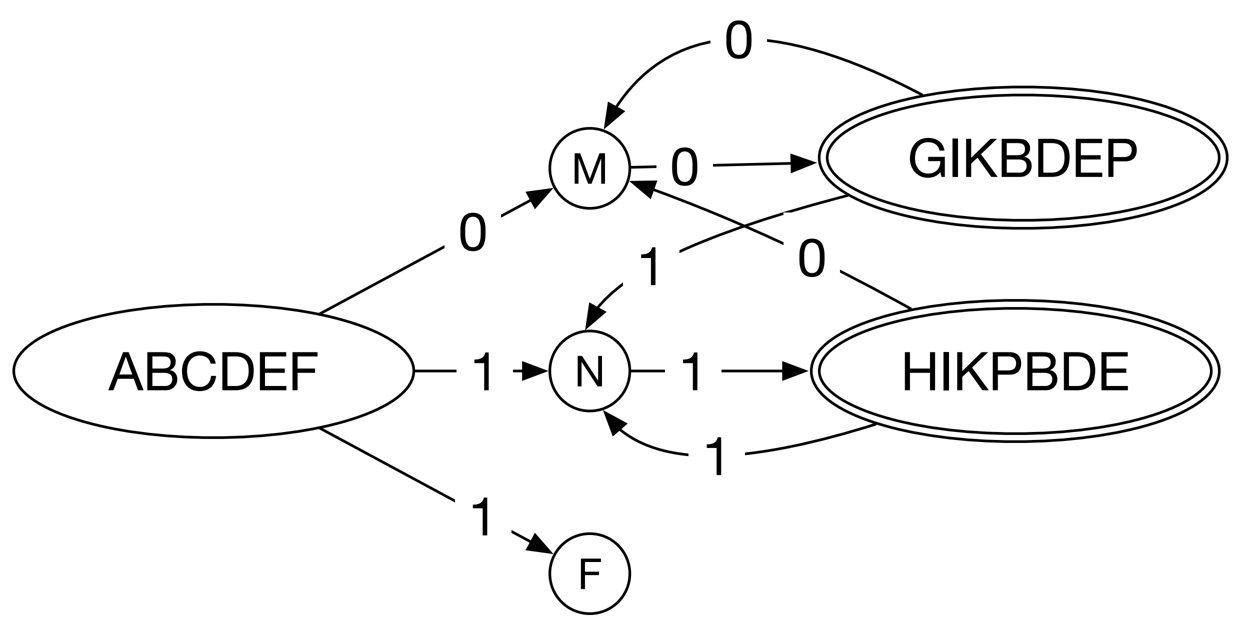
Equivalent NFA

- N has a transition to H on 1
  - We add the transition to the closure of N
  - Notice that the ϵ-closure contains a final state, so it is also final



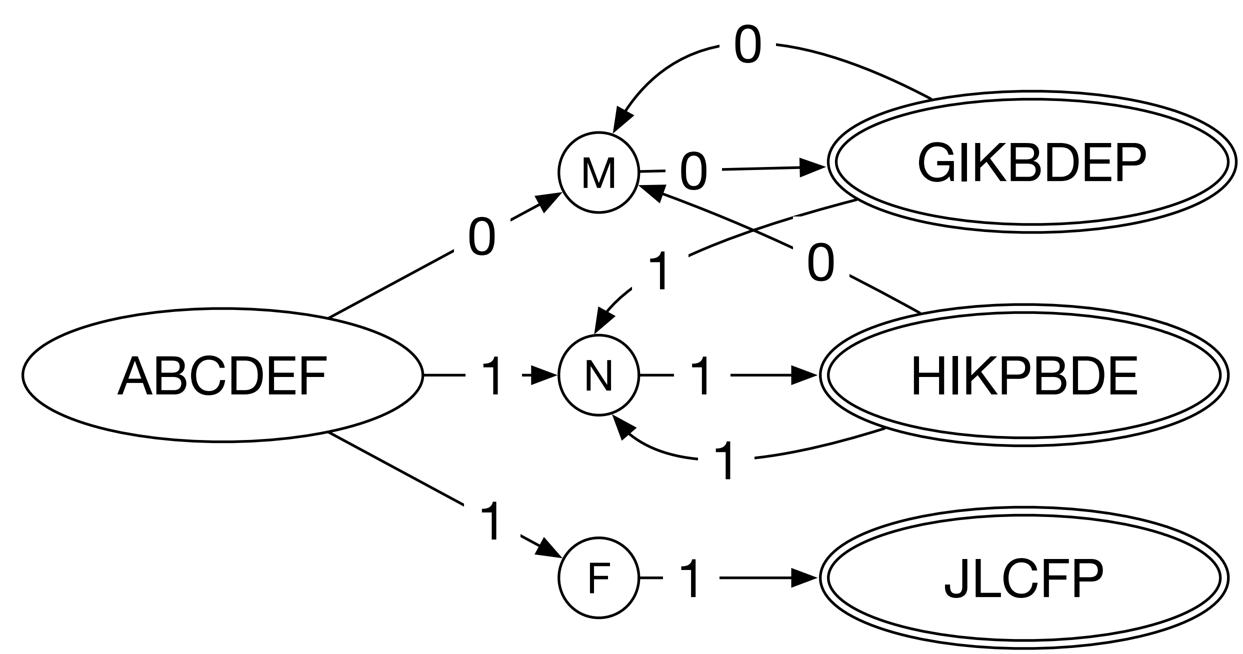
Equivalent NFA

- There are two transitions out of HIKPBDE, namely from D to M on 0, and from E to N on 1.
- This gives two transitions from HIKPBDE to M on 0 and to N on 1



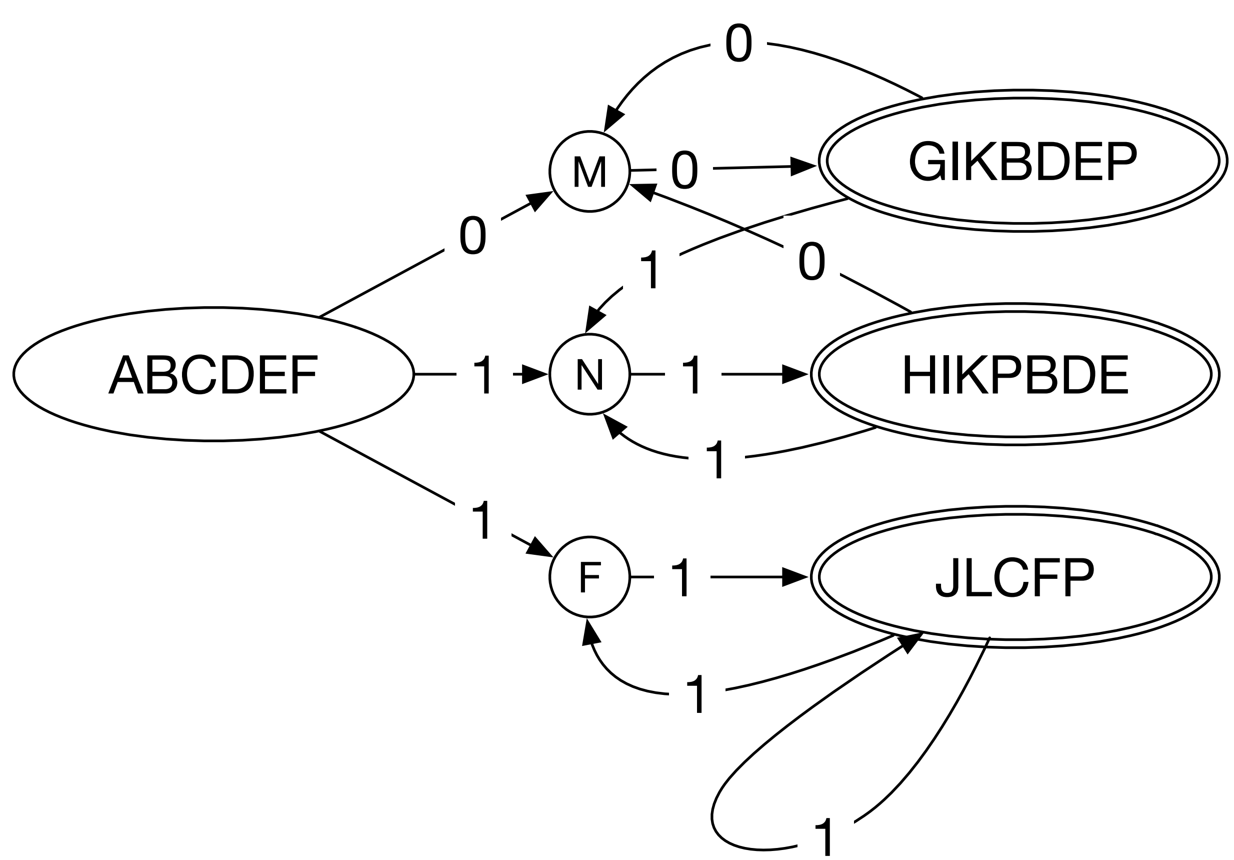
Equivalent NFA

- There is a transition from F to JLCFP



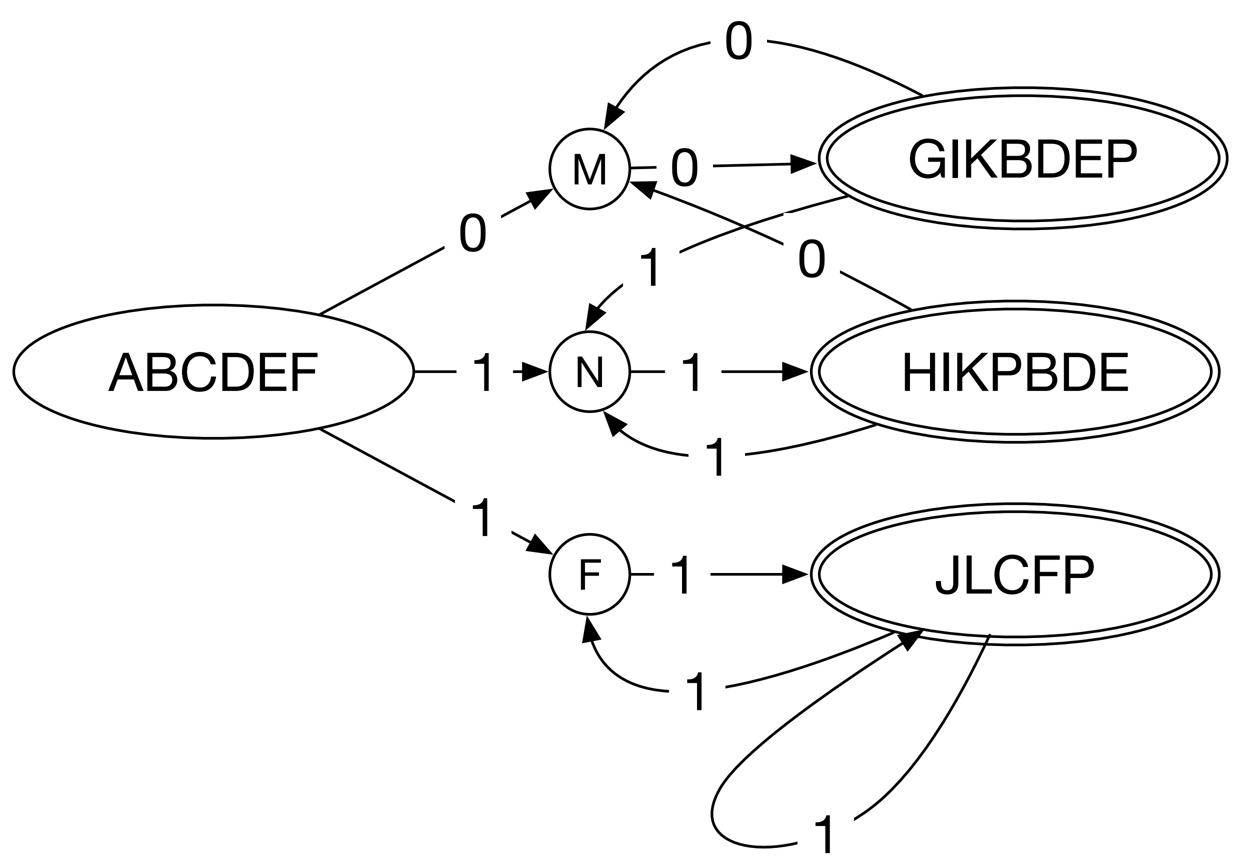
Equivalent NFA

- There is one transition on 1 out of F to J.



Equivalent NFA

- And out of JLCFP, there is only one transition, namely on 1 from F to J. The ϵ-closure of J is of course JLCFP, so we get a self-transition on 1



Equivalent NFA

- An inspection shows:
  - No more reachable states without non-ϵ transitions
  - We are done