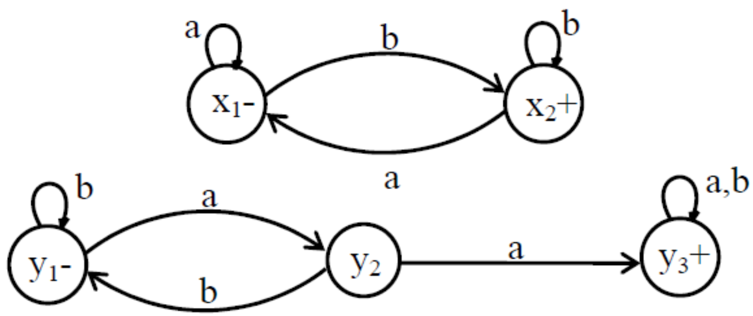
# CSC 2204 Finite Automata Theory and Formal Languages

Department of Computer Science
SZABIST (Islamabad Campus)

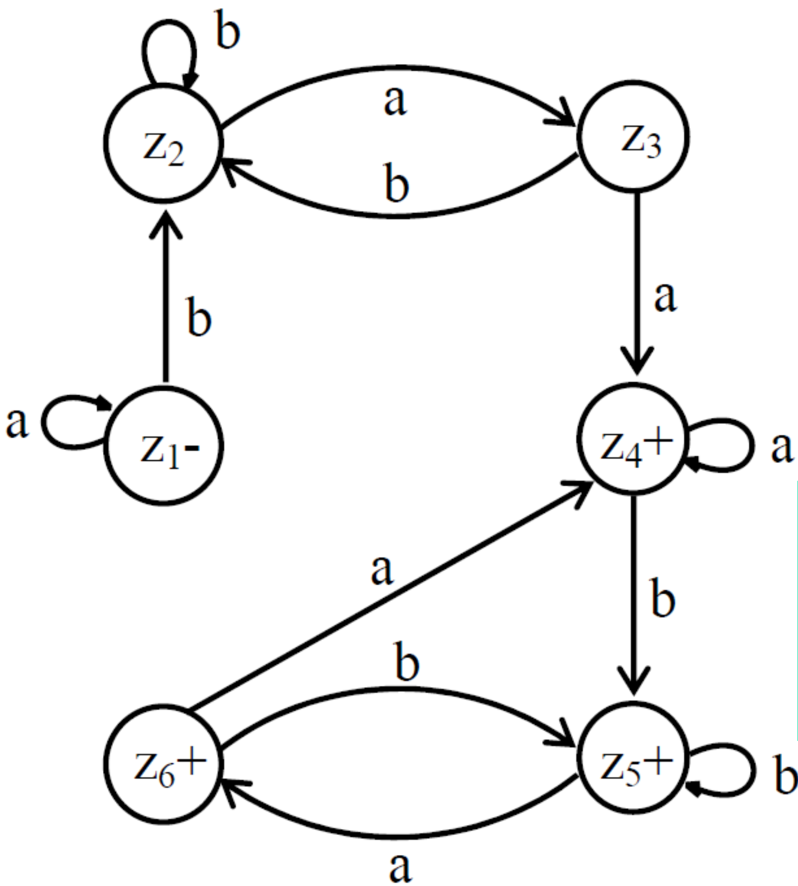
Week 6 (Lecture 2)

# Concatenation



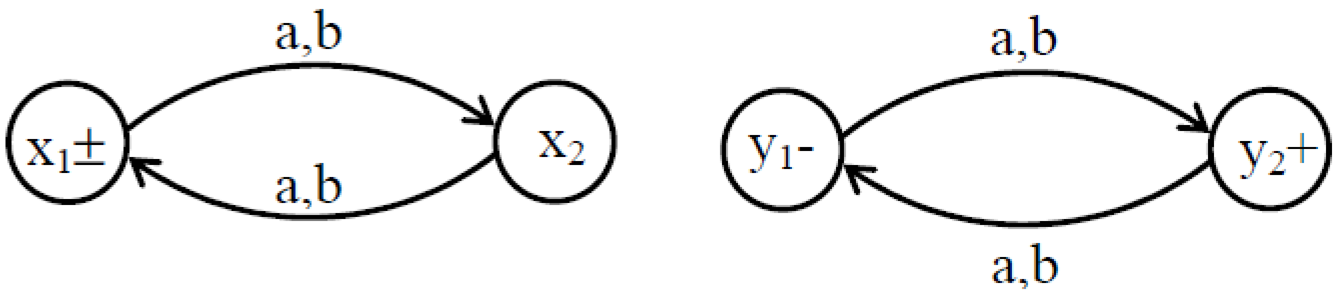

| Old States | New States after reading a | New States after reading b |
|---|---|---|
| $z_1- \equiv x_1$ | $x_1 \equiv z_1$ | $(x_2,y_1) \equiv z_2$ |
| $z_2 \equiv (x_2,y_1)$ | $(x_1,y_2) \equiv z_3$ | $(x_2,y_1) \equiv z_2$ |
| $z_3 \equiv (x_1,y_2)$ | $(x_1,y_3) \equiv z_4$ | $(x_2,y_1) \equiv z_2$ |
| $z_4+ \equiv (x_1,y_3)$ | $(x_1,y_3) \equiv z_4$ | $(x_2,y_1,y_3) \equiv z_5$ |
| $z_5+ \equiv (x_2,y_1,y_3)$ | $(x_1,y_2,y_3) \equiv z_6$ | $(x_2,y_1,y_3) \equiv z_5$ |
| $z_6+ \equiv (x_1,y_2,y_3)$ | $(x_1,y_3) \equiv z_4$ | $(x_2,y_1,y_3) \equiv z_5$ |

# Concatenation



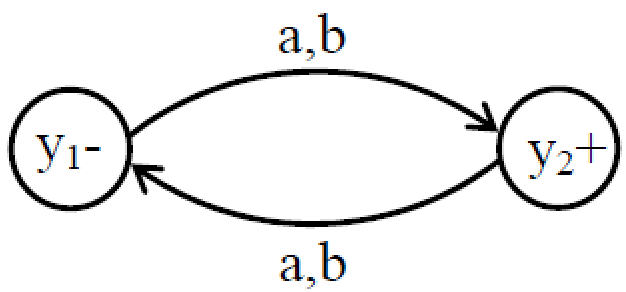

r1 = (a+b)*b
r2 = (a+b)*aa (a+b)*
r1r2 = ((a+b)*b)((a+b)*aa (a+b)*)

# Concatenation



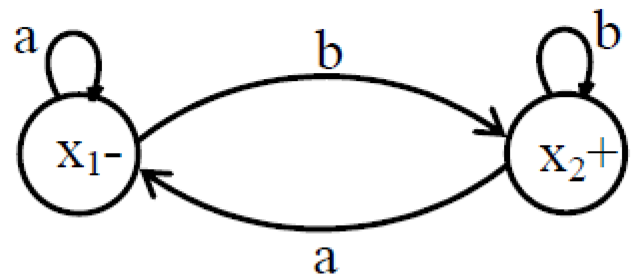

| Old States | New States after reading a | New States after reading b |
|---|---|---|
| $z_1- \equiv (x_1,y_1)$ | $(x_2,y_2) \equiv z_2$ | $(x_2,y_2) \equiv z_2$ |
| $z_2+ \equiv (x_2,y_2)$ | $(x_1,y_1) \equiv z_1$ | $(x_1,y_1) \equiv z_1$ |

# Concatenation



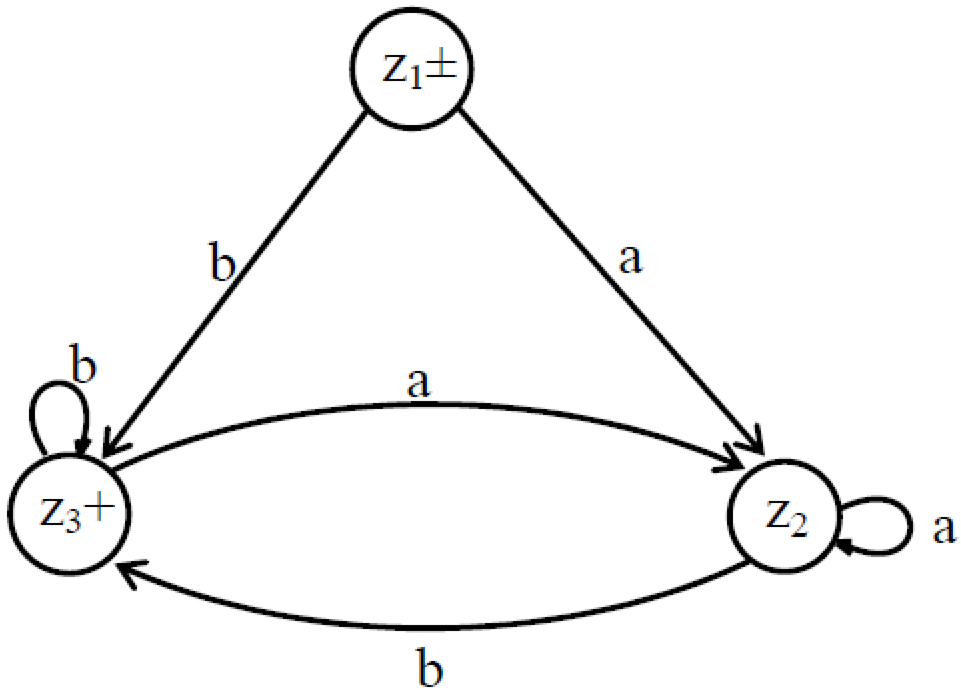

r1 = ((a+b)(a+b))*
r2 = (a+b)((a+b)(a+b))*
r2 = ((a+b)(a+b))*(a+b)
r1r2 = (((a+b)(a+b))*)((a+b)((a+b)(a+b))*)
r1r2 = (((a+b)(a+b))*)(((a+b)(a+b))*(a+b))

# Closure



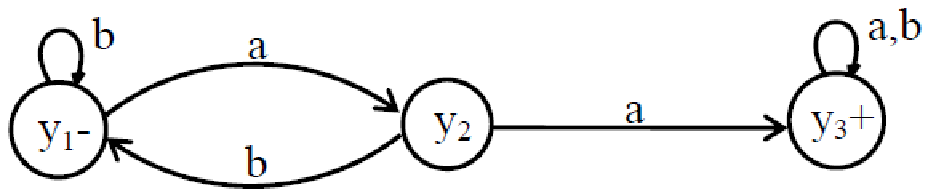

| Old States | New States after reading a | New States after reading b |
|---|---|---|
| Final $z_1 \pm \equiv x_1$ | $x_1 \equiv z_2$ | $(x_2,x_1) \equiv z_3$ |
| Non-final $z_2 \equiv x_1$ | $x_1 \equiv z_2$ | $(x_2,x_1) \equiv z_3$ |
| $z_3 + \equiv (x_2,x_1)$ | $x_1 \equiv z_2$ | $(x_2,x_1) \equiv z_3$ |

# Closure



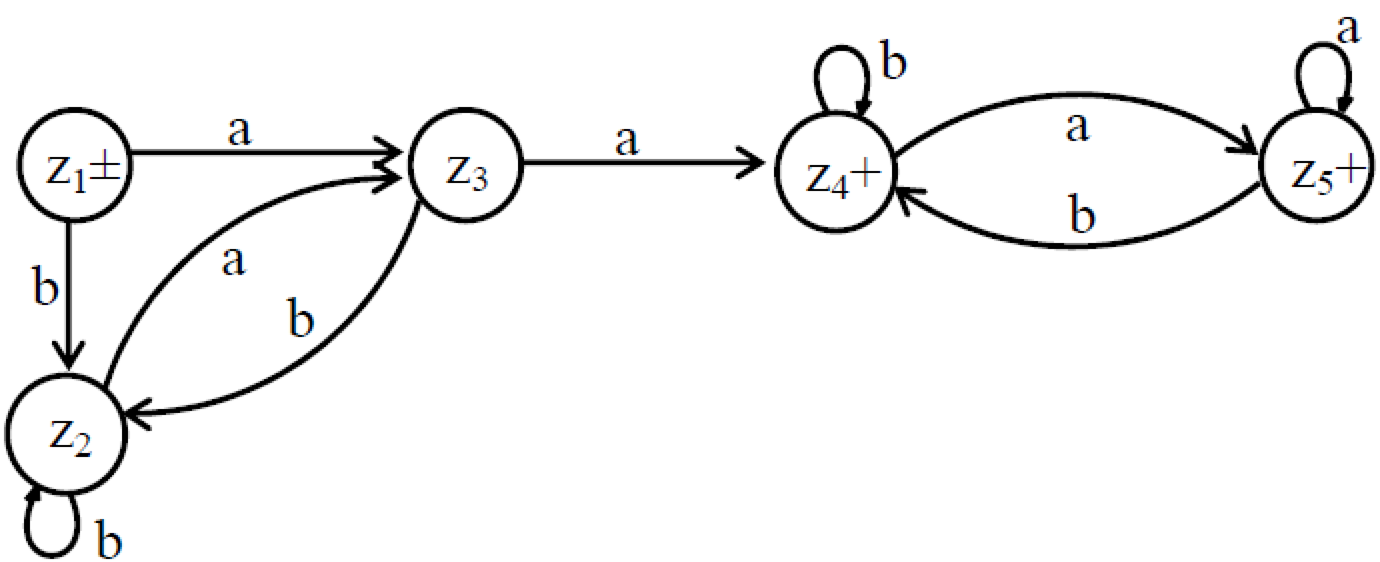

r = (a+b)*b
r* = ((a+b)*b)*

# Closure



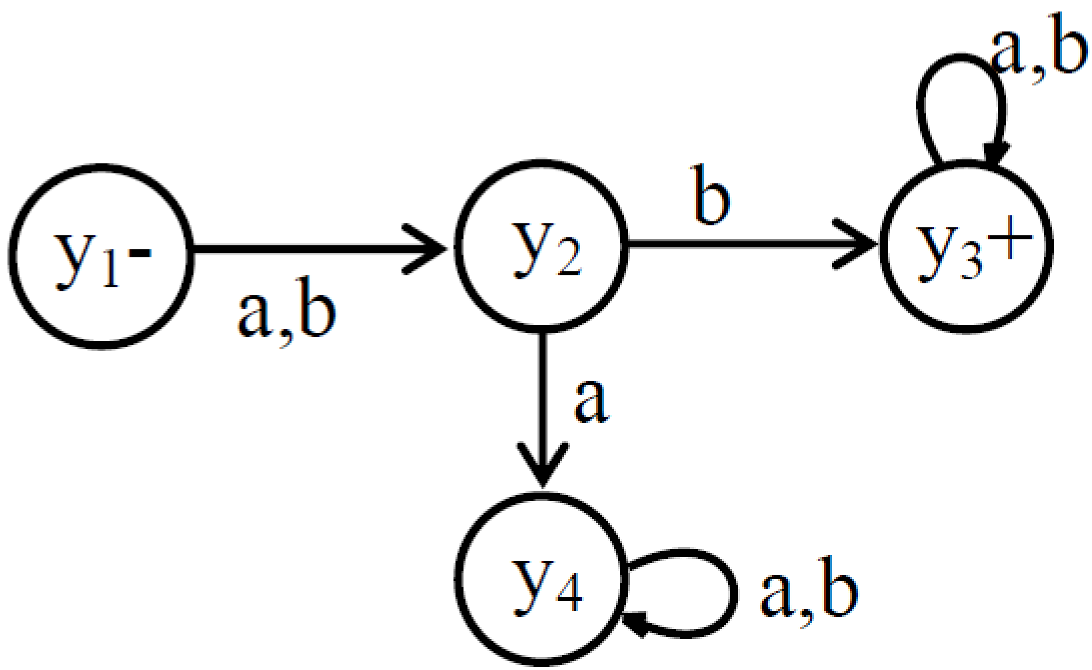

| Old States | New States after reading | |
|---|---|---|
| | a | b |
| Final $z_1\pm\equiv y_1$ | $y_2\equiv z_3$ | $y_1\equiv z_2$ |
| Non-Final $z_2\equiv y_1$ | $y_2\equiv z_3$ | $y_1\equiv z_2$ |
| $z_3\equiv y_2$ | $(y_3,y_1)\equiv z_4$ | $y_1\equiv z_2$ |
| $z_4+\equiv(y_3,y_1)$ | $(y_3,y_1,y_2)\equiv z_5$ | $(y_3,y_1)\equiv z_4$ |
| $z_5+\equiv(y_3,y_1,y_2)$ | $(y_3,y_1,y_2)\equiv z_5$ | $(y_3,y_1)\equiv z_4$ |

# Closure




r = (a+b)*aa(a+b)*
r* = ((a+b)*aa(a+b)*)*

# Closure (Exercise)

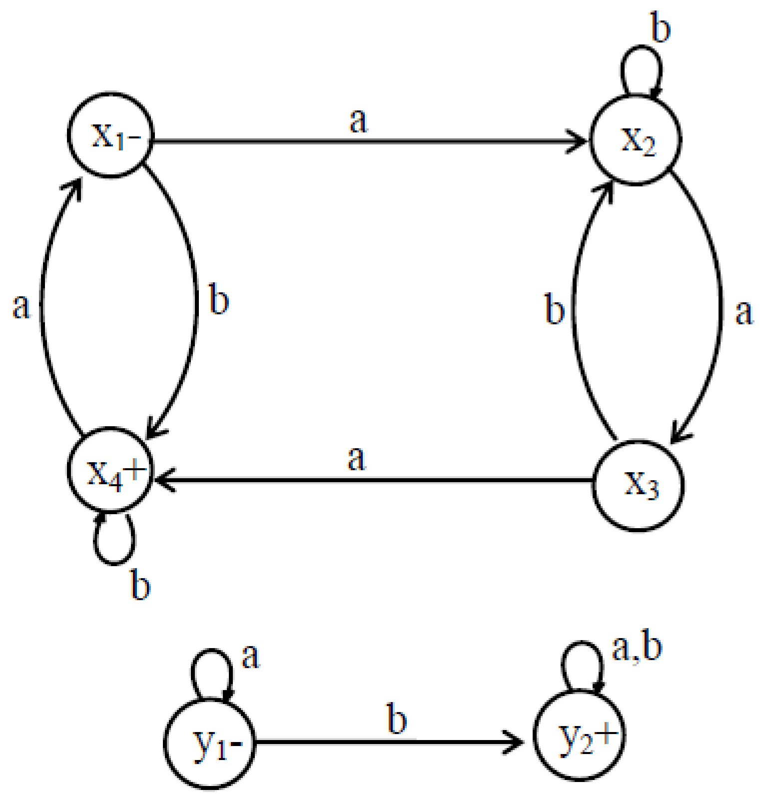



r = (a+b)b(a+b)*

Language accepting string with b as the second letter

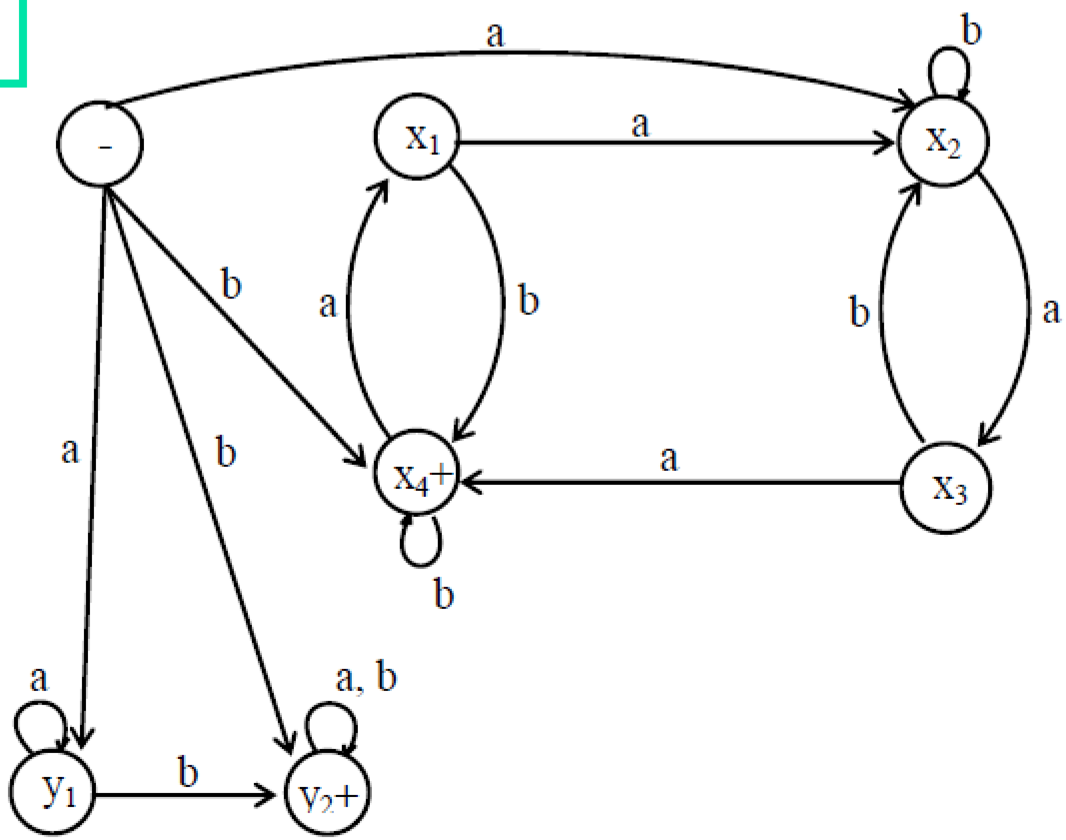
# Kleen’s Theorem for NFAs

Union



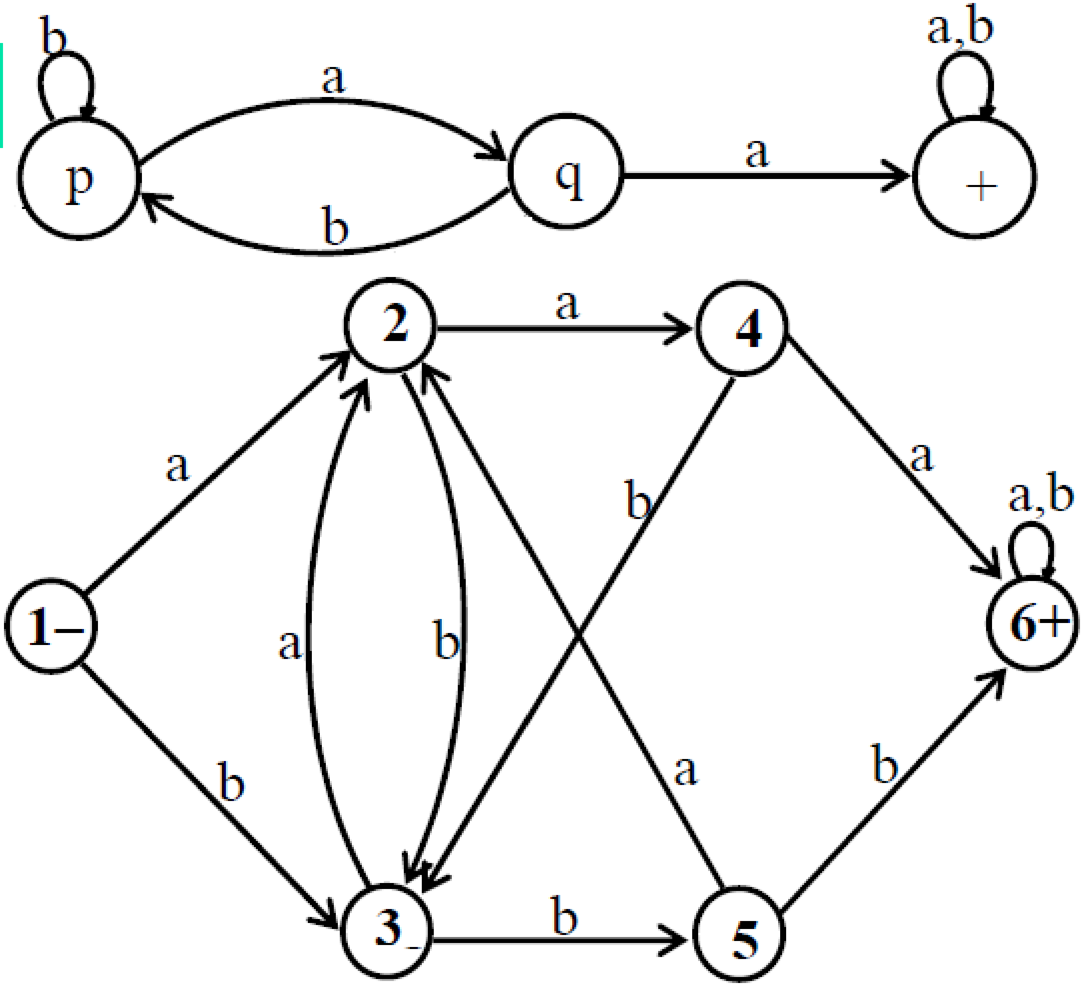
# Kleen’s Theorem for NFAs

Union



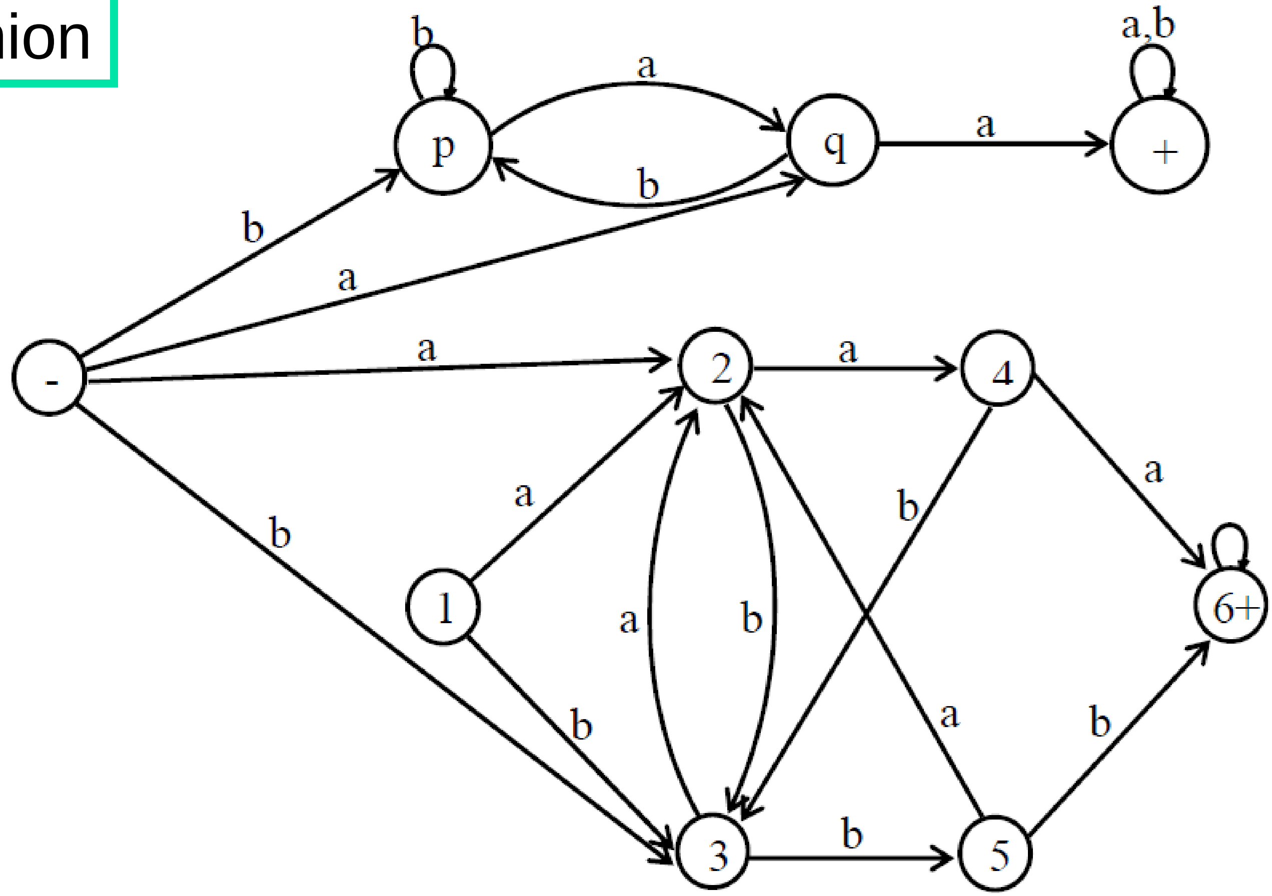
# Kleen’s Theorem for NFAs

Union



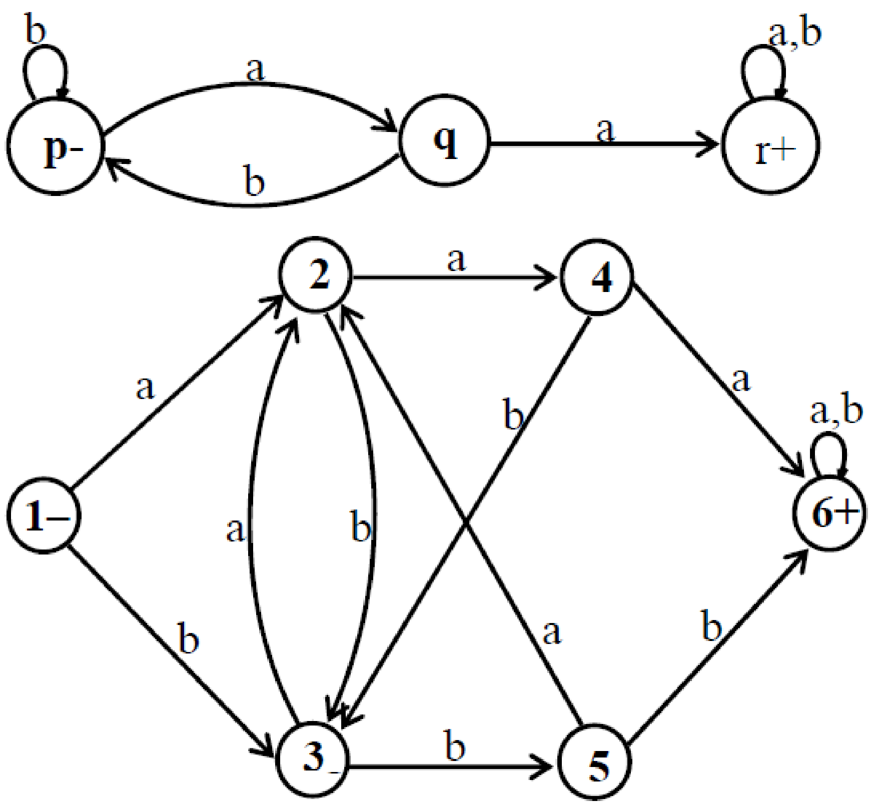
# Kleen's Theorem for NFAs

Union



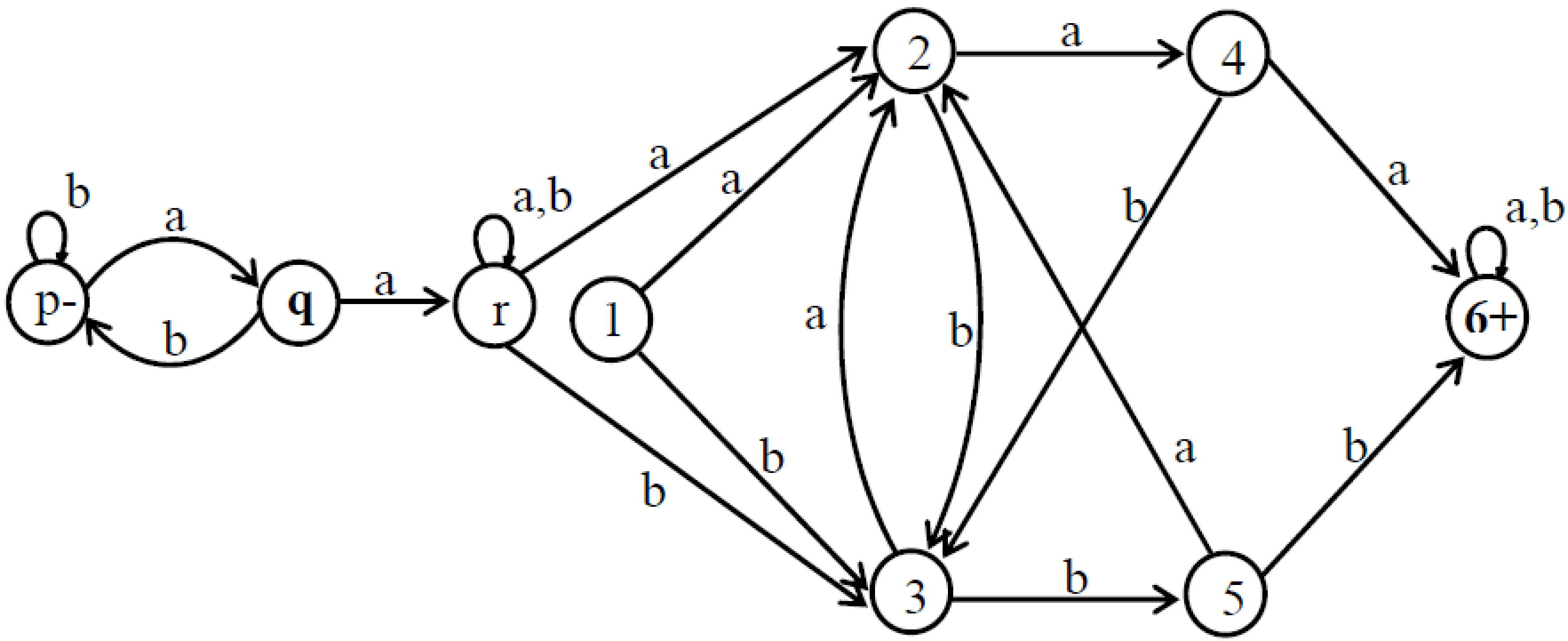
# Kleen's Theorem for NFAs

Concatenation



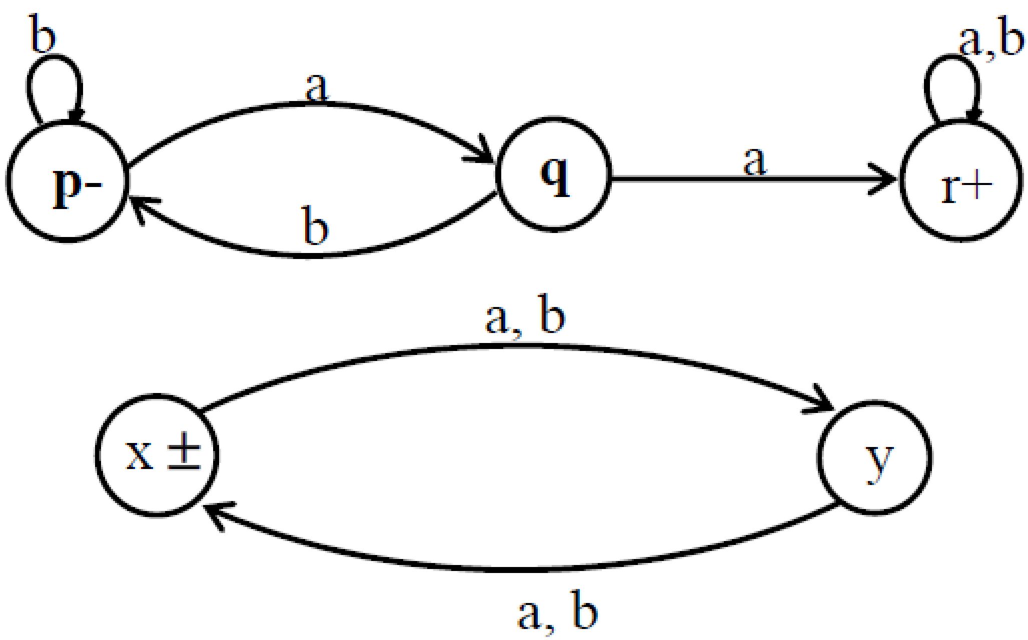
# Kleen’s Theorem for NFAs

Concatenation



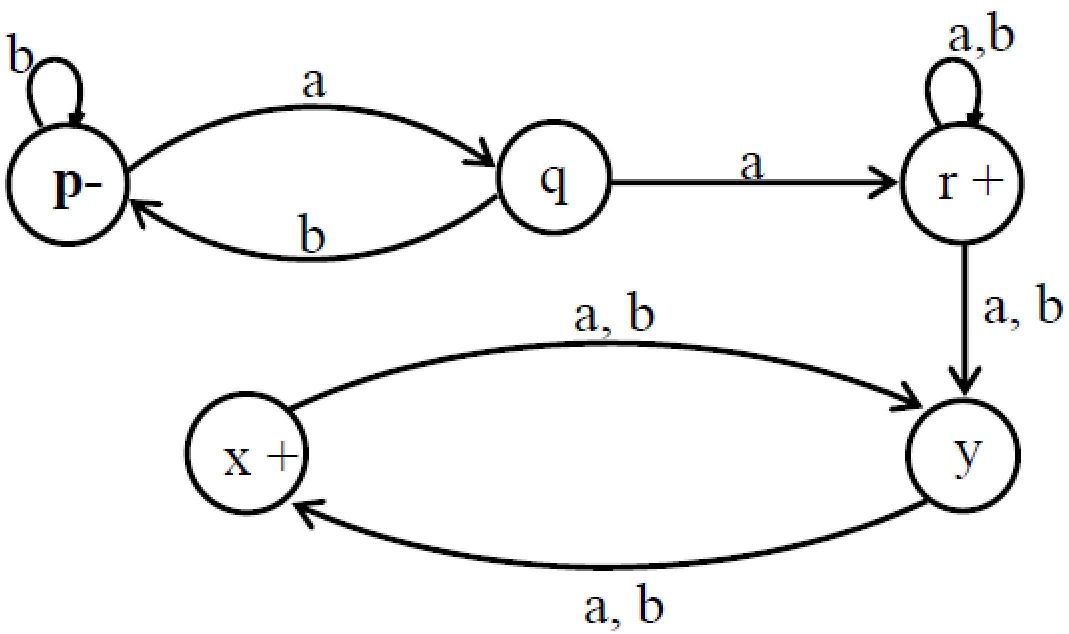
# Kleen’s Theorem for NFAs

Concatenation



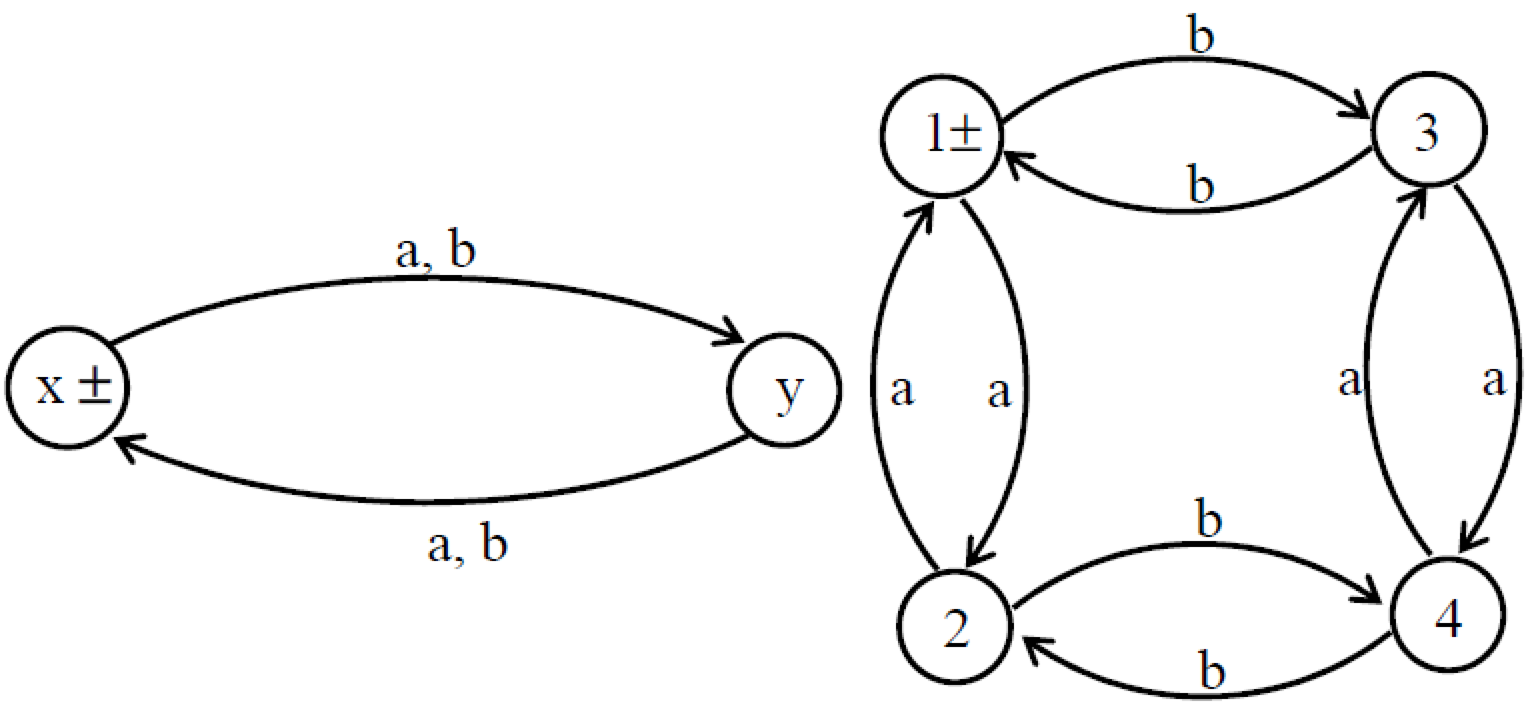
# Kleen's Theorem for NFAs

Concatenation



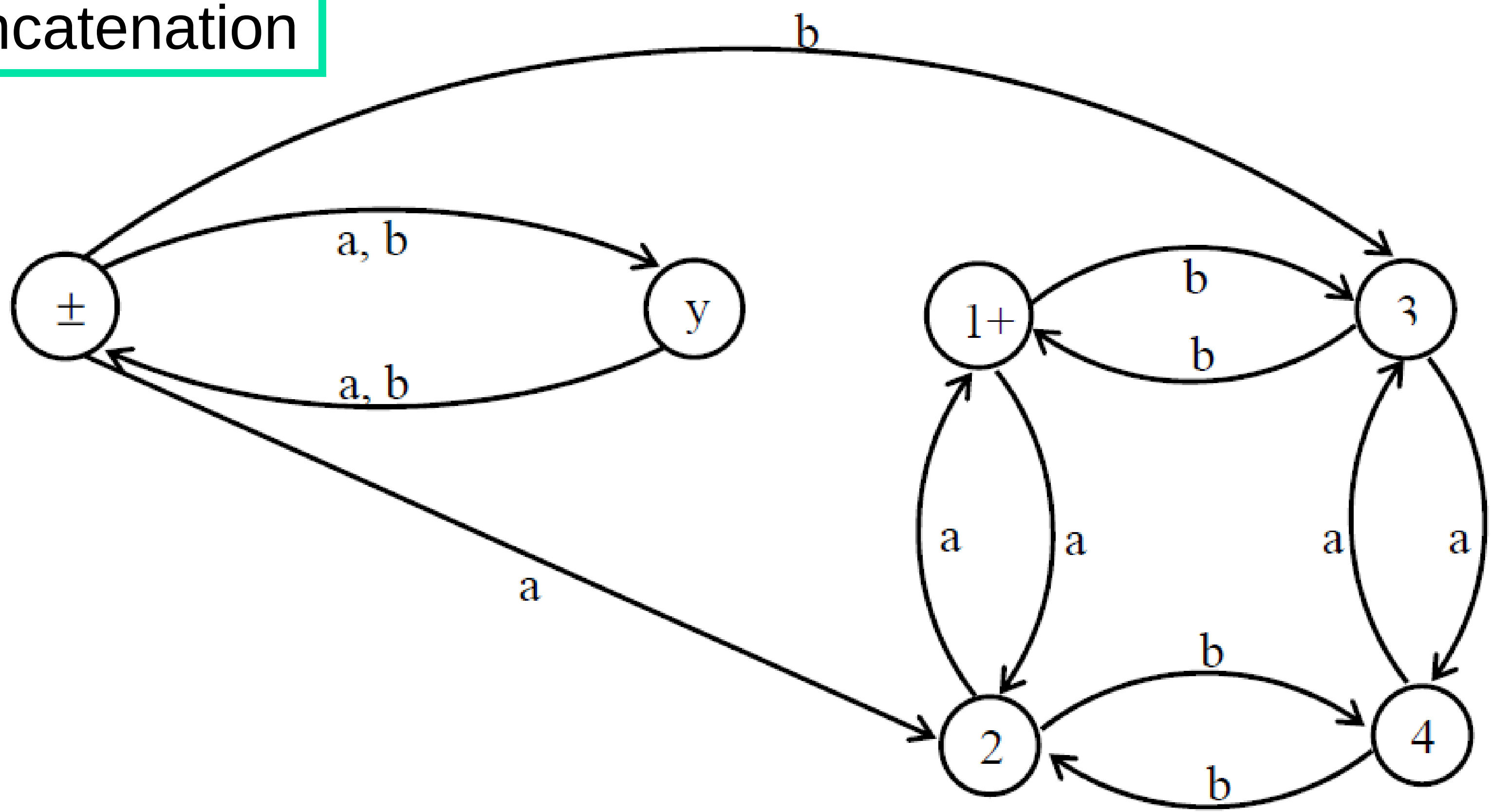
# Kleen's Theorem for NFAs

Concatenation



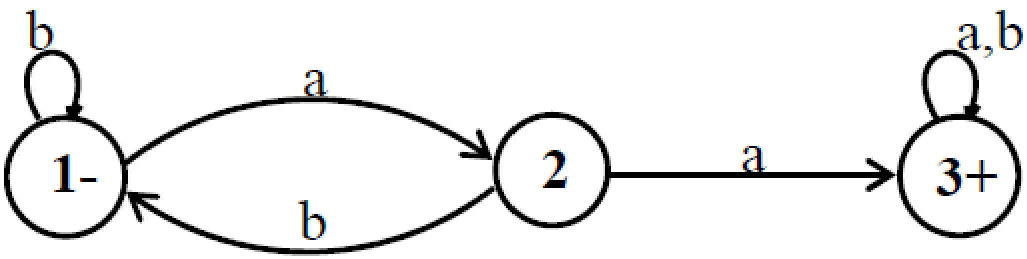
# Kleen’s Theorem for NFAs

Concatenation



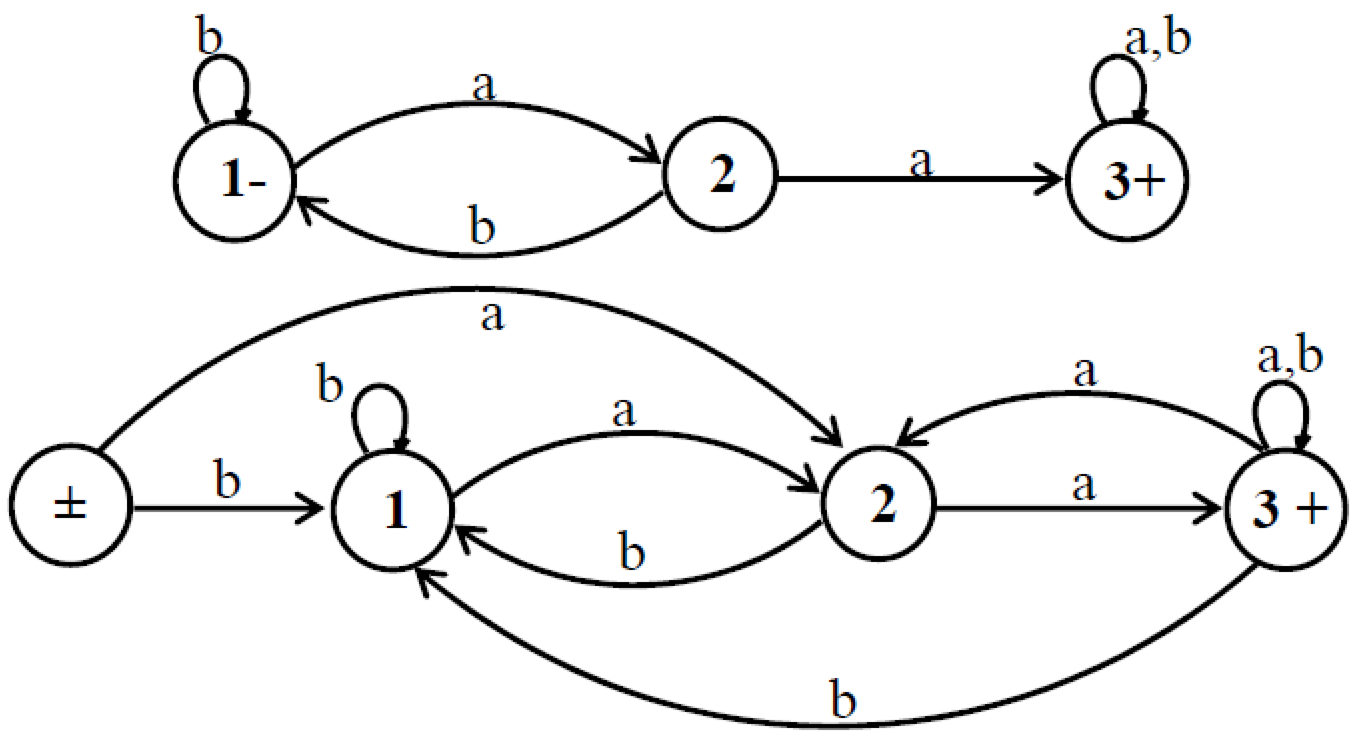
# Kleen’s Theorem for NFAs

Closure



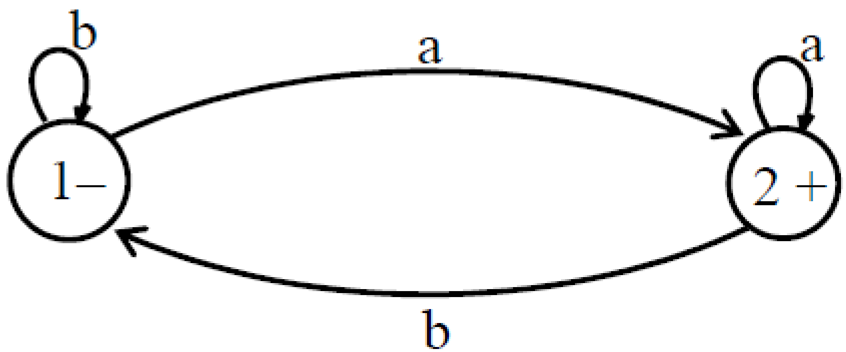
# Kleen's Theorem for NFAs

Closure



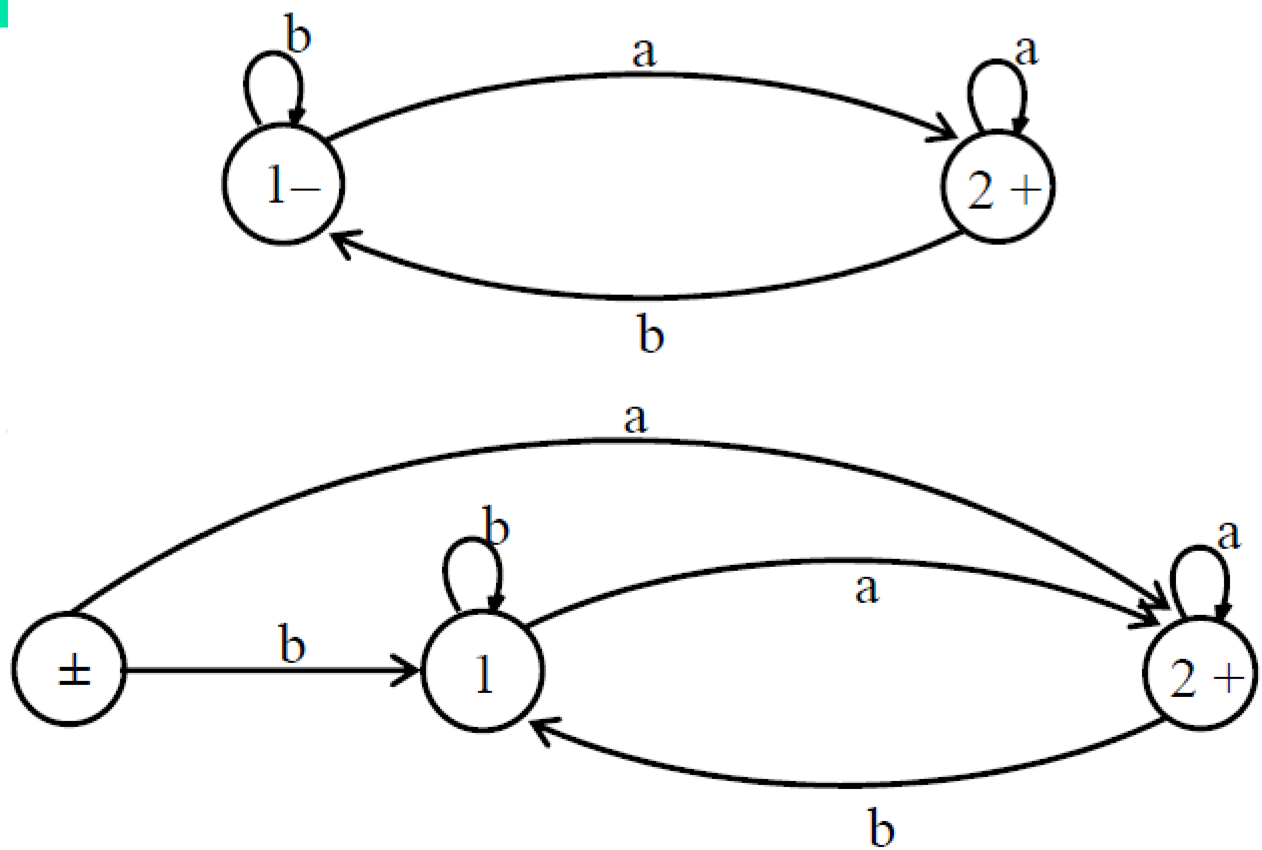
# Kleen’s Theorem for NFAs

Closure



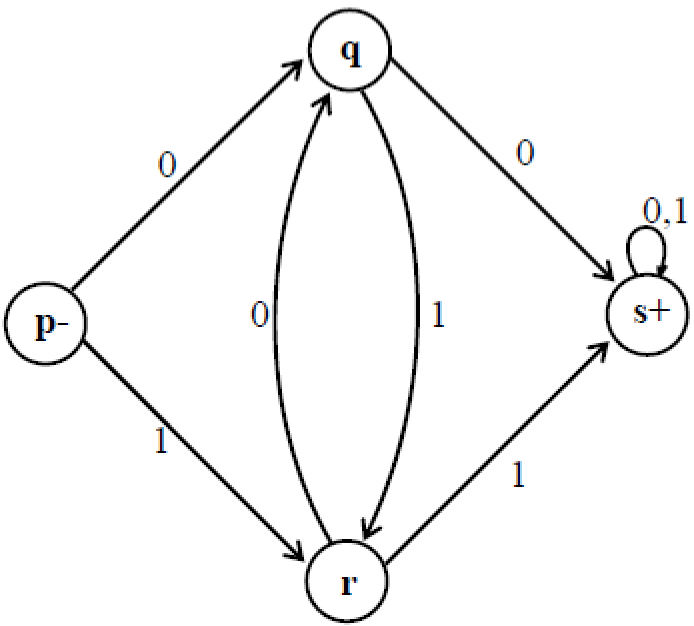
# Kleen's Theorem for NFAs

Closure



# Kleen's Theorem for NFAs

Closure



# Kleen’s Theorem for NFAs

Closure