

PA koji prihvata praznim stogom ->

PA koji prihvata prihvatljivim stanjem

$$M_1 = (\{x_1, x_2\}, \{\phi, \psi\}, \{N, J, K\}, S, x_1, \epsilon, \emptyset)$$

$$1) S(x_1, \phi, \epsilon) = \{(x_1, N\epsilon)\}$$

$$2) S(x_1, \psi, \epsilon) = \{(x_1, J\epsilon)\}$$

$$3) S(x_1, \phi, N) = \{(x_1, NN), (x_2, \emptyset)\}$$

$$4) (x_1, \psi, N) = (x_1, JN)$$

$$5) (x_1, \phi, J) = (x_1, NJ)$$

$$6) (x_1, \psi, J) = (x_1, JJ), (x_2, \emptyset)$$

$$7) (x_2, \phi, N) = (x_2, \emptyset)$$

$$8) (x_2, \psi, J) = (x_2, \emptyset)$$

$$9) (x_2, \epsilon, \epsilon) = (x_2, \emptyset)$$

$$10) (x_2, \epsilon, \epsilon) = (x_2, \emptyset)$$

$$M_1 = (\{z_1, z_2\}, \{\phi, \psi\}, \{N, J, K\}, S, z_1, \kappa, \emptyset)$$

$$1) S(z_1, \phi, \kappa) = \{(z_1, \text{NK})\}$$

$$2) S(z_1, \psi, \kappa) = \{(z_1, \text{JK})\}$$

$$3) S(z_1, \phi, N) = \{(z_1, NN), (z_2, \phi)\}$$

$$4) (z_1, \psi, N) = (z_1, JN)$$

$$5) (z_1, \phi, J) = (z_1, NJ)$$

$$6) (z_1, \psi, J) = (z_1, JJ), (z_2, \epsilon)$$

$$7) (z_2, \phi, N) = (z_2, \phi)$$

$$8) (z_2, \psi, J) = (z_2, \epsilon)$$

$$9) (z_2, \epsilon, \kappa) = (z_2, \kappa)$$

$$10) (z_2, \epsilon, \kappa) = (z_2, \kappa)$$

$$Q \cup \{z_0, z_\infty\} \quad T \cup \{x_0\}$$

$$M_2 = (\{z_1, z_2, z_0, z_\infty\}, \{\phi, \psi\}, \{N, J, K, x_0\}, S', z_0, x_0, \{z_\neq\})$$

$$M_1 = (\{z_1, z_2\}, \{\phi, 1\}, \{N, J, K\}, S, z_1, k, \emptyset)$$

- 1) $S(z_1, \phi, k) = \{(z_1, Nk)\}$
- 2) $S(z_1, 1, k) = \{(z_1, Jk)\}$
- 3) $S(z_1, \phi, N) = \{(z_1, NN), (z_2, \emptyset)\}$
- 4) $(z_1, 1, N) = (z_1, JN)$
- 5) $(z_1, \phi, J) = (z_1, NJ)$
- 6) $(z_1, 1, J) = (z_1, JJ), (z_2, \emptyset)$
- 7) $(z_2, \phi, N) = (z_2, \emptyset)$
- 8) $(z_2, 1, J) = (z_2, \emptyset)$
- 9) $(z_2, \emptyset, k) = (z_2, \emptyset)$
- 10) $(z_2, \emptyset, J) = (z_2, \emptyset)$

$$Q \cup \{z_0, z_\phi\} \quad T \cup \{x_0\}$$

$$M_2 = (\{z_1, z_2, z_0, z_\phi\}, \{\phi, 1\}, \{N, J, K, x_0\}, S', z_0, x_0, \{z_2\})$$

- 1)
2)
⋮
10)

$$M_1 = (\{z_1, z_2\}, \{\phi, \psi\}, \{N, J, K\}, S, z_1, k, \emptyset)$$

- 1) $S(z_1, \phi, k) = \{(z_1, Nk)\}$
- 2) $S(z_1, \psi, k) = \{(z_1, Jk)\}$
- 3) $S(z_1, \phi, N) = \{(z_1, NN), (z_2, \emptyset)\}$
- 4) $(z_1, \psi, N) = (z_1, JN)$
- 5) $(z_1, \phi, J) = (z_1, NJ)$
- 6) $(z_1, \psi, J) = (z_1, JJ), (z_2, \emptyset)$
- 7) $(z_2, \phi, N) = (z_2, \emptyset)$
- 8) $(z_2, \psi, J) = (z_2, \emptyset)$
- 9) $(z_2, \emptyset, k) = (z_2, \emptyset)$
- 10) $(z_2, \emptyset, \psi) = (z_2, \emptyset)$

$$Q \cup \{z_0, z_\phi\} \quad T \cup \{x_0\}$$

$$M_2 = (\{z_1, z_2, z_0, z_\phi\}, \{\phi, \psi\}, \{N, J, K, x_0\}, S', z_0, x_0, \{z_\phi\})$$

$$\circ) S'(z_0, \psi, x_0) = \{(z_1, Kx_0)\}$$

- 1)
2)
⋮
10)

$$M_1 = (\{x_1, x_2\}, \{0, 1\}, \{N, J, K\}, S, x_1, k, \emptyset)$$

- 1) $S(x_1, 0, k) = \{(x_1, Nk)\}$
- 2) $S(x_1, 1, k) = \{(x_1, Jk)\}$
- 3) $S(x_1, 0, N) = \{(x_1, NN), (x_2, 0)\}$
- 4) $(x_1, 1, N) = (x_1, JN)$
- 5) $(x_1, 0, J) = (x_1, NJ)$
- 6) $(x_1, 1, J) = (x_1, JJ), (x_2, E)$
- 7) $(x_2, 0, N) = (x_2, E)$
- 8) $(x_2, 1, J) = (x_2, E)$
- 9) $(x_2, E, k) = (x_2, E)$
- 10) $(x_2, E, E) = (x_2, E)$

$$Q \cup \{x_0, x_1\} \quad T \cup \{x_0\}$$

$$M_2 = (\{x_1, x_2, x_0, x_1\}, \{0, 1\}, \{N, J, K, x_0\}, S', x_0, x_0, \{x_2\})$$

$$\circ) S'(x_0, E, x_0) = \{(x_1, Kx_0)\}$$

1)
2)
⋮
10)

$$11) S'(x_1, E, x_0) = \{(x_2, E)\}$$

$$12) S'(x_2, E, x_0) = \{(x_1, E)\}$$

Kontekstno neovisna gramatika
-> PA koji prihvata praznim stogom

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{S\}, \{a, b\}, \{S, A\}, \delta, \{S\}, \emptyset)$$

$$\delta(S, a, S) = \{(S, AA)\} \quad 1)$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

tabaaa

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

tabaaaa

S

(2, abaaaa, S)

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

abaaaa

1)
 $S \Rightarrow a \underline{A} A$

$$(2, abaaaa, S) \succ (2, baaaa, AA)$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

abaaaaa

$$\begin{array}{c} 1) \quad 3) \\ S \Rightarrow a \underline{\overline{AA}} \Rightarrow a \underline{\overline{bS}} \overline{A} \end{array}$$

$$(2, abaaaaa, S) \succ (2, baaaaa, AA) \succ (2, aaaa, SA)$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

abaaa

$$\begin{array}{l} 1) \quad 3) \\ S \Rightarrow a \underline{AA} \Rightarrow a b \underline{S} A \Rightarrow a b a \underline{A} A A \end{array}$$

$$(2, abaaa, S) \succ (2, baaaa, AA) \succ (2, aaaa, SA) \succ (2, aaa, AAA,$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

abaaa

$$S \xrightarrow{1} a \underline{AA} \xrightarrow{3} a \underline{bS} A \xrightarrow{2} a \underline{ba} \underline{AA} \xrightarrow{4} a \underline{ba} \underline{a} \underline{AA}$$

$$(2, abaaa, S) \succ (2, baaaa, AA) \succ (2, aaaa, SA) \succ (2, aaa, AAA, \\ \times (2, aa, AA))$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, E)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

abaaaaa

$$S \xrightarrow[1]{=} a \underline{\overline{AA}} \xrightarrow[3]{=} a b \underline{\overline{SA}} \xrightarrow[1]{=} a b a \underline{\overline{AA}} \xrightarrow[4]{=} a b a a \underline{\overline{AA}} \xrightarrow[4]{=} a b a a a A$$

$$(2, abaaaaa, S) \succ (2, baaaaa, AA) \succ (2, aaaa, SA) \succ (2, aaa, AAA, \\ \succ (2, aa, AA) \succ (2, a, A)$$

$$G = (\{S, A\}, \{a, b\}, P, S)$$

P: GNO

- 1) $S \rightarrow aAA$
- 2) $A \rightarrow aS$
- 3) $A \rightarrow bS$
- 4) $A \rightarrow a$

$$PA \quad M = (\{2\}, \{a, b\}, \{S, A\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, AA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, S), (2, \epsilon)\} \quad 2) \quad 4)$$

$$\delta(2, b, A) = \{(2, S)\} \quad 3)$$

abaaaa

$$S \xrightarrow{1} a \underline{AA} \xrightarrow{3} a b \underline{S} A \xrightarrow{1} a b a \underline{AA} A \xrightarrow{4} a b a a \underline{A} A \xrightarrow{4} a b a a a \underline{A} = abaaaa$$

$$(2, abaaaa, S) \succ (2, baaaa, AA) \succ (2, aaaa, SA) \succ (2, aaa, AAA, \succ (2, aa, AA)) \succ (2, a, A) \succ (2, \epsilon, \epsilon)$$

$$G = (\{S, A, B\}, \{a, b\}, P, S)$$

P:

$$1) S \rightarrow aBA$$

$$2) A \rightarrow aB$$

$$3) A \rightarrow b$$

$$4) B \rightarrow bS$$

$$5) B \rightarrow b$$

miz: abab

$$G = (\{S, A, B\}, \{a, s\}, P, S)$$

P:

$$1) S \rightarrow aBA$$

$$2) A \rightarrow aB$$

$$3) A \rightarrow b$$

$$4) B \rightarrow bS$$

$$5) B \rightarrow b$$

miz: abab

$$PA = (\{2\}, \{a, b\}, \{S, A, B\}, \delta, 2, S, \emptyset)$$

$$\delta(2, a, S) = \{(2, BA)\} \quad 1)$$

$$\delta(2, a, A) = \{(2, B)\} \quad 2)$$

$$\delta(2, b, A) = \{(2, \epsilon)\} \quad 3)$$

$$\delta(2, b, B) = \{(2, S), (2, \epsilon)\} \quad 4) \quad 5)$$

$$G = (\{S, A, B\}, \{a, S\}, P, S)$$

P:

$$1) S \rightarrow aBA$$

$$2) A \rightarrow aB$$

$$3) A \rightarrow b$$

$$4) B \rightarrow bS$$

$$5) B \rightarrow b$$

$$\text{PA} = (\{\underline{2}\}, \{a, b\}, \{S, A, B\}, \delta, \underline{2}, S, \phi)$$

$$\delta(\underline{2}, a, S) = \{(2, BA)\} \quad 1)$$

$$\delta(\underline{2}, a, A) = \{(2, B)\} \quad 2)$$

$$\delta(\underline{2}, b, A) = \{(2, \epsilon)\} \quad 3)$$

$$\delta(\underline{2}, b, B) = \{(2, S), (2, \epsilon)\} \quad 4) \quad 5)$$

now: abab

$$S \Rightarrow a\underline{B}A \Rightarrow a\underline{b}A \Rightarrow ab\underline{a}\underline{B} \Rightarrow abab$$

$$(\underline{2}, abab, S) \succ (\underline{2}, bab, BA)$$

$$(\underline{2}, a^L, SA)$$

$$(\underline{2}, ab, A)$$

$$(\underline{2}, \epsilon, BAA)$$

$$(\underline{2}, b, B)$$

$$(\underline{2}, \epsilon, SAA)$$

$$(\underline{2}, \epsilon, \epsilon)$$

PA koji prihvaca praznim stogom
-> Kontekstno neovisna gramatika

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, \kappa\}, S, 2_1, \epsilon, \emptyset)$$

$$1) S(2_1, 0, \kappa) = \{(2_1, N\kappa)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, \epsilon)$$

$$4) (2_2, 1, N) = (2_2, \epsilon)$$

$$5) (2_2, \epsilon, N) = (2_2, \epsilon)$$

$$6) (2_2, \epsilon, \kappa) = (2_2, \epsilon)$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, k\}, S, 2_1, \leftarrow, \emptyset)$$

$$1) S(2_1, 0, \leftarrow) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, \leftarrow)$$

$$4) (2_1, 1, N) = (2_2, \leftarrow)$$

$$5) (2_2, \leftarrow, N) = (2_2, \leftarrow)$$

$$6) (2_2, \leftarrow, \leftarrow) = (2_2, \leftarrow)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, k, 2_1], [2_1, k, 2_2], [2_2, k, 2_1], [2_2, k, 2_2]\}$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, k\}, S, 2_1, \leftarrow, \emptyset)$$

$$1) S(2_1, 0, \leftarrow) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, \leftarrow)$$

$$4) (2_1, 1, N) = (2_2, \leftarrow)$$

$$5) (2_2, \leftarrow, N) = (2_2, \leftarrow)$$

$$6) (2_2, \leftarrow, \leftarrow) = (2_2, \leftarrow)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, k, 2_1], [2_1, k, 2_2], [2_2, k, 2_1], [2_2, k, 2_2]\}$$

$$1) S(2_1, 0, \leftarrow) = \{(2_1, Nk)\}$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, k\}, S, 2_1, \epsilon, \emptyset)$$

$$1) S(2_1, 0, \epsilon) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, \epsilon)$$

$$4) (2_2, 1, N) = (2_2, \epsilon)$$

$$5) (2_2, \epsilon, N) = (2_2, \epsilon)$$

$$6) (2_2, \epsilon, \epsilon) = (2_2, \epsilon)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, \epsilon, 2_1], [2_1, \epsilon, 2_2], [2_2, \epsilon, 2_1], [2_2, \epsilon, 2_2]\}$$

$$1) S(2_1, 0, \epsilon) = \{(2_1, Nk)\}$$

$$[2_1, \epsilon, 2_1] \rightarrow 0 [2_1, N, 2_1] [2_1, \epsilon, 2_1] / 0 [2_1, N, 2_2] [2_2, \epsilon, 2_1]$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, K\}, S, 2_1, E, \emptyset)$$

$$1) S(2_1, 0, E) = \{(2_1, N \cdot E)\}$$

$$2) (2_1, 0, N) = (2_1, N \cdot N)$$

$$3) (2_1, 1, N) = (2_2, E)$$

$$4) (2_2, 1, N) = (2_2, E)$$

$$5) (2_2, E, N) = (2_2, E)$$

$$6) (2_2, E, E) = (2_2, E)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, E, 2_1], [2_1, E, 2_2], [2_2, E, 2_1], [2_2, E, 2_2]\}$$

$$1) S(2_1, 0, E) = \{(2_1, N \cdot E)\}$$

$$\begin{array}{c} \cancel{2} \downarrow \cancel{E} \downarrow \\ [2_1, E, 2_1] \rightarrow 0[\cancel{2_1, N, 2_1}] [\cancel{2_1}, E, 2_1] / 0[\cancel{2_1, N, 2_1}] [\cancel{2_2}, E, 2_1] \end{array}$$

$$[2_1, E, 2_2] \rightarrow 0[\cancel{2_1, N, 2_1}] [\cancel{2_1, E, 2_2}] / 0[\cancel{2_1, N, 2_2}] [\cancel{2_2, E, 2_2}]$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, K\}, S, 2_1, E, \emptyset)$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, E)$$

$$4) (2_1, 1, N) = (2_2, E)$$

$$5) (2_2, E, N) = (2_2, E)$$

$$6) (2_2, E, E) = (2_2, E)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, E, 2_1], [2_1, E, 2_2], [2_2, E, 2_1], [2_2, E, 2_2]\}$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$\begin{array}{c} \cancel{2} \downarrow \downarrow \downarrow \downarrow \\ [2_1, E, 2_1] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, E, 2_1}] | 0[\underline{2_1, N, 2_1}] [\underline{2_2, E, 2_1}] \end{array}$$

$$[2_1, E, 2_2] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, E, 2_2}] | 0[\underline{2_1, N, 2_2}] [\underline{2_2, E, 2_2}]$$

$$2) S(2_1, 0, N) = \{(2_1, NN)\}$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, K\}, S, 2_1, E, \emptyset)$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, E)$$

$$4) (2_1, 1, N) = (2_2, E)$$

$$5) (2_2, E, N) = (2_2, E)$$

$$6) (2_2, E, E) = (2_2, E)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, E, 2_1], [2_1, E, 2_2], [2_2, E, 2_1], [2_2, E, 2_2]\}$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$\begin{array}{c} \cancel{2_1} \cancel{E} \cancel{2_1} \\ [2_1, E, 2_1] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, E, 2_1}] | 0[\underline{2_1, N, 2_1}] [\underline{2_2, E, 2_1}] \end{array}$$

$$[2_1, E, 2_2] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, E, 2_2}] | 0[\underline{2_1, N, 2_2}] [\underline{2_2, E, 2_2}]$$

$$2) S(2_1, 0, N) = \{(2_1, NN)\}$$

$$[2_1, N, 2_1] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, N, 2_1}] | 0[\underline{2_1, N, 2_2}] [\underline{2_2, N, 2_1}]$$

$$[2_1, N, 2_2] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, N, 2_2}] | 0[\underline{2_1, N, 2_2}] [\underline{2_2, N, 2_2}]$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, K\}, S, 2_1, E, \emptyset)$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, E)$$

$$4) (2_1, 1, N) = (2_2, E)$$

$$5) (2_2, E, N) = (2_2, E)$$

$$6) (2_2, E, E) = (2_2, E)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, E, 2_1], [2_1, E, 2_2], [2_2, E, 2_1], [2_2, E, 2_2]\}$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$[2_1, E, 2_1] \rightarrow 0 [2_1, N, 2_1] [2_1, E, 2_1] / 0 [2_1, N, 2_1] [2_2, E, 2_1]$$

$$[2_1, E, 2_2] \rightarrow 0 [2_1, N, 2_1] [2_1, E, 2_2] / 0 [2_1, N, 2_2] [2_2, E, 2_2]$$

$$2) S(2_1, 0, N) = \{(2_1, NN)\}$$

$$[2_1, N, 2_1] \rightarrow 0 [2_1, N, 2_1] [2_1, N, 2_1] / 0 [2_1, N, 2_2] [2_2, N, 2_1]$$

$$[2_1, N, 2_2] \rightarrow 0 [2_1, N, 2_1] [2_1, N, 2_2] / 0 [2_1, N, 2_2] [2_2, N, 2_2]$$

$$3) S(2_1, 1, N) = \{(2_2, E)\}$$

$$[2_1, N, 2_2] \rightarrow 1$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, K\}, S, 2_1, E, \emptyset)$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, E)$$

$$4) (2_2, 1, N) = (2_2, E)$$

$$5) (2_2, E, N) = (2_2, E)$$

$$6) (2_2, E, E) = (2_2, E)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{\dots, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], \\ [2_1, E, 2_1], [2_1, E, 2_2], [2_2, E, 2_1], [2_2, E, 2_2]\}$$

$$1) S(2_1, 0, E) = \{(2_1, Nk)\}$$

$$[2_1, E, 2_1] \rightarrow 0 [2_1, N, 2_1] [2_1, E, 2_1] / 0 [2_1, N, 2_1] [2_2, E, 2_1]$$

$$[2_1, E, 2_2] \rightarrow 0 [2_1, N, 2_1] [2_1, E, 2_2] / 0 [2_1, N, 2_2] [2_2, E, 2_2]$$

$$2) S(2_1, 0, N) = \{(2_1, NN)\}$$

$$[2_1, N, 2_1] \rightarrow 0 [2_1, N, 2_1] [2_1, N, 2_1] / 0 [2_1, N, 2_2] [2_2, N, 2_1]$$

$$[2_1, N, 2_2] \rightarrow 0 [2_1, N, 2_1] [2_1, N, 2_2] / 0 [2_1, N, 2_2] [2_2, N, 2_2]$$

$$3) S(2_1, 1, N) = \{(2_2, E)\}$$

$$[2_1, N, 2_2] \rightarrow 1$$

$$4) S(2_2, 1, N) = \{(2_2, E)\}$$

$$[2_2, N, 2_2] \rightarrow 1$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, \kappa\}, S, 2_1, \epsilon, \emptyset)$$

$$1) S(2_1, 0, \kappa) = \{(2_1, N\kappa)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, \epsilon)$$

$$4) (2_2, 1, N) = (2_2, \epsilon)$$

$$5) (2_2, \epsilon, N) = (2_2, \epsilon)$$

$$6) (2_2, \epsilon, \epsilon) = (2_2, \epsilon)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{\dots, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], \\ [2_1, \kappa, 2_1], [2_1, \kappa, 2_2], [2_2, \kappa, 2_1], [2_2, \kappa, 2_2]\}$$

$$1) S(2_1, 0, \kappa) = \{(2_1, N\kappa)\}$$

$$[2_1, \kappa, 2_1] \rightarrow 0 [2_1, N, 2_1] [2_1, \kappa, 2_1] / 0 [2_1, N, 2_1] [2_2, \kappa, 2_1]$$

$$[2_1, \kappa, 2_2] \rightarrow 0 [2_1, N, 2_1] [2_1, \kappa, 2_2] / 0 [2_1, N, 2_2] [2_2, \kappa, 2_2]$$

$$2) S(2_1, 0, N) = \{(2_1, NN)\}$$

$$[2_1, N, 2_1] \rightarrow 0 [2_1, N, 2_1] [2_1, N, 2_1] / 0 [2_1, N, 2_1] [2_2, N, 2_1]$$

$$[2_1, N, 2_2] \rightarrow 0 [2_1, N, 2_1] [2_1, N, 2_2] / 0 [2_1, N, 2_2] [2_2, N, 2_2]$$

$$3) S(2_1, 1, N) = \{(2_2, \epsilon)\}$$

$$[2_1, N, 2_2] \rightarrow 1$$

$$4) S(2_2, 1, N) = \{(2_2, \epsilon)\}$$

$$[2_2, N, 2_2] \rightarrow 1$$

$$5) [2_2, N, 2_2] \rightarrow \epsilon$$

$$6) [2_2, \epsilon, 2_2] \rightarrow \epsilon$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, k\}, S, 2_1, \epsilon, \emptyset)$$

$$1) S(2_1, 0, \epsilon) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, \epsilon)$$

$$4) (2_2, 1, N) = (2_2, \epsilon)$$

$$5) (2_2, \epsilon, N) = (2_2, \epsilon)$$

$$6) (2_2, \epsilon, \epsilon) = (2_2, \epsilon)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], [2_1, \epsilon, 2_1], [2_1, \epsilon, 2_2], [2_2, \epsilon, 2_1], [2_2, \epsilon, 2_2]\}$$

$$1) S(2_1, 0, \epsilon) = \{(2_1, Nk)\}$$

$$\begin{array}{c} \cancel{\downarrow} \quad \cancel{\downarrow} \\ [2_1, \epsilon, 2_1] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1}, \epsilon, 2_1] / 0[\underline{2_1, N, 2_1}] [\underline{2_2}, \epsilon, 2_1] \end{array}$$

$$[2_1, \epsilon, 2_2] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, \epsilon, 2_2}] / 0[\underline{2_1, N, 2_2}] [\underline{2_2, \epsilon, 2_2}]$$

$$2) S(2_1, 0, N) = \{(2_1, NN)\}$$

$$[2_1, N, 2_1] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, N, 2_1}] / 0[\underline{2_1, N, 2_2}] [\underline{2_2, N, 2_1}]$$

$$[2_1, N, 2_2] \rightarrow 0[\underline{2_1, N, 2_1}] [\underline{2_1, N, 2_2}] / 0[\underline{2_1, N, 2_2}] [\underline{2_2, N, 2_2}]$$

$$3) S(2_1, 1, N) = \{(2_2, \epsilon)\}$$

$$\begin{array}{c} \cancel{\downarrow} \quad \cancel{\downarrow} \\ [2_1, N, 2_2] \rightarrow 1 \end{array}$$

$$4) S(2_2, 1, N) = \{(2_2, \epsilon)\}$$

$$[2_2, N, 2_2] \rightarrow 1$$

$$5) [2_2, N, 2_2] \rightarrow \epsilon$$

$$6) [2_2, \epsilon, 2_2] \rightarrow \epsilon$$

$$0) S \rightarrow [2_1, \epsilon, 2_1] / [2_1, \epsilon, 2_2]$$

$$S \rightarrow [2_1, \epsilon, 2_1], 26Q$$

$$PA \quad n = (\{2_1, 2_2\}, \{0, 1\}, \{N, k\}, S, 2_1, \epsilon, \emptyset)$$

$$1) S(2_1, 0, \epsilon) = \{(2_1, Nk)\}$$

$$2) (2_1, 0, N) = (2_1, NN)$$

$$3) (2_1, 1, N) = (2_2, \epsilon)$$

$$4) (2_2, 1, N) = (2_2, \epsilon)$$

$$5) (2_2, \epsilon, N) = (2_2, \epsilon)$$

$$6) (2_2, \epsilon, \epsilon) = (2_2, \epsilon)$$

$$G = (V, \{0, 1\}, P, S)$$

$$V = \{S, [2_1, N, 2_1], [2_1, N, 2_2], [2_2, N, 2_1], [2_2, N, 2_2], \\ [2_1, \epsilon, 2_1], [2_1, \epsilon, 2_2], [2_2, \epsilon, 2_1], [2_2, \epsilon, 2_2]\}$$

$$1) S(2_1, 0, \epsilon) = \{(2_1, Nk)\}$$

$$\begin{array}{c} \swarrow \quad \searrow \\ [2_1, \epsilon, 2_1] \rightarrow 0[2_1, N, 2_1][2_1, \epsilon, 2_1] \mid 0[2_1, N, 2_1][2_2, \epsilon, 2_1] \end{array}$$

$$[2_1, \epsilon, 2_2] \rightarrow 0[2_1, N, 2_1][2_1, \epsilon, 2_2] \mid 0[2_1, N, 2_2][2_2, \epsilon, 2_2]$$

$$2) S(2_1, 0, N) = \{(2_1, NN)\}$$

$$[2_1, N, 2_1] \rightarrow 0[2_1, N, 2_1][2_1, N, 2_1] \mid 0[2_1, N, 2_2][2_2, N, 2_1]$$

$$[2_1, N, 2_2] \rightarrow 0[2_1, N, 2_1][2_1, N, 2_2] \mid 0[2_1, N, 2_2][2_2, N, 2_2]$$

$$3) S(2_1, 1, N) = \{(2_2, \epsilon)\}$$

$$\begin{array}{c} \swarrow \quad \searrow \\ [2_1, N, 2_2] \rightarrow 1 \end{array}$$

$$4) S(2_2, 1, N) = \{(2_2, \epsilon)\}$$

$$[2_2, N, 2_2] \rightarrow 1$$

$$5) [2_2, N, 2_2] \rightarrow \epsilon$$

$$6) [2_2, \epsilon, 2_2] \rightarrow \epsilon$$

$$0) S \rightarrow [2_1, \epsilon, 2_1] \mid [2_1, \epsilon, 2_2]$$

$$S \rightarrow [2_1, \epsilon, 2_1], \text{ qed}$$

$$S \rightarrow [2_1, \epsilon, 2_2]$$

$$[2_1, \epsilon, 2_2] \rightarrow 0[2_1, N, 2_2][2_2, \epsilon, 2_2]$$

$$[2_1, N, 2_2] \rightarrow 0[2_1, N, 2_2][2_2, N, 2_2]$$

$$[2_1, N, 2_2] \rightarrow 1$$

$$[2_2, \epsilon, 2_2] \rightarrow \epsilon$$

$$[2_2, N, 2_2] \rightarrow \epsilon$$

$$[2_2, N, 2_2] \rightarrow 1$$