

- ① $E' \Rightarrow$ leftover of left recursion
 $E \Rightarrow$ rewrite w/out left recursion
- ② Subscript the symbols
- ③ Chart

3. Construct pda P that accepts following language by empty stack:

$L = L(G)$ where $G = (T, N, P, E)$ with $T = \{id, +, *, (,)\}$;
 $N = \{E\}$, and $P = \{E \rightarrow E + E \mid E * E \mid (E) \mid id\}$

$E \rightarrow E + E \mid E * E \mid (E) \mid id$
 no left recursion
 same, so it's left recursion

add E'
 $E' \rightarrow +E \mid *E \mid +EE' \mid *EE'$ leftover of left recursion

take out stuff w/out left recur (1st part)
 $E \rightarrow (E) \mid (E)E' \mid id \mid idE'$ remaining w/ no left recursion

$E \rightarrow (E) \mid (E)E' \mid id \mid idE'$ * refer to the T

Stack \rightarrow

((id	id
E	E'	id	E'

Subscript Symbols after the top of the stack

$X,$

② $E \rightarrow (EX, \mid (EX, E' \mid id \mid idE'$

bring down 1st symbol

$E' \rightarrow +E \mid *E \mid +EE' \mid *EE'$

$X, \rightarrow)$

new pg



id + * () ϵ

always there

2 places

q means it's there

does id show up as top of the stack in E ?

E	(q, ϵ) (q, E')	/	/	(q, EX) (q, EX, E')	/	/	/
E'	/	(q, E) (q, EE')	(q, E) (q, EE')	/	/	/	/
X	/	/	/	/	(q, ϵ)	/	/

if by itself in block \rightarrow gets ϵ

$P_N = (\{q\}, \{id, +, *, (,)\}, \{E, E', X\}, \delta, q, \epsilon, \epsilon)$

the top of stack is on the left.

3. $L = L(G)$ where $G = (T, N, P, S)$ w/ $T = \{<, >, [,]\}$
 $N = \{S, A\}$ and $P = \{S \rightarrow <S>A \mid [A]A, A \rightarrow [A]S \mid <S>S \mid \epsilon\}$

$S \rightarrow <S>A \mid [A]A$

$A \rightarrow [A]S \mid <S>S \mid \epsilon$

get rid of ϵ (eliminate ϵ in all sets)

①

eliminate ϵ

$S \rightarrow <S>A \mid <S> \mid [A]A \mid [A] \mid []A \mid []$

$A \rightarrow [A]S \mid []S \mid <S>S$

eliminate ϵ

②

Subscript the symbol after top of the stack

$S \rightarrow <SX_1A \mid <SX_1 \mid [AX_1A \mid [AX_1 \mid [X_1A \mid [X_1$

$A \rightarrow [AX_1S \mid [X_1S \mid <SX_1S$

Symbols
definition \rightarrow

$X_1 \rightarrow >$

$X_2 \rightarrow]$

★★★★

the top of the stack is on the left.

where it begins w/ these symbols!

		<	>	[]	ϵ
q	S	(q, SX_1A) (q, SX_1)	/	$(q, AX_1A)(q, X_1)$ $(q, X_1A)(q, X_1)$	/	/
	A	(q, SX_1S)	//	(q, X_1S) (q, X_1S)	/	/
	X_1	/	(q, ϵ)	/	/	/
	X_2	/	/	/	(q, ϵ)	/

4 $P = (\overset{\text{part 1}}{\{p, q\}}, \{a, b\}, \{z, x\}, \delta, \overset{\text{part 1}}{(p, z)}, \emptyset)$

① $\delta(p, a, z) = \{(p, xz)\}$

② $\delta(p, \epsilon, z) = \{(p, \epsilon)\}$

③ $\delta(p, a, x) = \{(p, xx)\}$

④ $\delta(q, a, z) = \{(q, \epsilon)\}$

⑤ $\delta(p, b, x) = \{(q, x)\}$

⑥ $\delta(q, b, z) = \{(p, z)\}$

part 1

①

$S \rightarrow [p, z, p] \mid [p, z, q]$

get from line 1

part 2

②

do for all b - criss cross

① $\delta(p, a, z) = \{(p, xz)\}$

original

$(p, xz) \in \delta(p, a, z)$

rewrite w/ ϵ

$[p, z, p/q] \rightarrow a [p, x, p/q] [p/q, z, p/q]$

for p : $\rightarrow [p, z, p] \rightarrow a [p, x, p] [p, z, p] \mid a [p, x, q] [q, z, p]$

for q : $\rightarrow [p, z, q] \rightarrow a [p, x, p] [p, z, q] \mid a [p, x, q] [q, z, q]$
4 productions

② $\delta(p, \epsilon, z) = \{(p, \epsilon)\}$

$(p, \epsilon) \in \delta(p, \epsilon, z)$

criss cross

$[p, z, p/q] \rightarrow \epsilon [\text{---}]$

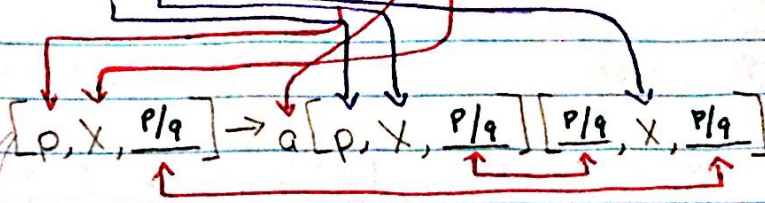
when you have ϵ , the rest doesn't matter
Whenever you have ϵ

$[p, z, p] \rightarrow \epsilon$

1 production.

$$\textcircled{3} \delta(p, a, x) = \{(p, xx)\}$$

$$(p, xx) \in \delta(p, a, x)$$



$$p \rightarrow [p, x, p] \rightarrow a[p, x, p][p, x, p] \mid a[p, x, q][q, x, p]$$

$$q \rightarrow [p, x, q] \rightarrow a[p, x, p][p, x, q] \mid a[p, x, q][q, x, q]$$

4 productions

$$\textcircled{4} \delta(q, a, z) = \{(q, \epsilon)\}$$

$$(q, \epsilon) \in \delta(q, a, z)$$

you have $\epsilon \rightarrow 1$ production

$$[q, z, q] \rightarrow a[q, \epsilon] \quad \text{take out } \epsilon$$

$$[q, z, q] \rightarrow a$$

1 production

$$\textcircled{5} \delta(p, b, x) = \{(q, x)\}$$

$$(q, x) \in \delta(p, b, x)$$

$$[p, x, p/q] \rightarrow b[q, x, p/q]$$

$$p \rightarrow [p, x, p] \rightarrow b[q, x, p]$$

$$q \rightarrow [p, x, q] \rightarrow b[q, x, q]$$

2 productions

$$\textcircled{6} \delta(q, b, z) = \{(p, z)\}$$

$$(p, z) \in \delta(q, b, z)$$

$$[q, z, p/q] \rightarrow b[p, z, p/q]$$

$$\rightarrow [q, z, p] \rightarrow b[p, z, p]$$

$$\rightarrow [q, z, q] \rightarrow b[p, z, q]$$

2 productions

Total = 14 productions.