

PDA  $\Rightarrow$  CFG

Assume:  
 $F = \{q_f\}$

input:  $(Q, \Sigma, \Gamma, q_0, \delta, F)$

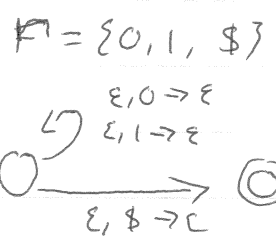
output:  $(V, \Sigma, R, S)$

$V = Q \times Q$      $\Sigma = \Sigma$      $S = (q_0, q_f)$   
 $(q_0, q_f) \Rightarrow^* w$  iff  $[q_0]w \rightarrow^* [q_f]$   
 $(q_i, q_j) \Rightarrow^* w$  iff  $u[q_i]wv \rightarrow^* u[q_j]v$

Assume on PDA: only pushes xor pops

	$a, \epsilon \rightarrow c$	push		$a, \epsilon \rightarrow c$	$\epsilon, c \rightarrow \epsilon$
X	$a, b \rightarrow \epsilon$	pop		$X \rightarrow z/y$	$\rightarrow y$
	$a, \epsilon \rightarrow \epsilon$	ignore		$X \xrightarrow{a,b \rightarrow \epsilon} z/c/y$	$\xrightarrow{\epsilon, \epsilon \rightarrow c} y$
	$a, b \rightarrow c$	replace			

Assume that the stack is fully emptied on accept



$\forall p \in Q$   
 $(p, p) \rightarrow \epsilon$      $u[p] \overset{\epsilon}{\cancel{v}} \Rightarrow^* u[p] \epsilon v$

$\forall p, q, r \in Q$      $\epsilon \in R$   
 $(p, r) \rightarrow (p, q)(q, r)$      $u[p]xyv \rightarrow^* u[q]yv \rightarrow^* u[r]v$

$(r, t) \in \delta(p, a, \epsilon)$	$u[p]axbv$
$(q, \epsilon) \in \delta(s, b, t)$	$\rightarrow ut[r]xbv$
$(p, q) \rightarrow a$ $(r, s) \rightarrow b$ $b \in R$	$\rightarrow^* ut[s]bv$
	$\rightarrow u[q]v$

1.  $\frac{1}{x^2} = x^{-2}$

2.  $\frac{1}{x^3} = x^{-3}$

3.  $\frac{1}{x^4} = x^{-4}$

4.  $\frac{1}{x^5} = x^{-5}$

5.  $\frac{1}{x^6} = x^{-6}$

6.  $\frac{1}{x^7} = x^{-7}$

7.  $\frac{1}{x^8} = x^{-8}$

8.  $\frac{1}{x^9} = x^{-9}$

9.  $\frac{1}{x^{10}} = x^{-10}$

10.  $\frac{1}{x^{11}} = x^{-11}$

11.  $\frac{1}{x^{12}} = x^{-12}$

12.  $\frac{1}{x^{13}} = x^{-13}$

13.  $\frac{1}{x^{14}} = x^{-14}$

14.  $\frac{1}{x^{15}} = x^{-15}$

15.  $\frac{1}{x^{16}} = x^{-16}$

16.  $\frac{1}{x^{17}} = x^{-17}$

17.  $\frac{1}{x^{18}} = x^{-18}$

18.  $\frac{1}{x^{19}} = x^{-19}$

19.  $\frac{1}{x^{20}} = x^{-20}$