

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

CFG DERIVATION  $\Rightarrow$  (one step)  
FORMAL DEFINITION

$\alpha A \beta \Rightarrow \alpha \gamma \beta$  if  $A \rightarrow \gamma \in R$

$(\alpha, \beta, \gamma \in (V \cup \Sigma)^*)$   $A \in V$   
strings of symbols and variables

(MULTI STEP) DERIVATION  $\Rightarrow^*$

$\alpha \Rightarrow^* \alpha$

$\alpha_1 \Rightarrow^* \alpha_3$  if  $\alpha_1 \Rightarrow^* \alpha_2 \wedge \alpha_2 \Rightarrow^* \alpha_3$

LANGUAGE GENERATED BY A CFG

$L(G) = \{ \underbrace{w \in \Sigma^*}_{\text{strings of terminals only}} \mid S \Rightarrow^* w \}$



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

## SOME PDA FORMAL DEFINITIONS

INSTANTANEOUS DESCRIPTION

OR

- CONFIGURATION  $CONF: Q \times \Sigma^* \times \Gamma^*$

example

$$(q, w, \alpha)$$

$\uparrow$       $\uparrow$       $\uparrow$   
 STATE    INPUT    STACK  
           STRING    CONTENT

- COMPUTATIONAL STEP  $\rightarrow$ : CONFIGURATION  $\rightarrow$  CONFIGURATION

$$(q, aw, X\alpha) \rightarrow (q', w, Y\alpha)$$

$$\text{if } (q', Y) \in \delta(q, a, X)$$

$$(a \in \Sigma \cup \{\epsilon\},$$

$$X, Y \in \Gamma \cup \{\epsilon\}, w \in \Sigma^*, \alpha \in \Gamma^*)$$

- MULTI STEP  $\xrightarrow{*} \equiv$

$$CONF \xrightarrow{*} CONF$$

$$CONF_1 \xrightarrow{*} CONF_3 \text{ if } CONF_1 \xrightarrow{*} CONF_2$$

$$CONF_2 \rightarrow CONF_3$$

- LANGUAGE RECOGNIZED BY PDA

$$L(P) = \{ w \in \Sigma^* \mid (q_0, w, \epsilon) \xrightarrow{*} (q, \epsilon, \alpha) \}$$

$q \in F$