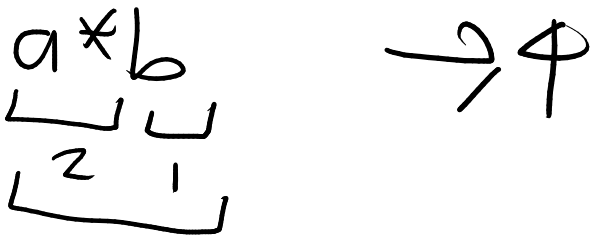


$$O(|r|) \quad m \leq 4|r|$$

$a \rightarrow \text{size } 1$

$a^* \rightarrow 2$

$a^*b \rightarrow 4$

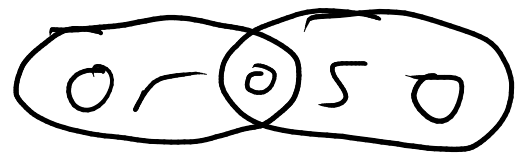


$a^*b|c \rightarrow 6$



$$m \leq 4||r||$$

0r050



$$|r| \leq k ||r||$$

size                  length

$$|rs| = |r| + |s| + 1$$

$$||rs|| = ||r|| + ||s||$$

$$|rs| \leq k ||rs|| + 1$$

# Context-Free Grammar

- terminals
  - nonterminals
  - start nonterminal
  - productions
- ] symbols

## Production

- "head" or LHS nonterminal
  - "body" or RHS list of symbols
- ::=

conventions on page 198-199

$\text{expr} \rightarrow \text{expr} + \text{term}$

$\text{expr} \rightarrow \text{expr} - \text{term}$

$\text{expr} \rightarrow \text{term}$

$\text{term} \rightarrow (\text{expr})$

$\text{term} \rightarrow \text{number}$

$\text{term} \rightarrow \text{id}$

$\text{a} + (\text{expr} - \text{b}) + \text{term}$

⑦ → ⑧

$\text{a} + (3 - \text{b}) + \text{c}$

- ①  $\text{expr}$
- ②  $\text{expr} + \text{term}$
- ③  $\text{expr} + \text{term} + \text{term}$
- ④  $\text{term} + \text{term} + \text{term}$
- ⑤  $\text{a} + \text{term} + \text{term}$
- ⑥  $\text{a} + (\text{expr}) + \text{term}$
- ⑦  $\text{a} + (\text{expr} - \text{term}) + \text{term}$
- ⑧  $\text{a} + (\text{term} - \text{term}) + \text{term}$
- ⑨  $\text{a} + (3 - \text{term}) + \text{term}$
- ⑩  $\text{a} + (3 - \text{b}) + \text{term}$
- ⑪  $\text{a} + (3 - \text{b}) + \text{c}$

r | s

$N_0 \rightarrow a$

$N_1 \rightarrow r$

$N_1 \rightarrow s$

$r | s$

$N_2 \rightarrow N_r N_s$

$r^*$

$N_3 \rightarrow // \text{nothing } \epsilon \quad \% \text{ empty}$

$N_3 \rightarrow N_3 N_r$

a \* b | c

$N_b \rightarrow b \quad N_c \rightarrow c$

$N_{a * b} \rightarrow N_{a * } N_b$

$N_a \rightarrow a$

$N_{a * } \rightarrow \epsilon$

$N_{a * b | c} \rightarrow N_{a * b}$

$N_{a * } \rightarrow N_{a * } N_a$

$N_{a * b | c} \rightarrow N_c$