

## More Examples

$(0^*1^*)^*$

$0^*1^*$

$(0 \cup 1)^*(00 \cup 11)^*(0 \cup 1)^*$

$(00 \cup 11)^*$

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## Context Free Grammars

A context free grammar (CFG) is a finite set of production rules over:

An alphabet  $\Sigma$  of "terminal symbols"

A finite set  $V$  of "nonterminal symbols"

A start symbol (one of the elements of  $V$ ) usually denoted  $S$ .

A production rule for a nonterminal  $A \in V$  takes the form

$A \rightarrow w_1 | w_2 | \dots | w_k$

Where each  $w_i \in (V \cup \Sigma)^*$  is a string of nonterminals and terminals.

## Examples

$$S \rightarrow 0S0|1S1|0|1|\varepsilon$$

$$S \rightarrow 0S|S1|\varepsilon$$

$$S \rightarrow (S)|SS|\varepsilon$$

The alphabet here is  $\{(),\}$  i.e. parentheses are the characters.

$$S \rightarrow AB$$

$$A \rightarrow 0A1|\varepsilon$$

$$B \rightarrow 1B0|\varepsilon$$

## Arithmetic

$$E \rightarrow E + E|E * E|(E)|x|y|z|0|1|2|3|4|5|6|7|8|9$$

Generate  $(2 * x) + y$

Generate  $2 + 3 * 4$  in two different ways

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