

CS 173 Lecture 5ai: Context-Free Grammars

Informally: a recursive way of construct strings \Rightarrow { see Chapter }

Historically:

- Linguistics

- attempt to model human language via constructing sentences out of recursive phrases.

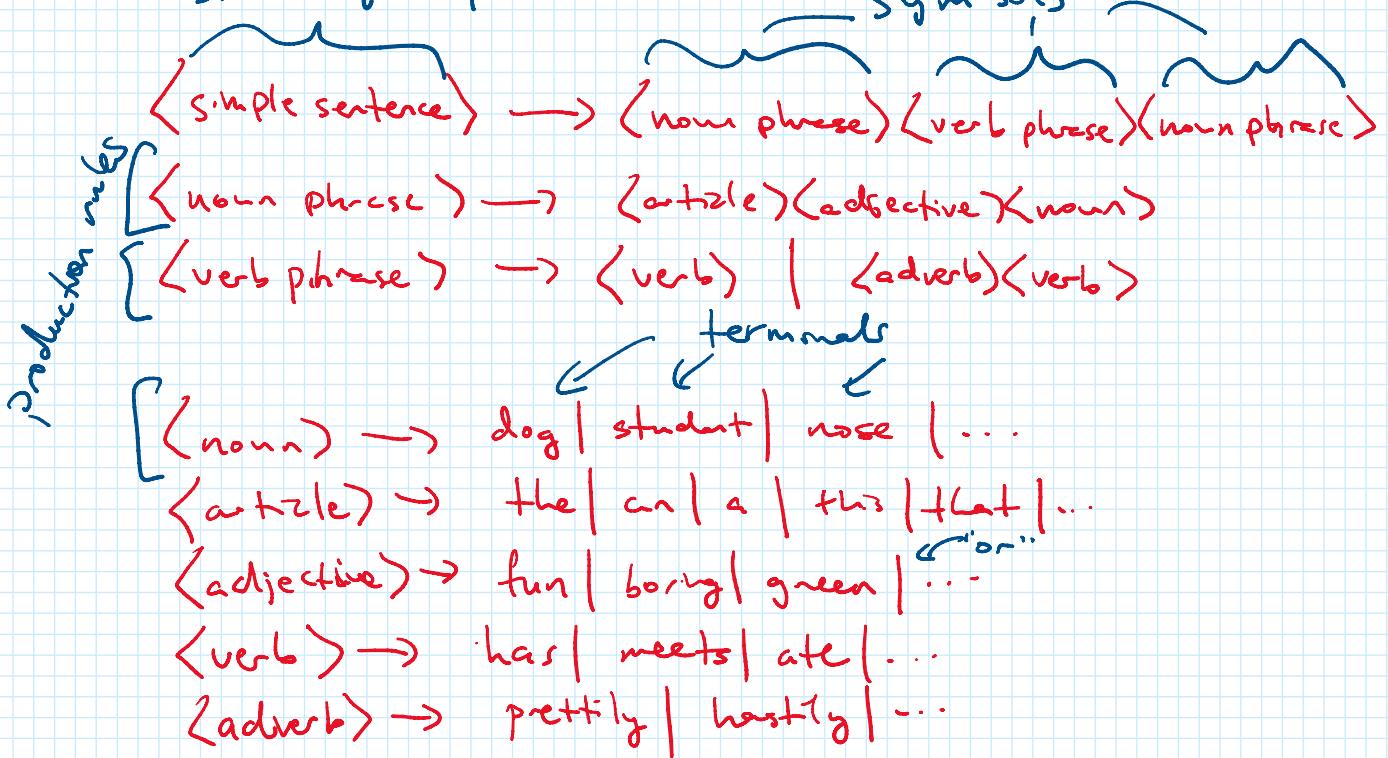
- Computer Science

- a way to construct new programming languages
- parsing \rightarrow compiling

CFG consists of

- symbols \rightarrow terminals

- production rules \rightarrow starting symbol
starting symbol



(PG: Starting w/ a starting symbol:

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 replace symbols w/ one of the
 options in the production rule
 then recurse until only terminals are left

$\langle \text{simple sentence} \rangle$

$\rightarrow \langle \text{np} \rangle \langle \text{vp} \rangle \langle \text{np} \rangle$ ↗ choose: $\langle \text{v} \rangle$ instead
 of $\langle \text{adv} \rangle \langle \text{v} \rangle$
 $\rightarrow \langle \text{art} \rangle \langle \text{adj} \rangle \langle \text{n} \rangle \langle \text{v} \rangle \langle \text{art} \rangle \langle \text{adj} \rangle \langle \text{n} \rangle$
 $\rightarrow \text{the fun dog has a green nose.}$
 ↙ ↑ ↗ ...
 choices

$\langle \text{ss} \rangle$

$\rightarrow \langle \text{np} \rangle \langle \text{vp} \rangle \langle \text{np} \rangle$
 $\rightarrow \langle \text{art} \rangle \langle \text{adj} \rangle \langle \text{n} \rangle \langle \text{adv} \rangle \langle \text{v} \rangle \langle \text{art} \rangle \langle \text{adj} \rangle \langle \text{n} \rangle$

$\rightarrow \text{This funny student prettily ate an boring homework.}$

valid string in the grammar.

bad English "an boring"
 makes no sense

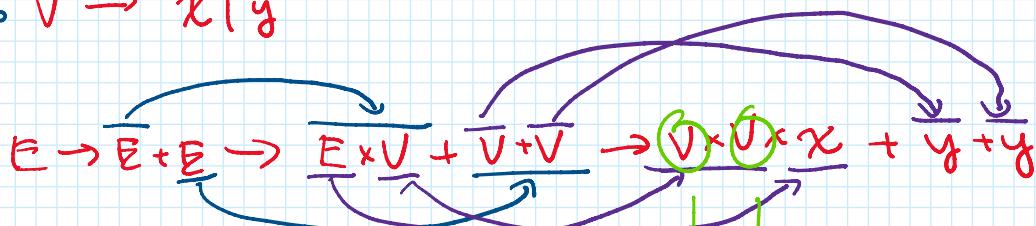
_____ X _____

Starting symbol's prod rule written first
 Some conventions: symbols are often upper case letters
 terminals are lower case letters or numbers

terminal (not always)
 (sometimes terminals in a different font)

expression
 Starting symbol → E → E + E | E × V | V + V | V × V

variables
 V → x | y



Feynman diagram illustrating the decay of a Z boson (E) into two photons ($\gamma + \gamma$). The process is shown as:

$$E \rightarrow E + E \rightarrow \underbrace{E \times V}_{\text{red}} + \underbrace{V + V}_{\text{blue}} \rightarrow \underbrace{V \times V}_{\text{green}} \times X + Y + Y$$

The diagram shows the flow of particles from left to right. A blue curved arrow at the bottom indicates the annihilation of the virtual electron-positron pair (e^+e^-) into a virtual photon (V) and a virtual gluon (G). A purple curved arrow at the bottom indicates the annihilation of the virtual photon (V) into two photons ($\gamma + \gamma$). Two green curved arrows at the bottom indicate the decay of the virtual gluon (G) into two Z bosons (Z), which then decay into two photons ($\gamma + \gamma$).

"CFG for 'simple' arithmetic expressions
w/ variables x & y"