# Programming Languages: Syntax

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- Sound and visuals check.
- Main online resource: Class Web site:
  - http://chaw.eip10.org/cos301/
  - also linked from my Web page, etc.
  - Includes (is) syllabus.
  - Brightspace for some things only.
- PLY: Install, study examples, modify, experiment, etc.
- Quiz 1 Friday.
  - Topics:
    - Everything discussed in class, and/or
    - Sections 2.0–2.6.
  - focus on:
    - material discussed in class
    - class exercises
  - Practice problems. (2 parses.)

## Plan for today

- (Review) Quick wrap-up of tokenization part of PLY example.
    - and very quick introduction to rest.
- Material from Chapter 2 of the textbook.
- Review: CFG, rules, derivations,
- Review: *Parse trees* (2.5) and *abstract syntax trees (AST)* (2.6).
- (Reminder) Bigger picture question (related to homework):
    - How to implement a simple language like:
        - $x = 5 + 3$
        - $y = 48 / (4 * 4)$
        - $z = x + 2 * y$
        - if-then-else, function definitions, loops, . . .

## Show me the code!

- PLY example (continued).
  - calc.py from the examples in the PLY package/sources.
    - If your package doesn't include the examples, grab them from PLY's Github page.
- (Review) Precedence in PLY v using purely CFG rules.
- Reminder: experiment.
  - Don't just download and install and forget.

- Switch to code.

## (Review) CFG formally

- $G = (N, T, P, S)$
  - $N$: a set of symbols (*nonterminals*)
  - $T$: another set of symbols (*terminals*)
    - $N \cap T = \emptyset$
  - $P$: set of *productions*
    - each of form $n \to \alpha$ where
    - where $n \in N$ and $\alpha \in \{N \cup T\}^*$
  - $S \in N$: special nonterminal called *start*

- example from the textbook

## (Review) Derivations

- Main question: Can a given string of tokens (terminals) be generated by a given grammar?
    - If so, how? Show the steps starting with the start symbol.
    - Is the derivation unique?
    - Is the leftmost derivation unique?
- Switch to example and practice in textbook.

## (Review) Parse Trees

- Informally, a tree that has $S$ as root and the children of each node are the items on the RHS of the rule that was used to replace the corresponding nonterminal. (Leaves correspond to terminals.)
- Example for infix expressions.
- Switch to practice problems.

## (Review) Abstract Syntax Trees

- closely related to, but different from, parse trees.
- abstract away unimportant details such as order in which a sequence of nonterminals is expanded.
- Two main changes:
  - Nonterminal nodes are replaced by *corresponding* parts of the input sentence.
  - Unit productions are collapsed.
- Example for infix expressions.
- Practice problems in textbook.

## Summary

- (E)BNF, CFGs, derivations, parse trees, ASTs.
- CFG formal definition.
- Practical examples of CFGs.
- PLY, *lex* and *yacc*.
- Bigger picture:
  - Process source code into AST
  - then we can interpret or compile it etc.

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