Programming Languages: Syntax

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Announcements and Reminders

- 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.
  - (most of) Chapter 2.
  - Practice problems. (2 parses.)
- Happy Equinox!

Plan for today

- PLY basics with the calc.py example.
  - *Python Lex-Yacc*
  - a member of a large and old family of *lex* and *yacc* tools.
- Material from Chapter 2 of the textbook.
  - (Review) Theory of CFGs etc.
  - Derivations (2.4).
  - *Parse trees* (2.5) and *abstract syntax trees (AST)* (2.6).
- (Review) 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.
- 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 $n \rightarrow \alpha$ where
    - where $n \in N$ and $\alpha \in \{N \cup T\}^*$
  - $S \in N$: special nonterminal called *start*

(Review) CFG for infix expressions

- 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.
- Before next class:
  - Read at least material due (syllabus).
  - Write some nontrivial code for HW02.
  - Don't fall behind!
  - Experiment with PLY (Python Lex-Yacc):
    - http://www.dabeaz.com/ply/
- Class Web site: http://chaw.eip10.org/cos301/