Class 12: Six-Week Wrap-up and Semantic Analysis I

SI 413 - Programming Languages and Implementation

Dr. Daniel S. Roche

United States Naval Academy

Fall 2011
Homework Review

1. How does an SLR parser resolve conflicts? What is different in an LALR parser?

2. List the steps in generating a table-driven SLR parser.

3. Come up with your own example of a grammar that is not SLR(0).
SLR(1) parsers handle conflicts by using one token of look-ahead:

- If the next token is an outgoing edge label of that state, shift and move on.
- If the next token is in the follow set of a non-terminal that we can reduce to, then do that reduction.

Of course, there may still be conflicts, in which case the grammar is not SLR(1). More look-ahead may be needed.

LALR parsers are similar, but they use more specialized FOLLOW sets rather than the “global” follow sets that we have seen.
Parse Trees

Beefed-up calculator language

\[
\begin{align*}
run & \rightarrow ares \ STOP \ run \ | \ ares \ STOP \\
ares & \rightarrow \ VAR \ \ ASN \ bres \ | \ bres \\
bres & \rightarrow bres \ \ BOP \ res \ | \ res \\
res & \rightarrow res \ \ COMP \ exp \ | \ exp \\
exp & \rightarrow exp \ \ OPA \ term \ | \ term \\
term & \rightarrow term \ \ OPM \ factor \ | \ factor \\
factor & \rightarrow \ NUM \ | \ VAR \ | \ LP \ bres \ RP
\end{align*}
\]

Download today’s tarball and run `make` to get a parse tree for some string in this language.

We notice that the parse tree is large and unwieldy with many unnecessary nodes.
Abstract Syntax Tree

Consider the program \( x := (5 + 3) * 2; x - 7; \). What should the AST for this look like?

![AST Diagram]

- \( := \) node
  - \( x \) node
  - \( * \) node
    - \( + \) node
      - 5 node
      - 3 node
    - 2 node
  - print node
    - \( - \) node
      - \( x \) node
      - 7 node
    - null node
Remember, **ASTs are not about the syntax!**
They *remove* syntactic details from the program, leaving only the semantics.

Typically, we show ordering (e.g. of *ares’s* in the previous example) by nesting: the last child of a statement is the next statement, or null.

Are ASTs language independent?
Static type checking

Consider the string $(7 > 2) + 3;$. This is an error. But where should this error be identified?
Static type checking

Consider the string $(7 > 2) + 3;$. This is an error. But where should this error be identified?

In semantic analysis, i.e. the AST creation step!

Each node in the AST has a type, possibly "void".
Static type checking with variables

What about the string \( x = 6 > 3; \ x \times 12; \)?

We have to know the type of the variable \( x \). Otherwise, there is no way to detect this error at compile-time.

Only *statically-typed languages* allow this sort of checking. Remember, in this class *errors are a good thing!*
Class outcomes

You should know:

- What an AST is, and why we need them.
- The relationship between language, parse tree, and AST.
- How static type-checking works, at a basic level.

You should be able to:

- Draw a parse tree for a given string, given the grammar.
- Determine the AST from the parse tree. Note that there is some flexibility here!