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

SI 413 - Programming Languages and Implementation

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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)

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

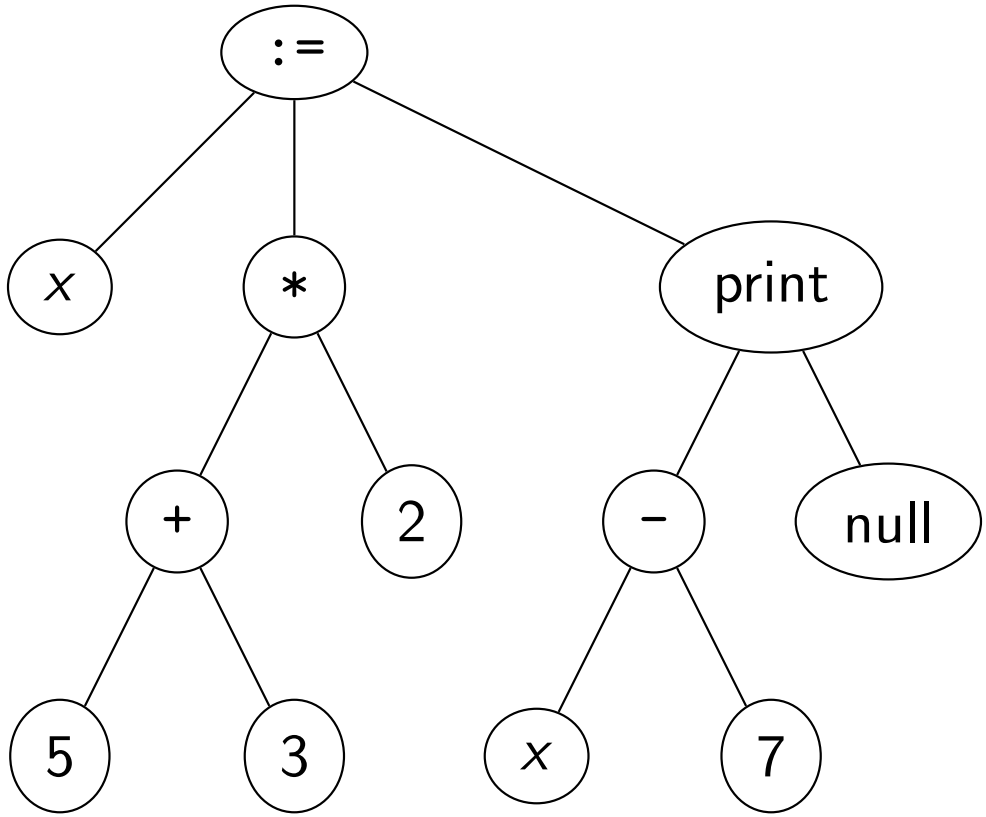
$$
\begin{aligned}
\textit{run} &\rightarrow \textit{ares}\ \texttt{STOP}\ \textit{run} \mid \textit{ares}\ \texttt{STOP} \\
\textit{ares} &\rightarrow \texttt{VAR}\ \texttt{ASN}\ \textit{bres} \mid \textit{bres} \\
\textit{bres} &\rightarrow \textit{bres}\ \texttt{BOP}\ \textit{res} \mid \textit{res} \\
\textit{res} &\rightarrow \textit{res}\ \texttt{COMP}\ \textit{exp} \mid \textit{exp} \\
\textit{exp} &\rightarrow \textit{exp}\ \texttt{OPA}\ \textit{term} \mid \textit{term} \\
\textit{term} &\rightarrow \textit{term}\ \texttt{OPM}\ \textit{factor} \mid \textit{factor} \\
\textit{factor} &\rightarrow \texttt{NUM} \mid \texttt{VAR} \mid \texttt{LP}\ \textit{bres}\ \texttt{RP}
\end{aligned}
$$

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 Properties

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?

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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 * 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!