

## Parse Trees

Beefed-up calculator language

$run \rightarrow stmt\ run \mid stmt$

$stmt \rightarrow ares\ STOP$

$ares \rightarrow VAR\ ASN\ bres \mid bres$

$bres \rightarrow bres\ BOP\ res \mid res$

$res \rightarrow res\ COMP\ exp \mid exp$

$exp \rightarrow exp\ OPA\ term \mid term$

$term \rightarrow term\ OPM\ factor \mid factor$

$factor \rightarrow NUM \mid VAR \mid LP\ bres\ RP$

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?

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!*

## Unit 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!