Plan for Today

One pass compilation

–Syntax-Directed, Recursive-Descent, Predictive Parsing and Code Generation

Multi-pass Compilation

–Abstract Syntax Trees (AST)

–Generating code from an abstract syntax tree

Creating an AST in a recursive descent parser

Recall Doing Syntax-Directed Interpretation

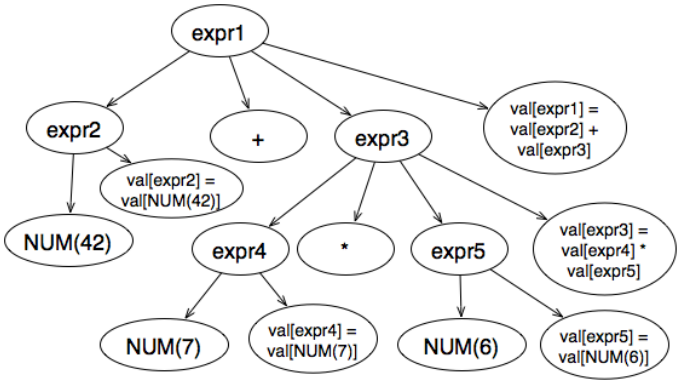
Grammar

(1) exp --> exp * exp
(2) exp --> exp + exp
(3) exp --> NUM

String

42 + 7 * 6

Semantic Rules for Expression Example



Code Generation versus Interpretation

When interpreting an expression . . .

- Each production matched will result in a computation that generates a value for the expression. Value should be returned.
- Each non terminal on the right hand side of a production has a value associated with it.
- This approach will also be useful when we are building the Abstract Syntax Tree (AST) in PA3, where the value will be the AST we are building.

When doing one pass compilation . . .

- Each production matched results in a string of target code (in this case AVR assembly)

Example Source and Target Language

Source Language

```
Slist ::= epsilon | S Slist
S     ::= "print" COLOR_LITERAL
```

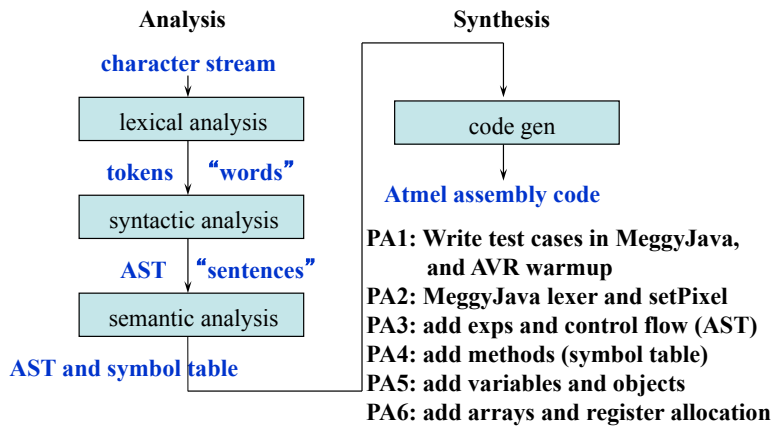
Target Language

- Each print should result in a call to Meggy.setPixel((byte)1,(byte)1, integer for COLOR_LITERAL);
- Essentially the target is a toy subset of the PA2 MeggyJava grammar.

Haskell for …

- Lexer for source language
- Recursive descent predictive parser
- Syntax-directed code generation of the target language

Structure of the MeggyJava Compiler, Multi-pass Compilation



Example program

```
class Byte {
  public static void main(String[] whatever){
      Meggy.setPixel
        (  // Byte multiplication: Byte x Byte -> Int
           (byte)( (byte)1*(byte)2 ),
           // Mixed type expression: Byte x Int -> Int
           (byte)( (byte)3 + 4 ),
           Meggy.Color.WHITE
        );
  }
}
```

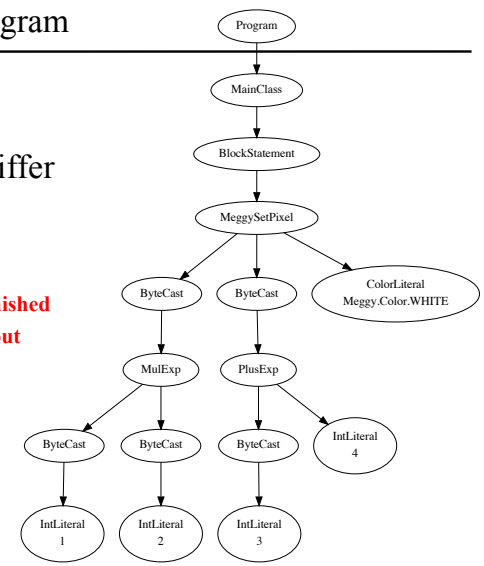

AST of Example Program

How does the AST differ from the parse tree?

Parentheses have been removed their role -to shape the AST is finished

Some terminals have been pulled out which?

Some have been pulled up which?



Code Generation Given an AST

Haskell data type for the AST for example source language

Function that generates code based on that AST

Syntax-directed Construction of AST

Can edit predictive parser to generate ASTs instead of strings.

See example code.

Add in a new statement type