Java CUP

Last Time

What do we want?

- An AST

When do we want it?

- Now!

This Time

A little review of ASTs

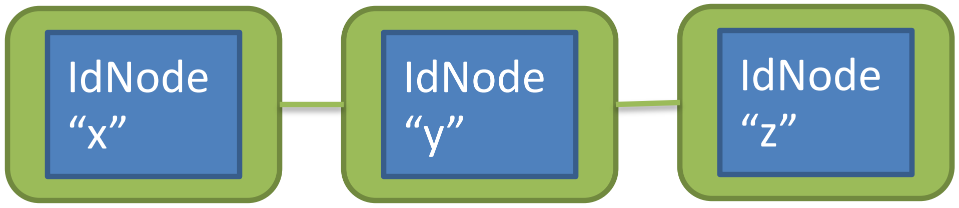
The philosophy and use of a *Parser Generator*

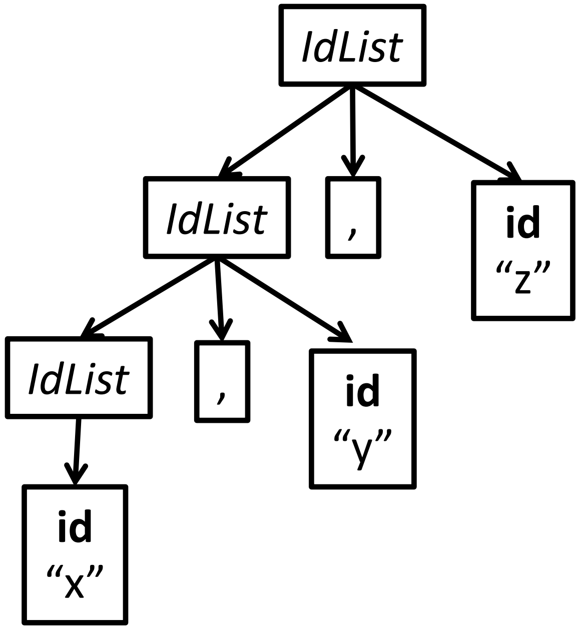
Translating Lists

CFG
```
IdList -> id
        | IdList comma id
```

Input
```
x, y, z
```

AST





IdList.trans = {L = new List<>; L.add(Id.value}'; IdList.trans = L;}
IdList.trans = {L' = IdList2.trans, L'.add(Id.value); IdList.trans=L'}

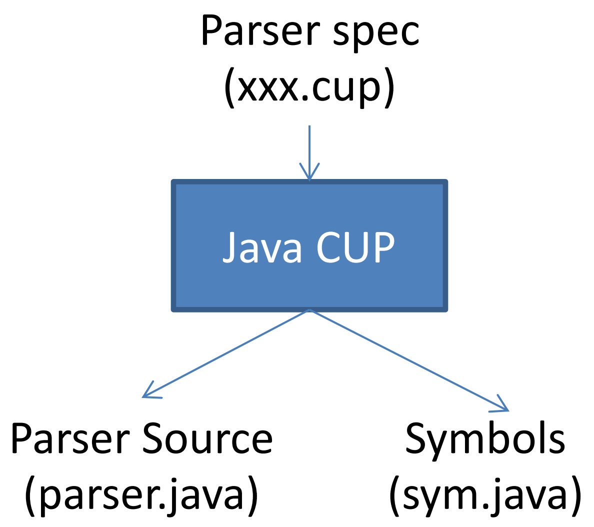
Parser Generators

Tools that take an SDT spec and build an AST

- YACC: Yet Another Compiler Compiler
- Java CUP: Constructor of Useful Parsers

Conceptually similar to JLex

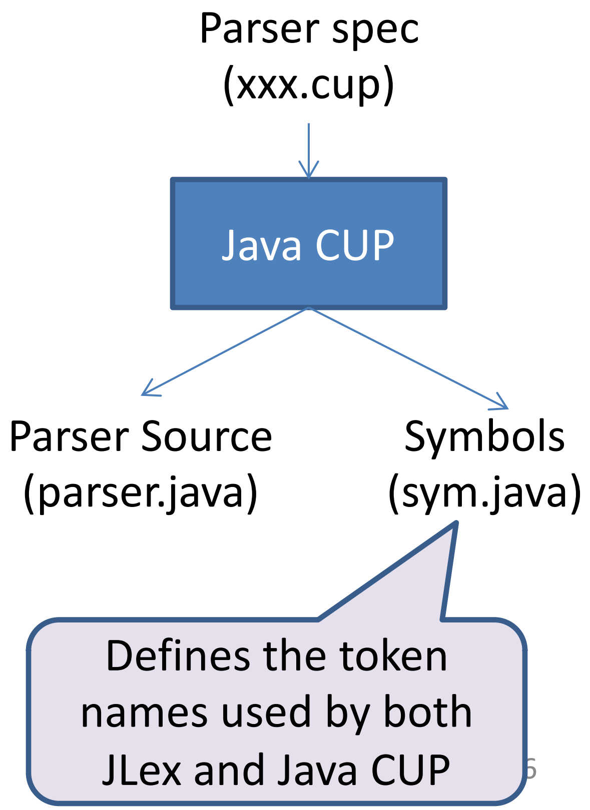
- Input: Language rules + actions
- Output: java code



Java CUP

Parser.java

- Constructor takes arg of type Scanner (i.e., yylex)
- Contains a parsing method
  - return: Symbol whose value contains translation of root nonterminal
- Uses output of JLex
  - Depends on scanner and TokenVals
- Uses defs of AST classes
  - Also in xxx.cup



Java CUP Input Spec

Terminal & nonterminal declarations

Optional precedence and associativity declarations

Grammar with rules and actions

Grammar rules

```
Expr ::= intliteral
       |  id
       |  Expr plus Expr
       |  Expr times Expr
       |  lparens Expr rparens
```

Terminal and Nonterminals

```
terminal intliteral;
terminal id;
terminal plus;
terminal times;
terminal lparen;
terminal rparen;
non terminal Expr;
```

Precedence and Associativity

```
precedence left plus;
precedence left times;
predevence nonassoc less;
```

lowest precedence

Java CUP Example

Assume ExpNode Subclasses

- `PlusNode`, `TimesNode` have 2 children for operands
- `IdNode` has a String field
- `IntLitNode` has an int field

Assume Token classes

- `IntLitTokenVal` with field intVal for int literal token
- `IdTokenVal` with field idVal for identifier token

Step 1: Add types to terminals

```
terminal IntLitTokenVal intliteral;
terminal IdTokenVal id;
terminal plus;
terminal times;
terminal lparen;
terminal rparen;

non terminal ExpNode expr;
```

Java CUP Example

```
Expr ::= intliteral
         {:

         :}
      |  id
         {:

         :}
      |  Expr plus Expr
         {:

         :}
      |  Expr times Expr
         {:

         :}
      |  lparen Expr rparen
         {:

         :}
      ;
```

Java CUP Example

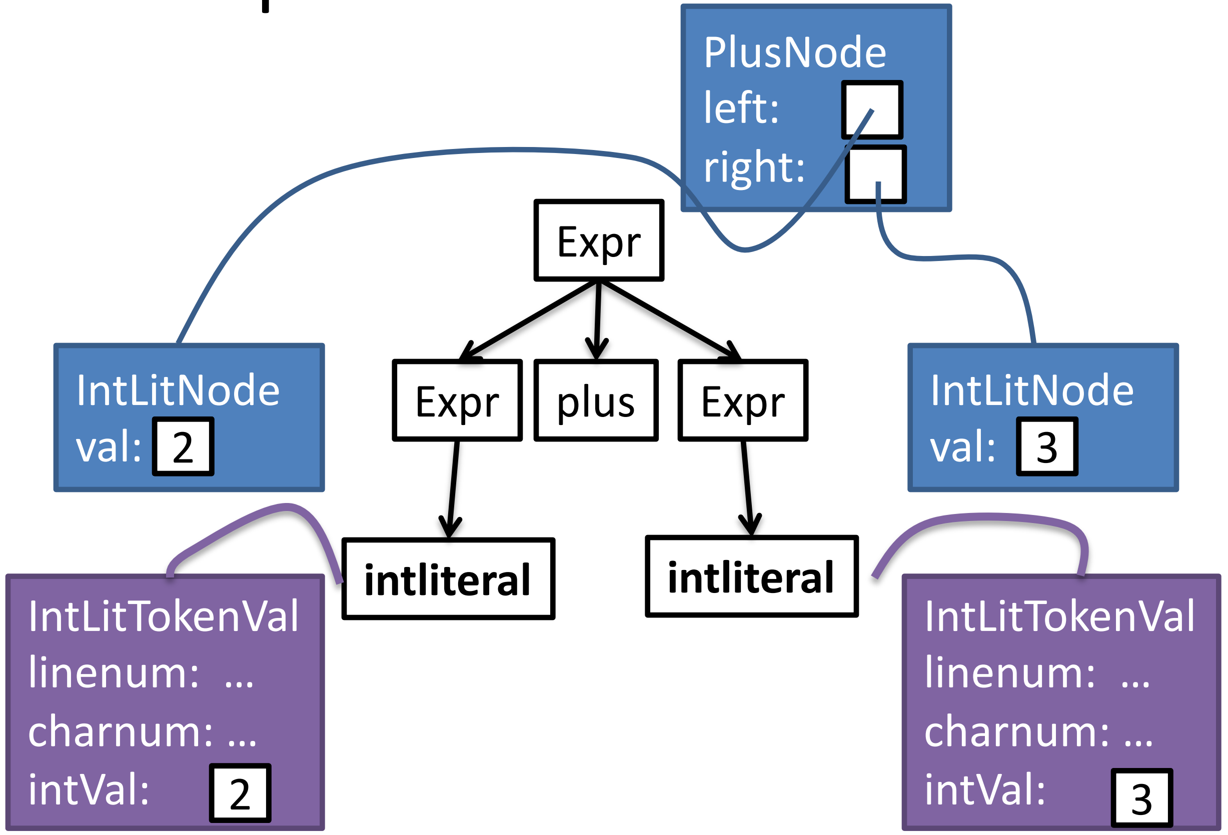
```
Expr ::= intliteral:i
         {:
            RESULT = new IntLitNode(i.intVal);
         :}
      |  id
         {:

         :}
      |  Expr plus Expr
         {:

         :}
      |  Expr times Expr
         {:

         :}
      |  lparen Expr rparen
         {:

         :}
      ;
```

Java CUP Example

```
Expr ::= intliteral:i
         {:
            RESULT = new IntLitNode(i.intVal);
         :}
      |  id:i
         {:
             RESULT = new IdNode(i.idVal);
         :}
      |  Expr:e1 plus Expr:e2
         {:
             RESULT = new PlusNode(e1,e2);
         :}
      |  Expr:e1 times Expr:e2
         {:
             RESULT = new TimesNode(e1,e2);
         :}
      |  lparen Expr:e rparen
         {:
             RESULT = e;
         :}
      ;
```

Java CUP Example

```
Input: 2 + 3
```



Purple = Terminal Token (Built by Scanner)
Blue = Symbol (Built by Parser)

Java CUP Demo