30. Parser-Generatoren

Prof. Dr. rer. nat. Uwe Aßmann

Institut für Software- und Multimediatechnik

Lehrstuhl Softwaretechnologie

Fakultät für Informatik

TU Dresden

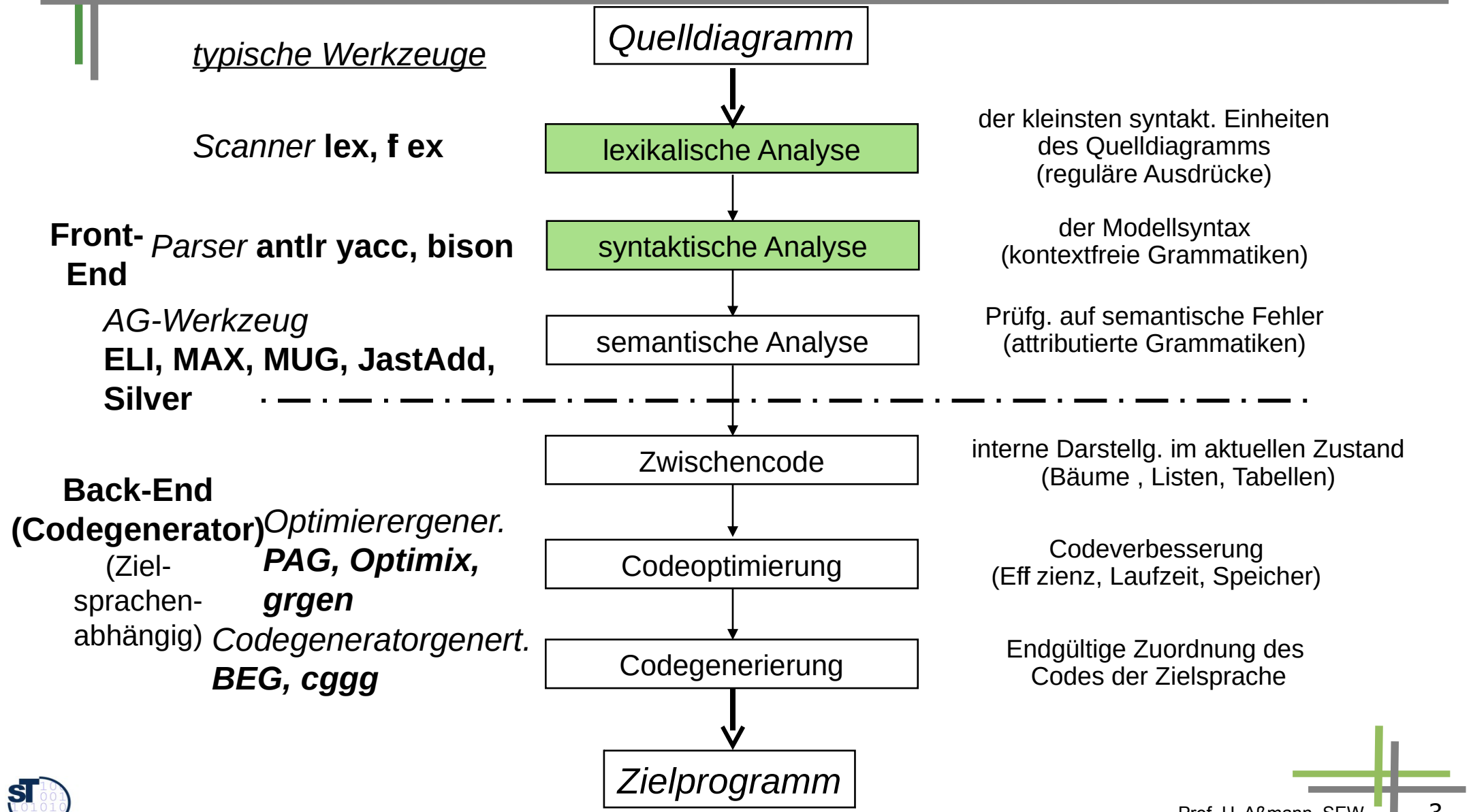
http://st.inf.tu-dresden.de

Version 11-0.1, 29.12.11

Literatur

- Obligatorisch:
- http://www.antlr.org
- Zusätzlich:
  - Cocktail www.cocolab.de, die Compiler-Toolbox für die schnellsten Compiler der Welt (kommerziell, Demoversionen erhältlich)

Phasen eines Compilers



Problem

Wie arbeite ich flexibel mit mehreren Programmiersprachen oder DSL?

Antwort

- Technikraum “Grammarware”

In dem ich aus Grammatiken Parser (Zerteiler) generiere

und

zusätzlich Prettyprinter

Beispiel EMFText

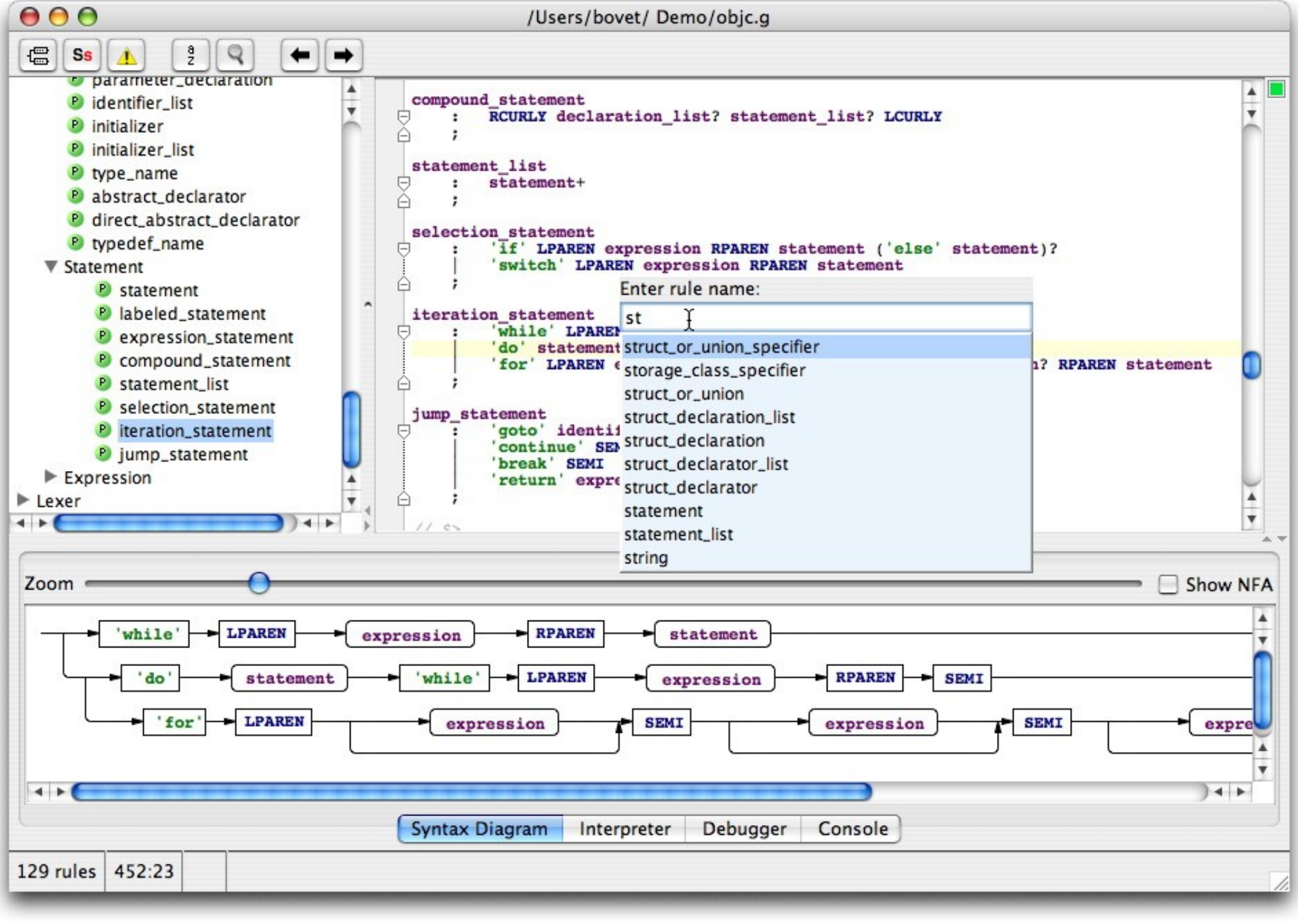
- Nutzt Parser-Generator ANTLR zur Generierung von Parsern
  - Parser und Metamodell werden aufeinander abgebildet (mapping), um konkrete auf abstrakte Syntax abzubilden
- Nutzt schablonengesteuerte Codegenerierung zur Erzeugung von Text und Programmen (siehe später).

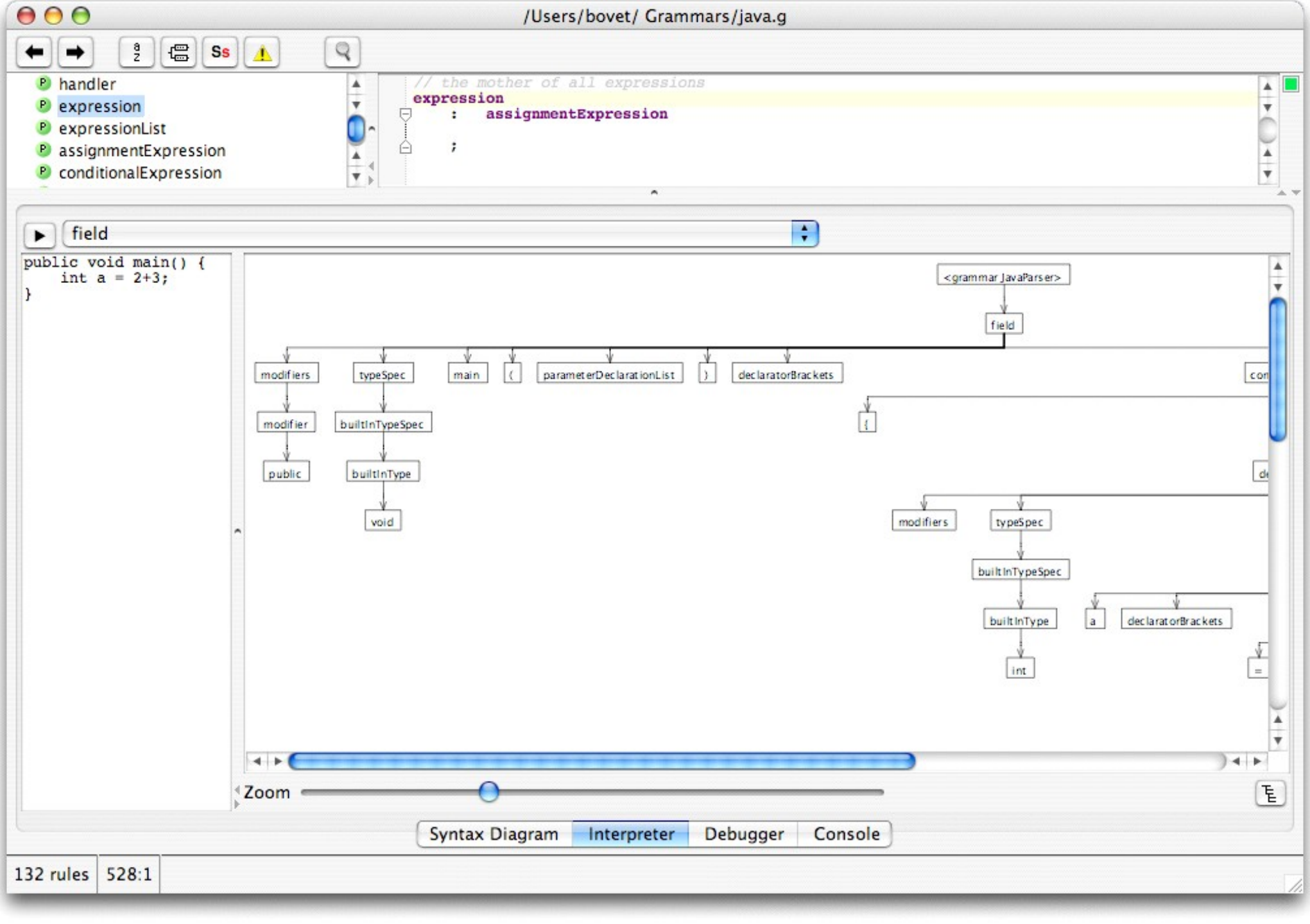
Beispiel EMFText

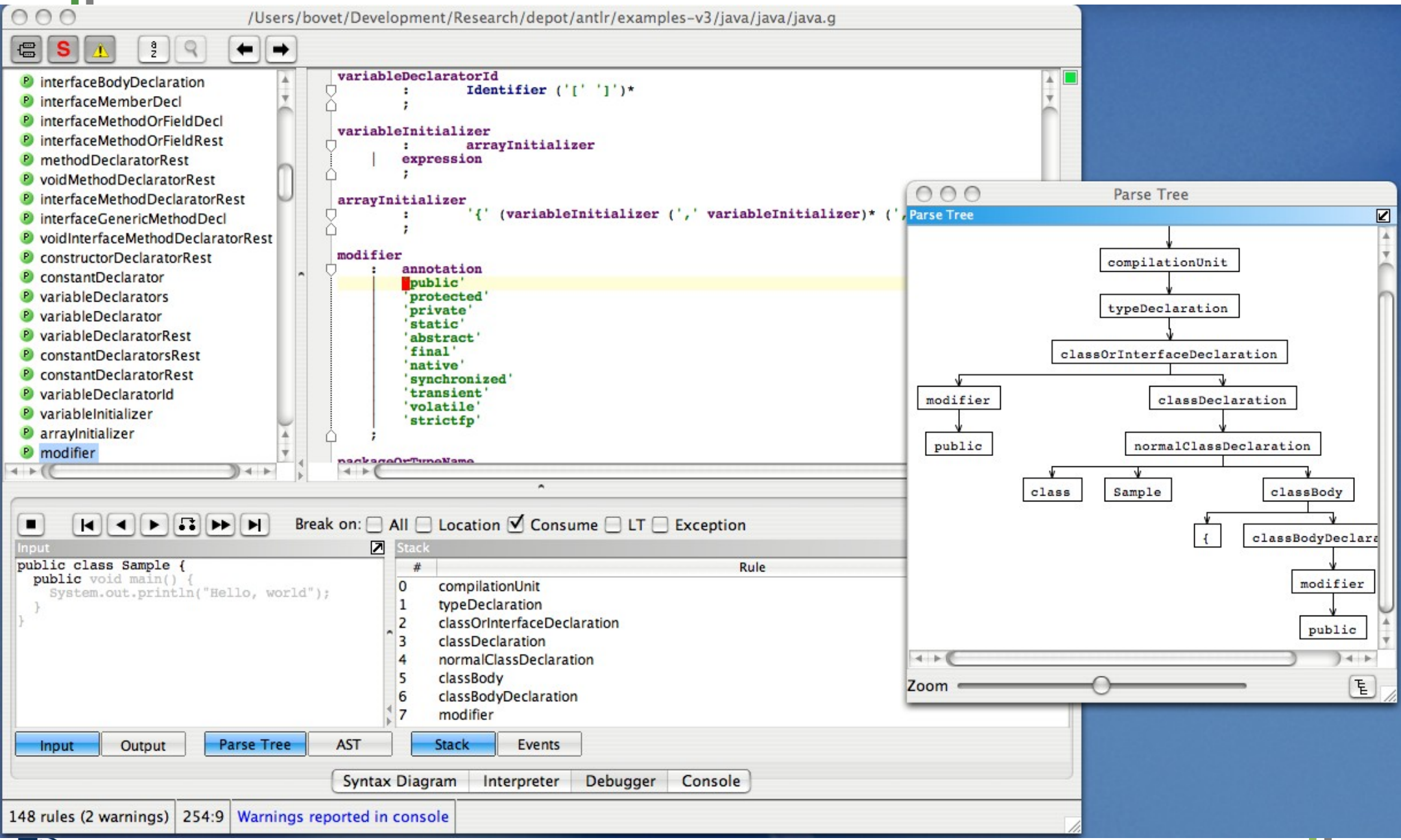
- Nutzt Parser-Generator ANTLR zur Generierung von Parsern
  - Parser und Metamodell werden aufeinander abgebildet (mapping), um konkrete auf abstrakte Syntax abzubilden
- Nutzt schablonengesteuerte Codegenerierung zur Erzeugung von Text und Programmen (siehe später).

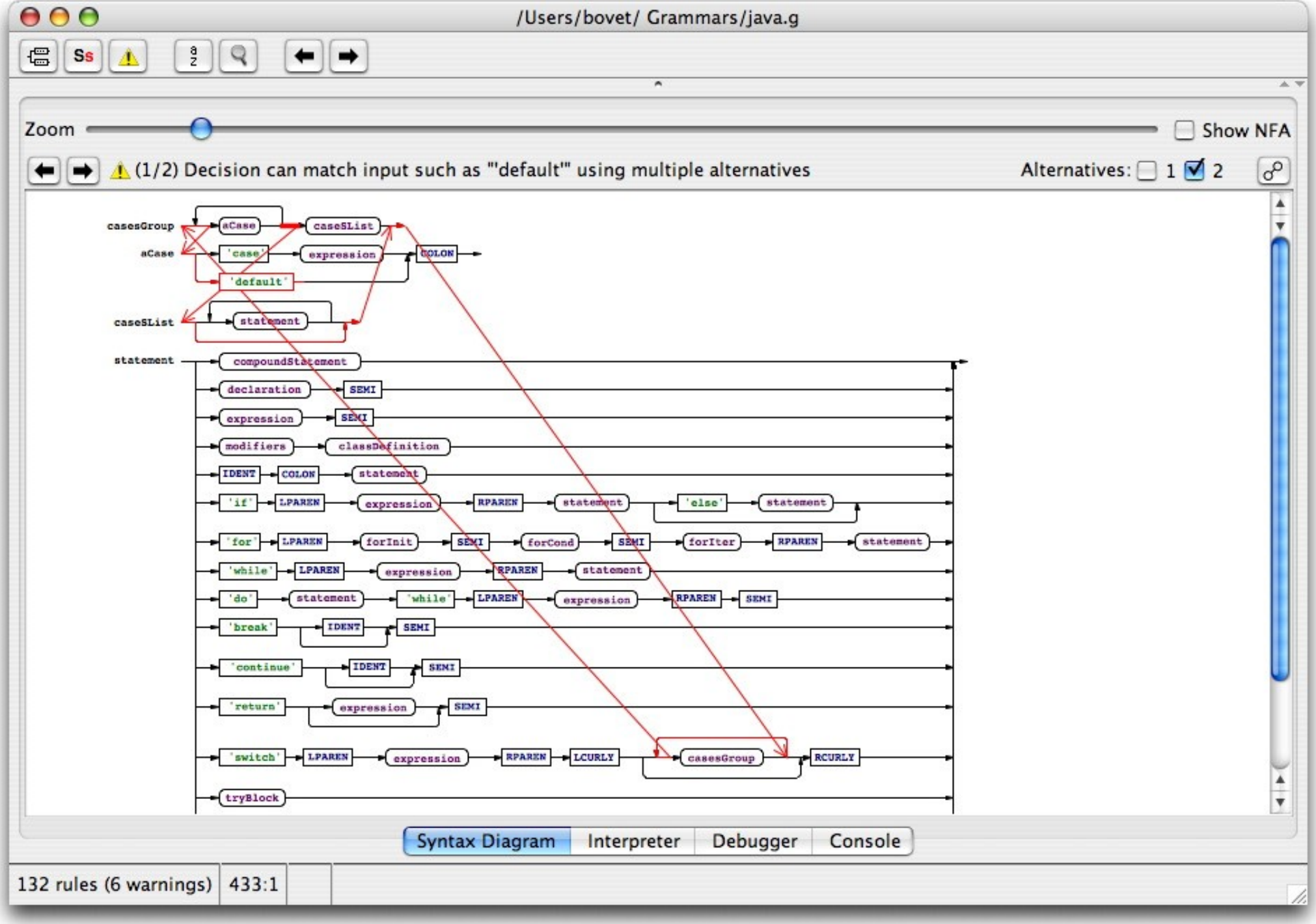
ANTLR www.antlr.org

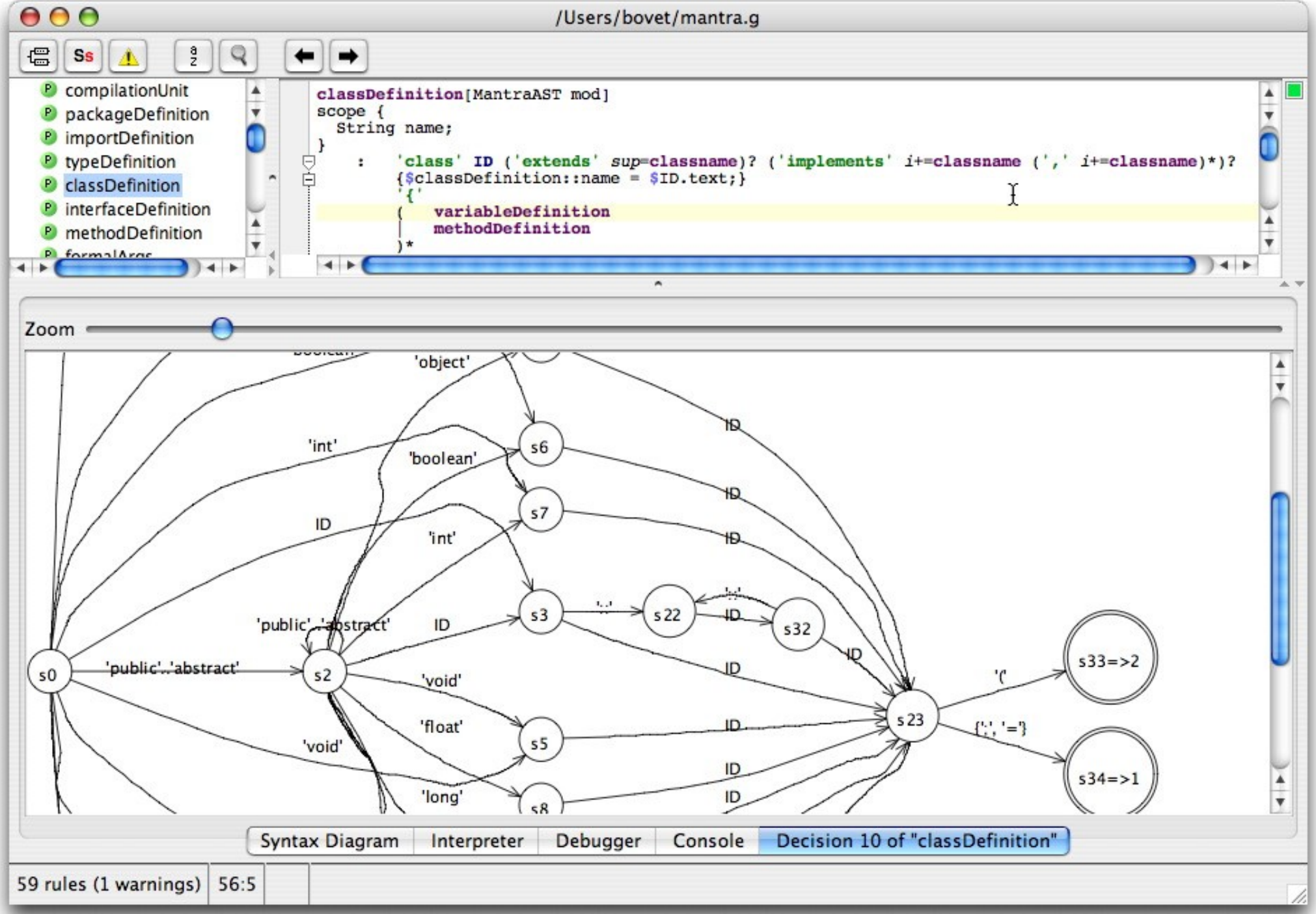
- In den 90ger Jahren gab es für C viele Parsergeneratoren
  - Cocktail's lalr, ell, lark www.cocolab.de
  - fnc2
  - flex und bison (gnu)
- Für Java ist ANTLR populär geworden
  - LL(k)
  - Generierter Parser mit Algorithmus “rekursiver Abstieg”
  - Etwas “gefärbte” Seite mit Geschichte http://www.bearcave.com/software/antlr/antlr_expr.html


/Users/bovet/ Demo/objc.g
parameter_declaration
identifier_list
initializer
initializer_list
type_name
abstract_declarator
direct_abstract_declarator
typedef_name
Statement
statement
labeled_statement
expression_statement
compound_statement
statement_list
selection_statement
iteration_statement
jump_statement
Expression
Lexer
compound_statement
: RCURLY declaration_list? statement_list? LCURLY
;
statement_list
: statement+
;
selection_statement
: 'if' LPAREN expression RPAREN statement ('else' statement)?
| 'switch' LPAREN expression RPAREN statement
;
iteration_statement
: 'while' LPAREN
| 'do' statement
| 'for' LPAREN
;
jump_statement
: 'goto' identi
| 'continue' SEM
| 'break' SEMI
| 'return' expr
;
Enter rule name:
st
struct_or_union_specifier
storage_class_specifier
struct_or_union
struct_declaration_list
struct_declaration
struct_declarator_list
struct_declarator
statement
statement_list
string
? RPAREN statement
Zoom
Show NFA
'while'
LPAREN
expression
RPAREN
statement
'do'
statement
'while'
LPAREN
expression
RPAREN
SEMI
'for'
LPAREN
expression
SEMI
expression
SEMI
Syntax Diagram
Interpreter
Debugger
Console
129 rules
452:23


/Users/bovet/ Grammars/java.g
handler
expression
expressionList
assignmentExpression
conditionalExpression
// the mother of all expressions
expression
: assignmentExpression
;
field
public void main() {
int a = 2+3;
}
<grammar JavaParser>
field
modifiers
typeSpec
main
(
parameterDeclarationList
)
declaratorBrackets
modifier
builtInTypeSpec
public
builtInType
void
{
modifiers
typeSpec
builtInTypeSpec
builtInType
int
a
declaratorBrackets
Zoom
Syntax Diagram
Interpreter
Debugger
Console
132 rules
528:1


/Users/bovet/Development/Research/depot/antlr/examples-v3/java/java/java.g
interfaceBodyDeclaration
interfaceMemberDecl
interfaceMethodOrFieldDecl
interfaceMethodOrFieldRest
methodDeclaratorRest
voidMethodDeclaratorRest
interfaceMethodDeclaratorRest
interfaceGenericMethodDecl
voidInterfaceMethodDeclaratorRest
constructorDeclaratorRest
constantDeclarator
variableDeclarators
variableDeclarator
variableDeclaratorRest
constantDeclaratorsRest
constantDeclaratorRest
variableDeclaratorId
variableInitializer
arrayInitializer
modifier
variableDeclaratorId
: Identifier ('[' ']')*
;
variableInitializer
: arrayInitializer
| expression
;
arrayInitializer
: '{' (variableInitializer (',' variableInitializer)* (',
;
modifier
: annotation
| 'public'
| 'protected'
| 'private'
| 'static'
| 'abstract'
| 'final'
| 'native'
| 'synchronized'
| 'transient'
| 'volatile'
| 'strictfp'
;
Break on: All Location Consume LT Exception
Input
public class Sample {
public void main() {
System.out.println("Hello, world");
}
}
Stack
Rule
0 compilationUnit
1 typeDeclaration
2 classOrInterfaceDeclaration
3 classDeclaration
4 normalClassDeclaration
5 classBody
6 classBodyDeclaration
7 modifier
Input
Output
Parse Tree
AST
Stack
Events
Syntax Diagram
Interpreter
Debugger
Console
148 rules (2 warnings)
254:9
Warnings reported in console
Parse Tree
Parse Tree
compilationUnit
typeDeclaration
classOrInterfaceDeclaration
modifier
classDeclaration
public
normalClassDeclaration
class
Sample
classBody
{
modifier
public
Zoom


/Users/bovet/ Grammars/java.g
Zoom
Show NFA
(1/2) Decision can match input such as "'default'" using multiple alternatives
Alternatives: 1 2
casesGroup
aCase
caseSList
statement
'case'
expression
COLON
'default'
compoundStatement
declaration
SEMI
modifiers
classDefinition
IDENT
'if'
LPAREN
RPAREN
'else'
'for'
forInit
forCond
forIter
'while'
'do'
'break'
'continue'
'return'
'switch'
LCURLY
RCURLY
tryBlock
Syntax Diagram
Interpreter
Debugger
Console
132 rules (6 warnings)
433:1

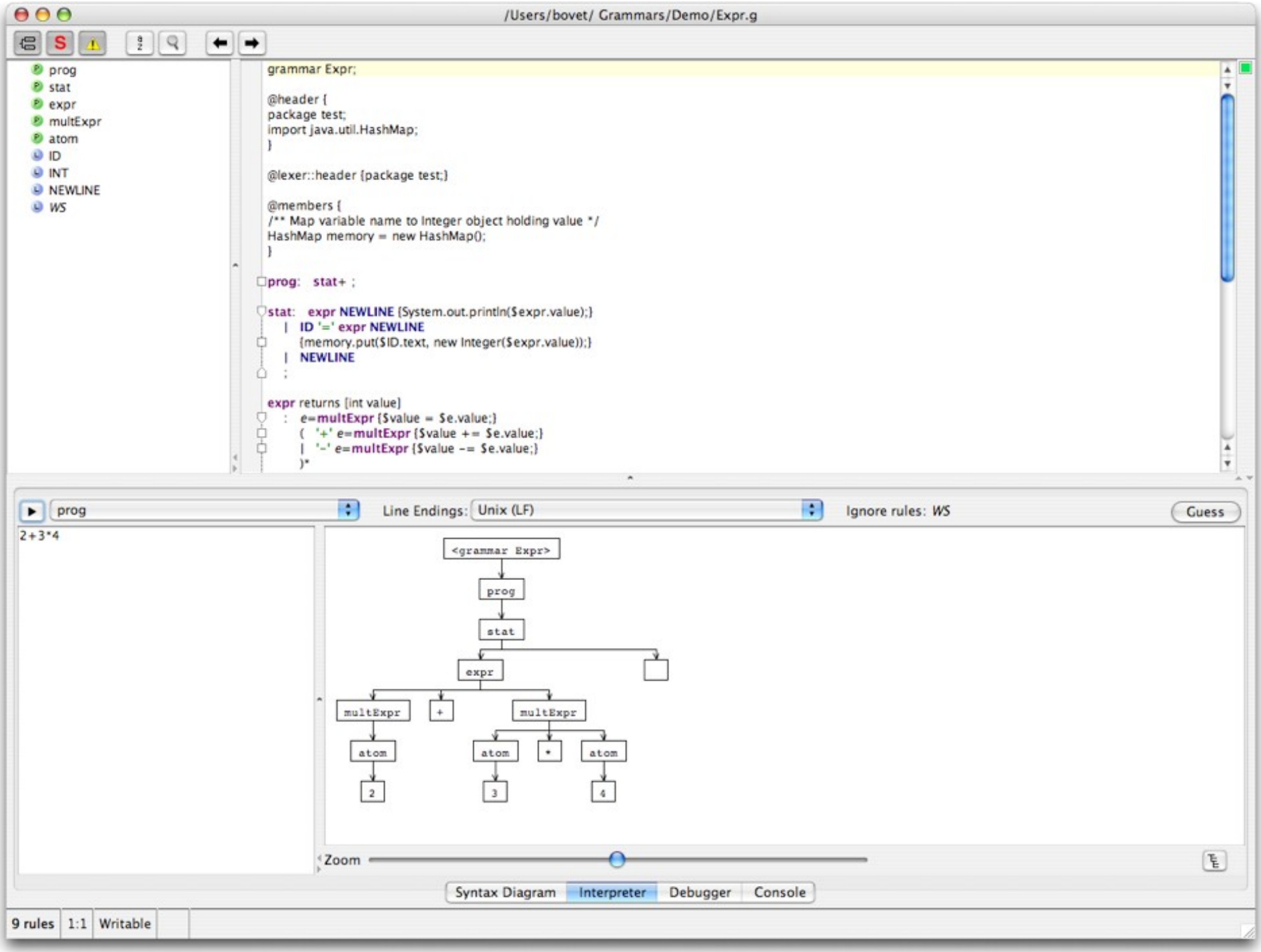

/Users/bovet/mantra.g
compilationUnit
packageDefinition
importDefinition
typeDefinition
classDefinition
interfaceDefinition
methodDefinition
classDefinition[MantraAST mod]
scope {
String name;
}
: 'class' ID ('extends' sup=classname)? ('implements' i+=classname (',' i+=classname)*)?
{$classDefinition::name = $ID.text;}
'{'
(variableDefinition
| methodDefinition
)*
Zoom
'object'
'int'
'boolean'
ID
'int'
'public'..'abstract'
ID
'public'..'abstract'
'void'
'float'
'void'
'long'
s0
s2
s3
s5
s6
s7
s8
s22
s23
s32
s33=>2
s34=>1
'.'
'('
{';', '='}
Syntax Diagram
Interpreter
Debugger
Console
Decision 10 of "classDefinition"
59 rules (1 warnings)
56:5

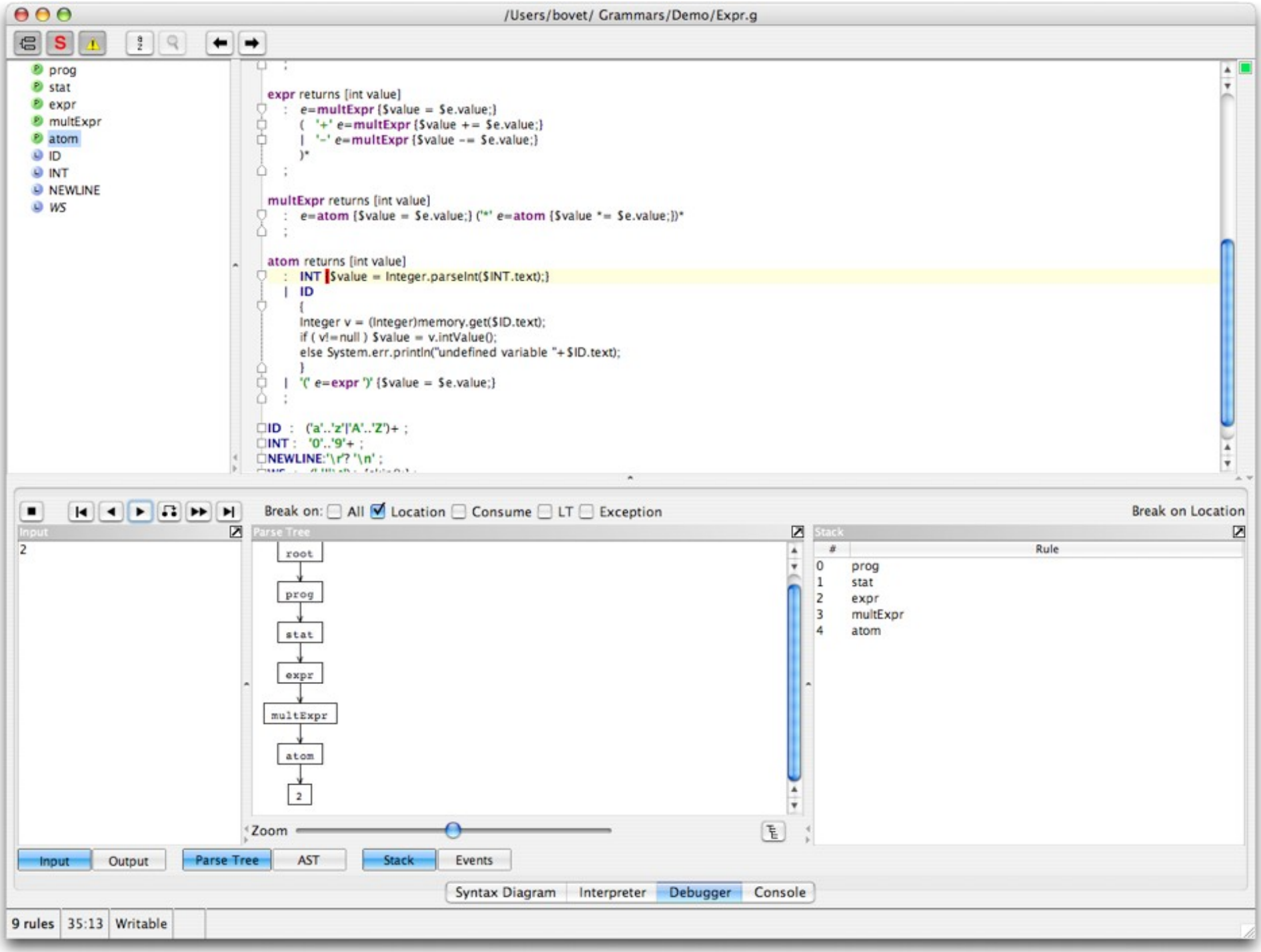
30.2 Ein Taschenrechner

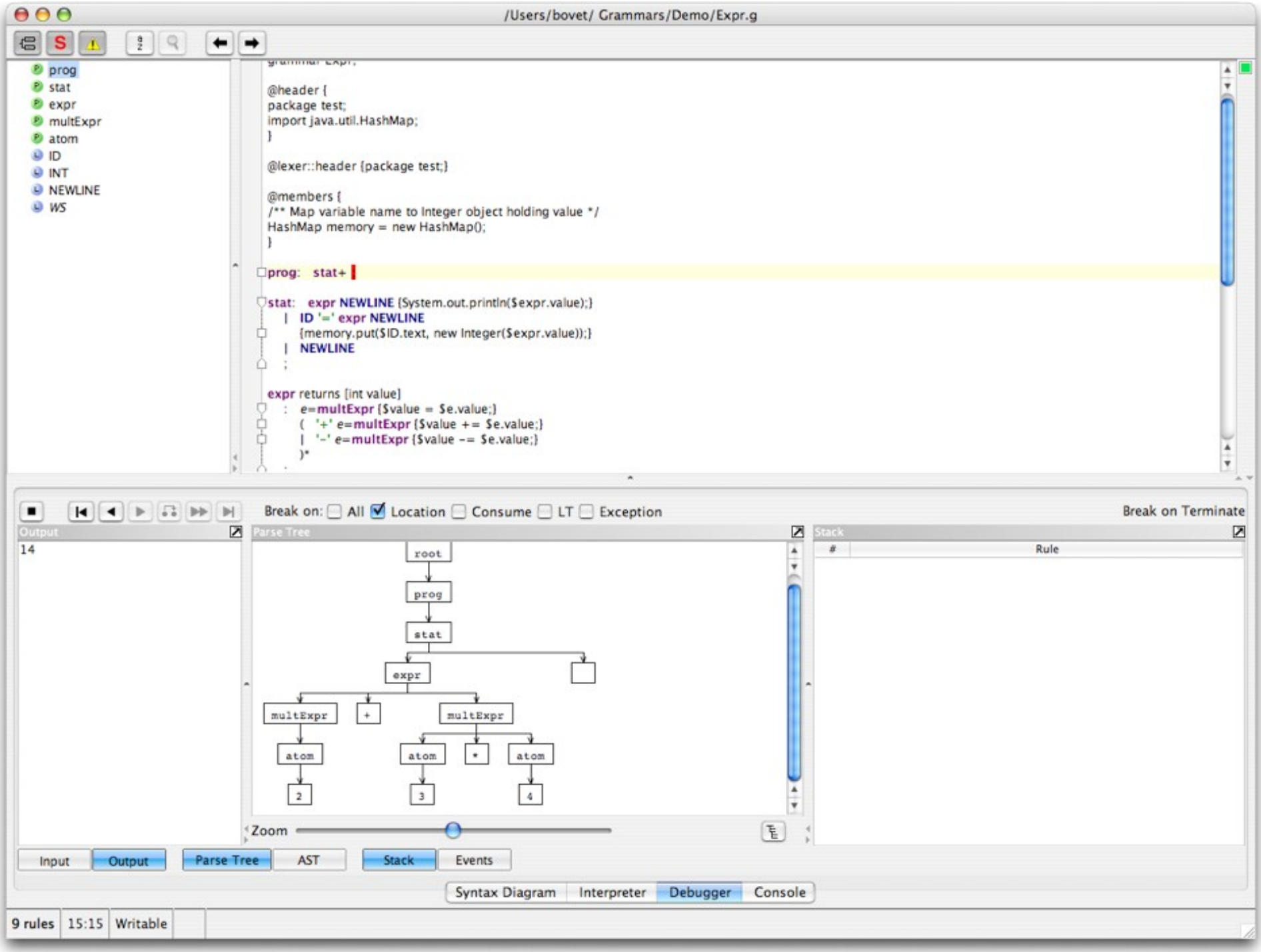
```
grammar Expr;
@header {
package test;
import java.util.HashMap;
}
@lexer::header {package test;}
@members {
/** Map variable name to Integer object holding value */
HashMap memory = new HashMap();
}
prog:   stat+ ;

stat:   expr NEWLINE {System.out.println($expr.value);}
    |   ID '=' expr NEWLINE
        {memory.put($ID.text, new Integer($expr.value));}
    |   NEWLINE
    ;
expr returns [int value]
    :   e=multExpr {$value = $e.value;}
        (   '+' e=multExpr {$value += $e.value;}
        |   '-' e=multExpr {$value -= $e.value;}
        )*
    ;
multExpr returns [int value]
    :   e=atom {$value = $e.value;} ('*' e=atom {$value *= $e.value;})*
    ;
atom returns [int value]
    :   INT {$value = Integer.parseInt($INT.text);}
    |   ID
        {
        Integer v = (Integer)memory.get($ID.text);
        if ( v!=null ) $value = v.intValue();
        else System.err.println("undefined variable "+$ID.text);
        }
    |   '(' e=expr ')' {$value = $e.value;}
    ;
ID  :   ('a'..'z'|'A'..'Z')+ ;
INT :   '0'..'9'+ ;
NEWLINE:'\r'? '\n' ;
WS  :   (' '|'\t')+ {skip();} ;
```

Ansteuerung

```
import org.antlr.runtime.*;
public class Test {
    public static void main(String[] args) throws Exception
{
        ANTLRInputStream input = new
ANTLRInputStream(System.in);
        ExprLexer lexer = new ExprLexer(input);
        CommonTokenStream tokens = new
CommonTokenStream(lexer);
        ExprParser parser = new ExprParser(tokens);
        parser.prog();
    }
}
```


/Users/bovet/ Grammars/Demo/Expr.g
prog
stat
expr
multExpr
atom
ID
INT
NEWLINE
WS
grammar Expr;
@header {
package test;
import java.util.HashMap;
}
@lexer::header {package test;}
@members {
/** Map variable name to Integer object holding value */
HashMap memory = new HashMap();
}
prog: stat+ ;
stat: expr NEWLINE {System.out.println($expr.value);}
| ID '=' expr NEWLINE
{memory.put($ID.text, new Integer($expr.value));}
| NEWLINE
;
expr returns [int value]
: e=multExpr {$value = $e.value;}
('+' e=multExpr {$value += $e.value;}
| '-' e=multExpr {$value -= $e.value;}
)*
prog
Line Endings: Unix (LF)
Ignore rules: WS
Guess
2+3*4
<grammar Expr>
prog
stat
expr
multExpr
+
multExpr
atom
atom
*
atom
2
3
4
Zoom
Syntax Diagram
Interpreter
Debugger
Console
9 rules
1:1
Writable


/Users/bovet/ Grammars/Demo/Expr.g
prog
stat
expr
multExpr
atom
ID
INT
NEWLINE
WS
expr returns [int value]
: e=multExpr {$value = $e.value;}
('+' e=multExpr {$value += $e.value;}
| '-' e=multExpr {$value -= $e.value;}
)*
;
multExpr returns [int value]
: e=atom {$value = $e.value;} ('*' e=atom {$value *= $e.value;})*
;
atom returns [int value]
: INT {$value = Integer.parseInt($INT.text);}
| ID
{
Integer v = (Integer)memory.get($ID.text);
if (v!=null) $value = v.intValue();
else System.err.println("undefined variable "+$ID.text);
}
| '(' e=expr ')' {$value = $e.value;}
;
ID : ('a'..'z'|'A'..'Z')+ ;
INT : '0'..'9'+ ;
NEWLINE:'\r'? '\n' ;
Break on: All Location Consume LT Exception
Break on Location
Input
2
Parse Tree
root
prog
stat
expr
multExpr
atom
2
Zoom
Stack
Rule
0 prog
1 stat
2 expr
3 multExpr
4 atom
Input Output Parse Tree AST Stack Events
Syntax Diagram Interpreter Debugger Console
9 rules 35:13 Writable


/Users/bovet/ Grammars/Demo/Expr.g
prog
stat
expr
multExpr
atom
ID
INT
NEWLINE
WS
@header {
package test;
import java.util.HashMap;
}
@lexer::header {package test;}
@members {
/** Map variable name to Integer object holding value */
HashMap memory = new HashMap();
}
prog: stat+
stat: expr NEWLINE {System.out.println($expr.value);}
| ID '=' expr NEWLINE
{memory.put($ID.text, new Integer($expr.value));}
| NEWLINE
;
expr returns [int value]
: e=multExpr {$value = $e.value;}
('+' e=multExpr {$value += $e.value;}
| '-' e=multExpr {$value -= $e.value;}
)*
Break on: All Location Consume LT Exception
Break on Terminate
Output
14
Parse Tree
root
prog
stat
expr
multExpr
+
multExpr
atom
atom
*
atom
2
3
4
Zoom
Stack
#
Rule
Input
Output
Parse Tree
AST
Stack
Events
Syntax Diagram
Interpreter
Debugger
Console
9 rules
15:15
Writable

Was haben wir gelernt?

- Parsergeneratoren gehören heute zum Werkzeugsatz jeden Softwareingenieurs
- Neben Cocktail gibt es freie Initiativen, z.B. ANTLR

The End