Grammer-3

COM S 319

REVIEW-1 (grammer)

- Grammer is formally defined as follows. A grammer G is a four tuple { V, T, P, S} where V and T are finite sets of variables and terminals (or symbols). V and T are disjoint. P is a finite set of production rules. S is a special variable called the start symbol.
- Example:

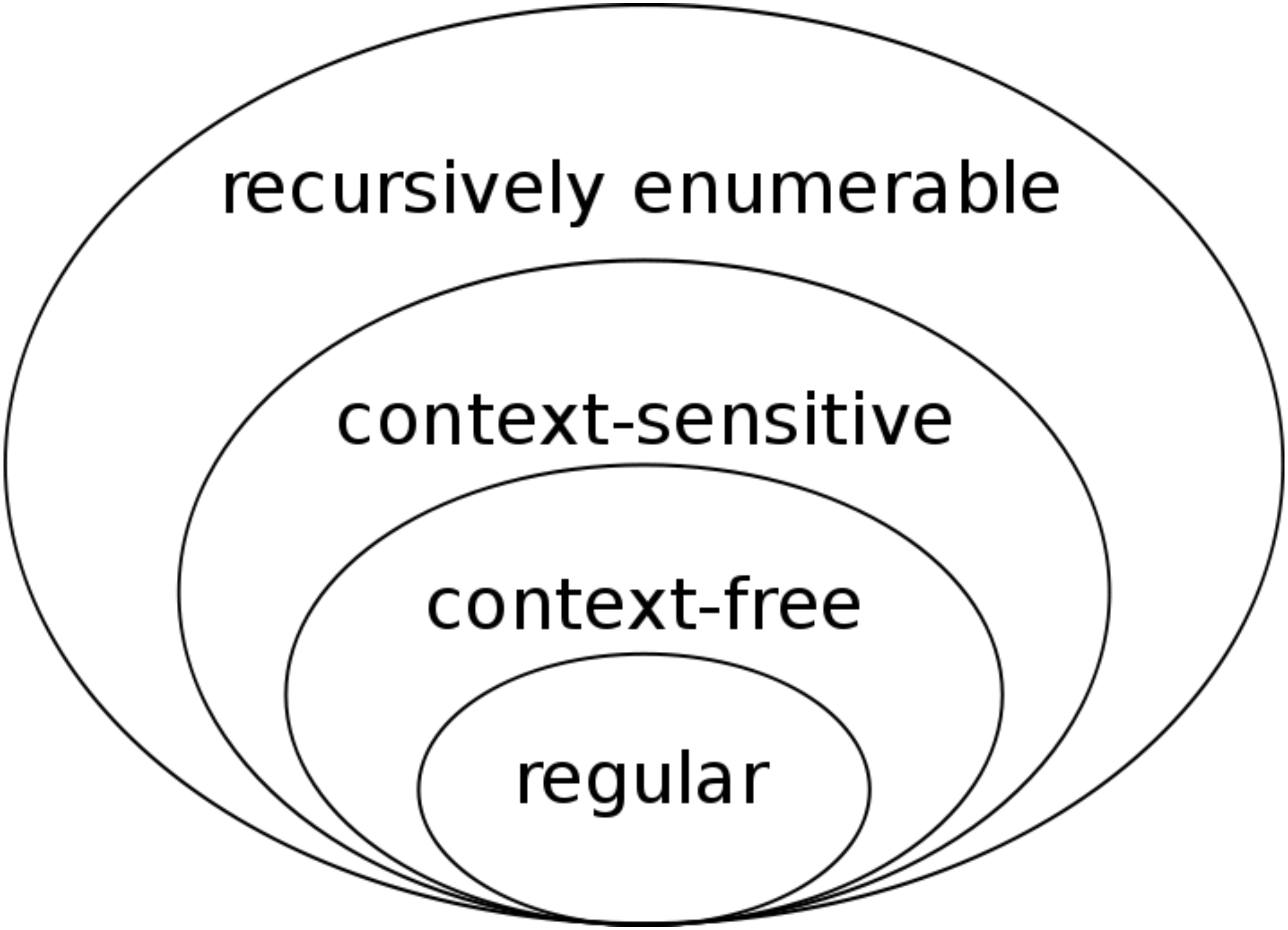
  G1 = {V, T, P, S} where V = {E}, T = {+, -, (,), id},

  S = E, P = rules below

  (rule1) E → E + E, (rule2) E → E - E,

  (rule3) E → (E), (rule4) E → id

REVIEW-2 (types of grammers)



REVIEW-3 Regular Grammer

- Production Rules have to have one of the forms
  1. A → a
  2. A → aB
  3. A → ε

where A and B stand for arbitrary variables and a stands for an arbitrary terminal (could also be empty). Epsilon is the empty string.

Note: There is an equivalent form, where middle rule is A → Ba

Review-4

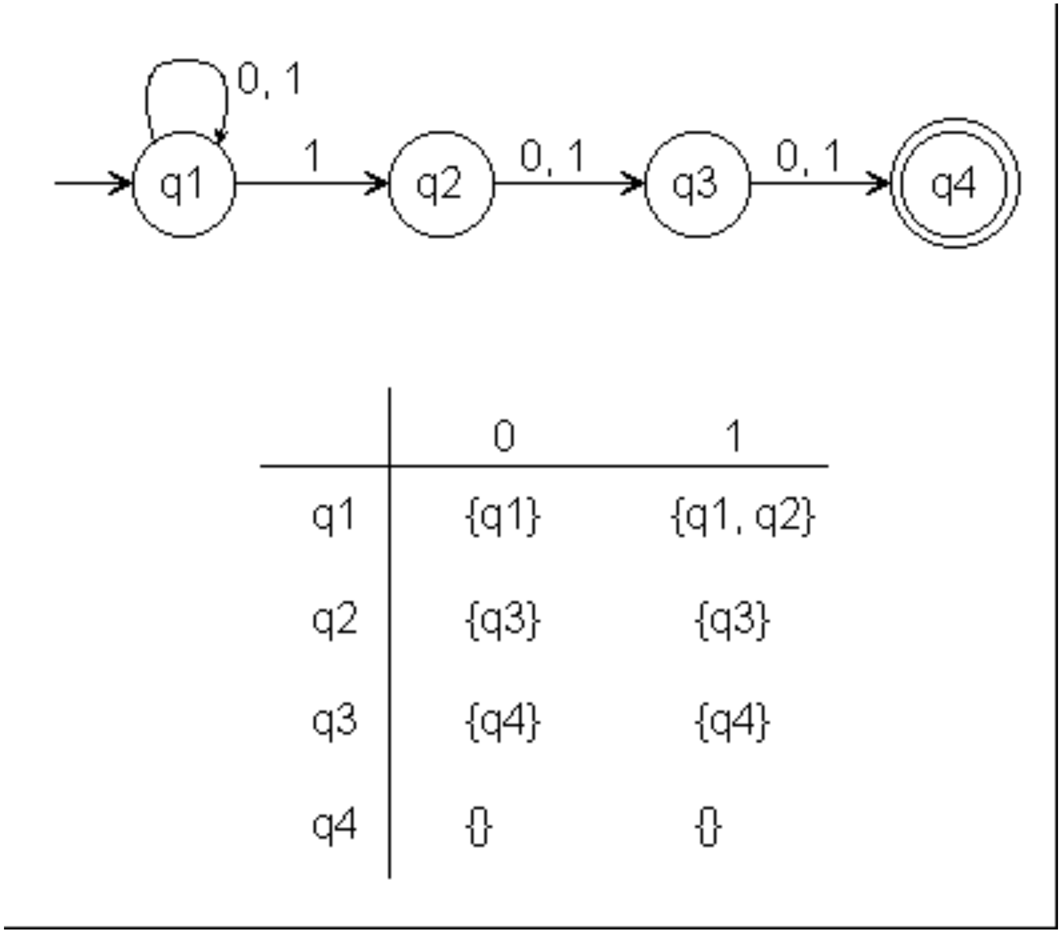
- Regular expressions express strings in regular language
- Regular grammer also expresses strings in regular language.
- Finite automaton is used to recognize regular expressions
- **RE, RG, FA are equivalent!**

Review-5 Non-deterministic FA

- A NFA is a 5-tuple (Q, A, T, S, F)
  - Q is a FINITE set of states
  - A is the alphabet
  - T is the transition function
    - Q x A+ε → P(Q) (i.e. state & alphabet gives state
  - S is the start state
  - F is set of final states
- NFA (non-deterministic finite automaton) can
  1. transition to multiple states on the same input and
  2. can also transition on epsilon

easier to express in NFA vs DFA (note DFA and NFA are equivalent)

Review-6: Transition table



	0	1
q1	{q1}	{q1, q2}
q2	{q3}	{q3}
q3	{q4}	{q4}
q4	{}	{}

LEX (LEXER OR LEXICAL ANALYSER)

lex & yacc

- describe rules for language in a file
- lex automatically generates lexical analyzer.
- yacc generates parser.

Format of lex rules file:

```
{definitions}
%%
{rules}
%%
{user subroutines}
```

Example Lex file

```
%{
#include <stdio.h>
%}

%%
[a-zA-Z][a-zA-Z0-9]*    printf("WORD ");
[a-zA-Z0-9\/.-]+        printf("FILENAME ");
\"                      printf("QUOTE ");
\{                      printf("OBRACE ");
\}                      printf("EBRACE ");
;                       printf("SEMICOLON ");
\n                      printf("\n");
[ \t]+                  /* ignore whitespace */;
%%
```

ANTLR

http://www.antlr.org

ANTLR (ANother Tool for Language Recognition) is a powerful parser generator for reading, processing, executing, or translating structured text or binary files. It's widely used to build languages, tools, and frameworks. From a grammar, ANTLR generates a parser that can build and walk parse trees.

ANTLR

- lex and yacc – standard unix utilities to build lexer and parser (to build compilers).
  - c code
  - lexer and parser rules kept in separate files

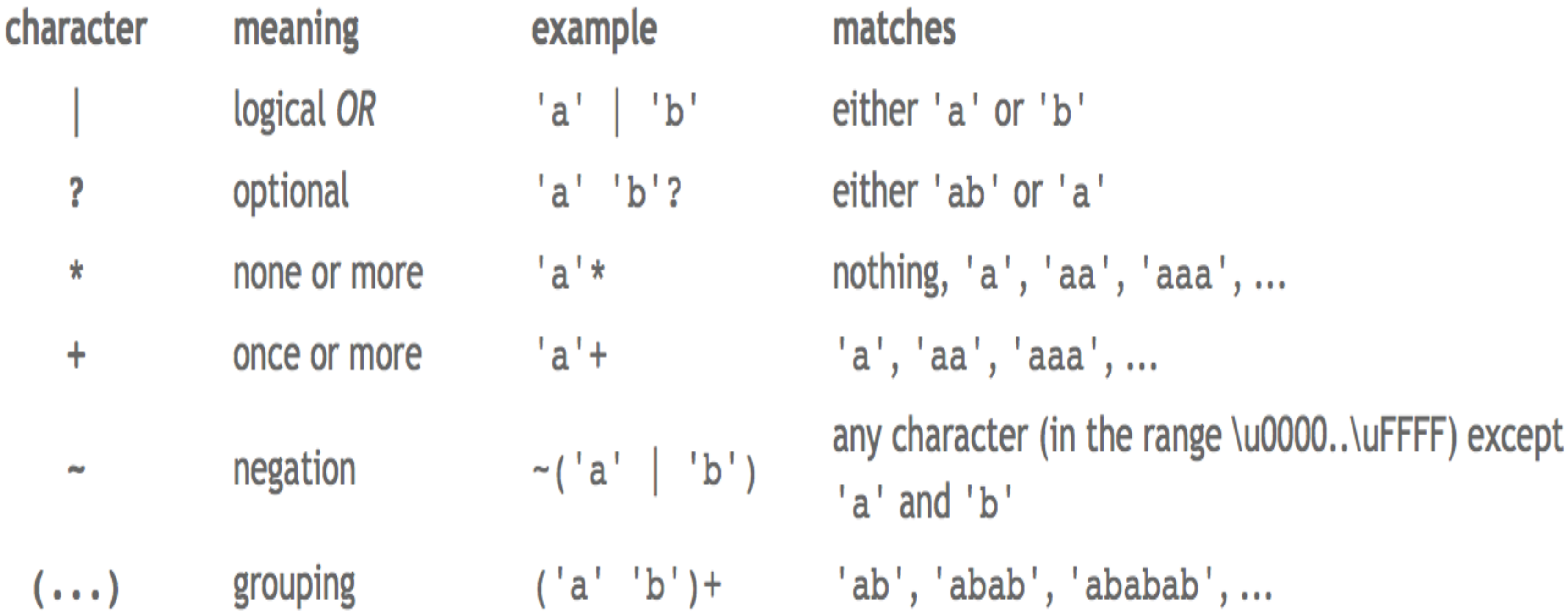
- ANTLR
  - completely Java code.
  - Both lexer and parser rules are specified in one file.

- Antlr Commands

```
antlr4 Expr.g4          // generates java code for lexer/parser
javac Expr*.java        // compile the code
grun Expr prog –gui      (or –tree or –tokens)
100+2*34 ^D
```

LEXER RULES

- RULE_NAME : RULE_CONTENTS ;



character	meaning	example	matches
|	logical *OR*	'a' | 'b'	either 'a' or 'b'
?	optional	'a' 'b'?	either 'ab' or 'a'
*	none or more	'a'*	nothing, 'a', 'aa', 'aaa', ...
+	once or more	'a'+	'a', 'aa', 'aaa', ...
~	negation	~('a' | 'b')	any character (in the range \u0000..\uFFFF) except 'a' and 'b'
(...)	grouping	('a' 'b')+	'ab', 'abab', 'ababab', ...

Example: ABC.g4

```
lexer grammar ABC;

options
{
  // antlr will generate java lexer and parser
  language = Java;
}

// ***************** lexer rules
//the grammar must contain at least one lexer rule
SALUTATION: ('Hello world');
ENDSYMBOL: '!' ;
```

Parser rules: HelloWorld.g4

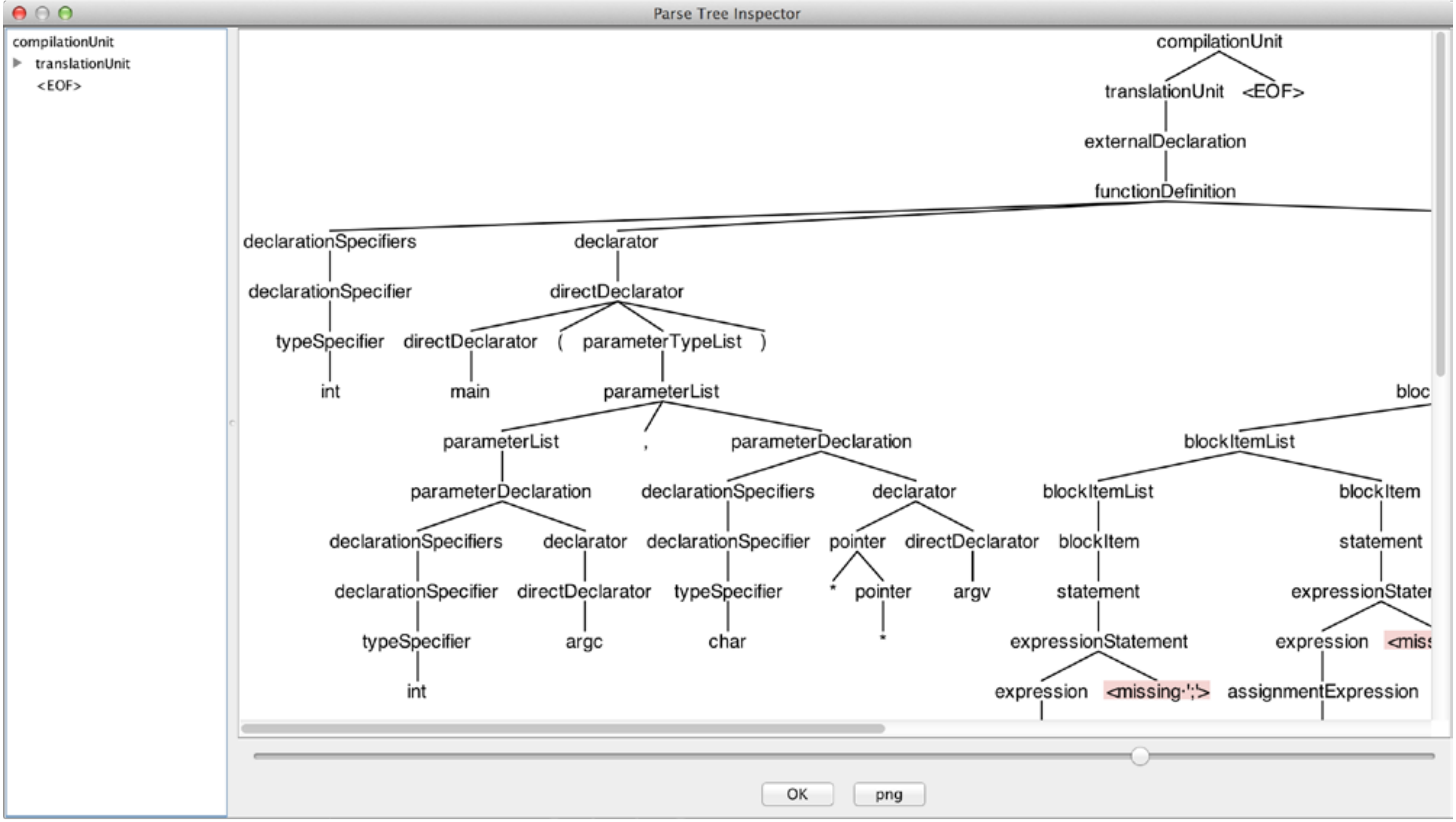
```
grammar HelloWorld;

options
{
  // antlr will generate java lexer and parser
  language = Java;
}

// ***************** lexer rules:
//the grammar must contain at least one lexer rule
SALUTATION: ('Hello world');
ENDSYMBOL: '!' ;

// ***************** parser rules:
//our grammer accepts only salutation followed by an end symbol
expression : SALUTATION ENDSYMBOL;
```

using –gui option


Parse Tree Inspector
compilationUnit
translationUnit
<EOF>
compilationUnit
translationUnit
<EOF>
externalDeclaration
functionDefinition
declarationSpecifiers
declarator
declarationSpecifier
directDeclarator
typeSpecifier
directDeclarator
(
parameterTypeList
)
int
main
parameterList
bloc
parameterList
,
parameterDeclaration
blockItemList
parameterDeclaration
declarationSpecifiers
declarator
blockItemList
blockItem
declarationSpecifiers
declarator
declarationSpecifier
pointer
directDeclarator
blockItem
statement
declarationSpecifier
directDeclarator
typeSpecifier
*
pointer
argv
statement
expressionStater
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argc
char
*
expressionStatement
expression
<miss
int
expression
<missing';'>
assignmentExpression
OK
png