COMP261 Parsing 4 of 4

A Better parser: using patterns

- Give names to patterns to make program easier to understand and to modify
- Precompile the patterns for efficiency:

```
private Pattern numPat =
        Pattern.compile("[-+]?(\\d+([.]\\d*)?|[.]\\d+)");
private Pattern addPat = Pattern.compile("add");
private Pattern subPat = Pattern.compile("sub");
private Pattern mulPat = Pattern.compile("mul");
private Pattern divPat = Pattern.compile("div");
private Pattern opPat
=Pattern.compile("add|sub|mul|div");
private Pattern openPat = Pattern.compile("\\(");
private Pattern commaPat = Pattern.compile(",");
private Pattern closePat = Pattern.compile("\\)");
```

A Better parser: using patterns

```
public Node parseExpr(Scanner s) {
  Node n;
  if (!s.hasNext())    { fail("Empty expr",s); }
  if (s.hasNext(numPat))    { return
  parseNumber(s); }
  if (s.hasNext(addPat))    { return parseAdd(s); }
  if (s.hasNext(subPat))    { return parseSub(s); }
  if (s.hasNext(mulPat))    { return parseMul(s); }
  if (s.hasNext(divPat))    { return parseDiv(s); }
  fail("Unknown expr",s);
  return null;
}
```

A Better parser: multiple arguments

```
public Node parseAdd(Scanner s) {
   List<Node> args = new ArrayList<Node>();
   require(addPat, "Expecting add", s);
   require(openPat, "Missing '('", s);
   args.add(parseExpr(s));
   do {
      require (commaPat, "Missing ','", s);
      args.add(parseExpr(s));
   } while (!s.hasNext(closePat));
   require(closePat, "Missing ')'", s);
   return new AddNode(args);
}
```

(need new version of require, which takes a Pattern instead of a String)

Multiple arguments: Printing AST

```
NumberNode:  public String toString(){
                return String.format("%.5f", value);
             }
AddNode:     public String toString(){
                String ans = "(" + first;
                for (Node nd : rest){ ans += " + "+
                nd; }
                return ans + ")";
             }
SubNode:     public String toString(){
                String ans = "(" + first;
                for (Node nd : rest){ ans += " - "+
                nd; }
                return ans + ")";
             }
```

Examples

Expr: add(10.5 ,-8)

Print → (10.5 + -8.0)
Value → 2.500

Expr: add(sub(10.5 ,-8), mul(div(45, 5), 6.8))

Print → ((10.5 – –8.0) + ((45.0 / 5.0) * 6.8))
Value → 79.700

Expr: add(14.0, sub(mul(div (1.0, 28), 17), mul(3, div(5, sub(7, 5)))))

Print → (14.0 + (((1.0 / 28.0) * 17.0) – (3.0 * (5.0 / (7.0 – 5.0)))))
Value → 7.107

Less Restricted Grammars

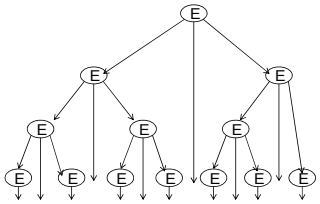
- This is enough for most of the assignment:
  - method for each Node type
  - peek at next token to determine which branch to follow
  - build and return node
  - throw error (including helpful message) when parsing breaks
  - use require(…) to wrap up "check then consume/return or fail"
  - adjust grammar to make it cleaner
- What happens when our grammar is not quite so helpful?
- For example:

  `E ::= number` | E "+" E | E "–" E | E "∗" E | E "/" E
- What are the problems, and how can you fix them?

Ambiguous Grammars

Grammar:

E ::= *number* | E "+" E | E "–" E | E "∗" E | E "/" E

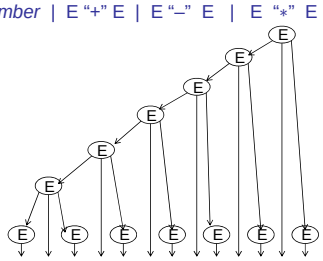


Text: 65 * 74 – 68 + 25 * 5 / 3 + 16

Possible Parses

Grammar:

E ::= *number* | E "+" E | E "–" E | E "∗" E | E "/" E

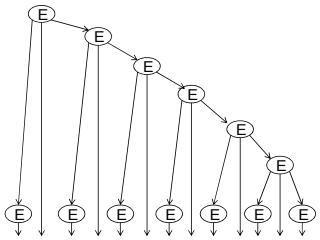


65 * 74 – 68 + 25 * 5 / 3 + 16

Possible Parses

Grammar:

E ::= *number* | E "+" E | E "–" E | E "∗" E | E "/" E



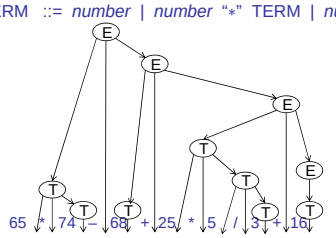
65 * 74 – 68 + 25 * 5 / 3 + 16

Ambiguous Grammars

- If a grammar allows multiple parses then we need to specify which we want (if it makes a difference)
- For example:

  EXPR ::= TERM | TERM "+" EXPR | TERM "–" EXPR

  TERM ::= *number* | *number* "∗" TERM | *number* "/" TERM



Telling which option to follow

EXPR ::= ~~TERM~~ | ~~TERM~~ "+" EX~~PR~~ | TERM "–" EXPR

TERM ::= ~~*number*~~ | ~~*number*~~ "∗" TER~~M~~ | ~~*number*~~ "/" TERM

- Break into subrules, collecting the shared elements:

  EXPR ::= TERM RESTOFEXPR

  RESTOFEXPR ::= "+" EXPR | "–" EXPR | ∈

  TERM ::= *number* RESTOFTERM

  RESTOFTERM ::= "∗" TERM | "/" TERM | ∈

  (∈ means "empty string")

- Transformations such as these can often turn a problematic grammar into a tractable grammar