Ambiguity Resolution

Imagine a rule for C identifiers:

```
[a-zA-Z_][a-zA-Z0-9_]*
```

And the rule for a keyword such as if:
```
"if"
```

How do we resolve the fact that `if` is a keyword and `if8` is an identifier?

Two rules:
1. Longest match – The match with the longest string will be chosen.
2. Rule priority – for two matches of the same length, the first regex will be chosen. I.e., Rule order matters.

Generating Lexical Analyzers

Lex and flex – Tools to generate table-driven lexical analyzers from regular expressions.

Lex and flex work primarily with C.

Java versions exist. We will use JFlex as it's input format is close to flex for C.

The general format of these tools is to take an input file in the following format:

```
REGEN | Java code to do on match
REGGEX | Java code to do on match
```

```
WhiteSpace = [ \t\r\n\] 
Identifier = [a-zA-Z_][a-zA-Z0-9_]* 
Integer = 0 | [1-9]\d* 

%%
"+" { return symbol(PLUS); }
{Integer} { return symbol(INTEGER, Integer.parseInt(yytext())); }
```

JFlex

```
import java.util.*;
\%\%
\%class SimpleLexer
\{
\}
private Symbol symbol(int type) {
return new Symbol(type); 
yyline, yycolumn);
}
private Symbol symbol(int type, Object value) {
return new Symbol(type, yline, yycolumn, value);
}
%
WhiteSpace = [ \t\r\n\] 
Identifier = [a-zA-Z_][a-zA-Z0-9_]* 
Integer = 0 | [1-9]\d* 
\%
"+" { return symbol(PLUS); }
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}
%
WhiteSpace = [ \t\r\n\] 
Identifier = [a-zA-Z_][a-zA-Z0-9_]* 
Integer = 0 | [1-9]\d* 
```

Divides sections
1. User Code – The text up to the first line starting with %% is copied verbatim to the top of the generated lexer class (before the actual class declaration).

2. Options and Declarations – It consists of a set of options, code that is included inside the generated scanner class, lexical states and macro declarations.

3. Lexical Rules – Regular expressions and actions (Java code) that are executed when the scanner matches the associated regular expression.

Conclusions

- Regular languages are powerful and convenient ways to accomplish lexical analysis.
- They can describe keywords, numbers, strings, comments, identifiers, email addresses, phone numbers, etc.
- However, they are the weakest formal language.

Many languages are not regular:
- C programming language is not
- "((...))" is also not

Finite automata cannot remember # of times
- We need more powerful languages for describing these structures

In the next part of the class, we introduce context-free languages which can express more complex things.