COMP 3002: Compiler Construction

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Course Information

- **Instructor:** Pat Morin
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  - Just "Pat"
- **Office Hours:** Tuesdays 9:00-10:00, 13:30-14:30
- **Webpage:**
  - http://cg.scs.carleton.ca/~morin/teaching/3002/
  - Contains all information related to the course
- **Texbook (not compulsory):**
  - Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, Compilers: Principles, Techniques, & Tools. Second edition, Addison-Wesley, 2007.

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Course Information

- **Grading Scheme:**
  - Assignments 4 * 20% = 80%
  - End-of-term exam: 20%
- **Grading:**
  - Assignments are graded by how well they work, not how much work you put into them
  - A buggy compiler is worse than a missing feature
- **Collaboration:**
  - Students may discuss assignments, but when it comes time to write code they should do so on their own. No student should ever show another student their code.

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Course Information

- Languages and Tools:
  - Programming in Java
  - SSCC parser generator
  - Jasmin JVM assembler
- Environment
  - Examples will be compiled under Linux on the command line
  - I/O will be through System.in/System.out
  - Assignments will generate command line tools

Definition of a Compiler

- What is a compiler?
  - **Input:** text in language *A*
  - **Output:** text in language *B*
- In this course, *A* is a programming language and *B* is a computer (machine) language
  - Programming languages: Java, C, C++, C#, Eiffel, Lisp, Pascal, Haskell, ...
  - Machine languages: i386, x86_64, PPC, JVM, ...

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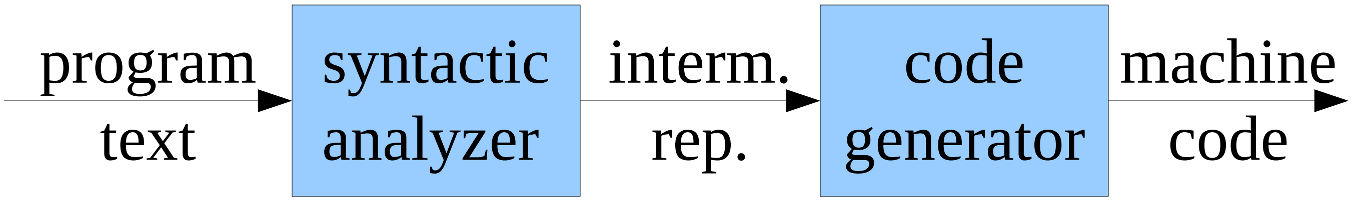
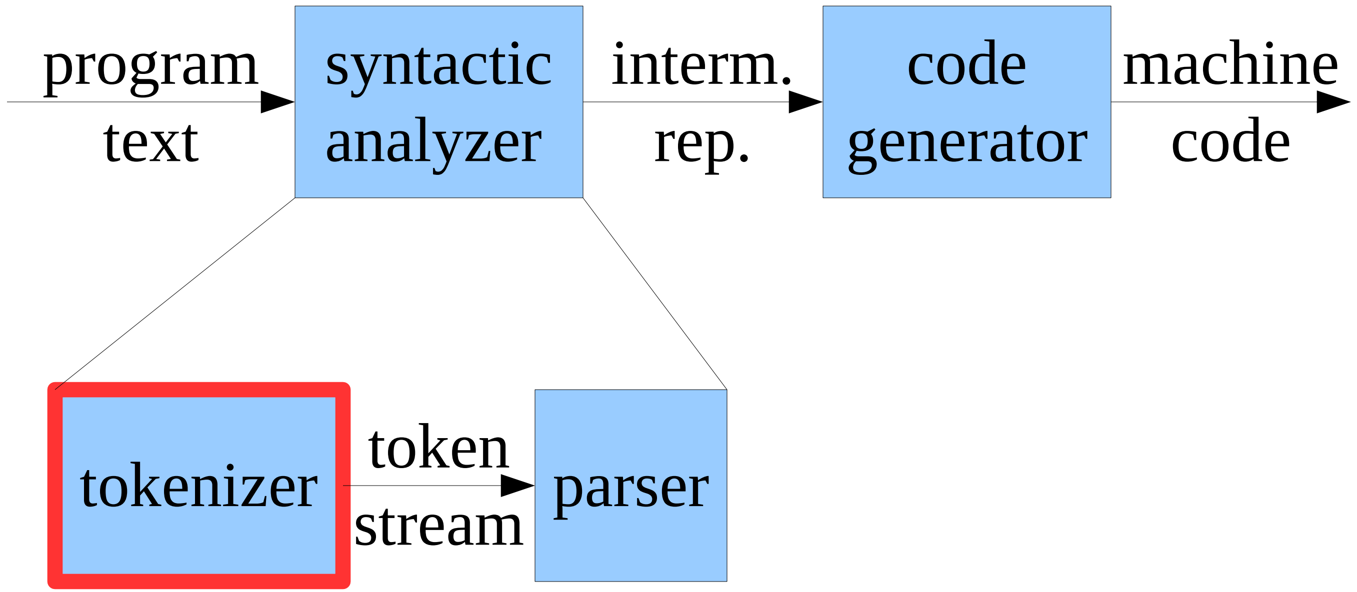
Structure of a Compiler

- Compilation usually works in (at least) two steps
  - Syntax analysis (tokenization and parsing)
  - Code generation and optimization
- Between the two is an *intermediate representation*
  - Sometimes called a *parse tree* or *pseudo instructions*



Syntax Analysis

- Syntax analysis has two parts
  - tokenization and parsing



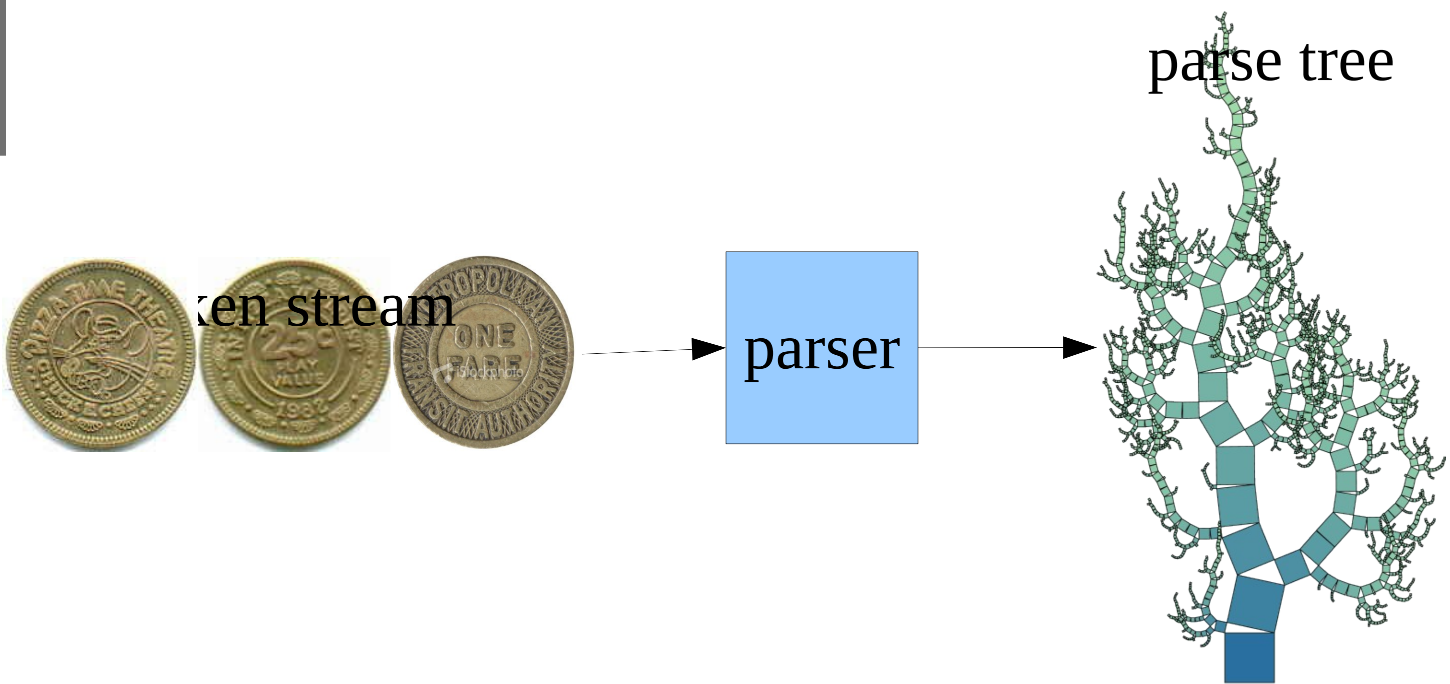
Tokenization

- Converts a character stream into a token stream

```
int main(void) {
  for (int i = 0;
       i < 10;
       i++) { ...
```

Parsing

- Converts a token stream into an intermediate representation
  - Captures the meaning (instead of text) of the program



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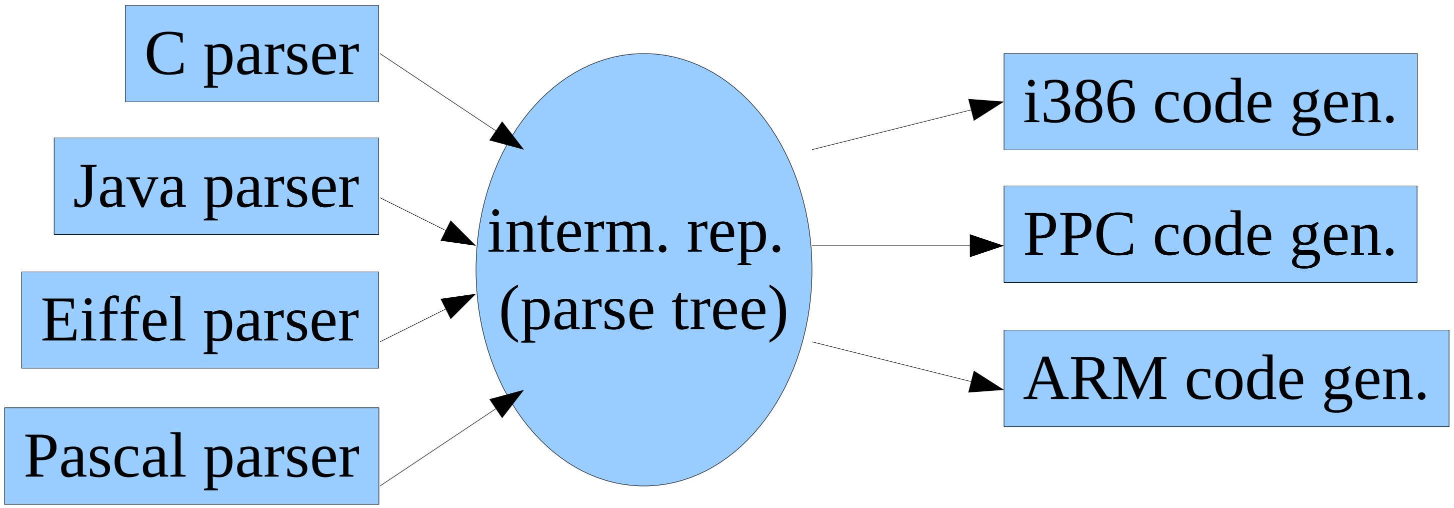
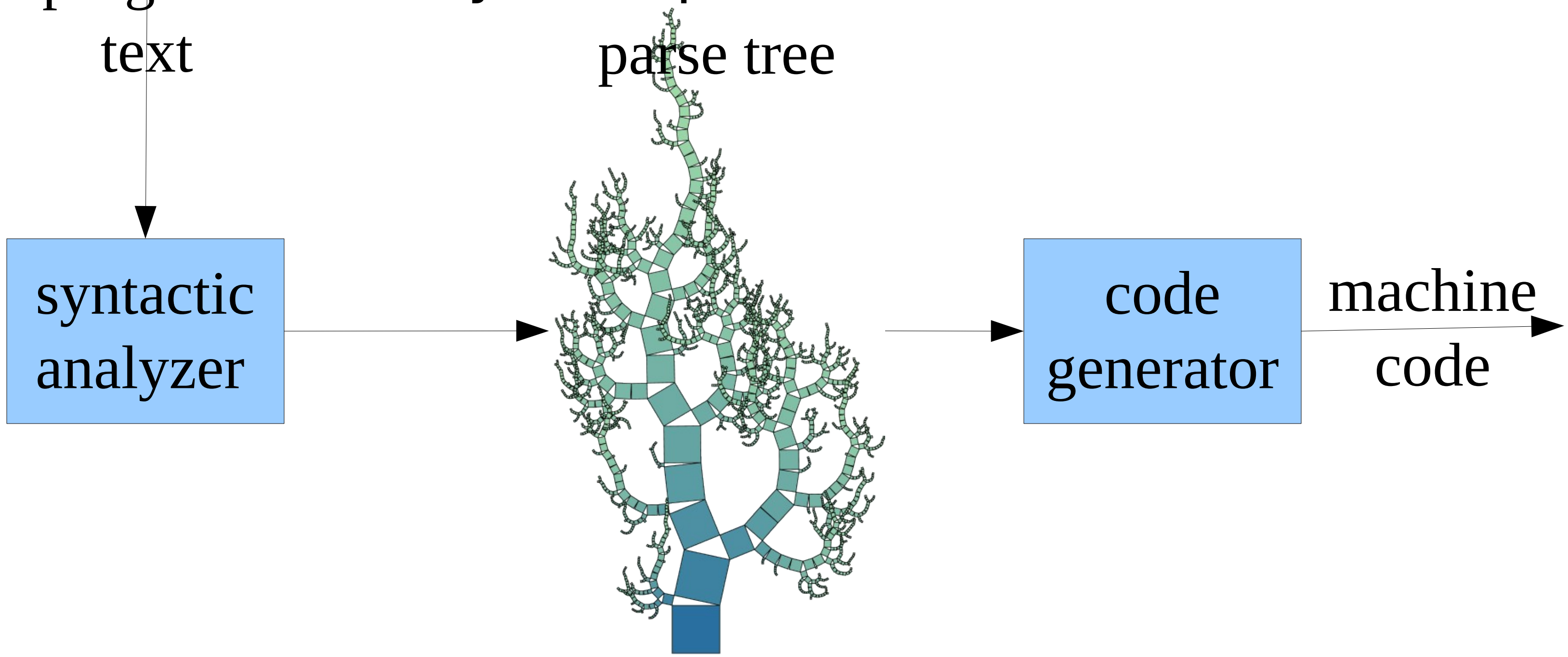
Compiler Structure

- This structure allows us to reuse compiler components
  - By writing n syntax analyzers and m code generators we get a nm compilers



Code Generation

- Code generation and optimization is the really hard part (to do well)



Code Generation

- Code generation can be done in several phases
  - *Machine independent optimizations* optimize code, without making use of machine-dependent details
  - *Basic code generation* makes no attempt to optimize code
  - *Machine dependent optimizations* optimize code for a specific machine architecture
  - Can be several iterations of each kind of optimization

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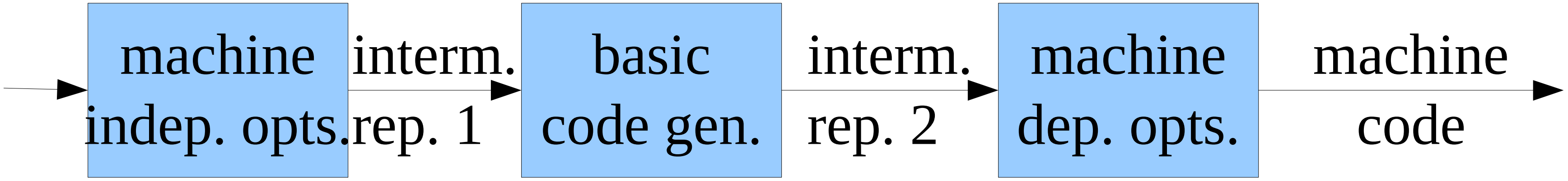

A Brief History of Compiler Construction

- 1945-1960: Code generation
- 1960-1975: Parsing
- 1975-Present
  - Code optimization
  - Programming language design
  - New programming paradigms

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Why Study Compilers?

- A great success story from theoretical computer science
- You may have to write a compiler or interpreter some day
- Parsers appear in a lot of applications
- Translators (file converters) are often required
- Code optimization is still a challenging and active field of research

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Why Study Compilers?

- Understanding compiler optimization can improve a programmer's code writing skills
- A programmer will eventually run into a compiler bug, limitation, or "quirk"
  – understanding compilers will help understand what is wrong
- And many more reasons...

http://xkcd.com/371/

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