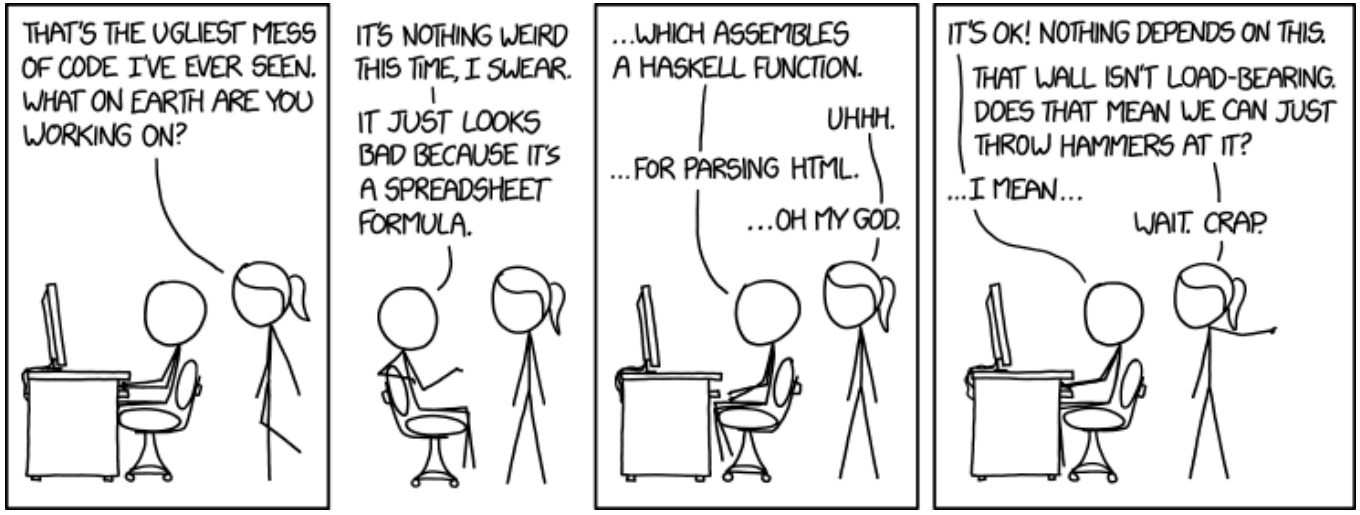
Compilers History and Review

Friday Review 1



EECS 483

January 4, 2018

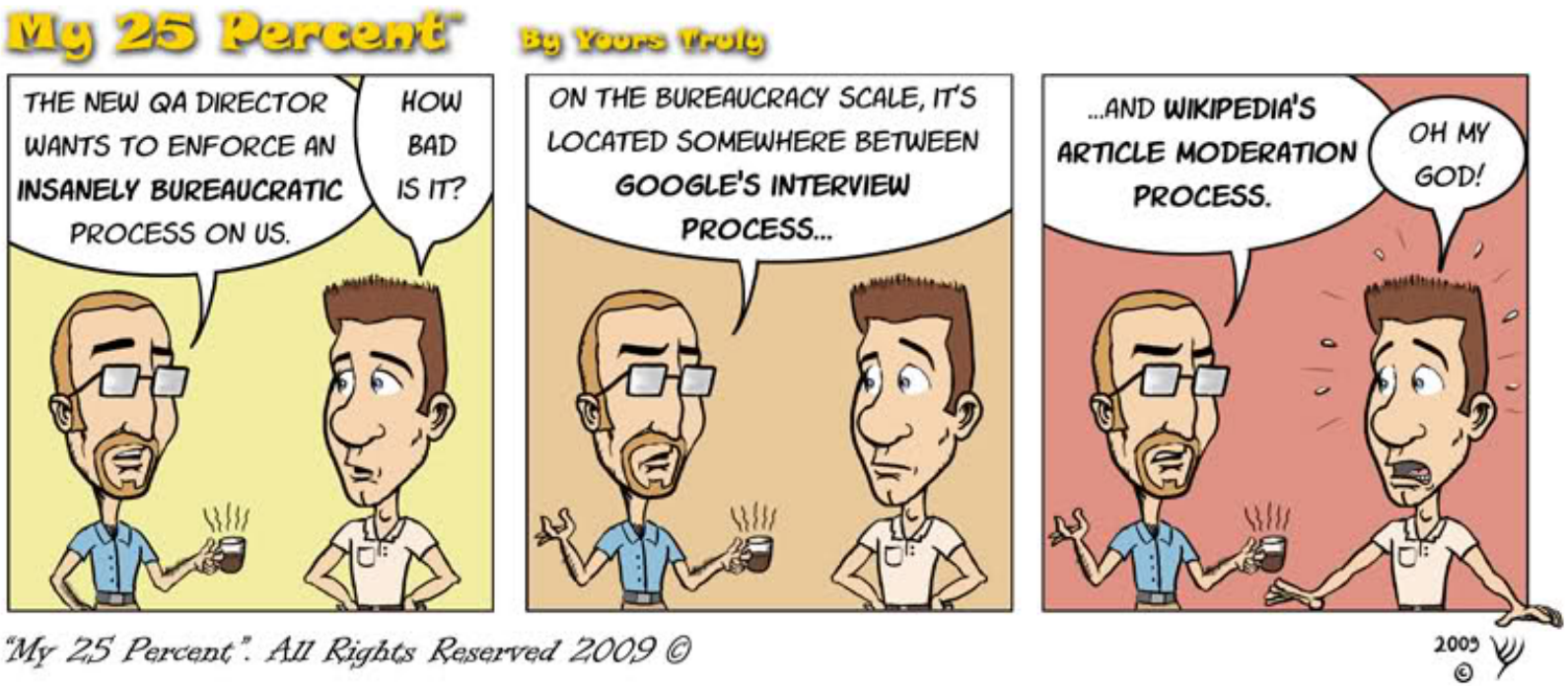
Course Information

- Office Hours: Thursday, 2-4pm in BBB 2717
- GSI: Ram Kannan
- IA: Lawrence Wu

- Please use Piazza as primary contact

Waitlisting

- Please be patient with the waitlist
- Protip! It is perfectly *cromulent* to audit the course. Anyone can use the autograder.
  - You *will not* receive course credit on your transcript if not enrolled
  - You *will* receive immense satisfaction in becoming an ultimate master of CS



Why Study History?

- Those who cannot remember George Santayana are condemned to misquote him.

Supernatural, 1999

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- Those who cannot remember the past are condemned to repeat it.

George Santayana

Why Study History?

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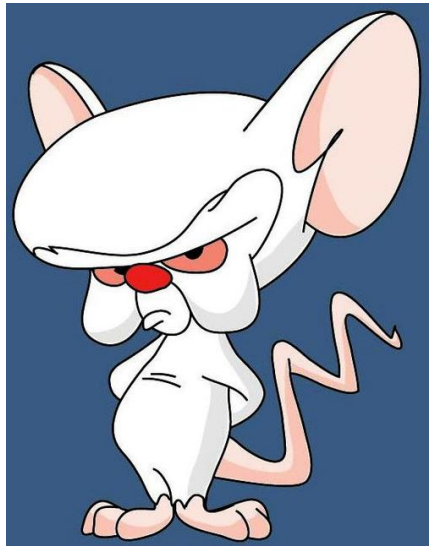
George Santayana

- Through meticulous analysis of history, I will find a way to make the people worship me. By studying the conquerors of days gone by, **I'll discover the mistakes that made them go awry.**

The Brain



PL and Compilers

- 1920: Computer = Human

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- Everything programmed manually!

Surprise!

- How many lines of code do you write per day?

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1. 10 LOC/day: Fred Brooks

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Compilers to the rescue

- **Allow software developers to specify program behavior with high level languages**

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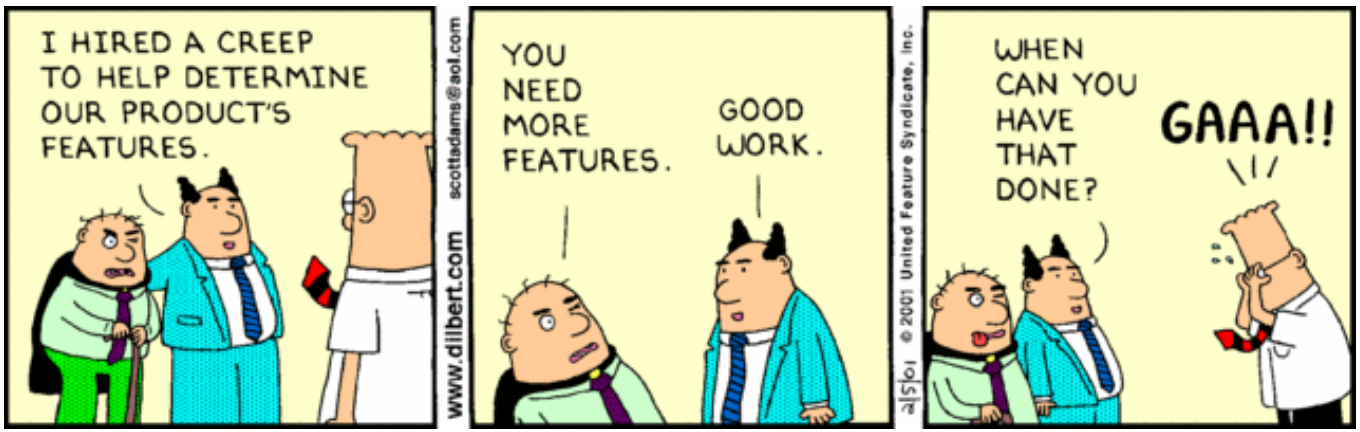
- **Allow software developers to specify program behavior with high level languages**
- 10 LOC of C++ slightly better than 10 LOC of x86 assembly

- 1972: C


I HIRED A CREEP TO HELP DETERMINE OUR PRODUCT'S FEATURES.
www.dilbert.com scottadams@aol.com
YOU NEED MORE FEATURES.
GOOD WORK.
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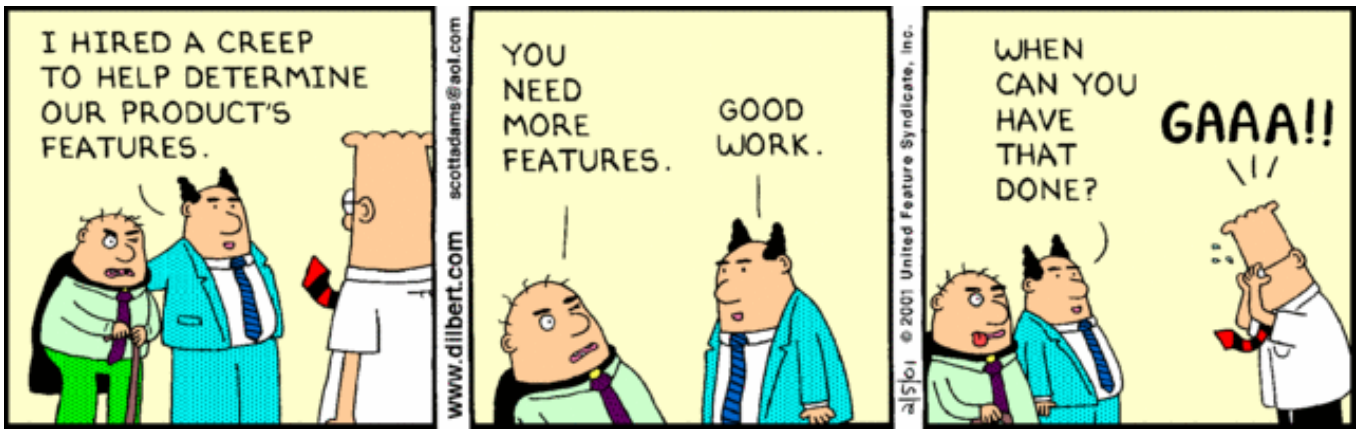
WHEN CAN YOU HAVE THAT DONE?
GAAA!!

- 1972: C
- 1983: Ada

Systems Programming

DOD, type safety



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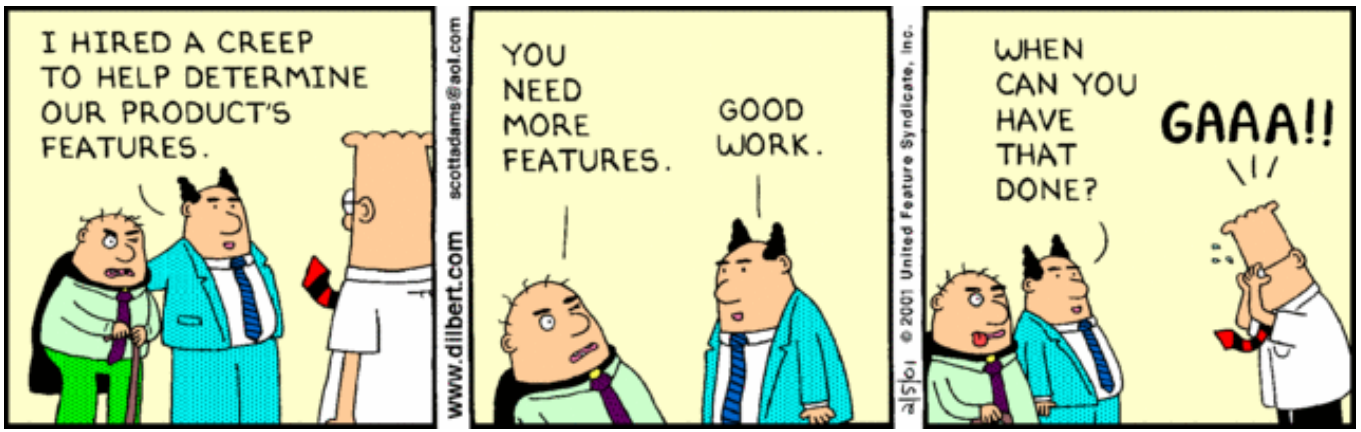
- 1983: C++ — Object-oriented!



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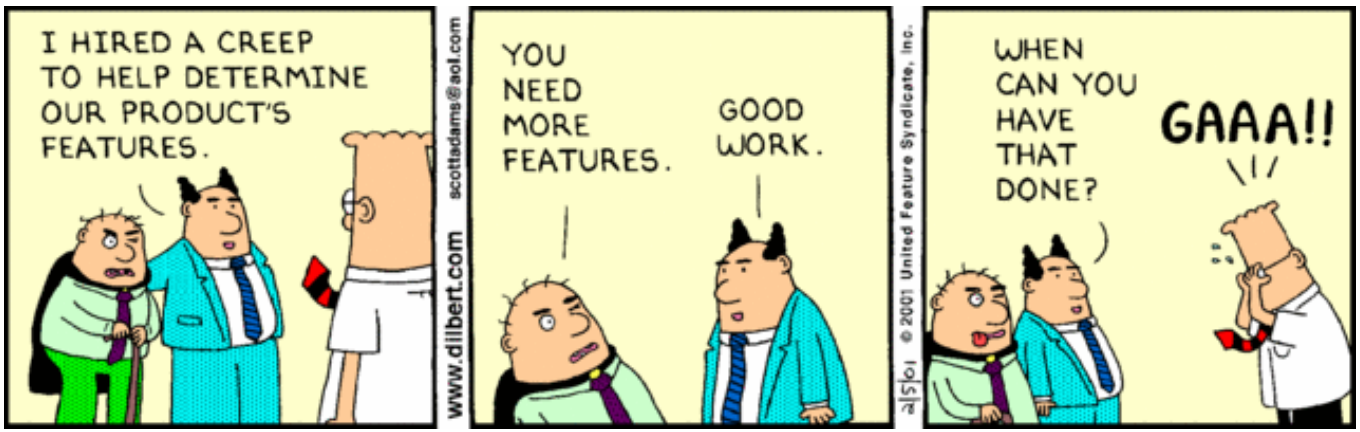

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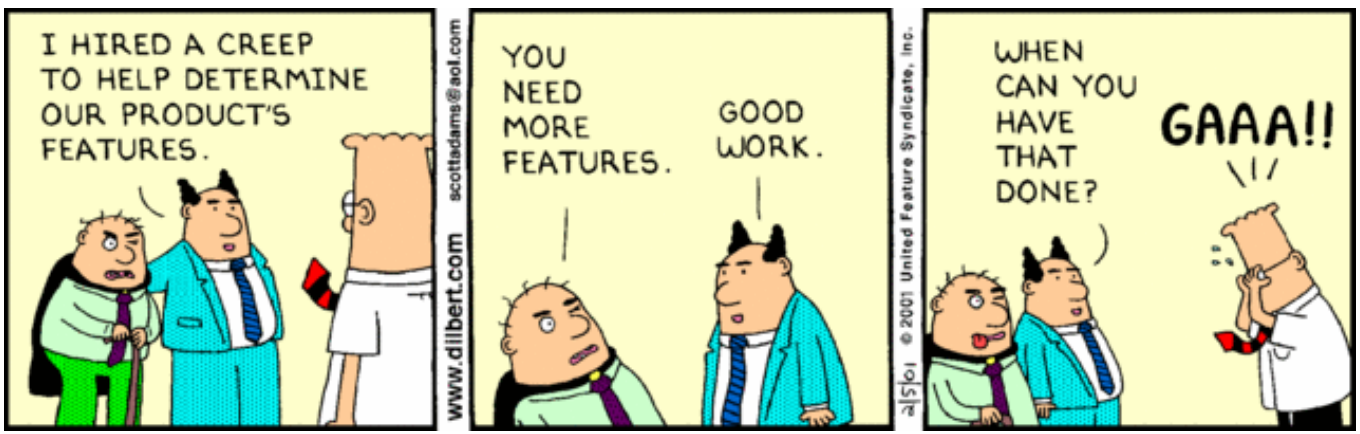

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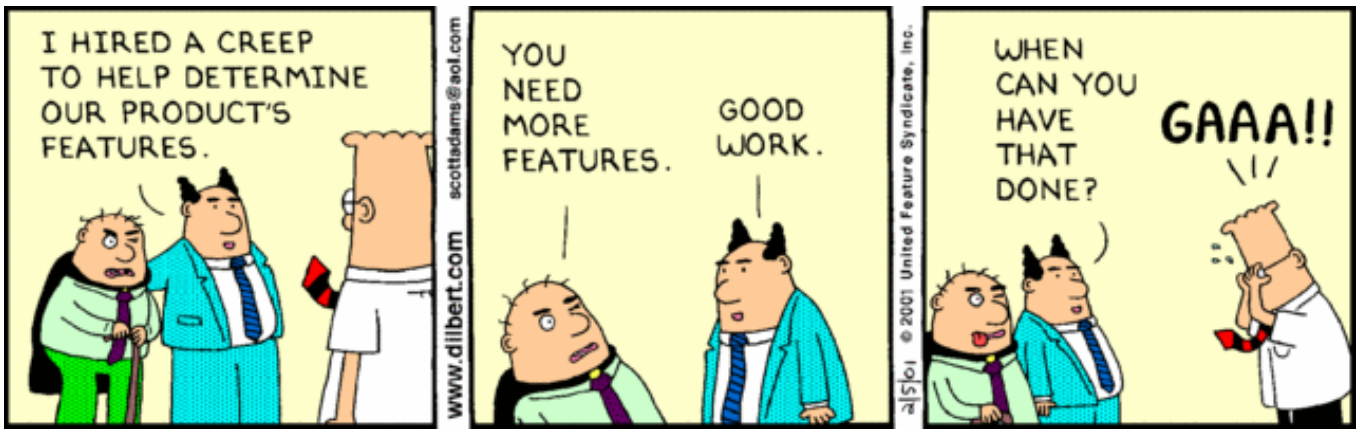

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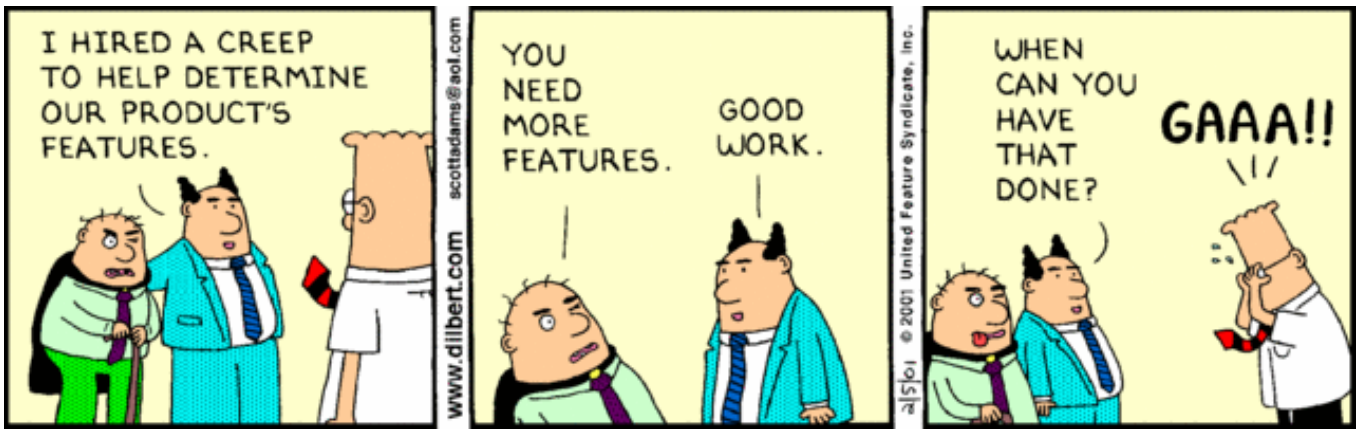

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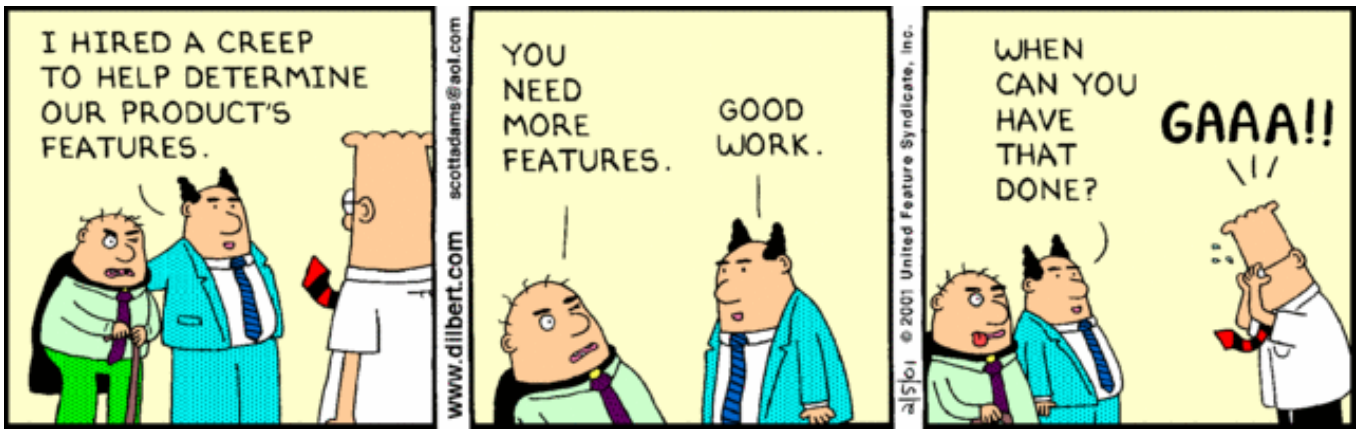

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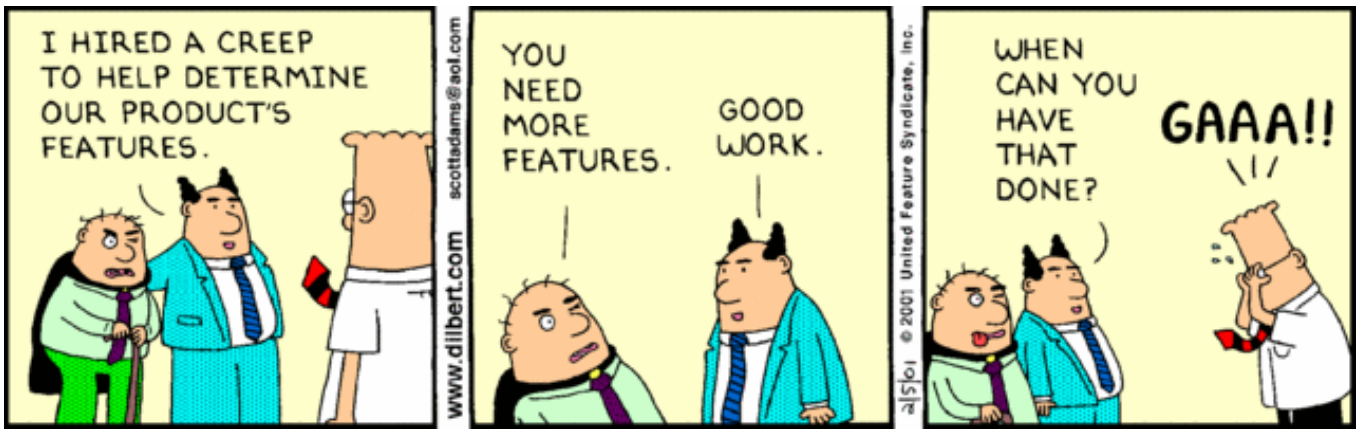
- 2000: C# — Microsoft Java



Bonus Question

- What was the original name of Java before the creators discovered their intended name was already trademarked?

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- Use classes?
  - Plan a known layout of each object's fields and methods
- Use shared libraries?
  - Prepare to pull your hair out

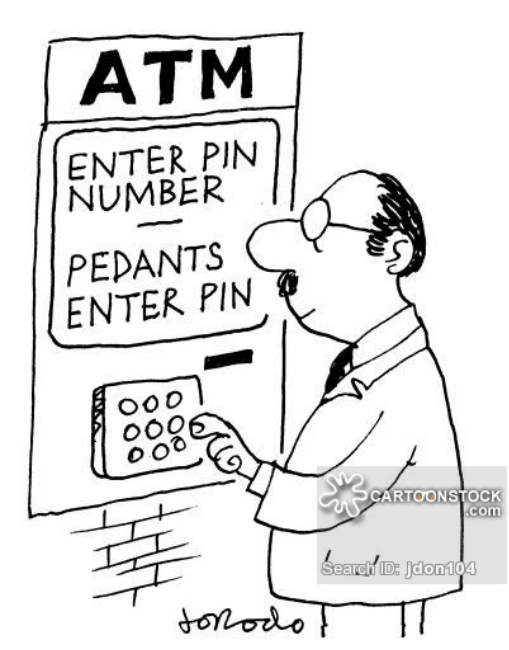
Compilation stages

Front End: Reject all invalid programs!

1. Lexical Analysis
2. Syntax Analysis
3. Semantic Analysis

Back End: Make code out of a valid program!

4. Code Generation
5. Optimization



Lexing

- Break input program into meaningful pieces:
  - Keywords: if, then, else, while, switch, class
  - Variable names: arbitrary strings of characters
  - Constant values: 0,1,2,..., "abc"
  - special characters: {, }, ;, #, //

  - `if (x < 5) { y = 2; }`
    becomes
    if, LPAREN, x, LT, 5, LBRACE, y, EQ, 2, SEMI, RBRACE

Parsing

- Ensure program follows **grammar rules** as defined by the language
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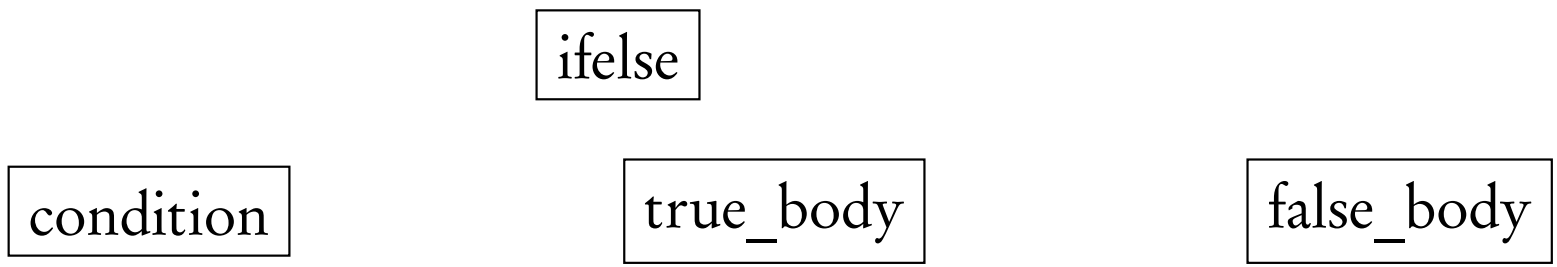

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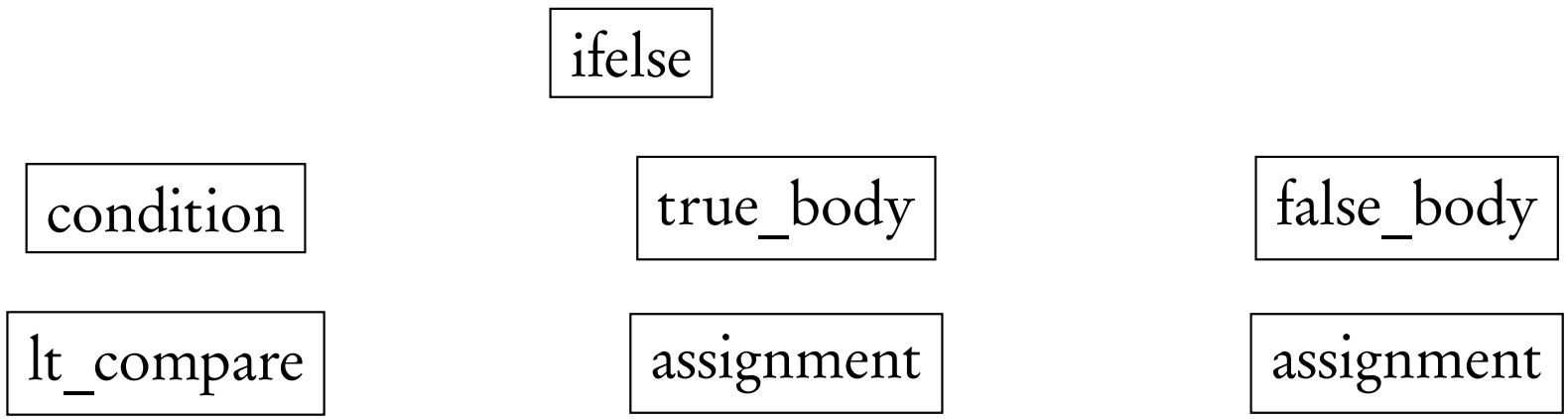

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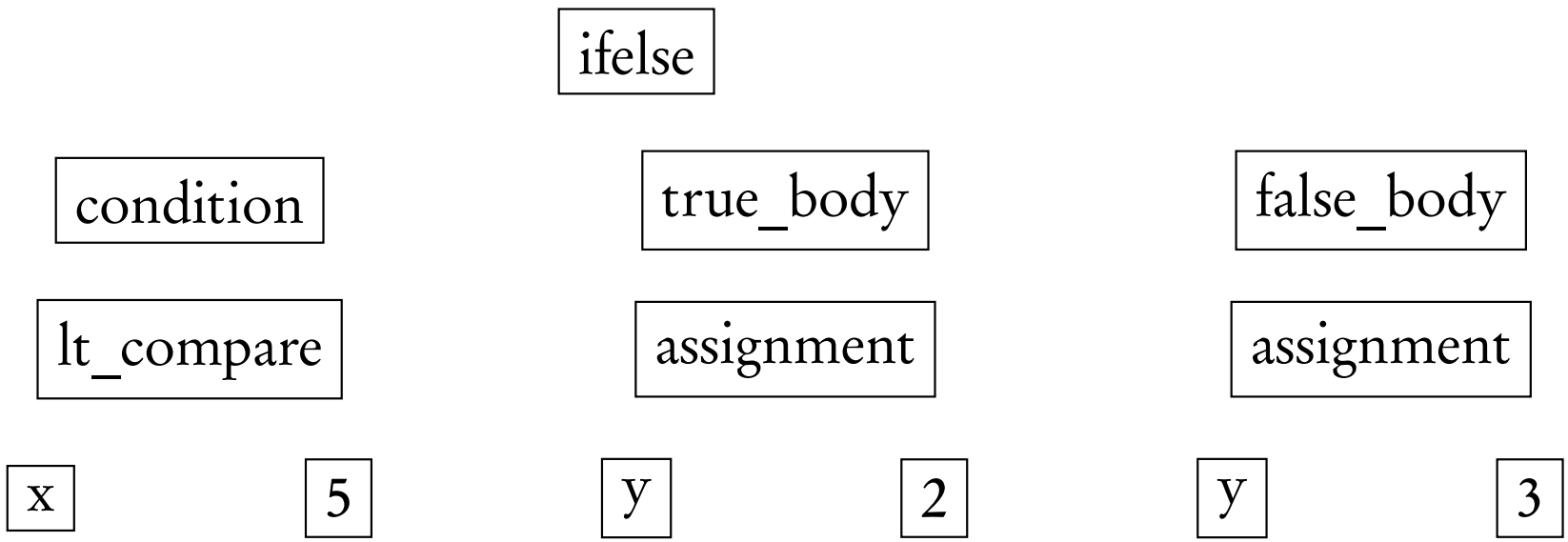

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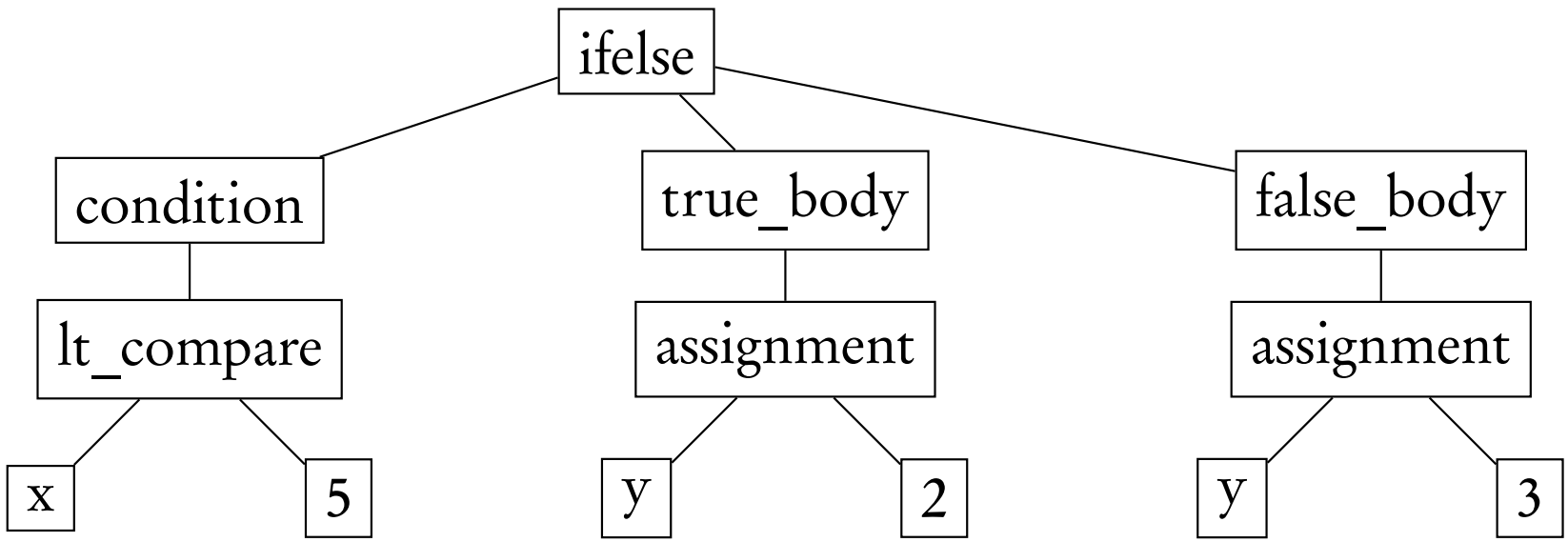
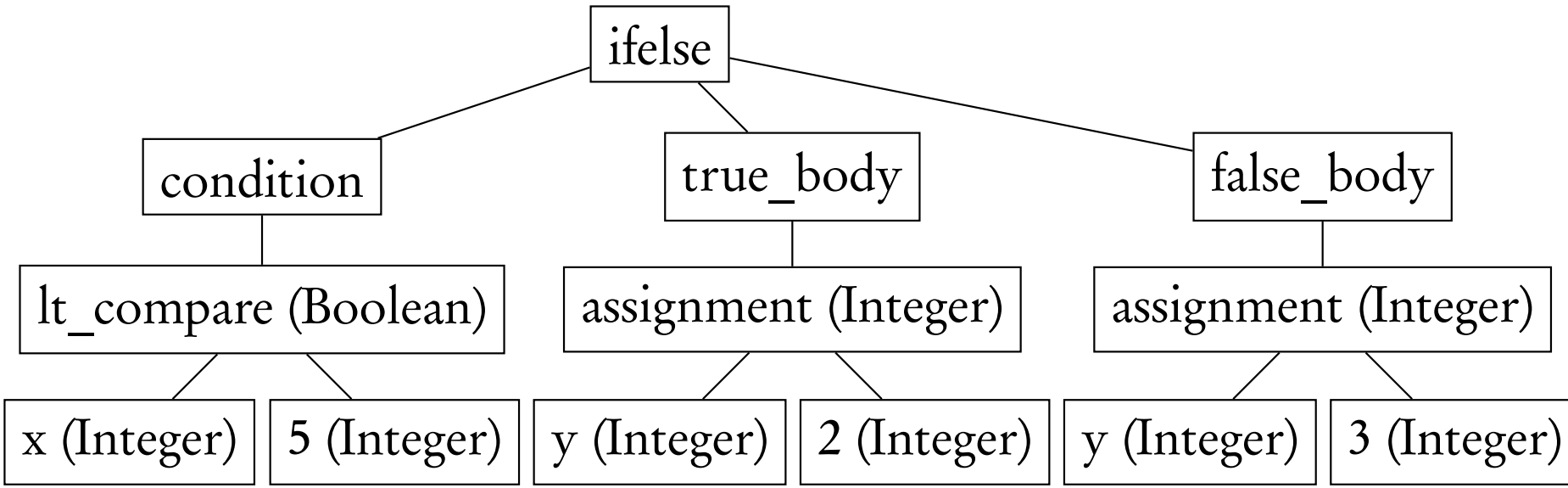


Semantic Analysis

- Annotate AST with type information!



Code Generation

- Traverse AST and generate code for each node!

```
load t0, x      ; need to load x from memory
lt t1, 5        ; check if t1 < 5
bfalse L2       ; if not, skip to else body

; true body
li t1, 2
store t1, y
jmp L2          ; skip over else body

; else body L1:
li t1, 3
store t1, y

L2:
...
```

Optimization

- Repeat after me: **I will not prematurely optimize**
- Your generated code will be insatiably dumb

- `if (x < 5) y = 2; else y = 3;`

```
// return true if x is great
// than or equal to y
bool value_to_return;
if(x > y) {
  value_to_return = true;
}
if(x < y) {
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- `if (x < 5) y = 2; else y = 3;`

- What if you know `x = 2`?
- Skip to the end, just remove it all and keep `y = 2;`

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