EECS 368
Programming Language Paradigms

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Class Information

How to find me

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Office Hours:	2:00-4:00 Wednesdays in Eaton Hall, or by appointment.

About the Class

Time:	10:00-10:50 MWF
Class Web:	Blackboard
Prerequisites:	EECS 268 is a hard prerequisite for this course.

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Class Texts

- Friedman and Felleisen, The Little Schemer, MIT Press, 1995, 4th edition. ISBN: 0262560992
- Hutton, Programming in Haskell, Cambridge University Press, 2007. ISBN: 0521692695
- Many other resources on class website.

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Who is Andy Gill?

- Researcher in the field of programming languages
- Ph.D. from Glasgow University
- Spent 12 years in industry as a compiler engineer
  - Worked on a Java compiler, a C++ compiler, and a Haskell compiler
  - Co-founded a technology startup in Portland, OR
- Moved to Lawrence three years ago
- Want to share my research interest: programming languages

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Back in the 50's

Machine Codes

Programing computer by literally giving the codes to perform operations. Examples are

- moving data (0x37)
- adding data (0x17)
- comparing data (0x28)
- storing data to tape (...)

This was interacting with the machine on its terms, 1s and 0s.

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Using Software Abstractions

Assembly Language

Programing computer by using mnemonics instead of numerical code.
Examples are

- moving data (ld r1,r2)
- adding data (add r1,r2,r3)
- storing data to tape (cmp r1,r2)
- goto to another set of instructions (goto label_44)

This is slightly better.

- A transliteration that is easier for humans to understand/remember.
- Still a one-to-one mapping to machine code.

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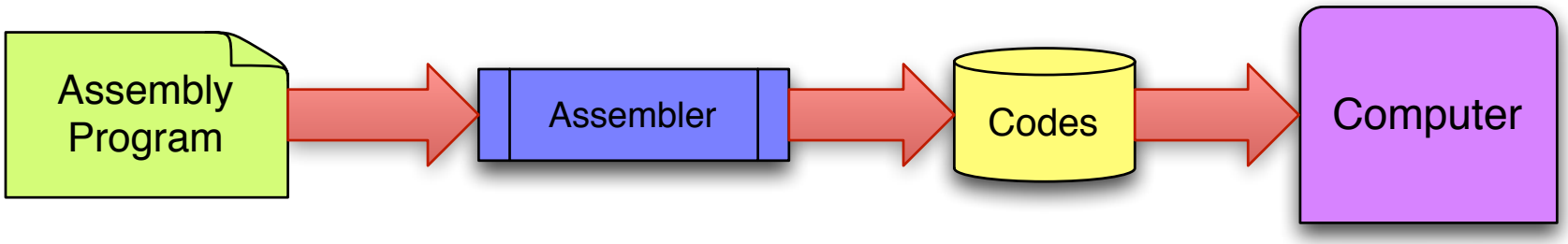
What an Assembler Does



Using Hardware Abstractions

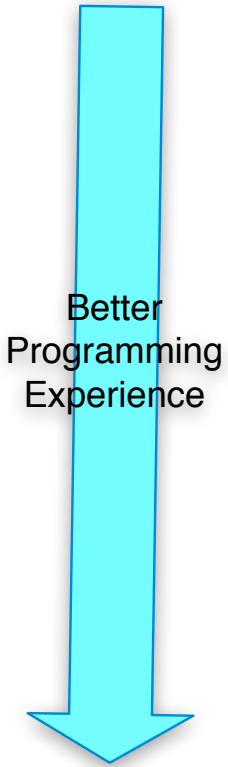
Better Codes

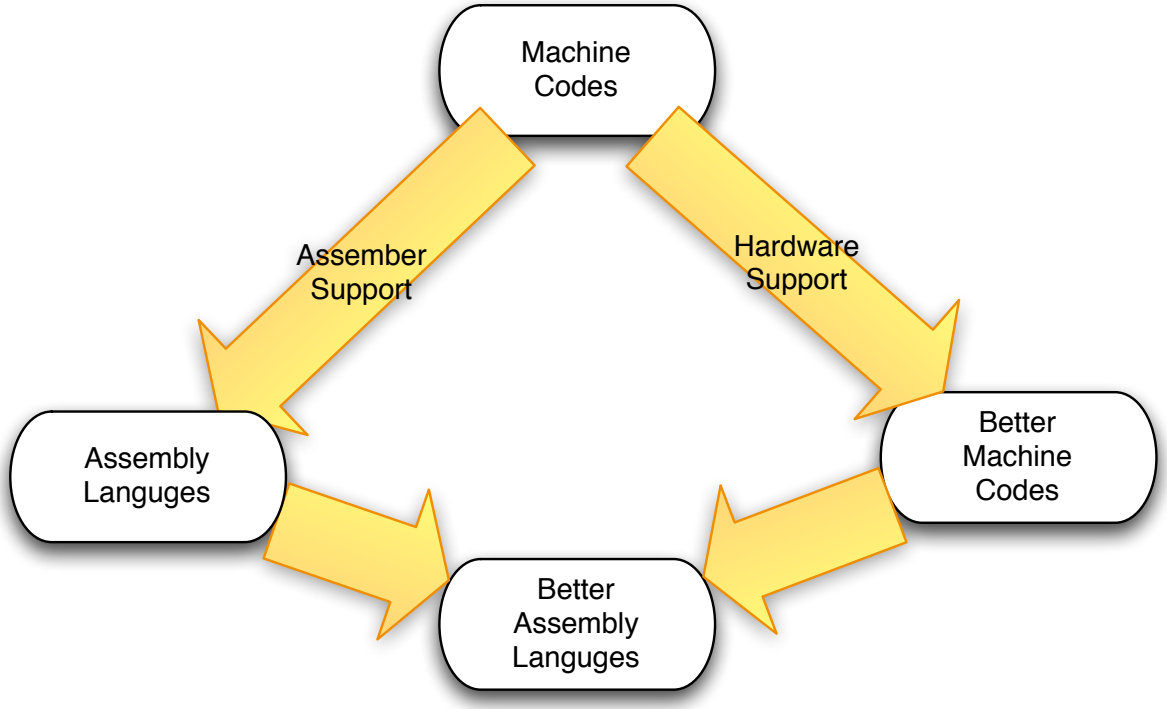
At the same time, the codes provided inside machines became more powerful

- codes for subroutines
- codes for multiplication, division, floating point.
- ...

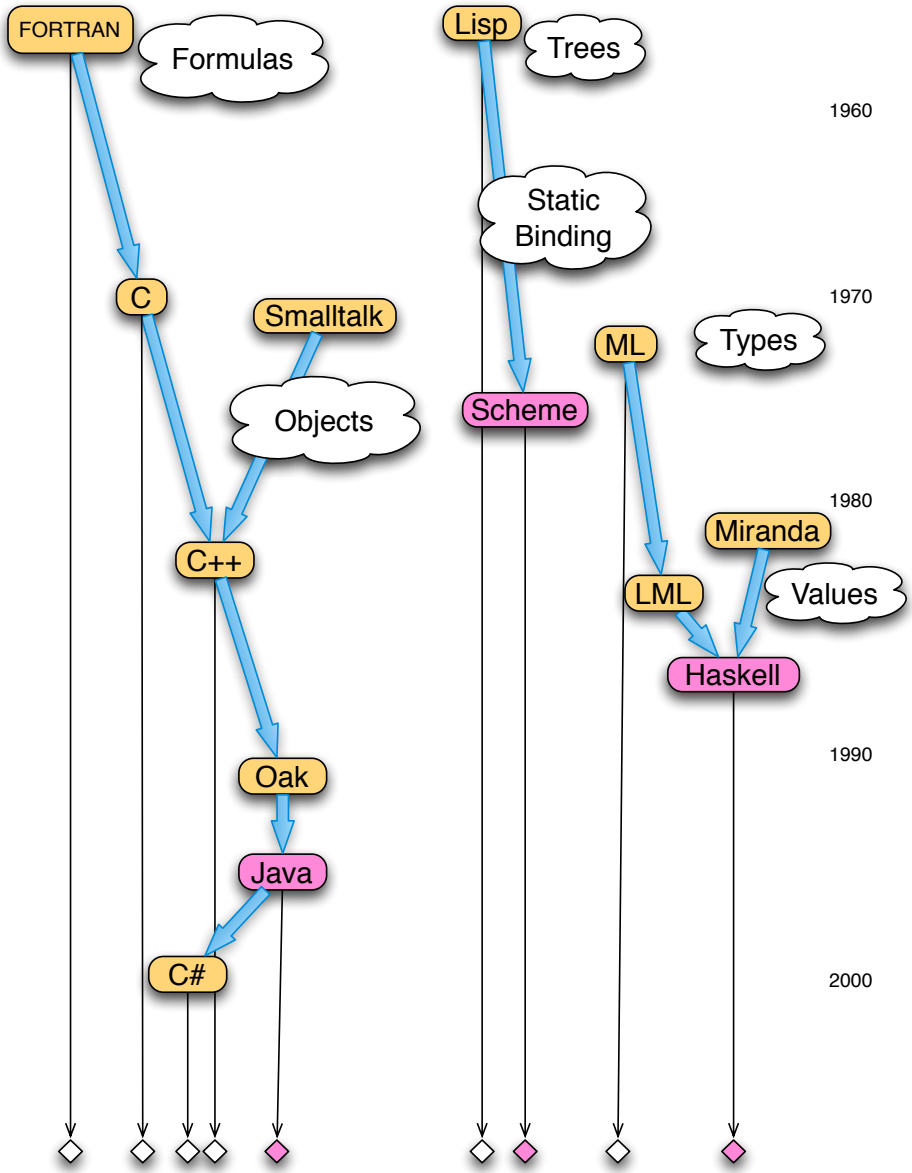
Can do the same operation faster and better.

Narrative of Early Computer Languages





A Short and Edited History of Computer Languages



Other Languages

There are many other idioms and ideas in programming languages.

- Different computational models: Logic languages, SQL, XSLT
- Scripting languages: TCL, Perl, Python
- Web services language: PHP

In this class, we are going to focus on the two main computational models, imperative and functional.

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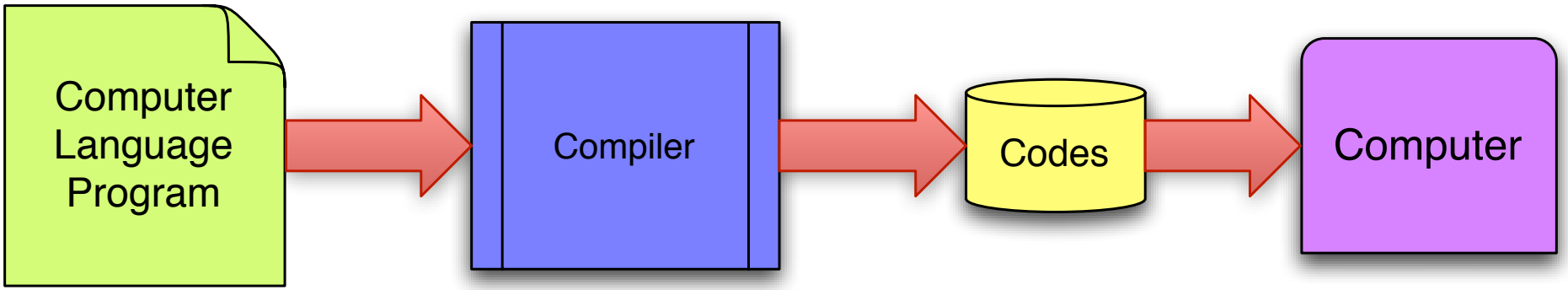
Tools for Understanding Languages

- Syntax - precisely describing what a language is
- Semantics - precisely describing what a language does
  - Static Semantics - what happens at compile time
  - Dynamic Semantics - what happens at runtime



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Syntax for Languages

C++

```
#include <iostream.h>
main()
{
    cout << "Hello World!";
    return 0;
}
```

Java

```
public class HelloWorld {
    public static void main (String[] args) {
        System.out.println ("Hello World!");
    }
}
```

Scheme

```
(display "Hello World!")
(newline)
```

Haskell

```
main :: IO ()
main = putStrLn "Hello World!"
```

Example Syntax Specification

```
expression ::= ( expression )
             |   expression operation expression
             |   number

operation ::= + | - | * | /
number    ::= digit
            | digit number

digit     ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
```

- `expression`, `operation`, `number` and `digit` are non-terminals.
- +, −, 0, 1 are terminals.

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Example of Ambiguity

```
1 + 2 * 3
```

```
(1 + 2) * 3
```

```
1 + (2 * 3)
```

We can pin down exactly what we accept and do not accept for a specific computer language.

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Tools for Understanding Languages (recap)

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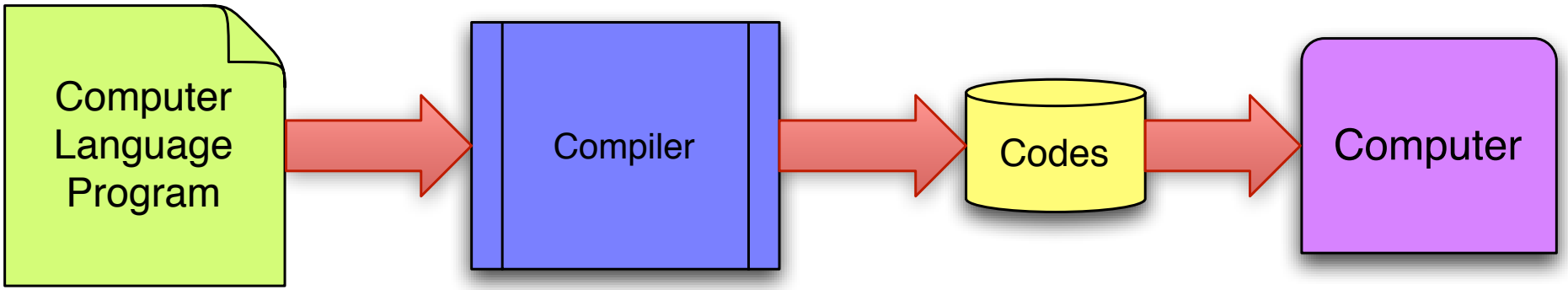
  - Dynamic Semantics - what happens at runtime



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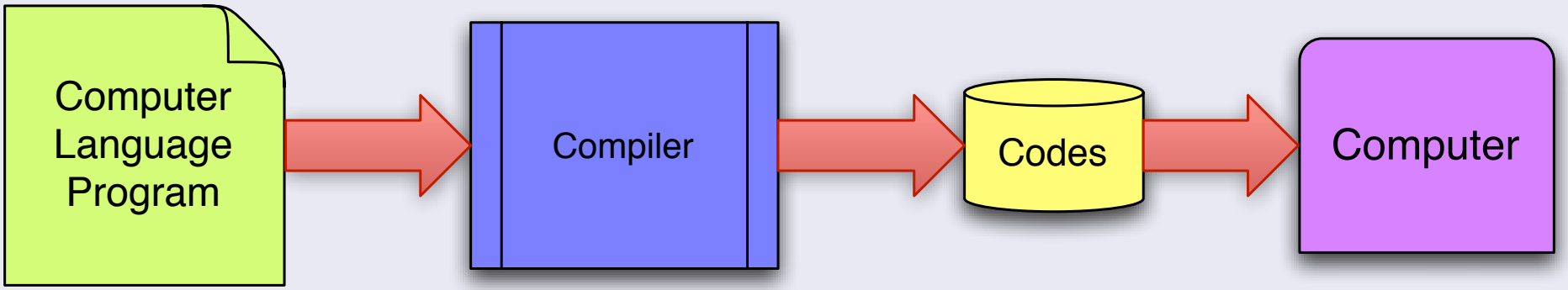
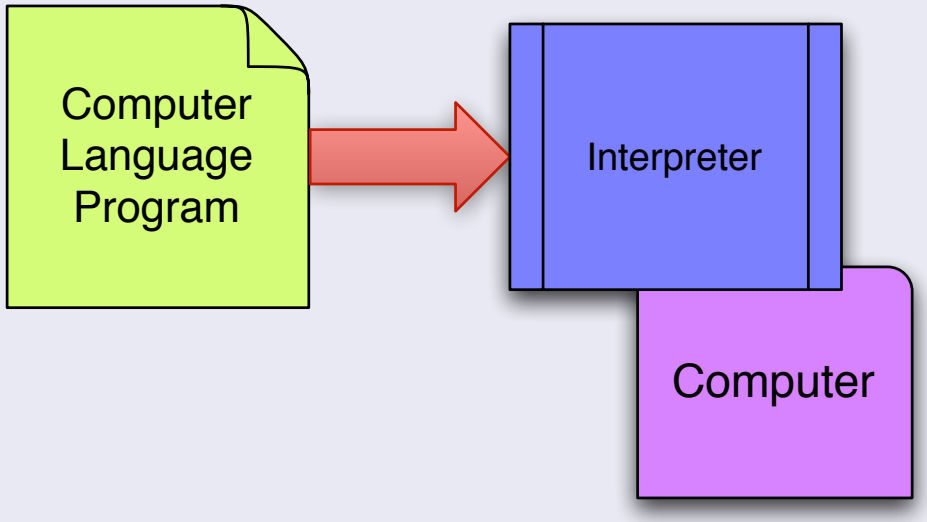
Compiling and Executing Languages

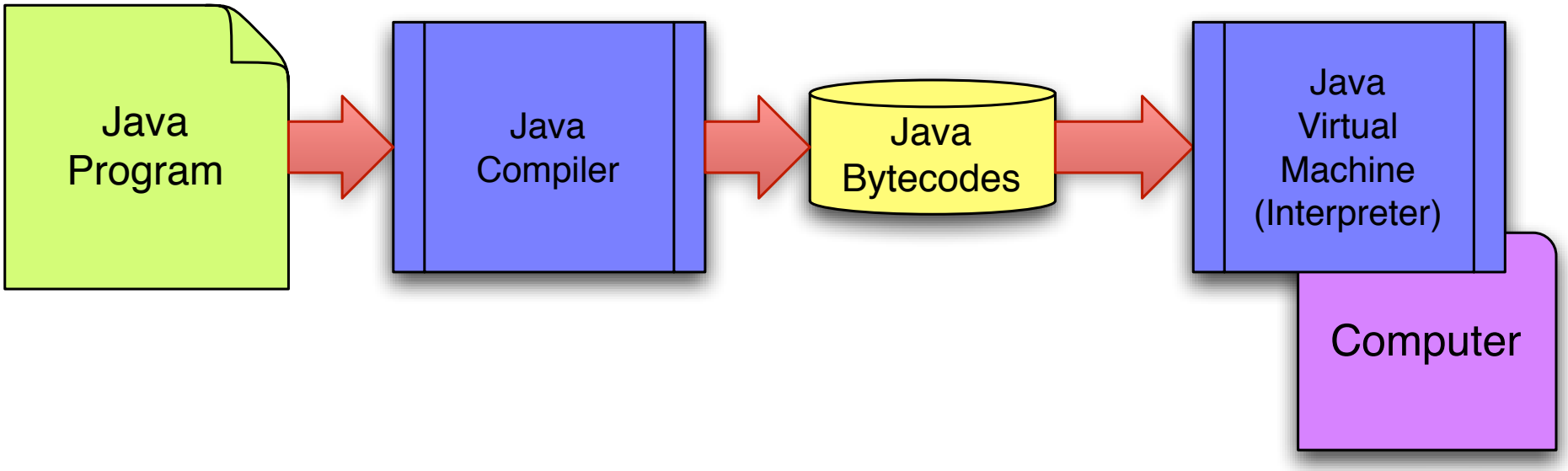
Compiler



Interpreter



Java Compilation and Execution Model




```
$ javac HelloWorld.java
$ ls
-rw-r--r--  1 andy  staff     426 Aug 22 09:29 HelloWorld.class
-rw-r--r--  1 andy  staff     126 Aug 22 09:26 HelloWorld.java
$ java HelloWorld
Hello World!
$
```

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What This Class is About

- Having the tools to be precise about a computer language
- Gaining an understanding and historical context for the major components and tradeoffs
- We are going to do this by looking at three languages is some detail
  - Java
  - Scheme
  - Haskell
- We will look at things like
  - Syntactical choices
  - Program idioms (examples, examples, examples)
  - Execution model

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