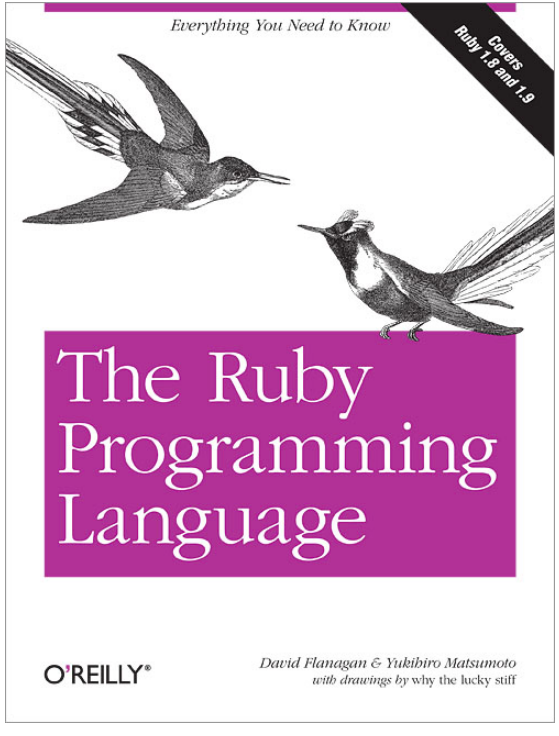
CMSC 330: Organization of Programming Languages

Introduction to Ruby

Ruby

- An *object-oriented, imperative, dynamically typed (scripting) language*
  - Similar to Python, Perl
  - Fully object-oriented
- Created in 1993 by Yukihiro Matsumoto (Matz)
  - "Ruby is designed to make programmers happy"
- Adopted by Ruby on Rails web programming framework in 2005
  - a key to Ruby's popularity



Applications of Scripting Languages

- Scripting languages have many uses
  - Automating system administration
  - Automating user tasks
  - Quick-and-dirty development

- Motivating application

Text processing

Output from Command-Line Tool

```
% wc *
     271     674    5323 AST.c
     100     392    3219 AST.h
     117    1459  238788 AST.o
    1874    5428   47461 AST_defs.c
    1375    6307   53667 AST_defs.h
     371     884    9483 AST_parent.c
     810    2328   24589 AST_print.c
     640    3070   33530 AST_types.h
     285     846    7081 AST_utils.c
      59     274    2154 AST_utils.h
      50     400   28756 AST_utils.o
     866    2757   25873 Makefile
     270     725    5578 Makefile.am
     866    2743   27320 Makefile.in
      38     175    1154 alloca.c
    2035    4516   47721 aloctypes.c
      86     350    3286 aloctypes.h
     104    1051   66848 aloctypes.o

...
```

Ruby is a ~~Scripting~~ Dynamic Language

- Ruby started with special purpose, but has grown into a general-purpose language
- But Ruby has distinctive features when compared to traditional general-purpose languages
  - Such as lightweight syntax, dynamic typing, evaluating code in strings, …
- We will call them scripting languages, still, but also dynamic languages

A Simple Example

- Let's start with a simple Ruby program

ruby1.rb:

```
# This is a ruby program
x = 1
n = 5
while n > 0
  x = x * n
  n = n - 1
end
print(x)
print("\n")
```

```
% ruby -w ruby1.rb
120
```

Interactive Ruby Shell

In addition to running on the command line with ***ruby file.rb***, you can run *interactively*

- irb – **i**nteractive **Ru**b**y** shell

```
% irb
irb(main):001:0> 1+1
=> 2
irb(main):002:0> x = 5
irb(main):003:0> x+x
=> 10
```

Some Ruby Language Features

- Implicit declarations
  - Java, C have explicit declarations
- Dynamic typing
  - Java, C have (mostly) static typing
- Everything is an object
  - No distinction between objects and primitive data
  - Even “null” is an object (called *nil* in Ruby), as are classes
- No outside access to private object state
  - *Must* use getters, setters
- No method overloading
- Class-based and Mixin inheritance

Implicit vs. Explicit Declarations

- In Ruby, variables are implicitly declared

```
x = 37;
y = x + 5
x = ”hello”
```

- Java and C/C++ use explicit variable declarations

```
int x, y;   // declaration
x = 37;   // use
y = x + 5;  // use
```

Tradeoffs?

Explicit Declarations	Implicit Declarations
More text to type	Less text to type
Helps prevent typos	Easy to mistype variable name

```
var = 37
If (rare-condition)
  y = vsr + 5
```

Typo!

Only caught when this line is actually run.

Bug could be latent for quite a while

Static Type Checking (Static Typing)

- Before program is run
  - Types of all expressions are determined
  - Disallowed operations cause compile-time error
    - Cannot run the program

- Static types are often explicit (*aka* manifest)
  - Specified in text (at variable declaration)
    - C, C++, Java, C#
  - But may also be inferred – compiler determines type based on usage
    - OCaml, C#, Rust, and Go (limited)

Dynamic Type Checking

- During program execution
  - Can determine type from run-time value
  - Type is checked before use
  - Disallowed operations cause run-time exception
    - Type errors may be latent in code for a long time
- Dynamic types are *not* manifest
  - Variables are just introduced/used without types
  - Examples
    - **Ruby**, Python, Javascript, Lisp
    - **Note**: Ruby v3 adds support for static types, mixed with its native dynamic ones. We'll discuss this more, later in the course.

Static and Dynamic Typing

- Ruby is dynamically typed, C is statically typed

```ruby
# Ruby
 x = 3
 x = "foo"   # gives x a
             # new type
 x.foo       # NoMethodError
             # at runtime
```

```c
 /* C */
 int x;
 x = 3;
 x = "foo"; /* not allowed */
/* program doesn't compile */
```

Tradeoffs?

Static type checking	Dynamic type checking
More work for programmer (at first)	Less work for programmer (at first)
Catches more (and subtle) errors at compile time	Delays some errors to run time
Precludes some correct programs	Allows more programs (Including ones that will fail)
More efficient code (fewer run-time checks)	Less efficient code (more run-time checks)

Java: *Mostly* Static Typing

- In Java, types are mostly checked statically

```
Object x = new Object();
x.println("hello");   // No such method error at compile time
```

- But sometimes checks occur at run-time

```
Object o = new Object();
String s = (String) o;  // No compiler warning, fails at run time
// (Some Java compilers may be smart enough to warn about above cast)
```

Quiz 1: Get out your clickers!

- True or false: This program has a type error

```
# Ruby
x = "hello"
y = 2.5
y = x
```

A. True

B. False

Quiz 1: Get out your clickers!

- True or false: This program has a type error

```
# Ruby
x = "hello"
y = 2.5
y = x
```

A. True

B. **False**

Quiz 2

- True or false: This program has a type error

```
/* C */
void foo() {
  int a = 10;
  char *b = "hello";
  a = b;
}
```

A. True

B. False

Quiz 2

- True or false: This program has a type error

```
/* C */
void foo() {
  int a = 10;
  char *b = "hello";
  a = b;
}
```

A. **True**

B. False

Control Statements in Ruby

- A control statement is one that affects which instruction is executed next
  - While loops
  - Conditionals

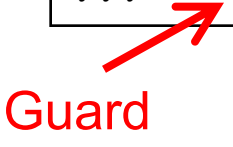
```
i = 0
while i < n
  i = i + 1
end
```

```
if grade >= 90 then
  puts "You got an A"
elsif grade >= 80 then
  puts "You got a B"
else
  puts "You're not doing so well"
end
```

What is True?

- The guard of a conditional is the expression that determines which branch is taken

```
if grade >= 90 then
...
```



- True: anything except
  - false
  - nil
- Warning to C programmers: **0 is not false!**

Quiz 3: What is the output?

```
x = 0
if x then
  puts "true"
elsif x == 0 then
  puts "== 0"
else
  puts "false"
end
```

A. Nothing – there's an error
B. "false"
C. "== 0"
D. "true"

Quiz 3: What is the output?

```
x = 0
if x then
  puts "true"
elsif x == 0 then
  puts "== 0"
else
  puts "false"
end
```

A. Nothing – there's an error
B. "false"
C. "== 0"
D. "true"

x is neither **false** nor **nil** so the first guard is satisfied