The plan

- Lecture materials may not recount every little language feature we use
  - Thomas book (2nd edition, Chapters 1-9) quite readable
  - Can skip/skim regexps and ranges
  - Also see online library documentation [large, searchable]
- Focus in class will be on OOP, dynamic typing, blocks, mixins

Logistics

- We will use Ruby 2.2.3
  - Installed on the Lab machines
  - In any case, use a version 2 of some kind (unit tests are different in 1.8.7)
  - Assignment 7 requires the tk graphics library
- Installation instructions, etc. on course web page
  - Can run programs with a REPL called irb
- Assignment 7 is a Ruby warmup exercise (extensions to tetris);
  Assignment 8 is the Ruby project

A Bit of History

- Some notable examples of early object-oriented languages and systems:
  - First object-oriented programming language: Simula I, then Simula 67, created by Ole-Johan Dahl and Kristen Nygaard at the Norwegian Computing Center in Oslo.
  - Smalltalk: developed at Xerox Palo Alto Research Center by the Learning Research Group in the 1970's (Smalltalk-72, Smalltalk-76, Smalltalk-80)
  - Today: mature language paradigm. Some significant examples: C++, Java, C#, Python, Ruby

Ruby

- Pure object-oriented: all values are objects (even numbers)
- Class-based: Every object has a class that determines behavior
  - Like Java, unlike Javascript
  - Mixins (neither Java interfaces nor C++ multiple inheritance)
- Dynamically typed
- Convenient reflection: Run-time inspection of objects
- Blocks and libraries encourage lots of closure idioms
- Syntax and scoping rules of a "scripting language"
  - Often many ways to say the same thing
  - Variables "spring to life" on use
  - Lots of support for string manipulation [we won't do this]
- Popular for building server-side web applications (Ruby on Rails)

Where Ruby fits

<table>
<thead>
<tr>
<th></th>
<th>functional</th>
<th>dynamically typed</th>
<th>statically typed</th>
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</thead>
<tbody>
<tr>
<td>object-oriented</td>
<td>Ruby</td>
<td></td>
<td>Java</td>
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<td></td>
<td>Racket</td>
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Historical note: Smalltalk also a dynamically typed, class-based, pure OOP language with blocks and convenient reflection
- Smaller just-as-powerful language
- Contrast Ruby’s "why not add that" attitude
- Ruby less elegant, more widely used

Dynamically typed OO helps identify OO’s essence by not having to discuss types
Defining a class

(For full code details and various expression constructs, see PosRational.rb)

Class PosRational
  # no instance variable (field) decls
  # just assign to $squid to create field
  squid
  def initialize (num,den=1)
    @num = num
    @den = den
  end
  def to_s ...
  end
  def add r ...
  end
end

Using a class

• ClassName.new(args) creates a new instance of ClassName and calls its initialize method with args
• Every variable holds an object (possibly the nil object)
  − Local variables (in a method) $squid
  − Instance variables (fields) @squid
  − Class variables (static fields) @@squid
• You use an object with a method call
  − Also known as a message send
  − Every object has a class, which determines its behavior
• Examples: x.m 4 x.m.m2 (y.m3) -42.abs
  − m and m(...) are sugar for self.m and self.m(...)
  − a1 + a2 is sugar for a1.+(a2) (really!)

Method / variable visibility

• private: only available to object itself
• protected: available only to code in the class or subclasses
• public: available to all code

This is different than what the words mean in Java

• All instance variables and class variables are private
• Methods are public by default
  − There are multiple ways to change a method's visibility

Some syntax / scoping gotchas

• You create variables (including instance variables) implicitly by assigning to them
  − So a misspelling just creates a new variable
  − Different instances of a class could have different fields
• Newlines matter
  − Often need more syntax to put something on one line
  − Indentation is only style (not true in some languages)
• Class names must be capitalized
• Message sends with 0 or 1 argument don't need parentheses
• self is a special keyword (Java's this)

Getters and setters

• If you want outside access to get/set instance variables, must define methods

  def squid
  end

  def squid= a
    @squid = a
  end

  x.squid = 42

• The squid= convention allows sugar via extra spaces when using the method

  x.squid = x.squid = 42

• Shorter syntax for defining getters and setters is:

  attr_reader :squid
  attr_writer :squid

• Overall, requiring getters and setters is more uniform and more OO
  − Can change the methods later without changing clients
  − Particular form of change is subclass overriding (next lecture)

Top-level

• Expressions at top-level are evaluated in the context of an implicit "main" object with class Object
• That is how a standalone program would "get started" rather than requiring an object creation and method call from within irb
• Top-level methods are added to Object, which makes them available everywhere
Class definitions are dynamic

- All definitions in Ruby are dynamic.
- Example: Any code can add or remove methods on existing classes.
  - Very occasionally useful (or cute) to add your own method to the Array class for example, but it is visible to all arrays.
- Changing a class affects even already-created instances.
- Disasterous example: Changing Fixnum's + method.
- Overall: A simple language definition where everything can be changed and method lookup uses instance's classes.

Duck Typing

"If it walks like a duck and quacks like a duck, it's a duck"  
- Or don't worry that it may not be a duck.

When writing a method you might think, "I need a Toad argument" but really you need an object with enough methods similar to Toad's methods that your method works.

- Embracing duck typing is always making method calls rather than assuming/testing the class of arguments.

Plus: More code reuse; very OO approach.

- What messages an object receive is all that matters.

Minus: Almost nothing is equivalent.

- x*x versus x*2 versus 2*x.

- Callers may assume a lot about how callees are implemented.

Duck Typing Example

```ruby
def mirror_update pt
  pt.x = pt.x * (-1)
end
```

- Natural thought: "Takes a Point object (definition not shown here), negates the x value".  
  - Makes sense, though a Point instance method more OO.
- Closer: "Takes anything with getter and setter methods for @x instance variable and multiplies the x field by -1".
- Closer: "Takes anything with methods @x and x and calls @x with the result of multiplying result of @x and -1".
- Duck typing: "Takes anything with method @x and x where result of @x has a * method that can take -1. Sends result of calling x the * message with -1 and sends that result to @x".