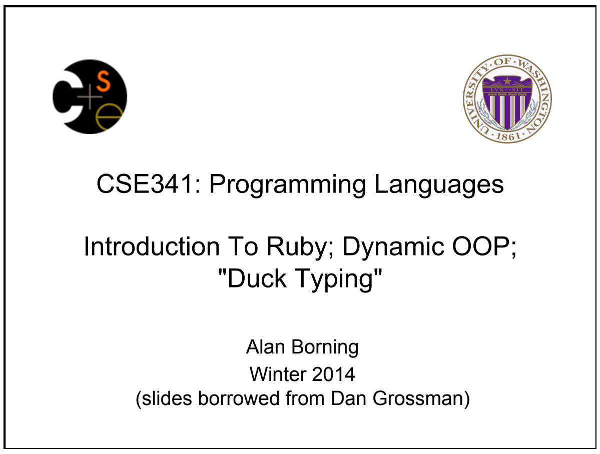

CSE341: Programming Languages

Introduction To Ruby; Dynamic OOP; "Duck Typing"

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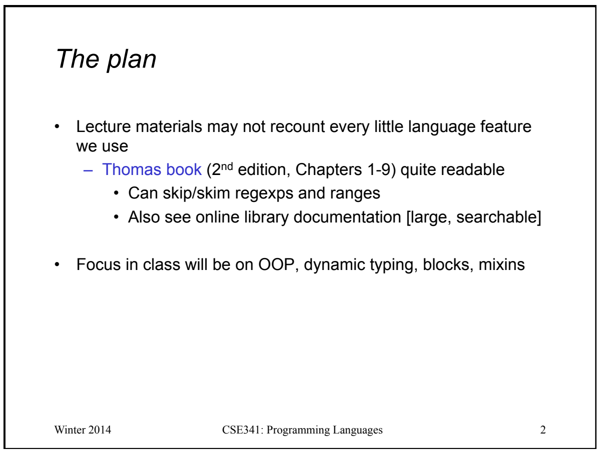
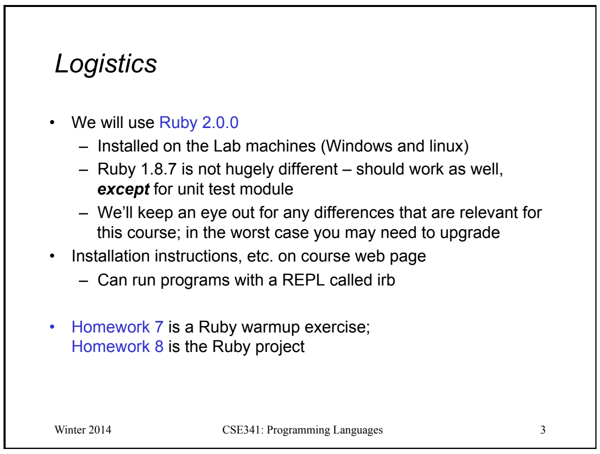
(slides borrowed from Dan Grossman)



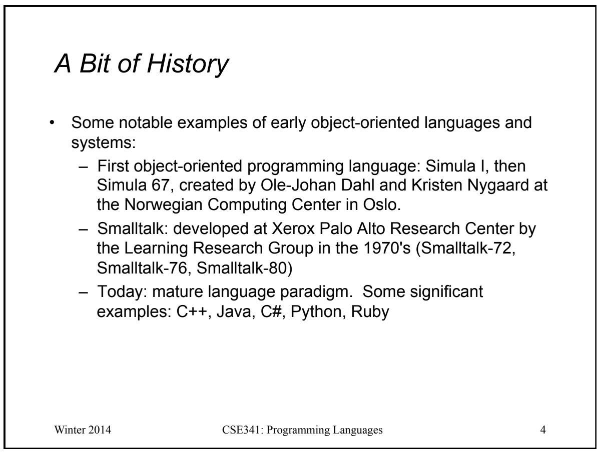
The plan

- 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



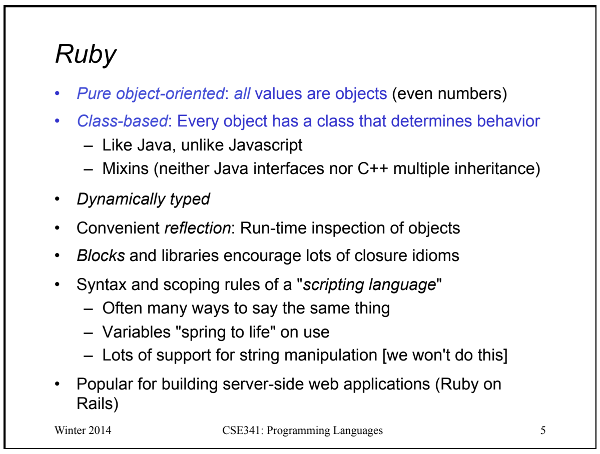
Logistics

- We will use Ruby 2.0.0
  - Installed on the Lab machines (Windows and linux)
  - Ruby 1.8.7 is not hugely different – should work as well, ***except*** for unit test module
  - We'll keep an eye out for any differences that are relevant for this course; in the worst case you may need to upgrade
- Installation instructions, etc. on course web page
  - Can run programs with a REPL called irb
- Homework 7 is a Ruby warmup exercise;
  Homework 8 is the Ruby project



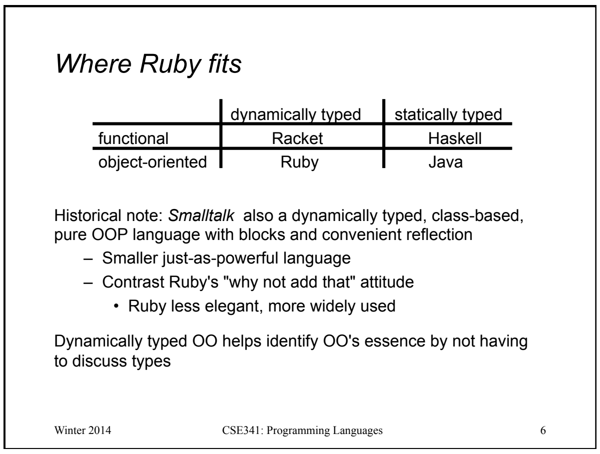
A Bit of History

- 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

	dynamically typed	statically typed
functional	Racket	Haskell
object-oriented	Ruby	Java

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 @foo to create field foo
  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) `foo`
  - Instance variables (fields) `@foo`
  - Class variables (static fields) `@@foo`
- 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.m1.m2(y.m3)`   `-42.abs`
  - `m` and `m(…)` are sugar for `self.m` and `self.m(…)`
  - `e1 + e2` is sugar for `e1.+(e2)` (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 foo
  @foo
end
```

```
def foo= a
  @foo = a
end
```

- The `foo=` convention allows sugar via extra spaces when using the method

`x.foo`   `x.foo = 42`

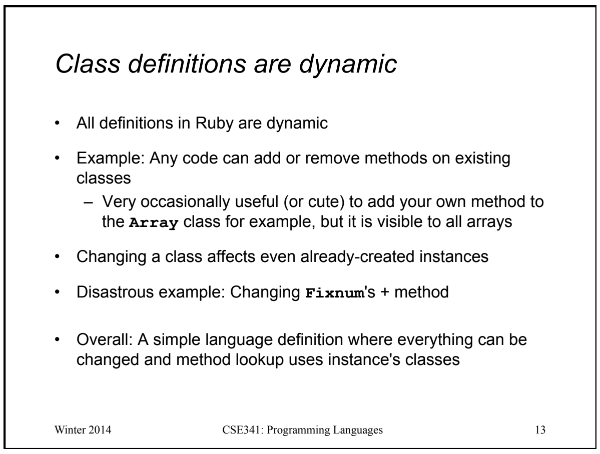
- Shorter syntax for *defining* getters and setters is:

`attr_reader :foo`   `attr_writer :foo`

- 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]

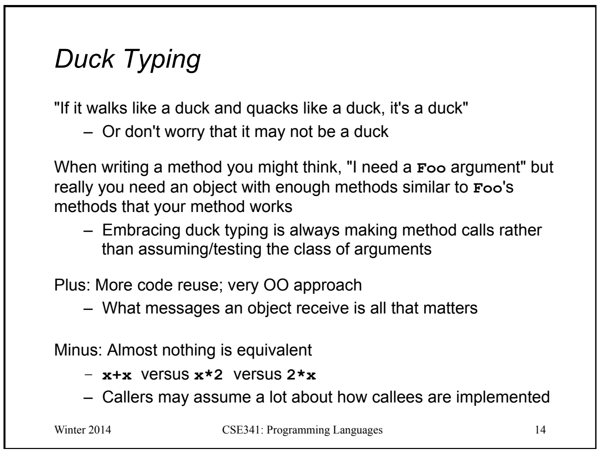
Top-level

- 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
- Disastrous 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 **`Foo`** argument" but really you need an object with enough methods similar to **`Foo`**'s methods that your method works

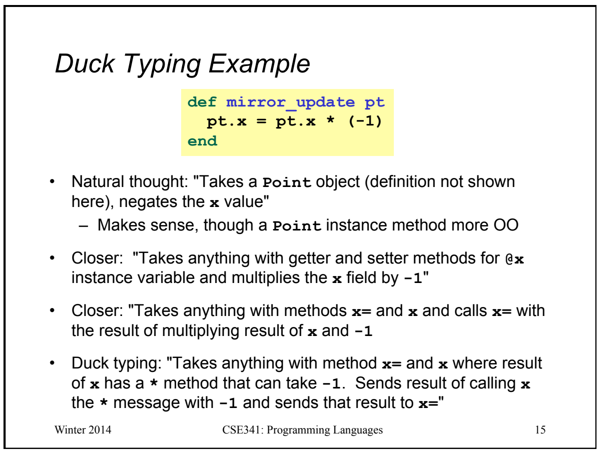
- Embracing duck typing is always making method calls rather than assuming/testing the class of arguments

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

```
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=`**"