Adapted from slides by Nick Shahan, Cody Schroeder, and Dan Grossman
Today’s Agenda

• Double Dispatch Again
• Mixins
• The Visitor Pattern
Dispatch Overview

Dispatch is the *runtime* procedure for looking up which function to call based on the parameters given:

• Ruby (and Java) use *Single Dispatch* on the implicit `self` parameter
  • Uses runtime class of `self` to lookup the method when a call is made
  • This is what you learned in CSE 143

• *Double Dispatch* uses the runtime classes of both `self` and a single method parameter
  • Ruby/Java do not have this, but we can emulate it
  • This is what you will do in HW7

• You can dispatch on any number of the parameters and the general term for this is *Multiple Dispatch* or *Multimethods*
Emulating Double Dispatch

• To emulate double dispatch in Ruby (on HW7) just use the built-in single dispatch procedure *twice*!
  • Have the principal method immediately call another method on its *first parameter*, passing `self` as an argument
  • The second call will implicitly know the class of the `self` parameter
  • It will also know the class of the *first parameter* of the principal method, because of *Single Dispatch*

• There are other ways to emulate double dispatch
  • Found as an idiom in SML by using case expressions
class A
  def f x
    x.fWithA self
    end
  def fWithA a
    "(a, a) case"
    end
  def fWithB b
    "(b, a) case"
    end
  end

class B
  def f x
    x.fWithB self
    end
  def fWithA a
    "(a, b) case"
    end
  def fWithB b
    "(b, b) case"
    end
  end
Double Dispatch Practice

• Write program to play Rock-Paper-Scissors

• Classes Rock, Paper, Scissors

• Want to have a method `fight(other)` in each that tells whether `self` or `other` won

• Use double dispatch!
Mixins

• A mixin is (just) a collection of methods
  • Less than a class: no instances of it
• Languages with mixins (e.g., Ruby modules) typically let a class have one superclass but include any number of mixins

• Semantics: Including a mixin makes its methods part of the class
  • Extending or overriding in the order mixins are included in the class definition
  • More powerful than helper methods because mixin methods can access methods (and instance variables) on self not defined in the mixin
Mixin Example

```ruby
module Doubler
  def double
    self + self # assume included in classes w/ +
  end
end
class String
  include Doubler
end
class AnotherPt
  attr_accessor :x, :y
  include Doubler
  def + other
    ans = AnotherPt.new
    ans.x = self.x + other.x
    ans.y = self.y + other.y
    ans
  end
end
```
Method Lookup Rules

Mixins change our lookup rules slightly:

• When looking for receiver obj's method m, look in obj's class, then mixins that class includes (later includes shadow), then obj's superclass, then the superclass' mixins, etc.

• As for instance variables, the mixin methods are included in the same object
  • So usually bad style for mixin methods to use instance variables since names can clash
The Two Big Ones

The two most popular/useful mixins in Ruby:

• Comparable: Defines $<$, $>$, $==$, $!=$, $\geq$, $\leq$ in terms of $\leq$, $\geq$
  • [http://ruby-doc.org/core-2.2.3/Comparable.html](http://ruby-doc.org/core-2.2.3/Comparable.html)

• Enumerable: Defines many iterators (e.g., map, find) in terms of each
  • [http://ruby-doc.org/core-2.2.3/Enumerable.html](http://ruby-doc.org/core-2.2.3/Enumerable.html)

• Great examples of using mixins:
  • Classes including them get a bunch of methods for just a little work
  • Classes do not “spend” their “one superclass” for this
  • Does not bring on the complexity of multiple inheritance
Mixin practice

• Implement Comparable on a simple Name class with fields for first and last name

• Implement Enumerable on a binary tree class
The Visitor Pattern

- A template for handling a functional composition in OOP
  - OOP wants to group code by classes
  - We want code grouped by functions
    - This makes it easier to add operations at a later time.
- Relies on Double Dispatch!!!
  - Dispatch based on (VisitorType, ValueType) pairs.
- Often used to compute over AST’s (abstract syntax trees)
  - Heavily used in compilers