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 (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

Double Dispatch Example
```
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
```

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

```
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 <, >=, !=, == in terms of <=>
  • 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
• 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

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 ASTs (abstract syntax trees)
  • Heavily used in compilers