



PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

CSE 341

Section 9

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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

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 AST's (abstract syntax trees)
 - Heavily used in compilers