PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

CSE 341
Section 9

Fall 2018

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Today’s Agenda

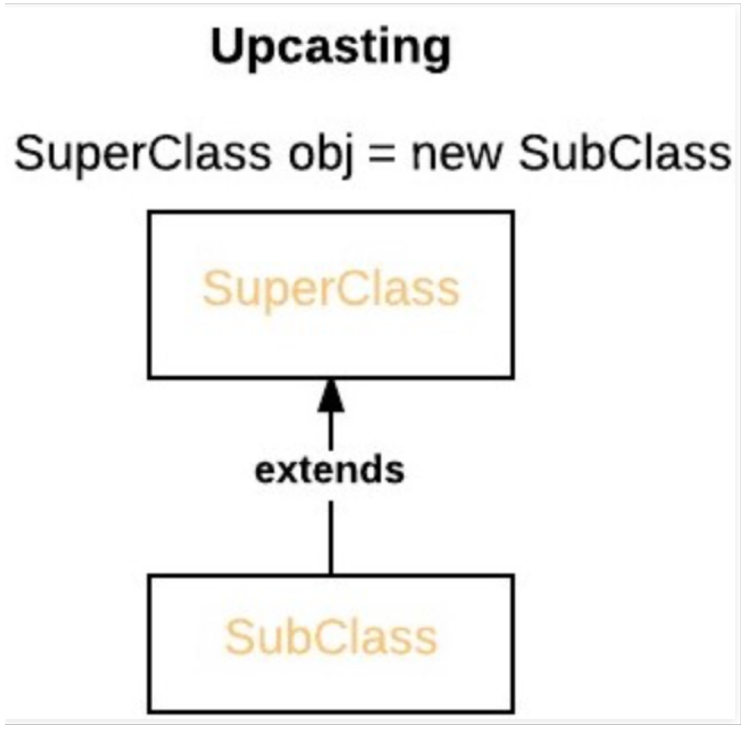
- Double Dispatch Again
- Mixins
- The Visitor Pattern

Dispatch Overview

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

```
class SuperClass {
   protected void m1() { a; }
}
class SubClass {
   protected void m1() { b; }
}

SuperClass obj = new SubClass();
obj.m1();
// runtime figures out obj's dynamic type
// and which instance method to call
```



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
    - Review Ruby method lookup in lecture 21 slides p#5
- *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 (not OOP style)

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
```

Method Lookup Rules

Mixins change our lookup rules slightly:

obj.m()

- 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

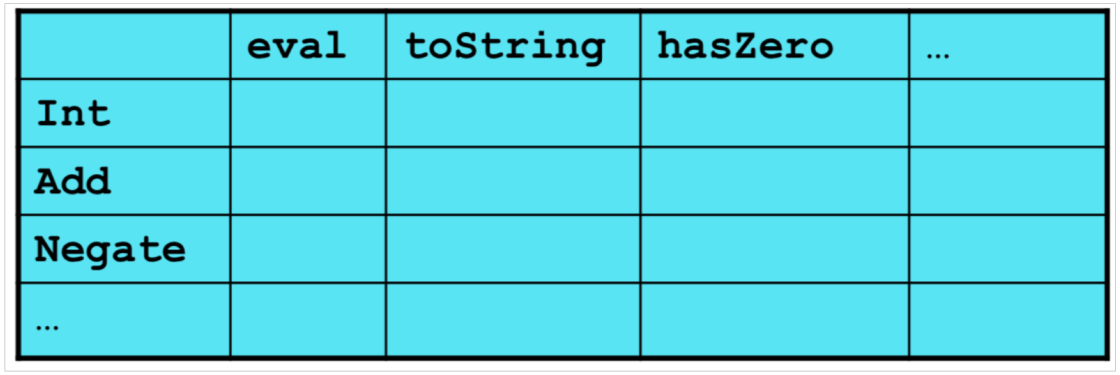
The two most popular/useful mixins in Ruby:

- 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

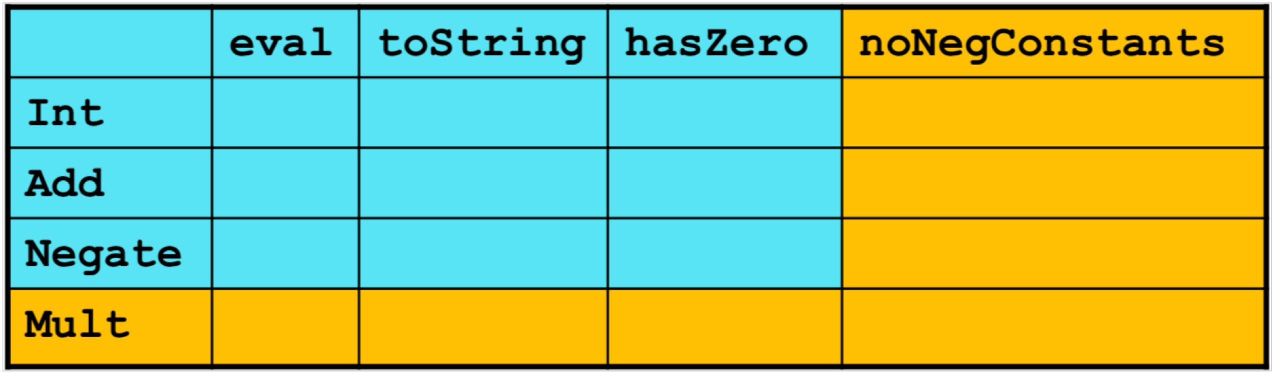
The Visitor Pattern

- 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

Extensibility



	eval	toString	hasZero	…
Int				
Add				
Negate				
…				



	eval	toString	hasZero	noNegConstants
Int				
Add				
Negate				
Mult				

- the Visitor Pattern makes OOP programs more easily extensible with new functionality
  - In class Mult : accept method
  - In visitor classes: + 1 method/class to deal with Mult
  - No need to change the existing class Int, Add or Negate