Today’s Agenda

• Double Dispatch Again
• The Visitor Pattern
• Mixins
Double Dispatch
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` (or “this”) 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: RPS

- Suppose we wanted to code up a game of “Rock-Paper-Scissors”:
  - A game that is played in rounds with 2 players.
  - Each player gets to pick a weapon: one of “Rock”, “Paper”, or “Scissors”.
- Each combination results in a winner/loser (except when both are the same):
  - Rock beats Scissors
  - Paper beats Rock
  - Scissors beats Paper
Double Dispatch Example: RPS

- What are the different combinations of games?
  - Player 1 fights Player 2 with a tool, and Player 2 responds, which determines the outcome.

<table>
<thead>
<tr>
<th></th>
<th>Rock</th>
<th>Paper</th>
<th>Scissors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock</td>
<td>Tie</td>
<td>Paper wins</td>
<td>Rock wins</td>
</tr>
<tr>
<td>Paper</td>
<td>Paper wins</td>
<td>Tie</td>
<td>Scissor wins</td>
</tr>
<tr>
<td>Scissors</td>
<td>Rock wins</td>
<td>Scissor wins</td>
<td>Tie</td>
</tr>
</tbody>
</table>
Double Dispatch Example: RPS

- How could we represent this in an OOP way?
  - How does “Class 1” fight “Class 2”? How do we encode the “tool”? How do we encode the “outcome”?

<table>
<thead>
<tr>
<th></th>
<th>Rock</th>
<th>Paper</th>
<th>Scissors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock</td>
<td>Tie</td>
<td>Paper wins</td>
<td>Rock wins</td>
</tr>
<tr>
<td>Paper</td>
<td>Paper wins</td>
<td>Tie</td>
<td>Scissor wins</td>
</tr>
<tr>
<td>Scissors</td>
<td>Rock wins</td>
<td>Scissor wins</td>
<td>Tie</td>
</tr>
</tbody>
</table>
Double Dispatch
Example: RPS
Code!
Double Dispatch Exercise: What’s the table? (hint, it’s 2x2)

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 Exercise: What’s the table?**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>(a,a) case</td>
<td>(b,a) case</td>
</tr>
<tr>
<td>B</td>
<td>(a,b) case</td>
<td>(b,b) case</td>
</tr>
</tbody>
</table>

Class 1
Extending RPS I

- What if we wanted to extend our game to add an action to convert each of the tools to strings?
  - What would we have to change so that we could still play this game, but with another action?

<table>
<thead>
<tr>
<th></th>
<th>Rock</th>
<th>Paper</th>
<th>Scissors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock</td>
<td>Tie</td>
<td>Paper wins</td>
<td>Rock wins</td>
</tr>
<tr>
<td>Paper</td>
<td>Paper wins</td>
<td>Tie</td>
<td>Scissor wins</td>
</tr>
<tr>
<td>Scissors</td>
<td>Rock wins</td>
<td>Scissor wins</td>
<td>Tie</td>
</tr>
<tr>
<td>toString*</td>
<td>Rock</td>
<td>Paper</td>
<td>Scissors</td>
</tr>
</tbody>
</table>

* note: not a Class, but a method, because it only operates on 1 class, not 2.
The Visitor Pattern
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
Visitor Example: RPS

Code!
Extending RPS II

- What if we wanted to extend our game to add a new tool: Laser?
  - What would we have to change so that we could still play this game, but with 4 tools instead of 3?

<table>
<thead>
<tr>
<th></th>
<th>Rock</th>
<th>Paper</th>
<th>Scissors</th>
<th>Laser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock</td>
<td>Tie</td>
<td>Paper wins</td>
<td>Rock wins</td>
<td>Laser wins</td>
</tr>
<tr>
<td>Paper</td>
<td>Paper wins</td>
<td>Tie</td>
<td>Scissor wins</td>
<td>Laser wins</td>
</tr>
<tr>
<td>Scissors</td>
<td>Rock wins</td>
<td>Scissor wins</td>
<td>Tie</td>
<td>Laser wins</td>
</tr>
<tr>
<td>Laser</td>
<td>Laser wins</td>
<td>Laser wins</td>
<td>Laser wins</td>
<td>Tie</td>
</tr>
</tbody>
</table>
Have to do it the hard way... :( 

Is functional better?
Mixins

• Collection of methods
  • Unlike class, you cannot instantiate it

• Can include any number of mixins

• Provides powerful extensions to the class with little cost
Mixins

• It’s just “Copy and paste the code into the class”
  • Will override existing code

• Have access to instance functions

• Have access to instance variables
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

1. Current class
2. Current class’s mixins
   a. Latest included mixin
   b. ..... 
   c. Earliest included mixin
3. Current class’s super class
4. Current class’s super class’s mixins
5. .....
Comparable

It provides you methods to compute \(<, >, ==, !=, >=, <=\)

What’s needed?

• Define function \(\equiv\) (spaceship operator)
  • Return negative, 0 or positive number

Very similar to Java Comparable interface which requires CompareTo
Enumerable

It provides you methods to iterator over the object -> supports map, find!

What’s needed?

• Define function **each**
  • Each will either call each of other object or will yield result

Very similar to Java Iterable interface