CSE341 – Section 9

Double Dispatch, Expression Problem, Mixins, and More!

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Outline

General Look

- Dispatch is the **runtime** procedure for looking up which function to call based on the parameters given.
  - What is Ruby's procedure? (Same as Java's)
  - Single Dispatch on the implicit **self** parameter.
    - They use the **runtime** class of the **self** parameter to lookup the correct method when a call is made.
    - This is CSE143.
- Single Dispatch isn't the only possible choice, though.
- What about dispatching based on the **runtime** classes of both **self** and the **first** method parameter?
  - This is generally known as Double Dispatch.
    - Ruby/Java doesn't have this, but we can emulate it.
    - This is HW7.
- Future Look: You can dispatch on any number of the parameters and the general term for this is Multiple Dispatch or Multimethods.

Emulating Double Dispatch

- The key idea to emulating double dispatch in Ruby, and on HW7, is use the built-in single dispatch procedure **twice**!
  - Sounds simple when put that way, doesn't it?
  - Have the *principal method* immediately call another method on its **first parameter**, passing in **self**.
    - That 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.
- Of course, there are other ways to emulate double dispatch.
  - It's often found as an idiom in SML by using case expressions.

Simple 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
```

```
A.new.f(A.new) # "(a, a) case"
A.new.f(B.new) # "(a, b) case"
B.new.f(A.new) # "(b, a) case"
B.new.f(B.new) # "(b, b) case"
```

Simple Example (SML)

```
datatype t = A | B

fun f x y =
    case (x, y) of
        (A, A) => "(a, a) case"
      | (A, B) => "(a, b) case"
      | (B, A) => "(b, a) case"
      | (B, B) => "(b, b) case"
```

```
f A A; (* "(a, a) case" *)
f A B; (* "(a, b) case" *)
f B A; (* "(b, a) case" *)
f B B; (* "(b, b) case" *)
```

Rock/Paper/Scissors Example

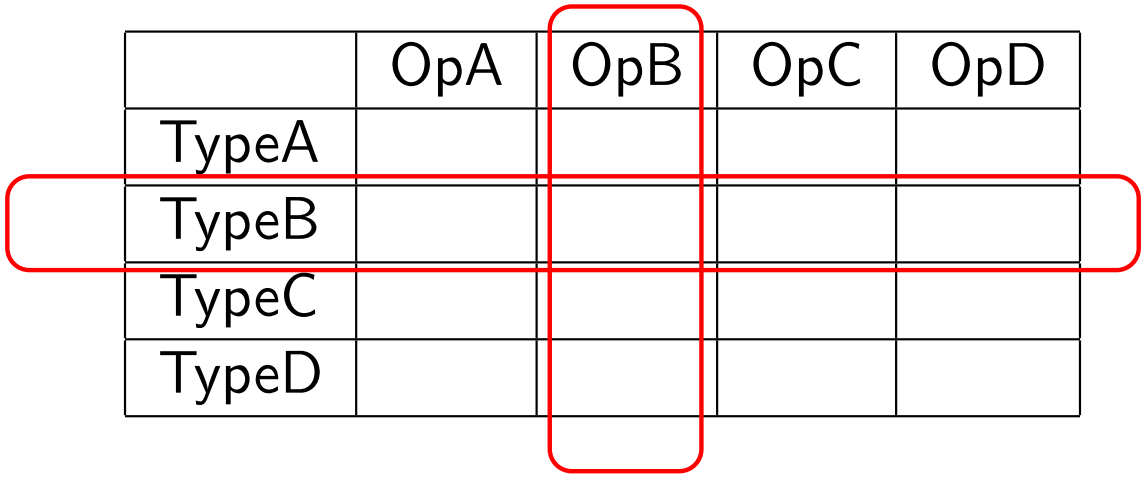
- We have three classes {Rock, Paper, Scissors}
- We want to write a **fight** method that returns a **winner** between the type of **self** and another {Rock, Paper, Scissors}

SML Version

```
fun fight w1 w2 =
    case (w1, w2) of
        (Paper p, Rock _) => wins p
      | (Rock r, Scissors _) => wins r
      | (Scissors s, Paper _) => wins s
      | (Rock _, Paper p) => wins p
      | (Scissors _, Rock r) => wins r
      | (Paper _, Scissors s) => wins s
      | _ => tie;
```

The Expression Problem

- Problem: Where do we put the code for each cell?
  - How do we group the code together?
    - By columns??? *OR* By rows???



	OpA	OpB	OpC	OpD
TypeA				
TypeB				
TypeC				
TypeD				

- This *can* be distilled down into an OOP vs FP argument...
  - OOP generally groups by row (by types/classes)
    - Preferable if more likely to add types rather than operations
  - FP generally groups by column (by operations/functions)
    - Preferable if more likely to add operations rather than types

Examples

Rock/Paper/Scissors

	fight	to_s
Rock		
Paper		
Scissors		

- Ruby (OOP): By rows (classes)
- SML (FP): By columns (functions)

lec22_stageC.rb

Same idea, just more complicated operations!

Mixins Motivation

- Look at all of these cool methods on every object!
- There seems to be a lot of recurring methods, though.
  - Is that implemented by code reuse or redundant code?
  - Maybe they have a common ancestor and use inheritance?
  - But what about String and FixNum?
    - Nearest common ancestors is Object, but Objects don't generally have <=>, <, . . . among other methods in common.
    - Inheritance doesn't work here, but we still want to reuse code
- Mixins are a Ruby construct that is simply for code reuse
  - Perfect for sharing code between otherwise unrelated classes

Code Examples

Sees `mixins.rb`.

Working with Mixins

Defining a Mixin

```
module MixinNameHere
  def method1
    # do stuff
  end
  def method2(x,y,z) # Any arguments...
    method1 # Calling above method (ignoring shadowing)
    someOtherMethod # This is not in the mixin
  end
end
```

Utilizing a Mixin

```
class SomeClass
  include MixinNameHere
end
```

Standard Mixins

Comparable Mixin

- All of these methods depend on a single method named <=>
  - If Dan asks... say that I called it the spaceship operator.
- It's almost the same as `Comparable#compareTo` from Java
  - The return is restricted to the values {-1,0,1}

```
0 <=> 5            # -1
"ab" <=> "a"       #  1 (lexicographical ordering)
[1,2] <=> [1,2]    #  0 (analogous to Strings)
```

Enumerable Mixin

- Awesomeness within a Module (contains 47 methods)!!!!
  - All depends on the **each** method that we've discussed

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
- Remember visitPostOrder???

Code Examples

See `visitor.rb` and `visitor.sml`.