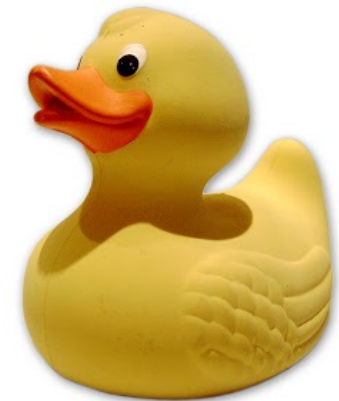

CSE 413

Programming Languages & Implementation



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Ruby: Duck Typing, Inheritance, and Modules

The plan...

Several related topics:

- “Duck typing” – dynamic typing in Ruby
- Inheritance and classes
- Modularity and mixins

Later:

- Multiple inheritance, interfaces, and mixins

And then:

- Start on grammars, scanners, parsers

Types in Ruby

- Ruby is dynamically typed – everything is an object
- Only notion of an object’s “type” is what messages it can respond to
 - i.e., whether it has methods for a particular message
 - This can change dynamically for either all objects of a class or for individual objects

Duck Typing

- “If it walks like a duck and talks like a duck, it must be a duck”
 - Even if it isn’t
 - All that matters is how an object behaves
 - (i.e, what messages it understands)
 - Maybe more accurate: it might as well be a duck if you can’t tell the difference

Thought Experiment (1)

- What must be true about x for this method to work?

```
def foo x
  x.m + x.n
end
```

Thought Experiment (2)

- What is true about x ?
 - $x.m + x.n$
- Less than you might think
 - x must have 0-argument methods m and n
 - The object returned by $x.m$ must have a $+$ method that takes one argument
 - The object returned by $x.n$ must have whatever methods are needed by $x.m.+$ (!)

Duck Typing Tradeoffs

- Plus
 - Convenient, promotes code reuse
 - All that matters is what messages an object can receive
- Minus
 - “Obvious” equivalences don’t hold: $x+x$, $2*x$, $x*2$
 - May expose more about an object than might be desirable (more coupling in code)
 - May allow objects to “work” in unintended / inappropriate contexts

Classes & Inheritance

- Ruby vs Java:
 - Subclassing in Ruby is not about type checking – it is not subtyping (because of dynamic typing)
 - Subclassing in Ruby is about inheriting methods
 - Java subclassing is about both (subtyping and code inheritance)
- Can use **super** to refer to inherited code
- See examples in **Points.rb**
 - **ThreeDPoint** inherits methods **x** and **y**
 - **ColorPoint** inherits **distance** methods

Overriding

- With dynamic typing, inheritance alone is just avoiding cut/paste
- Overriding is the key difference
 - When a method in a superclass makes a *self* call, it resolves to a method defined in the subclass if there is one
 - Example: `distFromOrigin2` in `PolarPoint`

Ruby – Why Subclasses?

- Since we can add/change methods on the fly, why use a subclass?
- Instead of class `ColorPoint`, why not just add a color field to `Point`?
 - Can't do this in Java
 - Can do it in Ruby, but it changes all `Point` instances (including subclasses), even existing ones
 - Pro: now all `Point` classes have a color
 - Con: Maybe that breaks something else or is the wrong abstraction for some `Point` clients

Organizing Large(r) Programs

- Issues
 - Idea: divide code into manageable components
 - Also: want to take advantage of reusable chunks of code (libraries, classes, etc.)
- Strategy: Split code into separate files
 - Typically, one or more classes per file
 - Use “require” (or sometimes “load”) to access in Ruby
 - What about components that aren’t classes?

Namespaces & Modules

- Idea: Want to break larger programs into pieces where names can be reused independently
 - Avoids clashes when combining libraries written by different organizations or at different times
- Ruby solution: modules
 - Separate source files that define namespaces, but not necessarily classes

Example (from Programming Ruby)

```
module Trig
  PI = 3.14
  def Trig.sin(x)
    # ...
  end
  def Trig.cos(x)
    # ...
  end
end
end
```

```
module Moral
  VERY_BAD = 0
  BAD      = 1
  def Moral.sin(badness)
    # ...
  end
end
end
```

Using Modules

```
# ...  
require 'trig'  
require 'moral'  
y = Trig.sin(Trig::PI/4)  
penance = Moral.sin(  
    Moral::VERY_BAD)  
# ...
```

- Key point: Each module defines a namespace
 - No clashes with same names in other modules
- Module methods are a lot like class methods

Mixins

- Modules can be used to add behavior to classes – *mixins*
 - Define instance methods and data in module
 - “include” the module in a class – incorporates the module definitions into the class
 - Now the class has its original behavior plus whatever was added in the mixin
 - Provides most of the capabilities of multiple inheritance and/or Java interfaces

Example

```
module Debug
  def trace
    # ...
  end
end
```

```
class Something
  include debug
  # ...
end
```

```
class SomethingElse
  include debug
  # ...
end
```

- Both classes have the trace method defined, and it can interact with other methods and data in the host class as if it was defined there
 - (trace is not “shared” by the classes and can’t pass information back and forth)

Exploiting Mixins – Comparable

- The real power of this is when mixins build on or interact with code in the classes that use them
- Example: library mixin **Comparable**
 - Class must define operator `<=>`
 - (`a <=> b` returns -1, 0, +1 if `a<b`, `a==b`, `a>b`)
 - **Comparable** mixin uses “client” `<=>` to define `<`, `<=`, `==`, `>=`, `>`, and **between?** for that class

Another example – Enumerable

- Container/collection class provides an **each** method to call a block for each item in the collection
- Enumerable module builds many mapping-like operations on top of this
 - **map, include?, find_all, ...**
 - If items in the collection implement \leq you also get **sort, min, max, ...**

Iterator Example

- Suppose we want to define a class of **Sequence** objects that have a **from**, **to**, and **step**, and contain numbers **x** such that
 - **from** \leq **x** \leq **to**, and
 - **x** = **from** + **n*****step** for integer value **n**

(Credit: *Ruby Programming Language*, Flanagan & Matsumoto)

Sequence Class & Constructor

```
class Sequence
  # mixin all of the methods in Enumerable
  include Enumerable

  def initialize(from, to, step)
    @from, @to, @step = from, to, step
  end

  ...
```

Sequence each method

- To add an iterator to Sequence and make it also work with Enumerable, all we need is this:

```
def each
  x = @from
  while x <= @to
    yield x
    x += @step
  end
end
```