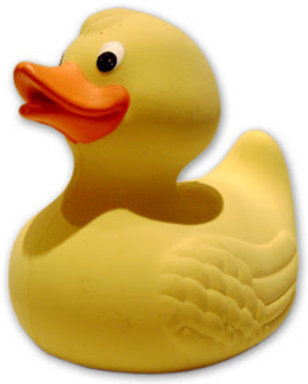
CSE 413 Programming Languages & Implementation



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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

Next:

- Multiple inheritance, interfaces, and mixins

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)

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 (because of dynamic typing)
  - Subclassing in Ruby is about inheriting methods
- 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 name spaces, but not necessarily classes

Example (from Programming Ruby)

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

```
module Moral
  VERY_BAD = 0
  BAD          = 1
  def Moral.sin(badness)
    # …
  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 <=> 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 <= x <= 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
```