Ruby: Object-Oriented Concepts

Lecture 9
Classes

- Classes have methods and variables
  ```ruby
  class LightBulb  # name with CamelCase
    def initialize  # special method name
      @state = false  # @ means "instance variable"
    end
    def on?
      @state          # implicit return
    end
    def flip_switch!  # name with snake_case
      @state = !@state
    end
  end
  ```

- Instantiation calls `initialize` method
  ```ruby
  f = LightBulb.new #=> <LightBulb:0x0000e71c2322
                        @state=false>
  f.on? #=> false
  ```
Visibility

- Instance variables are always private
  - Private to object, not class
- Methods can be private, protected, or public (default)

```ruby
class LightBulb
    private def inside
        ...
    end

    def access_internals(other_bulb)
        inside # ok
        other_bulb.inside # no! inside is private
        self.inside # no explicit recv'r allowed
    end
end
```
Getters/Setters

class LightBulb
  def initialize(color, state: false)
    @color = color # not visible outside object
    @state = state # not visible outside object
  end
  def color
    @color
  end
  def state
    @state
  end
  def state=(value)
    @state = value
  end
end
Attributes

class LightBulb
  def initialize(color, state: false)
    @color = color
    @state = state
  end
  def color
    @color
  end
  attr_accessor :state # name is a symbol
end
Attributes

class LightBulb
  def initialize(color, state: false)
    @color = color
    @state = state
  end

  attr_reader :color

  attr_accessor :state

end
Attributes

class LightBulb
  attr_reader :color
  attr_accessor :state
  attr_writer :size

  def initialize(color, state: false)
    @color = color
    @state = state
    @size = 0
  end
end
Classes Are Always Open

- A class can always be extended
  ```ruby
class Street
  def construction ... end
end
...
class Street
  def repave ... end # Street now has 2 methods
end
```

- Applies to core classes too
  ```ruby
class Integer
  def log2_of_cube # lg(self^3)
    (self**3).to_s(2).length - 1
  end
end
500.log2_of_cube #=> 26
```
Classes are Always Open (!)

- Existing methods can be redefined!

- When done with system code (libraries, core ...) called “monkey patching”

- Tempting, but... Just Don’t Do It
No Overloading

- Method identified by (symbol) name
  - No distinction based on number of arguments

- Approximation: default arguments
  ```ruby
  def initialize(width, height = 10)
    @width = width
    @height = height
  end
  ```

- Old alternative: trailing options hash
  ```ruby
  def initialize(width, options)
  ```

- Modern style: default keyword arguments
  ```ruby
  def initialize(height: 10, width:)
  ```
A Class is an Object Instance too

- Even classes are objects, created by :new

```ruby
LightBulb = Class.new do  #class LightBulb
  def initialize
    @state = false
  end
  def on?
    @state
  end
  def flip_switch!
    @state = !@state
  end
end
```
class LightBulb

@state1  # class instance var

def initialize
    @state2 = ...  # instance variable
    @@state3 = ...  # class variable
end

def bar  # instance method
    ...
    # sees @state2, @@state3
end

def self.foo  # class method
    ...
    # sees @state1, @@state3
end
end
Inheritance

- Single inheritance between classes
  ```ruby
class LightBulb < Device
  ...
  end
end
```
- Default superclass is Object (which inherits from BasicObject)
- Keyword `super` to call parent's method
  ```ruby
  class LightBulb < Device
    def electrify(current, voltage)
      do_work
      super # with current and voltage
    end
  end
end
```
Modules

- Another container for definitions

```ruby
module Stockable
  MAX = 1000
  class Item ... end
  def self.inventory ... end # utility fn
  def order ... end
end
```

- Cannot, themselves, be instantiated

```ruby
s = Stockable.new # NoMethodError
i = Stockable::Item.new # ok
Stockable.inVENTORY # ok
Stockable.order # NoMethodError
```
Modules as Namespaces

- Modules create independent namespaces
  - cf. packages in Java
- Access contents via scoping (::)
  ```ruby
  Math::PI #=> 3.141592653589793
  Math::cos 0 #=> 1.0
  widget = Stockable::Item.new
  x = Stockable::inventory
  Post < ActiveRecord::Base
  BookController < ActionController::Base
  ```
- Style: use dot to invoke utility functions (ie module methods)
  ```ruby
  Math.cos 0 #=> 1.0
  Stockable.inventory
  ```
Modules are Always Open

- Module contains several related classes
- Style: Each class should be in its own file
- So split module definition

```ruby
# game.rb
module Game
end

# game/card.rb
module Game
class Card ... end
end

# game/player.rb
module Game
class Player ... end
end
```
Modules as “Mixins”

- Another container for method definitions
  ```ruby
  module Stockable
    def order ... end
  end
  ```

- A module can be *included* in a class
  ```ruby
  class LightBulb < Device
    include Stockable, Comparable ...
  end
  ```

- Module's (instance) methods/vars are now (instance) methods/vars for class
  ```ruby
  bulb = LightBulb.new
  bulb.order # from Stockable
  if bulb <= old_bulb # from Comparable
  ```
Requirements for Mixins

- Mixins often rely on certain aspects of classes into which they are included.
- Example: Comparable methods use `#<=>`
  
  ```ruby
  module Comparable
    def <(other) ... end
    def <=(other) ... end
  end
  ```

- Enumerable methods use `#each`

- Recall *layering* in SW I/II? Roughly:
  - Class implements kernel methods
  - Module implements secondary methods
Software Engineering

- All the good principles of SW I/II apply
- Single point of control over change
  - Avoid magic numbers
- Client view: abstract state, contracts, invariants
- Implementer view: concrete rep, correspondence, invariants
- Checkstyle tool: rubocop
- Documentation: YARD
  - Notation for types: yardoc.org/types.html
  @param words Array<String> the lexicon
Summary

- Classes as blueprints for objects
  - Contain methods and variables
  - Public vs private visibility of methods
  - Attributes for automatic getters/setters

- Metaprogramming
  - Classes are objects too
  - “Class instance” variables

- Single inheritance

- Modules are namespaces and mixins