CSc 372 — Comparative Programming Languages

29 : Ruby — Blocks

Christian Collberg
Department of Computer Science
University of Arizona
collberg@gmail.com

November 1, 2011

1 Blocks

- Let's write a simple for loop to search through an array looking for a particular value:

```
$flock = ["huey","dewey","louie"]

def isDuck?(name)
   for i in 0...$flock.length
      if $flock[i] == name then
         return true
      end
   end
   return false
end

puts isDuck?("dewey"), isDuck?("donald")
```

2 Iterators

- Ruby's *iterators* are an easier way to do this.
- The `Array` class implements a method `find` that iterates through the array.

```
def isDuck?(name)
   $flock.find do |x|
      x == name
   end
end

puts isDuck?("dewey")
puts isDuck?("donald")
```

3 Yield

- A block is enclosed within {} or `do...end`. Arguments to the block (there can be more than one) are given within `|...|`.
- A block is passed to a method by giving it after the list of "normal" parameters.
- The method invokes the block by using `yield`.
- `yield` can take an argument which the method passed back to the block.

4 Yield...

```
def triplets()
   yield "huey"
   yield "dewey"
   yield "louie"
end

triplets() {|d| puts d}

triplets() do |d|
  puts d
end
```

5 Factorial

- Here's the factorial function, as an iterator.

```
def fac(n)
   f = 1
   for i in 1..n
     f *= i
     yield f
   end
end

fac(5) {|f| puts f}
```

6 Passing arguments

- `yield` can pass more than one value to the block.

```
def fac(n)
   f = 1
   for i in 1..n
     f *= i
     yield i,f
   end
end

fac(5) do |i,x|
```

```
   puts "#{i}! = #{x}"
end
```

7 Nesting iterators

- Iterators can be nested.

```
fac(3) do |i,x|
   fac(3) do |j,y|
      puts "#{i}! * #{j}! = #{x*y}"
   end
end
```

8 Scope

- A local variable which is active when the block is started up, can be accessed (and modified) within the block.

```
def sumfac(n)
   y = 0
   fac(n) do |i,x|
      y = y + x
   end
   return y
end

puts sumfac(5)
```

9 Implementing `Array#find`

- We can implement our own `find` method:

```
def find(arr)
   for i in 0..arr.length
      if yield arr[i] then return true end
   end
   return false
end

puts find($flock) {|x| x=="dewey"}
puts find($flock) {|x| x=="donald"}
```

10 `Array#collect`

- `collect` applies the block to every element of an array, creating a new array. This is similar to Haskell's `map`.

```
$flock = ["huey","dewey","louie"]
$flock.each {|x| puts x}
```

```
puts $flock.collect {|x| x.length}
puts $flock.collect do |x|
   "junior woodchuck, General " + x
end
```

11 `Array#inject`

- `inject(init)` is similar to Haskell's `foldl`.
- `inject()` without an argument is like Haskell's `foldl1`, i.e. it uses the first element of the array as the starting value.

```
x = $flock.inject("") do |elmt,total|
   total = elmt + " " + total
end
puts x

x = $flock.inject() do |elmt,total|
   total = elmt + " " + total
end
puts x
```

12 Exercise — MyHash

- Let's write our own version of Ruby's Hash class, called MyHash.
- The hash table should be implemented as an array of buckets [0..`size`-1], where each bucket i is an array of `[key,value]` pairs and such as

$$i = \texttt{key.hash} \bmod \texttt{size}$$

- First, declare the class and add a constructor.
- The constructor should take one argument, the size (number of buckets). It should create the buckets (an array of nil values) and set an instance variable `@size` to the number of buckets.
- HINT: `Array.new(size=...,obj=...)` creates an array of size `size`, with each value being `obj`.

13 Exercise — MyHash — `put`

- Now implement the `put(key,value)` method.
- The algorithms is as follows:
  1. Compute the bucket number for the key, i.e. `key.hash()` mod the size of the bucket array.
  2. Check of the bucket is empty (nil). If so, set it to be an empty list.
  3. Look through the table to see if there's already an element in the bucket with the right key. If so, change the element to the new value. Otherwise, add the [key,value] pair to the end of the bucket.
- HINT: `array.map! {|item| block }` invokes the block once for each element of self, replacing the element with the value returned by block.

14 Exercise — MyHash — `get`

- Now implement the `get(key)` method.
- The algorithms is as follows:
  1. Compute the bucket number for the key.
  2. Check of the bucket is empty (nil). If it is, return nil.
  3. Look through the table to see if there's an element in the bucket with the right key. If so, return the value. Otherwise, return nil.

15 Exercise — MyHash...

This code

```
h = MyHash.new(10)
h.put("hey","there")
h.put("yo","dude")
puts h.get("hey")
puts h.get("yo")
h.put("hey","baby")
puts h.get("yo")
puts h.get("hey")
```

should generate this output:

```
there
dude
dude
baby
```

16 Exercise — MyHash — `each`

- Now implement the `each` method which yields each element at a time.
- Use `each` to implement `keys()` and `values()` methods that yields each element at a time.
- Extend `keys()` such that it can yield each element at a time (if you pass it a block) or returns an array of keys if you don't.
- HINT: The method `block_given?` returns true if you've passed a block to the method.
- Add a method `to_s()` that return the key-value pairs of the hashtable as a string.

17 Exercise — MyHash — Example...

```
puts h.to_s()
```

should print

```
hey => baby
yo => dude
```

18 Exercise — MyHash — Example. . .

```
h.keys() {|x| puts x}
puts "-----------------------------------"
s = h.keys()
puts s
```

should print

```
hey
yo
-----------------------------------
hey
yo
```

19 Exercise — MyHash — Example. . .

- Extend the class so that in addition to using `put` and `get` you can also use []= and []. Example:

  ```
  h["banana"] = "fruit"
  puts h["banana"]
  ```

  should print

  ```
  fruit
  ```

- HINT: `alias :`*`newmethod`* `:`*`oldmethod`* makes a new method *newmethod* that simply calls *oldmethod*.

20 Exam Problem I — 372 Fall 2008

Let's implement methods `map`, `filter`, and `foldr`, corresponding to their Haskell namesakes, but this time in Ruby! Here is the class definition:

```
class Array
   def Array.map(a)
      ...
   end

   def Array.filter(a)
      ...
   end

   def Array.foldr(a,z)
      ...
   end
end
```

21 Exam Problem I — 372 Fall 2008

Each method is passed an array `a` as input and returns a new array as output. In Haskell these higher-order functions would also be passed a function as argument, but here in Ruby they're instead passed a block. The `foldr` method also has an argument `z`, the starting value.

22 Exam Problem I(a) — 372 Fall 2008

Write the `Array.map` method. This example

```
a = Array.map([1,2,3]) do |x|
       x+1
    end
puts a
```

should print out

```
2
3
4
```

23 Exam Problem I(b) — 372 Fall 2008

Write the `Array.filter` method. This example

```
a = Array.filter([1,2,3,4,5]) do |x|
       x % 2 == 0
    end
puts a
```

should print out

```
2
4
```

24 Exam Problem I(c) — 372 Fall 2008

Write the `Array.foldr` method. These examples

```
puts Array.foldr([1,2,3,4,5],0) do |x,z|
       x+z
    end
puts Array.foldr([1,2,3,4,5],0) do |x,z|
       x-z
    end
puts Array.foldr(["aaa","bbb","ccc"],"") do |x,z|
       x+z
    end
puts a
```

should print out

```
15
3
aaabbbccc
```

25 Readings

- Read Chapter 4, page 49–55, in *Programming Ruby — The Pragmatic Programmers Guide*, by Dave Thomas.
- Here's the documentation for the `Array` class: `http://www.ruby-doc.org/core/classes/Array.html`

26 Yum!

烤鸭
Kǎo Yā