

CMSC 330

Organization of Programming Languages

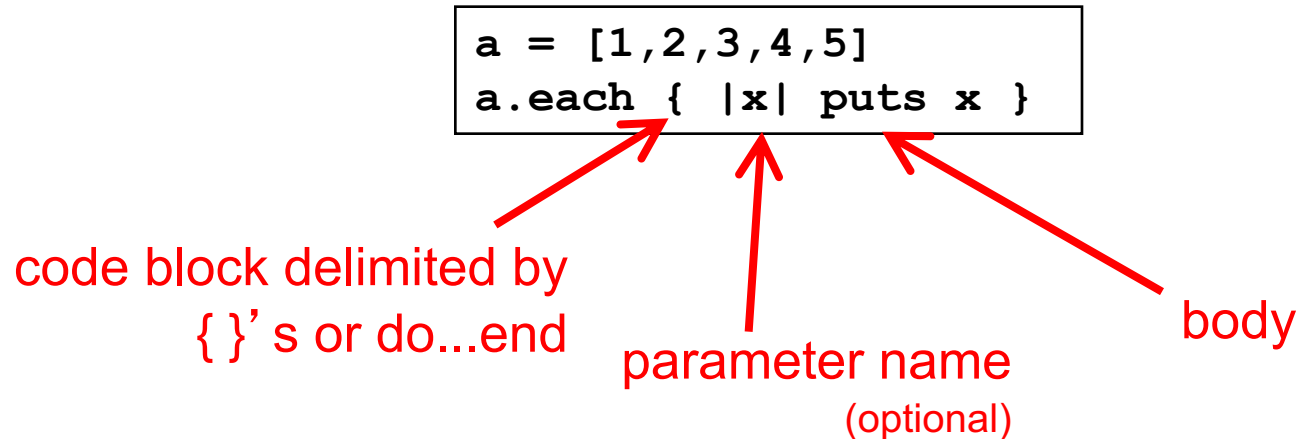
Code Blocks

Code Blocks

- ▶ A **code block** is a piece of code that is invoked by another piece of code
- ▶ Code blocks are useful for encapsulating repetitive computations

Array Iteration with Code Blocks

- ▶ The `Array` class has an `each` method
 - Takes a code block as an argument




So, What Are Code Blocks?

- ▶ A code block is a special kind of method
 - `{ |y| x = y + 1; puts x }` is almost the same as
 - `def m(y) x = y + 1; puts x end`
- ▶ The `each` method invokes the given code block
 - This is called **higher-order programming**
 - In other words, methods take other methods as arguments

Code Block Examples

```
def do_it_twice
  return "No block" unless block_given?
  yield
  yield
end
```

Call the code block



```
do_it_twice {puts "hello"}
```

Code block



```
# returns
hello
hello
```

Code Block Examples

```
# implicit code block
def m1
  yield 10
end
```

```
m1 {|x| x+1}
```

```
==>11
```

```
# argument and code block
def m2(x)
  yield x
end
```

```
m2(10) {|x| x*2}
==>20
```

Quiz 1: What is the output

```
a = [5,10,15,20]
a.each { |x| x = x*x }
puts a[1]
```

- A. 10
- B. 100
- C. (Nothing)
- D. *Error*

Quiz 1: What is the output

```
a = [5,10,15,20]
a.each { |x| x = x*x }
puts a[1]
```

- A. 10 – the array itself is not modified by *each*
- B. 100
- C. (Nothing)
- D. *Error*

More Code Blocks for Arrays

- ▶ Sum up the elements of an array with **each**

```
a = [1,2,3,4,5]
sum = 0
a.each { |x| sum = sum + x }
printf("sum is %d\n", sum)
```

- ▶ **a.find** returns first element of **a** for which the block returns true

```
[1,2,3,4,5].find { |y| y % 2 == 0 }
[5,4,3].collect { |x| -x }
```

- ▶ **a.collect** applies block to each element of **a** and returns new array; **collect!** modifies **a**

Quiz 2: What is the output

```
a = [5,10,15,20]
a.collect! { |x| x*x }
puts a[1]
```

- A. 10
- B. 100
- C. (Nothing)
- D. *Error*

Quiz 2: What is the output

```
a = [5,10,15,20]
a.collect! { |x| x*x }
puts a[1]
```

- A. 10
- B. 100
- C. (Nothing)
- D. *Error*

Code Blocks for Numbers, Strings

```
3.times { puts "hello"; puts "goodbye" }  
5.upto(10) { |x| puts(x + 1) }
```

- `n.times` runs code block `n` times
- `n.upto(m)` runs code block for integers `n..m`

```
s = "Student,Sally,099112233,A"  
s.split(',').each { |x| puts x }
```

- `s.split(x)` splits the string according to delimiter `x`, invoking the code block on each segment

(“delimiter” = symbol used to denote boundaries)

Code Blocks for Files

```
File.open("test.txt", "r") do |f|  
  f.readlines.each { |line| puts line }  
end
```

alternative syntax: `do ... end` instead of `{ ... }`

- `open` method takes code block with file argument
 - File automatically closed after block executed
- `readlines` reads all lines from a file and returns an array of the lines read
 - Use `each` to iterate
- Can do something similar on strings directly:
- `"r1\nr2\n\nr4".each_line { |rec| puts rec }`
 - Apply **code block** to each newline-separated substring

Standard Library: File

- ▶ Lots of convenient methods for IO

`File.new("file.txt", "rw")` # open for rw access

`f.readline` # reads the next line from a file

`f.readlines` # returns an array of all file lines

`f.eof` # return true if at end of file

`f.close` # close file

`f << object` # convert object to string and write to f

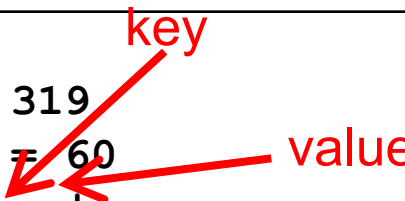
`$stdin, $stdout, $stderr` # global variables for standard UNIX IO

By default stdin reads from keyboard, and stdout and stderr both write to terminal

- ▶ **File** inherits some of these methods from **IO**

Code Blocks for Hashes

```
population = {}  
population["USA"] = 319  
population["Italy"] = 60  
population.each { |c,p|  
  puts "population of #{c} is #{p} million"  
}
```



- Can iterate over keys and values separately

```
population.keys.each { |k|  
  print "key: ", k, " value: ", population[k]  
}  
  
population.values.each { |v|  
  print "value: ", v  
}
```

Code Blocks are not Objects

- ▶ Code blocks are limited in their use
 - They cannot be stored in variables, or passed to or returned from methods

```
a = [1,2,3]
a.collect! { |z| z+1 } # ok
y = { |z| z+1 }      # syntax error
a.collect! y         # syntax error
```

- ▶ Only code block **literals** are permitted, and can only be passed as the last “argument”
 - And only one code block, at that (not 2, 3, ...)
- ▶ What about calling them from your methods?

Using Yield to Call Code Blocks

- ▶ Any method call can include a code block
 - Inside the method, the block is called with `yield`
- ▶ After the code block completes
 - Control returns to the caller after the `yield` instruction

```
def countx(x)
  for i in (1..x)
    puts i
    yield
  end
end

countx(4) { puts "foo" }
```

```
1
foo
2
foo
3
foo
4
foo
```

Yield Can Take an Argument

```
def do_it_twice
  return "No block" unless block_given?
  yield "hello"
  yield "there"
end
```

```
do_it_twice { |x| puts x }
```

hello
there

- It can take any number of arguments
 - Code block { |x,y| ... } invoked via `yield arg1,arg2`
 - Code block { |x,y,z| ... } would be invoked via `yield arg1,arg2,arg3`
 - Etc.

Quiz 3: What is the output

```
def myFun(x)
  yield x
end
myFun(3) { |v| puts "#{v} #{v*v}" }
```

- A. 3
- B. 3 9
- C. 9 81
- D. 9 nil

Quiz 3: What is the output

```
def myFun(x)
  yield x
end
myFun(3) { |v| puts "#{v} #{v*v}" }
```

- A. 3
- B. 3 9
- C. 9 81
- D. 9 nil

Procs: First-class “code blocks”

- ▶ **Proc** can make an object out of a code block
 - `t = Proc.new {|x| x+2}`
- ▶ Proc objects can be passed around, stored, and have their code invoked via `call`

```
def say(p)
  p.call 10
end
```

```
puts say(t)
```

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Procs are a Little Clumsy

- ▶ Stringing them together is a little (syntactically) heavyweight
 - We will see with OCaml a better integration into the language

```
def say(y)
  t = Proc.new {|x| Proc.new {|z| z+x+y }}
  return t
end
s = say(2).call(3)
puts s.call(4)
```

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Procs vs. code blocks

Code block

- ▶ **Lightweight** syntax
- ▶ **Common in libraries**, programming idioms
- ▶ **“Second class” status**
 - Can only be last, implicit function argument, as a literal
 - Can invoke only from within called method
 - Can't make one and call it in the same method

Proc

- ▶ **Heavier-weight syntax**:
Must make a Proc from code block first
- ▶ **Not commonly used** in standard libraries
- ▶ **“First class” status**
 - Can pass as argument (or more than one), return as result, store in fields, etc.
 - Call anywhere, directly

Exceptions

- ▶ Use `begin...rescue...ensure...end`
 - Like `try...catch...finally` in Java

```
begin
  f = File.open("test.txt", "r")
  while !f.eof
    line = f.readline
    puts line
  end
rescue Exception => e
  puts "Exception:" + e.to_s +
    " (class " + e.class.to_s + ")"
ensure
  f.close if f != nil
end
```

Class of exception
to catch

Local name
for exception

Always happens

Command Line Arguments

- ▶ Stored in predefined global constant **ARGV**
- ▶ Example
 - If
 - Invoke test.rb as “ruby test.rb a b c”
 - Then
 - ARGV[0] = “a”
 - ARGV[1] = “b”
 - ARGV[2] = “c”