

Ruby: Blocks, Enumeration, Hashes

Computer Science and Engineering ■ College of Engineering ■ The Ohio State University

Lecture 8

Blocks

- A block is a *statement(s)* passed in as an *argument* to a function

```
5.times do  
  puts 'hello world'  
end
```

- Equivalent, but more succinct:

```
5.times { puts 'hello world' }
```

- A block can, itself, have parameters!

```
5.times { |n| puts n**2 }
```

- Method calls block, passing in arguments

Calling Blocks

- Within a function, the passed-in block is called with keyword “yield”

```
def fib_up_to(max)
  i1, i2 = 1, 1
  while i1 <= max
    yield i1 if block_given?
    i1, i2 = i2, i1 + i2
  end
end

fib_up_to(1000) { |f| print "#{f} " }
fib_up_to(1000) { |f| sum += f }
```

Idioms for Blocks

- Bracketed code (eg open, do stuff, close)

```
File.open('notes.txt', 'w') do |file|  
  file << 'work on 3901 project'  
end # open method also closes the file after block
```

- Nested scope (eg for initialization code)

```
agent = Mechanize.new do |a|  
  a.log = Logger.new ('log.txt')  
  a.user_agent_alias = 'Mac Safari'  
end # isolates agent's initialization code
```

- Iteration (very common)...

Simple Iteration

- While/until loop: Boolean condition

```
while boolean_condition
```

```
...
```

```
end
```

- For-in loop: iterate over arrays (and other things like ranges)

```
for var in array
```

```
...
```

```
end
```

- Example

```
for str in 'hi'..'yo'
```

```
  puts str.upcase
```

```
end
```

- Usually avoided (rubystyle.guide/#no-for-loops)

Iterating on Arrays Using Blocks

- Do something with every element

```
a.each { |str| puts str.upcase }
```

- Do something with every index

```
a.each_index { |i| print "#{i}--" }
```

- Fill array with computed values

```
a.fill { |i| i * i } #=> [0, 1, 4, 9, 16]
```

```
a.fill { |i| [] }      # can omit parameter i: { |_| [] }
```

- Search

```
a.index { |x| x > limit }
```

- Filter

```
a.select! { |v| v =~ /[aeiou]/ }
```

```
a.reject! { |v| v =~ /[aeiou]/ } # aka filter
```

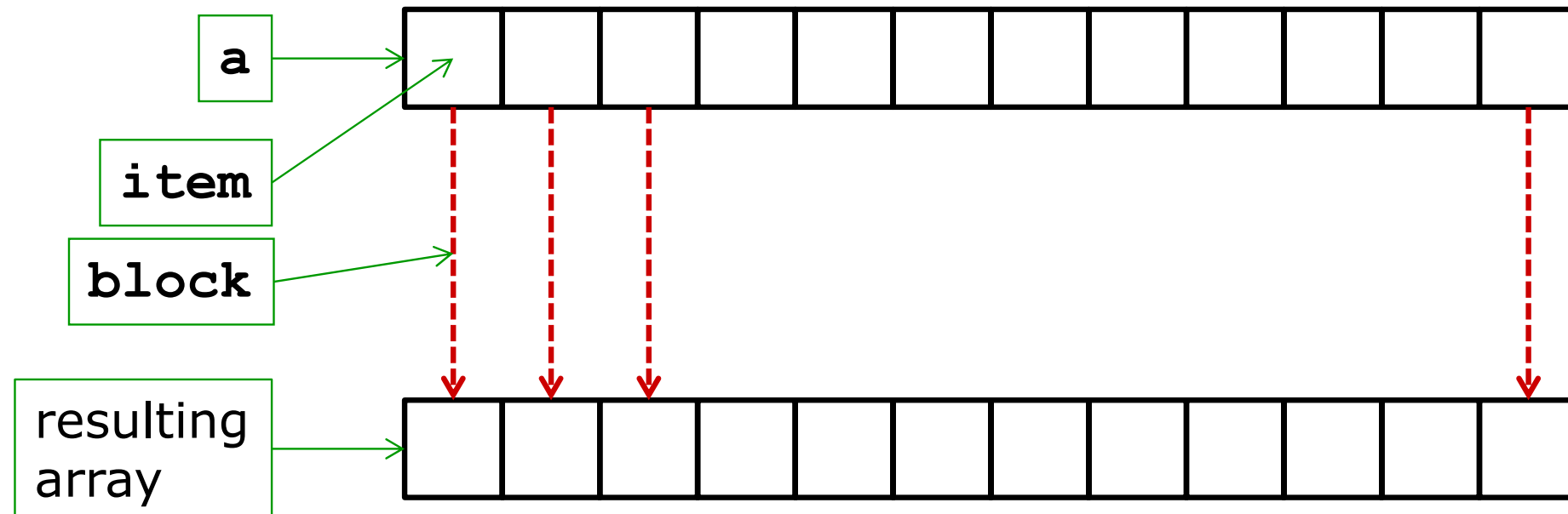
- Sort

```
a.sort! { |x, y| x.length <=> y.length }
```

Map

- Transform an array into a new array, *element by element*
- Uses *block* to calculate each new value

`a.map { |item| block } # +/- !`



Map: Examples

```
names = %w{ali noah marco xi}
#=> ["ali", "noah", "marco", "xi"]
names.map { |name| name.capitalize }
#=> ["Ali", "Noah", "Marco", "Xi"]
names.map { |name| name.length }
#=> [3, 4, 5, 2]
[1, 2, 3, 4].map { |i| i**2 }
#=> [1, 4, 9, 16]
[1, 2, 3, 4].map { |i| "x^{i}" }
#=> ["x^1", "x^2", "x^3", "x^4"]
```

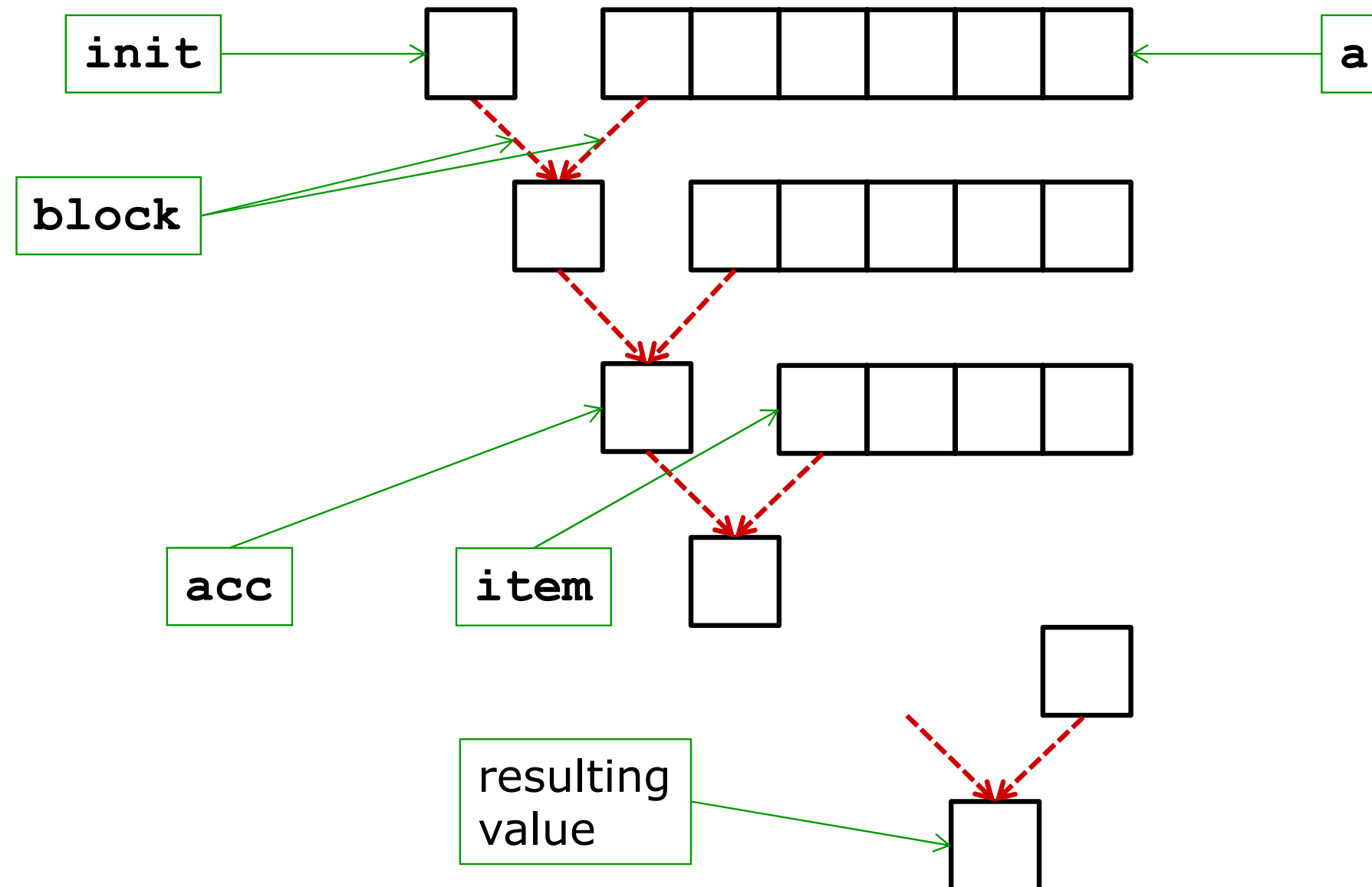
Reduce

- Transform an array into a *single value*, by incorporating one element at a time
 - Also called “fold”, or “inject”
- Uses block with 2 arguments: current accumulation and next array element

```
a.reduce(init) { |acc, item| block }
```

 - Value *returned* by block is the next **acc**
 - `a[0]` is initial **acc**, if `init` not provided
- Example: Sum the values of an array
 - `[15, 10, 8] → 0 + 15 + 10 + 8 → 33`

Reduction Chain



Reduce: Examples

```
[3, 4, 5].reduce { |sum, i| sum + i }    #=> 12
```

```
[1, 2, 3, 4, 5].reduce '' do |str, i|  
  str + i.to_s  
end                                     #=> "12345"
```

```
words = %w{cat sheep bear}  
words.reduce do |memo, word|  
  memo.length > word.length ? memo : word  
end                                     #=> "sheep"
```

```
[1, 2, 3].reduce [] do |acc, i|  
  acc.unshift i  
end                                     #=> ???
```

Module: Enumerable

□ Quantify over elements

```
['hi', 'yo!'].all? { |w| w.length >= 2 } #=> true
```

```
(0..100).any? { |x| x < 20 } #=> true
```

```
[1, 3, 17].none? { |x| x % 2 == 0 } #=> true
```

□ Min/Max

```
words.max_by { |x| x.length }
```

□ Search

```
(1..10).find_all { |i| i % 3 == 0 } #=> [3, 6, 9]
```

□ Map/reduce (only non-! version), returns an array

```
(5..8).map { 2 } #=> [2, 2, 2, 2]
```

```
(1..10).reduce(:+) #=> 55
```

```
book.reduce(0) { |sum, w| sum + w.length }
```

Your Turn: Find the Octothorps

□ Requirements

- Given a string
- Produce array of indices where '#' occurs in the string

□ Example:

- Given

`'a#asg#sdfg#d##'`

- Result

`[1, 5, 10, 12, 13]`

Your Turn: Squaring Evens

□ Requirements

- Given an array of integers
- Produce array that includes only the even elements, each squared

□ Example:

- Given

[1, 2, 3, 7, 7, 1, 4, 5, 6, 2]

- Result

[4, 16, 36, 4]

Your Turn: Flatten

□ Requirements

- Given an array of integers and arrays of integers, where the (top level) integers are unique
- Remove from the contained arrays all occurrences of the top-level integers

□ Example:

- Given

[3, 5, [4, 5, 9], 1, [1, 2, 3, 8, 9]]

- Result

[3, 5, [4, 9], 1, [2, 8, 9]]

Example: What Does This Do?

```
words = File.open('tomsawyer.txt') { |f|
    f.read }.split

freq, max = [], ''
words.each do |w|
    max = w if w.length > max.length
    freq[w.length] = 0 if !freq[w.length]
    freq[w.length] += 1
end
puts words.length
puts words.reduce(0) { |s, w| s + w.length }
freq.each_index do |i|
    puts "#{i}-letter words #{freq[i]}"
end
puts max
```

Hashes

- Partial map: keys $\rightarrow$ values

 - Keys must be unique

- Indexed with array syntax []

```
h['hello'] = 5
```

- Literal syntax for initialization

```
h = { 'red'    => 0xf00,  
      'green'  => 0x0f0,  
      'blue'   => 0x00f }
```

- Optional: Instantiate with a default value (or block)

```
h1 = Hash.new 0 #=> beware aliases
```

```
h2 = Hash.new { |h, k| h[k] = k + k }
```

Using Hashes

```
h = { 'age' => 21 }    # create new Hash
h['age'] += 1          # values are mutable
h['id'] = 0x2a         # hash can grow
h.size                #=> 2
h['name'] = 'Luke'     # heterogenous values
h[4.3] = [1, 3, 5]    # heterogenous keys
h.delete 'id'         # hash can shrink
```

```
# h == { 'age' => 22,
#       'name' => 'Luke',
#       4.3 => [1, 3, 5] }
```

Example: Hashes

```
list = %w{cake bake cookie car apple}
```

```
# Group by string length:
```

```
groups = Hash.new{ |h, k| h[k] = [] }
```

```
list.each { |v|
```

```
  groups[v.length] << v
```

```
}
```

```
# groups == { 4 => ["cake", "bake"],
```

```
#           6 => ["cookie"],
```

```
#           3 => ["car"], 5 => ["apple"] }
```

Your Turn: Frequency Count

□ Requirements

- Given an array of words (ie strings)
- Compute the frequency of occurrence of each word

□ Example:

- Given

`["car", "van", "car", "car"]`

- Compute

`{"car" => 3, "van" => 1}`

Your Turn: Frequency Count (Example)

```
list = %w{car van car car}
```

```
# Your code here
```

```
groups #=> {"car" => 3, "van" => 1}
```

Using Blocks with Hashes

- Do something with every key/value pair

```
h.each { |k, v| print "(#{k}, #{v}) " }
```

- Do something with every key or value

```
h.each_key { |k| print "#{k}--" }
```

```
h.each_value { |v| print "#{v}--" }
```

- Combine two hashes

```
h1.merge(h2) { |k, v1, v2| v2 - v1 }
```

- Filter

```
a.delete_if { |k, v| v =~ /[aeiou]/ }
```

```
a.keep_if { |k, v| v =~ /[aeiou]/ }
```

Immutability of Keys

- ❑ Rule: Once a key is in a hash, *never* change its value

```
grades[student] = 'C+'
student.wake_up! # danger, changes (value of) a key
```
- ❑ Problem: Aliases
- ❑ “Solution” (for strings as keys): Ruby implicitly *copies* and *freezes* strings used as keys in a hash

```
a, b = String.new('fs'), String.new('sn')
h = {a => 34, b => 44}
puts a.object_id, b.object_id
h.each_key { |key| puts key.object_id }
```

Symbols

- ❑ Roughly: *unique & immutable* strings
- ❑ Syntax: prefix with ":"
 - :height
 - : 'some symbol'
 - : "#{name}'s crazy idea"
- ❑ Easy (too easy?) to convert between symbols and strings
 - :name.**to_s** #=> "name"
 - 'name'.**to_sym** #=> :name
- ❑ But symbols are *not* strings
 - :name == 'name' #=> *false*

Operational View

- ❑ A symbol is created once, and all uses refer to that same object (aliases)
- ❑ Symbols are immutable
- ❑ Example

```
[] .object_id      #=> 200
>[] .object_id      #=> 220
[].equal? []        #=> false
:world.object_id    #=> 459528
:world.object_id    #=> 459528
:world.equal? :world #=> true
```

Symbols as Hash Keys

- Literal notation, but note location of the colon!

```
colors = {red: 0xf00,  
          green: 0x0f0,  
          blue: 0x00f}
```

- This is just syntactic sugar

- {name: value} same as {:**name** => **value**}
- The key is a *symbol* (eg :red)

- Pitfalls

```
colors.red      #=> NoMethodError  
colors["red"]   #=> nil  
colors[:red]    #=> 3840 (ie 0xf00)
```

Keyword Arguments

- Alternative to positional matching of arguments with formal parameters

```
def display(first:, last:)  
  puts "Hello #{first} #{last}"  
end  
  
display first: 'Mork', last: 'Ork'  
display last: 'Hawking', first: 'Steven'
```

- Providing a default value makes that argument optional

```
def greet(title: 'Dr.', name:)  
  puts "Hello #{title} #{name}"  
end
```

- Benefits: Client code is easier to read, and flexibility in optional arguments

Summary: Blocks, Enumerations, Hashes

- Blocks
 - Code passed as argument to a function
 - Elegant iteration over arrays
- Map and Reduce
 - Transform an array into an array (element-wise)
 - Squash an array into a single value
- Enumerable
 - Many useful iteration methods
- Hashes
 - Partial maps (aka associative arrays)
- Symbols
 - Unique, immutable strings
 - Often used as keys in hashes