Ruby: Blocks and Hashes

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 # file closed by open method
```

- 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 init'n code and temp var a
```

- 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 }
a.fill { |i| [] } # or omit i: { |_| [] }
```

- Search

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

- Filter

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

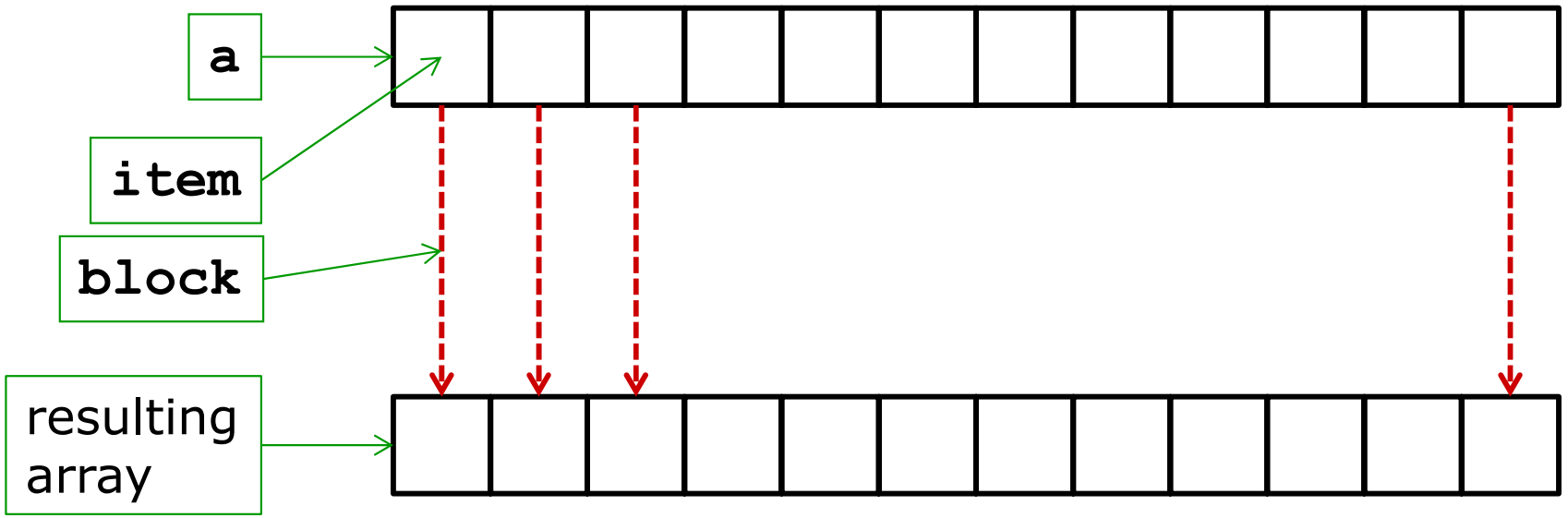
- Sort

```
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 } # also !
```



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"]
```

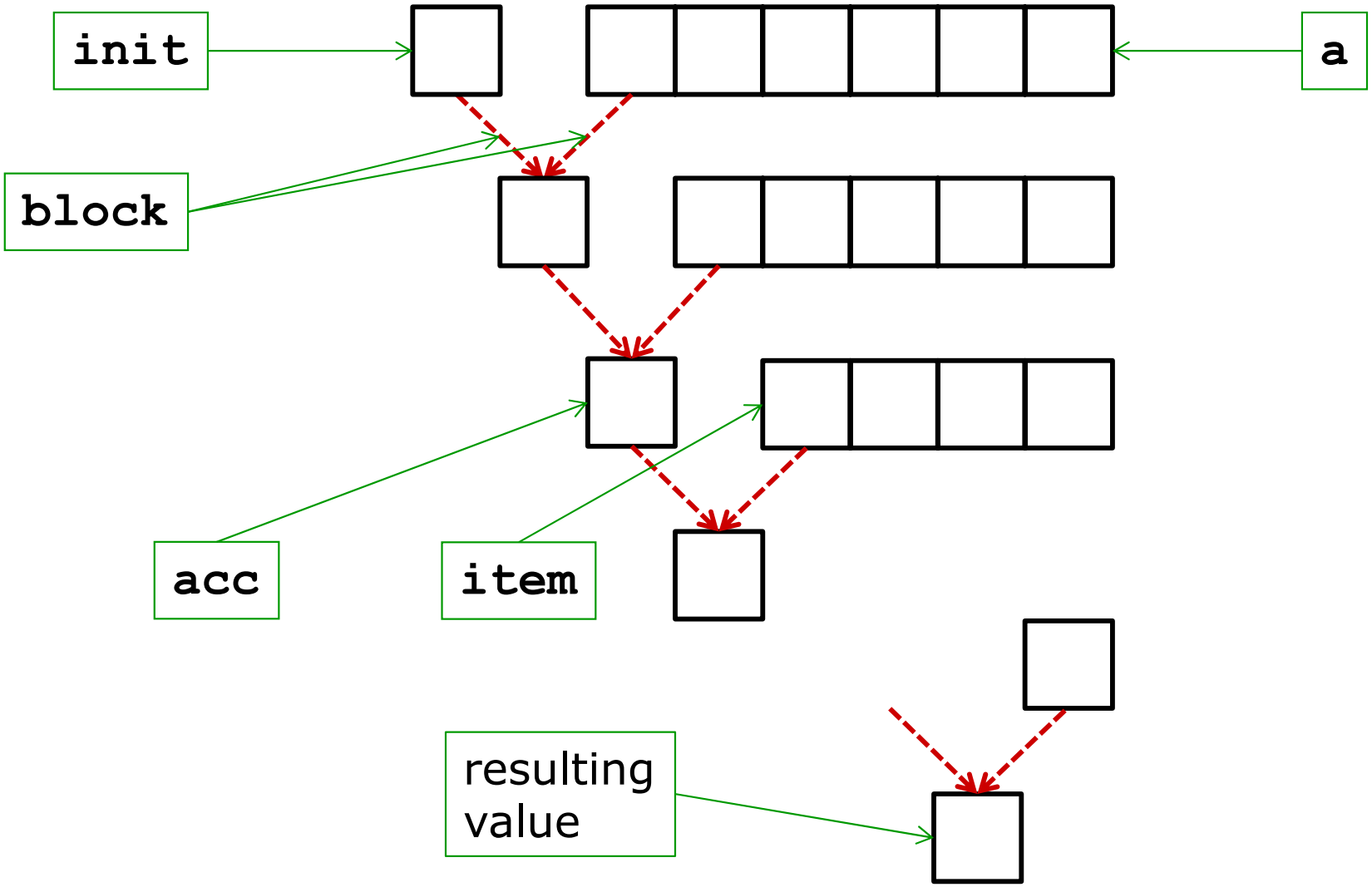
Reduce

- 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 }
(0..100).any? { |x| x < 0 } #=> false
[1, 2, 3].none? { |x| x % 2 == 0 }
```

- 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)

```
(5..8).map { 2 } #=> [2, 2, 2, 2]
(1..10).reduce(:+) #=> 55
book.reduce(0) { |sum, w| sum + w.length}
```

Your Turn

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

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

  - Result

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

Your Turn

- Given an array of integers
- Produce the 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

- Given an array of (a mix of) integers and array 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 → 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       # mutable values
h['id'] = 0x2a      # can grow
h.size              #=> 2
h['name'] = 'Luke'  # heterog. values
h[4.3] = [1, 3, 5]  # heterog. keys
h.delete 'id'       # can shrink

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

Example


```
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

- Write the Ruby code that, given an array of strings, computes frequency of occurrence of each word
- Example:
  - Given

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

  - Compute

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

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
```

- Problem: Aliases
- "Solution": For strings, Ruby *copies* (and *freezes*) a string when added to 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 }
```

Summary

- Blocks
  - Code passed as argument to a function
  - Elegant iteration over arrays
- Enumerable
  - Many useful iteration methods
- Hashes
  - Partial maps (aka associative arrays)