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CSE 413

Programming Languages &  
Implementation

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Ruby Containers, Blocks, and Procs

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# The Plan

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- Ruby container data structures
- Blocks and control structures (iterators, etc.)
- Blocks and first-class closures
  
- Later:
  - Duck typing
  - Inheritance
  - Modules and mixins

# Containers in Ruby

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- Like most scripting languages, Ruby provides very general container classes
- Two major kinds
  - Arrays: ordered by position
  - Hashes: collections of <key, value> pairs
    - Often known as associative arrays, maps, or dictionaries
    - Unordered

# Ruby Arrays

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- Instances of class `Array`
- Create with an array literal, or `Array.new`

```
words = [ "how", "now", "brown", "cow" ]  
stuff = [ "thing", 413, nil ]  
seq = Array.new
```
- Indexed with `[]` operator, 0-origin; negative indices count from right

```
words[0]   stuff[2]   words[-2]  
seq[1] = "something"
```

# Ruby Hashes

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- Instances of class `Hash`
- Create with an hash literal, or `Hash.new`

```
pets = { "spot"=>"dog", "puff"=>"cat" }  
tbl = Hash.new
```
- Indexed with `[]` operator specifying keys

```
pets["puff"]    pets["fido"]  
pets["cheeta"] = "monkey"
```

  - Can use almost anything as key type; can use anything as element type

# Containers and Iterators

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- All containers respond to the message “each”, executing a block of code for each item in the container

```
words.each { puts "another word" }  
words.each { | w | puts w }
```

# Blocks

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- A block is a sequence of statements surrounded by `{ ... }` or `do ... end`
- Blocks must appear immediately following the method call that executes them, on the same line
- Blocks may have 1 or more parameters at the beginning surrounded by `| ... |`
  - Initialized by the method that runs (executes, “calls”) the block

# Blocks as Closures

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- Blocks can access variables in surrounding scopes

```
wordlist = ""  
words.each { |w| wordlist = wordlist +  
              w + " " }
```

- These are almost, but not quite, first-class closures (some differences in scope rules compared to Racket)



# More Block Uses

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- Besides iterating through containers, blocks are used in many other contexts

```
3.times { puts "hello" }
```

```
n = 0  
100.times { | k | n += k }  
puts "sum of 0 + ... + 99 is " + n
```

# Block Execution

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- Any method call can be followed by a block. The block is executed by the method – when depends on the method
- A block is executed in the context of the method call
  - Block has access to variables at the call location
  - Return in a block returns from surrounding method(!)

```
def search(x, words)
  words.each { |w| if x==w then return end }
  puts "not found"
end
```

# yield

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- Any method call can be followed by a trailing block. A method “calls” the block with a `yield` statement.

```
def repeat
```

```
  yield
```

```
  yield
```

```
end
```

```
repeat { puts "hello" }
```

Output:

```
hello
```

```
hello
```

# yield with arguments

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- If the block has parameters, use expressions with yield to pass arguments

```
def xvii
  yield 17
end

xvii { | n | puts n+1 }
```

- This is exactly how an iterator works

# Blocks are “second-class”

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- Blocks (and methods) are not objects in Ruby – i.e., not things that can be passed around as first-class values
- All a method can do with a block is **yield** to it (i.e., call it)
  - Can’t return it, store it in an object, etc.
  - But we also can turn blocks into real closures (next slide)

# First-class closures

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- Implicit block arguments and `yield` are often sufficient
- But when you want a closure that can be returned, stored, passed as an argument:
  - The built-in `Proc` class
  - `Lambda` method of `Object` takes a block and makes a `Proc`
  - Instances of `Proc` have a `call` method that can be used to execute them

# Creating Procs: examples

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- Create a `Proc` object explicitly

```
p = Proc.new { | x, y | x+y }  
...  
p.call(x,y)
```

- Use Object's `lambda` method

```
is_positive = lambda { |x| x > 0 }
```

# Procs vs. Lambdas

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- A Proc is a block wrapped in an object – and behaves just like a block
  - In particular, a return in a Proc will return from the *surrounding* method where the Proc's closure was created
    - Error if that method has already terminated
- A Lambda is more like a method
  - Return just exits from the lambda



# Coming up next time...

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- Duck typing
- Modules
- mixins
- ...and more