CS 596 Functional Programming and Design
Fall Semester, 2014
Doc 7 Branching, Loops, Destructuring
Sep 18, 2014

Multiple lines

```
(defn average
      [a b c]
   (println (str "a is " a)
      (+ 1 3)
      (/ (+ a b c) 3))
```

(average 1 2 3)

returns 2

prints on standard out

a is 1

Why not use def & multiple lines?

```
(defn average-bad
  [a b c]
  (def sum (+ a b c))
  (def size 3)
  (/ sum size))
```

```
(defn average
  [a b c]
  (let [sum (+ a b c)
        size 3]
    (/ sum size)))
```

(average-bad 1 2 3)	2
sum	6
size	3

(average 1 2 3)	2
sum	Error
size	Error

def defines global names/values

let defines local names/values

Don't use def inside functions

Bindings, Shadowing & Functions

```
(dec 10)

(let [dec "December"
      test (dec 10)]
  test)

      Compile Error
```

```
(dec 10)

(def dec "December")

(dec 10)          Compile Error

(clojure.core/dec 10)
```

```
(def + -)
(+ 4 3)          1
```

Variable Number of Arguments

```
(defn variable
  [a b & rest]
  (str "a:" a " b:" b " rest:" rest))
```

(variable 1 2)	"a:1 b:2 rest:"
(variable 1 2 3)	"a:1 b:2 rest:(3)"
(variable 1 2 3 4)	"a:1 b:2 rest:(3 4)"
(variable 1)	Error

reduce

(reduce f coll)
(reduce f val coll)

Applies f to coll

(reduce + [1 2 3 4])	10
(reduce + [])	0
(reduce + 1 [])	1
(reduce + 1 [2 3])	6
(reduce + '(1 2 3))	6
(reduce str ["a" "b" "c"])	"abc"
(reduce conj #{} [1 2 3])	#{1 3 2}

Better Average

```
(defn average
  [& numbers]
   (let [sum (reduce + numbers)
         size (count numbers)]
    (if (> size 0)
     (/ sum size))))
```

(average)	nil
(average 1)	1
(average 1 2)	3/2
(average 1 2 3 4 5 6)	7/2

But + works on multiple values - Why Reduce?

(+ 1 2 3)	6
(+ [1 2 3])	Error
(reduce + [1 2 3])	6
(reduce + 1 2 3)	Error

Control Structures

Block

Branch

Loops

Not what you think

Block - do

```
(do
    form1
    form2
    …
    formN)
```

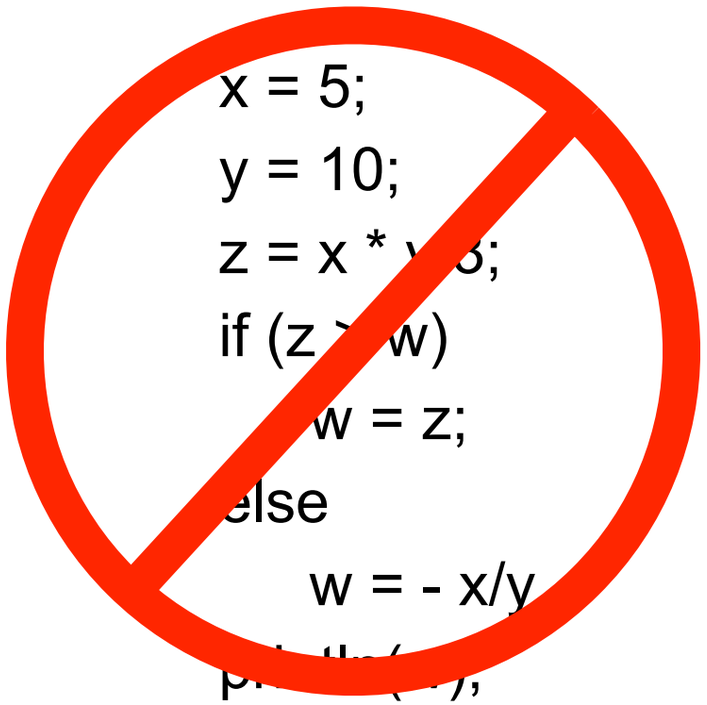
Executes sequence of expressions
Returns the result of last expression

No way to pass results between expressions

```
(do
    (println "starting do")
    (spit "log.txt" "in do")
    (+ 10 x))
```

Used to evaluate forms with side effects
I/O
Setting globals

Execute a sequence of statements?



Can't stack statements

Compose functions

let helps

```
(defn foo
    [x y w]
    (let [z  (/ (* x y ) 3)]
        (println
    (if (> z w)
        z
        (- (/ x y)))))
```

Branching

if
if-not
if-let
if-some
when
when-not
when-let
when-first
when-some
cond
condp

if

(if test then)
(if test then else)

if test is true then execute then

(if-not test then)
(if-not test then else)

if test is true then execute then

if is a form so returns a value

```
(defn middle
  [a b c]
  (if (or (<= a b c) (<= c b a))
    b
    (if (or (<= a c b) (<= b c a))
      c
      a)))
```

(middle 3 1 2) ⟶ 2

Comparing

	(> 3)	true
	(> 8 5)	true
=	(> 8 5 3)	true
==	(> 8 5 3 1)	true
not=	(> 8 5 6 1)	false
<		
>		
<=		
>=		
compare		

```
-1
 1
 0
 0
Error
 1
-1
 1
-1
-3
-2
```

Tests

nil?	Returns true if the argument is nil, false otherwise
identical?	Tests if the two arguments are the same object
zero?	Returns true if the argument is zero, else false
pos?	Returns true if the argument is greater than zero
neg?	Returns true if the argument is less than zero, else false
even?	Returns true if the argument is even, throws an exception if the argument is not an integer
odd?	Returns true if n is odd, throws an exception if the argument is not an integer
coll?	Returns true if the argument implements IPersistentCollection
seq?	Return true if the argument implements ISeq
vector?	Return true if the argument implements IPersistentVector
list?	Returns true if the argument implements IPersistentList
map?	Return true if the argument implements IPersistentMap
set?	Returns true if the argument implements IPersistentSet
contains?	Returns true if key is present in the given collection, else false
distinct?	Returns true if no two of the arguments are =
empty?	Returns true if the collection argument has no items same as (not (seq coll))

Naming Convention

Tests

- Return true/false
- end in ?

So why not

- compare?

Truthiness

Things that are false

- false
- nil

Things that are true

- Everything else

some

(some predicate collection)
(some pred coll)

Returns first true value of (predicate x) for any x in collection

(some even? [1 2 3]) true

(some even? [1 3 5]) nil

(some #(if (even? %) %) [1 2 3 4]) 2

#{2 3
"two" 3 "three"} [nil 3 2])

(some {2 "two" 3 "three"} [nil 3 2]) 3

(some [2 "two" 3 "three"] [nil 3 2]) IllegalArgumentException

Idiomatic Clojure

Using collections as functions

Very odd to non-clojure programmers

Done a lot

Testing Collections

Is a collection

- nil
- empty
- has elements

(empty? nil)	true
(empty? [])	true
(empty? [1 2 3])	false
(seq nil)	nil
(seq [])	nil
(seq [1 2 3])	(1 2 3)

if-let

```
(if (not (empty? (rest x)))
   {:value (reduce + (rest x))}
  {:value :empty})
```

```
(if-let [tail (seq (rest x))]
  {:value (reduce + tail)}
  {:value :empty})
```

```
(let [tail  (rest x)]
  (if (not (empty? tail))
     {:value (reduce + tail)}
    {:value :empty}))
```

```
(if-let [binding-form test]
      then
      else)
```

```
(let [tail (seq (rest x))]
  (if tail
     {:value (reduce + tail)}
    {:value :empty}))
```

binding-form = result of test
Then do if on binding-form

if-let

```
(def personA {:name "Roger" :illness "flu"})
(def personB {:name "Roger"})


(defn example
  [person]
  (if-let [disease (:illness person)]
        disease
        "Well"))
```

(example personA) "flu"

(example personB) "Well"

if-some

Added Clojure 1.6
Like if-let
tests for not nilness

```
(if-some [a nil]
  :true
  :false)
```
:false

```
(if-some [a false]
  :true
  :false)
```
:true

```
(if-let [a nil]
  :true
  :false)
```
:false

```
(if-let [a false]
  :true
  :false)
```
:false

when, when-not, when-let, when-some

if with only the true condition
Returns nil when condition is false

```
(when condition
    expresssion1
    expresssion2
    …
    expresssionN)
```

```
(if condition
  (do
    expresssion1
    expresssion2
    …
    expresssionN))
```

```
(when (> x 2)
  4)
```

```
(when (> x 2)
  (println "foo")
  4)
```

```
(when (seq collection)
    ;do something with collection
)
```

Idiomatic Clojure

```
(when (seq collection)
      ;do something with collection
)
```

Body only executed if collection has elements

```
(when (seq [1 2]) :body-executed)          :body-executed

(when (seq []) :body-executed)             nil

(when (seq nil)  :body-executed)           nil
```

when verses if

when is an if without branch

What is the point of when?

cond

```
(defn pos-neg-or-zero
  [n]
  (cond
    (< n 0) "negative"
    (> n 0) (str n "is positive")
    :else "zero"))
```

```
(defn pos-neg
  [n]
  (cond
    (< n 0) "negative"
    (> n 0) "positive"))
```

```
positive
nil
```

Find first condition that is true

Return the result of that condition's expression

condp

(condp function expression
    test-expression1 result-expression1
    …
    test-expressionN result-expressionN
    optional-default)

Return result-expressionK for first K where

    (function test-expressionK expression) evaluates to true

If no such K return default

Runtime exception if no match

Example - With default

```
(defn example
  [value]
  (condp = value
    1 "one"
    2 "two"
    3 "three"
    (str "unexpected value, " value)))
```

```
(example 2)        "two"
(example 9)        "unexpected value, 9"
```

Example - Without default

```
(defn example
  [value]
  (condp = value
    1 "one"
    2 "two"
    3 "three"))
```

```
(example 2)        "two"
(example 9)        IllegalArgumentException
```

condp - Complex version

(condp function expression
    test-expression1 :>> result-fn1
    …
    test-expressionN :>> result-fnN
    optional-default)

Find first (lowest) K where

    (function test-expressionK expression) evaluates to true

    then return (result-fnK function)

If no such K return default

Runtime exception if no match

Loops

loop
for
doseq

For

Returns a lazy sequence

```
(for [x (range 2)
      y (range 3)]
  [x y])
```

```
([0 0] [0 1] [0 2] [1 0] [1 1] [1 2])
```

```
(for [x (range 5)
      y (range 5)
      :while (< y x)]
  [x y])
```

```
([1 0] [2 0] [2 1] [3 0] [3 1] [3 2] [4 0] [4 1] [4 2] [4 3])
```

```
(for [x [0 1 2 3 4 5]
      :let [y (* 3 x)]
      :when (even? y)]
  y)
```

```
(0 6 12)
```

doseq

Same options as for

Returns nil

```
(doseq [x [1 2 3]
        y [1 2 3]]
    (prn [x y]))
```

```
(doseq [x [1 2 3]
            y [1 2 3]
            :when (> x y)]
    (prn [x y]))
```

Destructuring - Positional

```
(let [[a b c] (range 5)]
  (println "a b c are: " a b c))
```

```
a b c are:  0 1 2
```

```
(let [[a b c :as all] [1 2 3 4 5]]
  (println "a b c are:" a b c)
  (println "all is:" all))
```

```
a b c are:  1 2 3
all is: [1 2 3 4 5]
```

```
(let [[a b c & more :as all] (range 5)]
  (println "a b c are:" a b c)
  (println "more is:" more))
```

```
a b c are:  0 1 2
more is: (3 4)
```

```
(let [[a b c & more :as all] (range 5)]
  (println "a b c are:" a b c)
  (println "more is:" more)
  (println "all is:" all))
```

```
a b c are:  0 1 2
more is: (3 4)
all is: (0 1 2 3 4)
```

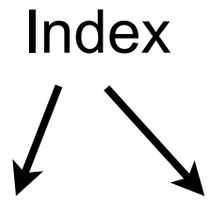
Destructuring - Positional

```
(defn destructuring
  [[a b c & more :as all]   z]
  (println "a b c are:" a b c)
  (println "more is:" more)
  (println "all is:" all)
  (println "z is:" z))
```

```
(destructuring [1 2 3 4 5] "cat")
```

```
a b c are: 1 2 3
more is: (4 5)
all is: [1 2 3 4 5]
z is: cat
```

Associative Destructuring




```
(let [{first 0, third 2, last 4} [1 2 3 4 5]]
  [first third last])
```

[1 3 5]

Destructuring - Maps

```
(def guys-name-map {:first-name "Guy" :middle-name "Lewis"
                    :last-name "Steele"})

(let [{l-name :last-name, f-name :first-name} guys-name-map]
  (str f-name " "  l-name))


(let [{:keys [last-name first-name]} guys-name-map]
  (str first-name " " last-name))
```

Destructuring - :keys, :strs, :syms

[{:keys [a b c]} map]	a, b, c get values at keys :a :b :c in map
[{:strs [a b c]} map]	a, b, c get values at keys "a" "b" "c" in map
[{:syms [a b c]} map]	a, b, c get values at keys 'a 'b 'c in map

Destructuring :as - The Entire map

```
(def guys-name-map {:first-name "Guy" :middle-name "Lewis"
                    :last-name "Steele"})

(let [{l-name :last-name, f-name :first-name :as whole-name} guys-name-map]
  (println f-name " "  l-name)
  whole-name)

    ;; Guy Steele
    ;;{:first-name "Guy", :middle-name "Lewis", :last-name "Steele"}
```

Destructuring :or - Default Values

```
(def guys-name-map {:first-name "Guy" :middle-name "Lewis"
                    :last-name "Steele"})

(let [{l-name :last-name, title :title,
               :or {title "Mr."} guys-name-map]
  (str title " " f-name " "  l-name))
```

Map, Reduce, Filter

Higher order functions

Very important

Map

Apply a function to each element of a collection, return resulting collection

Ruby - collect, map

Smalltalk - collect

Filter

Returns elements of collection that make