

# Random Numbers

The **random** operator is strange—it doesn't return the same result every time for the same input:

```
> (random 3)  
0  
> (random 3)  
2  
> (random 3)  
1  
> (random 3)  
2
```

# Random Symbols

Suppose we need a **random-symbol** function

```
> (random-symbol 'huey 'dewey 'louie)
'dewey
> (random-symbol 'huey 'dewey 'louie)
'huey
> (random-symbol 'huey 'dewey 'louie)
'dewey
> (random-symbol 'huey 'dewey 'louie)
'louie
```

Can we implement it with **random**?

# Random Symbols

```
; random-symbol : sym sym sym -> sym
(define (random-symbol a b c)
  (cond
    [(= (random 3) 0) a]
    [(= (random 3) 1) b]
    [(= (random 3) 2) c])))
```

This doesn't work, because **random** produces a different result each time

# Saving a Random Number

On the other hand...

```
(define n (random 3))  
(list n n n)
```

produces `(list 0 0 0)`, `(list 1 1 1)`, or  
`(list 2 2 2)`

Constant definitions name constants, so `(random 3)`  
must be evaluated when defining `n`

*Try it in the stepper*

# A Random Constant

Does this work?

```
(define n (random 3))  
  
; random-symbol : sym sym sym -> sym  
(define (random-symbol a b c)  
  (cond  
    [(= n 0) a]  
    [(= n 1) b]  
    [(= n 2) c])))
```

Not quite, because it always picks the same symbol

We want `(define n (random 3))` that is local to `random-symbol's` body

# Local Definitions

This works, in the *Intermediate* language

```
; random-symbol : sym sym sym -> sym
(define (random-symbol a b c)
  (local [(define n (random 3))])
  (cond
    [(= n 0) a]
    [(= n 1) b]
    [(= n 2) c])))
```

- The **local** form has definitions and a body
- Local definitions are only visible in the body
- Local definitions are evaluated only when the **local** is evaluated
- The result of **local** is the result of its body

# Evaluation with Local

```
(define (random-symbol a b c)
  (local [(define n (random 3))])
  (cond
    [(= n 0) a]
    [(= n 1) b]
    [(= n 2) c])))
(random-symbol 'huey 'dewey 'louie)
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)
(local [(define n (random 3))])
(cond
  [(= n 0) 'huey]
  [(= n 1) 'dewey]
  [(= n 2) 'louie]))
(random-symbol 'huey 'dewey 'louie)
```

# Evaluation with Local

```
(define (random-symbol ...) ...)
(local [(define n (random 3))]
  (cond
    [(= n 0) 'huey]
    [(= n 1) 'dewey]
    [(= n 2) 'louie]))
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)
(define n17 (random 3))
(cond
  [(= n17 0) 'huey]
  [(= n17 1) 'dewey]
  [(= n17 2) 'louie])
(random-symbol 'huey 'dewey 'louie)
```

Evaluation of `local` lifts and renames the definition



# Evaluation with Local

```
(define (random-symbol ...) ...)  
(define n17 (random 3))  
(cond  
  [(= n17 0) 'huey]  
  [(= n17 1) 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)  
(define n17 1)  
(cond  
  [(= n17 0) 'huey]  
  [(= n17 1) 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

# Evaluation with Local

```
(define (random-symbol ...) ...)
(define n17 1)
(cond
  [(= n17 0) 'huey]
  [(= n17 1) 'dewey]
  [(= n17 2) 'louie])
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)
(define n17 1)
(cond
  [(= 1 0) 'huey]
  [(= n17 1) 'dewey]
  [(= n17 2) 'louie])
(random-symbol 'huey 'dewey 'louie)
```

Evaluation of a constant name finds the value

# Evaluation with Local

```
(define (random-symbol ...) ...)  
(define n17 1)  
(cond  
  [(= 1 0) 'huey]  
  [(= n17 1) 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)  
(define n17 1)  
(cond  
  [false 'huey]  
  [(= n17 1) 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

# Evaluation with Local

```
(define (random-symbol ...) ...)  
(define n17 1)  
(cond  
  [false 'huey]  
  [(= n17 1) 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)  
(define n17 1)  
(cond  
  [(= n17 1) 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

# Evaluation with Local

```
(define (random-symbol ...) ...)
(define n17 1)
(cond
  [(= n17 1) 'dewey]
  [(= n17 2) 'louie])
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)
(define n17 1)
(cond
  [(= 1 1) 'dewey]
  [(= n17 2) 'louie])
(random-symbol 'huey 'dewey 'louie)
```

# Evaluation with Local

```
(define (random-symbol ...) ...)  
(define n17 1)  
(cond  
  [(= 1 1) 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)  
(define n17 1)  
(cond  
  [true 'dewey]  
  [(= n17 2) 'louie])  
(random-symbol 'huey 'dewey 'louie)
```

# Evaluation with Local

```
(define (random-symbol ...) ...)
(define n17 1)
(cond
  [true 'dewey]
  [(= n17 2) 'louie])
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)
(define n17 1)
'dewey
(random-symbol 'huey 'dewey 'louie)
```

# Evaluation with Local

```
(define (random-symbol ...) ...)
(define n17 1)
'dewey
(random-symbol 'huey 'dewey 'louie)
```

→

```
(define (random-symbol ...) ...)
(define n17 1)
'dewey
(local [(define n (random 3))]
  (cond
    [(= n 0) 'huey]
    [(= n 1) 'dewey]
    [(= n 2) 'louie])))
```



# Evaluation with Local

```
(define (random-symbol ...) ...)
(define n17 1)
'dewey
(local [(define n (random 3))]
  (cond
    [(= n 0) 'huey]
    [(= n 1) 'dewey]
    [(= n 2) 'louie])))
```

→

```
(define (random-symbol ...) ...)
(define n17 1)
'dewey
(define n45 (random 3))
(cond
  [(= n45 0) 'huey]
  [(= n45 1) 'dewey]
  [(= n45 2) 'louie]))
```

Evaluation of `local` picks a new name each time

# Evaluation with Local

```
(define (random-symbol ...) ...)
(define n17 1)
'dewey
(define n45 (random 3))
(cond
  [(= n45 0) 'huey]
  [(= n45 1) 'dewey]
  [(= n45 2) 'louie])
```

→

```
(define (random-symbol ...) ...)
(define n17 1)
'dewey
(define n45 0)
(cond
  [(= n45 0) 'huey]
  [(= n45 1) 'dewey]
  [(= n45 2) 'louie])
```

# Another Example

```
(define (remove-from-list log i)
  (cond
    [(empty? log) empty]
    [(cons? log)
     (cond
       [(false? (remove-person (first log) i))
        (remove-from-list (rest log) i)]
       [else
        (cons (remove-person (first log) i)
              (remove-from-list (rest log) i))]]))
```

Easier to read, removes only once:

```
(define (remove-from-list log i)
  (cond
    [(empty? log) empty]
    [(cons? log)
     (local [(define first-removed (remove-person (first log) i))]
       (cond
         [(false? first-removed)
          (remove-from-list (rest log) i)]
         [else
          (cons first-removed (remove-from-list (rest log) i))]])))]))
```

# Another Example

```
(define (remove-from-list log i)
  (cond
    [(empty? log) empty]
    [(cons? log)
     (cond
       [(false? (remove-person (first log) i))
        (remove-from-list (rest log) i)]
       [else
        (cons (remove-person (first log) i)
              (remove-from-list (rest log) i))]]]))
```

Even better:

```
(define (remove-from-list log i)
  (cond
    [(empty? log) empty]
    [(cons? log)
     (local [(define first-removed (remove-person (first log) i))
             (define rest-removed (remove-from-list (rest log) i))]
          (cond
            [(false? first-removed) rest-removed]
            [else (cons first-removed rest-removed)]))]))
```

# Another Use for Local

**local** can define functions as well as constants:

```
(define (random-symbol a b c)
  (local [(define (real-random-symbol a b c)
            (local [(define n (random 3))]
              (cond
                [(= n 0) a]
                [(= n 1) b]
                [(= n 2) c]))]))
  (cond
    [(and (symbol? a) (symbol? b) (symbol? c))
     (real-random-symbol a b c)]
    [else (error 'random-symbol "not a symbol")]))))
```

*Use Check Syntax and mouse over variables*

# Lexical Scope

Names obey *lexical scope*:

```
(define (random-symbol a b c)
  (local [(define (real-random-symbol a b c)
            (local [(define n (random 3))]
              (cond
                [(= n 0) a]
                [(= n 1) b]
                [(= n 2) c]))]))
  (cond
    [(and (symbol? a) (symbol? b) (symbol? c))
     (real-random-symbol a b c)]
    [else (error 'random-symbol "not a symbol")]))))
```

Italic *a* could be changed to *z* without affecting non-italic *a*, no matter how the code runs