

# Programming Abstractions

## Lecture 5: Variations on let

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# Announcements

Office hours 14:00–15:00 tomorrow (half hour later than usual!)

Homework 1 due Friday

What values does this code return?

```
(define (foo x)
  (let ([y (add1 x)]
        [z (* 2 x)]))
    (+ y z)))
(foo 3)
```

A. 10

B. 11

C. 12

D. Some other value

E. Error

What values does this code return?

```
(define (bar x)
  (let ([x (add1 x)]
        [z (* 2 x)]))
    (+ x z)))
(bar 3)
```

A. 10

B. 11

C. 12

D. Some other value

E. Error

# A common problem

When writing programs, it's not uncommon to define some local variables in terms of other local variables

Example: Return the elements of a list of numbers that are at least as large as the first element (the head) of the list, in reverse order

```
(define (at-least-as-large lst)
  (cond [(empty? lst) empty]
        [else
         (let ([head (first lst)])
           [bigger (filter ( $\lambda$  (x) ( $\geq$  x head)) lst)])
         (reverse bigger))])
```

This doesn't work; we can't use `head` in the definition of `bigger`

# The issue

The issue is the scope of the binding for head: just the body of the let

One (bad) work around would be to use multiple lets

```
(define (at-least-as-large lst)
  (cond [(empty? lst) empty]
        [else
         (let ([head (first lst)])
           (let ([bigger (filter (λ (x) (>= x head)) lst)])
             (reverse bigger)))]))
```

# Sequential let

```
(let* ([id1 s-exp1] [id2 s-exp2]...) body)
```

Later s-exps can use earlier ids, e.g.,

```
(let* ([x 5]  
      [y (foo x)]  
      [z (+ x y)])  
  (bar z y))
```

# Returning to our example

```
(define (bar x)
  (let* ([x (add1 x)]
         [z (* 2 x)])
    (+ x z)))
(bar 3)
```



# A more realistic example

Write a procedure (`split-by pred lst`) that splits `lst` into two lists, the first contains all of the elements that match `pred`, the second contains all the elements that do not match `pred`

```
(split-by even? (range 10)) => '((0 2 4 6 8) (1 3 5 7 9))
```

```
(split-by (λ (x) (< x 3)) (range 5)) => '((0 1 2) (3 4))
```

```
(define (split-by pred lst)
```

# Another problem: recursion

Often, we're going to want to define a recursive procedure but we can't do that with `let` or `let*`

```
(let ([fact (λ (n)
              (if (<= n 1)
                  1
                  (* n (fact (sub1 n))))))]
  (fact 5))
```

We can't use `fact` in the definition of `fact`



# Recursive let drawback (subtle)

The values of the identifiers we're binding can't be used in the bindings

Invalid (the value of *x* is used to define *y*)

```
▸ (letrec ([x 1]
           [y (+ x 1)])
    y)
```

Valid (the *value* of *x* isn't used to define *y*, it's only used when *y* is called)

```
▸ (letrec ([x 1]
           [y (λ () (+ x 1))])
    (y))
```