MASSACHVSETTS INSTITVTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science
6.001—Structure and Interpretation of Computer Programs
Spring Semester, 1999

Recitation – Wednesday, March 17

0. Administrivia

- Don't miss lecture tomorrow! Really.
- PS #4 is due today (in section or, for Sandia, 36-115, for Hooman, 36-117).
- PS #5 is due on March 31st (not during spring break)

1. Functions Aren't Functions Anymore

Up until now, every time we called a procedure with the same arguments, we got the same value back. For example, if `(foo 7)` returned `12`, then **every time** we called `(foo 7)` we would get back 12. Consider the example below. Draw the box and pointer diagram and evaluate the following expressions.

```
(define count (list 0))
(define (counter)
  (set-car! count (+ (car count) 1))
  (car count))
```

```
(counter)  ⇒  1
(counter)  ⇒  2
(counter)  ⇒  3
```

Notice that we're in danger if someone else is using the variable count. We'll step on each other's feet. How can we prevent this from happening?

```
(define counter
  (let ((count (list 0)))
    (lambda ()
      (set-car! count (+ (car count) 1))
      (car count)))
)
```

We'll see more tomorrow in lecture on how and why this technique of local state works.

2. Buffers

Write a function called `buffer` that takes one argument `x` and at each call, it returns the argument of the previous call to buffer. For example:

```
(buffer 1)       ⇒ #f
(buffer 7)       ⇒ 1
(buffer 'x)      ⇒ 7
(buffer '(2 5))  ⇒ x
(buffer +)       ⇒ (2 5)
```

```
(define buffer
  (let ((store (list #f)))
    (lambda (x)
      (let ((result (car store)))
        (set-car! store x)
        result)))
)
```

3. Remembering Values

Write a function called `seen?` that takes one argument and returns #t only if that function has been called before with that argument. Assume you have the function `element?` that takes an object and a list, and returns #t if the object is in the list.

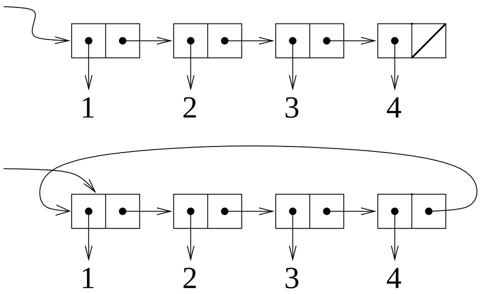
```
(seen? 1)  ⇒ #f
(seen? 'x) ⇒ #f
(seen? 1)  ⇒ #t
(seen? 'y) ⇒ #f
(seen? 'x) ⇒ #t
(seen? 'y) ⇒ #t
```

```
(define seen?
  (let ((store (list 'values)))
    (lambda (x)
      (cond ((element? x (cdr store)) #t)
            (else (set-cdr! store (cons x (cdr store)))
                  #f))))
)
```

4. List Mutation – Rings

Rings are circular structures similar to lists. If we define a ring r, `(define r (make-ring '(1 2 3 4)))`, the following is true:

```
(nth 0 r)
⇒ 1
(nth 1 r)
⇒ 2
...
(nth 4 r)
⇒ 1
```



Write the function `make-ring!` that takes a list and makes a ring out of it. *Hint: It might be helpful to write a helper function called* `last-pair`.

```
(define (make-ring! ring-list)
   (define (last-pair lst)
      (if (null? (cdr lst))
          lst
          (last-pair (cdr lst))))
   (set-cdr! (last-pair ring-list) ring-list)
   ring-list
)
```

Write the procedure `rotate-left` that takes a ring and returns a ring that has been rotated one to the right.

```
(define (rotate-left ring)
   (cdr ring)
)
```

```
(define r1 (rotate-left r))
(nth 0 r1)
⇒ 2
```

We can also rotate a ring to the right. Rotating to the right is harder than rotating to the left. Define a procedure `ring-length` that will tell us the length of the ring (which is the length of the original list). *Hint: remember* `eq?`

```
(define (ring-length ring)
   (define (helper n here)
      (if (eq? here ring)
          n
          (helper (+ 1 n) (cdr here))))
   (helper 1 (cdr ring))
)
```

Now write the procedure `rotate-right`. If you're tired of writing helper procedures, you can use repeated.

```
(define (rotate-right ring)
   ((repeated rotate-left
      (- (ring-length ring) 1)) ring)
)
```

```
(define r2 (rotate-right r))
(nth 0 r1)
⇒ 4
```

5. Append!

Recall the function `append` that takes two lists and returns a list of the two appended. Recall that to do this, we made a **copy** of the first list and `cons`'d it onto the second. Now that we had side effects, we can append two lists without creating a copy of one of them. Assuming you have the function `last-pair` that we wrote above, write the function `append!`.

```
(define (append! x y)
   (set-cdr! (last-pair x) y)
   x
)
```