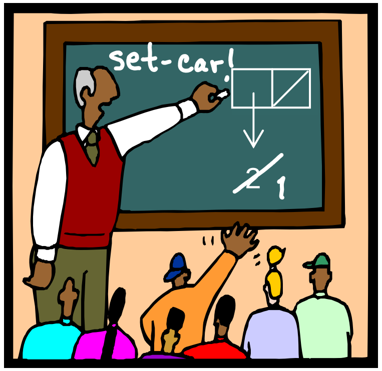
6.001 recitation 3/21/07

- set-car! and set-cdr!
- ring problems
- more set-car!, set-cdr! problems



Dr. Kimberle Koile

compound data mutation

constructor:

`(cons x y)`	**creates a new pair**

selectors:

`(car p)`	**returns car part of pair**
`(cdr p)`	**returns cdr part of pair**

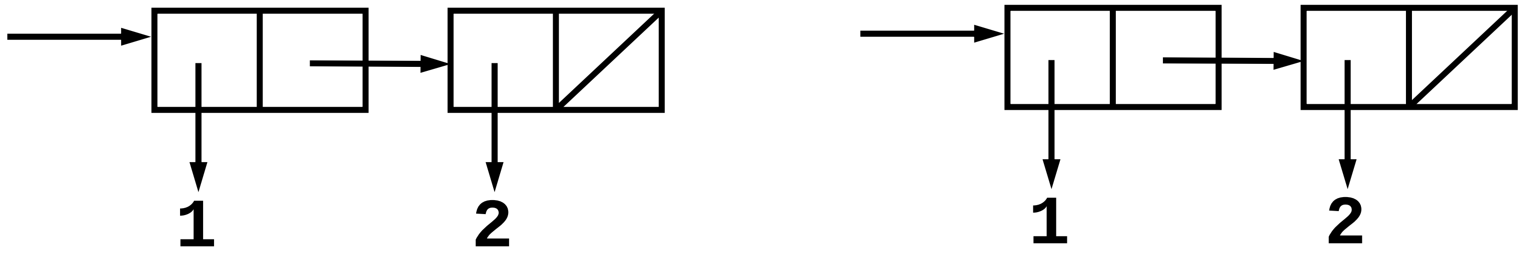
mutators:

`(set-car! p new-x)`	**changes car pointer in pair**
`(set-cdr! p new-y)`	**changes cdr pointer in pair**
`; Pair,anytype -> undef`	**--** **side-effect only!**

How can we tell if two things are equivalent?

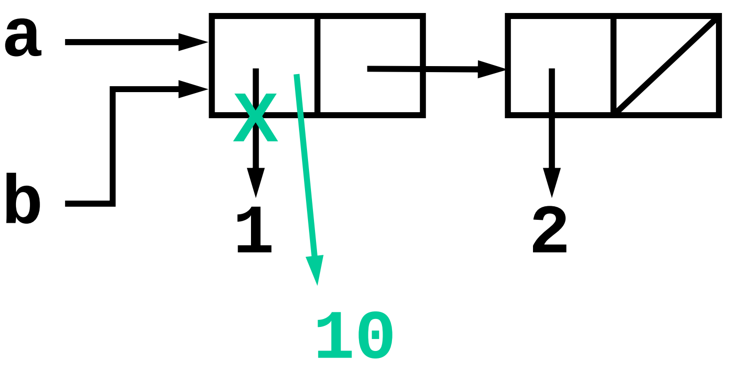
-- What do you mean by "equivalent"?

1. **The *same object*: test with** `eq?`
   `(eq? a b) ==> #t`
2. **Objects that *"look" the same*: test with** `equal?`
   `(equal? (list 1 2) (list 1 2)) ==> #t`
   `(eq? (list 1 2) (list 1 2)) ==> #f`



example 1: pair/list mutation

```
(define a (list 1 2))
(define b a)
 a ==> (1 2)
 b ==> (1 2)
```




```
(set-car! a 10)
```

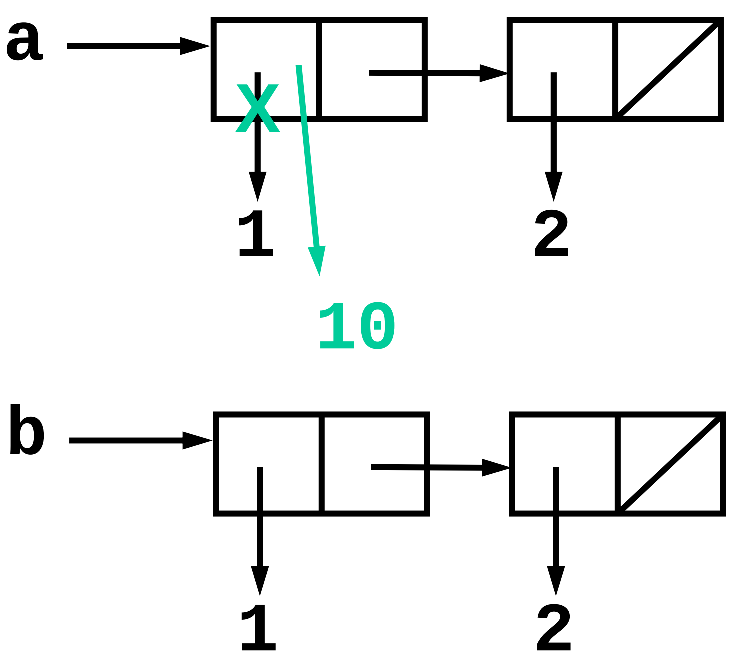
```
b ==> (10 2)
```

Compare with:

```
(define a (list 1 2))
(define b (list 1 2))
```

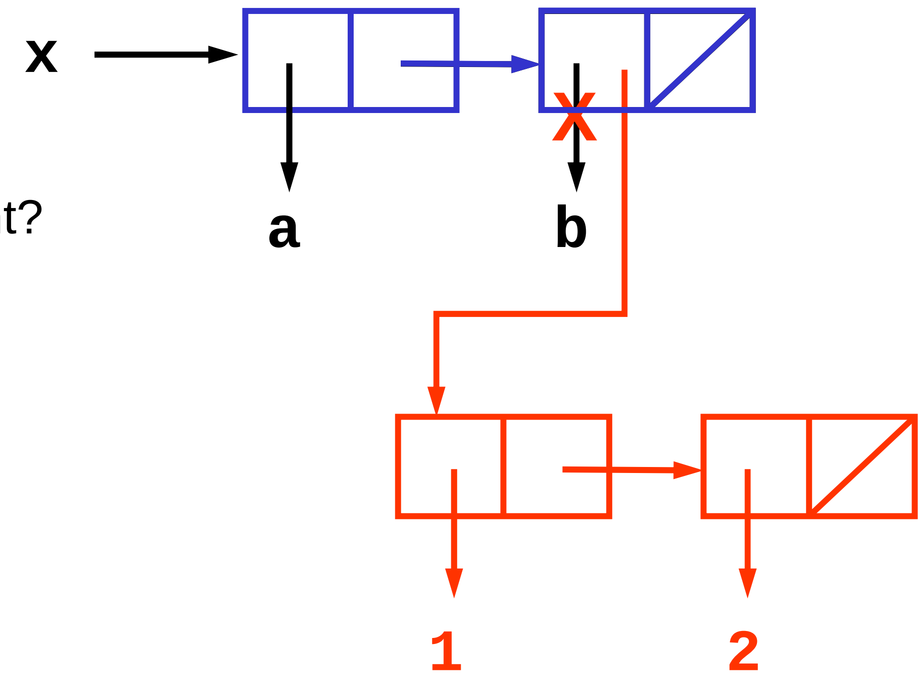
```
(set-car! a 10)
```

```
b ==> (1 2)
```



example 2: pair/list mutation

```
(define x (list 'a 'b))
```

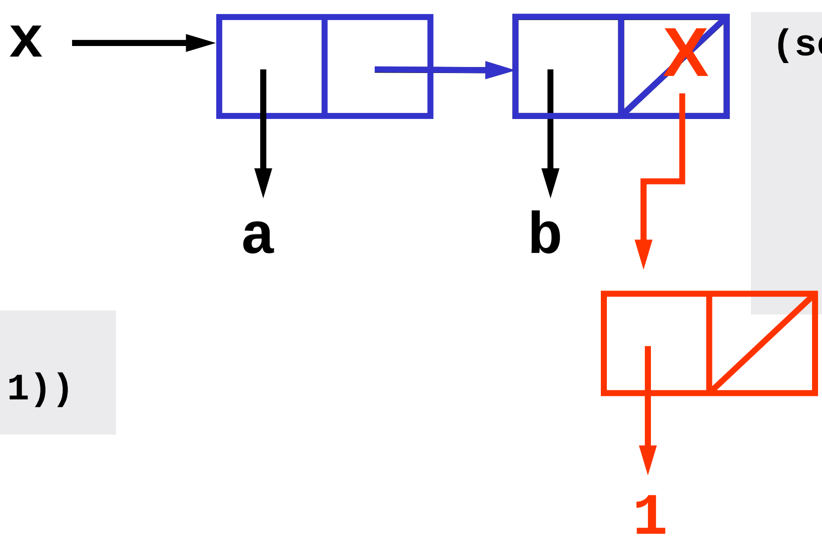


How is x mutated to achieve the result at right?

```
(set-car! (cdr x)
          (list 1 2))
```

1. Eval **(cdr x)** to get a pair object
2. Change car pointer of that pair object

And this one?




```
(set-cdr! (cdr x)
          (list 1))
```

set-car! and set-cdr! problems

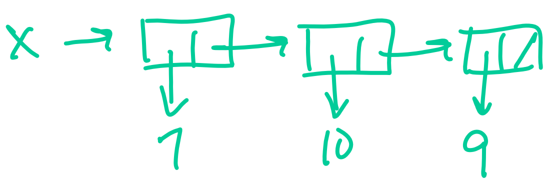
For the given expressions:

(a) Draw the box and pointer diagram corresponding to the list or pair structure

(b) Write what Scheme prints out after evaluating the last expression in the sequence

1. (define x (cons 7 (list 8 9)))
   (set-car! (cdr x) 10)

a. box and pointer diagram for x



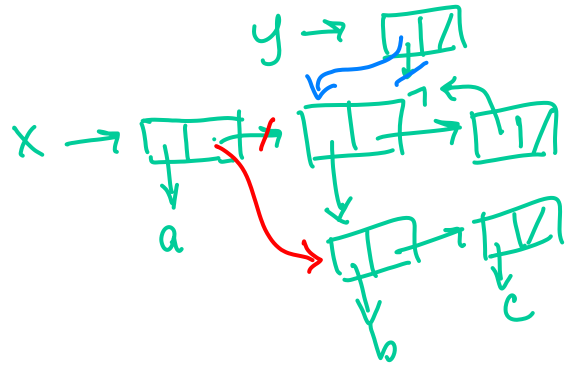
b. printed result for x

(7 10 9)

set-car! and set-cdr! problems

For the given expressions:
(a) Draw the box and pointer diagram corresponding to the list or pair structure
(b) Write what Scheme prints out after evaluating the last expression in the sequence

2.
```
(define y  '(7))
(define z  (let ((x (list 'a '(b c)   (car y))))
                     (set-car! y (cdr x))
                     (set-cdr x (car (cdr x)))
                     x))
z
```



a. box and pointer diagram for x, y and z

b. printed result for z

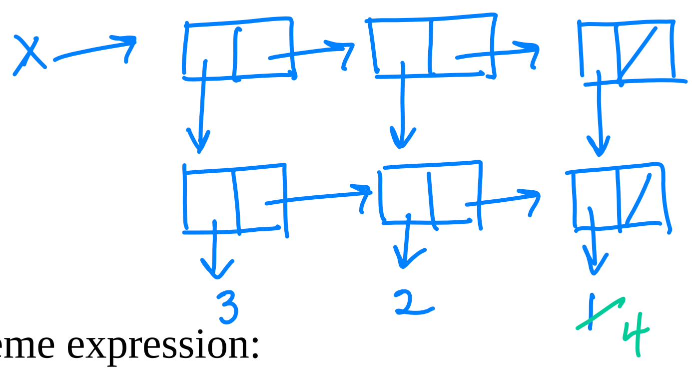
(a b c)

instructor notes

more set-car! and set-cdr! problems

For the box & pointer diagram:
(a) Write what Scheme prints out for the structure (if it can)
(b) Write a Scheme expression that makes the structure (if an error, describe it)
(c) Draw the structure that results from the mutation, and its printed representation.

3.



a. x => ((3 2 1) (2 1) (1))

instructor notes

b. Scheme expression:

instructor notes

```
(define x
   (let ((z '(3 2 1)))
      (list z (cdr z) (cddr z))))
```

c. mutation: (set-car! (cdr (second x)) 4)

x => ((3 2 4) (2 4) (4))

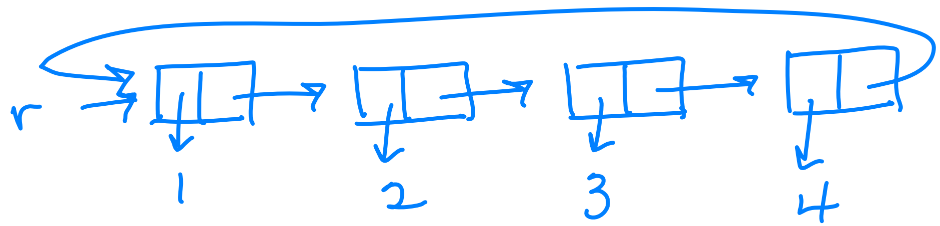
instructor notes

ring problems

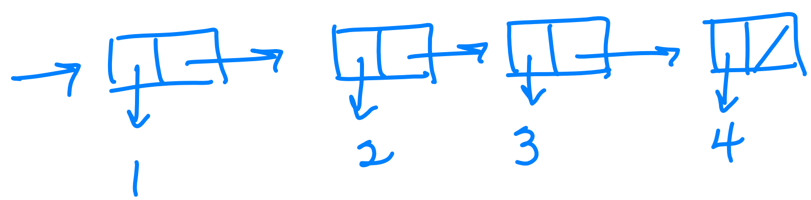
Rings are circular structures similar to lists.

If we define a ring r: (define r (make-ring ‘(1 2 3 4)))

the following are true: (nth 0 r) => 1 (nth 1 r) => 2 … (nth 4 r) => 1



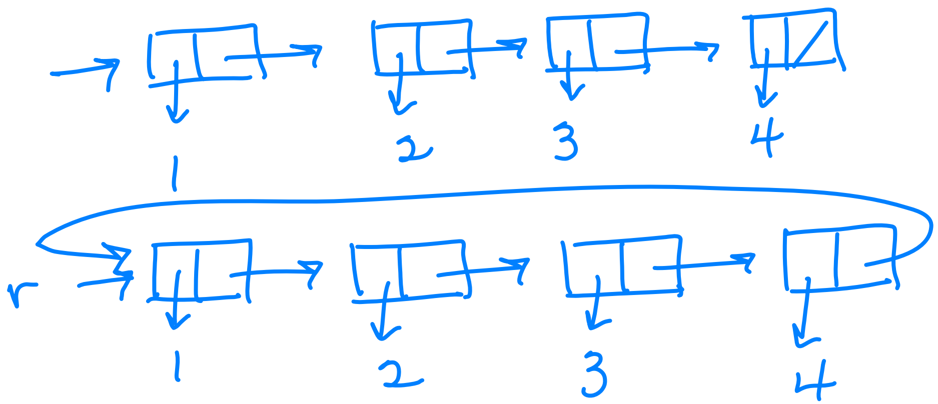
In order to make a ring, we need a procedure last-pair which returns the last pair in its argument:
(last-pair (list 1 2 3 4))=> (4)



1. Write last-pair.

```
(define (last-pair x)
  (if (null? (cdr x))
      x
      (last-pair (cdr x))))

or (cond ((null? x) (error "..." x))
         ((not (list? x)) x) ;pair
         ((null? (cdr x)) x)
         (else (last-pair (cdr x)))))
```

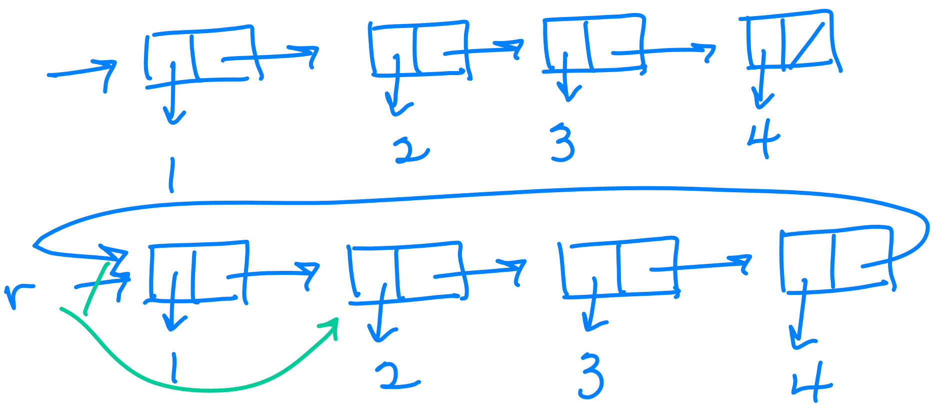
ring problems



2. Write make-ring!, which takes a list and makes a ring out of it..

```
(define (make-ring!  x)

   (set-cdr! (last-pair x) x)

         x)

)
```

ring problems



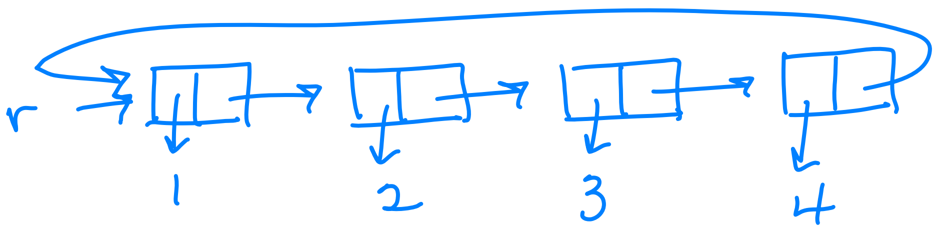
3. Write the procedure rotate-left, which takes a ring and returns a ring that has been rotated one to the right.

   (define r1 (rotate-left r))

   (nth 0 r1) => 2

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

ring problems

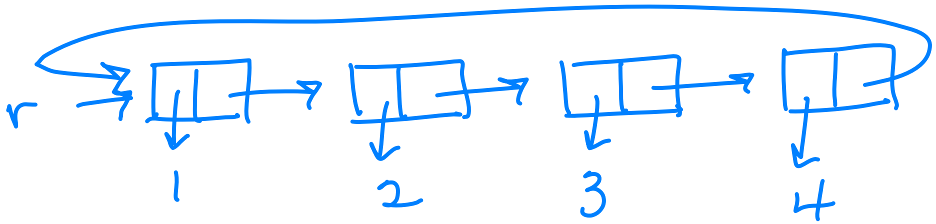


4. What happens if you evaluate (length r) on the above ring?

Write the procedure ring-length, which returns the length of the original list used in constructing the ring. (Hint: Write a helper procedure.)

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

ring problems



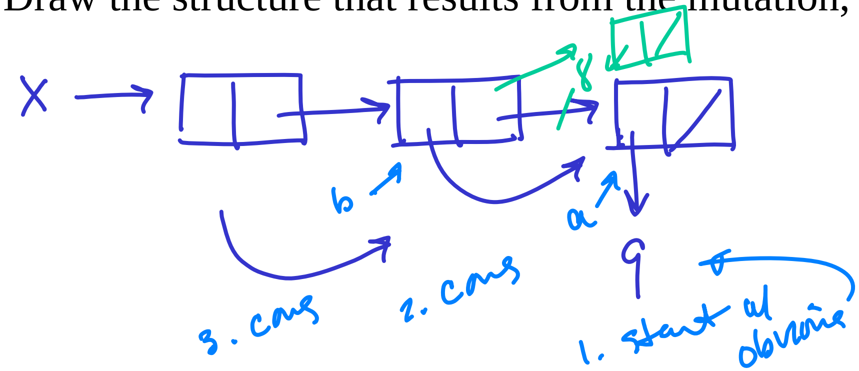
5. Rotating a ring to the right is harder than rotating to the left. (Why?) Write the procedure rotate-right. (Hint: You might want to use the procedure repeated, which takes a procedure, a number n, and an argument to the procedure, and repeatedly calls the op on the argument n times.)

```
(define (rotate-right ring)

    (repeated rotate-left
              (- (ring-length ring) 1)
              ring))

)
```

more set-car! and set-cdr! problems

For the box & pointer diagram:
(a) Write what Scheme prints out for the structure (if it can)
(b) Write a Scheme expression that makes the structure(if an error, describe it)
(c) Draw the structure that results from the mutation, and its printed representation.

1.



a. x =>

(((9) 9) (9) 9)

3 elts

- start w/ # elts

b. Scheme expression:

```
(define x
    (let ((a '(9)))          1.
        (let* ((b (cons a a)))   2.
            (cons b b))))        3.
```

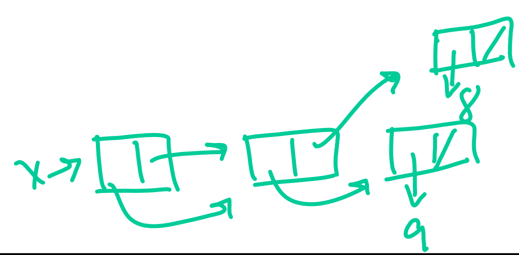
or let*

or

```
(define x
 (let ((a (list 9 9 9)))
   (set-car! (car a) (cddr a))
   (set-car! a (cdr a))
 a))
```

can be anything

c. mutation: (set-cdr! (car x) '(8))



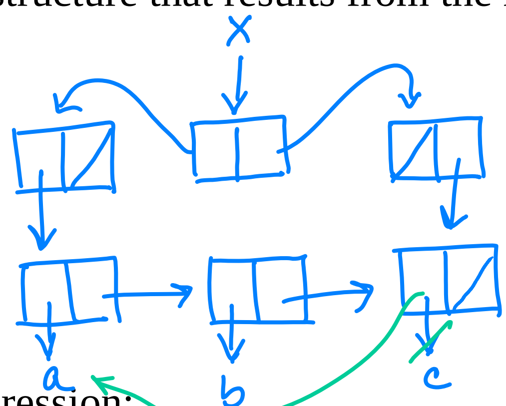
x => (((9) 8) (9) 8)

more set-car! and set-cdr! problems

* ptr can point to any part of box

For the box & pointer diagram:
(a) Write what Scheme prints out for the structure (if it can)
(b) Write a Scheme expression that makes the structure (if an error, describe it)
(c) Draw the structure that results from the mutation, and its printed representation.

2.



a. x =>

(((a b c)) () c)

b. Scheme expression:

```
(define x
   (let ((w '(a b c)))
      (cons (list w)
            (cons '() (cddr w)))))
```

c. mutation: (set-cdr! (cddr x) (caaar x))

x =>

(((a b a)) () a)

more set-car! and set-cdr! problems

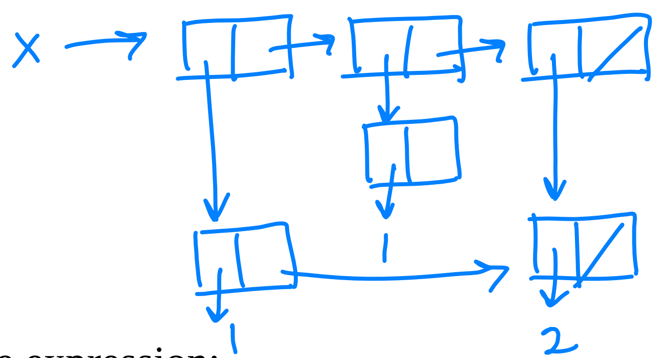
For the box & pointer diagram:

(a) Write what Scheme prints out for the structure (if it can)

(b) Write a Scheme expression that makes the structure (if an error, describe it)

(c) Draw the structure that results from the mutation, and its printed representation.

3.



a. x =>

((1 2) (1) (2))

b. Scheme expression:

```
(define x
   (let ((two '(2)))
      (list (cons 1 two)
            (list 1) two)))
```

c. mutation: (set-car! (caar x) 3)

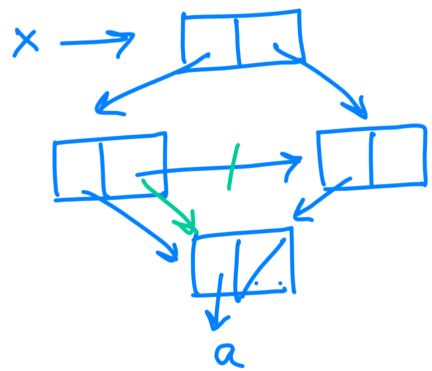
x =>

error: (caar x) => 1

more set-car! and set-cdr! problems

For the box & pointer diagram:
(a) Write what Scheme prints out for the structure (if it can)
(b) Write a Scheme expression that makes the structure (if an error, describe it)
(c) Draw the structure that results from the mutation, and its printed representation.

4.



a. x =>

(((a) (a)) (a))

b. Scheme expression:

```
(define x
  (let ((k '(a)))
    (let ((m (list k k)))
      (cons m (cdr m)))))
```

c. mutation: (set-cdr! (first x) (second x))

x =>

(((a) a) (a))

more set-car! and set-cdr! problems

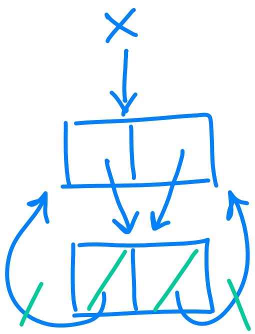
For the box & pointer diagram:

(a) Write what Scheme prints out for the structure (if it can)

(b) Write a Scheme expression that makes the structure (if an error, describe it)

(c) Draw the structure that results from the mutation, and its printed representation.

5.



a. x =>

((((((... . unprintable

b. Scheme expression:

```
(define x
    (let ((c (cons '() '())))
        (let ((d (cons c c)))
            (set-car! c d)
            (set-cdr! c d)
        c)))
```

c. mutation: (set-car! (cdr x) '())
(set-cdr! (car x) '())

x => ((()) ())