MASSACHVSETTS INSTITVTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science
6.001—Structure and Interpretation of Computer Programs
Spring 2006

Recitation 13 — 3/24/2006
Stateful Functions and Rings

Counter

Before this week, every time we evaluated a procedure with a given argument, we got the same value back. For example, if a procedure `(foo 7)` returned 12, `(foo 7)` would always return 12. No longer! Consider the following example:

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

```
(counter) ==> 1
(counter) ==> 2
(counter) ==> 3
```

There's one problem with this approach though – what if count is defined somewhere else? Redefine `counter` to fix this problem:

```
(define counter
```

Remember

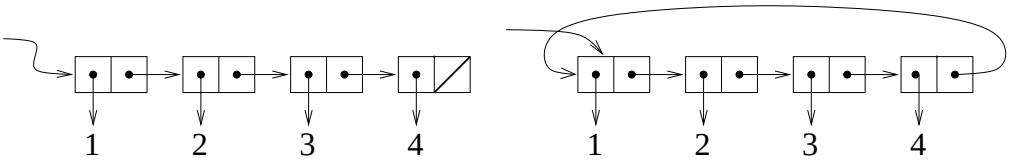
Write a function called `remember` that takes one argument `x` and returns the value of the last call to `remember`. For example:

```
(remember 1)  ==> #f
(remember 2)  ==> 1
(remember 'x) ==> 2
(remember '(y)) ==> x
(remember -) ==> (y)

(define remember
```

Rings

Rings are a circular structure, similar to a list. Unlike a list however, the cdr of the last pair of a ring points back to the first element:

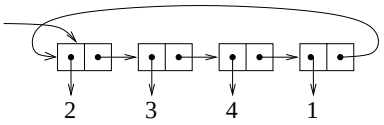


1. Write a function called `make-ring!` that takes a list and makes a ring out of it. You may want to start off writing a helper procdedure called `last-pair`.

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

2. Write a procedure `rotate-left` that takes a ring and returns a rotated version of the same ring. This procedure should take $\Theta(1)$ time, and not create any new cons cells.

   A left-rotated version of the ring above:

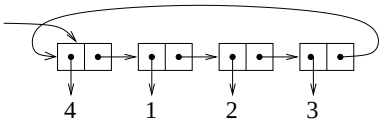

   ```
   (define (rotate-left ring)
   ```

3. Write a procedure `ring-length` which returns the length (number of elements) in a ring

   ```
   (define (ring-length ring)
   ```

4. Write a procedure `rotate-right` that rotates a ring to the right. Unlike `rotate-left`, `rotate-right` takes $\Theta(n)$ operations, though it still should not create any new cons cells.

   A right-rotated version of the ring above:


   ```
   (define (rotate-right ring)
   ```

Ring Buffer

Using the ring procedures defined previously, design an ADT for a queue of fixed maximum capacity. It should have a constructor `(make-ring-buffer n)`, which creates a ring of `n` elements. `(ring-enqueue! x)` should add `x` to the queue, and `(ring-dequeue!)` should return the next element from the queue. Each enqueue or dequeue operation should take constant time, and not create any new cons cells. The queue may contain at most `n` elements at any one time. Adding more than `n` elements is an error.

For example:

```
(define rb (make-ring-buffer 2))  --> unspecified
(ring-enqueue! rb 1)              --> unspecified
(ring-enqueue! rb 2)              --> unspecified
(ring-dequeue! rb)                --> 1
(ring-enqueue! rb 3)              --> unspecified
(ring-enqueue! rb 4)              --> error -- too many elements
```