CSE 341 AA: Section 6

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Fibonacci case study:

Here is one intuitive solution, but can we do better?

(define (fibonacci x)
  (if (or (= x 1) (= x 2))
      1
      (+ (fibonacci (- x 1))
          (fibonacci (- x 2))))))
Memoization

- Why compute the same recursive call for a function twice when there are no major side-effects?
- Memoization is a way to “remember” previous calls
- Requires a way for the function to store both the input and the result of previous calls to that function
Lexical-scope and mutation

(define count-calls-correct
  (let [(count 0)] ; This remembers the count from previous calls
    (lambda ()
      (begin (set! count (+ count 1)) count))))
Lexical-scope and mutation

(define count-calls-wrong
  (lambda ()
    (let [(count 0)] ; This starts at 0 every time
      (begin (set! count (+ count 1)) count))))
Mutable Lists

- Similar to regular lists and pairs but not the same datatype.
  - Mutable pairs have type \texttt{mpair}. Use \texttt{mcons} for creation, \texttt{mcar} to get the first thing and \texttt{mcdr} for the second

- \texttt{set-car!} and \texttt{set-cdr!} actually change the “fields” of a \texttt{mpair}

- Use mutable types only when necessary! Prefer immutable!
Mutable Lists Example

(define mp (mcons 1 (mcons 2 null)))
(mpair? mp) ; #t
(mcar mp) ; get the first element in mp (car won’t work!)
(mcdr mp) ; get the second element in mp (cdr won’t work!)
(set-mcar! mp 5) ; change head of list in mp to 5
(set-mcdr! mp (mcons 3 null)) ; change tail list of mp
Associative Lists

- List of key/value pairs!
- Racket has a built in function assoc that takes a value (key), and a list, and returns the first pair with the given key it finds in the given list (false if there is no pair with the given key).

```
(define my-list (list (cons 1 2) (cons 3 4)))
(assoc 1 my-list) ; returns the pair '(1 . 2)
(assoc 4 my-list) ; returns #f
```
Putting it all together... a better fibonacci

(define memo-fibonacci
  (letrec([memo null]
      [f (lambda (x)
        (let ([ans (assoc x memo)]))
          (if ans
              (cdr ans) ; return memoized answer
              (let ([new-ans (if (or (= x 1) (= x 2))
                                1
                                (+ (f (- x 1))
                                  (f (- x 2)))]))
              (begin
                (set! memo (cons (cons x new-ans) memo))
                new-ans)))))))
  f))
Streams

- A function that when evaluated results in a pair with a value in the car and another stream in the cdr
- Create an infinitely long stream of values!

(define (ones) (cons 1 ones))

(define natural-numbers
  (letrec ([next-nat (lambda (x)
                          (cons x (lambda ()
                                      (next-nat (+ x 1))))))]) ; return next pair
    (lambda () (next-nat 0)))) ; "seed" the stream