Section 6: Racket intro

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Slides adopted from Porter Jones's
Agenda

● Basic Racket Review
● Memorization
● Mutation
● Stream
Fibonacci case study:

Let’s write a function to calculate nth fibonacci number!

(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)]
    (lambda ()
      (begin (set! count (+ count 1)) count))))

What's the difference

(define count-calls-wrong
  (lambda ()
    (let [(count 0)]
      (begin (set! count (+ count 1)) count)))))
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).

```racket
(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)))))))
Mutable Lists

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

- `set-car!` and `set-cdr!` actually change the “fields” of a `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
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 natural-numbers
  (letrec ([next-nat (lambda (x)
                        (cons x (lambda ()
                                   (next-nat (+ x 1))))))]) ; return next pair
    (lambda () (next-nat 0)))); "seed" the stream
```
Exercise

Write a fibonacci stream!