Lecture #27: Scheme Examples

- A little philosophy: why are we talking about interpreters, etc.?
- Idea is to understand your programming language better by understanding common concepts in the design of programming languages
- ... And also to get better mental models of what programs are doing by actually studying how a program might be executed.
- With this, you can perhaps develop better intuitions about what usages are likely to be expensive.
- More directly, many projects can benefit from the introduction of specialized "little languages" and studying interpreters gives you some background in defining and implementing them.

Tail-Recursive Length?

Last time, we came up with this:

```
;; The length of list L
(define (length L)
    (if (eqv? L '())        ; Alternative: (null? L)
        0
        (+ 1 (length (cdr L)))))
```

but this is not tail recursive. How do we make it so?

Tail-Recursive Length: Solution

```
;; The length of list L
(define (length L)
    ;; n + the length of R.
    (define (length+ n R)
        (if (null? R) n
            (length+ (+ n 1) (cdr R))))
    (length+ 0 L))
```

Standard List Searches: assoc, etc.

- The functions `assq`, `assv`, and `assoc` classically serve the purpose of Python dictionaries.
- An *association list* is a list of key/value pairs. The Python dictionary `{1 : 5, 3 : 6, 0 : 2}` might be represented

  ```
  ((1 . 5) (3 . 6) (0 . 2))
  ```

- The ass$x$ functions access this list, returning the pair whose `car` matches a key argument.
- The difference between the methods is whether we use `eq?` (Python is), `eqv?` (more like Python `==`), or `equal?` (does "deep" comparison of lists).

  ```
  ;; The first item in L whose car is eqv? to key, or #f if none.
  (define (assv key L)
  )
  ```

Assv Solution

```
;; The first item in L whose car is eqv? to key, or #f if none.
(define (assv key L)
    (cond ((null? L)              #f)
          ((eqv? key (caar L)) (car L))
          (else                 (assv key (cdr L))))
)
```

- Why `caar`?
  - L has the form `((key1 . val1) (key2 . val2) ...)`.
  - So the `car` of L is `(key1 . val1)`, and its key is therefore `(car (car L))` (or `caar` for short).

A classic: reduce

```
;; Assumes f is a two-argument function and L is a list.
;; If L is (x1 x2...xn),  the result of applying f n-1 times
;; to give (f (f (... (f x1 x2) x3) x4) ...).
;; If L is empty, returns f with no arguments.
;; [Simply Scheme version.]
;; >>> (reduce + '(1 2 3 4)) ===> 10
;; >>> (reduce + '()) ===> 0
(define (reduce f L)


)
```

Reduce Solution (1)

```
;; Assumes f is a two-argument function and L is a list.
;; If L is (x1 x2...xn),  the result of applying f n-1 times
;; to give (f (f (... (f x1 x2) x3) x4) ...).
;; If L is empty, returns f with no arguments.
(define (reduce f L)
    (cond ((null? L)
           (f))      ; Odd case with no items
          ((null? (cdr L))
           (car L))  ; One item
)         (else
(reduce f (cons (f (car L) (cadr L))
               (cddr L)))
; E.g.:
;    (reduce + '(2 3 4))
;    -calls->  (reduce + (5 4))
;    -calls->  (reduce + (9))
;    -yields-> 9
```

Reduce Solution (2)

```
;; Assumes f is a two-argument function and L is a list.
;; If L is (x1 x2...xn),  the result of applying f n-1 times
;; to give (f (f (... (f x1 x2) x3) x4) ...).
;; If L is empty, returns f with no arguments.
(define (reduce f L)
    (define (reduce-tail accum R)
       (cond ((null? R) accum)
             (else (reduce-tail (f accum (car R)) (cdr R)))))

    (if (null? L) (f)   ;; Special case
        (reduce-tail (car L) (cdr L))))
```