CS 61A Spring 2021 — Scheme, Scheme, and More Scheme

Lost 7: April 2, 2021 Solutions

1 Learning Goals

- Learn the basics of Scheme
- Begin to see that Scheme is, in fact, beautiful

2 What Would Scheme Display

2.1 What would Scheme display? As a reminder, the built-in `quotient` function performs floor division.

```
scm> (define a (+ 1 2))
```

```
a
```

```
scm> a
```

```
3
```

```
scm> (define b (- (+ (* 3 3) 2) 1))
```

```
b
```

```
scm> (= (modulo b a) (quotient 5 3))
```

```
#t
```

2.2 What would Scheme display?

```
scm> (cons 10 (cons 11))
```

```
Error
```

```
scm> (car (cons 10 (cons 11 nil)))
```

```
10
```

```
scm> (cdr (cons 10 (cons 11 nil)))
```

```
(11)


scm> (cons 5 '(6 7 8))

(5 6 7 8)


scm> (define a 10)
a
scm> (list 8 9 a 11)    ; list procedure evaluates all operands

(8 9 10 11)


scm> '(8 9 a 11)        ; quote special form does not evaluate operand

(8 9 a 11)


scm> (list? (cons 1 2))

#f


scm> (list? (cons 1 (cons 2 '())))

#t


scm> (define null nil)
scm> (equal? null 'null)

#f


scm> (equal? nil 'null)
```

```
#f


scm> (equal? null 'nil)

#t


scm> (equal? nil 'nil)

#t


scm> (equal? 'nil ''nil)

#f


scm> (equal? ''nil ''nil)

#t


scm> (eqv? ''nil ''nil)

#f
```

3 Intro-Level Practice

3.1 Write a function that returns the factorial of a number.

```
(define (factorial x)


    (if (< x 2)
        1
        (* x (factorial (- x 1)))))
```

Video walkthrough

3.2 Define `reduce`, where the first argument is a function that takes two arguments, the second is a starting value, and the third is a list. This should work like **Python**'s `reduce`.

```
(define (reduce fn s lst)

                                            )
```

```
(define (reduce fn s lst)
    (if (null? lst)
        s
        (reduce fn (fn s (car lst)) (cdr lst))))
```

4 Exam-Level Prep

4.1 Write a function that takes a procedure and applies to every element in a given nested list.

The result should be a nested list with the same structure as the input list, but with each element replaced by the result of applying the procedure to that element.

Use the built-in `list?` procedure to detect whether a value is a list.

```
(define (deep-map fn lst)


  (cond ((null? lst) lst)
        ((list? (car lst)) (cons (deep-map fn (car lst)) (deep-map fn (cdr lst))))
        (else (cons (fn (car lst)) (deep-map fn (cdr lst))))
        )
   )
```

```
scm> (deep-map (lambda (x) (* x x)) '(1 2 3))
(1 4 9)
scm> (deep-map (lambda (x) (* x x)) '(1 ((4) 5) 9))
(1 ((16) 25) 81)
```

4.2 **Fall 2019 Final, Question 7a: Mull It Over** Implement *mulxy*, which multiplies integers x and y. **Hint**: (- 2) evaluates to -2.

```
;; multiply x by y (without using the * operator).
;; (mulxy 3 4) -> 12           ; 12 = 3 + 3 + 3 + 3
;; (mulxy (- 3) (- 4)) -> 12   ; 12 = - ( -3 + -3 + -3 + -3 )
(define (mulxy x y)


  (cond ((< y 0) (- ____________________________________________________________ ))


        ((= y 0) 0)


        (else ( ___________________ x (mulxy x ___________________________________ )))))
```

```
;; multiply x by y (without using the * operator).
;; (mulxy 3 4) -> 12           ; 12 = 3 + 3 + 3 + 3
;; (mulxy (- 3) (- 4)) -> 12   ; 12 = - ( -3 + -3 + -3 + -3 )
(define (mulxy x y)
```

```
(cond ((< y 0) (- (mulxy x (- y))))

      ((= y 0) 0)

      (else (+ x (mulxy x (- y 1))))))
```