************** SOLUTIONS **********

Getting Started

For each Scheme expression below, what value results when the expression is evaluated?

42 => 42

"Hello World" => "Hello World"

(8 + 9) => Error, expected procedure, given 8

(+ 8 9) => 17

(define a 10) => undefined

a => 10

b => error

(define b a) => undefined

b => 10

(* a b) => 100

Nested Expressions

For each Scheme expression below, what value results when the expression is evaluated?

(* (- 8 4) (+ 1 10)) => 44

(define foo 100) => undefined

(define bar (* 10 foo)) => undefined

(+ (- (- 2010 (/ bar foo)) (* foo (- (/ bar foo) 3))) 37) => 1337
Hello, λ

For each Scheme expression below, what value results when the expression is evaluated?

(lambda (x) (/ x 1024)) => procedure

(((lambda (x) (/ x 1024)) 4096) => 4

(lambda () 1) => procedure

(((lambda () 1)) => 1

(((lambda () 1))) => Error, expected procedure, given 1

((lambda () 1) 5) => Error, too many arguments (expected: 0, got: 1)

(lambda (y z) (+ z y)) => procedure

(((lambda (y z) (+ z y)) 5 4) => 9

(((lambda (y z) (+ z y)) x 7) => error, x undefined

What’s in a name?

Assume that you’ve already evaluated the following Scheme expressions:

(define x 1)
(define y -1)
(define foo (lambda (a b) (+ a b)))
(define bar (lambda (x) x))
(define baz (lambda () 1))
(define quux (lambda (p) (foo p 5)))

Alright, now to what value do each of these Scheme expressions evaluate?

x  => 1

foo  => procedure

(foo 1 2) => 3

(foo 1) => error, too few arguments (expected: 2, got: 1)

(foo)  => error, too few arguments (expected: 2, got: 0)
(baz)  =>  1
(bar 10) => 10
(quux (foo (baz) (bar y))) => 5

Short and sweet: Syntactic Sugar

For each Scheme expression below, write an equivalent Scheme expression that doesn’t explicitly use lambda.

(define foo (lambda (a b) (+ a b))) => (define (foo a b)
  (+ a b))
(define bar (lambda () 1)) => (define (bar)
  1)

Sum of all its parts

Write a procedure named sum-numbers which takes as input two integers, M and N, and returns the sum of all the numbers on the interval [M,N].

(define sum-numbers-rec
  (lambda (m n)
    (if (> m n)
      0
      (+ m (sum-numbers-rec (+ m 1) n)))))

(define sum-numbers-iter
  (lambda (m n)
    (sum-helper m n 0))

(define sum-helper
  (lambda (m n sum)
    (if (> m n)
      sum
      (sum-helper (+ m 1) n (+ m sum))))))

Fibonacci

(define (fib n)
  (if (= n 0)
0
 (if (= n 1)
  1
  (+ (fib (- n 1)) (fib (- n 2))))

For the iterative one, definitely show the table as per the lecture before writing code:

<table>
<thead>
<tr>
<th>(F_{x-2})</th>
<th>(F_{x-1})</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>13</td>
<td>1</td>
</tr>
</tbody>
</table>

(define (fib-iter n)
  (if (= n 0)
    0
    (fib-helper 0 1 n)))

(define (fib-helper Fx-2 Fx-1 n)
  (if (= n 1)
    Fx-1
    (fib-helper Fx-1 (+ Fx-2 Fx-1) (- n 1))))
Feel the power

(define (my-expt-rec x y)
  (if (= y 0)
     1
     (* x (my-expt-rec x (- y 1))))

(define (my-expt-iter x y)
  (define (expt-helper y answer)
    (if (= 0 y)
       answer
       (expt-helper (- y 1) (* x answer))))
  (expt-helper y 1))

fast-expt

For this one, first make the error of writing

  (* (fast-expt x (/ y 2)) (fast-expt x (/ y 2)))

and then discuss the difference between that and the version below.

(define (fast-expt x y)
  (if (= y 0)
     1
     (if (even? y)
        (square (fast-expt x (/ y 2)))
        (* x (fast-expt x (- y 1))))))