Some More Practice Questions

Spring 2018
This is a selection of questions that might be similar, in broad terms, to exam questions.

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Write a function `sum-even-llt` that consumes a LLT and returns the sum of all the even leaves.

For example,

```
(sum-even-ll (list 2 (list 3 5) (list 91 (list 4 6)))) => 12
```
(define (corge L n)
  (cond
    [(empty? L) '()]
    [(even? (first L))
      (cons (first L)
        (corge (rest L) (+ 1 (remainder n 2)))]
    [else
      (cons (+ n (first L))
        (corge (rest L) (+ 1 (remainder n 2)))]))

(corge (list 3 3 2 2) 1)

By hand, determine what is (corge (list 3 3 2 2) 1) returns. (You may verify your answer by running the code.)
(define-struct node (key val left right))

;; A binary search tree (BST) is either
;; * () or
;; * (make-node Nat Any BST BST)...
;; which satisfies the ordering property recursively:
;; * every key in left is less than key
;; * every key in right is greater than key

Exercise

Write a function (count-smaller B value) that consumes a BST and returns the number of nodes where the key is less than value. For example,

(define dict1
  (make-node 10 "ten"
    (make-node 5 "five" () '())
    (make-node 15 "fifteen" () '()))

(check-expect (count-smaller dict1 16) 3)
(check-expect (count-smaller dict1 14) 2)
(check-expect (count-smaller dict1 9) 1)
(check-expect (count-smaller dict1 4) 0)
Exercise

Determine what (fun-a 6) returns.

(define (fun-a n)
  (local [(define a (range 0 n 1))
           (define b (filter even? a))
         ]
    (foldr + 7 b)))
(define-struct binode (op arg1 arg2))

;; a binary arithmetic expression internal node (BINode)
;; is a (make-binode Operator BinExp BinExp)

;; A binary arithmetic expression (BinExp) is either: 
;; a Num or 
;; a BINode

Exercise 1
1. Draw a picture of the tree corresponding to the expression 
   \(((2 \times 6) + (5 \times 2)) \div (5 - 3)\)
2. Write the Racket expression corresponding to that tree.

Exercise 2
1. Determine the mathematical expression corresponding to the Racket expression:
   (make-binode '*
           (make-binode '-' 7 5)
           (make-binode '+'
                   (make-binode '*' 2 5)
                   (make-binode '+' 3 4)))
2. Draw a picture of the tree corresponding to the expression.
Complete collection-price by writing its body.

```scheme
(define-struct book (title author price))
;; a Book is a (make-book Str Str Num)
;; Requires: price >= 0

;; (collection-price author catalog) return the cost of
;; buying all the books in catalog written by author.
;; collection-price: Str (listof Book) -> Num
;; Example:
(define library (list
    (make-book "Green Eggs and Ham" "Seuss" 11.69)
    (make-book "Red Planet" "Heinlein" 19.31)
    (make-book "Fox in Socks" "Seuss" 11.18)
    (make-book "Democracy and Education" "Dewey" 8.81)
    (make-book "Starman Jones" "Heinlein" 9.99)))
(check-expect (collection-price "Seuss" library) 22.87)
(check-expect (collection-price "Heinlein" library) 29.30)
(check-expect (collection-price "King" library) 0)
```

Some More Practice Questions
In this question you will write a function that consumes a \((\text{listof Num})\) and returns a new list, where the distance from the end has been added to each value.

For example,

\[(\text{add-distance-to-end (list 2 3 5 7 11)}) \Rightarrow (\text{list 6 6 7 8 11})\]

Since the distance from 11 to the end is zero, so it is unchanged; the distance from 7 to the end is 1, so it becomes 8; the distance from 5 to the end is 2, so it becomes 7, etc.

Ex. Write \text{add-distance-to-end} without using recursion, using higher order functions such as \text{map}, \text{foldr}, and \text{filter}.

Ex. Write \text{add-distance-to-end2} using recursion, without using any higher order functions.
Determine the fully simplified value of each expression.

Exercise

(define (func-a L)
  (local
    [(define (f x) (+ x (first L)))]
    (map f (range 0 (length L) 1))))

(func-a (list 2 3 5 7 11))

Exercise

(define (func-b L M)
  (local
    [(define (h a b)
        (cond [(even? a) (cons a b)]
              [else (cons (* 2 a) b)]))]
    (foldr h M L)))

(func-b (list 1 2 3 4) (list 1 2 3 4))
Determine the fully simplified value of each expression.

**Exercise**

```scheme
(define (func-c L)
  (foldr (lambda (a b)
           (cons (range 0 a 1) b))
         '() L))

(func-c (list 2 3 0))
```

```scheme
(define (func-d L)
  (local [
    (define (q n)
      (cond [ (= n 0) 1]
            [else (* n (q (- n 1)))]))
    (map q L)))

(func-d (list 3 4 1))
```
Write a function \( \text{pyramid } l_0 \text{ hi} \). It consumes two \( \text{Nat} \), and returns a list containing the values counting up from \( l_0 \) to \( \text{hi} \), then back down to \( l_0 \).

You may assume \( l_0 \) is not greater than \( \text{hi} \).

For example,

\[
\text{pyramid } 2 \ 5 \Rightarrow (\text{list } 2 \ 3 \ 4 \ 5 \ 4 \ 3 \ 2)
\]

\[
\text{pyramid } 7 \ 7 \Rightarrow (\text{list } 7)
\]

Do not use \texttt{range}. 
(define-struct blnode (left right))
;; a BLNode is a (make-blnode BTL BTL)
;; a Binary Leaf-labelled Tree (BLT) is either
;;   Num or
;;   a BLNode

(define T1 (make-blnode 4 (make-blnode 2 2)))
(define T2 (make-blnode (make-blnode 8 0) T1))

Exercise
Write a function (blt-total T) that returns the total of all the leaves in T.

(blt-total T1) => 8
(blt-total T2) => 16
Less well known than the Fibonacci numbers are the Tribonacci numbers, defined as follows:

\[
T(n) = \begin{cases} 
0 & \text{if } n = 0 \\
1 & \text{if } n = 1 \text{ or } n = 2 \\
T(n - 1) + T(n - 2) + T(n - 3) & \text{otherwise.}
\end{cases}
\]

Ex. Write a function to compute the \( n \)th Tribonacci number

Ex. What is \( T(5) \)?