CS 135 Winter 2020

Midterm Help Session

Reminder: Midterm (March 2)

- The midterm will be held on Monday, March 2 at 7:00 PM.
- Check your seating for the midterm on Odyssey.
- The midterm will cover up to and including the end of Module 09.
- There will be **NO** assignment due Tuesday, March 3.

Group Problem - direct translation

This function calculates the area of a trapezoid:

$$\text{area-of-trapezoid}(base1, base2, height) =$$

$$\frac{1}{2} \cdot (base1 + base2) \cdot height$$

Translate this function into Racket. Provide a contract.

Group Problem - pair?

Write a Racket function pair? which consumes 4 Nats. pair? produces true if any two of the consumed parameters are the same, and false otherwise. For this question, you may only use Boolean expressions (no cond allowed). Include a purpose and a contract.

Clicker Question - List Translation

Given this list:

```
(list (list) 'cons (list (list 2 'green) 3))
```

Which of the following is equivalent to the given list?

A `(list empty (cons 'cons (list 2 'green) (cons 3 empty)))`

B `(list (list empty (cons 'cons (cons 2 (cons 'green empty) (cons 3 empty)))))`

C `(list 'cons (list (list 2 'green) 3))`

D `(cons empty (cons 'cons (cons (list (cons 2 (cons 'green empty))) 3) empty)))`

E `(cons empty 'cons ((2 'green) 3))`

Stepping through Lists

Give the first and second substitution steps as well as the final value for the following expression:

```
(length (rest (rest (second (list (list 'hello 'red) (list 0 1 1 2 3 5) (list))))))
```

Template functions - Shapes

Consider the following definitions:

```
;; A Base is a Num
;; A Width is a Num
;; A Height is a Num
;; a Color is a Sym


;; A Rectangle is a (list Width Height Color)
;; requires: width, height > 0


;; A Triangle is a (list Color Base Height)
;; requires: base, height > 0


;; A Shape is (anyof Rectangle Triangle)
```

Template functions - Shapes

These following functions will be useful:

```
(define (rectangle-width shape) (first shape))
(define (rectangle-height shape) (second shape))
(define (rectangle-color shape) (third shape))

(define (triangle-color shape) (first shape))
(define (triangle-base shape) (second shape))
(define (triangle-height shape) (third shape))
```

Functions rectangle? (produces true if the given shape is a rectangle) and triangle? (produces true if the given shape is a rectangle) are available to use as well.

Write template functions for a Shape and a (listof Shape).

Insertion Sort - sort-shapes

Using your template functions as a guide, write a function called sort-shapes that sorts a list of Shapes in non-decreasing order of area. If two shapes have the same area, they should appear in the same order as in the original list. The ordering of a rectangle vs a triangle does not matter.

Recursing on a list and 2 Nats - sublist

Write a function called sublist which consumes a list, lst, and 2 natural numbers, start and end. sublist should produce the elements in lst indexed from start up to but not including end. If the list doesn't have sufficient elements at any point then any contents within the range so far are returned. Note that the first element of a list is indexed at 0.

(sublist '(a b c d e f) 2 5) $\Rightarrow$ '(c d e)

(sublist '(a b c d e f) 4 8) $\Rightarrow$ '(e f)

2-dimensional lists - get-table-chunk

Consider the following data definition:

```
;; A Table is a (listof (listof Any))
;; requires: all the sublists have the same length
```

Using sublist, write a function called get-table-chunk which consumes a Table and 4 natural numbers, col-start, col-end, row-start and row-end. get-table-chunk should produce the table with only rows from row-start up to but not including row-end with their columns indexed from col-start up to but not including col-end. You may assume the input is valid. Note that columns and rows' indices start at 0.

(get-table-chunk '((1 2 3 4 5) (a b c d e) (3 6 9 12 15) (f g h i j)) 1 3 1 3)
⇒ '((b c) (6 9))
(get-table-chunk '((1 2 3 4 5 7) (a b c d e 8) (3 6 9 12 15 8) (f g h i j l) (f g h i j l) (f g h i j l)) 1 4 0 3)
⇒ '((2 3 4) (b c d) (6 9 12))

Recursing on a Nat - add

In this problem, we will be implementing the addition of 2 Nats without using the built-in Racket function +.

Write a function called add that adds together 2 natural numbers.

The only built-in arithmetic functions you may use are add1 and sub1. You may not use any helper functions.

Recursing in lockstep - hangman

In the game of hangman, one player decides on a secret word and the other player tries to guess the word one letter at a time. In this problem, we will write a function that simulates one such guess.

Write a function called hangman that consumes a string called secret-word and another string called current-state, as well as a single character guess. current-state is the same string as secret-word except all the letters that have not been guessed yet are replaced by "_". hangman should produce a new string such that if guess is in secret-word, all the corresponding blanks in current-state are replaced by guess. Otherwise, current-state is produced.

(hangman "cat" "c_t" #\a) ⇒ "cat"
(hangman "boo" "___" #\o) ⇒ "_oo"
(hangman "onion" "_n__n" #\p) ⇒ "_n__n"

Recursing at different rates - compute-average

```
;; A Grade-list is one of:
;; * empty
;; * (cons (list Str Num) Grade-list)
;; requires: strings in a grade-list are sorted using string<? and are unique
;; numbers in the grade-list are between 0 and 100, inclusive
```

Write a function compute-average that takes in 2 grade-lists and produces one grade list combining students from both grade-lists sorted by string<?. If a student appears in both of the grade-lists, their new grade is the average of their grades from both of their classes.

Recursing at different rates - compute-average

Here are a few examples:

```
(compute-average (list (list "Jason" 95) (list "Jimmy" 69)) (list (list "Anne" 90) (list "Jason" 87)))
⇒ (list (list "Anne" 90) (list "Jason" 91) (list "Jimmy" 69))

(compute-average (list (list "Jason" 100) (list "Jimmy" 69)) (list (list "Jason" 100) (list "Jimmy" 69)))
⇒ (list (list "Jason" 100) (list "Jimmy" 69))

(compute-average (list (list "Jason" 99) (list "Jimmy" 70)) (list (list "Anne" 90) (list "Jason" 100)))
⇒ (list (list "Anne" 90) (list "Jason" 99.5) (list "Jimmy" 70))
```

Mastering the Design Recipe

Following the design recipe helps you understand the problem and produce correct code. Here are the complete steps in tackling a problem using the design recipe:

- Read the question and summarize your task using a purpose.
- Next, determine the types for all of your input and output and express them in the form of a contract.
- Think of some valid input to the problem and calculate the output manually. These are your examples.
- After writing your function, test your function thoroughly by considering edge cases related to your function.

Templates

- If it is a (listof X), you need to consider whether it is an empty list. For a non-empty list, you need to process the first item and the rest of the list

```
;; listof-str-template: (listof Str) → Any
(define (listof-str-template los)
  (cond [(empty? los)...]
        [else (... (first los)... (rest los)...)]))
```

- In general, if your data definition has ”one of..”, which also includes lists, then include a conditional expression with one test for each possibility.

Templates

We write a template for functions that consume compound data. Here are a few things to pay attention to:

- If it is a fixed length list, you need to access all of its elements.

```
;; A Std is a (list Str Nat)
;; std-template: Std → Any
(define (std-template std)
    (...(first std) ... (second std)...))
```

Recursion Strategies

In this course, we looked at the following ways of recursion:

- recursion on a number, such as adding numbers from 0 to n
- recursion on a list, such as adding numbers in a list
- recursion on a list and a number, such as getting the ith item of a list
- recursion on 2 lists(locked step or different rates), such as taking the dot product or merging 2 lists
- recursion on 2D-list/nested lists

To succeed in recursion questions, identify the type(s) of recursion you need to use and apply them effectively.