CS270: LAB #2

Racket Lists

You may work in groups of one or two people (three is acceptable in the event of an unscheduled absence). Unless stated otherwise, the lab is due to be submitted into Gradescope at the end of the day.
In order to receive credit, follow these instructions:

[a] Every team member should be discussing simultaneously the same problem – do NOT try to divvy up the labor and assign different problems to different students since the material is cumulative.

[b] Directly edit this lab PDF using Sedja/PDFescape with your answers (extra pages can be added in the rare event you need more than the allotted space)

[c] Each lab, rotate which member has the responsibility of being the Scribe. This is the person that is typing the answers and uploading the final PDF – note that only a single copy of the filled in PDF is turned into Gradescope. Only one lab needs to be submitted for the entire team, and all members receive the same score. Make sure to use a font that your PDF editor is compatible with (otherwise you might find your answers appear as weird shapes/sizes or simply disappear entirely!)

[d] The Gradescope submission must have each answer properly tagged with the appropriate question. Moreover, every member of the team must be listed as a submitter. Although it is the Scribe which executes these actions, it is still the responsibility of the entire team to make certain this is done properly (thus it is highly recommended that the Scribe share their screen so the entire team can witness it). Answers which are improperly tagged cannot be seen by the grader and thus cannot be scored.

[e] **FOR REMOTE ONLY**: Each lab, rotate which member has the responsibility of being the Recorder. This is the person who hits the Zoom Record button (once the technical permission is granted by the TA/RCF/Professor) and ensures that everyone has their camera/microphone on. They are also the member that is responsible to make sure the DrexelStream video is marked as viewable and entered into the https://tinyurl.com/VidLinkForm webform before 11:59pm (they should also email the rest of their team as confirmation.) Note that the video file doesn't get created/processed until after the Recorder has quit Zoom.

[f] Each lab, rotate which member has the responsibility of being the Manager. This is the person that ensures that everyone is participating equally and honestly, keeps the group on task, ensures that all team members understand a solution before going on to the next question, and presses the "hand up" button in Zoom to summon a TA or the professor (but they only do so after surveying the group to make sure everyone has the same question).

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Scribe name: Evelyn Thai

Recorder name: Terie Ha

Manager name: Lixiao Yang

Other team member (if any):   Jerry Li

Question 1 : 10 points

A Racket List is similar to a linked list.

There are a few basic list commands in Racket.

(null? L)	Returns true if the list is empty
(list? L)	Returns true if L is a list
(cons? L)	Returns true is L is a list built from a cons
(first L)	Returns the first element in list L
(rest L)	Returns list without the first element
(cons a L)	Adds a to the front of list L, returns new list

Each position in the list is a pair with two items (value, location of next element).

Unlike in some programming languages, we cannot see the pointer values in Racket.

This is still a good method to visualize what the commands are doing. We will use imaginary memory address in this assignment. We will use 00 to mean null.

Memory	First	Rest
A0	10	A4
A1	12	00
A2	15	A3
A3	17	A1
A4	19	A2

The list that starts at memory location $A3$ is (17 12). The value at location $A3$ is 17. It's rest column says the next value is at $A1$ The value at $A1$ is 12. The pair at $A1$ has a null next, that means it is the end of the list.

(a) (2 points) What is the list that starts at memory location $A0$?

(10 19 15 17 12)

(b) (2 points) Assume the list starting at memory location $A0$ is called L.
What value is returned when we call (first L)?

10

(c) (2 points) What list is returned what we call (rest L)?

(19 15 17 12)

(d) (2 points) What is the memory location of the first element of the list returned by (rest L)?

A4

(e) (2 points) When we call (cons 5 L) a new row of memory is needed. Write the contents of memory row $A5$ after 5 is inserted.

(5 10 19 15 17 12)

Question 2 : 15 points

We can create lists using only cons and null.

For example, $(1\,(2\,3))$ is created from $(\text{cons}\,1\,(\text{cons}\,(\text{cons}\,2\,(\text{cons}\,3\,\text{null}))\,\text{null}))$

Write a Racket Command, using only cons, null, and integers to generate each of the following lists.

Spacing between parenthesis is just for readability.

(a) (3 points) (1 2 3)

(cons 1 (cons 2(cons 3 null)))

(b) (3 points) ((1) (2))

(cons (cons 1 null) (cons(cons 2 null) null))

(c) (3 points) (((1)))

(cons (cons (cons 1 null) null) null)

(d) (3 points) (() ())

(cons (cons null null) null)

(e) (3 points) ((1 2) (3))

(cons (cons 1 (cons 2 null)) (cons (cons 3 null) null))

Question 3 : 15 points

What is returned by each of the following commands?

(a) (3 points) (first '(1 2 3))

1

(b) (3 points) (first '((1) (2)))

'(1)

(c) (3 points) (rest '(((1))))

'()

(d) (3 points) (rest '(() ()))

'(())

(e) (3 points) (first (rest (first '((1 2) (3)))))

2

Question 4 : 15 points

Use the only the functions first and rest to get the requested value out of the below list.

(define L '((1 2) (3 (4 5)) 6))

(a) (3 points) Give a command to get the value 1 out of the list L.

   (first (first L))

(b) (3 points) Give a command to get the value 3 out of the list L.

   (first (first (rest L)))

(c) (3 points) Give a command to get the value 4 out of the list L.

   (first (first (rest (first (rest L)))))

(d) (3 points) Give a command to get the value 5 out of the list L.

   (first (rest (first (rest (first (rest L))))))

(e) (3 points) Give a command to get the value 6 out of the list L.

   (first(rest (rest L)))

Question 5 : 5 points

Copy the following code into Racket.

```
; input contract: a and b are positive integers
; output contract: (mystery a b) is......
(define (mystery a b)
        (if (zero? b) null (cons a (mystery (+ a 1) (- b 1)))))
```

Experiment with the mystery function. Explain in plain English what the output of this function is. Do not tell us how the function works "it adds a+1 to the list", explain in your own words what the final answer comes out to be.

   The function returns an ascending sequence starting at a and with b elements.
   If b is 0, the function will return an empty list.

Question 6 : 20 points
    Write a Racket function according to the specifications below.

    ; input contract: n is a nonnegative integer, L is any list
    ; output contract: (getElement n L) is the nth element of the list L, which we consider as zero-indexed.
                        if the nth index doesn't exist in L (e.g. L doesn't have enough elements)
                        then return null.
    ; Requirement: do NOT use the built-in Racket function "length" in your implementation
    ; Examples: (getElement 0 '(3 7 6 2 5)) would be 3 since that is the starting (zeroth) value,
                (getElement 4 '(3 7 6 2 8)) would be 8, and (getElement 9 '(3 7 6 2 8)) would be null.

```
(define (getElement n L)
 (cond
   [(null? L) null]
   [(= n 0) (first L)]
   [else (getElement (- n 1) (rest L))]))
```

Question 7 : 20 points

    Write a racket function according to the specifications below.

    ; input contract: n is a positive integer
    ; output contract: (seq n) is the decreasing list of numbers starting from n down to 1
    ; Requirement: even though n=0 will never be input by the user, it is still useful to have as your base case
                    since it will make the coding more elegant
    ;Examples: (seq 3) would be '(3 2 1), (seq 5) would be '(5 4 3 2 1)

```
(define (seq n)
 (if (zero? n) null (cons n (seq (- n 1)))))
```