

CSE 461: Programming Languages Concepts

Prof. G. Tan
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Homework 7: Memory Management Due on Apr 23rd before class (12:20pm) in Canvas.

Submission: Please submit your homework via Canvas. It's okay if you submit a scanned version of your on-paper answers, but please make sure your scanned version is legible.

1. (4 points) For each of the following Scheme lists, draw its memory representation using atom and cons cells:
 - (a) '(everyday (is a winding) road)
 - (b) '((everyday) (is) (a) (winding) (road))
2. (4 points) For each of the following Scheme expressions, draw the memory representation after its evaluation:
 - (a) (cons (cons 'a (list 'b 'c)) (list 'b 'c))
 - (b) ((lambda (x) (cons (cons 'a x) x)) (list 'b 'c))
3. We have a Scheme program below:

```
(define lst '(Scheme (is fun)))  
(define lst2 (car (cdr lst)))  
(set-car! lst2 'has)
```

 - (a) (2 points) Draw the memory layout in terms of cells for each execution step of the above program. Assume Garbage Collection does not run in intermediate steps.
 - (b) (1 point) What is the value of lst at the end?
 - (c) (1 point) Suppose the system decides to perform a Mark-and-Sweep Garbage Collection at the end, which memory cells would be recycled?
4. (3 points) C and C++ do not have garbage collection built in. Find out whether if there is an external package that provides garbage collection to C/C++ programmers. If there is, understand and describe briefly how a C/C++ programmer should use this package.