

EIGHTH QUIZ

You have 15 minutes from the start of class to complete this quiz. Read the problems with care; work with deliberate speed. Don't give us more than we ask for. The usual instructions apply. Good luck!

Problem 1 (7 points)

We have distributed a Deus X reference sheet; you don't have to turn it back in, but we'll recycle it if you do. We'll have a better chance of assigning you partial credit if you show your work (e.g., draw a picture of the register(s) and/or memory locations).

(a) (3 points) Suppose that location 444 of the Deus X machine's memory holds the number 25 and that location 777 holds the number 100. What is in location 777 after executing these three instructions? (The first number on each line indicates the instruction's address in memory.) Mark your final answer clearly.

```
0.  10  444  (lda 444)
1.   1  777  (add 777)
2.  20  777  (sta 777)
```

(b) (4 points) Suppose that location 222 of the Deus X machine's memory holds the word CATS, that location 333 also holds the word CATS, and that location 444 holds the word BATS. What does the deus X machine print after executing these instructions? Mark your final answer clearly.

```
0.  10  222  (lda 222)
1.  50  444  (cmpa 444)
2.  60    5  (je 5)
3.   6  444  (out 444)
4.   7    6  (jmp 6)
5.   6  333  (out 333)
6.   8      (halt)
```

Problem 2 (4 points)

For each of the algorithms or operations described below, check the box corresponding most closely to its complexity (i.e., its O-notation) in the average case.

(a) Inserting a new item into a (balanced) binary search tree.

☐ Constant— $O(1)$ ☐ Logarithmic— $O(\log n)$ ☐ Linear— $O(n)$ ☐ Quadratic— $O(n^2)$

(b) Adding an item at the beginning of a list using `cons`:

☐ Constant— $O(1)$ ☐ Logarithmic— $O(\log n)$ ☐ Linear— $O(n)$ ☐ Quadratic— $O(n^2)$

(c) Searching for an item in a list (e.g., using `member?`):

☐ Constant— $O(1)$ ☐ Logarithmic— $O(\log n)$ ☐ Linear— $O(n)$ ☐ Quadratic— $O(n^2)$

(d) Collecting all the items in a (balanced) binary search tree into a list, in order:

☐ Constant— $O(1)$ ☐ Logarithmic— $O(\log n)$ ☐ Linear— $O(n)$ ☐ Quadratic— $O(n^2)$

Problem 3 (4 points)

A binary search tree is either empty or a node defined as (define-struct node (rootvalue leftsubtree rightsubtree)).

Complete the following definition by filling in the blanks, one function, constant, or other identifier per blank. To make this function work for any type of root value, we pass it a function that compares two items in the tree to see if the first is less than the second.

```
;; BST-insert: item BST-of-item (item item -> boolean) -> BST-of-item
;; Return the BST with the item inserted in the appropriate place
(define BST-insert
  (lambda (i T item<?)
    (cond
      ((empty? T) (make-node _____ _____ _____))

      ((equal? i (_____ T)) _____) ; Duplicate entry---ignore it

      ((item<? i (_____ T))

        (make-node (node-rootvalue T)

                    (_____ i (_____ T) item<?)
                    (_____ T)))

      (else
       (make-node (node-rootvalue T)

                   (_____ T)
                   (_____ i (_____ T) item<?))))))
```

Problem 4 (5 points)

We have distributed a version of the restaurant program with this quiz. You can keep it; don't pass it in with the quiz.

- (a) (0.5 points) What data structure does this program use to represent the collection of restaurants? A word or two is enough.
- (b) (1.5 points) When this program adds a new restaurant to the collection, it checks to see whether the same restaurant is already in the collection (and if it is, it just combines the menus). How does the program determine whether two restaurants are the same; in other words, what does it check or compare? And what is the name of the function where this comparison occurs?
- (c) (3 points) Complete the definition below. All the parts you need are in the definition of `print-rrant-list` on the third page of the code. You may assume that the input list is not empty.

```
;; collection-average-price: list-of-rrant -> number
;; Return the average price of (the menus of) the rrants on the (non-empty) input list
(define collection-average-price
  (lambda (RL)
```