COS126: General Computer Science	**Spring 1996**

Practice Questions for Final Exam

Date: May 13, 1996

Note: *This handout is in response to requests from many of you for sample questions on C programming. The final exam will also cover material from the second half of the course, such as virtual memory, parsing, finite state machines, and logic. To study for those topics, use the exercises we already handed out.*

Problem 1 (25 points): You are given a data structure that is a binary tree with the following properties:

1. The nodes of the tree are defined by the declaration

   `struct node {int value; struct node *left, *right;};`

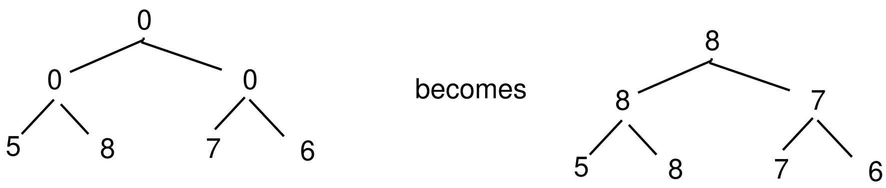
2. The leaves of the tree (nodes with no children) contain positive integer values.
3. The internal nodes of the tree contain value 0.

Write a C function

```
void maxvalue (struct node *t);
```

that, for the tree pointed to by `t`, replaces the value of each internal node with the maximum value found in the leaves that are its decendents (i.e. the maximum value of all leaves in the subtree rooted at the internal node). If `t` is NULL or points to a leaf (pointers to left and right children are both NULL), `maxvalue` does nothing.

The example below shows the result of `maxvalue` when `t` points to the tree shown.



Problem 2: a)(15 points) Given an array A of N integers, (declared as `int A[N]`, where `N` is a declared constant), write a fragment of C-code that fills in the entries of a two-dimensional array S[N][N] as follows:

For $i \leq j$, S[i][j] contains the sum A[i] + A[i+1] + ... + A[j].
For $i > j$, S[i][j] contains 0.

Try to make your program efficient.

b)(10 points) What is the running time of your algorithm in part a)? Use order notation, e.g. $O(N)$ or $O(N \log N)$ or $O(N^2)$ or $O(N^3)$, etc.

Problem 3 (25 points): Write a program that reads all the lines in a file, and prints out any duplicate line. Hint: read a line, look it up in a binary search tree to see if it's a duplicate, then enter it in the tree. *Break your program into functions. You will get partial credit if you just show the function headers (parameter declarations) and describe in words what each function does.*

The filename should be passed to `main()` as a command line argument.

Note that to read one line of text from `stdin` into a character array `line`, you can use the function call `gets(line)`, which will return a zero value if end-of-file was reached (and therefore it didn't put anything useful in `line`), or nonzero if it actually filled in `line` with a line of text. Assume that a line of text is at most 256 characters long.

Problem 4 (25 points): If you are given an array A of N numbers, each in the range $[0, K-1]$, then a *histogram* (also called `frequency table`) of A is an array B of K numbers such that $B[i]$ is the number of times i appears in A.

Write a fragment of TOY code that computes a histogram. Assume that R1 contains the value N and R2 contains K. Also, the starting addresses of arrays A and B are stored in R3 and R4 respectively. Include comments with your TOY code.

Problem 5 (25 points): Give brief answers to the following five questions. Each question is worth 5 points. Use at most 3-4 lines for each answer; verbose answers will be ignored.

1. What does a compiler do? Name one compiler you may have used.
2. What is the chief difference between combinational and sequential circuits?
3. What is a "fetch-increment-execute" cycle? Where is it used?
4. What is the difference between a stack and a queue? Name one use of a stack.
5. Why do computers use virtual memory?