
\$Id: lab6c-malloc-free.mm,v 1.21 2014-05-02 19:15:43-07 - - \$

PWD: /afs/cats.ucsc.edu/courses/cms012b-wm/Labs-cms012m/lab6c-malloc-free

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1. Overview

This lab introduces you to `malloc(3)`, `free(3)`, and `strdup(3)`, linked lists in C, dangling pointers, and memory leak. There are two programs in this assignment, each of which will read in data, insert the data into a linked list in sorted order, and print out the data. One program will use `double` and the other will use character strings represented as `char*`. See the `code/` subdirectory. Also, read the man page: `man -s 3 malloc`.

2. Program `nsort` specification

As usual, the program is presented in the form of a Unix `man` page specification.

NAME

`nsort` – sort numbers read from `stdin`

SYNOPSIS

`nsort [-d]`

DESCRIPTION

Reads in numbers from `stdin`, and stops at end of file. Error messages are printed for any word that is not recognized by `scanf(3)` as a number. The numbers are printed sorted in ascending order, one per line, to `stdout` using the `printf(3)` format `"%24.15g\n"`.

OPTIONS

Options are scanned by `getopt(3)`.

`-d` Output is printed in debug format with pointers in `"[%p]"` format.

EXIT STATUS

0 No errors were detected.

1 Syntactically incorrect input numbers were detected.

3. Program `lsort` specification

As usual, the program is presented in the form of a Unix `man` page specification.

NAME

`lsort` – sort lines read from `stdin`

SYNOPSIS

`lsort [-d]`

DESCRIPTION

Reads in lines from `stdin`, stopping at end of file. The lines are printed sorted in ascending order to `stdout`. The output should be the same as that from `sort(1)`.

OPTIONS

Options are scanned by `getopt(3)`.

-d Output is printed in debug format with pointers in "[%p]" format.

EXIT STATUS

- 0 No errors were detected.
- 1 An unterminated line or a line longer than 80 characters was detected.

4. Preparation

Before you begin, study the code provided.

- (1) The file `code/Makefile` is complete, but no source code has been provided for the two C programs.
- (2) Read the `man(1)` pages for `malloc(3)`, `free(3)`, and `strdup(3)`.
- (3) Study the code in the `misc` subdirectory. None of the code in this directory should be directly copied into your programs, but parts of it will be adapted for use.
- (4) Study the sample code `sortlist.java`, which shows you the exact algorithm you are to use for your program. It is exactly equivalent to `lsort` when you run without options. It is similar to `nsort`. Adapt its algorithm line by line.

5. Program `nsort` implementation

This program deals only with lists of numbers.

- (1) Study the file `scanf.c` to see how to use `scanf(3)` to read numbers from `stdin`.
- (2) Study the file `numlist.c` to see how to declare a linked list of nodes containing numbers and how to use `malloc(3)` to allocate space and how to use `free(3)` to free up the nodes when done. C does not have a garbage collector.
- (3) Print out the numbers either in ordinary format or in debug format.
- (4) Instead of inserting the new node onto the front of the list, put in the list in the proper position. See the program `sortlist.java` for the insertion algorithm.
- (5) Use the command `valgrind --leak-check=full` to check for memory leak.

6. Program `lsort` implementation

This program deals with lists of strings, so that each node uses two heap objects.

- (1) To begin work, `cp nsort.c lsort.c`. Change the declaration of the `item` field from `double` to `char *`.
- (2) Look at `strlist.c` to see how strings are handled. Create a character buffer of dimension 82 (`char buffer[82];`) and read in lines. Insert each line into the list. Print an error message for any line that is not terminated by a newline character (`'\n'`). The buffer holds up to 80 characters read in from each line, plus the newline character plus the null plug (`'\0'`).
- (3) When comparing strings in the insertion routine, use `strcmp(3)`. This works very much like `compareTo` in Java.

- (4) Use the command `valgrind --leak-check=full` to check for memory leak.

7. What to submit

Submit the files `nsort.c`, `lsort.c`, and `Makefile`. Your `Makefile` should build the executables `nsort` and `lsort` from the target `all`. If you are doing pair programming, see [/afs/cats.ucsc.edu/courses/cms012b-wm/Syllabus/pair-programming/](http://afs/cats.ucsc.edu/courses/cms012b-wm/Syllabus/pair-programming/) and follow those instructions as well.