DESIGN - Assignment 3

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1 Description

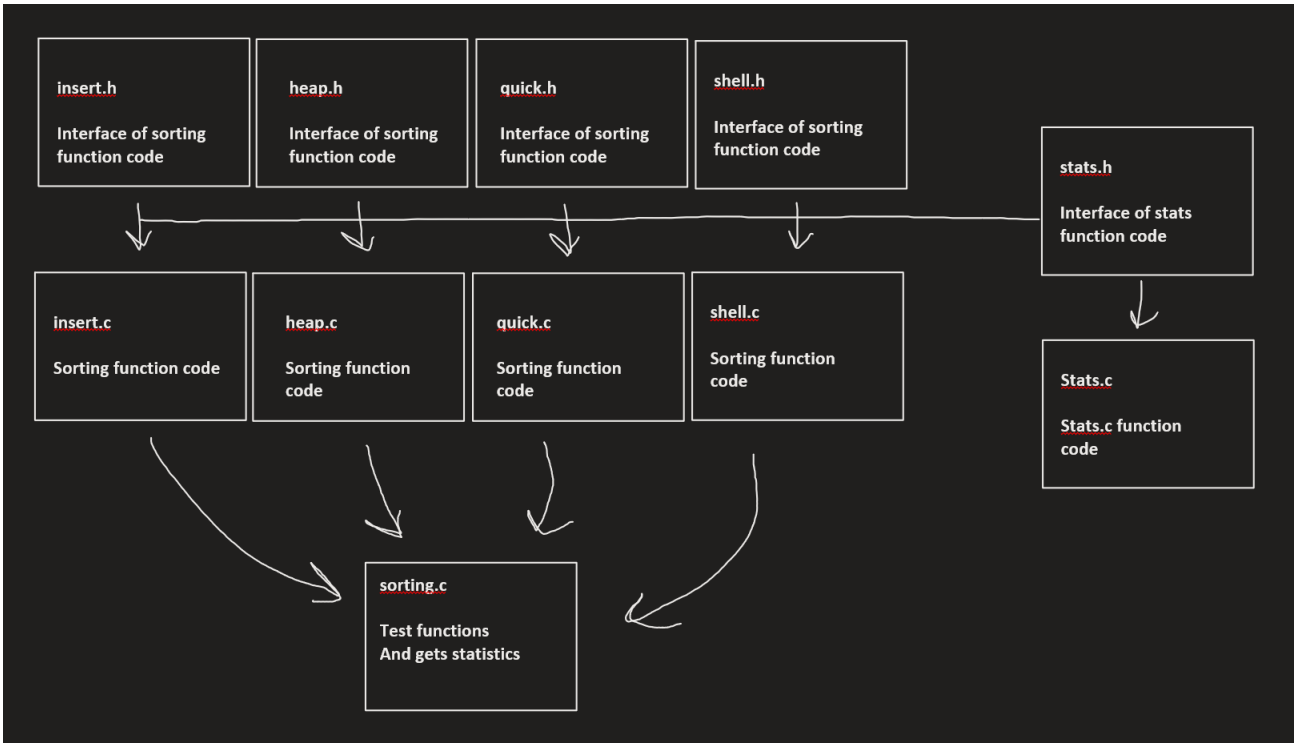
This program will contain a library of files with functions that implements sorting algorithms in C using the methods: Insertion, Shell, Heap, and Quick sort. It also contains a test harness that prints out an n-element array along with statistics (moves and comparisons) about the sorting method.

2 Files

1. insert.c
   - This source file contains the code that sorts an array using Insertion Sort.
2. heap.c
   - This source file contains the code that sorts an array using Heap Sort.
3. quick.c
   - This source file contains the code that sorts an array using Quick Sort.
4. shell.c
   - This source file contains the code that sorts an array using Shell Sort.
5. sorting.c
   - This source file contains the main() function that return/print the sorts in action and its statistics.
6. stats.c
   - This source file contains the code that returns the moves and comparisons the sorts make.
7. insert.h
   - This header file contains the initialized function for Insertion Sort.

8. heap.h
    - This header file contains the initialized function for Heap Sort.
9. quick.h
    - This header file contains the initialized function for Quick Sort.
10. shell.h
    - This header file contains the initialized function for Shell Sort.
11. stats.h
    - This header file contains the initialized functions and variables for stats.c.
12. set.h
    - This header file contains the initialized functions for Sets used for sorting.c and stats.c.
13. Makefile
    - This make file contains the code that builds and compiles the sorting library program to be run. It also cleans all compiler generated files and formats the code to be submitted.
14. README.md
    - This markdown file describes the program, how to build it, how to run it, and also lists and explains all the command-line options that the sorting program accepts. It also documents any false positives given by scan-build.
15. DESIGN.pdf
    - This pdf is the manual that explains the program, files included, layout or structure, and pseudo-code of the sorting library.
16. WRITEUP.pdf
    - This pdf is a scientific writeup made up of graphs and explanations by the gnuplot tool which shows the moves and elements of each sort algorithm and its performance.

3 Structure



4 Pseudo-code

All pseudo code is based off asgn3.pdf python code

4.1 Insertion Sort

(Iterates through the array one by one and moves elements around in ascending order given the input of a pointer to the array which directly manipulates and returns nothing)
define insertion_sort
    for loop using i from 0 to array length
    set variable current index element to i
    set temp to i index element array (move value to a temp var to store)
    while loop comparing values
        current index array element = previous index array element
        decrement j
    set current index array element to temp (move it back to correct spot)

4.2 Shell Sort

```
(Generates the gap size to be used for shell_sort (pseudo-generator))
define gaps
    for loop using i from max gap length to 0 (Decrement)
        "yield" gap to use

(Iterates through the array given a gap size and moves elements around in ascending order given the input
of a pointer to the array which directly manipulates and returns nothing)
define shell_sort
    for loop using gap from 0 to array length
    for loop using i from gap to array length
    set current index element to i
    set temp to i indexed element array (move value to a temp var to store)
    while loop comparing values
    set current index element array
        current index array element = gap diff index array element (move it back to correct spot)
        decrement j by gap
    set current index array element to temp
```

4.3 Heap Sort

```
(Returns the value of the greatest child node (left or right))
define max_child
    set left child to 2 times first
    set right child to left plus 1
    if right is bigger
        return right
    return left

(If the child node is greater than its parent node it swaps positions)
def fix_heap
    set found to false
    set mother to first
    set great to max child of mother and last
    while mother isnt last/2 and not found
        if mother element is less than great element
            swap elements
            set mother to great
            set great to max child of mother and last
```

```
        else make found true

(Calls on fix heap to re-sort or re-build the array after removing elements or swapping it out)
def build_heap
    for loop using father from last/2 to first - 1 (0 index, decrement)
        fix heap with father and last

(Calls on build heap to build the array, then swaps values based on if its greater than others, then fixes
the heap to repeat the process)
def heap_sort
    set first to 1
    set last to legnth of array
    do build heap with first and last
    for loop using leaf from last to first
        swap leaf and first
        fix heap with first and leaf - 1
```

4.4 Quick Sort

```
(Divides the array into two divisions and sorts the array by swapping elements based on if it is less or greater
than the pivot indicated by where the array is split)
def partition
    set low checker to lo - low checker
    for loop using high checker from lo to high
        if current element of array is less than hi element of array
            incrememnt low checker
            swap elements
        return low checker + 1

(Recursive function that uses partitions to divide the array then recursively sorts both sides)
def quick_sorter (recursive helper function for quick sort)
    if low less than hi
        do partition of lo and high
        quick sorter of lo and p - 1
        quick sorter of p + 1 and high

(Calls on quick sorter to do the recursive sorting (the main function of the sort so to speak))
def quick_sort
    quick sorter of 1 and array length
```

4.5 Sorting

use sets
enum, the sets to sort names (for convinience)

main()
- set a random seed with srand
- generate random numbers and put in array (30-bits)
- make another array with same numbers (to be used to "unsort" the sorted array)
- make an empty set
- use getopt
- use switch cases with command line args
- detect which is being used and assign using sets then break
- use if statements based on set chosen to execute sort
  - do sort
  - print out stats and array
  - replace sorted array with unsorted (in case other functions are sorting too)
- free memory

5 Credits

1. I used the asgn3.pdf from Professor Long for explanations and pseudocode.
2. I watched the Lab Section recording from Eugene held on 10/12.
3. I watched the Lab Section recording from Christian held on 10/15.