Cairo University
Faculty of Engineering
Computer Engineering
Fall 2018

<div align="center">

Design and Analysis of Algorithms
Homework 2

DEADLINE Monday, October 22ⁿᵈ 2018, 11:59 PM

</div>

<u>Your code should be taking into consideration the following requirements:</u>

1. Implement your code in C++ under Linux.
2. Use the Python script for each problem to a) generate the problem input data, b) compile your source file, c) run the binary file, d) validate the output of the program.
3. Do not alter the Python file.
4. Do not alter the program arguments
5. Consult he Python script to determine the name of your main source file. The source file name is included in the Python file for compilation.
6. Consult the Python script to determine the order and type of arguments passed to your program.
7. Make sure that the test case in the Python file passes successfully. It is recommended to extend the test cases in the script to more thorough ones to ensure you program is bug-free.
8. Do not submit back the Python script. We will test with our own script that follows the same process in the supplied one.
9. The code will be judged according to consistent coding convention, code cleanliness, and documentation.
10. Remember! Plagiarism is not tolerated. Any sign of cheating or plagiarism will be graded as ZERO in this assignment and all other assignments.

Deliverables:

- A brief (one page is enough) report.pdf document with the answers for the text questions in each problem (if applicable).
- Source code for every problem in a folder with problem name following the convention "pi" where i is the problem number. For example "p1" is the folder name for the first problem, and so on.
- Create a root directory named "hw2" containing the subfolders of all problems. It should contain too the PDF file.
- The final hierarchy should be:
  - hw2
    - report.pdf
    - p1
      - …..cpp
    - p2
      - …..cpp
    - pi
      - …..cpp
    - pn
      - …..cpp
- Submit "hw2.zip" which is the compressed "hw2" folder.

Submission:

- Go to www.elearn.eng.cu.edu and login with your student account (the same you use in the student portal).
- If not already enrolled, enroll in the course with the key sent to your class representative.
- Submit all deliverables through the website by the indicated deadline.

Problems:

1. Implement an algorithm to reverse a linked list. What are the time, heap space and stack space complexities?

   Problem instructions:

   a. The supplied input will be a file containing a list of integers with one integer per line.
   b. Place every integer into one node in the linked list.
   c. Process the data as requested in the problem.
   d. Write back the data in the same format in the specified output file.
   e. Write the running time into the corresponding file in the arguments.

2. Given an array with duplicates, sort the values in decreasing frequency. If two values have the same frequency, sort them according to their values. Implement an algorithm to solve the problem using hash tables. What are the time, heap space and stack space complexities?

   Example:

   Input: [6 2 5 1 6 5 2 6]

   Output: [6 6 6 2 2 5 5 1]

   Problem instructions:

   a. The supplied input will be a file containing a list of integers with one integer per line.
   b. Read this list into an appropriate data structure to represent an array.
   c. Process the data as requested in the problem.
   d. Write back the data in the same format in the specified output file.
   e. Write the running time into the corresponding file in the arguments.

3. Implement an iterative merge sort without using recursion or stack data structure in the same time complexity as the recursive one. *Hint*: Study the tree of merging the subarrays.

   a. The supplied input will be a file containing a list of integers with one integer per line.
   b. Read this list into an appropriate data structure to represent an array.
   c. Process the data as requested in the problem.
   d. Write back the data in the same format in the specified output file.
   e. Write the running time into the corresponding file in the arguments.

4. Given an array $A[1..N]$ of integers and integer K, compute array $B[1..N - K + 1]$ such that $B[i] = \min(A[i], A[i + 1], ... A[i + K - 1])$. Implement an algorithm to solve the problem in the minimum possible time and space. What are the time, heap space and stack space complexities?

   a. The supplied input will be a file containing a list of integers with one integer per line.
   b. Read this list into an appropriate data structure to represent an array.
   c. The parameter K will be supplied to the program arguments.
   d. Process the data as requested in the problem.
   e. Write back the data in the same format in the specified output file.
   f. Write the running time into the corresponding file in the arguments.