National Yang Ming Chiao Tung University
Department of Electrical & Computer Engineering
Computer Intelligence on Automation (C.I.A.) Lab

Algorithm Assignment 02
2022/04/07
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ECM5605 (5085) S'22: Homework 02

!!! DUE: 2022/04/07 23:59:59 !!!

[Problem 1] (100%) Sort, sort, sort!

All you need to do is sort. Here is a video demonstrating some sorting algorithm:
https://www.youtube.com/watch?v=kPRA0W1kECg

[Requirement]

In this homework, you are going to design an algorithm to sort a sequence of numbers by the value after passing a given function $f(x)$.

1. Input: (1) a sequence of n integer numbers $a_0, a_1, \ldots, a_{n-1}$ in an **almost-sorted** increasing order

   (2) a function $f(x)$ that returns a floating-point number

2. Output: a permutation $\langle \pi(0), \pi(1), \ldots, \pi(n-1) \rangle$ of the input sequence such that $f(a_{\pi(0)}) \leq f(a_{\pi(1)}) \leq \cdots \leq f(a_{\pi(n-1)})$

   (i.e., $\pi(i) = j$ is a mapping from the position (i) of the input sequence to the position (j) of the sorted sequence.)

Input (pass to the sorting function via a vector)

Format:

<size of the sequence **n** >
$a_0\ a_1\ \ldots\ a_{n-1}$ // separated by a single space

Example:

19   // Size of the sequence
-9   -8   -6   -7   -5   -4   -3   -2   1   0   -1   2   5   4   3   6   7   8   9

Function file <.cpp>

A file that defines the function $f(x)$. For example, $f(x) = -x$

Output (return a vector from your function)

Format:

$\pi(0)\ \pi(1)\ \ldots\ \pi(n-1)$ // Position for each number after sorting

Example 1 ($f(x) = x$):

0	1	3	2	4	5	6	7	10	9	8	11	14	13	12	15	16	17	18

Example 2 ($f(x) = -x$):

18	17	15	16	14	13	12	11	8	9	10	7	4	5	6	3	2	1	0

Example 3 ($f(x) = |x|$):

18	16	12	14	10	8	6	4	2	0	1	3	9	7	5	11	13	15	17

Notes that you need to be aware of:

1. You should implement your code in my_sort() in **your_id_hw2.cpp** and rename it as "**<your student id>_hw2.cpp**"
   (e.g., 0580706_hw2.cpp)

2. $a_0, a_1, \ldots, a_{n-1}$ are long integer numbers

3. n is a long integer number ≤ 30000000

4. $f(x)$ is a double-precision floating-point number such that
   DBL_MAX $\geq f(x) \geq$ -DBL_MAX

5. Your code will be compiled with
   $g++ -std=c++17 validate_code.cpp f.cpp *_hw2.cpp -o validate_code

Things you need to provide:

1. Your code in C++ named by "**<your student id>_hw2.cpp**" with the function **my_sort** implemented
   (e.g., 0580706_hw2.cpp)

2. A simple report describing your design of your algorithm named by
   "**<your student id>_hw2_report.pdf**". (e.g., 0580706_hw2_report.pdf)

3. Don't zip your files

   Please note that wrong file name and file format will result in a zero for this homework.

How we evaluate your code:

1. Correctness: Check whether your output is sorted properly:
   a. $f(a_{\pi(0)}) \leq f(a_{\pi(1)}) \leq \cdots \leq f(a_{\pi(n-1)})$
      We will accept your answer only when your result is <u>correct.</u>
      (You'll obtain 70 points for the correct result.)

2. Execution time (50%)

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You are **NOT encouraged** but welcome to use parallel programming. Note that we will accumulate CPU clocks in all the threads/tasks you use.

*Your code will be terminated after running for **5 minutes**, so please be aware of the execution time.

3. Memory Usage (50%)

    We will measure the resident set size, which is your RAM usage including your code size.   *RSS = Heap size + MetaSpace + OffHeap size.*

    *Your code will be terminated if you try to use too much RAM (8GB), so please be aware of the memory usage.

You score will be based on your ranking on the <u>execution time</u> and the <u>memory usage</u> among your classmates. (Partial of 30 points)

Good luck~