CS222: Assignment 1 - sorting algorithms

1. Submission deadline: Monday, 9 January at 3 pm.
2. Take k to be a large enough natural number.
3. Follow good coding practices to gain more marks.
4. No copying among the students or from the Internet or any other source.
5. The assignment can be submitted in groups of size ≤ 2.
6. Submit two `.cpp` files and one `.pdf` file.
7. Write the names and roll numbers of the students at the top of each file.
8. The files should be called

   `mergesort_firstRollNumber_secondRollNumber.cpp`,

   `quicksort_firstRollNumber_secondRollNumber.cpp`,

   `sorting_firstRollNumber_secondRollNumber.pdf`.
9. The pdf should contain the output obtained when each program was run.

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1. (15 points) Mergesort: Write a C++ *function* `mergesort()` that takes an array as input and outputs it in a sorted order.

   Write a C++ program that for every $i \in \{1, 2, 3, \ldots, k\}$, takes a *random integer array* of size $n = 2^i$, and outputs the time $T(n)$ taken by your `mergesort` function to process it.

   What can we say about the fraction $c_i = \frac{T(n)}{n \log n}$? Print the tuple $(i, 2^i, T(2^i), i2^i, c_i)$ for each i on a new row[1]. Find the expected value and the variance of the c_is and print it.

2. (15 points) Quicksort: Write a C++ *function* `quicksort()` that takes an array as input and outputs it in a sorted order.

   Write a C++ program that for every $i \in \{1, 2, 3, \ldots, k\}$, takes a *random integer array* of size $n = 2^i$, and outputs the time $T(n)$ taken by your `quicksort` function to process it.

   What can we say about the fraction $c_i = \frac{T(n)}{n \log n}$? Print the tuple $(i, 2^i, T(2^i), i2^i, c_i)$ for each i on a new row. Find the expected value and the variance of the c_is and print it.

[1] Note that when $n = 2^i, n \log n = i2^i$.