I111E Algorithms and Data Structures
Report 2

Propose: November 20 (Wed)

Deadline: November 28 (Thu), 9:00am

Note: Do not forget to write your name, student ID, problems, and answers on your report. You can send your report by email (to both of us) in PDF file format before the deadline. Reports in Word file formats are not accepted.

Answer <u>one</u> of the following problems in English or in Japanese. Each problem has 20 points. (If you choose more, we will estimate appropriately up to 20.)

Problem 1 When we compare two strings, their ordering is defined as follows:

$$\epsilon, 0, 1, 00, 01, 10, 11, 000, 001, 010, 011, 100, \ldots,$$

where ϵ represents the empty string of length 0. This is not the same as the "usual" ordering in your English dictionary. Define the "length-preferred" lexicographical ordering and the "usual" lexicographical ordering. Why might we want to use this length-preferred ordering rather than the usual one?

Problem 2 In quick sort, there are cases where a bad choice of a pivot makes the algorithm run slower. Give concrete examples of arrays and poorly chosen pivots that make quick sort have the worst possible running time.

Problem 3 Let us consider the following shuffle problem, which is the *reverse* of sorting:

Input: An array $a[0], \ldots, a[n-1]$.

Output: The array $a[0], \ldots, a[n-1]$, where the items are randomly shuffled.

That is, we want an algorithm that randomly re-orders an array of n items in such a way that each possible ordering appears with uniform probability. Assume that we can use a function `random(k)` that returns any integer i with $0 \le i < k$ with probability $1/k$. Then give an *efficient* algorithm to solve the shuffle problem.

Note
- If you talk about and/or write your report with other students and/or some references, specify them. You may have bad marks if it is not declared.
- If you submit by email, write your name, student id, and subject in the email, and the name of the PDF file should be [s*student ID*.pdf], like s12345678.pdf. Submit from the address with domain "jaist.ac.jp".
- If you submit by paper, use A4-size sheets, and staple them at the top-left corner. You may attach a cover or not.