

CS648A : Randomized Algorithms
Semester II, 2022-23, CSE, IIT Kanpur

Programming Assignment 2

Deadline : 11:55 PM, 31 March 2023.

Most Important guidelines

- It is only through the assignments that one learns the most about the algorithms and data structures. You are advised to refrain from searching for a solution on the net or from a notebook or from other fellow students. Remember - **Before cheating the instructor, you are cheating yourself**. The onus of learning from a course lies first on you. So act wisely while working on this assignment.
- Refrain from collaborating with the students of other groups. If any evidence is found that confirms copying, the penalty will be very harsh. Refer to the website at the link: <https://cse.iitk.ac.in/pages/AntiCheatingPolicy.html> regarding the departmental policy on cheating.

General guidelines

1. This assignment is to be done in groups of 2 students. You have to form groups on your own. You are strongly advised not to work alone.
2. **Naming the file:**
The submission file has to be given a name that reflects the information about the type of the assignment, the number of the assignment, and the roll numbers of the 2 students of the group. If you are submitting the solution of Programming Assignment x, you should name the file as **Prog_x_Rollnumber1_Rollnumber2.pdf**.
3. **Each student of a group** has to upload the same submission file separately. Be careful during the submission of an assignment. Once submitted, it can not be re-submitted.
4. Deadline is strict. Make sure you upload the assignment well in time to avoid last minute rush.

Recall the load balancing problem - n clients and n servers in a distributed environment. In this assignment, you will have to implement 2 protocols that aim at minimizing the the maximum load and draw inferences based only on the empirical results.

Maximum Load with simple randomization

We showed in this course that the following simple protocol \mathbf{P}_1 ensures that the maximum load is concentrated around $\Theta((\log n)/(\log \log n))$.

Each client selects a server randomly uniformly among all servers and gets queued there for the execution of its job.

Fill up the following table on the basis of your experimental results of \mathbf{P}_1 . This has to be followed by a concise inference (not exceeding 5 sentences)

$n \rightarrow$	10^3	10^4	10^5	10^6
Average value of maximum load				
$(\log_e n)/(\log_e \log_e n)$				
No. of cases where maximum load exceeds average by 20%				
No. of cases where maximum load exceeds average by 30%				
No. of cases where maximum load exceeds average by 50%				
No. of cases where maximum load exceeds average by 100%				

Maximum Load with two random choices

At the end of the recent lecture on “Delay Sequences”, we discussed another simple protocol \mathbf{P}_2 for this problem. Here, the clients arrive in a sequential order. The i th client in the sequence executes the following protocol.

1. *It selects 2 servers randomly uniformly and independently.*
2. *Sends requests to each of the selected servers about their load. These 2 servers communicate back their exact loads to the i th client.*
3. *the i th client selects the server which has less load than the other and gets queued there for its job.*

Fill up the following table on the basis of your experimental results of \mathbf{P}_2 . This has to be followed by a concise inference (not exceeding 5 sentences).

$n \rightarrow$	10^3	10^4	10^5	10^6
Average value of maximum load				
$\log_e \log_e n$				
No. of cases where maximum load exceeds average by 20%				
No. of cases where maximum load exceeds average by 30%				
No. of cases where maximum load exceeds average by 50%				
No. of cases where maximum load exceeds average by 100%				

Important point you should consider in this assignment

1. You must make sure that for any given n , you repeat the corresponding experiment sufficiently large number of times. In particular, the number of repetitions should be at least 500 (and preferably few thousands). In the report, you must mention very explicitly the number of repetitions.
2. Make sure you use a suitable random number generator.
3. Follow good programming practice(indentation, comments, suitable names for variables).
4. **[Do not miss this point]**
Please note that the students need to upload the code as well. Each group will have to give a demo of the assignment as well on the code it submits. There will be severe penalty for those involved in cheating in any form.
5. If each group does this assignment very sincerely and meticulously, the outcome will be truly memorable for the years to come.