CSEN B603 Berlin Winter 2023

Deadline is the 3^{rd} of November, 2023 11:59pm

1 Overview

Welcome to your first indvidule *Analysis and Algorithm Design* assignment. This assignment is focused on your analysis skills learned so far in the lectures and tutorials. Kindly fill the following Google form with your information and a GitHub repo on which you will upload your assignments till the end of the semester: https://forms.gle/emYNQJ14BEWqf8kD8
Deadline for filling the form is November 1^{st}.
Deadline for uploading your assignment on the GitHub repo is November 3^{rd}

2 Requirements and Deliverable

You are required to implement the following programming exercises:

1. Question 1
   (a) Write two program segments to implement the computation of powering a number, a^n , where n is a natural number, in two different ways:
      i. Naïve iterative method through multiplication by n times in a loop.
      ii. Repeat the same problem using a divide-and-conquer approach.
   (b) Determine each algorithm's asymptotic running time complexity using the big theta notation. Solve the recurrence for the divide-and-conquer algorithm.
   (c) One way to check the correctness of the above asymptotic analysis is to code up the program and see if the empirically observed running time matches the running time predicted by the analysis. Determine the scalability of each algorithm experimentally by running it with different power sizes n ranging between 1 and 10^6, and plot experimental results in a graph.
   (d) Determine whether experimental results confirm the theoretical analysis results in 1.(b).
2. Question 2:
   (a) Write an efficient program utilizing the divide-and-conquer paradigm and applying the Merge Sort and the Binary Search algorithms to determine, in a given set S of n integers, all pairs of integers whose sum is equal to a given integer.
   (b) Determine the asymptotic running time complexity of the proposed algorithm. Solve the recurrence for the divide-and-conquer algorithm.
   (c) Determine the scalability of the algorithm experimentally by running it with different power sizes n ranging between 1 and 10^6, and plot experimental results in a graph. Compare the empirically observed running time with the running time predicted by the analysis in 2. b.

The assignment is worth 10% and would be evaluated according to the following criteria:

- Fulfilling the mentioned requirements in the previous section; your code should be working properly with every input.
- Your report should contain the asymptotic diagram and real-time diagram with the relevant discussion on each. You can use the overleaf template "Example Project" for the report.
- Submitting the assignment before the deadline. No late submissions will be accepted
- Plagiarism will not be tolerated and might result in a zero.

Good Luck!