

CS/SE 4348: Operating Systems Concepts

Section 006

Programming Project 1

Instructor: Neeraj Mittal

Assigned on: Monday, January 29, 2024

Due date: Monday, February 12, 2024

This is a group assignment. A group can consist of at most two members. Each group is expected to write the code independently and submit only their own work. Copying or using work not your own will result in disciplinary action and the suspected incident will be referred to the Office of Community Standards and Conduct for investigation!

1 Project Description

Given an array A consisting of n numbers (may be negative), the prefix sum problem involves computing another array B of size n such that that i^{th} element in B is the sum of first i elements in A . Formally,

$$\forall i : 0 \leq i < n : B[i] = \sum_{j=0}^i A[j]$$

You have to implement the well-known *Hills and Steele's concurrent algorithm* to solve the prefix-sum problem using multiple cores (see https://en.wikipedia.org/wiki/Prefix_sum). The algorithm assumes that you have as many cores as the number of elements. You will have to adapt it to work for a given number of cores, and divide the work equally among the cores to the extent possible. Your program should accept four arguments:

- (1) the number of elements in the input array, denoted by n ,
- (2) the number of cores, denoted by m ,
- (3) the input file that contains the elements in A , denoted by `A.txt`, and
- (4) the output file that will contain the elements in B , denoted by `B.txt`.

Note that it is your responsibility to validate the arguments. For example, $n > 0$, $m > 0$, `A.txt` exists and contains at least n elements, and so on. In short, your program should not exhibit an undefined behavior if one or more input arguments is erroneous; if is not able to continue, it should terminate gracefully.

In your program, the main process should create m worker (child) processes to perform the work as required by modified Hills and Steele's algorithm. The main process is responsible for reading the input array from `A.txt` and writing the output array to `B.txt`.

Hills and Steele's algorithm works iteratively. Each iteration generates a new array with the final iteration generating the output array. All worker processes must finish the current iteration before any worker process can start the next iteration. *You can use a barrier to achieve this synchronization.* All processes should use shared memory to share all arrays, which includes the input array, the output array and all intermediate arrays.

You can write your program in C or C++. Name your program as `my-count`. Also, *ensure that your program runs on one of the department machines `cs1.utdallas.edu`, `cs2.utdallas.edu` or `giant.utdallas.edu`; otherwise you will not get any credit.* Any deviation from the description would result in significant penalty.

2 Grading Criteria

As such, projects will be graded with these criteria in mind:

- Solutions must adequately address the problem at hand. Specifically:
 - The solution represents a good-faith attempt to actually address the requirements for the assignment.
 - The program complies and executes.
 - The program runs correctly.
- The solution constitutes a high quality product expected of a professional. Specifically:
 - The program is easy to read and to understand, that is, it is well commented. In addition, method and variable names are meaningful, all potentially confusing/complex code is well documented.
 - The general design of the program is clear and reasonable.
 - All procedure and function headers include comments explaining what the method is supposed to do (not how it does it) and the purpose of each formal parameter. Be as precise and careful as you can be.
 - The program is robust and handles important errors and exceptions properly.

3 Submission Information

You have to submit your project through eLearning. Along with all the source files, submit the following:

- (i) A Makefile to compile the program, and
- (ii) A README file that contains the names of all the team members, and the instructions for running the compiled program.

Points will be deducted if you fail to submit any of the above-mentioned files. Only one team member needs to submit the files.