

Problem set 2, Part 1

TDT4200, Fall 2016

Deadline: 21.09.2016 at 20.00 Contact course staff if you cannot meet the deadline.

Evaluation: Pass/Fail

Delivery: Use It's Learning. Deliver exactly two files:

- *yourusername_ps2.pdf*, with answers to the theory questions

General notes: All problem sets are to be done **INDIVIDUALLY**.

Problem 1

Consider a parallel program working on a $n \times n$ 2D array of data. The program is run on a cluster with $p = qr$ nodes, where q and r are even integers. When the array is subdivided, each node thus gets a rectangular subdomain of size $\frac{n}{q} \times \frac{n}{r}$.

- Find an expression for the total number of grid elements which must be sent when the grid is distributed and gathered.
- Find an expression for the total number of grid elements which must be sent (by all the processors combined) when the processors perform a periodic border exchange. (That is, when each processors sends the border of its subdomain to each of its four neighbours, (wrapping around at the edges)).
- Assume that each processor can perform full-duplex communication with at most one other processor at a time, that multiple pairs of processors can communicate at the same time, and that the processors can communicate at b bytes/second with a startup time of s . Find an expression for the time required to perform a periodic border exchange, assuming each grid element is d bytes.
- Consider the case where $p = 64$. Which values of q and r minimize the cost of computation?

Problem 2

Consider the parallel odd-even sort described in Section 3.7.2 of Pacheco.

- Find the speedups and efficiencies of the program. Select some appropriate problem sizes and number of processes.
- Does the program obtain linear speedups? Explain why/why not.
- Is the program weakly scalable? Explain why/why not.
- Is the program strongly scalable? Explain why/why not.

Problem 3

What are two of the main differences between threads and processes, in general?

Problem 4

Consider the thread based global sum example described in Section 4.5 of Pacheco. Explain why using private variables, and moving the busy-wait flag lock outside the loop improves the performance.

Problem 5

- What is a race condition?
- What is a critical section?
- Name three schemes for protecting access to critical sections, and list two pros and cons of each.