Department of Mathematics, Faculty of Science, UU.
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In 2006/2007, the course WISM459 was given by Rob H. Bisseling.

Parallel Algorithms (WISM459)
October 11, 2006

Each of the five questions is worth 10 points. Total time 45 minutes. Note that this exam has 2 pages!

Question 1

Explain the architecture of a BSP computer.

Question 2

50 processors of a parallel computer are matched in pairs $(P(s), P(s+1))$, with s even. Processor $P(s)$ sends s data words to processor $P(s+1)$, for even s. What is the value h of the h-relation defined by this communication pattern?

Question 3

Let $\mathbf{x}$ and $\mathbf{y}$ be given vectors of length n which are distributed over p processors, with $n \bmod p = 0$; $\mathbf{x}$ is distributed by the cyclic distribution, and $\mathbf{y}$ by the block distribution. Give an efficient BSP algorithm for processor $P(s)$ (in the notation we learned) for the computation of the vector $\mathbf{z} = \mathbf{x} + \mathbf{y}$. Analyse its BSP cost. You are free to choose the output distribution.

Question 4

Let p, n be integers, with $2 \leq p \leq n$. Define a permutation σ by $\sigma(i) = n - 1 - i$, for $0 \leq i < n$. What is the exact communication cost of permuting a block distributed vector $\mathbf{x}$ by σ, i.e., assigning $y_{\sigma(i)} = x_i$? The length of the input and output vectors is n.

Question 5

We want to evaluate a polynomial

$$f(x) = \sum_{i=0}^{n-1} a_i x^i$$

in parallel using p processors. Here, x is a given real number and $a_0, \ldots, a_{n-1}$ are given real coefficients. Sequentially, this is usually done by applying Horner's rule:

$$f(x) = a_0 + x(a_1 + x(a_2 + \cdots + x(a_{n-2} + x(a_{n-1}))\cdots)).$$

Assume that x is known at $P(0)$, and that the coefficients are already distributed by the block distribution over p processors, where $n \bmod p = 0$. Give an efficient BSP algorithm for processor $P(s)$ for the computation of $f(x)$. The output $f(x)$ should become known at $P(0)$. Analyse the BSP cost.