



Lab Parallelization · Summer Semester 2017

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Assignment 2

Hand out: 9.05.2017

Hand in: 22.05.2017, till 2:00 pm at ppva-tut@informatik.uni-frankfurt.de

Task 1

Trapezoidal Rule

In the numerical analysis, Trapezoidal Rule is a method for numerical integration. Consider $y = f(x)$ over $[a, b]$. Suppose that the interval $[a, b]$ is subdivided into N equidistant subintervals. The length of the subintervals is $s = \frac{b-a}{N}$ and the sample points are $x_0 = a$, $x_N = b$, $x_k = x_0 + k \cdot s$ for $k = 0, 1, 2, \dots, N-1$.

The Composite Trapezoidal Rule for N subintervals is:

$$\int_a^b f(x) dx \approx \frac{s}{2} \left[f(a) + f(b) + 2 \sum_{k=1}^{N-1} f(a + ks) \right]$$

Write an MPI program for a parallel numerical integration based on the Trapezoidal Rule. The number of intervals and integration limits a, b must be specified by the user during runtime. Send the integration limits and the number of subintervals from the root in one step with `MPI_Bcast` to all other processes. After calculation all processes send the subresults to all processes by using the butterfly-algorithm and blocking buffered communication.

Use your program to compute the following integrals:

$$\int_a^b \frac{1}{\sqrt{2x+1}} dx$$
$$\int_a^b \ln x \, dx$$

Measure the time needed for computation: Measure each sequential component, each parallel component and all communication components.

Task 2

Odd-even Transposition Sort

Implement the Odd-even Transposition Sort. The algorithm is explained in the lab. Each process generates N random numbers. Write a program which sort the numbers by the rank of the processes. For the local sort you can use the quicksort function from the C-Library.

- a) Use non-blocking MPI_Send and MPI_Recv for the data exchange.
- b) Using persistent MPI_Send- and MPI_Recv-Operations for the data exchange.

The user should specify N and the communication mode as parameter.