Parallel Matrix by Matrix Multiplication using MPI

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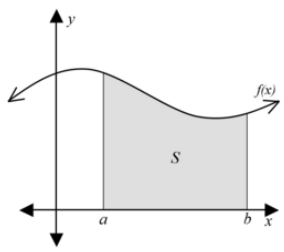
PRACE Training @ BSC, November 2012

1 Hands On - Numerical Quadrature

In order to solve the integral

$$\int_a^b f(x)\,dx \tag{1}$$



numerically we can divide the interval $[a, b]$ into n sub-intervals, where $a = x_0 < x_1 < x_2 < x_3 \ldots < x_{n-1} < x_n = b$. We can estimate

$$\int_{x_i}^{x_{i+1}} f(x)\,dx \tag{2}$$

by the area of the trapezium formed by joining the points $(x_i, 0)$, $(x_{i+1}, 0)$, $(x_i, f(x_i))$ and $(x_{i+1}, f(x_{i+1}))$, which can be calculated by

$$A_i = \frac{h_i(f(x_i) + f(x_{i+1}))}{2} \tag{3}$$

where h_i is the length of the ith interval defined by $h_i = x_{i+1} - x_i$. If we then sum all A_i

$$S = \sum_{i=0}^{n-1} A_i \tag{4}$$

we get an approximation of the solution of our original problem.

1.1 Practical

We assume that $f(x)$ is a function with n terms of the form $\alpha_0 x^0 + \alpha_1 x^1 + \alpha_2 x^2 \cdots \alpha_{n-1} x^{n-1}$. As the input we consider a list of coefficients $\alpha_0 \quad \alpha_1 \quad \alpha_2 \quad \cdots \quad \alpha_{n-1}$, the number of sub-intervals and the number of compute nodes to use. For this work the interval $[a, b]$ is to be divided into equal sized sub-intervals.

1. Complete the given demonstration program.
   (a) As the input use a file[1] with an integer number in the first line indicating the number of terms and a list of integer numbers where the first number is the coefficient α_0, the second α_1, the third α_2 and the last is α_{n-1} in the following line. For the speedup and efficiency tests you should use term lengths of 50 and 100 and interval steps of 10000, 100000 and 1000000.
   (b) The number of sub-intervals, the endpoints a and b, the number of compute nodes to use and the filename for the coefficients shall be passed as arguments to the program.
2. Analyse and take note of:
   (a) the design of the programs;
   (b) the speedup achieved in using multiple compute nodes for different parameters;
   (c) the efficiency of the parallel programs;
   (d) the results for the different problem sizes.

[1] some test files are provided, more can be generated using intgen.c