

Exercises for Advanced Topics in High Performance Scientific Computing

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Exercise Sheet 3 (until November 4, 2015)

Exercise 3*

Use the finite difference method to discretize the Laplace equation on the unit square

$$\Delta u(x, y) = 0, \quad (x, y) \in (0, 1) \times (0, 1) \quad (1)$$

with the boundary conditions given by

$$u(x, 0) = u(x, 1) = 0, \quad u(0, y) = u(1, y) = \sin(\pi y), \quad x, y \in [0, 1]. \quad (2)$$

Solve the resulting linear system $Au = f$ with the Jacobi method with an initial guess $u^{(0)} = u_0$ and for $k > 0$ calculate

$$u_i^{(k+1)} := \frac{1}{a_{ii}} \left(f_i - \sum_{\substack{j=1 \\ j \neq i}}^n a_{ij} u_j^{(k)} \right), \quad i = 1, \dots, n. \quad (3)$$

Implement the Jacobi iteration in C/C++ with the system matrix A stored in a) compressed row storage (CRS) format and b) in a matrix-free approach. Compare the performance of the two methods. Terminate the Jacobi iteration if the norm $\|f - Au\|_2 < 10^{-6}$. Compare the results with a Matlab implementation.

* Place all source files of the exercises in a folder named **Exercise3** in your home directory on the `mephisto.uni-graz.at` cluster.