TP2 – Second part : : Solving the Laplacian equation with Boundary conditions through the pseudospectral method using the BiCGStab algorithm and the BLAS library

David Loureiro

May 30, 2007

Abstract

The purpose of this second part is to discretize the problem to solve, apply the boundary conditions, and solve the linear system resulting with the BiCGStab algorithm where the matrix-vector and the dot products has been optimized with the BLAS routines.

1 The problem to solve

The problem corresponds to the resolution of the Laplacian Equation on $[-1, 1]$ with a Dirichlet boundary condition on -1 and a Neumann boundary condition on 1:

$$\Delta u = f \quad (1)$$
$$u(-1) = a \quad (2)$$
$$\frac{\partial u}{\partial x}(1) = b \quad (3)$$

With $f(x) = -2\sin(x) - x\cos(x)$, $a = -\cos(-1)$ and $b = \cos(1) - \sin(1)$.

2 Numerical resolution

In the archive file named `part2.tgz` you will find three files :

- One containing the subroutine initializing the matrix corresponding to the first derivative and the vector of the grid points
- One another that provide a diagonal preconditionning for the system, and the solution
- The last one containing the declarations of the subroutines to write for the resolution of the problem

To solve the problem you must write :

- a subroutine initializing the matrix corresponding to the discretized operator (the Laplacian)
- a subroutine applying the boundary conditions to the matrix
- a subroutine initializing the right and side
- a subroutine applying the boundary conditions to the right hand side
- a subroutine initializing the grid of the problem

Finally you have to write a main program solving the problem with the existing routines (BiCGStab with/without BLAS) and using the preconditionning.

Plot the obtained solution and the error between your solution and the real one. Comment the repartition of the error corresponding to collocation points.