

M.Sc. Simulation Sciences, Winter Semester 2012/2013

Fast Iterative Solvers

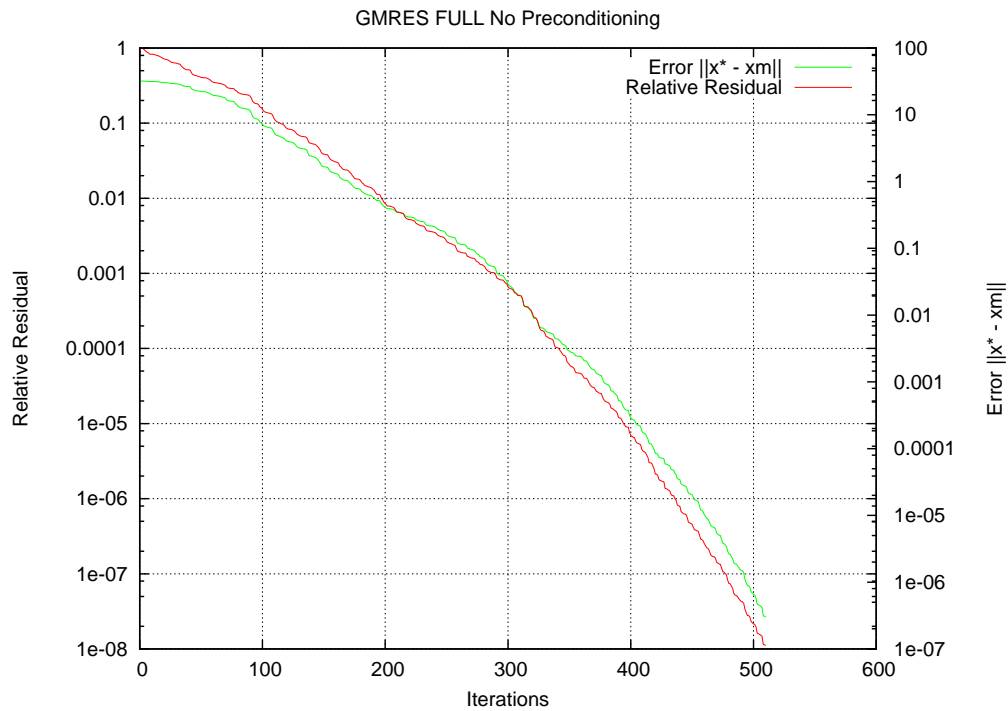
Project 1: GMRES and CG

Group Members:

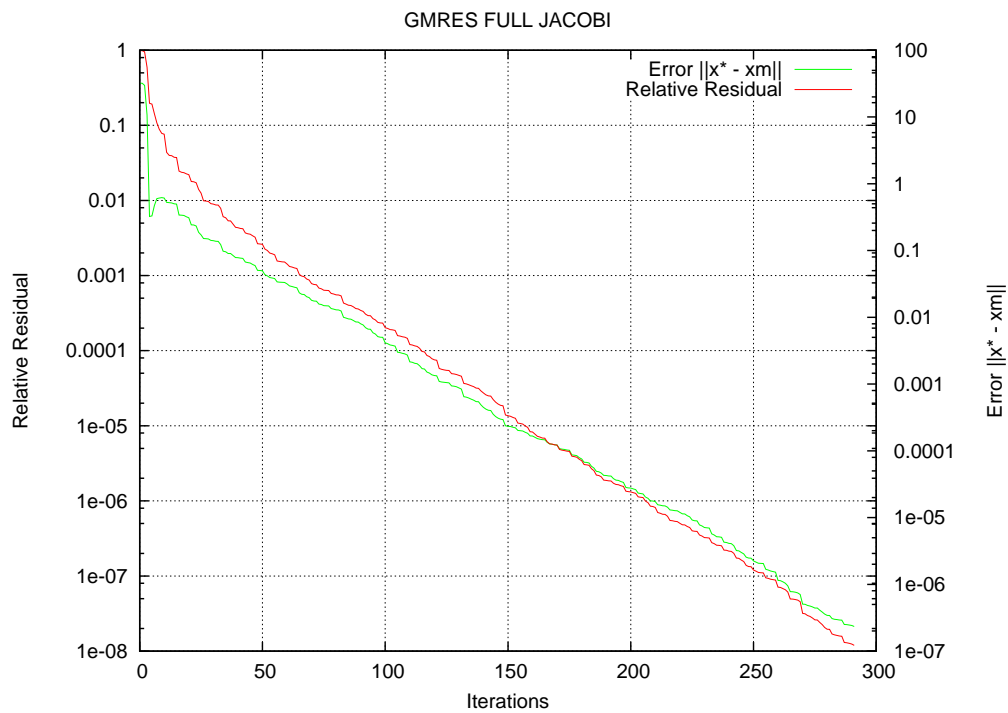
Abhishek Y. Deshmukh, R. Varun Raj, Raghavan Lakshmanan, Mohsin Ali Chaudry

June 10, 2013

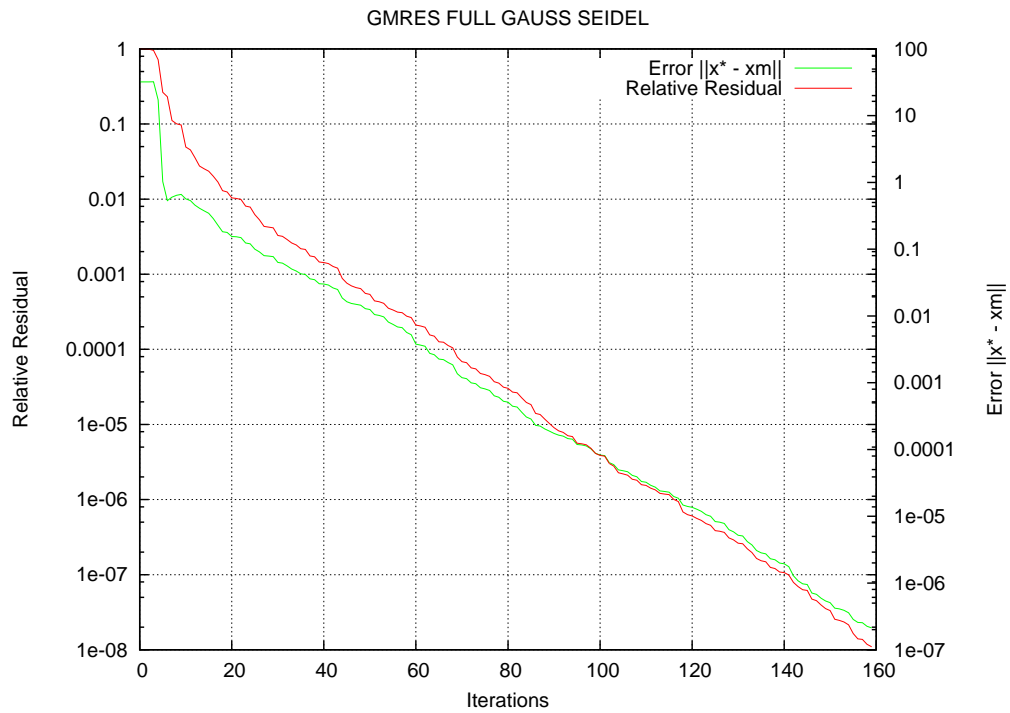
1 Plots: Error and Residual Vs. Iteration Index



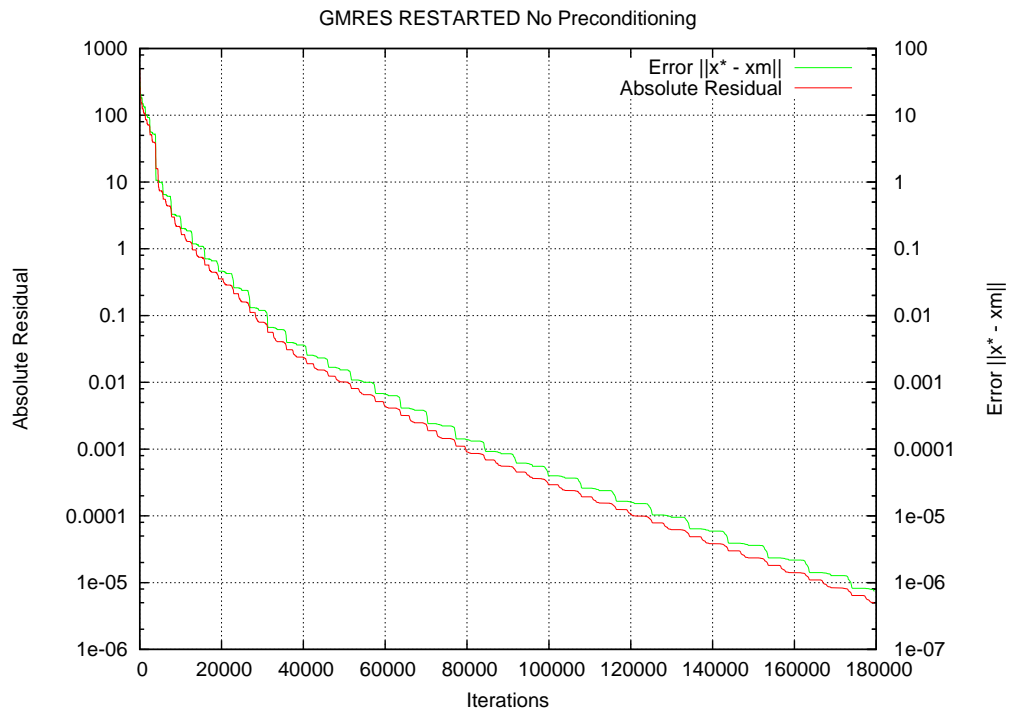
Plot 1: GMRES FULL No Preconditioning



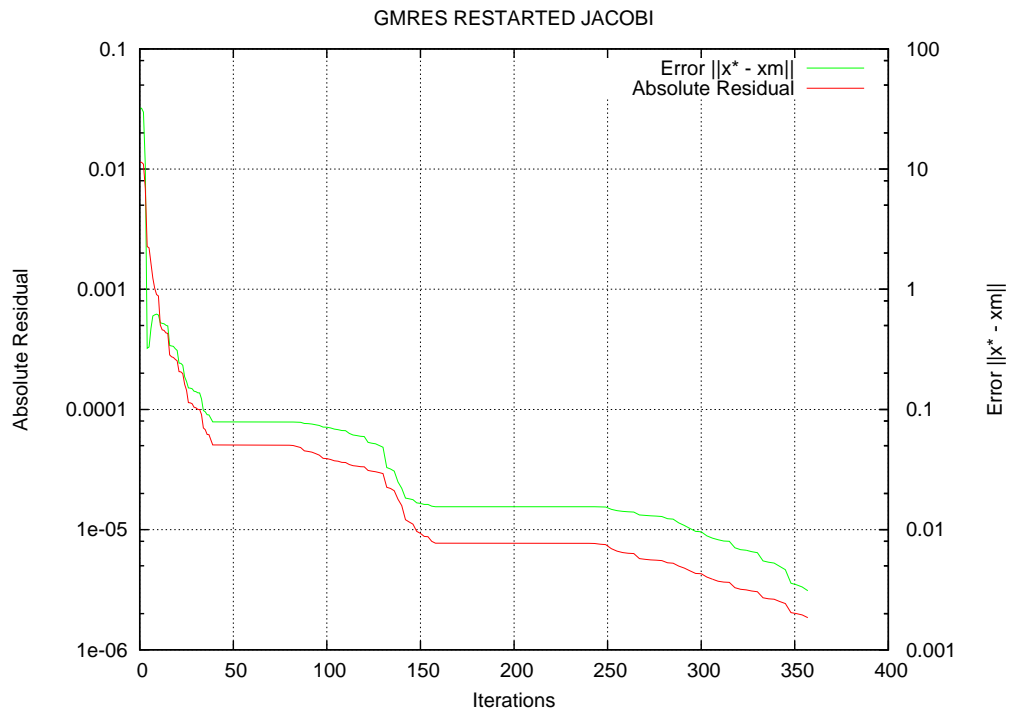
Plot 2: GMRES FULL Jacobi Preconditioning



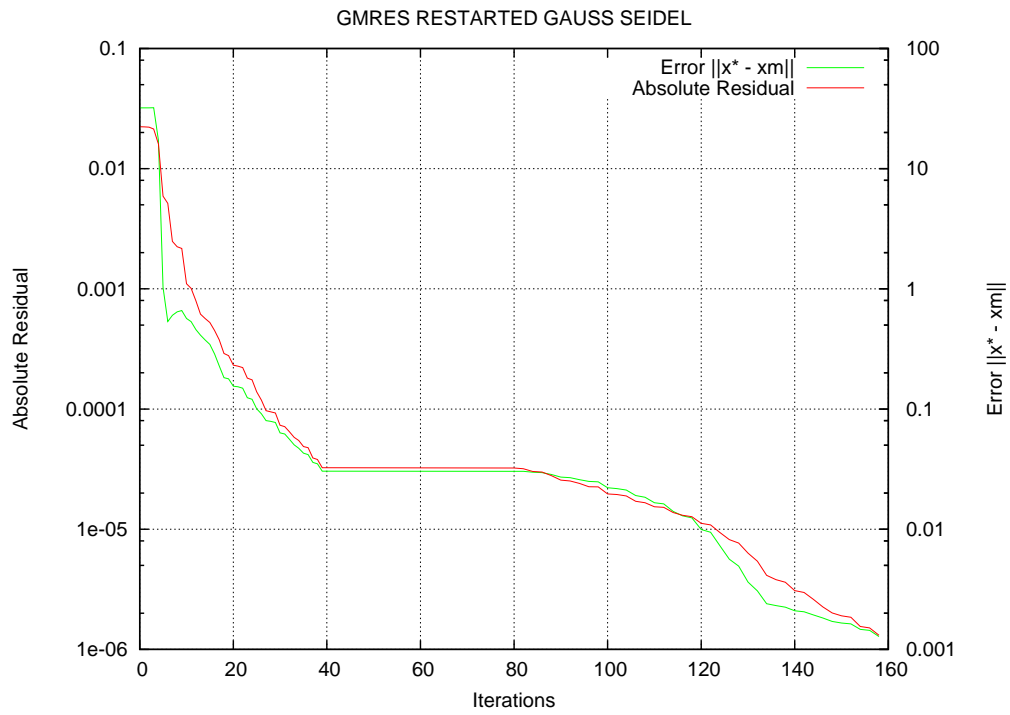
Plot 3: GMRES FULL Gauss Seidel Preconditioning



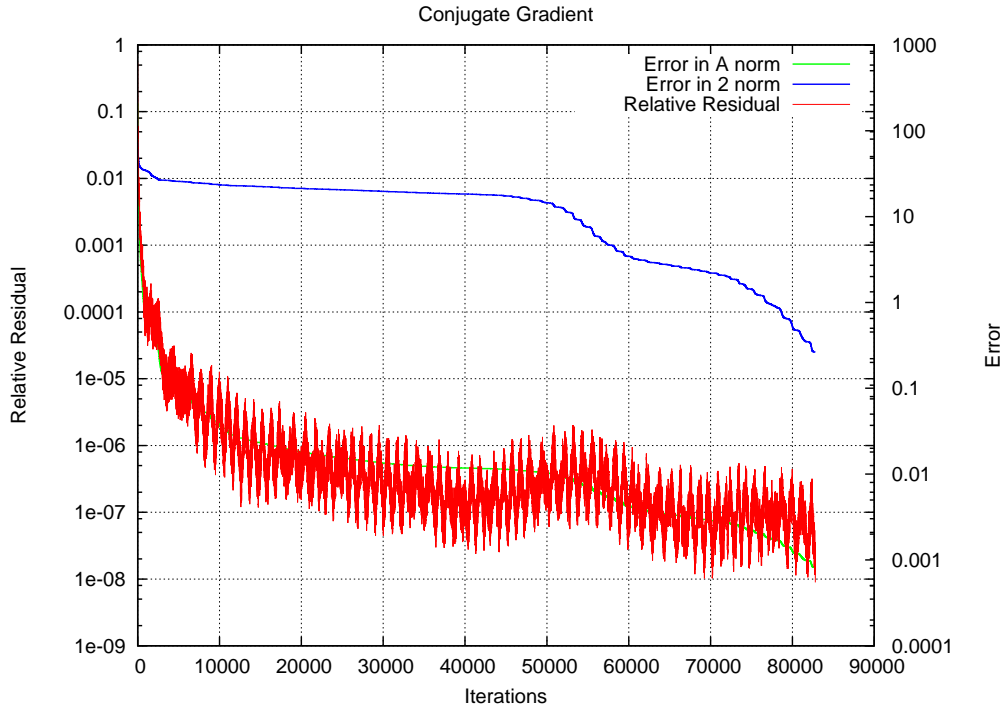
Plot 4: GMRES RESTARTED No Preconditioning



Plot 5: GMRES RESTARTED Jacobi Preconditioning



Plot 6: GMRES RESTARTED Gauss Seidel Preconditioning



Plot 7: Conjugate Gradient

2 Full GMRES Method:

Number of Krylov Vectors required: **512**

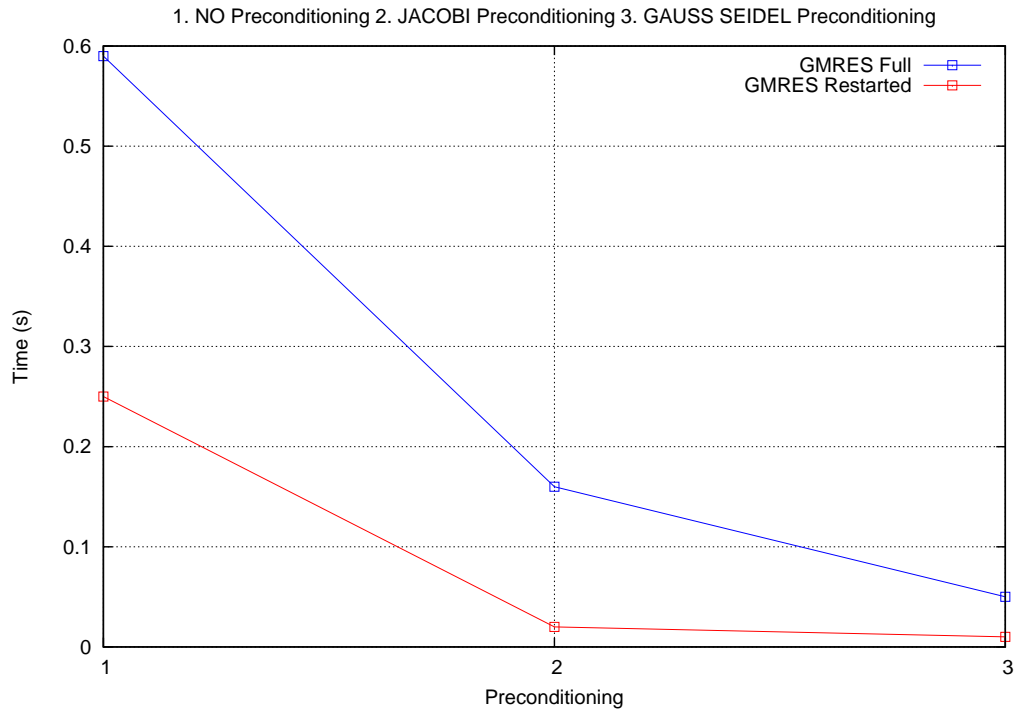
3 Restarted GMRES Method:

Best restart parameter (m) = 40 with time $\sim 0.26 - 0.28s$

This optimal method is faster than full GMRES method because the number of Krylov vectors is fixed to a lower number (40) than that required by full GMRES (512) which reduces the number of operations significantly [$O(512^2)$ to $O(40^2)$].

Additionally, the initial guess is improved at every execution of GMRES algorithm.

4 Preconditioned GMRES Method:



Plot 8: Comparison of Timings with and without preconditioning

GMRES Method with Gauss Seidel preconditioning is the fastest one.

Compare the true absolute residual $r := \|b - Ax\|$ with the residual of preconditioned system. Does the relative residual reduction depend on which residual you monitor? (Why would one rather not monitor the true residual during the computation of the solution?)

5 Conjugate Gradient Method:

Both the errors, i.e. error in A norm and error in 2 norm are plotted in Plot 7.

Compare qualitatively the difference in convergence behavior. (i.e. the difference between the two norms). Is there an explanation for what you observe?