PETSc Iterative Solver Investigations

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1 Overview

The goal of this assignment is to experiment with the ksp.c file in order to better understand various matrix solvers. While the code is in C and compiled with CMake, this assignment was completed using a handful of shell scripts, with additional python scripts to visualize outputs.

2 Different Solvers

The three solvers analyzed in this assignment are CG, BCGS, and GMRES. BCGS performed generally slightly better than CG, and GMRES consistently performed much worse than both (as seen in Figure 1).

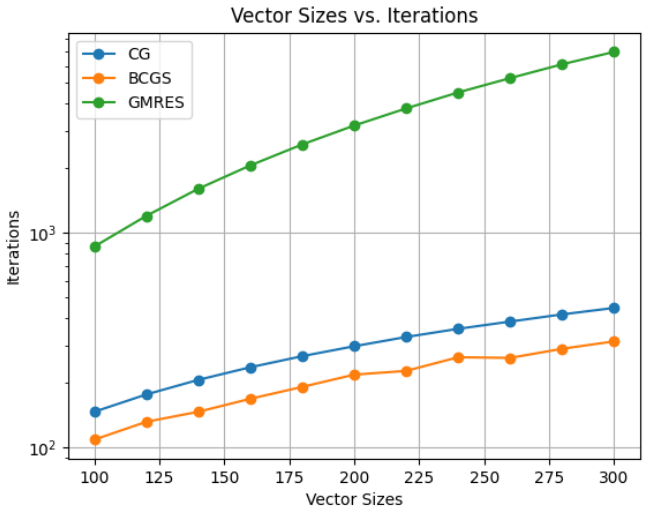

Figure 1: Vector Size vs. Iterations for CG, BCGS, and GMRES solvers

3 Unsymmetry Parameter

The unsymmetry parameter was varied between -1 and 1. The results are mostly symmetrical across the y-axis, however there is a slight asymmetry noticeable in the BCGS data. BCGS outperformed both other solvers at all values sampled. CG performs better than GMRES at small magnitudes, but quickly performs worse after a threshold in between 0.5 and 0.75.

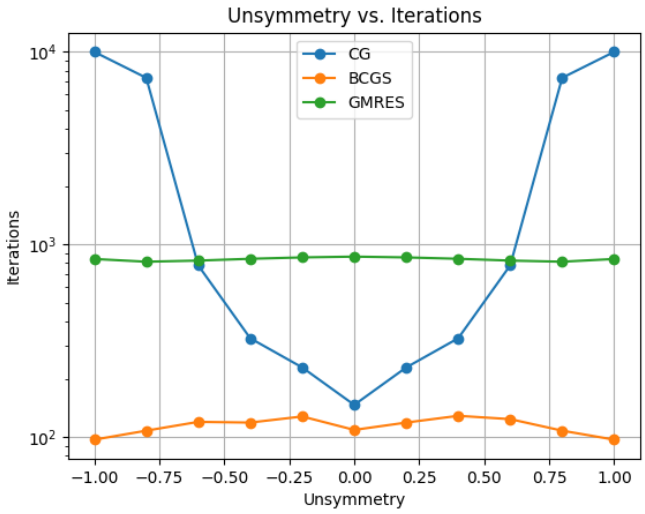

Figure 2: Unsymmetry vs. Iterations for CG, BCGS, and GMRES solvers

With the unsymmetry parameter held constant at 0.5, the difference was taken between the default configurations for CG, BCGS, and GMRES, and their unsymmetrical counterparts. Figure 3 shows noticeable improvedment with unsymmetrical GMRES runs. BCGS stays decently constant, and CG shows noticeable decrease in performance.

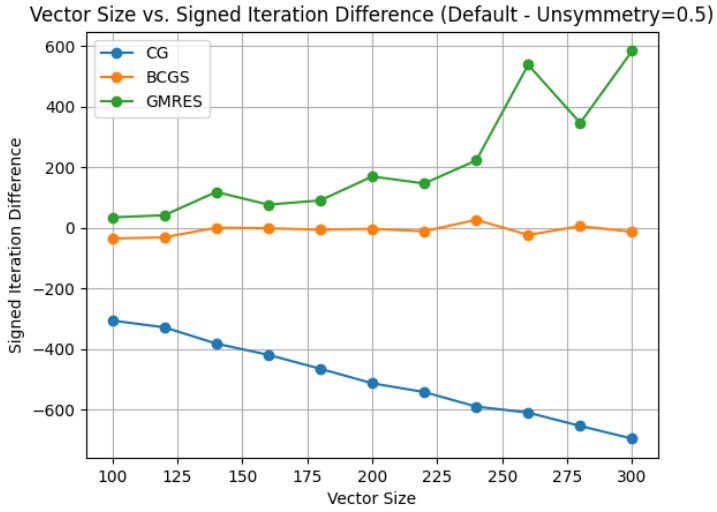

Figure 3: Vector Size vs. Signed Iteration Difference for CG, BCGS, and GMRES solvers

4 Various Costs

PCSetup time is greatest for any configuration using the lu setting by a significant amount (0.07sec vs 0.005sec). GMRES ilu configurations appear to produce the highest flops per second at around $1.3 * 10^9$Flops/Sec vs the more typical $0.4 * 10^9$Flops/Sec for other configurations. The matrix/vector products per iteration appears to either be 1.0 (CG, GMRES) or 0.5 (BCGS), or extremely close to these values.

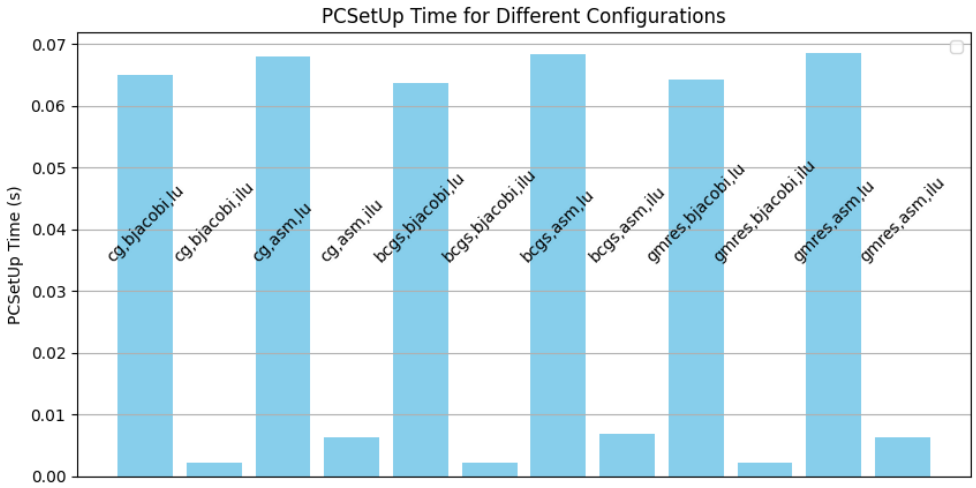

Figure 4: PCSetup Time Cost for Different Configurations

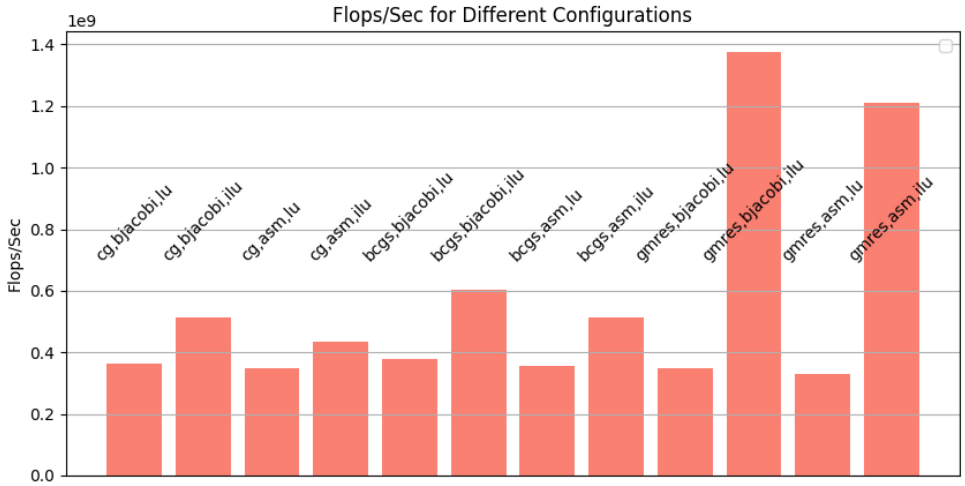

Figure 5: Flops per Second for Different Configurations

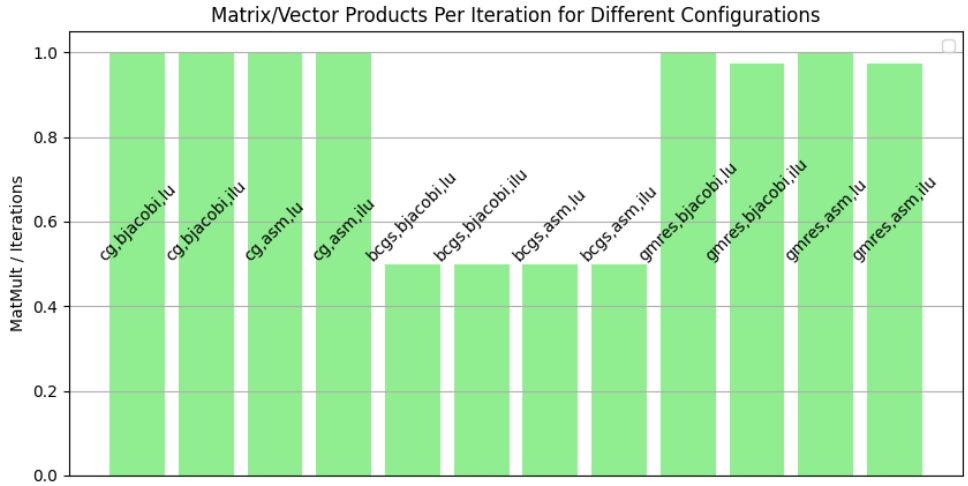

Figure 6: Matrix/Vector Products per Iteration for Different Configurations