# Report on parallel code on solving darcy equation

- The following table is to check the Weak Scaling Efficiency of the code when the grid size is increased but the local domain size for each processor remains the same. In this table each grid size has a local domain size of 1024x1024. It can be seen that there is less than 25% efficiency loss as the number of processors increases.

| Num_procs | Grid size | Setup times (sec) | Solver times (sec) | Weak Scaling Effiiciency (%) |
|---|---|---|---|---|
| 1 | 1024x1024 | 0.47 | 3.54 | 100 |
| 2 | 2048x1024 | 0.49 | 3.66 | 96.8 |
| 4 | 2048x2048 | 0.50 | 3.75 | 94.4 |
| 8 | 4096x2048 | 0.62 | 3.85 | 92 |
| 16 | 4096x4096 | 0.58 | 4.39 | 80.6 |
| 32 | 8192x4096 | 0.68 | 4.68 | 75.6 |

- The following table shows the Strong Scaleing Efficiency of my code. These results are for a grid size 8192x4096 points which is the maximum possible grid size that can run on a single core of a node of our server with the available memory resources. There is less than 25% efficiency loss from 1 processor to 32 processors.

| Num_procs | Setup times (sec) | Solver times (sec) | Strong Scaling Effiiciency (%) |
|---|---|---|---|
| 1 | 18.21 | 116.77 | 100 |
| 2 | 8.64 | 58.68 | 99.5 |
| 4 | 4.32 | 29.91 | 97.6 |
| 8 | 2.23 | 15.75 | 92.7 |
| 16 | 1.28 | 9.04 | 80.7 |
| 32 | 0.68 | 4.70 | 77.6 |

- The first tests were performed for a square grid with different sizes in a single processor to check a rough scaling in solver times with the grid size.

| Grid size | Solver times (sec) |
|---|---|
| 128x128 | 0.06 |
| 512x512 | 0.92 |
| 1024x1024 | 3.55 |
| 2048x2048 | 14.68 |

- The following table is for a fixed grid size 4096x4096 and the initial condition is varied by changing the roughness in lognorm distribution to check the stability of HYPRE and the sparse matrix solver. In simpler words, the variance of the input data to the code is changed by many orders of magnitude to check the stability of the code. It is found that the process times are consistent with high variance of 0.1 to very variance of 0.00001.

| Roughness | Setup times (sec) | Solver times (sec) |
|---|---|---|
| 0.1 | 0.68 | 4.47 |
| 0.01 | 0.66 | 4.47 |
| 0.001 | 0.64 | 4.48 |
| 0.0001 | 0.69 | 4.47 |
| 0.00001 | 0.66 | 4.47 |