COMP 705: Advanced Parallel Computing
HW 5: Jacobian Iterative Solver for 3D Heat Equation

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Due: Presentation: 10/18/17, Report: 10/20/17
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Table of Contents

Problem 3B: 3D Jacobian Solver - Implementation

- Implement your 3D solver by modifying your 2D solver.
- Modify code to process command line arguments for
  - 3D processor distribution: $P(p_i, p_j, p_k)$
    - where $1 <= p_i <= NP$;
    - $NP = p_i \star p_j \star p_k$; set default to be $p_i = p_j = p_k$
  - 3D data distribution: $N(n_i, n_j, n_k)$
    - where $1 <= n_i <= M$;
    - $M = n_i \star n_j \star n_k$; set default to be $n_i = n_j = n_k$
- Create routines for saving periodic time slices of temperature.
- Modify parallel code to use communicators created using MPI_Cart functions; use MPI_Cart_Shift to get neighbors
- Update code to used derived datatypes and code timers
- You can choose to work with Kadin or Gropp code
- Writeup results in lab report format (use references) 10/20/17
- Prepare short in-class presentation due 10/18/17

Analysis

- Compare serial to parallel.
- Measure speedup/efficiency (compare to fig in below)
- Capture time data to generate video (or show multiple images on one page)
- Visualize heat propagation using Matlab, gnuplot, or other plotting routines.

Parallel Jacobian SOR solver Speedup

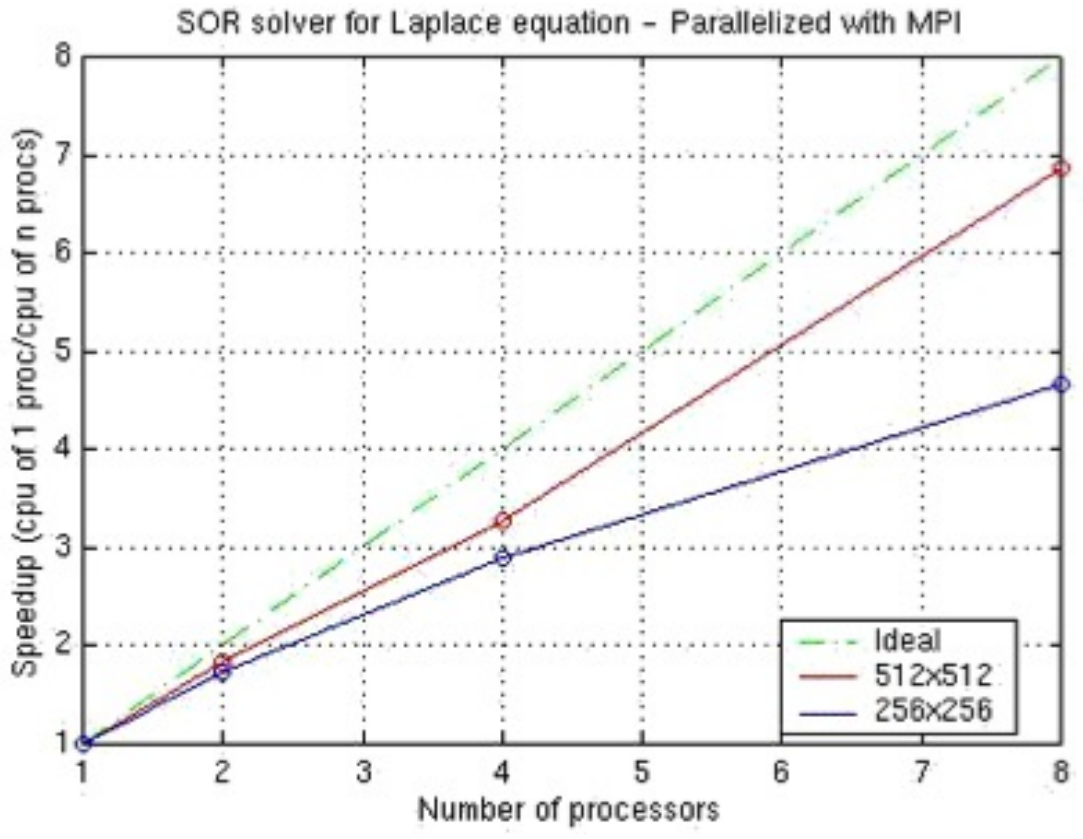

Figure shows the scalability of the MPI implementation of the Laplace equation using SOR on an SGI Origin 2000 shared-memory multiprocessor.

Source: `http://site.sci.hkbu.edu.hk/tdgc/tutorial.php`

Matlab code for visualizing heat propagation

- 2D routines provided with code base.
- Requires modification for file names (needs full path to file): define a HOME variable.
- "laplace.m" outputs image shown on right.
- Examples of 3D visualization can be found in paper by M. Qubeissi (see topics/iterative solvers)

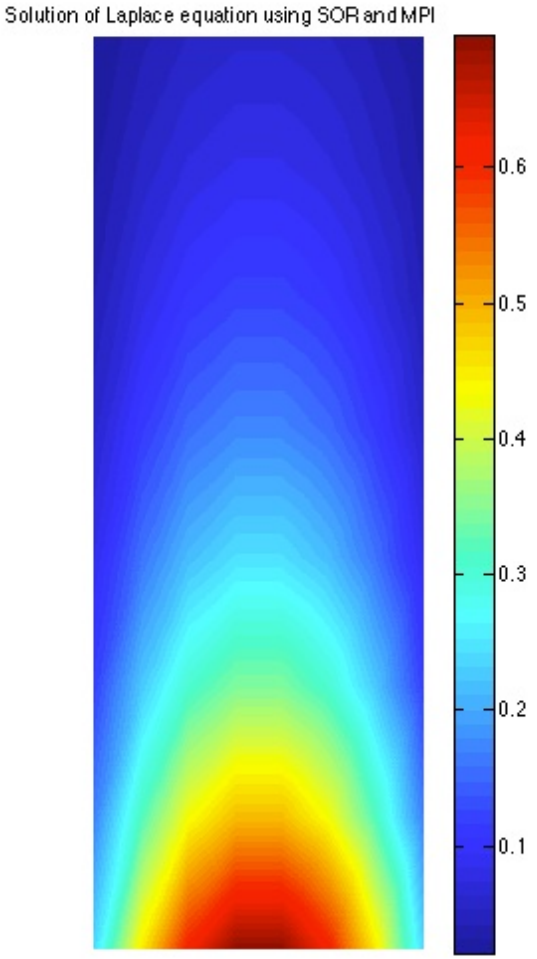

Table: Diffusion of Heat in a 3D Volume

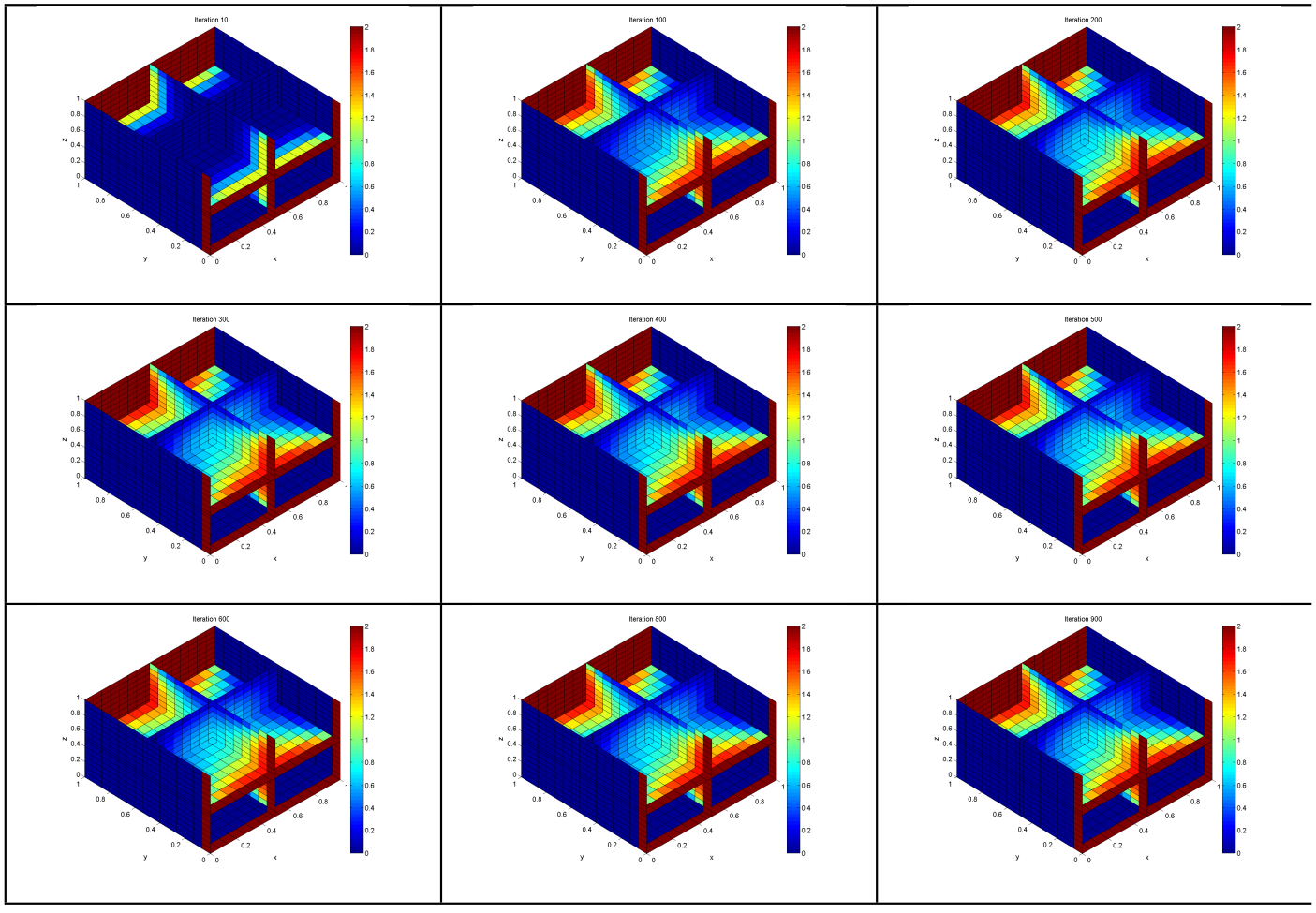

Table: Credit: Neelam Patel, Fall 2017

Reading

- See papers listed in topics at:
  `https://edoras.sdsu.edu/~mthomas/f17.705/topics/iter_solv/`
- In particular, see Gropp Iterative Solvers and Advanced MPI Notes:
  - Kjoldstad and Gropp (2010), "Ghost Cell Pattern"
  - Gropp (2003), The 2-D Poisson Problem
- Souce code (suggested):
  - Kaden Tseng Notes:
    `https://edoras.sdsu.edu/~mthomas/17.705/topics/iter_solv/`
  - Gropp, Using Intermediate MPI: `http://www.mcs.anl.gov/research/projects/mpi/usingmpi/examples-usingmpi/advanced/index.html`