Mid-Sem Project Report

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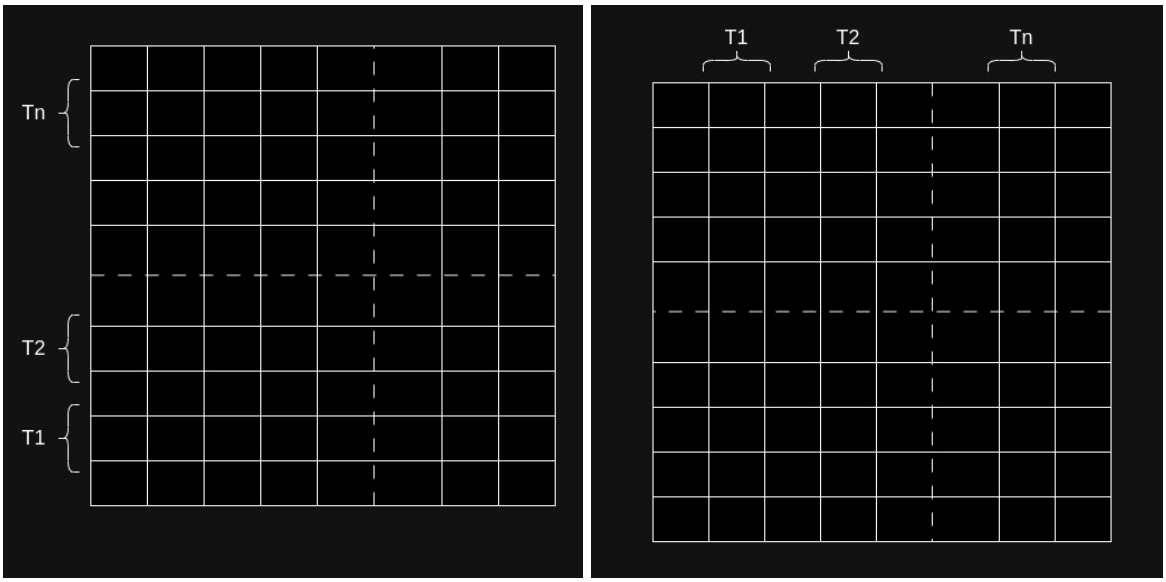
Problem statement: -

A code for solving the 2D diffusion equation with the Finite Volume method.
Given a 2D plate and boundary conditions on all four sides, we need to calculate the temperature value at every point on the grid at different timestamps.

Solution direction: -

(Tar file has not been shared, using a sample code for 2D fvm.)

- Code consists of sections (for loops, etc.) that can be parallelized.
- A shared memory setup can parallelize many sections independent of threads.
- For sections that are dependent on each other,
    - Divide the grid into smaller sections, and each thread performs calculations on one of the sections.
    - Since the Gauss-Seidel method uses the values calculated in an iteration to calculate the further values in the same iteration, the temperature values of points at the boundary of thread divisions will not converge quickly. To tackle this problem, we will divide the grid row-wise when the iteration number is even and column-wise when the iteration number is odd.
      This idea is shown in the figure below:



    - Further improvements can also be made. For example, all the arrays will be stored as 1-dimensional arrays, decreasing the number of cache misses.

- **Explore domain decomposition** - Distributed memory setting, splitting the big grid problem into small grids and thread solving each grid independently. But here, we need to think about boundary conditions and how to exchange data among threads.