Boston University

EC500: Final Project

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1 Introduction

In this project, we solve in two dimensions the heat equation

$$\rho c_p \frac{\partial T}{\partial t} - \nabla \cdot (k \nabla T) = \dot{q}, \tag{1.1}$$

where

- k is a constant taken to be 1,
- ρ is the density of the medium (assumed to be constant),
- c_p is the specific heat of the medium (assumed to be constant),
- $\dot{q}$ is the volumetric heat flux as a function of spacial coordinates (x, y), and
- T is the temperature of the material as a function of spatial coordinates (x, y) and of time t.

In discrete form, the equation can be written as follows:

$$\rho c_p (T_{x,y,t+1} - T_{x,y,t}) - k(T_{x+1,y,t} + T_{x-1,y,t} + T_{x,y+1,t} + T_{x,y-1,t} - 4T_{x,y,t}) = \dot{q}. \tag{1.2}$$

The time step and spatial step have both been taken to be 1 in the finite difference approximations.

We now solve this problem using three different approaches:

- Red-black iteration, parallelized with OpenMP and MPI
- Conjugate gradient method
- Using a triangular lattice instead of a conventional square lattice

2 Parallelized Red-Black

3 Conjugate Gradient Method

4 Triangular Lattice