Optimization of a Finite-Volume Method Application

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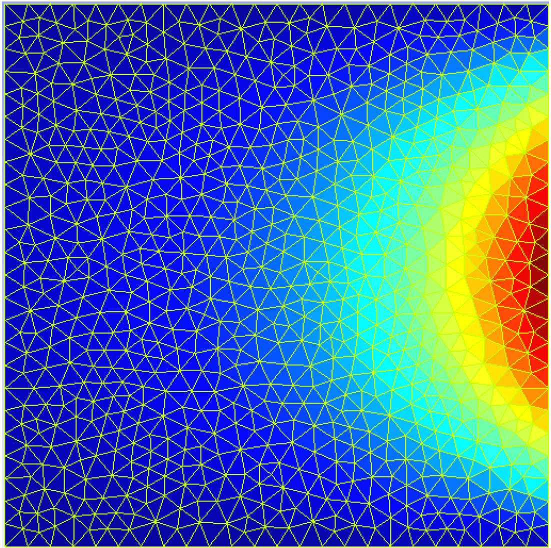
conv-diff (Recap)

What? Computes the heat diffusion of a fluid spreading over an area;

How? Uses a Finite-Volume method;

Why? Represents surface as a mesh, making each cell only dependent of its neighbours;



The main objective is to compute a vector $\overline{\phi}$ such that

$\overline{\phi} \longrightarrow G(\overline{\phi}) = \begin{pmatrix} 0 \\ 0 \\ \vdots \end{pmatrix}$ This is accomplished in three different stages:

1. We begin with a candidate vector ϕ
2. For each edge, we compute the flux F_{ij}, with i and j being the indexes of the adjacent cells
3. For each cell, we compute $\sum |e_{ij}| F_{ij} - |c_i| f_i$

Thus: $\phi = \begin{pmatrix} \phi_1 \\ \vdots \\ \phi_I \end{pmatrix} \longrightarrow G = \begin{pmatrix} G_1 \\ \vdots \\ G_I \end{pmatrix}$

makeFlux Compute the contribution from each edge;

makeResidual Compute the ϕ vector, adding the flux for each cell from each contribution;

Original implementation

- ***Arrays-of-Pointers***;

makeFlux

For all **edges**:

1. Read adjacent cell data;
2. Compute edge velocity;
3. Compute flux through edge;

makeResidual

For all **edges**:

1. Subtract flux from right cell;
2. Add flux to left cell;

Naive Optimizations

- Removed redundant loads and calculations;
- Changed some variable definitions to *const*;
- Usage of a recent compiler auto-optimizations(SLP);

OpenMP

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