

Optimization of a Finite-Volume Method Application

MPI: Implementation and Analysis

José Alves, Rui Brito

Universidade do Minho

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Convection-Diffusion (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;

Approach

- Mesh is shared by all processes;
- Work is divided among all processes;
- Master process gathers all data;

Problems

- High level of communication between processes;
- High level of barrier synchronization;
- Some balancing problems;
- Computed error spikes;
- Some of FVLib's templates are hard to serialize (locality);
- Sequential portion is slow;

Environment

Environmental Setup

- SeARCH Group 101
 - 64-bit Intel®Xeon™@ 3.2 GHz;
 - 4 hardware threads per node;
 - 16 KB L1 data cache, 2 MB L2 cache, 2 GB RAM;

Results

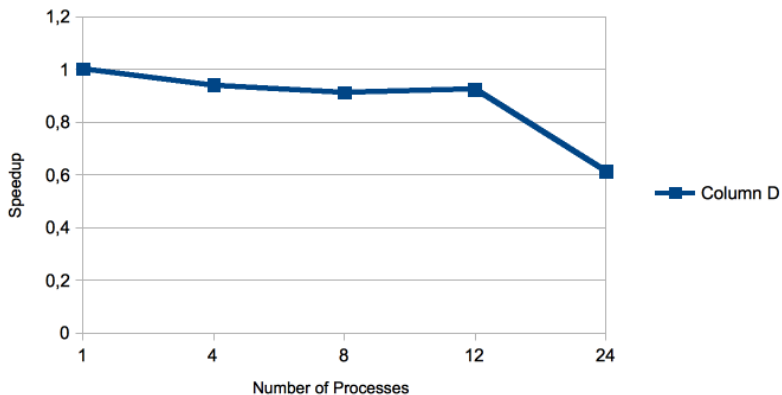


Figure : Achieved Speedups

Results

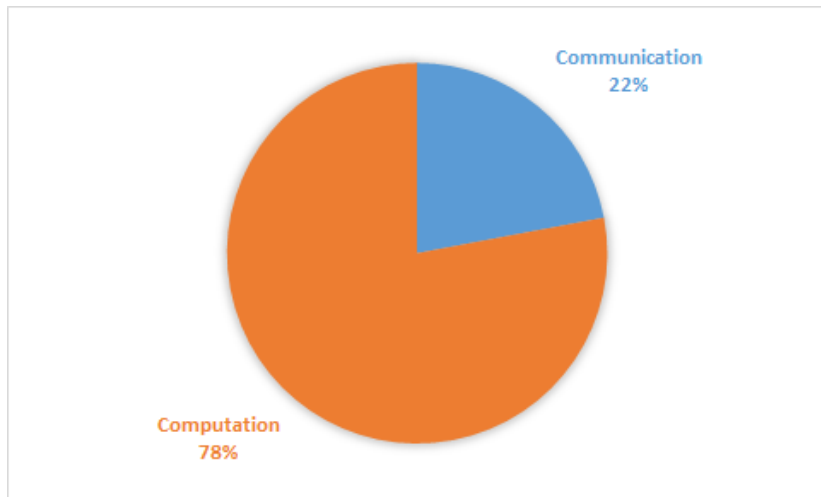


Figure : Communication/Computation Ratio

Conclusions

- Excessive communication hinders performance in MPI;
- FVLib's templates were a problem;
- Further optimization would be difficult;

Roadmap

- Converting structures to SOA;
- Optimize for OpenMP;
- Finally try a CUDA implementation;

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