Lattice Botlzmann Methods

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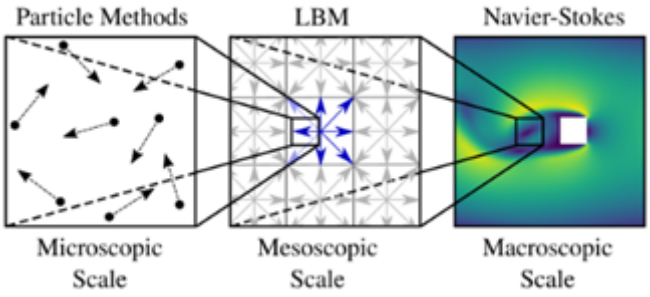

1 Introduction

The lattice Boltzmann methods (LBM) [1, 2], is a class of computational fluid dynamics (CFD) methods for fluid simulation. Unlike CFD methods that solve the conservation equations of macroscopic properties (i.e., mass, momentum, and energy) numerically, LBM models the fluid consisting of fictive particles, and such particles perform consecutive propagation and collision processes over a discrete lattice.

2 Objectives

Write a parallel code (see Chapter 13.4 of [3]) using MPI or OpenMP for solving the 2D lid-driven cavity problem at Reynolds=100. Check the correctness of the code by comparing your solution at the center of the domain with reference data provided [4]. Run strong and weak scalability test and report the results.

3 Ideas for an exam project

- Extend the code to work on 3D lattice
- Parallelize the code with CUDA
- Add an obstacle in the domain and compute the lift and drag

References

[1] Inamuro, T., Yoshino, M., & Suzuki, K. (2022). An Introduction to the Lattice Boltzmann Method: A Numerical Method for Complex Boundary and Moving Boundary Flows.
[2] https://github.com/jviquerat/lbm
[3] Krüger, T., Kusumaatmaja, H., Kuzmin, A., Shardt, O., Silva, G., & Viggen, E. M. (2017). The lattice Boltzmann method. Springer International Publishing, 10(978-3), 4-15.
[4] U. Ghia, K. N. Ghia, C. T. Shin, High-Re solutions for incompressible flow using Navier-Stokes equations and multigrid method.