Lattice Boltzmann Method

Introduction

The Lattice Boltzmann Method (LBM) is used in fluid dynamics to simulate fluid flow by tracking the evolution of particle distribution functions across a lattice. At the heart of LBM lie two pivotal steps: *streaming* and *collision*, which together dictate the evolution of the fluid's state over time (see [1,2]).

Goal

The goal of this project is to optimize the LBM as much as possible. In particular:

- Start with optimizing the 2D version of LBM (called D2Q9 [1]) using the Bhatnagar Gross and Krook (BGK) model in the collision step. Use the Python code (ported to C/C++) in [4] as baseline.
- Implement and optimize a 3D version of LBM (e.g. D3Q19 [3]). A C++ implementation is in [5] and can be used a starting point.
- You can extend this project by trying other more accurate models in the collision step besides BGK.

References

[1] https://cfdflowengineering.com/basics-of-lattice-boltzmann-method-for-cfd-modeling/
[2] https://feaforall.com/creating-cfd-solver-lattice-boltzmann-method/
[3] https://www.sciencedirect.com/science/article/pii/S0898122113006068 (Section 2.1)
[4] https://github.com/pmocz/latticeboltzmann-python/blob/main/latticeboltzmann.py
[5] https://github.com/callummarshall9/LBM/tree/master