User Guide for Lattice Boltzmann Solver

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1 Revision History

Date	Version	Notes
Dec. 12, 2019	1.0	Initial Document

Contents

List of Tables

2 Symbols, Abbreviations and Acronyms

Please see Section 2.2 and Section 2.3 of the Commonality Analysis (Michalski [1]).

3 General Information

3.1 Purpose

The purpose of this document is to help users of Lattice Boltzmann Solver.

3.2 Scope

The document has separate sections that address usage of the system and references which arise in other documents of Lattice Boltzmann Solver.

4 Quick Start

This section outlines how to use Lattice Boltzmann Solver.

4.1 Environment Setup

The following python libraries need to be installed on the system:

1. datetime
2. logging
3. matplotlib.pyplot
4. numpy
5. os
6. pylbm
7. sumpy
8. sys
9. time

Depending on your Python version, many of these should already be available.

pyLBM can be installed in the following ways:

1. with conda:
   conda install pylbm -c conda-forge
2. with pypi:
   pip install pylbm
3. from source:
   git clone https://github.com/pylbm/pylbm

4.2 Using Lattice Boltzmann Solver

4.2.1 Inputs

The inputs.txt file shall be placed into the Input directory found within the src directory.

The inputs of the input.txt file shall be structured in the following manner:

Key Value
Key Value
etc..

For example:

Library 1
Problem 1

The keys required for a Von Karman Vortex Street problem (Problem 1) using pyLBM (Library 1) are:

1. Dimensions
2. VelocityDirections
3. ReynoldsNumber
4. Density
5. BulkViscosity
6. Time
7. Size

The acceptable range of inputs can be found in Table 2 of Section 6.2.

4.2.2 Running Lattice Boltzmann Solver

Run M2SystemControl.py to run Lattice Boltzmann Solver.

4.3 Error Messages

The following are error messages that reference this User Guide:

1. MssngProb : The input.txt file is missing (or has incorrect) required parameters for the designated problem. Please see the User Guide.

   Required parameters (keys) for the designated problem can be found in Section 4.2.1.

2. OuBounds: The input file parameter X is out of bounds. Please see the User Guide.

   Allowable input bounds can be found in Table 2 in Section 6.1.

3. UnknwnParm: The parameter X is not known to the system. Please see the User Guide.

   Correct parameters (keys) can be found in the column "**Correct Input File Key**" of Table 1 in Section 6.1.

5 References from Other Documents

This section addresses references to this document from other documents of Lattice Boltzmann Solver.

5.1 MIS

This section addresses references from the MIS (Michalski [2]).

Libraries available in the first implementation:

1. pyLBM

Problems solved in the first implementation:

1. Von Karman Vortex Street

5.2 System VnV

This section addresses references from the System VnV (Michalski [3]). Please see Section 4.2.

5.3 Unit VnV

This section addresses references from the Unit VnV (Michalski [4]). Please see Section 4.2.

References

[1] Peter Michalski. Lattice Boltzmann Solvers - CA, . URL https://github.com/peter-michalski/LatticeBoltzmannSolvers/blob/master/docs/SRS/CA.pdf.

[2] Peter Michalski. Module Interface Specification for Lattice Boltzmann Solvers, . URL https://github.com/peter-michalski/LatticeBoltzmannSolvers/blob/master/docs/Design/MIS/MIS.pdf.

[3] Peter Michalski. System Verification and Validation Plan for Lattice Boltzmann Solver, . URL https://github.com/peter-michalski/LatticeBoltzmannSolvers/blob/master/docs/VnVPlan/SystemVnVPlan/SystemVnVPlan.pdf.

[4] Peter Michalski. Unit Verification and Validation Plan for Lattice Boltzmann Solver, . URL https://github.com/peter-michalski/LatticeBoltzmannSolvers/blob/master/docs/VnVPlan/UnitVnVPlan/UnitVnVPlan.pdf.

6 Appendix

6.1 Input Key Mapping

System VnV Symbol	Unit VnV Symbol	Correct Input File Key
η_b	BulkViscosity	BulkViscosity
ρ	Density	Density
D	Dimensions	Dimensions
Library	Library	Library
Problem	Problem	Problem
Re	ReynoldsNumber	ReynoldsNumber
η_s	ShearViscosity	ShearViscosity
Size	Size	Size
t	Time	Time
Q	VelocityDirections	VelocityDirections

Table 1: First Stage Implementation Input Mapping

6.2 Input Range

Input Key	**Minimum Value**	**Maximum Value**
BulkViscosity	0.0001	20000
Density	0.0708	13.6
Dimensions	2	2
Library	1	1
Problem	1	1
ReynoldsNumber	0.0001	50000
ShearViscosity	0.001	20000
Size	1	1
Time	1	N/A
VelocityDirections	9	9

Table 2: First Stage Implementation Input Range