Spring 2021 ME/CS/ECE759 Final Project Report

University of Wisconsin-Madison

Shallow Water Equation Solver with Multiple Finite Volume Numerical Schemes

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**Abstract**

In this project, I implemented a finite volume solver for shallow water equations, which follows conservation law and is a classical system of hyperbolic equations. This solver have several volume schemes including first order upwind, second order Lax-Wendroff, any order of WENO method, and SDWLS, which stands for Solution Dependent Weighted Least Squares gradient, a new high resolution finite volume method that I recently learned. Instead of coding in C/C++, I decided to develop this solver using Java, which is not commonly used in high performance computing but has its own advantages. Due to the time limitation, I only implemented the serial version of this solver and tested one simplest parallel way in Java. More work towards expanding this current solver into a generic system of hyperbolic equation solver will be proceeded in the future.

Link to Final Project git repo: *dropthelinkhere*

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# General information

In this short section, please provide only the following information, in bulleted form (four bullets) and in this order:

1. Your home department:
   * AMEP (Math Department)
2. Current status: undergraduate
3. Individuals working on the Final Project (include yourself)
   * Kangqi Fu (kfu9@wisc.edu)
4. Choose one of the following two statements (there should be only one statement here):
   * I am not interested in releasing my code as open source code.

# Problem statement

I chose to work on this project because of two reasons. First after taking Math 714-Computational Mathematics 1 last semester, I found myself extremely into solving PDE using numerical methods. In that class, we learned finite difference and finite volume methods. I therefore decided to do more practice via implementing both serial and parallel generic conservation law solver. Conservation law has another name of

As part of this section, touch on the motivation/rationale for your project selection. Explain why you chose to work on this project. For instance, if it’s work related, explain in rough terms what the big process is, and what part you’re trying to take care of.

# Solution description

Indicate how you went about implementing your solution. Explain data structures, algorithms used, code structure, functions you implemented, etc. Provide a panoramic snapshot of your Final Project effort.

# Overview of results. Demonstration of your project

Explain here what you obtained, explained why the results are good/bad. This is the place where you talk about the outcomes of your Final Project effort. It is not the end of the world if your code doesn’t work as anticipated. Explain here how far you have made it.

Make sure you include plots and/or tables to show your results.

# Deliverables:

Discuss what is delivered for this Final Project. Important points:

* This report should be in Canvas.
  + On multi-student teams, each team member should submit a final PDF report yet it is ok for the code to be in one repo
* Talk about the structure of your code: what files you generated, where input files are (if any), etc.
* IMPORTANT: tell us how we should compile and run your code to get the results you report

# Conclusions and Future Work

Summarize the lessons learned and the highlights of your project work. Explain what remains to be done in the future, and how hard it would be to accomplish what is left at this point.

# References

[1] Make sure to give credit where it’s due.