

Daily Research Report

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1 Current Research Direction

Write methods section of my the Method of Manufactured Solution for my thesis

2 Research Performed

Attended online lecture on scientific writing,

Notes from lecture

Importance of methods section:

- Explains how the hypothesis is tested
- how the data is collected and analyzed.
- the methods section is important because it convinces the reader that the study and results are believable. If the reader doubts your findings they will look at the methods section. Methods will also help people trying to replicate the work if they get different answers.

Content of the method section. An example research paper about apples was used

The question that is being asked is:

How does the color of sliced apple change over time, after being dipped in different chemicals?

The independent variable : chemical used on the apple. dependent variable change: color of apples. other variables that could effect the results are discussed in the method

Organization:

1. Object of Study

Explain what you are studying . The object of the study is NOT all the things used in your experiment/simulation

2. Treatment for the object

Explain what are you doing to your object/ This is the independent variable: what are you going to change in between conditions.

3. Procedure to collect the data

Explain what was measured and how it was measured This is the dependent variable. The experiment is testing how this changes based on the independent variable.

4. Procedure to analyze data

Transform the data.

Formula, software, statistical analysis.

Draft of methods

1. Object of Study

The method of manufactured solutions(MMS) is a code verification procedure that is used to provide an analytical solution for SWIRL, a frequency domain, linearized euler equation code, for cases that do not have a known analytical solution. The MMS is used to obtain an order of accuracy for a given numerical approximation which gives a measure of “goodness” for a given number of grid points.

2. Treatment for the object

The number of grid points used for a given domain is often not reported and is often different depending on the accuracy of the answer. In addition, many numerical codes rely on various numerical techniques, not just one, which can lead to a compounding of numerical error from an insufficient number of grid points for a given numerical technique. Since the order of accuracy is directly dependent on the numerical method and number of grid points used, this study aims to outline a procedure for determining the minimum number of grid points need for a series of numerical techniques used to obtain integrals and derivative approximations.

3. Procedure to collect the data

SWIRL uses a series of numerical techniques in a given run. MMS will be used to obtain a manufactured analytical solution and an order of accuracy for the numerical integration used to compute the speed of sound. The MMS will also be used for the radial derivatives within the linearized euler equations. A minimum number of 7 gridpoints will be used as a starting grid and the number of grid points will be doubled until the computed order of accuracy has reached the expected order of accuracy for the given numerical scheme.

4. Procedure to analyze the data.

To obtain a manufactured analytical solution a test function is chosen for each variable that is going to be approximated. Python’s SciPy library was used to evaluate the expressions needed for the manufactured solution. A range of boundary conditions and auxillary conditons were used to make the manufactured solution sufficient for computing an order of accuracy. The manufactured solutions were then converted to FORTRAN 90 to keep the computation uniform with SWIRL.

3 Issues and Concerns

- 7 grid points is too small, and it was suggested at the SIAM conference that I should play Around with the grid spacing because doubling the grid points would be considerably slow. Right now it is at 8 iterations for second order and the given test I chose.

4 Planned Research

This outline sort of serves as an introduction. The results and discussion will be after