SIMULATION OF 2D WAVE EQUATION- A REVIEW

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Author: Matteo Delucchi Reviewer: Eldhose Poulose

Zurich University of Applied Sciences
Applied Computational Life Sciences

1 Highlights

- Simulation of 2D-Wave Equation with different boundary conditions and multiple sources are presented.
- All tasks provided for case study are attended and are explained with mathematical equations.
- Several useful 1D and 2D plots of multiple simulations are provided.
- Additional plots and R code is provided in the APPENDIX section.

2 Abstract

In this review, a critical analysis of the case study report[5] on Simulating 2D Wave Equation in R by Matteo Delucchi is presented, based on the evaluation criteria provided. Periodic Boundary Conditions, Gaussian pulse, Dirichlet boundary conditions on North&South and Neumann boundary conditions on East&West are considered, in different tasks; algorithms and mathematical equations are also provided along with several interesting plots. Several packages in RStudio are used and the links to access these resources are provided in the reference section. The error estimation task is completed with minor bugs and the author has provided the reasons for this and considered it as a future work. The author also recommended to apply more boundary conditions and extention of mesh size to validate the wave inference modelled in the report.

3 Evaluation

To begin with, the task to simulate the wave equation in 2D with periodic boundary conditions is considered with a minor change from the original task, and this change is mentioned at the Appendix. The author started with the basic equations along with the description of the terms in the equation with the help of real life examples. Even though the author provided final equations, the guidelines for deriving the equations to the reader is missing. For instance, the notations provided by the author on equation 6 and 7 and the base equation for equation 12 are not explained clearly. All these minor errors are making the flow of derivation more complex to a novice reader to understand. The author also made minor spelling errors like 'beeing' for 'being', 'know' instead of 'now' and 'profen' in the place of 'proven' under section 2, 2.1 and 4 respectively. However, these minor errors are not affecting the simulation of 2D wave equation. The nature of periodic boundary conditions and the after effects of this condition is shortly described. The author has succeeded to provide a detailed visualisation in 1D and 2D at different time intervals, with a short interpretation at the end.

Moving ahead, the author made few changes and corrected the errors in the tasks provided in the original task and the changes are specified in the Appendix section. The overall approach by the author to the task is more general, which is good to a novice reader to understand

the topic at ease. The second, third and fourth task are about adding sources in different locations. Even though the author corrected the fault in the given tasks, the author failed to mentioned about the position of the 3rd and 4th sources, which are at same location (50,25) as given in the task. However, the author simulated the 4th source at (25,25) and this change is not mentioned anywhere in the report, this is misleading the reader from task. But, the 2D simulation results provided in the Appendix gives a clear picture on the author's intention and provides more creative results to the reader.

Furthermore, in the task to apply Dirichlet and Neumann boundary conditions on North&South and East&West sides of the mesh respectively is simulated successfully and provided the corresponding 2D plots in different frequencies and time duration in the Appendix section. The author also specified the conditions which is applied in the simulation program with the same keywords used in the code provided. The attempt to the last task to make the error analysis using infinity norm by an appropriate h , in which the author came across with a bug during simulation, and the author mentioned this problem as a comment in the code file given at the end of the report. The convergence towards continuous solution is an another task in the last part of the case study. In this the author tried the calculation with some assumptions and appropriate theorem. While, the equation 19 lacks clarity on the terms and methods which the author came across with the equation may be added as an improvement to the report. Also, the author does not provide a conclusive answer to the task about convergence of the simulation carried out by the author towards a continuous solution. In sum, the last task has to undergo a troubleshooting stage to finalise the error analysis in the model.

4 Conclusion

In this paper, simulation of 2D wave equation with different boundary conditions and sources are presented and discussed. Regardless of the minor flaws in the notations and spelling errors the author represented the case study report in a well structured manner, which meets all the tasks and provide proper justification. The author also provided the problems where the author struggles to find the solution for the error calculation, this is a future work which the author wants to research on along with some improvement on model-space and boundary conditions.

5 Reference

[1]. https://github.com/EldhosePoulose/2D-Wave-Equation