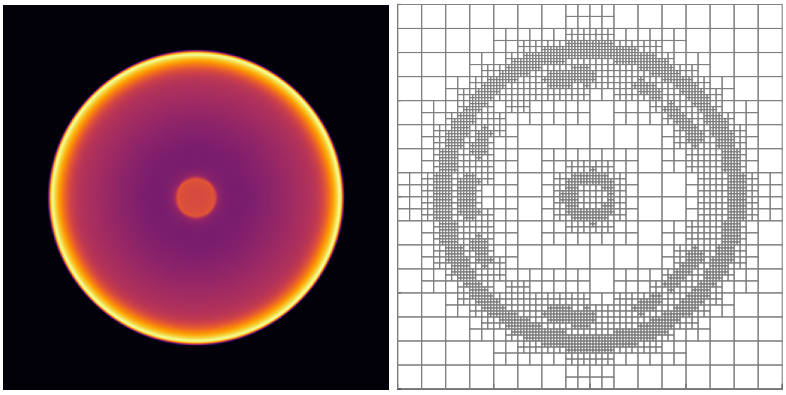
Applied and Computational Mathematics | RWTH AACHEN UNIVERSITY

HiWi-Job / Seminar/Project/Bachelor/Master Thesis

Implementation of a Modal DG solver in julia

Topic

The *Discontinuous Galerkin (DG)* method has become a standard technique to numerically solve hyperbolic conservation laws such as the Euler equations of gas dynamics, magnetohydrodynamics, acoustics, or Shallow Water flows. The DG method combines concepts from Finite Element & Finite Volume techniques to achieve high order on irregular meshes while keeping the stencils locally confined.



(a) Pressure p. (b) Adaptively refined mesh.

Abbildung 1: Simulation of a blast wave (e.g. explosion) with `Trixi.jl`.

Fundamentally, there are two types of DG methods: Nodal und Modal, which correspond to a certain choice of the basis polynomials (Nodal: *Lagrange*, Modal: *Legendre*). The nodal Ansatz is already implemented in `Trixi.jl`, the modal approach is subject of this project.

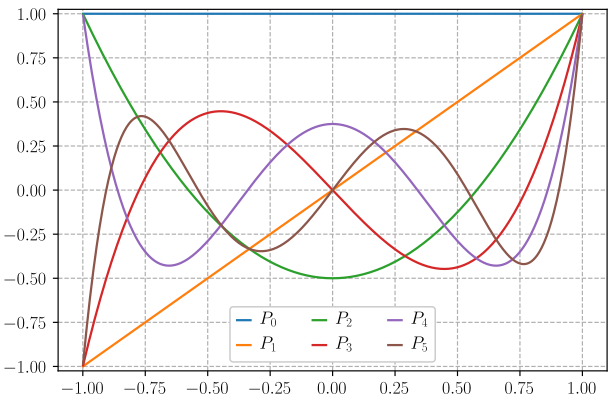


Abbildung 2: First six Legendre-Polynomials P_i.

The motivation to implement now also a modal DG method stems from the fact that for these, limiting techniques, i.e., oscillation surpressing capabilities, are more easily realized.

Tasks

Depending on whether you are interested in doing a HiWi-Job or a thesis, the expectations obviously vary due to the outer conditions. In any case, the first steps are:

- Implementation of first order modal DG for 1D, cartesian meshes, scalar equations
- Validation with testcases

Extensions are in principle limitless, for instance

- Second order with limiting
- 2D, 3D cartesina Grids
- Systems of conservation laws
- algorithmic differentiation
- parallelization with threads and MPI
- Curved meshes, `p4est` meshes
- Higher order of accuracy ($p \geq 2$)
- ...

Your Profile

- Studies: Computational Engineering/Simulation Science, Mathematics, Mechanical Engineering, Physics
- Experience in Programming, preferrably already experience with larger softwares
- Above-Average grades

Interested! Reach out to me!

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