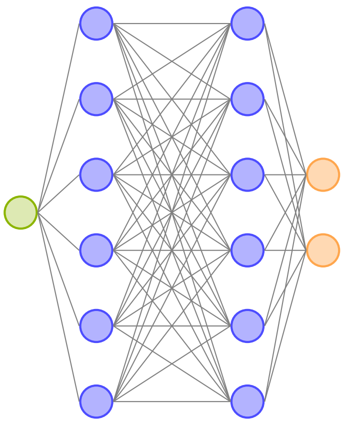
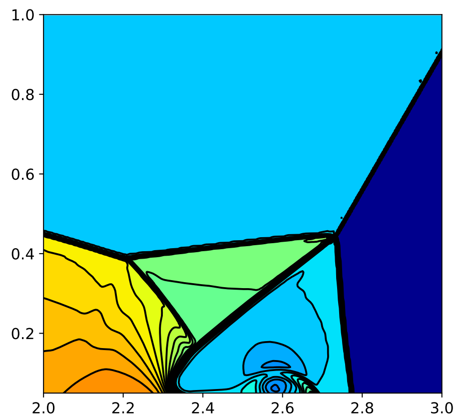
Chair of Aerodynamics and Fluid Mechanics
Department of Mechanical Engineering
Technical University of Munich

Master's Thesis May 31, 2021

Data-driven Riemann Solvers for Gas Dynamics

The time-dependent Euler equations are a set of hyperbolic partial differential equations (PDEs) and govern compressible fluid flow. It is a well known fact that hyperbolic conservation laws may develop shock discontinuities over time. The numerical solution of such flows is a challenging task due to the presence of these discontinuities (shocks) and adaptive numerical methods have to be devised. A large class of numerical schemes are build around the seminal idea by Godunov to solve local Riemann problems at cell interfaces. In recent years, machine learning strategies have replaced certain parts of classical numerical schemes. Hybrid numerical schemes (data-driven yet physics-informed) have become more and more prevalent.
In this thesis, first, deep learning strategies are to be implemented into a classical numerical solver for hyperbolic conservation laws. Second, these ML methods are to be trained and their performance evaluated against established methods. Please send me a short email with your motivation, your prior experience in fluid mechanics, and an up-to-date transcript of records.





Requirements:

- Keen interest in fluid mechanics and numerical methods
- Good understanding of compressible fluid mechanics and basic understanding of numerical methods
- Basic understanding of programming (working knowledge of Python beneficial)
- Basic understanding of machine learning, beneficial

Take away:

- Hyperbolic differential equations and their numerical solution
- Data-driven methods for partial differential equations
- State-of-the-art machine learning methods and frameworks (e.g. Tensorflow or Pytorch)
- Scientific working and writing

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