

Numerical solution of hyperbolic conservation laws: A practical introduction

David Ketcheson*

*King Abdullah University of Science and Technology

Date: 21st May, 2014 9:00 – 17:00

Place: Széchenyi István University, Győr (Room: UT. 220)

This course will cover the basic theory and numerical solution of hyperbolic conservation laws, including models of traffic flow and fluid dynamics as examples. Concepts will be introduced in the context of one-dimensional scalar problems, and then applied to more complex problems including multidimensional fluid dynamics. The ideas will be illustrated and explored using the [PyClaw](#) software. Students will be taught how to use PyClaw to solve problems of their own interest.

Students should have some scientific programming experience and a basic understanding of differential equations. The course will use the Python programming language, but prior experience with Python is not necessary. No software installation is necessary; everything required for the course will be provided via [SageMathCloud](#). Participants who wish to preinstall the PyClaw software on their own computer may follow [the instructions in the Clawpack documentation](#).

1. Setup
 - SageMathCloud
 - IPython notebooks
 - Python tutorial
2. Scalar conservation laws
 - Advection and characteristics
 - Upwind method and the CFL condition
 - The LWR traffic model
 - Shock formation
 - Vanishing viscosity, weak solutions, and the entropy condition
 - The Riemann problem and Rankine-Hugoniot conditions
3. Godunov-type methods
 - Finite volume discretization
 - Riemann solvers
 - Slope limiters
4. Systems of hyperbolic PDEs
 - Linear systems
 - Nonlinear systems: the Euler equations
 - Approximate (linearized) Riemann solvers and Roe's solver
 - Entropy fix
5. Solving problems with PyClaw
 - Examples
 - Setting up problems in 1 and 2 dimensions
 - Running in parallel
 - Solver options (Classic and SharpClaw)
 - Extensions to more general problems
 - Time for participants to experiment or implement their own problems