Nonlinear Hyperbolic Conservation Laws

Course information and motivation

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COURSE INFORMATION

- Webpage:
  - http://www.am.uni-dusseldorf.de/~ryan/homethods.html
- Lectures:
  - Tuesday 14:30-16:15 and Thursday 10:30-12:15
  - 4 hours of lecture/week
- Exercise classes: TBA - to be announced
  - 2 hours of exercise classes/week
  - Exercise classes will begin in week 4 (week of 29 October)
  - 1st exercises due 23 October.
- Requires: Knowledge a programming language.
  - For Matlab, consult *Driscoll, "Learning Matlab", SIAM.* (Codes available from Hesthaven book.)
  - Fir Python, consult https://docs.python.org/3/
- References (available electronically from the library):
  - B. Cockburn, C.-W. Shu, C. Johnson, E. Tadmor, **Advanced Numerical Approximation of Nonlinear Hyperbolic Equations**, *C.I.M.E. foundation Subseries, Springer* 1997.
  - J.S. Hesthaven, **Numerical Methods for Conservation Laws: From Analysis to Algorithms**, *SIAM* 2018.

TOPICS COVERED

- Review of PDEs: (8 lectures)
  - Basics of hyperbolic conservation laws
  - Characteristic curves
  - Weak solutions
  - Rankine-Hugoniot condition
  - Entropy/viscosity solution
  - Entropy conditions
  - Riemann Problem
- Fluxes used in numerical solution to hyperbolic equations (3 lectures)
  - Lax-Friendrichs
  - Enquist-Osher
  - Godunov
  - Lax-Wendroff
  - MacCormack

TOPICS COVERED

- Monotonicity and Nonlinear Schemes (3 lectures)
- Time discretisation: The TVD property (2 lectures)
- Multiple dimensions and systems (2 lectures)
  - Characteristic Decomposition
- Higher Order Methods (9 lectures)
  - Essentially Non-Oscillatory Schemes (ENO)
  - Weighted Essentially Non-Oscillatory Schemes (WENO)
  - Discontinuous Galerkin (DG) method

GOALS OF COURSE

- Understand the basics of hyperbolic conservation laws.
- Obtain a basic understanding of translating these equations into a numerical technique.
- Understand which tools are appropriate for a given equation.
- Understand whether the code is giving reasonable results.

FURTHER INFORMATION

- Exercises
  - Combination of theoretical and computational
- Exam
  - Oral exam
  - For admittance to exam 40% on exercises should be satisfactorily completed.
  - Possible exam dates: 7 and 8 February