Pre-class assignment # 15

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PHY-905-002, Computational Astrophysics and Astrostatistics
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This assignment is due the evening of Tuesday March 16, 2021. Turn in all materials via GitHub.

Reading:

1. Chapter 8 ("Euler Equations: Numerical Methods) of Mike Zingale's Computational Hydrodynamics Tutorial, which you can find in the pre-class assignment for Day 8. Focus your attention on Sections 8.1-8.5 and 8.9.1 ("Shock tubes"), but skim Section 8.2.3 (piecewise parabolic reconstruction) rather than diving deeply into the mathematics. Also skim the other sections in Chapter 8 to get the general idea.

2. Wikipedia page on Riemann solvers. This is a short but useful resource for understanding the various types of Riemann solver that exist.

Your assignment: Work through the sections listed above and make sure you understand the math. Answer the following questions in `ANSWERS.md`, and be prepared to discuss those answers in class:

1. What are the key components of a code that solves the Euler equations for the 1D Sod Shock Tube (described in Section 8.9.1)? How is this similar to, or different from, the codes you've created so far for the linear advection equation and Burgers' equation?

2. What are the benefits and drawbacks of using differnet methods of reconstructing the states of cell interfaces? Specifically, compare and contrast piecewise constant, piecewise linear, and piecewise parabolic reconstruction (as discussed in Sections 8.2.1-3) in terms of accuracy, simplicity, and speed.

3. Why is there such a profusion of Riemann solvers for computational fluid dynamics? Why doesn't everybody use the best one?

4. What, if anything, do you want to know more about numerically solving the Euler equations after working through this chapter?

5. What are at least two questions that you have from the readings that you'd like us to address in class?

Handing it in: Submit via GitHub as usual. Include anything necessary, including code, plots, and your answers to the questions about the readings (in the file `ANSWERS.md`) as part of your assignment.