Ay190 – Worksheet 15
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1 1D SPH Code Applied to a Shock Tube Problem

Figure 1 shows 4 stages in the evolution of the density profile obtained from executing the 1D SPH code. The code is briefly described in the following sections.

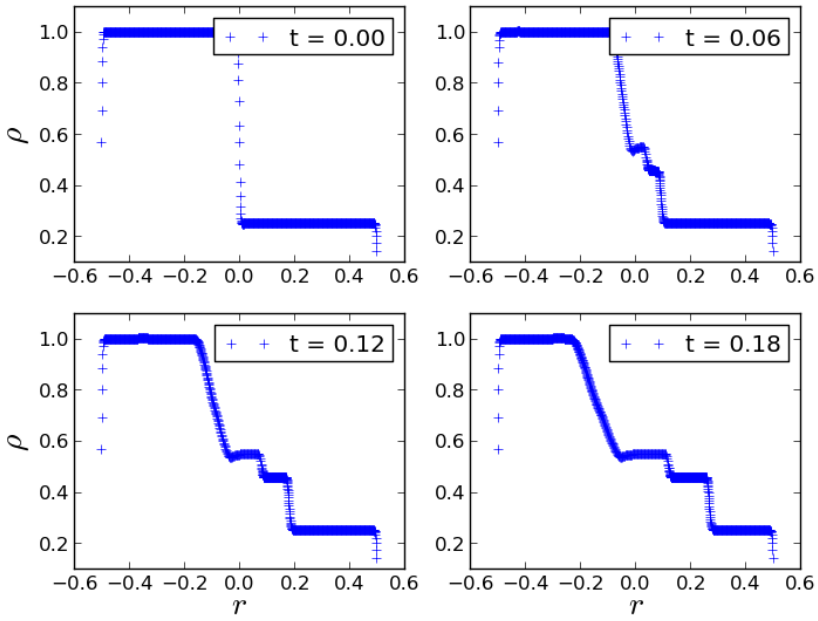

Figure 1: Evolution of the density profile from $t = 0.0$ to $t = 0.2$ shown at four stages.

1.1 Methods

The two smoothing kernel methods are fairly self-explanatory. The only thing worth mentioning is pehraps that the smoothing length in this SPH code does not vary from particle to particle, so in the equations using the smoothing kernel, $W(r_{ij}, h_i) = W(r_{ij}, h_j$. The neighbour search method returns a tuple containing two arrays. The first array, 'neibs' contains a row for each particle, the columns of which indicate the indices of the particles neighbours. The second array, 'nneibs' is a one dimensional array containing a count of neighbours within a $2h$ radius of each particle. The method 'get density' computes a local density using the smoothing kernel, and is the implementation of equation IV.4.6 in the lecture notes. The artificial viscosity method implements equation IV.4.19, which calculates the variable Π. The method to get accelerations calculates the acceleration of each particle based on a combination of inviscid fuid dynamics and artificial viscosity. While I can't find this in the notes, it's basically the energy equation without the velocity factor. Finally, the last computationally intensive method is the energy equation:

$\frac{d\epsilon}{dt} = \frac{1}{2} m_j v_{ij} \bigtriangledown_i W_{ij} (\frac{p_i}{\rho_i^2} + \frac{p_j}{\rho_j^2} + \Pi_{ij})$

The last two methods are fairly simple. The 'get dt' method uses the courant-friedricks condition to calculate the time-step and the 'set bcs' method simply assigns a value to the boundaries of a given array. In the case of this code, the arrays passed to this method are 'accels' and 'epsrhs' and the values are 0.0.

1.2 Main Code

The code runs as follows. First, the initial conditions described by the worksheet are set up, which is fairly straightforward. The loop then iterates through getting the artificial viscosity, the accelerations, updating energy using the energy equation above and updating the velocities and positions. Then the neighbours are re-calculated and the density, pressure and sound-speed are updated.