Your project will be to write a friends-of-friends code, which will identify halos from a dark matter particle distribution.
Your input data will be a list of particle positions X,Y,Z (using periodic boundary conditions, which means that you should allow particles near a boundary to connect to particles on the other side of the box, as if they were on the other side of the boundary).

Your code should find groups of particles, where all particles are connected to other particles if their distances are less than a given linking length r_link. So if particle A is less than r_link distance from particle B and then particle B is less than r_link distance from particle C, and there are no other particles within a distance r_link of A, B, or C, then this group contains exactly three particles (A, B, and C), even if A and C are further apart from each other than r_link. Some groups will have thousands of members and others might just contain one member.

The output of your code should be a list of dark matter halos, where for each halo you calculate:
1) its mass (the mass of each particle is 1.4x10^10 Msun/h
2) its center-of-mass position
3) its rms radius (i.e., the root-mean-square of all the particle distances from the halo center)

Then make the following plots:
1) the cumulative halo mass function: x-axis: log10(Mass/Msun), y-axis: log10(number density of halos with mass greater than Mass in units of h^3/Mpc^3)
2) a scatter plot of the halo radius vs. its mass (log10-log10)

Do this for a linking length that is equal to 0.2 times the mean inter-particle separation in the box.

Use the DM.dat data file from problem set #3 to start writing and testing your code, but eventually I will give you a much larger file, so your code shouldn't be too slow! I'm happy to discuss with you ways to do this and I'm happy to help you in any way I can as you work on this. Good luck!

Andreas

Dr. Andreas A. Berlind
Associate Professor
Director of Graduate Studies in Astrophysics
Department of Physics and Astronomy
Vanderbilt University
email: a.berlind@vanderbilt.edu
