12.010 Computational Methods of Scientific Programming
Fall 2008

12.010 Homework #1 **Due Thursday September 25, 2008**

Question (1): (10-points) Express the following numbers in base 2, 8, 10, and 16 as appropriate (subscript denotes the base of the input number). (See notes on web page and power point)
65261_{10}
15_{16}
5655_{8}
6013_{8}

Question (2): (10-points) How long will it take on a 56K modem to transfer a 1 Gbyte file? How long on a Gigabit-per-second Ethernet line? Calculation should be accurate to 3-significant digits.

Question (3): (10-points) In a computer with 1 Gbyte of memory, what is the maximum size matrix that can be stored with 8-bytes per number in (a) full storage i.e., NxN, (b) lower triangular form. What are the values if the numbers are stored in 4-byte number (assume all of the memory can be used for storage). The numbers here should be exact, not approximations.

Question (4): (20-points) In class we gave the precision and range for IEEE 4-byte floating point numbers. What is the precision and range for IEEE 8-byte floating-point numbers? (For 8-byte floating point IEEE uses 11 bits for the exponent and 53 bits for the mantissa (don't forget about the sign bits). (see Notes on web page and power point)

Question (5): (50-points) Design an algorithm to predict the evolution of galactic systems. In these types of simulations, the galaxy is represented by a set of particulars that interact with each other. The simulation then determines how the systems evolve with time based on assumptions about the interactions. This problem will lead to later questions where you will write a program to simulate the evolution of the galaxy. In this question you are not writing computer code: You are finding the equations you will need to use and thinking about how to implement those equations into an algorithm to solve this problem.

You will write (in English) a description of
(1) Approximate equations of motions that might be used in the galaxy evolution.
(2) Converting forces and accelerations: Given the forces acting on the components of the galaxy, how do you calculate their motions. You should write out how you will integrate the equations of motions (i.e., converting acceleration to velocity and velocity to position).
(3) Input and outputs for the program. What types of information will the programs will need input and output? In the input here should be considered carefully given that the problem could include large numbers of particles.
(4) How might the problem be scaled up to large numbers of particles.

Your answer should address each of the items above. Your answer should be equations

and written description. The more completely you think about how to solve this problem, the easier the coding of the solution in the next homework will be.
Answers should be emailed as PDF, Word or text files.