6.055J / 2.038J The Art of Approximation in Science and Engineering
Spring 2008

6.055J/2.038J (Spring 2008)

Homework 1

*Do the following warmups and problems. Due in class on **Friday, 15 Feb 2008**.*

Open universe: *Collaboration, notes, and other sources of information are **encouraged.** However, avoid looking up answers until you solve the problem (or have tried hard). That policy helps you learn the most from the problems.*

Bring a photocopy to class on the due date, *trade it for a solution set, and figure out or ask me about any confusing points. Your work will be graded lightly: P (made a reasonable effort), D (did not make a reasonable effort), or F (did not turn in).*

Warmups

1. **Air mass**

   Estimate the mass of air in the 6.055J/2.038J classroom and explain your estimate with a tree. If you have not seen the classroom yet, then make more effort to come to lecture (!); meanwhile pictures of the classroom are linked from the course website.

2. **747**

   Estimate the mass of a full 747 jumbo jet, explaining your estimate using a tree. Then compare with data online. We'll use this value later this semester for estimating the energy costs of flying.

Problems

3. **Random walks and accuracy of divide and conquer**

   Use a coin, a random-number function (in whatever programming language you like), or a table of reasonably random numbers to do the following experiments or their equivalent.

   The first experiment:

   1. Flip a coin 25 times. For each heads move right one step; for each tails, move left one step. At the end of the 25 steps, record your position as a number between −25 and 25.

   2. Repeat the above procedure four times (i.e. three more times), and mark your four ending positions on a number line.

   The second experiment:

   1. Flip a coin once. For heads, move right 25 steps; for tails, move left 25 steps.

2. Repeat the above procedure four times (i.e. three more times), and mark your four ending positions on a second number line.

Compare the marks on the two number lines, and explain the relation between this data and the model from lecture for why divide and conquer often reduces errors.

4. Your turn to create

Invent – but do not solve! – an estimation question for which dividing and conquering into assorted subproblems would help solve it (i.e. that would illustrate heterogeneous divide and conquer). To give you an idea for the kinds of problems that might work well, the classic of this genre, due to Fermi, is 'How many piano tuners are there in Chicago?' Other examples are the warmup problems on this problem sheet and the problems that we solved in lecture.

Particularly interesting or instructive questions will appear on the website or as examples in lecture or the notes (let me know should you *not* want your name attributed in case your question gets selected).