6.055J/2.038J (Spring 2009)

Homework 2

*Do the following warmups and problems. Due in class on **Monday, 09 Mar 2009**.*

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.*

Homework will be graded with a light touch: P (made a reasonable effort), D (did not make a reasonable effort), or F (did not turn in).

Several questions reference `decline.txt`: It is the plain-text file on the course website that contains volume 1 of Gibbon's *Decline and Fall*. It is also available (like any other file on the course website) on any Athena machine as `~6.055/data/decline.txt` where the notation `~6.055` refers to the home directory of the `6.055` user.

On `linux.mit.edu` (the Athena GNU/Linux machine), an (American) English dictionary lives in `/usr/share/dict/words`

Warmups

1. **Bandwidth**

   Estimate the bandwidth (bits/s) of a 747 crossing the Atlantic filled with CDROM's, and explain your estimate using a tree.

2. **Integrals**

   Evaluate these definite integrals:

   a. $\displaystyle\int_{-10}^{10} x^3 e^{-x^2}\, dx$

   b. $\displaystyle\int_{-\infty}^{\infty} \frac{x^3}{1 + 7x^2 + 18x^8}\, dx$

3. **Explain a Unix pipeline**

   What does this pipeline do?

   ```
   ls -t | head | tac
   ```

4. **Different word counts by different methods**

   Why do the following two commands produce different counts:

   ```
   $ wc -w < decline.txt
   268863
   $ tr -cs 'a-zA-Z' '\n' < decline.txt  | wc -l
   264164
   ```

5. **Spell checkers**

   Why, from the point of view of making abstractions, is it worth separating spell checking into its own program rather than building it into a word processor?

Problems

6. **Number sum**

   Use symmetry to find the sum of the integers between 200 and 300 (inclusive).

7. **Searching text files**

   a. What English word, besides `angry`, ends in `gry`?

   b. How many times does the word `Empire` (uppercase E, then all lowercase) occur in `decline.txt`? Give a pipeline that does the counting.

Optional

8. **Email indexer**

   Design a set of shell scripts for doing quick keyword searches of a large database of emails. Assume that each email is stored in its own plain-text file. Perhaps one shell script generates an index, and a second script searches the index.

9. **Running time**

   Ordinary long multiplication requires $O(n^2)$ digit-by-digit multiplications. Show that the Karatsuba multiplication method explained in lecture requires $O(n^{\log_2 3}) \approx O(n^{1.58})$ digit-by-digit multiplications.

10. **Heat equation**

    In lecture we used symmetry to argue that the temperature at the center of the metal sheet is the average of the temperatures of the sides.

    Check this result by making a simulation or, if you are bold but crazy, by finding an analytic solution of the heat equation.