Winter, 2006

Physics 780.20: Assignment #1

This assignment is designed to give you practice in the basic tasks from class, which we'll need repeatedly and build upon, and to verify to me that you can do them. Please ask questions! It is due at the end of the day (midnight) on Tuesday, January 17.

To "hand in" the assignment, email me (at `furnstahl.1@osu.edu`) a "tarball" (see below) of your program and makefile (with the answers to any questions in the comments), a postscript file of the log-log plot, and a Mathematica notebook with the command(s) and result. (Send the tarball as an attachment.) Use C++ and any plotting program you want (gnuplot recommended for now). Check the 780.20 webpage for suggestions and hints if you get stuck. Please give feedback early and often.

To make a tarball, create a directory with the name: your_name_ps1 (replace "your_name" by your last name!), e.g., `mkdir furnstahl_ps1`
Copy all of the files to pack up into that directory. Then give the command:

```
tar cfvz furnstahl_ps1.tarz furnstahl_ps1
```

and you're done! The command "tar tfvz furnstahl_ps1.tarz" lists the contents, so you can check that you've packed all the files correctly. [Note: The "c" is for "create a new archive", the "f" is for file and goes with the archive name furnstahl_ps1.tarz, "v" is for verbose mode (say what is going on), and "z" means to compress the tar file with gzip (tar stands for "tape archive").]

1. **Summing up vs. summing down.**

   This problem is taken from problem 3 in section 3.4 of the Landau–Paez *Computational Physics* text, which examines the summation of $1/n$. The analysis should be similar to the one on finding the roots of quadratic equations from class (you might find the quadratic_equation_2.cpp printout useful). Consider the two series for integer N:

   $$S^{(\mathrm{up})} = \sum_{n=1}^{N} \frac{1}{n} \qquad S^{(\mathrm{down})} = \sum_{n=N}^{1} \frac{1}{n}$$

   Mathematically they are finite and equivalent, because it doesn't matter in what order you do the sum. However, when you sum numerically, $S^{(\mathrm{up})} \neq S^{(\mathrm{down})}$ because of round-off error.

   (a) Write a program to calculate $S^{(\mathrm{up})}$ and $S^{(\mathrm{down})}$ in single precision as functions of N.

Create an appropriate makefile to compile it. Make sure you include appropriate comments and use "indent" to format it.

(b) Make a log–log plot of the relative difference divided by the relative sum versus N.

(c) Discuss the interpretation of the linear regime on your graph and explain briefly why the downward sum is more precise.

2. **Mathematica scavenger hunt.** To get practice using the Help Browser and loading packages, use Mathematica to find the day of the week of the big stock market crash of October 29, 1929.

3. (BONUS) **Randomness of round-off errors.** The "Are Round-Off Errors Random" task from the *780.20: 1094 Session 2* handout. This is not a required program, but I recommend giving it a try if you found the other parts easy.