Assignment 1 Design

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1 Program Description

This program compiles and visualizes monte_carlo.c as two plots. The first shows a visual representation of the simulation, with individual randomized dots. The first plot displays a square with a quarter circle inside of it, and dots might be placed either within the quarter circle (blue) or outside of the quarter circle (red). The second plot graphs the trend of multiple simulations of monte_carlo.c and shows the error between the simulation's estimation of pi and pi (approximately 3.141592653).

2 Files in asgn1

plot.sh: This bash script produces the Monte Carlo plots described above.
monte_carlo.c: The c program that contains the implementation of the Monte Carlo program.
Makefile Compiles the Monte Carlo program.
README.md: Describes how to use Makefile and the bash script.
DESIGN.pdf: (This document) Describes the files for asgn1 and the design process behind them.
WRITEUP.pdf: A document containing the plots produced by plot.sh. Discusses the UNIX commands used and why.

3 PSEUDOCODE:

3.1 Visual Representation

Using bash script, run a simulation of Monte Carlo with many iterations (preferably several thousand). The simulation should be formatted to exclude the header (since it is not a data point) and only include the third, fourth, and fifth columns of the output, which contain the x variables, y variables, and circle values respectively. This information is stored in a temporary .dat file, i.e. /tmp/monte.dat

The third and fourth rows of the column correspond to randomized values of x and y, which are then plotted as dots onto a visual representation of the simulation using gnuplot. The fifth row is used to control the color of the dot, with a value of "1" corresponding to a red dot inside the circle and a value of "0" corresponding to a blue dot outside the circle.

3.2 Error Estimation

To create the second plot, run several more simulations of Monte Carlo, also with many iterations. These simulations also exclude the headers and include the first and second columns of the output, which contain the number of the iteration and the estimated value of pi (based on the previous iterations of the simulation). The values of the second column are subtracted from pi to find the error value, and the second column now contains this error estimation value. This information is stored in multiple temporary .dat files.

The first and second rows of the column are plotted as lines onto a graph of the Monte Carlo Error estimation. The y axis has a range from -1 to 1, and the x axis has a logscale of base 4. This graph should demonstrate that when more iterations of Monte Carlo are performed, the accuracy of the estimation of pi generally increases.

3.3 Histogram

To create the last plot, multiple simulations of Monte Carlo need to be run. The graph compares the consistency between the estimates of pi for simulations with only 20 iterations of Monte Carlo and simulations with 20,000 iterations of Monte Carlo. For this comparison, 10 simulations of Monte Carlo with 20 iterations are run and the last result of the second row, corresponding to the last approximation of pi for that simulation, is assigned to individual temporary .dat files. These files are then concatenated into a single .dat file. This process is then repeated with 20,000 iterations instead of 20. The purpose of having just the last estimation of pi and then concatenating is to be able to compare the estimations in the histograms. This should demonstrate that, generally speaking, more iterations produces a more accurate and consistent estimation of pi.

4 Credits

For code that was not created by me:

On Tuesday (1/17/23) I had a tutor session with Jennie Lin where she showed me how to use tail and the -q/-n flags to filter the headers out of the data.

On Friday (1/20/23) I had a tutor session with Audrey Ostrom where she explained how to hardcode pi and use awk to subtract pi from the values in column 2 of the Monte Carlo output.

On Saturday (1/21/23) Professor Long posted code using sleep 1 to generate unique Monte Carlo data sets for the Error Estimation graph.