Pre-Course: Estimating Pi

Exam Number: Y0071170

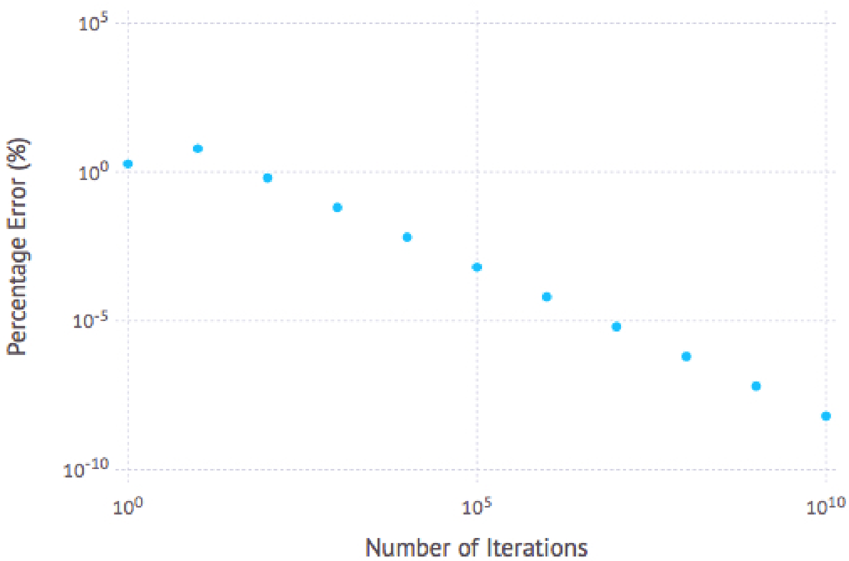

Figure 1: The accuracy of the estimate as the number of iterations gets large. Note that both axes are a log scale.

The most important factor in the accuracy of the estimate is the number of iterations that the algorithm is run for. Figure 1 shows how the accuracy of the estimate changes depending on the number of iterations. The error was calculated using the formula

$$PercentageError = \left| \frac{\pi_e - M_{PI}}{M_{PI}} \cdot 100 \right|$$

where π_e is the value of π estimated using the algorithm and M_{PI} is the value of M_PI from math.h.

Figure 1 shows that the accuracy of the estimate is continually increasing, even until 10000000000 iterations which was the largest order of magnitude that could be run on this computer in a reasonable time. Figure 2 suggests that the accuracy has an e^{-N} dependence.

Increasing the number of iterations can only go so far, however, since π is an irrational number in binary and would therefore need an infinite number

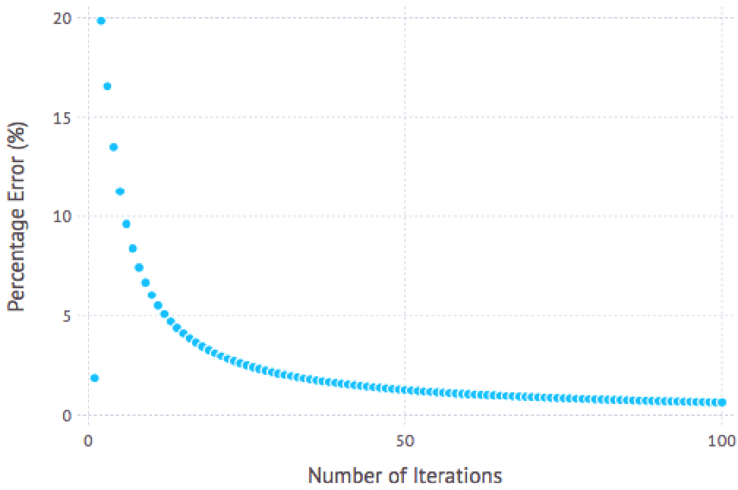

Figure 2: The accuracy of the estimate when the number of iterations is small.

of bits to store. This means that there would be a point where a double could not store the value more accurately regardless of how many more iterations are run. At this point you would need a data type with a larger number of storage bits available, such as quad_t. If even more accuracy was required a multiple-precision arithmetic library could be used, such as GNU's MPFR.