Pre-Course: Estimating Pi

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Exam Number: Y0071170

The most accurate value for π obtained on this computer was 3.141592653789451, this was obtained using 10000000000 iterations and is roughly $6.3553 \cdot 10^{-09}\%$ away from the true value.

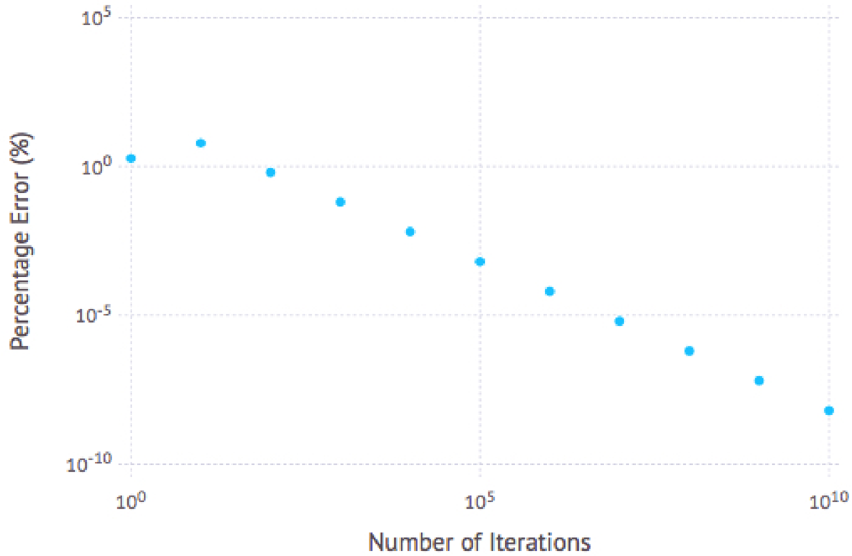

Figure 1: The accuracy of the estimate as the number of iterations gets large. Note that both axes are a log scale.

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

$$\text{Percentage Error} = \left| \frac{\pi_e - M_{PI}}{M_{PI}} \cdot 100 \right|$$

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 a negative exponential, or possibly a reciprocal, dependence.

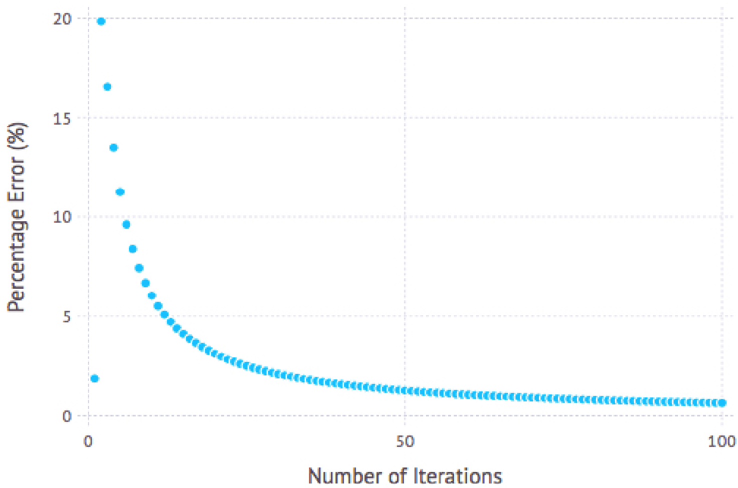

Figure 2: The accuracy of the estimate when the number of iterations is small.

Increasing the number of iterations can only go so far, however, since π can't be accurately represented in binary, needing an infinite number 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.