

Computational Physics - Problem Set 2

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1 IEEE 32-bit Value

By extracting the sign, mantissa and the exponent from the 32-bit float value: 100.98763, I compute the actual value by using eq. (2) from the "Intro" notesheet. The actual number is computed to be 100.98763275146484, where the difference between that and the actual value is: $2.75146484 \times 10^{-6}$.

2 32-Bit Precision

I declare respectively 32 Bit and 64 Bit floats of 1.0 and a subtraction value and let a loop run starting from a very small subtraction value (1×10^{-40}). The loop runs as long as the subtraction is equal to 1.0 and at every iteration the subtraction value is scaled with a factor of 1.0001.

For 32-Bit precision the smallest possible subtraction value is 2.9803843×10^{-8}

For 64-Bit precision the smallest possible subtraction value is $5.551172870064363 \times 10^{-17}$

Secondly, I find the largest and smallest values that 32-bit and 64-bit floats can take without underflow and overflow.

I iterate like before with a small scaling at each step of 1.001. Before updating the value, I ask if the float is equal to Inf. If it is, I will print the i-1 value of the iteration. Maximum value for 32-bit float: 3.4026×10^{38} Maximum values for 64-bit float: 1.7975×10^{308}

The minimum values are found in a similar way: Minimum value for 32-bit float: 1×10^{-45} Minimum values for 64-bit float: 1×10^{-323}

3 Newman 2.9

The Madelung constant is calculated to 1.747564 (compared to the actual value, 1.747565 for $L \rightarrow \infty$) with $L=20$ using three nested for-loops. Using Timeit, the average time to complete the computation is $395 \text{ ms} \pm 105 \text{ ms}$. By creating a mesh with np.meshgrid, we sum over the lattice sites which is much faster. This way, it only takes 593 ± 80.6 micro seconds per computation. Strangely, this computation gives a different result of 1.71940116 for reasons that might have something to do with the way the singularity is handled in the different programs.

4 Newman 3.7

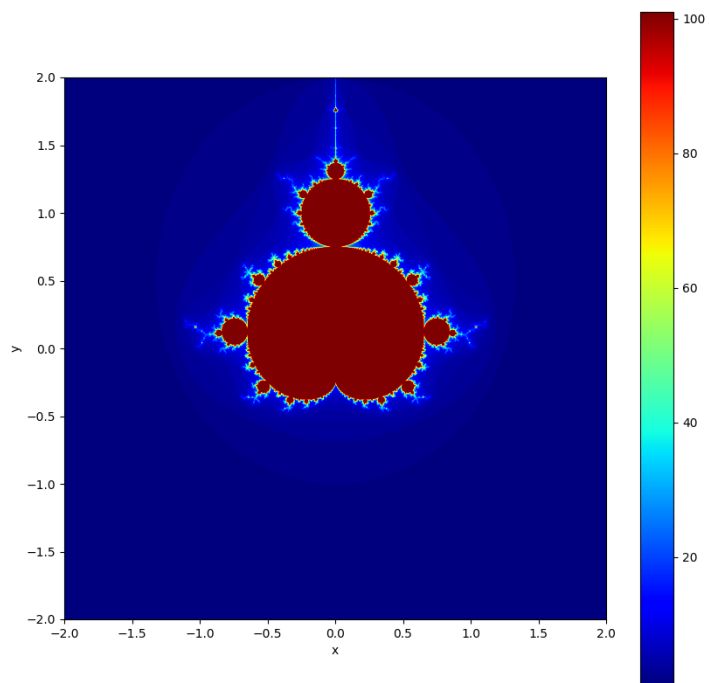


Figure 1: The Mandelbrot set with maximum iteration number of 100. Heightmap is set so that points that are larger than two, take on the number of iterations before it exceeds two. Points that never become larger than 2 will take the value 101.