Homework 1 Report

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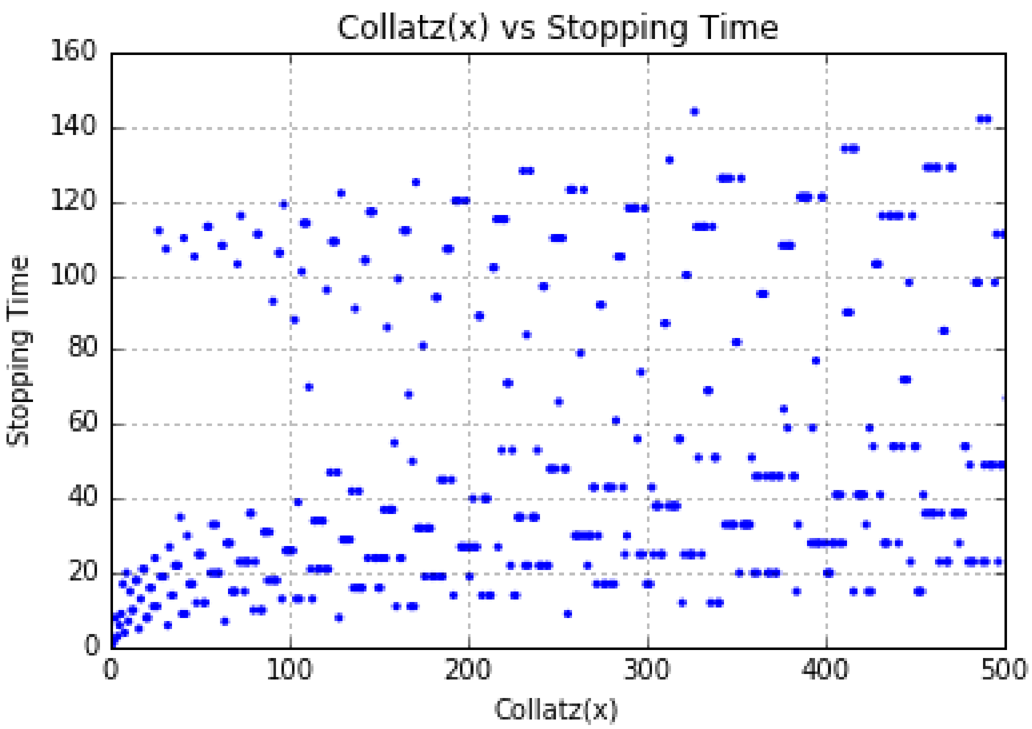
Exercise 1



Based on this picture, my guess is that the Collatz Conjecture is true. My thought process is that the stopping time of the Collatz sequence increases, on average, so much slower than the input numbers. This would mean that on average, the stopping time will be lower than the input value. As long as the stopping time is lower than the input value, there will never been a number such that the Collatz sequence does not reach 1, as such a number would have a stopping time of infinity (and all numbers the sequence reaches would have stopping times of infinity).

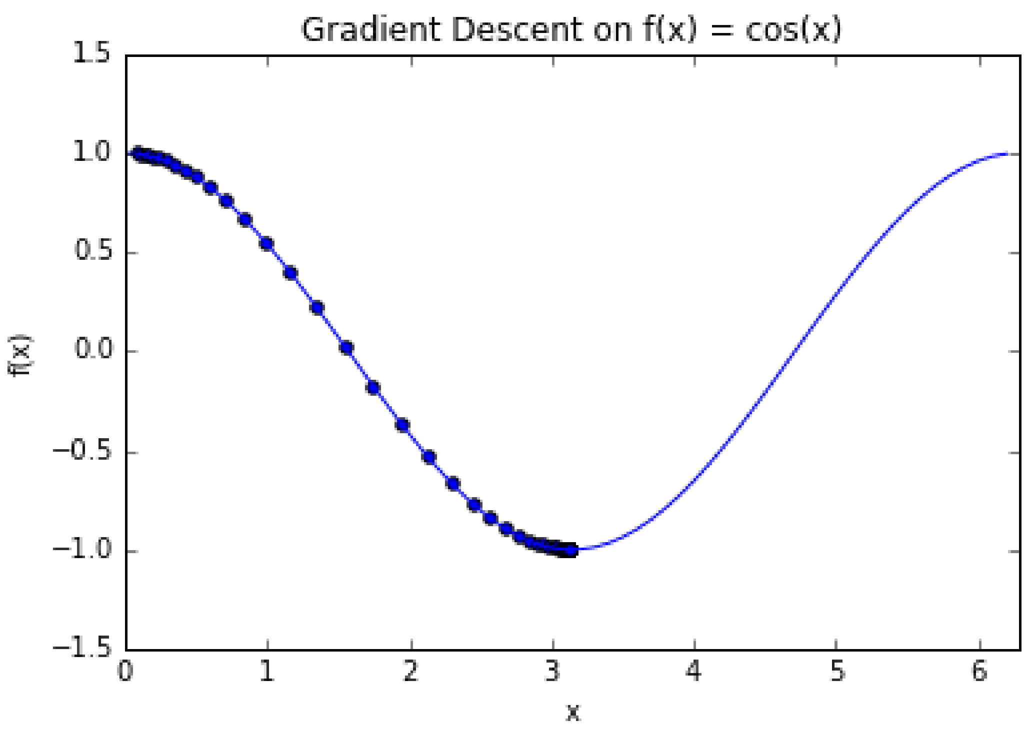
I tested this theory by only plotting values where the stopping time was greater than the input value. It occurs a few times before the input value of 150, but after that, there is not a single value with a higher stopping time than the input value.

Plotting larger n shows this very same trend and running my test confirms this (I ran this test on a value of 2500000).

This picture could tell me the same information I got by running my test. I could draw a line $x = y$ on the graph and if I have data point above it then the stopping time is larger than the input value.

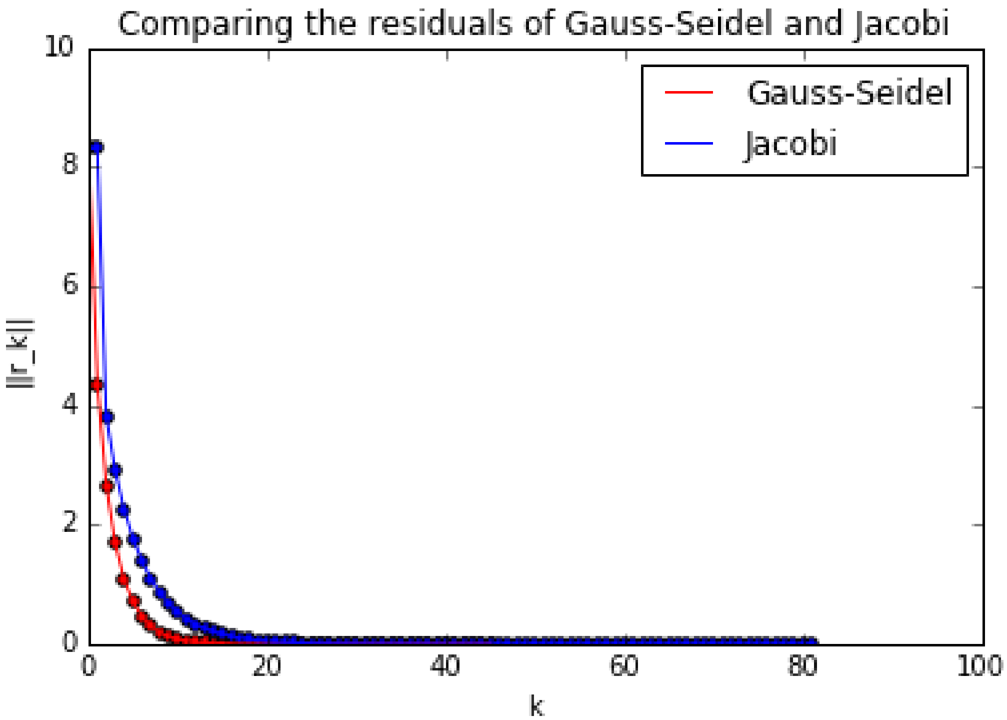
However, the test I'm using to assume a conclusion is not the best test available and will not come close to confirming the truthfulness of the conjecture.

Exercise 2



If $\sigma > 1$ is allowed, it's relatively easy to select a sigma greater that $x^* - x_0$ will be chosen, where x^* is the nearest local minimum and x_0 is the selected starting point. If this occurs, the the nearest local minimum will not be found and on an oscillating function, nothing will ever be returned as the gradient descent will continually be unable to find a minimum of any kind.

Exercise 3



We see that Gauss-Seidel converges faster. While it is difficult to see on the plot, Gauss-Seidel converges in 46 iterations while Jacobi takes 82 iterations to converge.

If ϵ of $1e-20$ is taken, then both Gauss-Seidel and Jacobi hit an iteration limit. It doesn't matter if ϵ is decreased to smaller quantities, both methods will iterate the exact same number of times.

The iteration limits are:

170 - Jacobi

90 - Gauss-Seidel