Ps 5 Problem 2

Adam Guerin

October 17, 2023

Abstract

This short paper will show some plots and discuss fitting of some given and unknown signal.

1 Introduction

SVD is a method of factorizing a matrix into orthonormal components that I cannot explain very well. By decomposing a matrix into orthonormal components then dotting that correctly with your signal you will have created a model signal that depends on your components that made up the matrix you factorized. AKA you can create a matrix of constants, and different orders of x, and create a model signal that is a polynomial up to the max order of x.

2 Methods

After importing the unknown signal I tried matching a 3rd order polynomial, and it was bad. I then tried matching a 21st order polynomial and it fit better, but still poorly. The signal is periodic, so I fourier transformed the signal to find the primary frequency of the signal, and then used that frequency to fit the data using a sum of sin and cos with that frequency which did much better.

3 Results

Fitting with a polynomial for the data did very poorly, even when doing of a higher order. You want your condition number to be pretty close to unity for whatever you're fitting and your residuals to be pretty small. For 3rd order polynomial my residuals were of order the signal and for the 21st order polynomial, my condition number was in the thousands of trillions while my residuals were still pretty high. With my sin and cos fitting, both of these were much better with the only issue being that the data itself is noisy. From the fourier transform of the data, taking the inverse of the principle frequency gives us a periodicity of .135.

4 Discussion

I couldn't get a near perfect fitting for the data due to noise, but besides that using that the data was periodic, I was able to get a frequency associated with it and plot fit pretty well. If you have to use a higher order polynomial, often that isn't the best choice. There aren't actually that many situations where you need extremely high order polynomials.

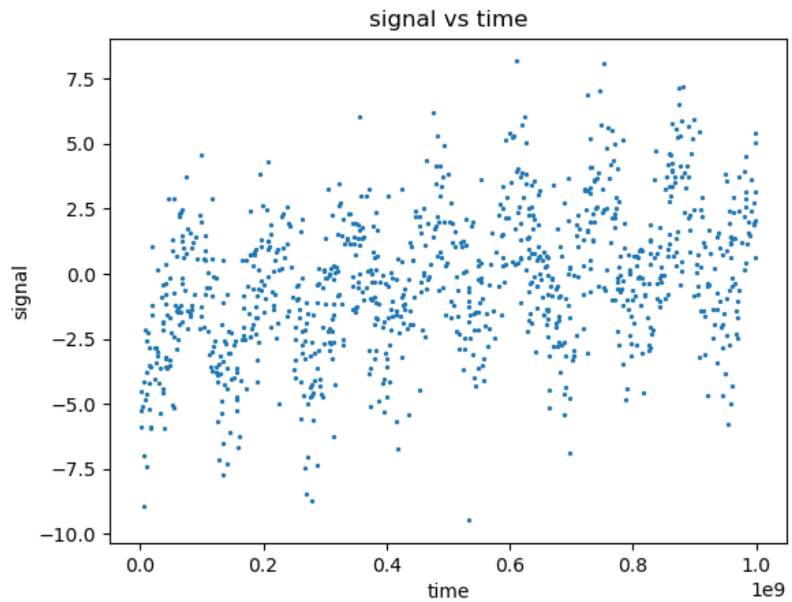

Figure 1: Our signal, very noisy, can see a linear trend upwards and some sort of periodic behavior.

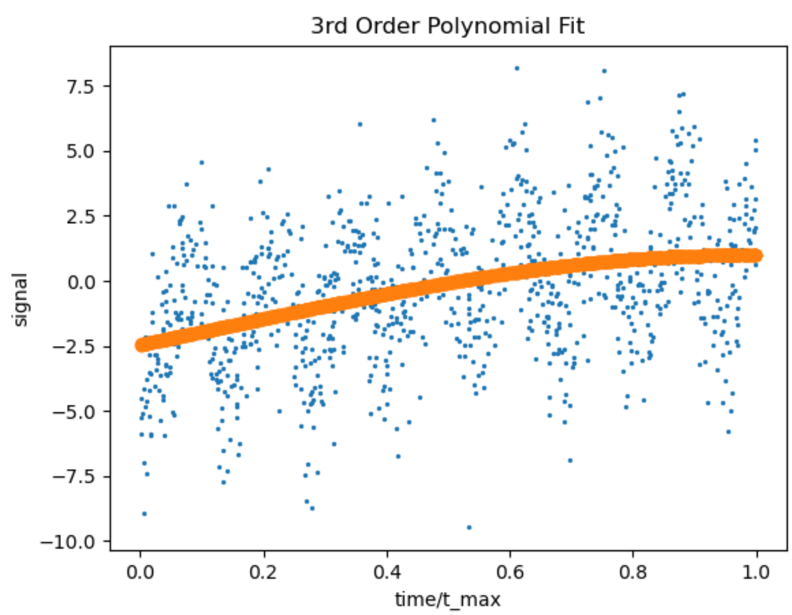

Figure 2: Clearly a very poor fit for the data. Residuals are of order of the signal.

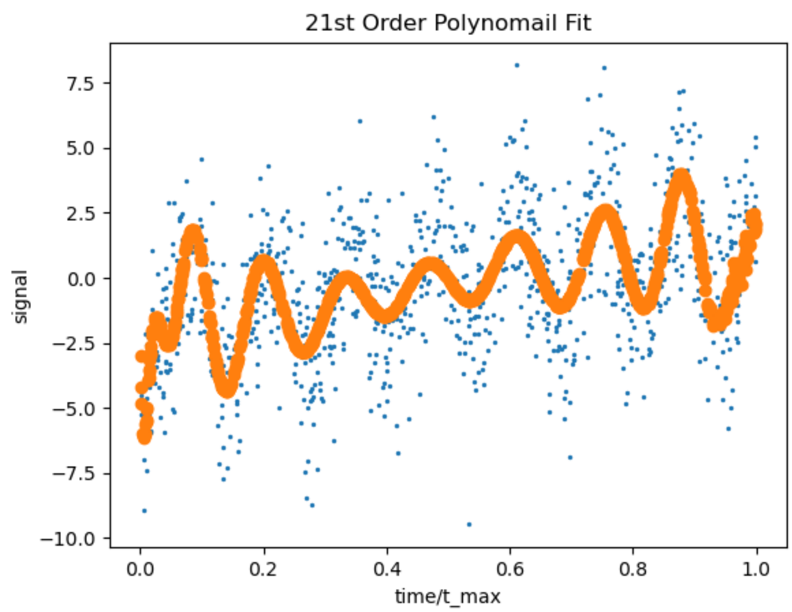

Figure 3: A much better fit than the previous one (but clearly still not that good), the condition number (ratio of highest and lowest eigenvalues) is 5125181840807780, order 10^{16}, far far too large to be reasonable.

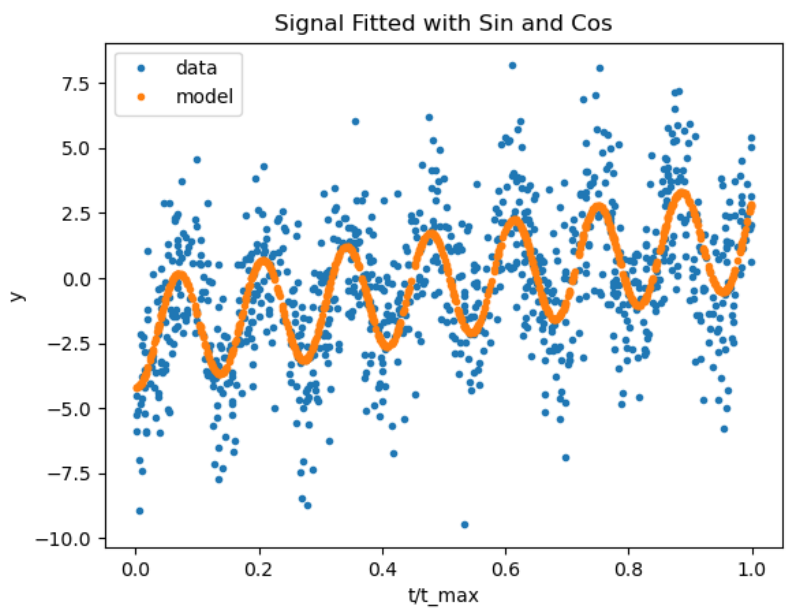

Figure 4: A much better fit than the previous two. The Condition number in this case is 4.36. Of order unity, a much better guess.