Data Analysis Project

Eric Rupert

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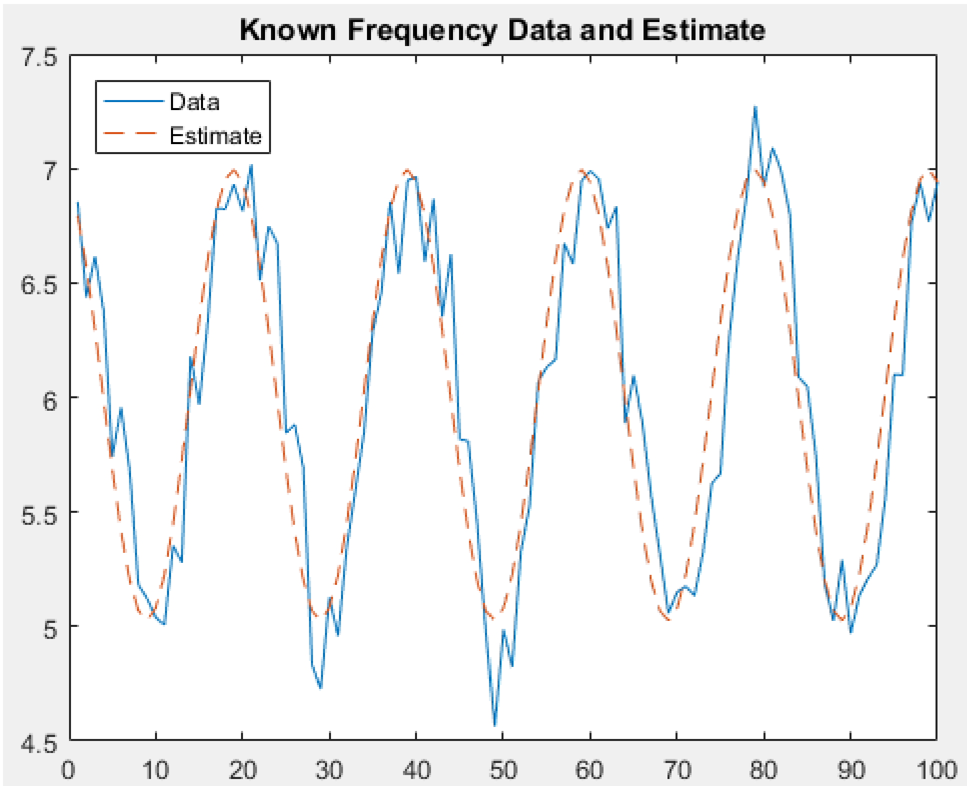
Introduction

This project is an analysis of BPSK data in two parts. The first part entails a known frequency sinusoid with unknown phase, amplitude and DC offset to be estimated embedded in known σ^2 white gaussian noise. The second part has unknown frequency (within a bounded range) in addition to the other parameters to be estimated, also in known σ^2 white gaussian noise.

Known Frequency Estimation

The data stream is loaded into MatLab. Given a period of 20 samples and a data length of 100,there are an integral number of cycles in the data stream, the DC offset is estimated as the mean of the data. Next sin and cos obser-vatoin matricies are made (using the given frequency), and the amplitude and phase are converted into a new pair of variables not embedded in a sinusoid. This allows for the variables to be solved for as proportinal to the product of observation matrix transposed times the data stream. The variables are then reverted to amplitude and phase. The parameters are estimated as follows:

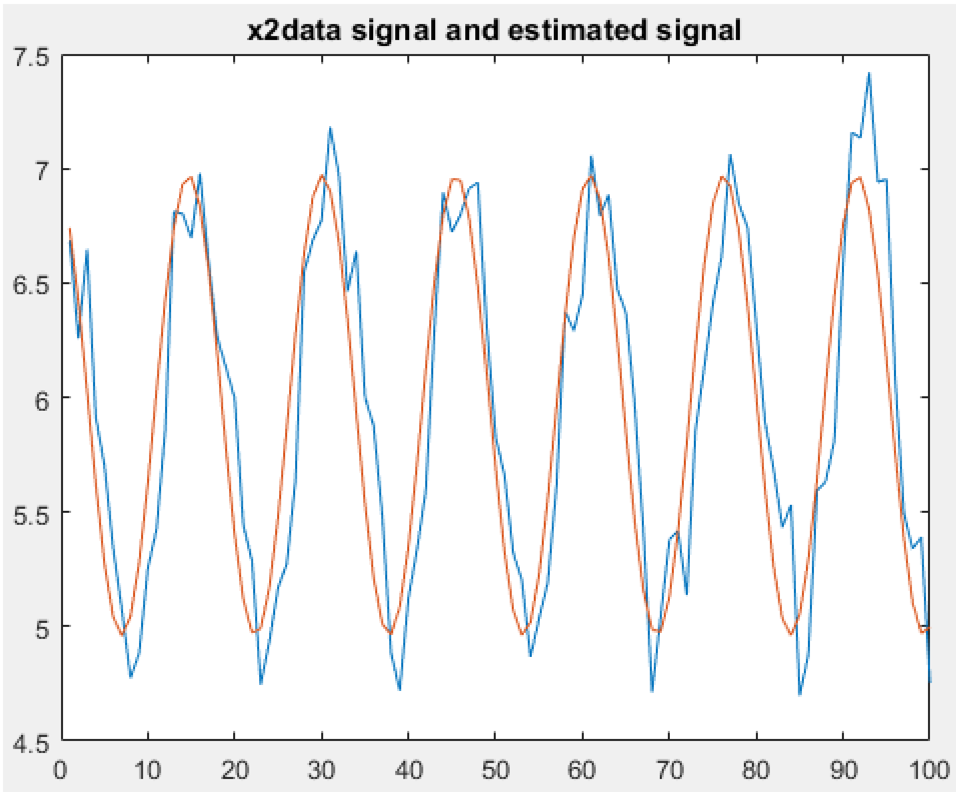
$\hat{\mu} = 6.0107$, $\hat{A} = 0.9843$, $\hat{\phi} = 0.3359$



Unknown Frequency Estimation

Because the number of cycles in the data stream is unknown, a worst case scenario is examined. Averaging a sinusoid over 2.5 cycles will give a maximum offset with the smallest denominator in the mean, within our frequency range. This inconsistency in DC level will be approximately $A * 10^-4$ and is an acceptable error. Thus the DC offset is estimated to be the mean of the data. Because the frequency is unknown, the observation matrices are to be generated within a grid search, and the frequency where the optimization parameter is maximized is estimated to be the signal frequency. This method is contracted with a method of moments estimator, which gives frequencies out of the known frequency range. Once the frequency is estimated, the maximum likelihood estimation from the first part is repeated. The parameters are estimated as follows:

$\hat{\mu} = 5.9662,\ \hat{f}_0 = 0.065,\ \hat{A} = 1.0055,\ \hat{\phi} = 0.2854$



Conclusion

These estimates look reasonable, although from the images there appears to be some inaccuracy between estimates and the signal. Without knowing the transmitted signal, however, it is impossible to know how close these estimates are from the original.