EE20B051 ASSIGNMENT 3

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1   AIM:

The aim of the assignment is:

- To analyse the give noisy data and plot the graphs of the data.

- To Observe the error in fitting the Least Error Fit function for the given set of data.

- To Find the relation between the error observed and the noise in the data.

- Get used with matplot.lib library

2   Observation:

The function which is used is:

$$f(t) = 1.05J_2(t) - 0.105t \tag{1}$$

where $J_2(t)$ is the *Bessel Function of the first kind of 2nd order.* we can obtain the true data using this equation.

2.1   Analysing the data:

First the data in **fitting data** file is being uploaded into the program. This has data that is being stored in columns out of which the first columns contains the time values and the other columns contain the noisy data.The plot of the noisy data and the true value against the time axis is shown in the below diagram:
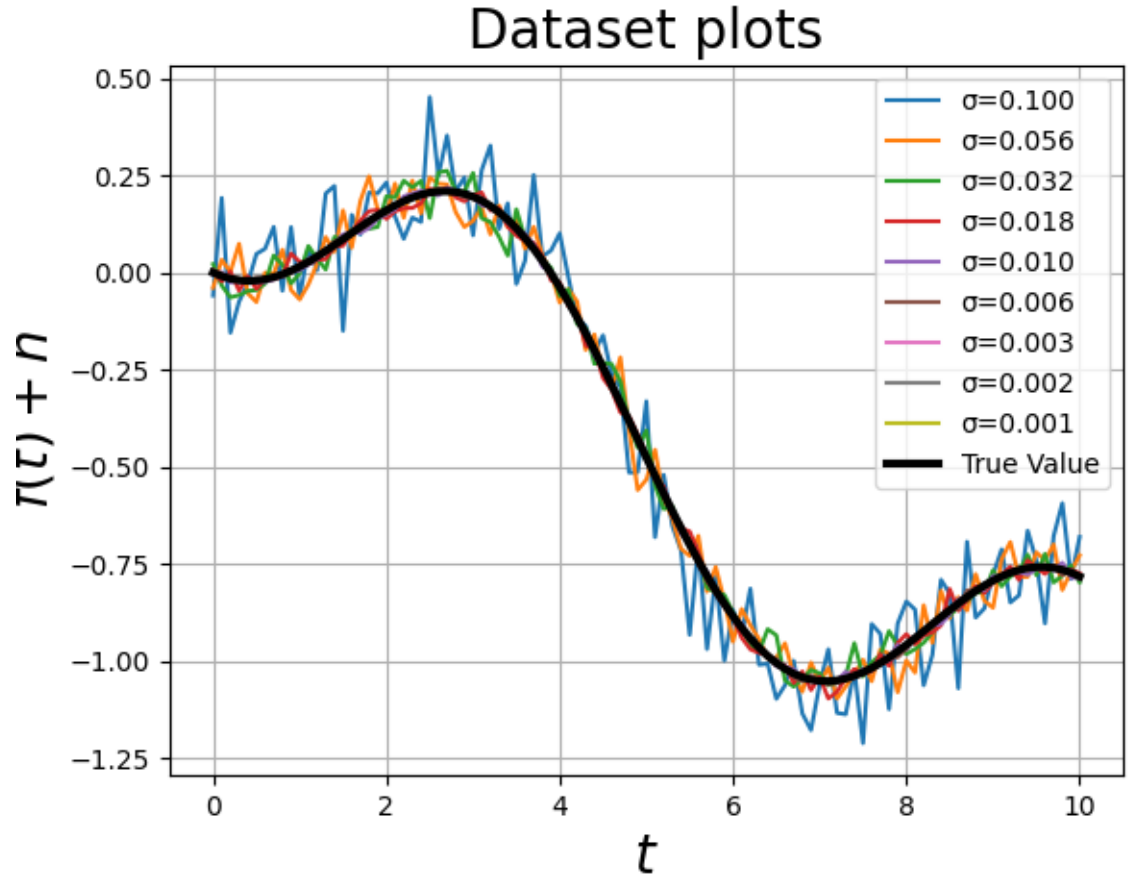
Figure 1: Noisy Data with True Data

By the above above graph we can say that as the value of increases the data becomes more noisier.The below plot is the *Errorbar plot* of the first coloumn of noisy data with the true value against the time axis.
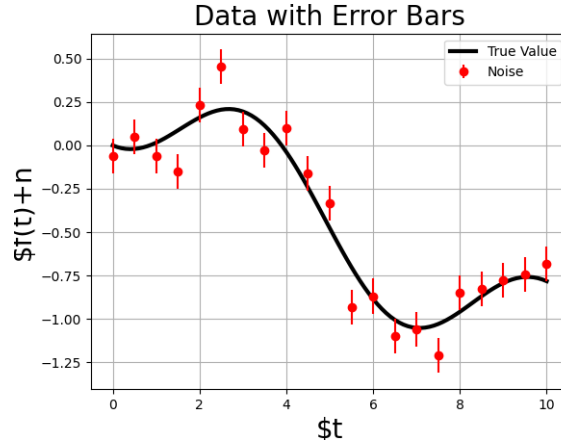
Figure 2: Noisy Data with Errorbar

The red lines (*error bar*) in the above plot indicate the standard deviation of the noisy data from the original data, at that value of t. To make the plot more readable it is plotted at every $5^t extth$ point.

2.2 To find the best approximation for the obtained noisy data:

From analyzing the data, we can understand that the noisy data can be approximately fitted into a function shown below:

$$g(t, A, B) = AJ_2(t) + Bt \tag{2}$$

where A and B are constants, which are to be found using graphical and least square fit function of the python. To find the coefficients A and B, we will find the mean square error between the noisy data (1st column) and the function for a range of values of A [0,0.1,0.2 ... 2] and B [-0.2,-0.19,-0.18,....,-0.01,0], which is given by:
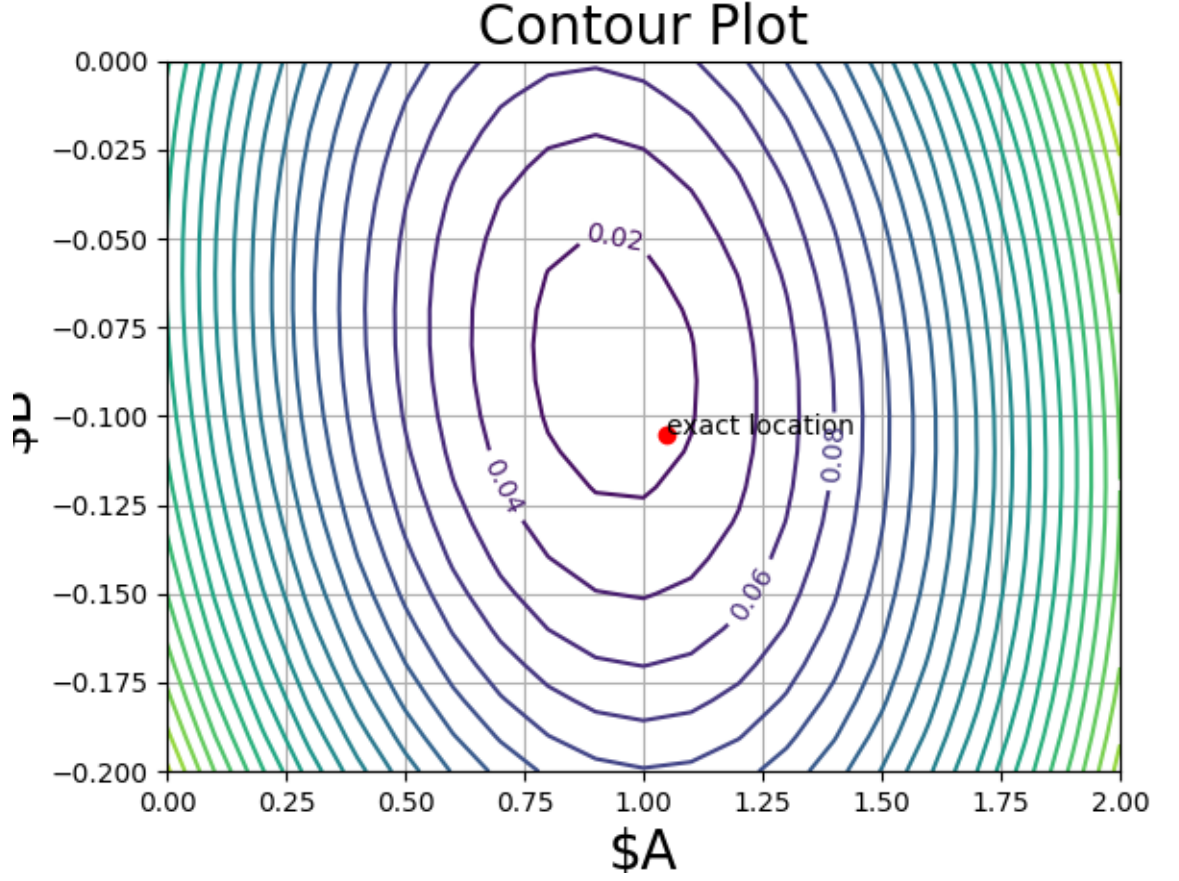
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Figure 3: Contour Plot of ϵ_{ij}

We can observe that the location of the minima is approximately near the orignal function coefficients.

2.3 Finding out the variation of ϵ with σ_n

We find that the variation of the mean squared error of values A_p and B_p is as follows:

$$\epsilon_{ij} = \frac{1}{101} \sum_{k=0}^{101} (f(t_k) - g(t_k, A_i, B_j))^2 \tag{3}$$

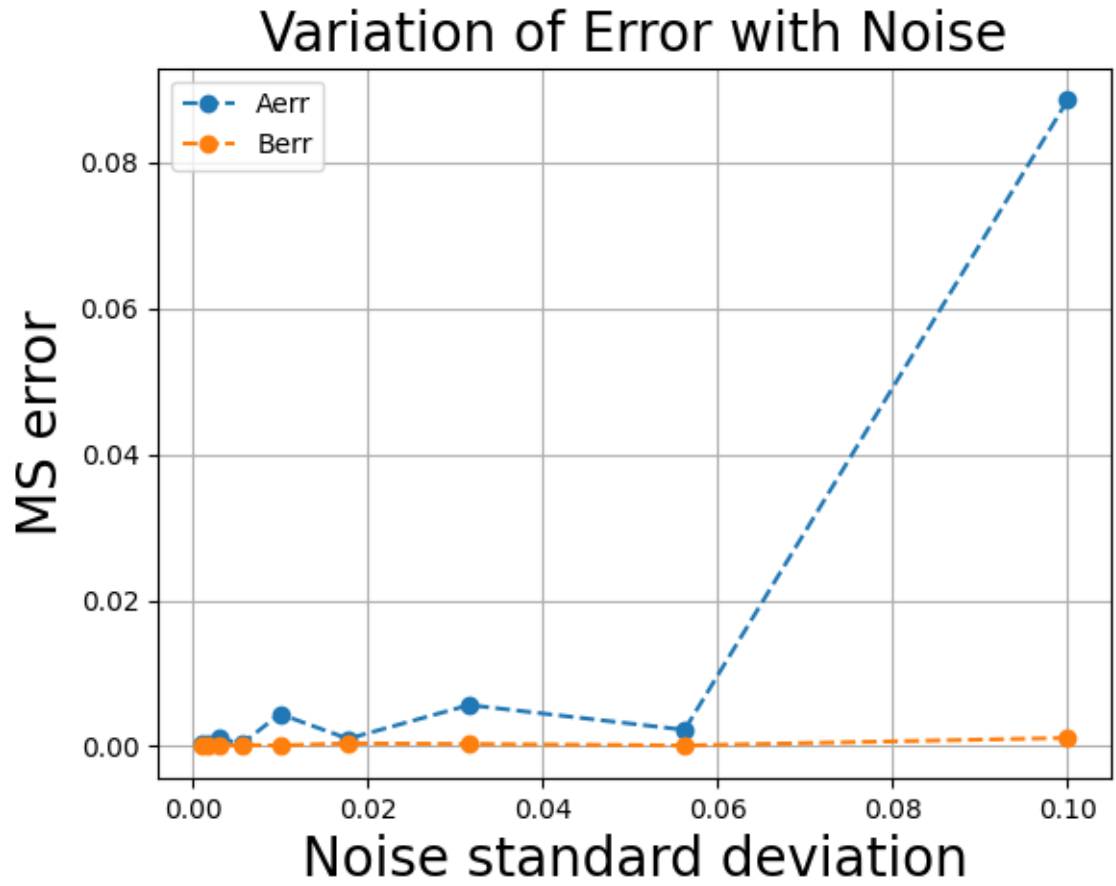where ϵ_{ij} is the error for (A_i, B_j).

Figure 4: Mean Squared Error vs Standard Deviation

By observing the above graph we can conclude that the plot doesn't give essential relationship between σ_n and ϵ. To get the more accurate plot we can use loglog plot which will give the below output
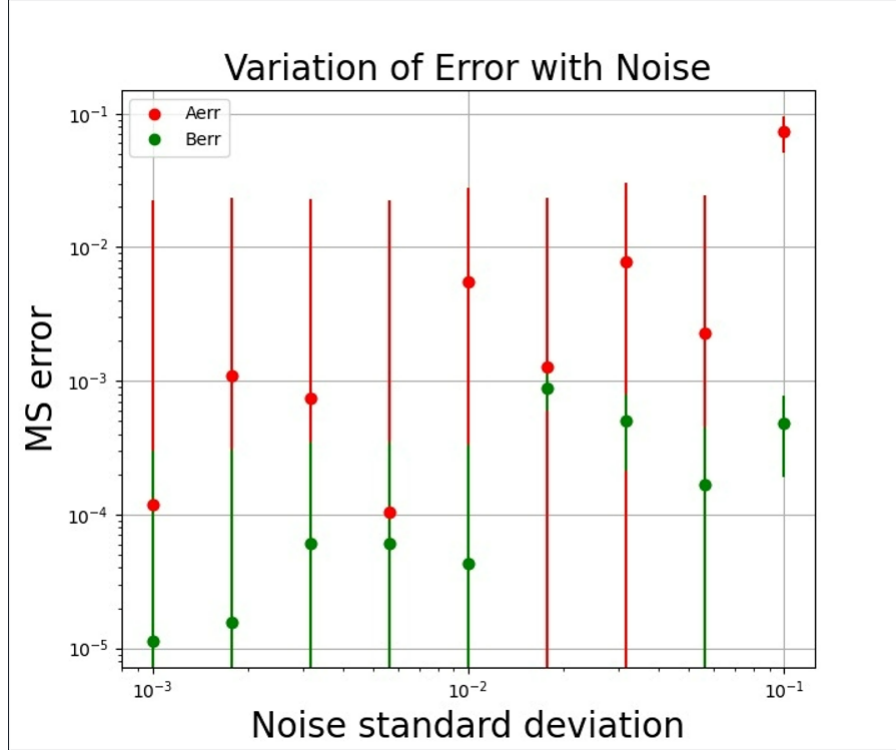
Figure 5: Error vs Standard Deviation `loglog` Plot

From the above plot we can observe that we are approximately getting linear relationship between σ_n and ϵ.

3 Conclusion

The given noisy data was extracted and the best possible estimate for the underlying model parameters were found by minimizing the mean squared error. This is one of the most general engineering use of a computer, modelling of real data.