Assignment No 3

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1 Data extraction and visualization

The data is obtained by running the gen_data.py script. The data contains 10 columns, the first column represents time, and the remaining 9 columns have random fluctuations with different amounts of noise where the standard deviation is uniformly sampled from a logarithmic scale. Following is the graph of all the 9 columns.

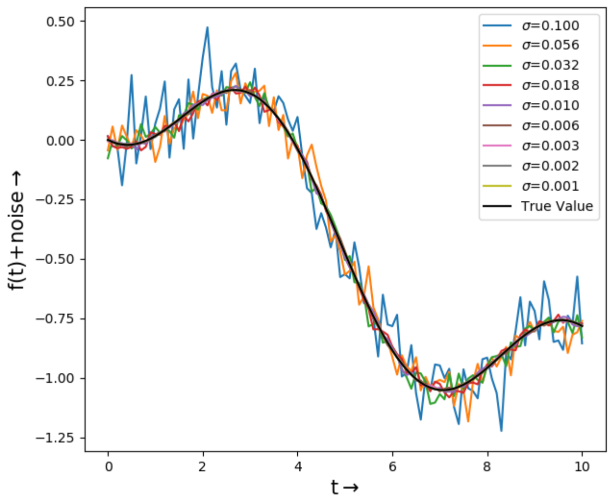

Figure 1: Plot of the data

2 The Errorbar plot

The errorbars for the first data column are plotted using the errorbar() function. The graph is obtained by plotting every 5th data point with errorbars and the original data. Each point in the data column is varying mostly within a σ width of the true value.

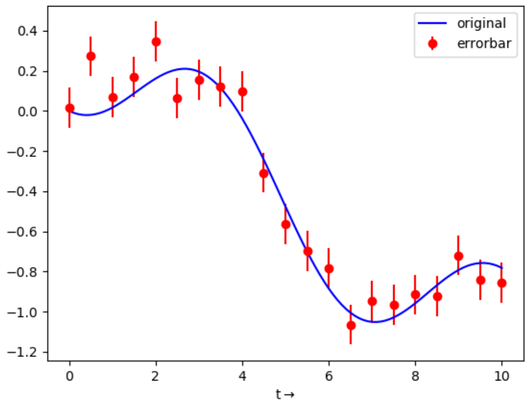

Figure 2: The errorbar plot

3 Calculating the error

The error is calculated and stored in the array e.

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

The mean squared error for the first data column can now be plotted and the minima can be found to obtain the best estimate for A and B. This is done by the following code block :

```
pylab.contour(A,B,e[:,:,0])
a = np.unravel_index(np.argmin(e[:,:,0]),e[:,:,0].shape)
pylab.plot(A[a[0]],B[a[1]],'o',markersize=3)
```

The np.argmin() function returns the index of minima for the flattened array, and the np.unravel index() function is used to get the location of the minimum in the original array.

As we can see in the graph, the error function has one minimum and it occurs at A = 1.10 and B = -0.10

4 Error in estimation of the parameters

The error estimate in the first plot is non-linear with respect to the noise. On plotting the axes in the log scale, the graph becomes approximately linear.

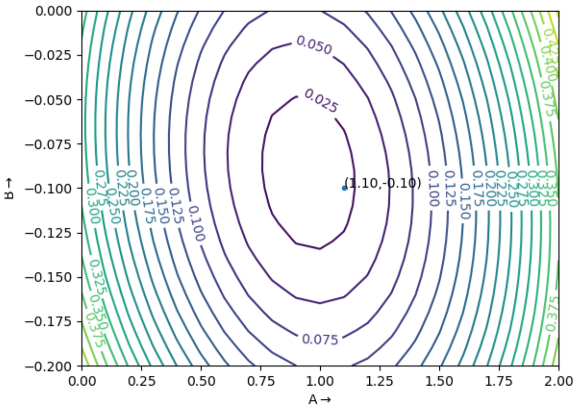

Figure 3: The contour plot

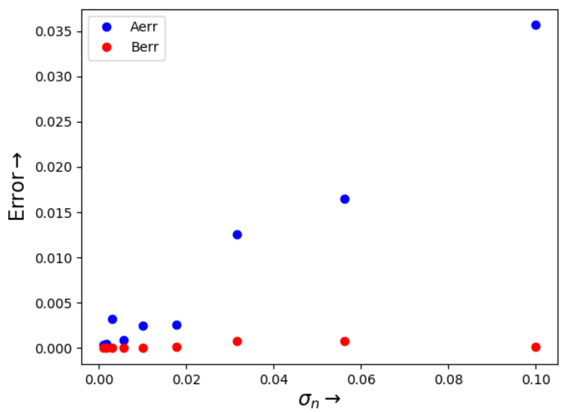

Figure 4: Error vs σ

5 Conclusion

The data with some noise is extracted and the best possible estimate for the underlying model parameters is found by minimizing the mean squared error. We can see that the error is approximately linear with σ in the log scale.

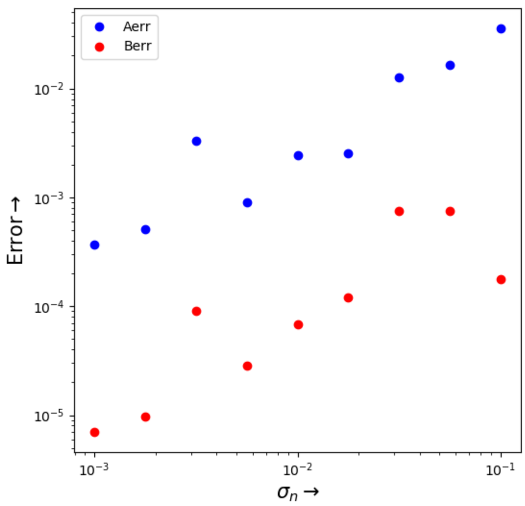

Figure 5: Error vs σ(log scale)