Assignment 3: Fitting Data to Models

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Q1:Solution

Get the "fitting.dat" file by running generate_data.py

Q2:Solution

Load fitting.dat file using following code

```
import numpy as np

data_table = np.loadtxt('fitting.dat')
t = c_[data_table[:,0]]
N,k = shape(data_table)
print(N,k)
```

Q3:Solution

The data columns correspond to the function with different amounts of noise added.

$$f(t) = 1.05J_2(t) - 0.105t + n(t)$$

$$sigma = logspace(-1, -3, 9)$$

Q4:Solution

Model Function for this data

$$g(t; A, B) = AJ_2(t) + Bt$$

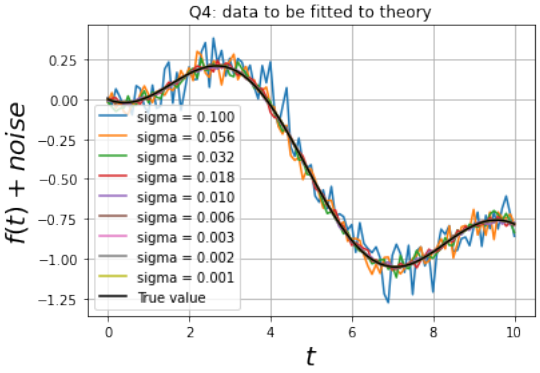

Figure 1: Data to be fitted to theory

Q5:Solution

A plot of the first column(sigma = 0.1) of data with error bars with every 5th data item to make the plot readable.Use following command to plot error bars.

$$errorbar(t[::5], data[::5], stdev, fmt =' ro')$$

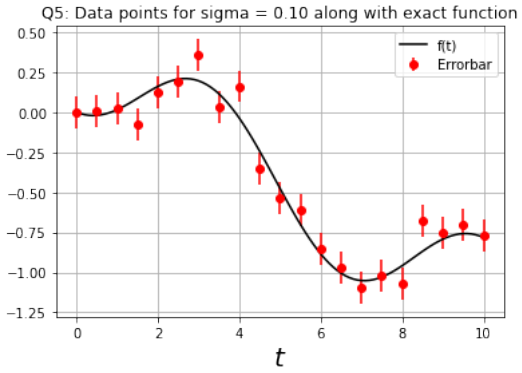

Figure 2: Data points for sigma = 0.10 along with exact function

Q6:Solution

g(t, A, B) = M.p
Construct M and inorder confirm two vectors are equal, confirm their elements must be equal

Q7:Solution

For A = 0, 0.1, . . . , 2 and B = -0.2, -0.19, . . . , 0, compute "mean squared error"

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

Q8:Solution

countour plot of ϵ_{ij} with B on Y-axis and A on X-axis.

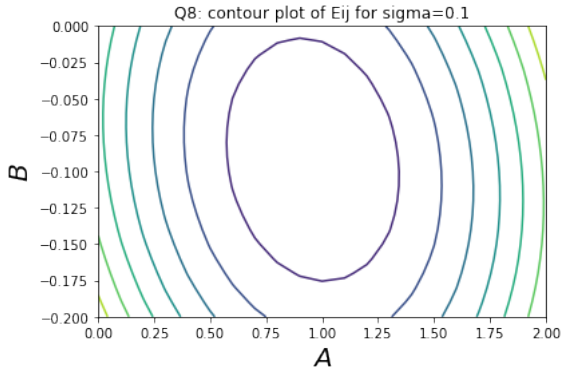

Figure 3: contour plot of ϵ_{ij} for sigma = 0.1

Q9:Solution

Use the Python function "lstsq" from "scipy.linalg" to obtain the best estimate of A and B.
Use following Code

```
Aerr = np.zeros(k)
Berr = np.zeros(k)
from scipy.linalg import lstsq
for i in range(k):
  p,resid,rank,sig=lstsq(M,c_[data_table[:,i+1]])
  Aerr[i] = abs(p[0] - 1.05)
  Berr[i] = abs(p[1] - (-0.105))
```

Q10:Solution

Repeating this with the different columns (i.e., columns 1 and i).

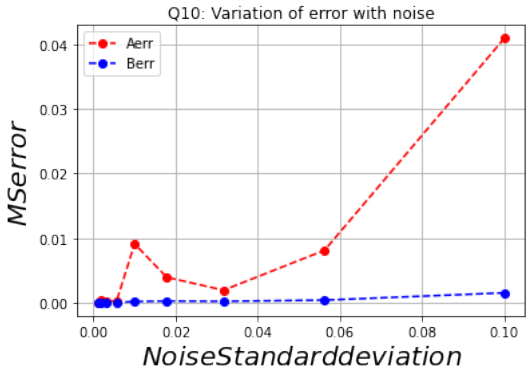

Figure 4: Variation of error with noise

Q11:Solution

Replotting the above curves using loglog.

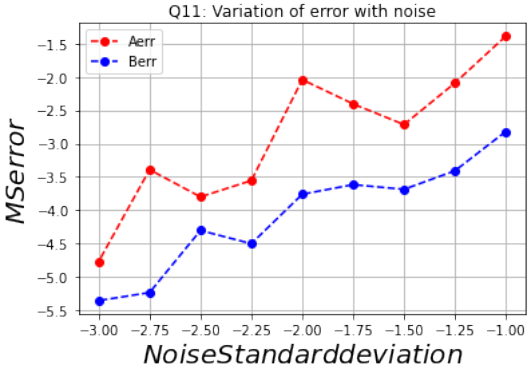

Figure 5: Variation of error with noise using loglog scale

From the graph we can see that error is approximately linear with σ in the log scale.