Computational methods Hw 1

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`https://github.com/AasimZahoor/Comp_methods.git`

Question 1.

Given We have been given the data file *cepheiddata.txt* which contains information about Cepheid variables. There are eight columns in the text file, they are:

Period(days), Distance(kpc), V(mag), J(mag), H(mag), K(mag), E(mag), Z([Fe/H])

Using the given data we are supposed to find out the parameters in the PLZ equation and the associated errors.

$$M = \alpha + \beta * log_{10}(P) + \gamma[Fe/H]$$

Approach

First we had to choose a band out of the four given bands, I chose **J band**. Then using that band you find A_λ. To find A_λ you use this relation.

$$A_\lambda = R_V * constant * E_{B-V}$$

Here, R_V is 3.1 and constant is 0.271 because we chose the J band. Using the A_λ values you find absolute magnitude values using the relation:

$$M_\lambda = m_\lambda - 5 * log_{10}(d) + 5 - A_\lambda$$

The M values give you the data matrix Y. After that we created the design matrix X which is basically [1,$log_{10}(P)$,[Fe/H]]. Now that we have X and Y we calculate parameter vector θ using relation 12 from lecture notes which is:

$$\theta = (X^t X)^{-1} X^t Y$$

. Errors are calculated using relation 30 from lecture notes. It is:

$$errors_j^2 = (X^t X)^{-1}_{jj}$$

Here j means the error of j^{th} parameter.

Results

The parameter values and the associated errors are:

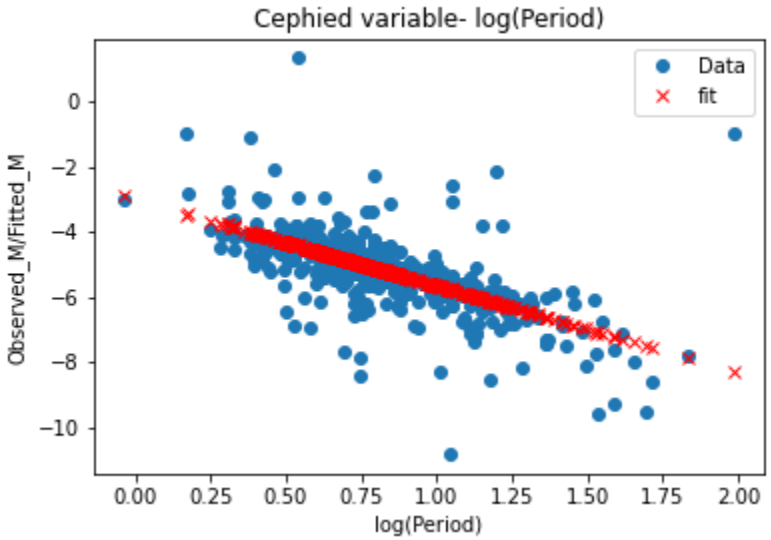
```
In [55]: runcell(1, '/Users/aj3008/Desktop/MS_3rd_Sem/Comp_methods_in_AST/Comp_methods/
Hw_6/pb1.py')
Alpha = -3.0176407970978474 error= [0.14305259812299914]
Beta= -2.6380018159383694 error= [0.1676473246898527]
Gamma= -0.07686360487729615 error= [0.2523499571456189]

In [56]:
```

Question 2.

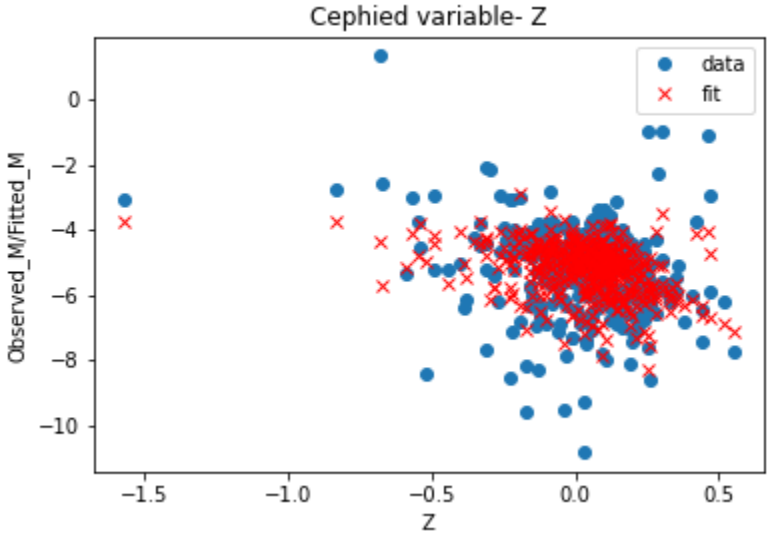
Approach Using this relation I found the values of M using the parameters I found in problem 1 and then I plotted ht fitted M with the data and observed M with the data.

$$M = \alpha + \beta * log_{10}(P) + \gamma[Fe/H]$$

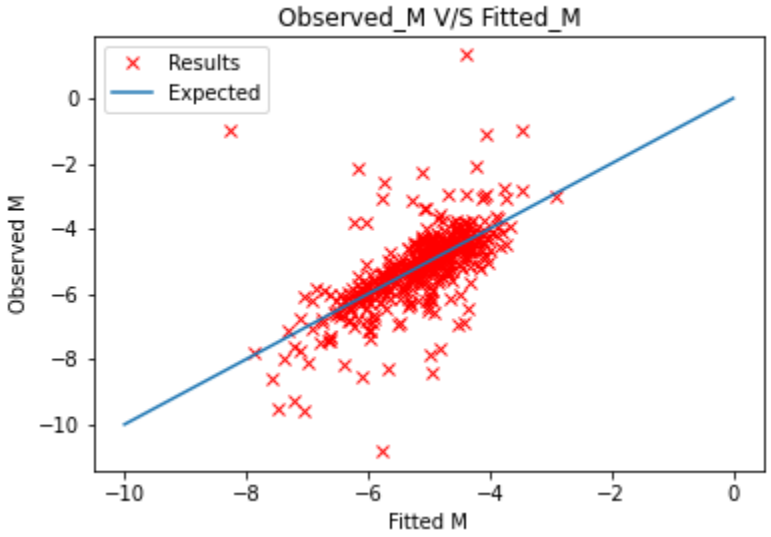
Results



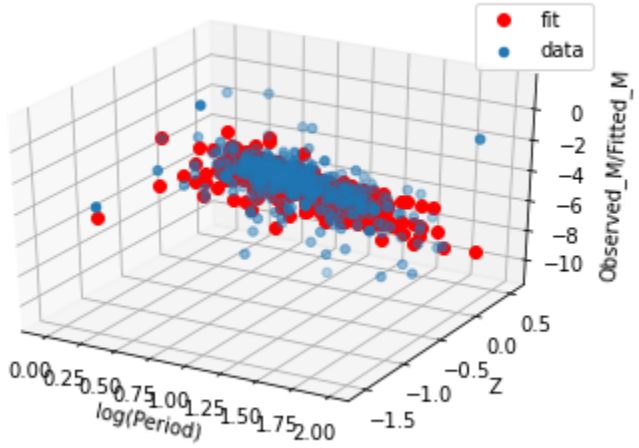
This plot is between log(period) and fitted M/observed M



This plot is between Z and fitted M/observed M



This plot is between fitted M and observed M. We expect it to be follow the trend y=x



3D plot of the given data and fitted M/ observed M

Question 3.

Approach

The problem was set up in the same way as problem 1. The parameter values were obtained using relation 18 from lecture notes which is:

$$\theta = (X^t X)^{-1} X^t Y$$

and the errors were obtained using the relation:

$$errors_j^2 = \sigma^2 (X^t X)_{jj}^{-1}$$

Here sigma is given as 0.1

Results

```
In [71]: runcell(1, '/Users/aj3008/Desktop/MS_3rd_Sem/Comp_methods_in_AST/Comp_methods/
Hw_6/pb3.py')
Alpha = -3.0176407970978474 error= [0.014305259812299916]
Beta= -2.6380018159383694 error= [0.016764732468985268]
Gamma= -0.07686360487729615 error= [0.025234995714561892]

In [72]:
```

4. Bonus

Given

For this problem we have to calculate the parameter values and associated errors for the nested model which is the equation:

$$M = \alpha + \beta * log_{10}(P)$$

Using the approach we described earlier we find parameters and errors. After finding parameters, we find fit values of M. After finding those we use scipy.stats.chisquare to find the chisqaure for nested and full model. Using these values in the below equation we find the F statistic:

$$F = \frac{(X^2_{nested} - X^2_{full})/(v_{full} - v_{nested})}{(X^2_{full}/v^2_{full})}$$

Here, v_{full} is degree of freedom of full model which number of data points minus 3 and v_{nested} is degree of freedom of nested model which is number of data points minus 2.

To get the probability we were supposed to use stats.f.cdf(F,numerator dof, denominator dof), I tried but in different values for numerator dof and denominator dof. I inserted v_{full}-v_{nested} and v_{full}. I also inserted v_{full}-v_{nested} and len(data)- v_{full} but nothing came out. :(

Results

```
In [110]: runcell(1, '/Users/aj3008/Desktop/MS_3rd_Sem/Comp_methods_in_AST/Comp_methods/
Hw_6/Bonus.py')
For nested model
Alpha = -3.0068963262133863 error= [0.013863519522330099]
Beta= -2.6541664789723782 error= [0.015902578365528545]
full model dof= 449 nested model dof= 450
F statisic based on the given equation= 0.7318655482913003


In [111]:
```