

Computational methods Hw 1

Aasim Zahoor Jan (aj3008@g.rit.edu)

October 16, 2020

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 create 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, which 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:

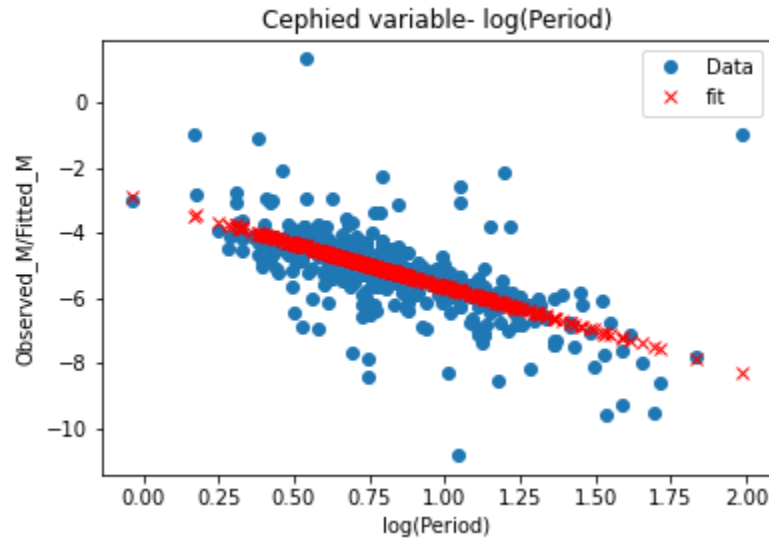
```
In [55]: runcell(1, '/Users/aj3008/Desktop/MS_3rd_Sem/Comp_methods_in_AST/Comp_methods/Hw_6/pb1.py')
Alpha = -3.0176407970978474 error= [0.14305259812299914]
Beta= -2.6380018159383694 error= [0.1676473246898527]
Gamma= -0.07686360487729615 error= [0.2523499571456189]

In [56]:
```

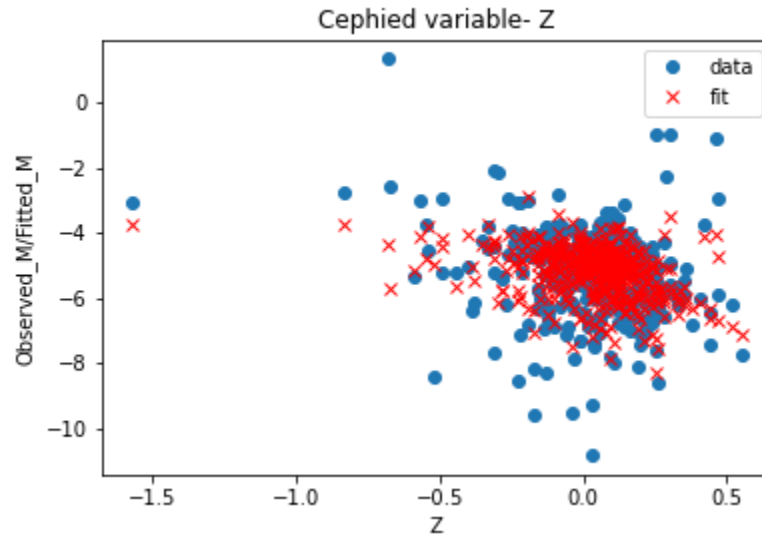
Question 2.

Approach Using the relation given below I found the expected values of M(using the parameters I found in problem 1) and then I plotted expected M and observed M with the data.

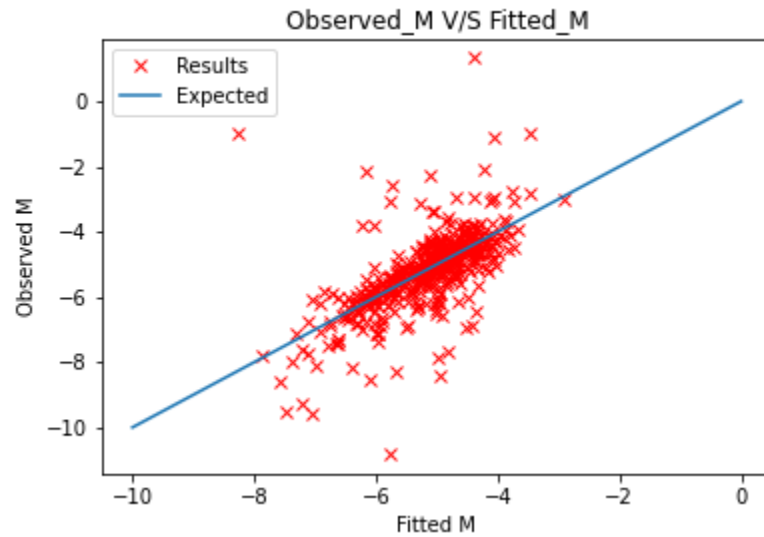
$$M = \alpha + \beta * \log_{10}(P) + \gamma[Fe/H]$$

Results

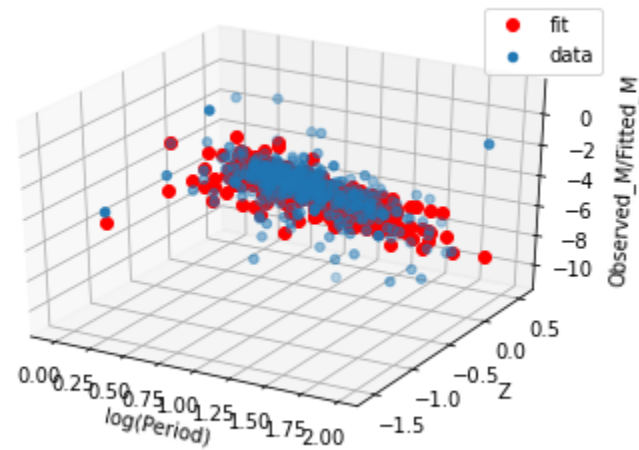
This plot is between log(period) and expected M/observed M



This plot is between Z and expected M/observed M



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



3D plot of the given data and expected 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:

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

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 given by the equation:

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

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

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

Here, v_{full} is degree of freedom of full model which number of data points(452) minus 3 and v_{nested} is degree of freedom of nested model which is number of data points(452) minus 2.

To get the probability we were supposed to use stats.f.cdf(F,numerator dof, denominator dof), I tried putting 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 $\text{len}(\text{data})-v_{full}$ but it just showed nan. :(

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 statistic based on the given equation= 0.7318655482913003
In [111]:
```