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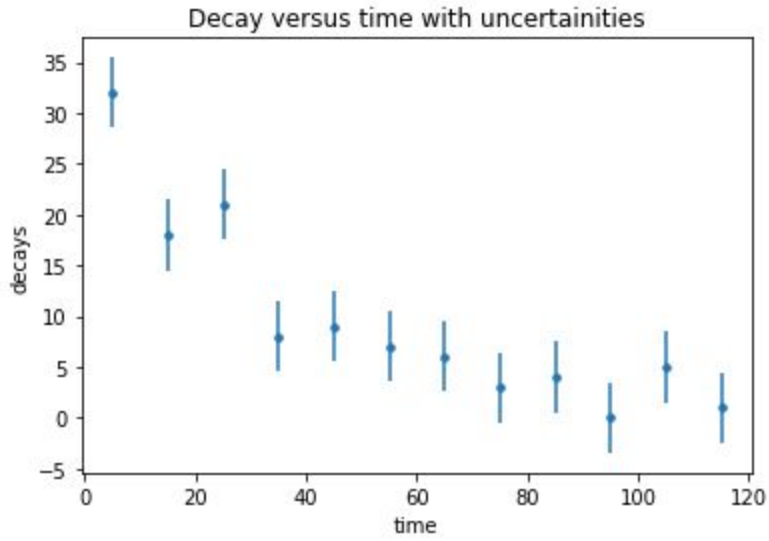
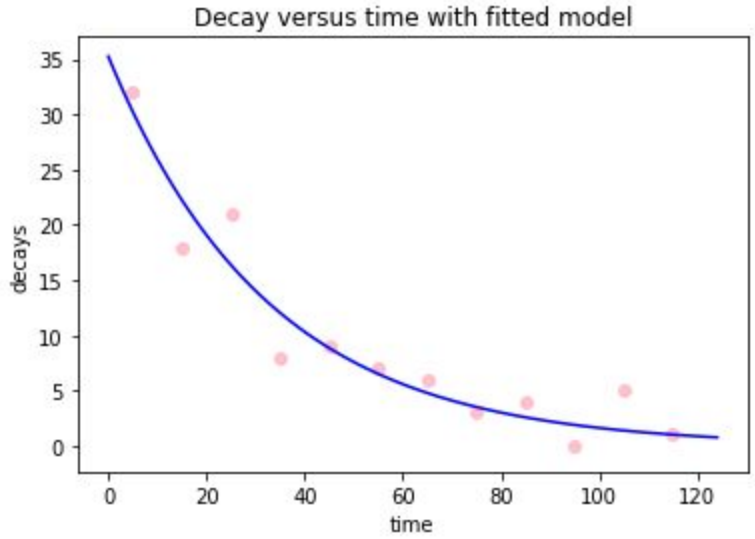
Computational
Exercise 18
Pi Meson Lifetime

Looking at data for the decay of a pi meson, we can determine a best fit curve like the following.

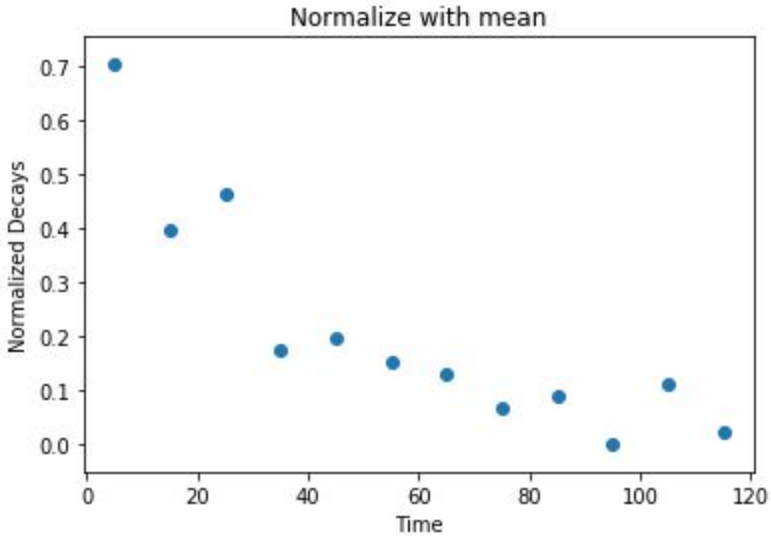


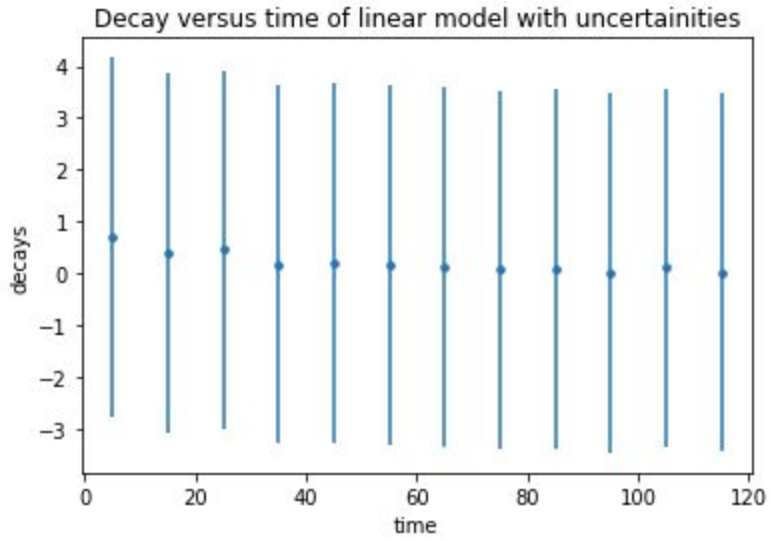
Estimated curve fit:
35.23 x + 0.03067



This fit suggests the pi meson lifetime is 3.523e-08. When is close, but not quite right in comparison to the accepted value of 2.8e-08.

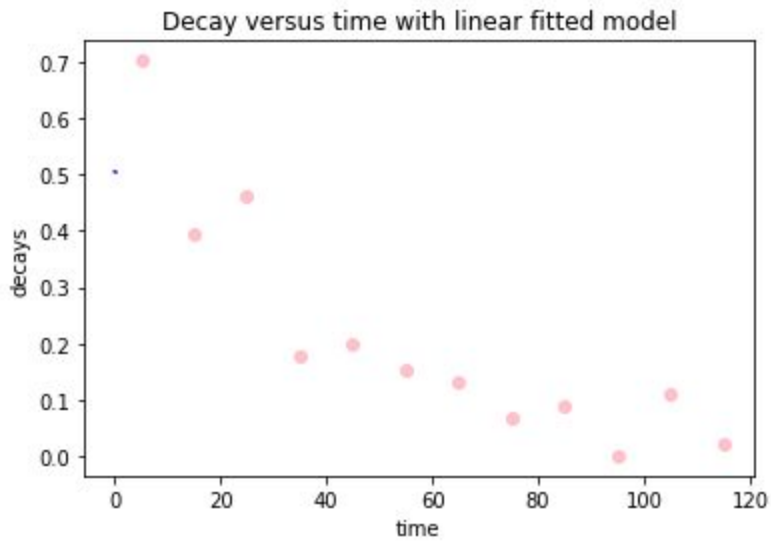
Below is the linearized fitted model first attempted with normalizing the data and using curve fit to estimate a linear fitted model. Then the second attempt is with the linear regression model.

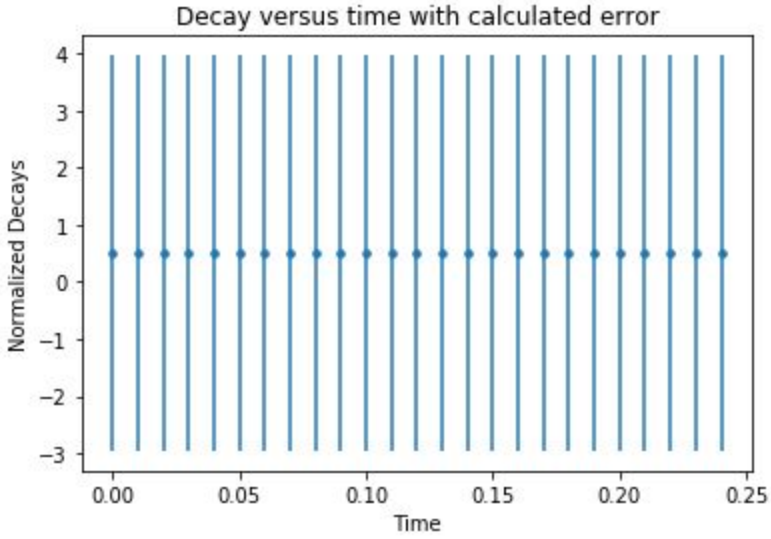


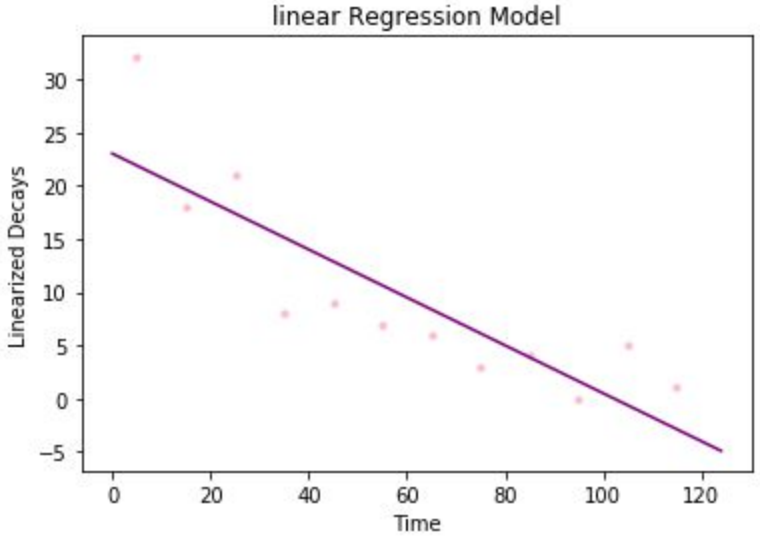


estimated linear curve fit:
1.658 x + 0.004949

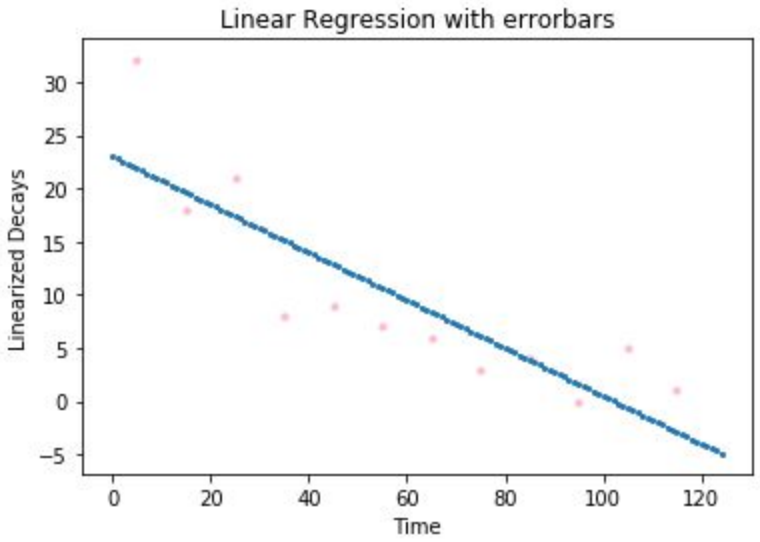
Below is the graph and solution for the linear regression


Decay versus time with linear fitted model
decays
time
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
20
40
60
80
100
120


Decay versus time with calculated error
Normalized Decays
Time
4
3
2
1
0
−1
−2
−3
0.00
0.05
0.10
0.15
0.20
0.25


linear Regression Model
Linearized Decays
Time
30
25
20
15
10
5
0
−5
0
20
40
60
80
100
120

Estimated Linear regression fit -0.22517482517482518x + 23.01048951048951



To me, the best fit is accomplished with the curve fit model, but the linear regression works as well for an overall fitted model. The estimated lifetime for a pi meson is off though in this model. The curve fit model tends to be more precise, but makes sense considering the data given. For better fitting, unfortunately, there is no real way of knowing if there are any skewed points that affect the curve. Although the uncertainty is calculated in the data, if there are any outliers, it can influence the fit. This can shift the curve in any direction. Along the same lines for the linear fitted model, if you have to manipulate the data in order to fit a function, there is a chance the manipulation will introduce unnecessary uncertainties in the data that would not be there otherwise. When computing the linear fit, it would be better to not actually have to change the data. To me, this would suggest the other fitted model is a better option. Consider the linear regression from above with the original data, the fit is a better fit for the data since there is no added manipulation. Another way we can potentially improve the fit would be to better constrain the uncertainties to help guide the curve fit model.