Report on the week of November 11

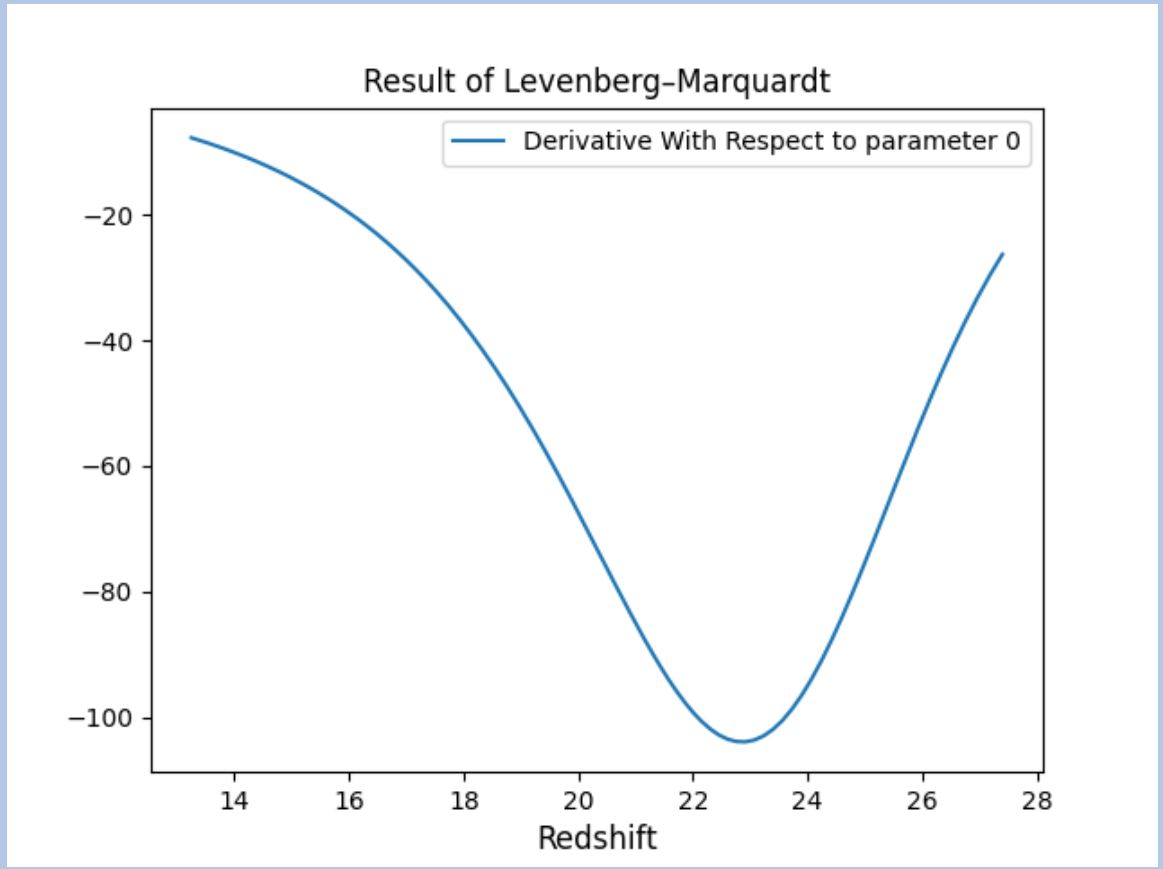
I would like to submit an abstract for **Cosmology on Safari 2023.**

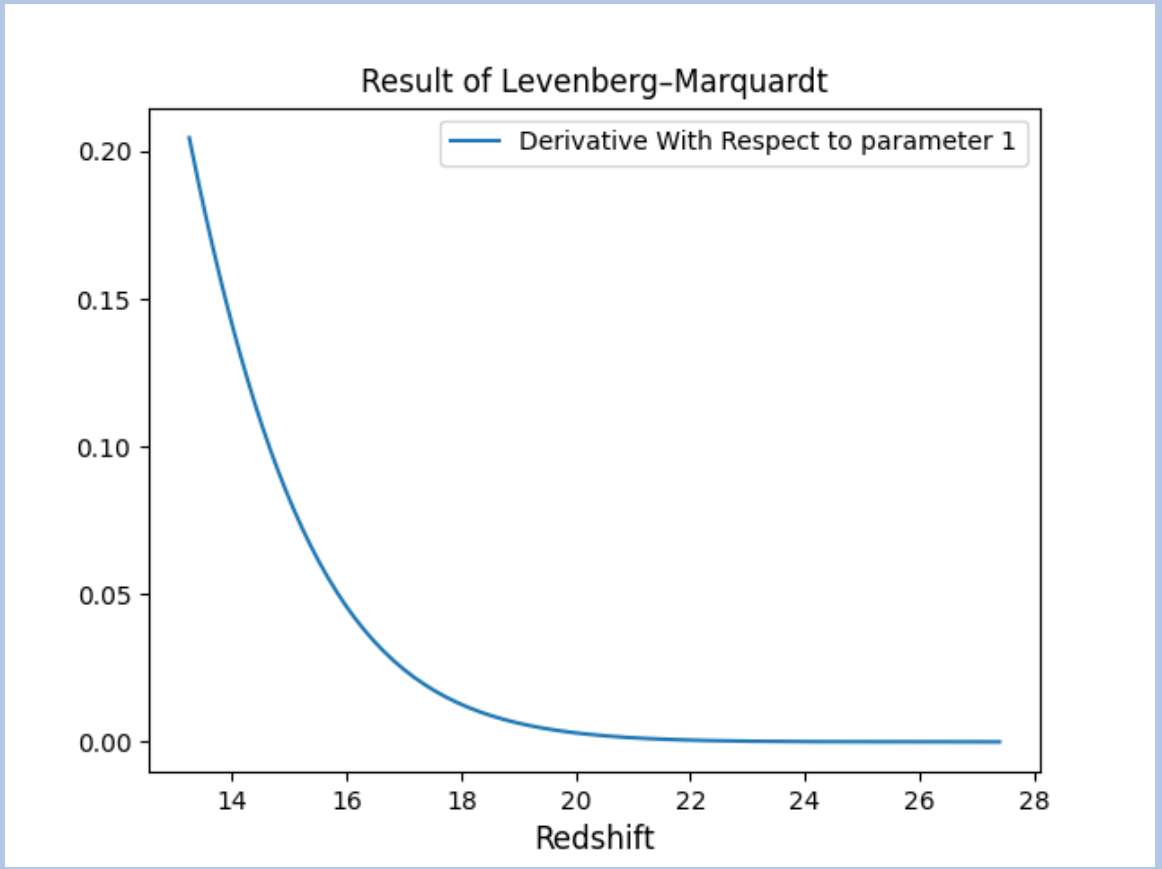
Abstract submission deadline: 15 Jan 2023

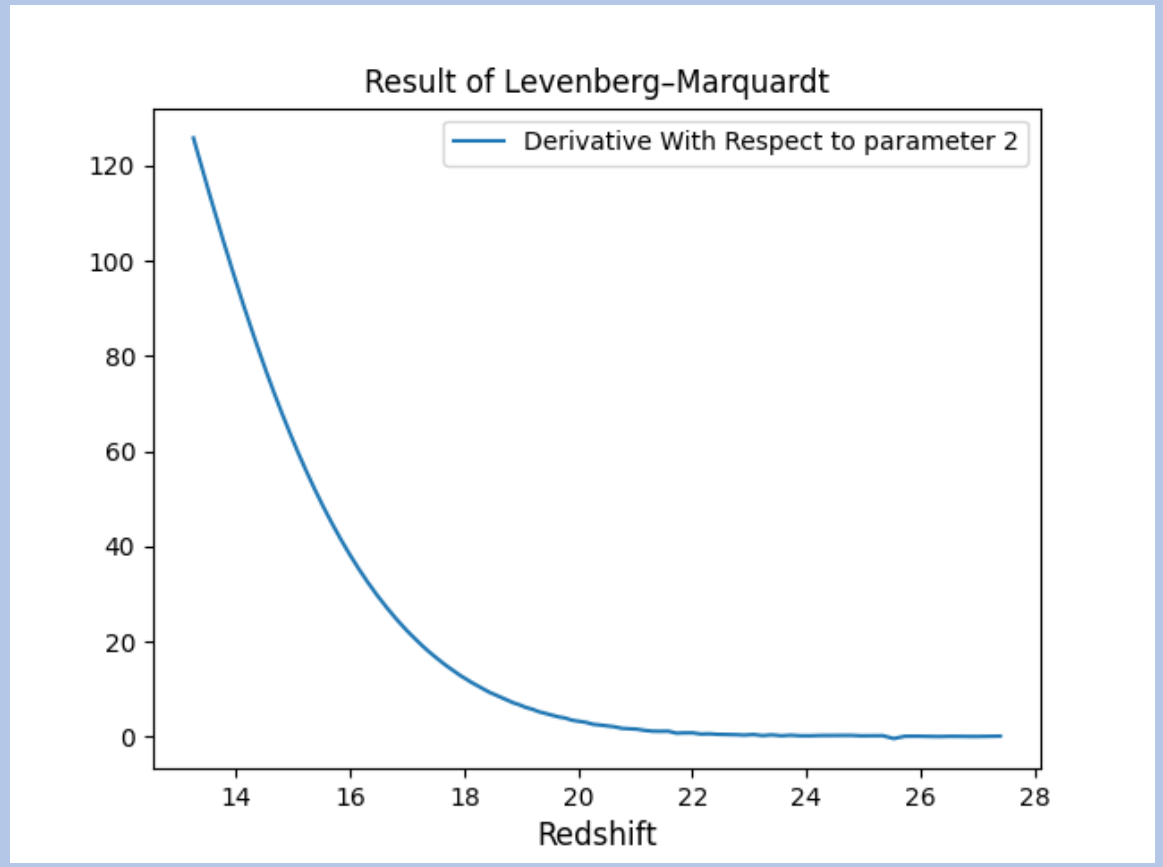
- I continued checking the Levenberg-Marquardt and make it converge
- As mentioned in the last meeting, it can fit a gaussian in a few steps, so there is a certain level of confidence in it

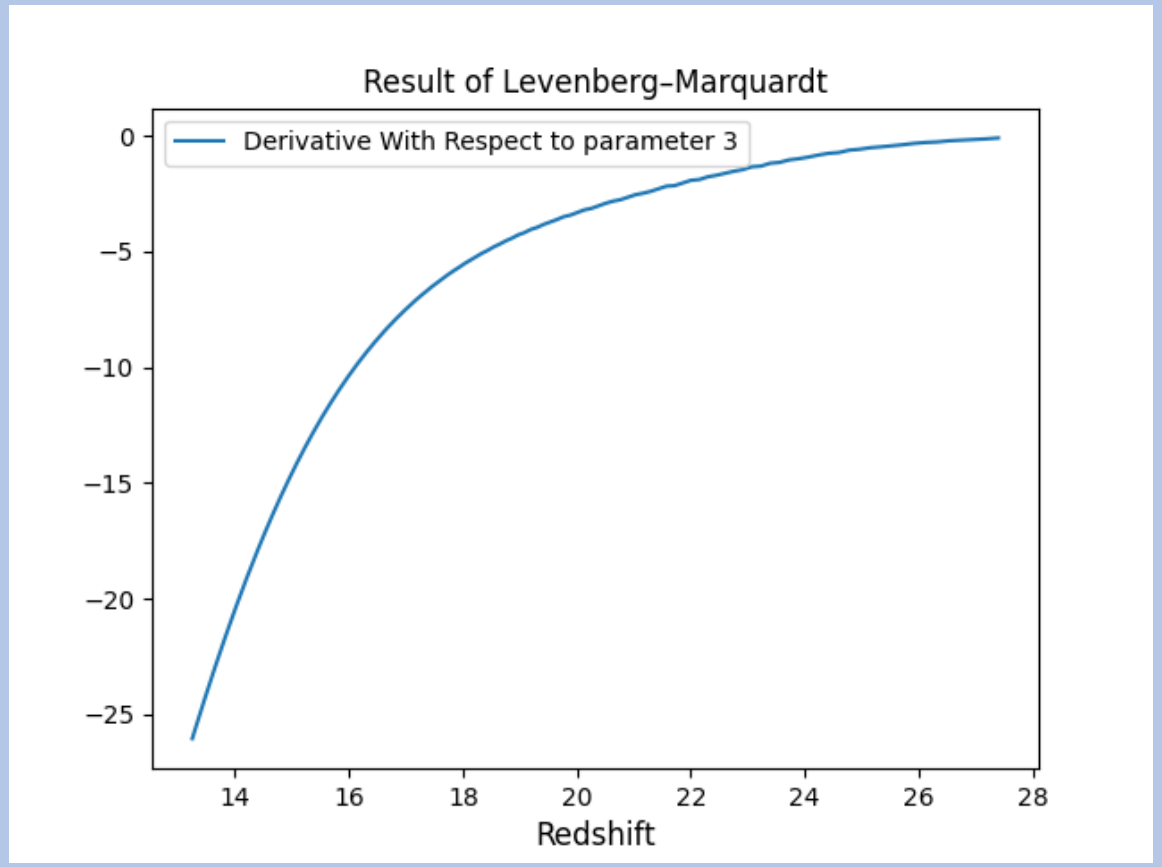
```
on iteration  0  chisq is  1301.12665204293  with step  [-3.84833162  0.29801673 -3.90835905 -2.94170175]  and lamda  0

on iteration  1  chisq is  1301.12665204293  with step  [ 2.78575931 -2.56269589 11.36311004 23.06651958]  and lamda  1

on iteration  2  chisq is  1256.8102781142484  with step  [0.01788139 0.04319891 1.5424843  0.35576182]  and lamda  0.6666666666666666

on iteration  3  chisq is  1202.9948153080268  with step  [0.02921233 0.07865494 0.69540515 1.8302011 ]  and lamda  0

on iteration  4  chisq is  1202.9948153080268  with step  [ 2.050588   -1.4885116  -0.34914871  6.68180249]  and lamda  1

on iteration  5  chisq is  1173.4831547083518  with step  [ 0.03972393  0.10405648 -0.10199425  0.32499774]  and lamda  0.6666666666666666

on iteration  6  chisq is  1150.4427244585272  with step  [ 0.03679277  0.09556392 -0.03401206  0.35540736]  and lamda  0

on iteration  7  chisq is  1150.4427244585272  with step  [ 0.6733674  -0.31019005 -0.09158164  1.97619931]  and lamda  1

on iteration  8  chisq is  1138.4372038974589  with step  [ 0.02558864  0.05870255 -0.02058331  0.18736099]  and lamda  0.6666666666666666

on iteration  9  chisq is  1125.9288721509529  with step  [ 0.03615662  0.05615219 -0.01698394  0.21508078]  and lamda  0
0.9247691917744305
Converged after  10  iterations of LM
```

Checking the local derivatives of the ARES curve with respect to the 4 parameters that I am using






Result of Levenberg–Marquardt
Derivative With Respect to parameter 2
120
100
80
60
40
20
0
14
16
18
20
22
24
26
28
Redshift


Result of Levenberg–Marquardt
Derivative With Respect to parameter 3
0
−5
−10
−15
−20
−25
14
16
18
20
22
24
26
28
Redshift

Checking on a known ARES curve

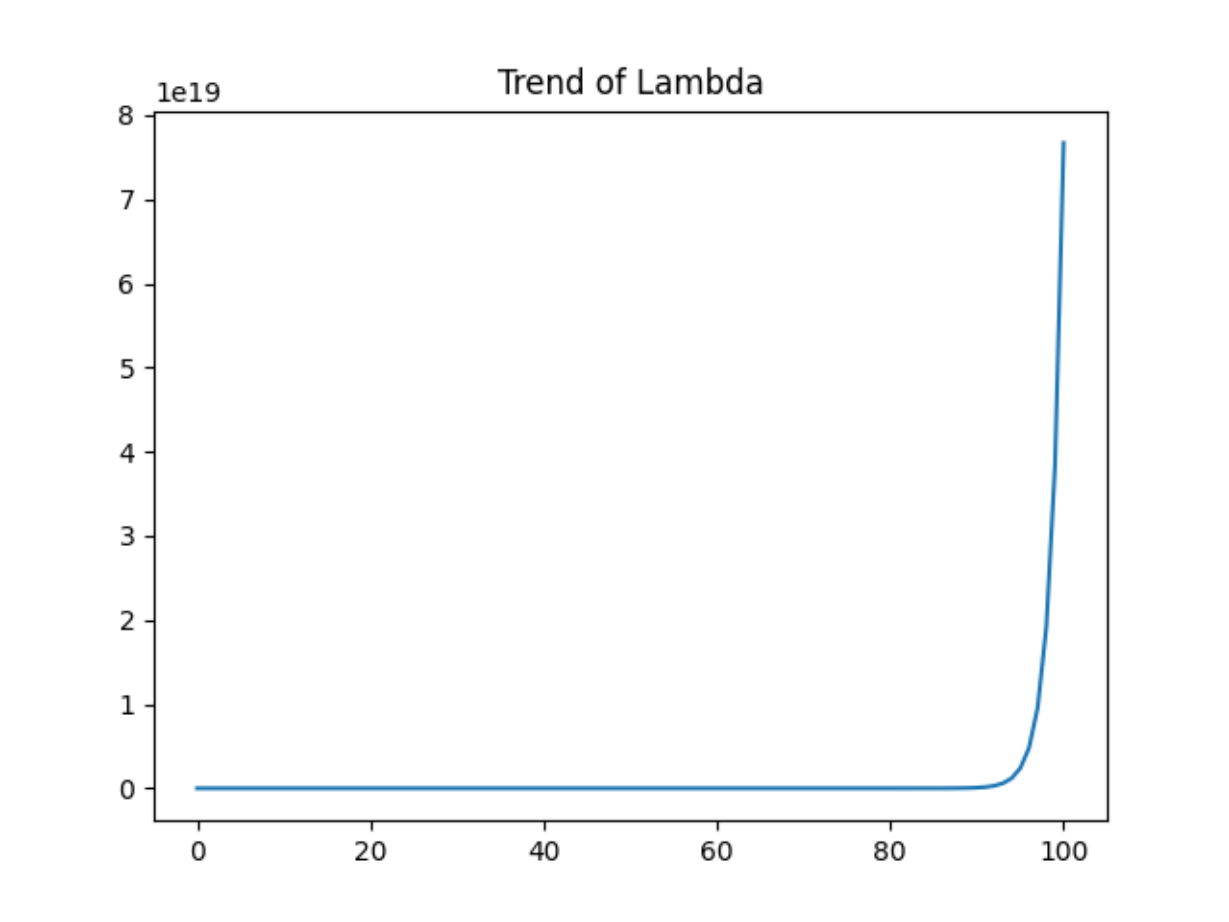
Instead of using EDGES, I used a known ARES curve as my data

```
on iteration  0  chisq is  659314.5997012766  with step  [ 7.54353909e-01 -2.30541051e+04  3.64802067e+00  4.43953061e+00]  and lamda  1
on iteration  1  chisq is  175745.6599154332  with step  [ 5.04585217e-01 -1.77554861e+04 -1.42572816e-01  1.77531875e-01]  and lamda  0.6666666666666666
on iteration  2  chisq is  31388.278969963212  with step  [ 2.49787986e-01  1.36695524e-15 -7.07196303e-02  2.00252385e-01]  and lamda  0
on iteration  3  chisq is  5381.076192602726  with step  [ 1.92146023e-01 -2.35079407e-16  7.29705897e-02  4.85526714e-01]  and lamda  0
on iteration  4  chisq is  905.6740258949205  with step  [-5.13298592e-02 -3.95442656e-15  2.37564625e-01  6.44892640e-01]  and lamda  0
on iteration  5  chisq is  122.01803833532043  with step  [ 2.93458216e-03 -3.17681571e-16  1.42610525e-02  1.49660250e-01]  and lamda  0
on iteration  6  chisq is  117.9368157615858  with step  [ 2.43857013e-04 -8.67943659e-17 -1.16564541e-04  6.98340761e-03]  and lamda  0
on iteration  7  chisq is  117.9368157615858  with step  [ 1.90212890e-04  1.09369887e-16 -2.54070678e-03 -9.34818755e-03]  and lamda  1
on iteration  8  chisq is  117.92294164350257  with step  [ 2.71290882e-06  1.93106036e-19 -1.02896098e-05 -1.20101193e-04]  and lamda  0.6666666666666666
on iteration  9  chisq is  117.92294164350257  with step  [ 1.56783716e-05 -1.54893870e-18 -4.75266177e-05 -1.74916305e-04]  and lamda  1.3333333333333333
on iteration  10  chisq is  117.92294164350257  with step  [ 9.53937063e-06 -2.18126317e-20 -2.30397050e-05 -9.04107600e-05]  and lamda  2.6666666666666665
on iteration  11  chisq is  117.92294164350257  with step  [ 5.43626313e-06 -9.33067769e-20 -1.10985660e-05 -4.66772648e-05]  and lamda  5.333333333333333
on iteration  12  chisq is  117.92179048391122  with step  [ 2.92435827e-06  8.26308633e-20 -5.36109530e-06 -2.39636976e-05]  and lamda  3.5555555555555554
on iteration  13  chisq is  117.92179048391122  with step  [ 4.81325716e-06 -1.05282174e-19  4.86336525e-06  5.25771559e-04]  and lamda  7.111111111111111
on iteration  14  chisq is  117.92179048391122  with step  [ 2.18500584e-06 -8.04494041e-20 -1.07973772e-07  2.91266194e-04]  and lamda  14.222222222222221
on iteration  15  chisq is  117.92179048391122  with step  [ 1.06313340e-06  2.08885020e-20 -9.34668299e-07  1.54836283e-04]  and lamda  28.444444444444443
on iteration  16  chisq is  117.915456246768  with step  [ 5.30753133e-07 -2.32659681e-20 -7.31324350e-07  8.00895398e-05]  and lamda  18.962962962962962
on iteration  17  chisq is  117.9151543310561  with step  [ 8.50609467e-07 -3.36057360e-21 -9.51050746e-07 -1.17778956e-05]  and lamda  12.641975308641975
on iteration  18  chisq is  117.9151543310561  with step  [ 1.25604557e-06 -1.14793231e-20 -2.00405590e-06 -1.56103252e-05]  and lamda  25.28395061728395
on iteration  19  chisq is  117.91437630940318  with step  [ 6.04315680e-07  6.08477092e-21 -9.35325841e-07 -7.98448685e-06]  and lamda  16.8559670781893
```

The chi-square decreased very great but it did not converge after 20 steps

100 step test with EDGES data

```
on iteration  0  chisq is  11217.141492467588  with step  [-4.36985678e-01 -1.90598155e+03 -6.88726983e+00 -4.07660442e+01]  and lamda  1
on iteration  1  chisq is  8477.611732084952  with step  [ -0.36025266 -11.6759714   -0.20625418   0.43160438]  and lamda  0.6666666666666666
on iteration  2  chisq is  8430.458780981218  with step  [-2.26027273e-02  8.28434229e-11 -4.98066540e-02 -6.68460323e-02]  and lamda  0
on iteration  3  chisq is  8430.458780981218  with step  [ 2.31446262e-01 -4.43798946e-07 -6.97394747e+00 -3.70511692e+01]  and lamda  1
on iteration  4  chisq is  8416.097317437894  with step  [ 5.35712032e-03 -5.36008393e-10 -1.27573730e-02 -9.24979444e-02]  and lamda  0.6666666666666666
on iteration  5  chisq is  8373.219292309563  with step  [ 4.09997303e-03 -5.98570158e-09 -3.65967745e-02 -2.94005652e-01]  and lamda  0
on iteration  6  chisq is  8373.219292309563  with step  [-2.19715606e-01  6.28774507e-06 -5.09394672e+00 -2.69308968e+01]  and lamda  1
on iteration  7  chisq is  8334.19389623
on iteration  8  chisq is  8334.19389623
on iteration  9  chisq is  8334.19389623
on iteration  10  chisq is  8331.7829553
on iteration  11  chisq is  8325.4742341
on iteration  12  chisq is  8294.8053986
on iteration  13  chisq is  8294.8053986
on iteration  14  chisq is  8294.8053986
on iteration  15  chisq is  8294.8053986
on iteration  16  chisq is  8294.8053986
on iteration  17  chisq is  8294.8053986
on iteration  18  chisq is  8294.8053986
on iteration  19  chisq is  8293.9538069
on iteration  20  chisq is  8291.2743757
on iteration  21  chisq is  8289.7200809
on iteration  22  chisq is  8286.8788036
on iteration  23  chisq is  8283.9022392
on iteration  24  chisq is  8283.9022392
on iteration  25  chisq is  8282.3618270
on iteration  26  chisq is  8278.5737901
on iteration  27  chisq is  8278.5737901
on iteration  28  chisq is  8276.9569191
on iteration  29  chisq is  8269.9539638
on iteration  30  chisq is  8269.3063144
on iteration  31  chisq is  8269.3063144
on iteration  32  chisq is  8269.3063144
on iteration  33  chisq is  8269.3063144
on iteration  34  chisq is  8268.9010233
on iteration  18  chisq is  8294.805398601353  with step  [ 6.21127179e-05 -4.70342079e-11 -1.56759733e-03 -1.52398011e-01]  and lamda  50.5679012345679
on iteration  19  chisq is  8293.95380695186  with step  [ 6.59216169e-05 -1.17993082e-11 -6.93654553e-04 -7.75762622e-02]  and lamda  33.7119341563786
on iteration  20  chisq is  8291.274375701501  with step  [ 3.61532784e-04  3.74317059e-12 -1.55041253e-03 -3.00247936e-03]  and lamda  22.474622770919066
on iteration  21  chisq is  8289.720080904639  with step  [-1.09909828e-04  1.49440682e-12 -1.34648020e-03 -1.09339830e-02]  and lamda  14.983081847279378
on iteration  22  chisq is  8286.87880360353  with step  [ 5.86147250e-05 -1.07288053e-11 -2.63453128e-03  1.54060461e-02]  and lamda  9.988721231519586
on iteration  23  chisq is  8283.902239223242  with step  [-8.06643011e-04 -3.92935206e-12 -2.12320080e-03  1.33699087e-02]  and lamda  6.659147487679724
on iteration  24  chisq is  8283.902239223242  with step  [-6.03709194e-03 -1.30285093e-10 -1.12261384e-03 -6.54492896e-02]  and lamda  13.318294975359448
on iteration  25  chisq is  8282.361827042996  with step  [-1.44129774e-03 -4.08863760e-11 -1.57302577e-03 -3.47803319e-02]  and lamda  8.8788633169063
on iteration  26  chisq is  8278.573790101367  with step  [-3.21253980e-04 -1.48036736e-11 -2.80848553e-03  2.34866047e-02]  and lamda  5.919242211270866
on iteration  27  chisq is  8278.573790101367  with step  [-5.77068862e-03 -9.49847725e-11  6.47692278e-04 -7.61702051e-02]  and lamda  11.838484422541732
on iteration  28  chisq is  8276.956919130731  with step  [-1.27716480e-03 -3.00786876e-11 -1.04294467e-03 -4.07133776e-02]  and lamda  7.892322948361155
on iteration  29  chisq is  8269.953963845637  with step  [ 2.00569263e-03 -3.91692941e-11 -5.65616895e-03 -2.08790302e-02]  and lamda  5.26154863224077
on iteration  30  chisq is  8269.30631441257  with step  [-1.99054564e-03 -1.07804381e-11 -1.84781925e-03  2.86564542e-02]  and lamda  3.5076990881605137
on iteration  31  chisq is  8269.30631441257  with step  [-6.55034912e-03 -5.04258181e-12  8.49454131e-03  2.11193468e-02]  and lamda  7.015398176321027
on iteration  32  chisq is  8269.30631441257  with step  [-1.32304729e-03  7.19354853e-13  1.87901320e-03  1.15338579e-02]  and lamda  14.030796352642055
on iteration  33  chisq is  8269.30631441257  with step  [6.59179748e-05 6.74661086e-13 1.09028111e-04 6.10170221e-03]  and lamda  28.06159270528411
on iteration  34  chisq is  8268.901023314309  with step  [ 2.60707461e-04  2.58907361e-13 -1.97587842e-04  3.15162312e-03]  and lamda  18.707728470189405
on iteration  35  chisq is  8268.901023314309  with step  [ 1.37820740e-04 -2.04739947e-12 -1.09947604e-03  9.21805705e-03]  and lamda  37.41545694037881
on iteration  36  chisq is  8268.901023314309  with step  [ 2.10780974e-04 -5.92099482e-13 -6.81615744e-04  4.73728415e-03]  and lamda  74.83091388075762
on iteration  37  chisq is  8268.901023314309  with step  [ 1.44328104e-04 -1.59505380e-13 -3.76549082e-04  2.40340931e-03]  and lamda  149.66182776151524
on iteration  38  chisq is  8268.901023314309  with step  [ 8.23782689e-05 -4.14150969e-14 -1.97591288e-04  1.21076889e-03]  and lamda  299.3236555230305
on iteration  39  chisq is  8268.901023314309  with step  [ 4.38058666e-05 -1.05529964e-14 -1.01174937e-04  6.07699449e-04]  and lamda  598.647311046061
on iteration  40  chisq is  8268.901023314309  with step  [ 2.25652249e-05 -2.66367852e-15 -5.11887154e-05  3.04434753e-04]  and lamda  1197.294622092122
on iteration  41  chisq is  8268.901023314309  with step  [ 1.14492125e-05 -6.69083096e-16 -2.57454826e-05  1.52364428e-04]  and lamda  2394.589244184244
on iteration  42  chisq is  8268.901023314309  with step  [ 5.76638552e-06 -1.67682336e-16 -1.29106248e-05  7.62190769e-05]  and lamda  4789.178488368488
on iteration  43  chisq is  8268.901023314309  with step  [ 2.89365379e-06 -4.19736881e-17 -6.46479611e-06  3.81187667e-05]  and lamda  9578.356976736975
on iteration  44  chisq is  8268.901023314309  with step  [ 1.44944418e-06 -1.04960106e-17 -3.23477059e-06  1.90616920e-05]  and lamda  19156.71395347395
on iteration  45  chisq is  8268.901023314309  with step  [ 7.25376666e-07 -2.62566774e-18 -1.61797863e-06  9.53142335e-06]  and lamda  38313.4279069479
on iteration  46  chisq is  8268.901023314309  with step  [ 3.62852008e-07 -6.56169988e-19 -8.09137673e-07  4.76585604e-06]  and lamda  76626.8558138958
on iteration  47  chisq is  8268.901023314309  with step  [ 1.81466927e-07 -1.64850702e-19 -4.04605929e-07  2.38296411e-06]  and lamda  153253.7116277916
on iteration  48  chisq is  8268.901023314309  with step  [ 9.07436948e-08 -4.08447075e-20 -2.02312238e-07  1.19149108e-06]  and lamda  306507.4232555832
on iteration  49  chisq is  8268.901023314309  with step  [ 4.53744053e-08 -1.03622622e-20 -1.01158438e-07  5.95747796e-07]  and lamda  613014.8465111664
on iteration  50  chisq is  8268.901023314309  with step  [ 2.26878421e-08 -2.58107578e-21 -5.05797984e-08  2.97874462e-07]  and lamda  1226029.6930223329
on iteration  51  chisq is  8268.901023314309  with step  [ 1.13440809e-08 -6.26569631e-22 -2.52900441e-08  1.48937372e-07]  and lamda  2452059.3860446657
on iteration  52  chisq is  8268.901023314309  with step  [ 5.67208043e-09 -1.41753504e-22 -1.26450583e-08  7.44687213e-08]  and lamda  4904118.772089331
on iteration  53  chisq is  8268.901023314309  with step  [ 2.83605021e-09 -5.24847226e-23 -6.32253820e-09  3.72343695e-08]  and lamda  9808237.544178663
```


Trend of Lambda
1e19
8
7
6
5
4
3
2
1
0
0
20
40
60
80
100

An idea

Can we add some amount of noise to our data and check if our algorithm converges with this noisy data?

Thus, we can state that if future experiments observe data close to this, we will be able to fit it.

Other points

- Any other resources to read more about the algorithm
- Chapters of my thesis
- Applications (earliest deadline: Dec 1)