Assignment 3 Curve Fit

In this Assignment, we performed curve fitting on three datasets: Dataset 1, Dataset 2, and Dataset 3.

Dataset 1

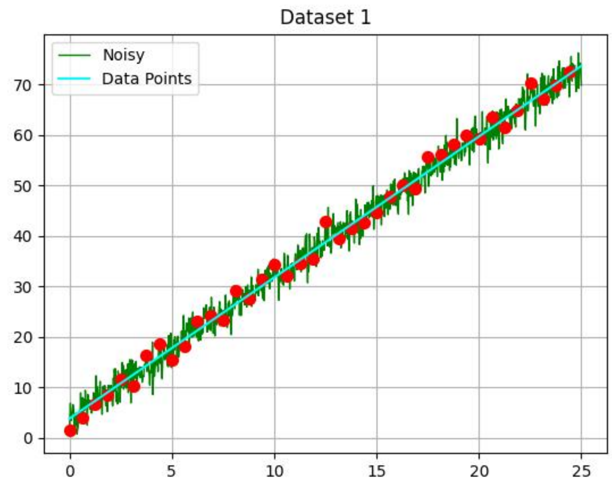
Curve fit for a data with noise representing a straight line

- For the dataset 1 we were told it was a straight line with some noise added to it.
  - We have a number of observations $g1, g2, ..., gn$ of this function at different time instants $t1, t2, ..., tn$. These observations can

$$\mathbf{g} \equiv \begin{pmatrix} g_1 \\ g_2 \\ \vdots \\ g_n \end{pmatrix} = \begin{pmatrix} t_1 & 1 \\ t_2 & 1 \\ \vdots & \vdots \\ t_n & 1 \end{pmatrix} \begin{pmatrix} p_1 \\ p_2 \end{pmatrix} \equiv \mathbf{Mp}$$

    then be written as:

- The curve fit estimation is done by assuming it to be a `straight line with noise` then using the `least squares curve fitting` method to estimate the curve.
- The `M matrix` here is constructed in the same way as shown in the `curvefit` notebook.
- After generating the `M matrix`, we pass that matrix to the python function `numpy.linalg.lstsq` to get the 2 unknown parameters `m and c` of the estimated line `y = mx + c`.
  - The values i got were `m = 2.791124245414918` and `c = 3.8488001014307436`.



- The graph is

Dataset 2

Curve fit for sum of 3 sin waves with some noise and offset

- For the dataset 2 we were given that it is of the form `y = A0 + A1 * sin(wx) + A2 * sin(3wx) + A3 * sin(5wx)` where $w = 2\pi/T$ is the angular frequency.
- This estimation was done via 2 methods:-

1. Linalg.lstsq function:

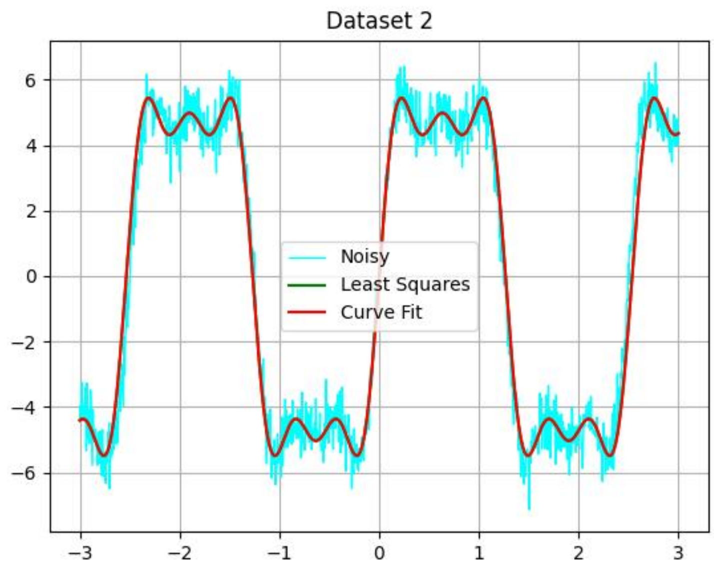
- To estimate this `p values` in this method we had to first get the `time period` of the graph.
- This was done roughly via the logic that for a sum of sin wave the max value and the largest -ve value are equal in magnitudes if the offset is 0 and are a distance of `T/2`.
- Once we get `T` we try to form the `M matrix` of row length = no of datapoints.

$$m = \begin{pmatrix} 1 & sin(wx1) & sin(3wx1) & sin(5wx1) \\ 1 & sin(wx2) & sin(3wx2) & sin(5wx2) \\ . & . & . & . \\ . & . & . & . \\ . & . & . & . \end{pmatrix}$$

- After this just using the function to get the parameters as `p0 = -0.02587519 p1 = 5.99504337 p2 = 1.96486465 p3 = 0.97681364` and `T = 2.5349`

2. Curve_fit function:

- For this function we have the unknown parameters as `p0, p1, p2, p3 and T`.
- We input this in the curve_fit function with some `initital guess`.
- For the parameters for which `y depends on linearly (like all p values)`can be given anything as an initial guess but for `T` we need to give a close value for the `curve_fit function to converrge`.
- The parameter values are `p0 = -0.02587519 p1 = 5.99504337 p2 = 1.96486465 p3 = 0.97681364 T = 2.50053687`



- The graph for the dataset 2 is:

Dataset 3

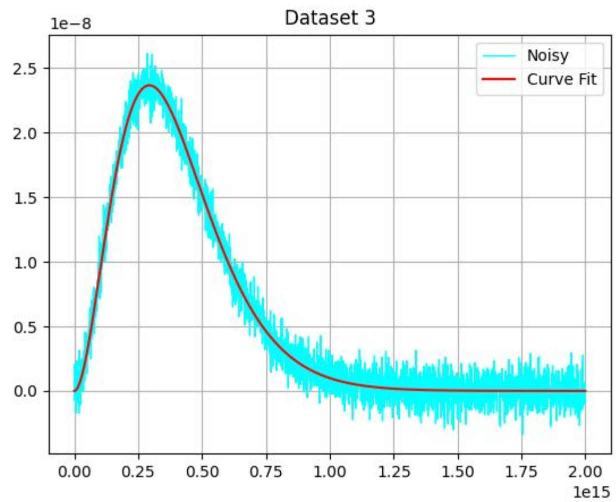
Curve Fit for a data representing the Black Body Radiation

- This dataset or program had two parts

Part 1 - Curve fit to Find only T

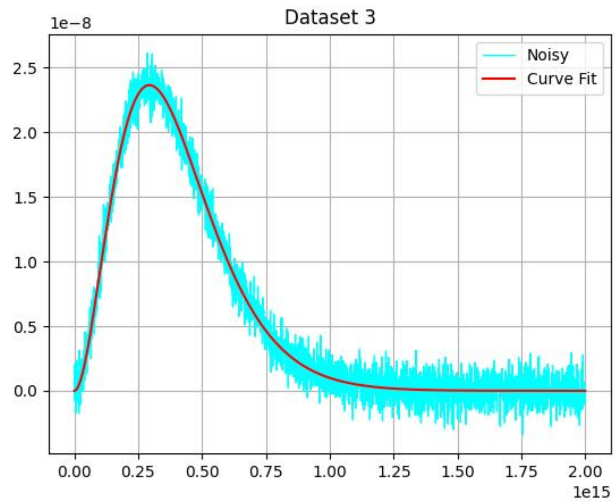
- In part 1 we only have to find the `Temparature T` for the given dataset comprised of the `Black Body Radiation value Y` and `Frequency X` of the radiation.
- The formula is $B(f,T) = \frac{2hf^3}{c^2}\frac{1}{e^{(\frac{hf}{tk}-1)}}$.

- Here T is the only unknown parameter and its initial guess was given as 1000K.
- From the curve_fit function the Temp `T = 4997.341993867475 K`
- The graph is



Part 2 - Curve fit to find all h, c, k, T

- Here we tried to get the values of the constants `h, c, k` as well from the curve fit function.
- The formula $B(f,T) = \frac{2hf^3}{c^2}\frac{1}{e^{(\frac{hf}{tk}-1)}}$ can be reduced to $B(f,T) = p1f^3\frac{1}{e^{(p2f-1)}}$ where $p1 = \frac{2h}{c^2}$ and $p2 = \frac{h}{tk}$.
- Since we are using curve fit to find `h, c, k and T` the values we get are not accurate even if we give very inital guess is beacuse the above formula effectively has only `2 parameters`.
- So after getting the values of `h, c, k and T` and find `p1` and `p2` we will notice that it is equal to the actual ratio of the quantities.
- This simply means there are many values of `h, c, k and T` which can be given by the curve fit funtion but the ratio $p1 = \frac{2h}{c^2}$ and $p2 = \frac{h}{tk}$ will always be the same.
- Only when we give initial guess as their own value we get almost similar value.
- The values of `h, c, k and T` from the curve fit are `h = 4.03731445e-33, c = 7.41369653e+08, k = 2.98992780e-23, T = 1.40735360e+04`.


Dataset 3
1e−8
2.5
2.0
1.5
1.0
0.5
0.0
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
1e15
Noisy
Curve Fit

- The graph is