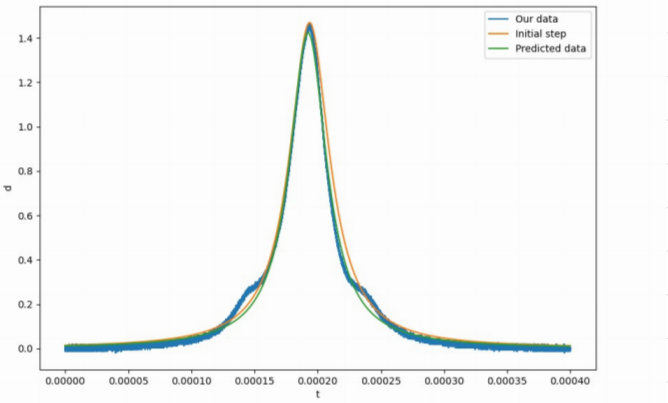
Assignment 4:

1) a)

Our best fit parameters are:

$a = 1.423$
$w = 1.792 \times 10^{-5}$
$t_0 = 1.924 \times 10^{-4}$



The standard error on the fit is

0,016

b) Our formula for the noise is:

$$\text{noise} = \text{Standard deviation}\left(|\text{prediction} - \text{actual data}| \right)$$

We have:

$$\langle \delta_m \delta_m^T \rangle = \left(A^T N^{-1} A \right)^{-1} \quad \text{with} \quad N^{-1} = \text{noise} \cdot \text{Identity}$$

Hence error on parameters is:

$$\text{err} = \sqrt{\text{diagonal}\left(\langle \delta_n \delta_m^T \rangle \right)}$$

Therefore: error on a is 2.730×10^{-4}

error on w is 4.869×10^{-9}

error on t_0 is 3.438×10^{-9}

c) Using numerical derivatives such that

$$f'(x) = \frac{f(x+h) - f(x-h)}{2h} \qquad \text{with} = 1\times10^{-6}$$

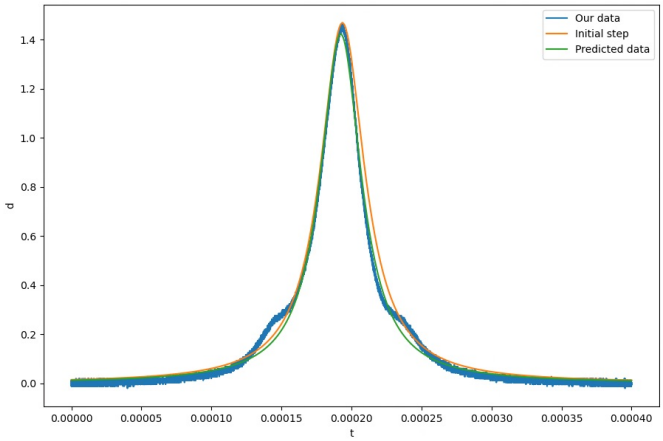
We get $a = 1.422$

$w = 1.792 \times 10^{-5}$

$t_0 = 1,924 \times 10^{-4}$

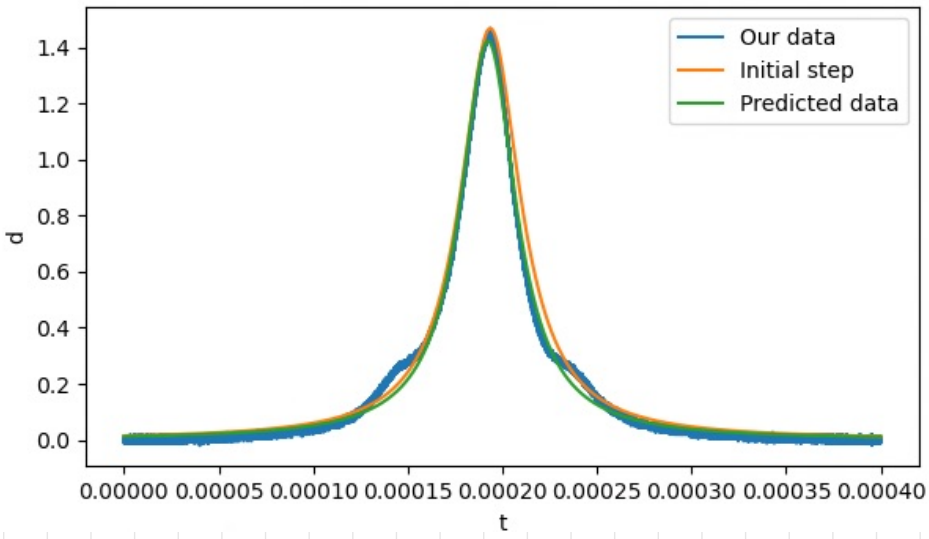
The standard error on the fit is 0,025.

It is larger than in 2)



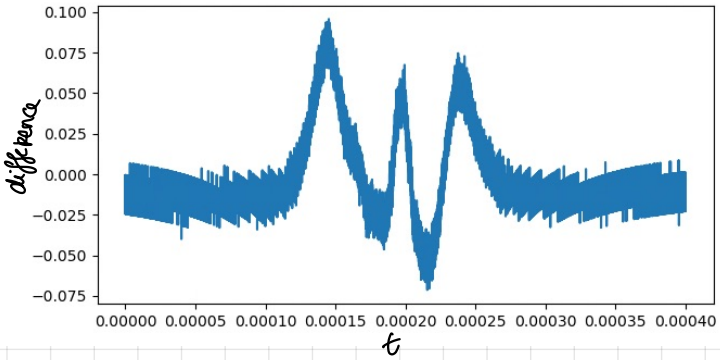
d) Using three lorentzian we get

$a = 1,423 \pm 2,73\times10^{-4}$
$w = 1.79\times10^{-5} \pm 4.873\times10^{-9}$
$t_0 = 1,92\times10^{-4} \pm 3.44\times10^{-9}$
$b = -5,37\times10^{-2} \pm 8.16\times10^{-13}$
$c = -5.37\times10^{-2} \pm 8.16\times10^{-12}$



e) By plotting the residuals we get:

This shows us that our fit for the data is wrong. We don't have a uniform variance. It is not a complete description of the data.



g) Using MCMC we get:

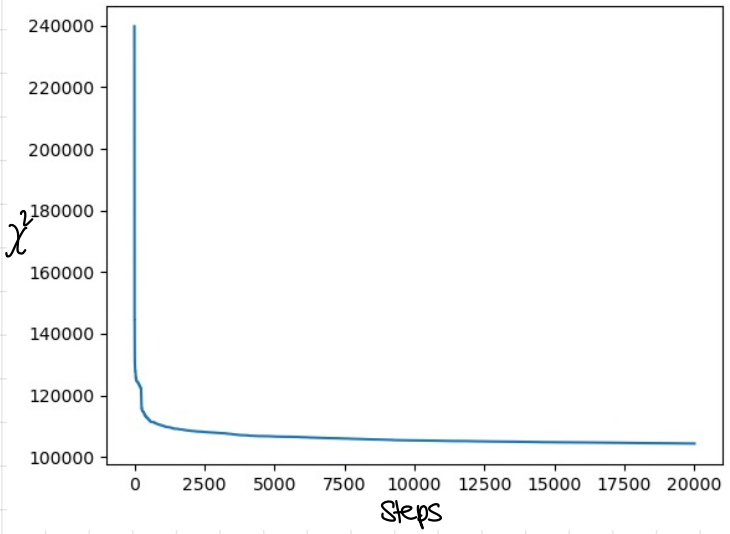
We have that χ^2 decreased to settle at around 10000 which is about the number of points we want to fit. It implies that that our chain converged.

Our errors bars, however, increased:

error on a is 3.66

error on t_0 is 1.792×10^{-6}

error on w is 2.176×10^{-6}



h)