Exercise: Parameters of an FID Signal

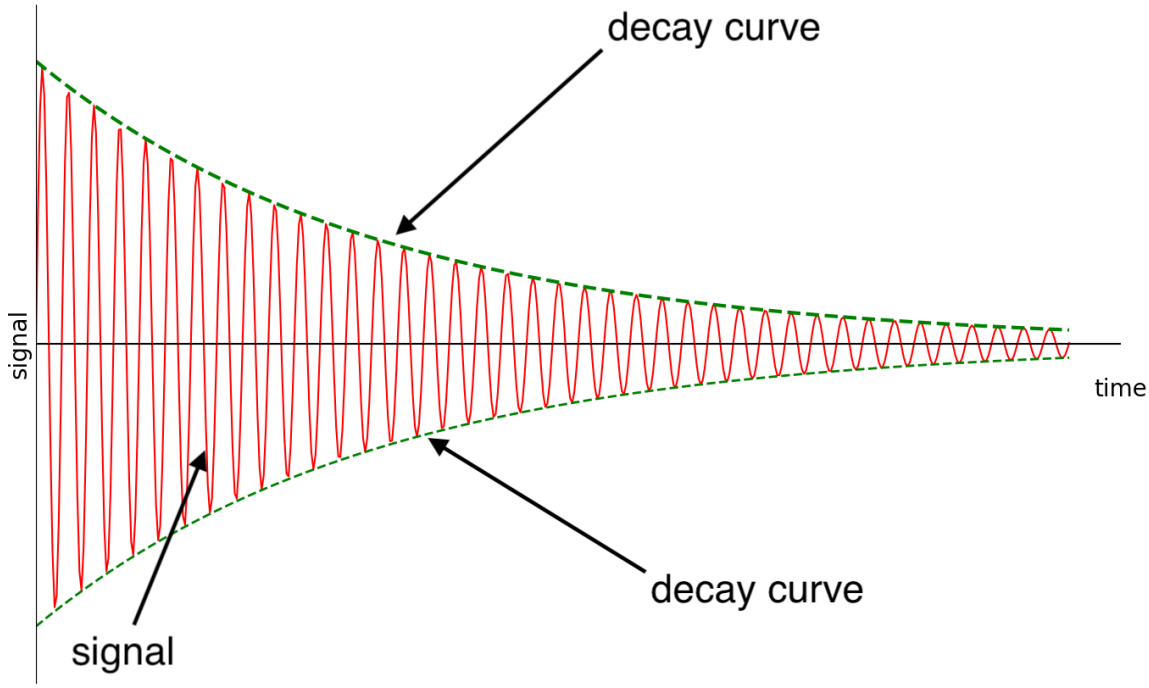
In this exercise, we will find the optimized parameters of a raw FID signal.

WE'LL COVER THE FOLLOWING

Task

In Fourier transform nuclear magnetic resonance spectroscopy, free induction decay (**FID**) is the observable Nuclear Magnetic Resonance (**NMR**) signal generated by non-equilibrium nuclear spin magnetization precessing about the magnetic field. The signal has decayed oscillations and is defined by the equation:

$$y(t) = [sin(2\pi f_o t)]e^{-\alpha t}$$



Decay curves are given by the equation:

$$e^{-\alpha t} \text{ and } -e^{-\alpha t}$$

In this exercise, you are given raw data directly from an NMR system and will fit the curve to reduce RMSE and find the unknown coefficients: f_o and α.

Problem statement

The raw data is stored in the variable `data` and its corresponding time data is stored in the variable `time`. The `numpy` module has already been imported as `np`.

Use `data`, `time` and the equation of the FID signal to find the unknown coefficients f_o and α and plot the fitted curve.

> 💡 Keep in mind that you might need to alter the initial guesses for the fitting to work. Click below if you need a head start.

Get a Head Start

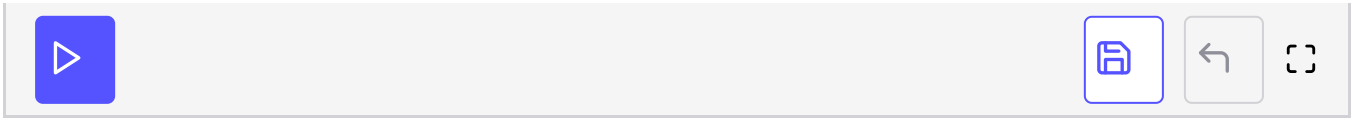
You can use the `RMSE` utility function to calculate and minimize the root mean square error.

Also, plot the decay curves with `linetype = '--'` and `linewidth = 3` .

> 💡 The figure and axis configuration have been given to you to for a better visualization.

```
from scipy.optimize import curve_fit
import matplotlib.pyplot as plt

def RMSE(y1, y2):
  return (np.square(np.subtract(y1, y2))).mean

# function for FID signal
  # write your code here

# figure and axes settings
```

```
fig = plt.figure(figsize=(16 , 16))
axes = fig.add_axes([0.1, 0.3, 0.8, 0.4])
axes.set_xlabel('time', fontsize='20')

axes.set_ylabel('signal', fontsize='20')
axes.tick_params(axis="both", labelsize=18)
axes.set_xlim(0, max(time))
axes.set_ylim(-1, 1)

# plotting raw data
axes.plot(time, data, '.', color='b', label='observed')

# plotting fitted data
  # write your code here

# plotting decay curves
  # write your code here

# setting legend
axes.legend(loc='best', fontsize='xx-large')

# print RMSE
  # write your code here

# saving the figure
fig.savefig('output/fid.png')
```



Show Actual Parameters

The solution to this exercise will be discussed in the next lesson.