Linear Regression Fit to Data

Purpose: Fit data using linear regression least squares method for both a Linear function and a Power Law function.
Algorithm. Enable the user to fit data to both a linear and a power law function.

Here is a data set for CO_2 levels in the World over a range of years.

year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
CO2 level ppm	316.5	320	325	331	338	346	353	360	368.5	378

The supplied data file used for the fits, CO2.txt shown below, is the same data as above but 1960 has been subtracted from each of the years and 316.5 has been subtracted from each CO2 level. In other words, 1960 is the start year and levels are measured relative to what it was in that year. This is done to reduce the size of products and sums that occur in the least-squares formulas and increase to accuracy of the results.
CO2.txt

year	5	10	15	20	25	30	35	40	45
CO2 level ppm	3.5	8.5	14.5	21.5	29.5	36.5	43.5	52	61.5

1. **Fit to a Linear function y = mx + c**

In the linear case you are fitting the CO2.txt data to the straight line y = mx + c, where y represents the CO2 level and x represents the year in the file CO2.txt and m and c are constants. Solve these equations using the least-squares linear regression formulas in the lecture notes to get to get solutions for m and c. Using the fit, offer the user the option of interpolating/extrapolating the data by including the (1960, 316.5) offsets to the formula you calculate.

2. **Fit to a power law $y = ax^b$.**

In this case you are fitting the data to the power law $y = ax^b$ where y represents the CO2 level and x represents the year in the file CO2.txt and a and b are constants. To do a linear regression the data need to be transformed as dicussed in class notes. With the transformed data solve the least-squares linear regression formulas in the lecture notes to get solutions for a and b. Then using the power law formula, offer the user the option of interpolating/ extrapolating the data by including the (1960, 316.5) offsets to the formula you calculate.

Example Output

```
        LEAST_SQUARES LINEAR REGRESSION
MENU
 1. Linear Fit
 2. Power Law Fit
 3. Quit
2
Please enter the name of the file to open: CO2.txt
There are 9 records.
y = 0.43x^1.31
MENU
 1. Interpolate/Extrapolate
 2. Main Menu
 1
Please enter the year to interpolate/extrapolate to: 2020
The power law interpolated/extrapolated CO2 level in the year 2020.0 is 405.99
MENU
 1. Interpolate/Extrapolate
 2. Main Menu
 1
Please enter the year to interpolate/extrapolate to: 1968
The power law interpolated/extrapolated CO2 level in the year 1968.0 is 322.94
MENU
 1. Interpolate/Extrapolate
 2. Main Menu
 2

        LEAST_SQUARES LINEAR REGRESSION
MENU
 1. Linear Fit
 2. Power Law Fit
 3. Quit
1
Please enter the name of the file to open: CO2.txt
There are 9 records.
y = 1.45*x + -6.18
MENU
 1. Interpolate/Extrapolate
 2. Main Menu
 1
Please enter the year to interpolate/extrapolate to: 2020
The linear interpolated/extrapolated CO2 level in the year 2020.0 is 397.42
MENU
 1. Interpolate/Extrapolate
 2. Main Menu
 1
Please enter the year to interpolate/extrapolate to: 1968
The linear interpolated/extrapolated CO2 level in the year 1968.0 is 321.93
MENU
 1. Interpolate/Extrapolate
 2. Main Menu
```