Activity: Fitting the sea level changes – linear models

The world's oceans have a two-way relationship with weather and climate. The oceans influence the weather on both local and global scales, and changes in climate can also alter many properties of the ocean.

A data file from the EPA (United States Environmental Protection Agency) contains data on sea level changes, which refer to the height of the ocean surface changes, over time[1].

Get the data set (sea-level_fig-1.csv) containing Global Average Absolute Sea Level Change, 1880–2021 from the EPA website https://www.epa.gov/climate-indicators/climate-change-indicators-sea-level

The first field of the data set contains the year, and the second field contains the adjusted sea level values in inches.
You will use Python to visualize and fit the sea level data.

In a script called **A21-sea-level.py**, do the following:

Note: Use vectorization and DO NOT USE LOOPS/COMPREHENTION ANYWHERE.

a. Use pandas. Read in the data, and only include the necessary fields (1st and 2nd).
   Notice that the data set contains missing value in the first two fields, which you need to remove it.
   Store the year and the adjusted sea level in two separate variables.

b. Convert the sea level values from inches to centimeters (1 inch corresponds to 2.54 cm).

c. Visualize the raw data by plotting the sea level (in cm) vs. the year. Set figure size to (6,4) and font size to 12 and label the axis.

d. Fit the sea level (in cm) vs. the year using a 1-degree polynomial, y=ax+b.
   Year should be the independent variable, and sea level the dependent variable.
   Print to screen the fitted model function and fitted parameters.

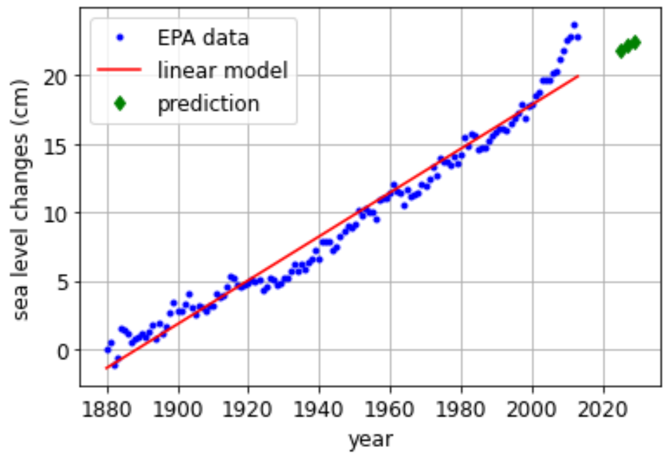
e. Calculate the R2 and print it to screen. Is the linear model good?

f. Make a prediction of the sea level for years 2025 to 2070 (use a step of 5) based on the linear model you created in part (d) and store the predicted value in a variable. Do not hardcode the fitted model.

g. Add the fitted model, and the prediction to the same Axes Object (same plot)

h. Save the figure in jpeg format with 200dpi resolution (Fig_sea.jpg).

[1] www.epa.gov/climate-indicators



Activity: Calculate and Visualize Errors

Experiment Description:

Data from a sound velocity experiment conducted at three different temperatures (10°C, 20°C, and 30°C) is provided in the file **sound_data.txt.** In this experiment, the velocity of sound was determined using a resonance method. For each temperature, five trials were conducted to measure the velocity of sound.

The data file is a rectangular array of numerical values.
Each row corresponds to a different temperature, and each column after the first represents a trial for that temperature. The first field in each row reports the temperature in Celsius, while the subsequent fields (2nd to 6th) report the velocity of sound in meters per second (m/s) for each trial (there are 5 trials)

After collecting the data, the researcher identified an offset in the instrument calibration, resulting in a systematic error of +2 m/s in the velocity values.

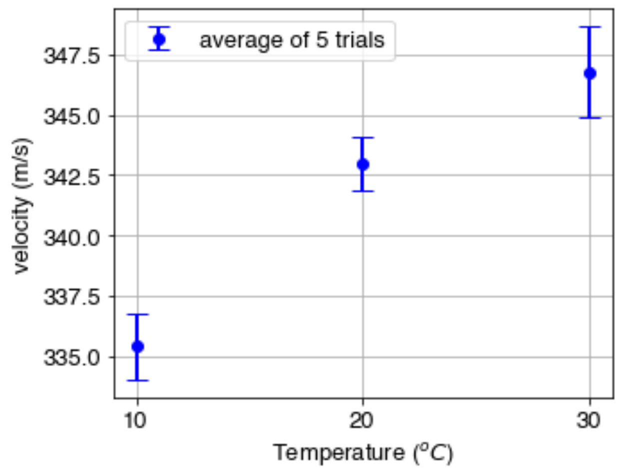
In this exercise (in a script called **A21-sound-error.py**), you should first subtract the systematic error from the velocity values, then calculate the average velocity and its standard error for each temperature and make this error bar.

Calculate the standard error (SE):

$$SE = \frac{\sigma}{\sqrt{N}}$$

where σ is the standard deviation and N is the number of trails.

Use the Matplotlib function ***errorbar()*** to plot in x axis the temperature and in the y axis the mean velocity $\pm$ standard error. Try to format the figure as the one reported below.



Submit to A21:

A21-sea-level.py

A21-sound-error.py