Steps and specific functions of the code:

1. Reads data from the files in the folders /input_files/compared_files and /input_files/referent_files.
The code is meant to work with one referent and multiple compared files

- Splits each line according to the separator given in the config file
- Multiplies the value and its uncertainty by the multipliers given in the config file.
- Takes the time and the value (and its uncertainty) by indexes (the column numbers), parses them to datetime and float and combines them in an object (data point).

  Datapoint = (t, x, σ_x),

  where σ_x is the absolute uncertainty if it's found in the input file or zero.
- Returns a list of data points for each file.
- Rows for which parsing is unsuccessful are skipped

2. If not given the start and end of the interval are set according to these in the referent file.

3. Looks for the detector serials in the file title and file content (the detector type is known from the config)

4. Prepares the intervals for which values will be averaged using the start time t_0 and the interval length Δt provided in the config. The start time of the k-th interval is:

$$T_k = T_0 + k\Delta t$$

5. Averages the values for the given intervals:

- Filters on the data are applied as set in the config:
  - 'Zero' filter: transmits if $x \neq 0$
  - Thresholds: transmits if $thr_{min} < \bar{x} < thr_{max}$

    where $\bar{x} = \frac{\sum_{i=1}^{N} x_i}{N}$ is the average of all values in the interval and thr_{min} and thr_{max} are set in the config.

  - 'Jumps' filter (removes intervals with sharp changes in value):

    Transmits if $x_{max} - x_{min} < 0.5\bar{x}$???

    where x_{max} and x_{min} are the minimum and maximum value in the interval

- Estimates average value by two approaches (one is chosen in the config):
  - 'inside' – average of all values in the interval. For the k-th interval:

$$\bar{x}_k = \frac{\sum_{i=1}^{N} x_i}{N}$$

  - 'weighted' – weighted average of the values in the interval + the following value. The weights are equal to the cross section of the measurement interval and the interval over which the values are averaged:

$$\bar{x}_k = \frac{\sum_{i=1}^{N+1} w_i x_i}{\sum_{i=1}^{N+1} w_i}$$

$$\text{where } w_i = (t_i, t_{i+1}) \cap (T_k, T_k + \Delta t) \quad \text{and} \quad \sum_{i=1}^{N+1} w_i = \Delta t$$

Note: The weighted average is not recommended for RadonEYE neither in auto (10-minute), nor in manual (60-minute) mode. In auto mode the recorded measurements are not equidistant and some are not recorded at all. In the manual mode the recorded measurement is actually the last of the 10 minute measurement for the 60 minute interval.

In the auto mode the *i*-th measurement interval duration may vary. For lack of better assumption, it is accepted that the reported value is true for the whole interval between the two recordings. Another possible assumption is that value readings are equidistant, but some of them are recorded at different times. However, such an approach will lead to problems with values that are never recorded.

A small modification in the last formula is made when the recording following these in the interval is not in the next interval, but after a longer time (i.e. when many auto recordings are skipped). Then the last value in the interval is taken with a bigger weight – till the end of the interval.

- If no value is available for the interval, the interval is skipped for the given detector.

- Estimates the uncertainty of the average by three approaches (one is chosen in the config):
  - As a standad deviation of the average or the weighted – 'stdev':

$$\sigma_{\bar{x}} = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N(N-1)}} \quad \text{or} \quad \sigma_{\bar{x}} = \sqrt{\frac{\sum_{i=1}^{N+1} w_i (x_i - \bar{x})^2}{N \sum_{i=1}^{N+1} w_i}}$$

  - As a propagation of the uncertainties of the values – 'propagation':

$$\sigma_{\bar{x}} = \frac{\sqrt{\sum_{i=1}^{N} {\sigma_i}^2}}{N} \quad \text{or} \quad \sigma_{\bar{x}} = \frac{\sqrt{\sum_{i=1}^{N+1} (w_i \sigma_i)^2}}{\sum_{i=1}^{N+1} w_i}$$

  - As the bigger of the two for each interval – 'max'.
- Corrects for background and takes into account its uncertainty (set in the config for each detector type):

$$x_{k,net} = \bar{x}_k - x_b$$
$$\sigma_{x_{k,net}} = \sqrt{\sigma_{\bar{x}_k}^2 + \sigma_{x_b}^2}$$

- Values that are negative after background correction are set to zero. If 'zero' filter is active, such data points are removed.

- Returns a list with averaged data – Datapoint = (T_k, $x_{k,net}$, $\sigma_{x_{k,net}}$) for each input file

6. Prepares couples of data points for comparison

- Combines values of the referent (x^{ref}) and the compared detector (x) in the same interval and returns an object Datacouple:

Datacouple(T_k, ${x^{ref}}_{k,net}$, ${\sigma_{x^{ref}}}_{k,net}$, $x_{k,net}$, $\sigma_{x_{k,net}}$, r, σ_r)

where r is the ratio of the referent to the compared value:

$$r = \frac{{x^{ref}}_{k,net}}{x_{k,net}},$$

$$\sigma_r = r\left(\left(\frac{{\sigma_{x^{ref}}}_{k,net}}{{x^{ref}}_{k,net}}\right)^2 + \left(\frac{\sigma_{x_{k,net}}}{x_{k,net}}\right)^2\right)$$

If $x_{k,net} = 0$ or ${x^{ref}}_{k,net} = 0$ the ratio and the uncertainty are set to None.

- Skips intervals in which one of the detectors doesn't have a value
- Returns a list of data couples for each compared detector
- Saves the data couples in a file in the folder /output_files/coupled_data if set in the config.

6*. Data couples can be read from a previously saved file in which case steps 1-5 are skipped

This option is set in the config

- Files of data couples are read in the folder /input_files/coupled_data-files
- Detector names are read from the file title.
- Data couples are read as lines in the file, if they have the required columns and the values are successfully parsed.
- Returns a list of data couples for each compared detector

7. Plotting – plots are saved in the folder /output_files/plots or shown if plot saving is disabled in the config file. In all cases for each compared detector graphs of the selected types are generated.

For unsuccessful fits the graphs are skipped and exceptions are logged in the file /output_files/plots/exception.log.

- 'original' – Plots the raw data without errorbars of the referent and a compared detector on a graph.
- 'averaged time' – Plots the data averaged over the selected intervals with errorbars – for the referent and a compared detector

!Find the exact method for fitting here – add examples or leave them for the How to part?

8. Saving fit parameters

All files in the code are saved in the format:

ReferentDetector_ComparedDetector_*_CurrentDatetime