Exercise - Sensors

Exercises in Data Modeling (190.021)

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This cheat sheet is supposed to give some additional information on the Jupyter notebook on sensors.

1 Analyse Sensor Data

Within the first section, we take a look at an experiment where we want to measure the water level of a water tank. To do so, we use two different sensors, an ultrasonic sensor measuring the distance from the top of the tank to the water surface and a pressure sensor measuring the hydrostatic pressure at the bottom.

To simulate this experiment, we need to configure the offset and the noise of each of those sensors. To do so, fill in the respective variables:

- ultra_offset
- ultra_noise
- pressure_offset
- pressure_noise

Configure each of those variables with a float value between 0 and 0.1.

In the notebook, you can then inspect how the offset and the noise have a direct impact on the measurement. Additionally, it will be shown how to calculate the accuracy and estimate the transfer function. As a last part, we can combine both sensor measurements using variance weighting to achieve the best possible estimate of the true water height.

2 Sensor Uncertainty

In the second section, we want to estimate the error of the two sensor model already described above. We will estimate the uncertainty of the sensor-to-sensor regression model as a function of the ultrasonic measurement. With this approach, we include the uncertainties of both sensors (noise & offset). Within the notebook, the error will be estimated using classical and Gaussian error propagation.

3 Single- & Multi-Sensor System

In the last chapter, we will have a closer look at another type of multi-sensor system, as we are now inspecting a multi-sensor system, where each sensor is measuring another property (e.g., one is sensing the temperature, the other one the humidity). As we are also working with simulated data in this example, you can select the means and standard deviations of temperature and humidity in cases where it is raining and in cases where it is not raining. The objective of this multi-sensor system is to detect whether it is raining or not based on temperature and humidity.

First, insert the following variables with float or integer values within the defined ranges:

- mean_temp_no_rain   [0, 70]
- std_temp_no_rain   [0, 70]
- mean_humid_no_rain   [0, 100]
- std_humid_no_rain   [0, 100]
- mean_temp_rain   [0, 70]
- std_temp_rain   [0, 70]
- mean_humid_rain   [0, 100]
- std_humid_rain   [0, 100]

The notebook will then generate a scatter plot of the data and train a classification model to classify whether it is raining or not.