Gymnasiearbetet

Evaluation of sensor random error

Purpose

Random error can, for example, result from natural fluctuations in the environment or from the measuring equipment. To evaluate the random error of the sensors, we can attempt to control for the environment and investigate the sensors sample distribution.

Method

Sensors 1-6 were placed together alone in an indoor office room. There was ventilation, but the air quality in the room should reasonably be more stable than in the outdoors with more external factors. The sensors were on for 54 minutes and 8 seconds. The first 150 seconds and last 30 second were omitted to let the sensors stabilize. This resulted in 51 minutes and 8 seconds of calibration data. The measurements were visualized over time and histograms were made to visualize the sampling distribution for each sensor individually and for all sensors combined.

Results

Measurement period: 51 minutes 8 seconds
Average PM2.5 across all sensors: 0.62
Median PM2.5 across all sensors: 0.61

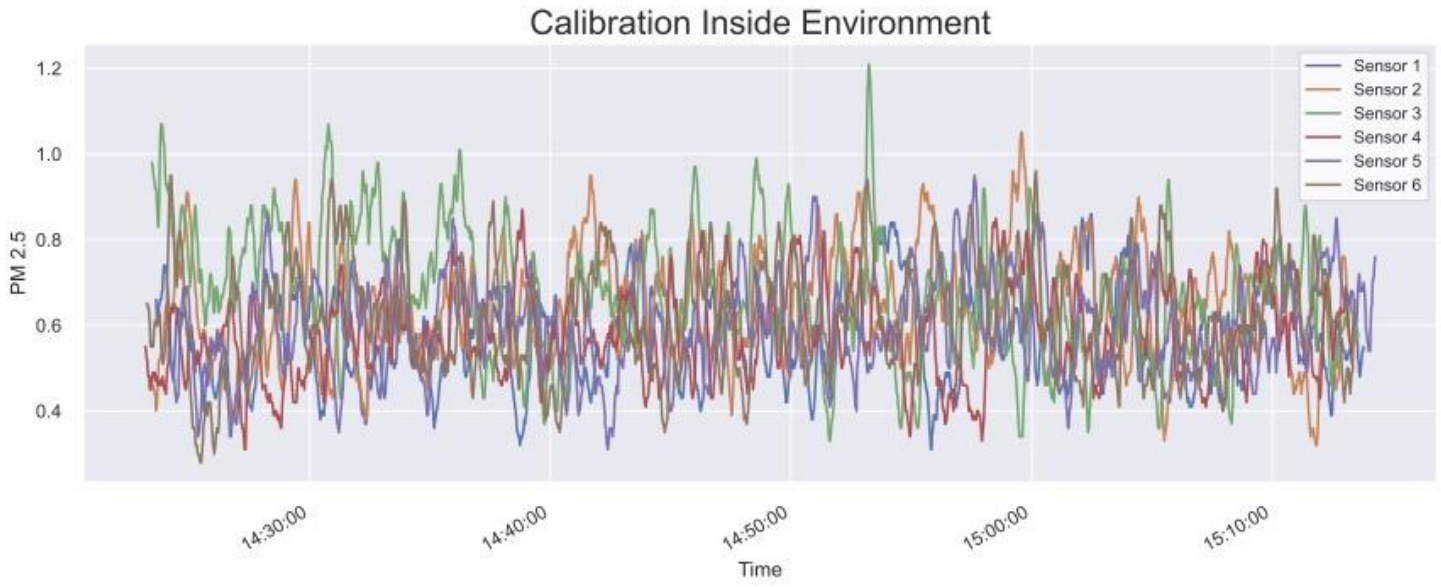

Figure 1: Raw sensor data from calibration for sensor 1-6.

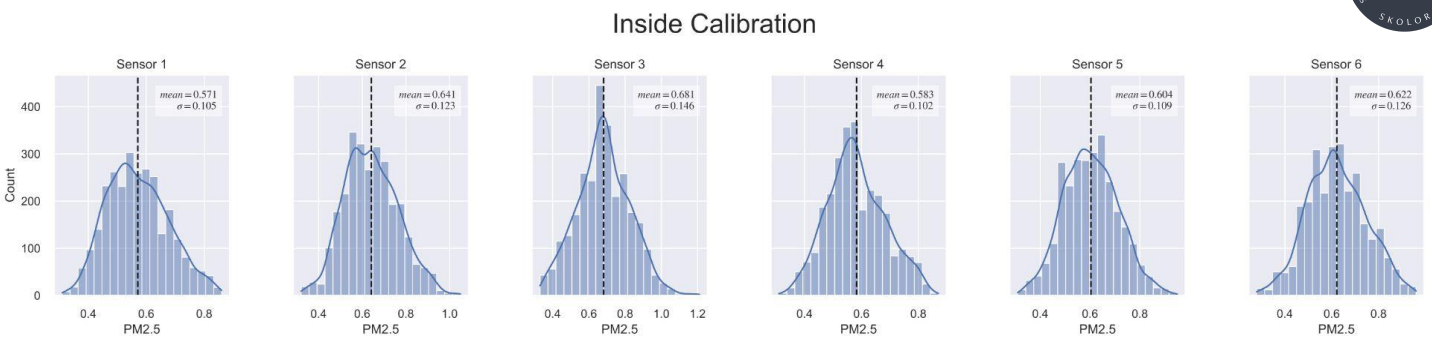

Figure 2: Distributions of samples for each sensor. The dotted line represents the mean PM2.5 value for each sensor. The mean and standard deviation are written in the boxes.

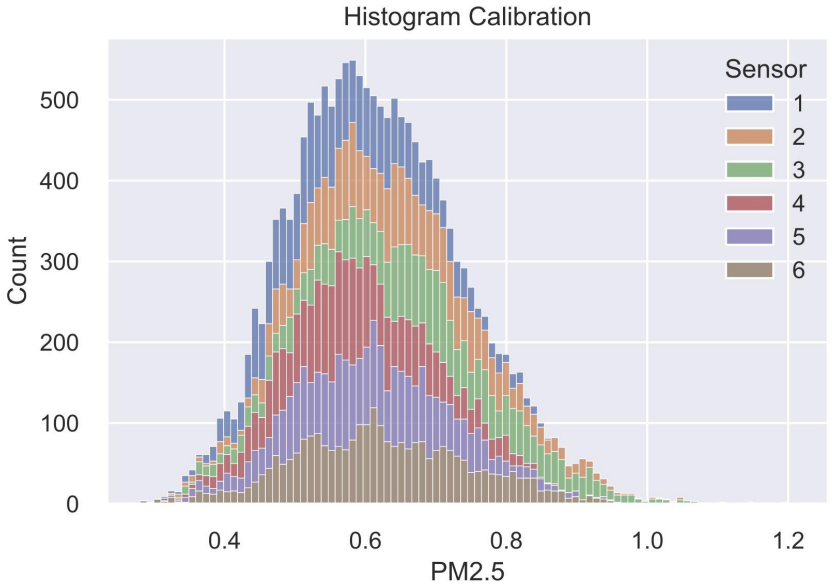

Figure 3: All distributions layered on top of each other.

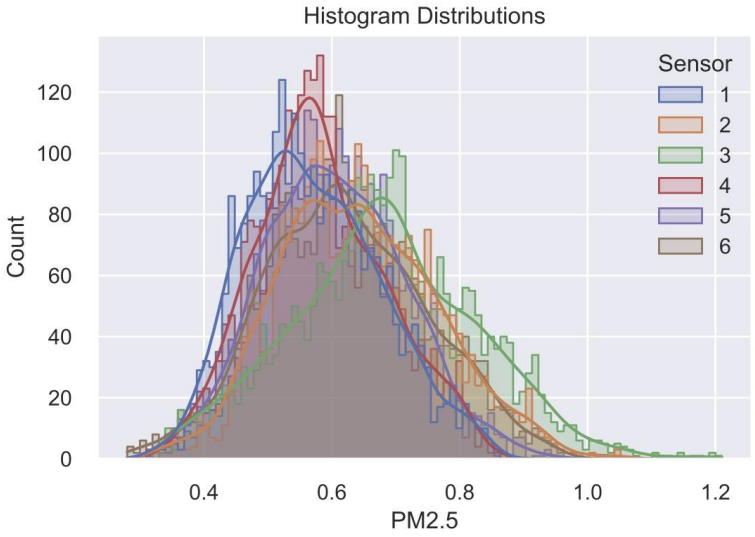

Figure 4: All distributions layered on top of each other.

Extra information

Table 1: Number of unique samples per sensor during the calibration period.

Sensor	N
1	2714
2	2699
3	2709
4	2705
5	2706
Total	**16243**

Table 2: The minimum, maximum, mean, median, and standard deviation across all samples for every sensor. The diff-column in the difference between the highest and lowest value.

Sensor	**min**	**max**	**diff**	**mean**	**median**	**std**
1	0.31	0.86	0.55	0.57	0.56	0.105
2	0.32	1.05	0.73	0.64	0.64	0.123
3	0.33	1.21	0.88	0.68	0.68	0.146
4	0.31	0.87	0.56	0.58	0.57	0.102
5	0.31	0.95	0.64	0.60	0.60	0.110
6	0.28	0.96	0.68	0.62	0.61	0.126

Mean diff: 0.673
Mean std: 0.119
Largest diff across all measurements and sensors: 0.93

Discussion

The results insinuate that, for stable environments, the sensors are relatively evenly distributed around a central value. Overall, the sensors correlate well with each other, differing at most 0.93 µg/m3. The standard deviations are close to zero. From *Table 2*, however, it can be seen that Sensor 3 is the most volatile and the sensor that fluctuates the most. *Are these valid points? More bins standard deviations per sensor?*