Quantifying nitrogen oxides and ammonia via frequency modulation in gas sensors

Master Thesis - Mid term seminar

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Outline

Problem in a nutshell

NOx are detrimental to the environment
Ammonia can neutralize NOx
Gas sensors can be used to quantify NOx and Ammonia
However, it is not trivial:
hey

What has been done so far

- Writing
  - Introduction - Done.
  - Theory - Done.
  - Data - Partially done.
- Some preliminary implementation of the methods
  - Linear Regression
  - Principal Component Regression
  - Partial Least Squares Regression
  - Ridge Regression

Caveats

- Real data not yet available - lab problems
- Methods used on "dummy" data
- Dummy data has problems:
  - Small number of observations
  - Measurement of shape features
  - Naïve window of measurements
  - High frequencies problematic

(Dummy) data

Example of dummy data measurement
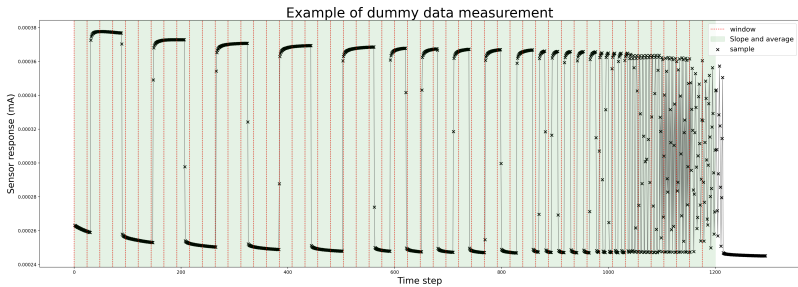
(Dummy) data

	Unnamed: 0	NO2	NO	NH3	slope0	slope1	slope2	slope3	slope4	slope5	...	avg40	avg41	avg42	avg43	avg44
0	mix0	50	100	25	0.000261	0.000347	0.000378	0.000342	0.000255	0.000254	...	1.788009e-07	-0.000001	-1.270353e-06	-1.920155e-06	-1.117044e-06
1	mix1	100	25	100	0.000244	0.000334	0.000371	0.000342	0.000256	0.000257	...	-6.433617e-06	0.000002	2.373382e-06	1.108367e-06	1.701933e-06
2	mix2	25	100	50	0.000258	0.000343	0.000374	0.000340	0.000256	0.000254	...	-3.621577e-06	-0.000003	-9.317178e-07	7.781265e-06	-3.612217e-06
3	mix3	50	25	100	0.000249	0.000341	0.000375	0.000341	0.000261	0.000261	...	2.510960e-06	0.000003	1.811447e-06	7.319652e-08	4.306713e-07
4	mix4	100	100	25	0.000256	0.000340	0.000371	0.000332	0.000252	0.000251	...	3.064678e-06	0.000003	9.766817e-07	-7.697217e-07	-3.745022e-07

Methods

1. Linear Regression
2. Principal Component Regression
3. Partial Least Squares Regression
4. Ridge Regression

(Preliminary) Results

Real data will be much better!

- More gas mixtures
- More frequencies
- More cycles
- Shape features directly measured

Real data will be much better!

Table: Data acquisition details

Parameter	Value
Factors (gases)	3
Levels (concentrations)	5
Frequencies	16
Features per frequency	4 (2 slopes and 2 averages)
Features per cycle	64
Number of cycles	5
Data points per mixture	320
Number of mixtures	125
Datapoints per experiment	40.000
Number of experiments	3
Total data points	120.000

Real data will be much better!

Frequency cycle and feature extraction

Cycle duration: 60 seconds. Measurement window: 0.4s
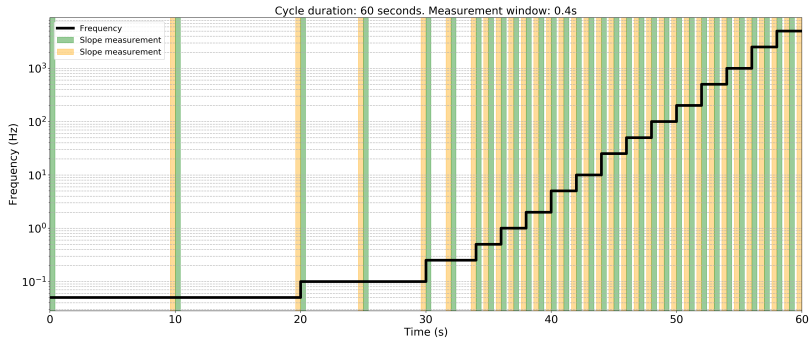
What is next

1. Apply methods to real data
2. Assess results
3. Define what is "good" in "good prediction levels"
4. Look into neural networks alternatives
5. Keep writing!

Thank you!