Building Tools for Automatically Processing Lab Data

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Abstract

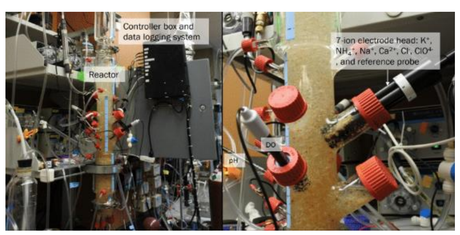
Phosphorus (P) is a major nutrient that wastewater treatment plants are making all efforts to eliminate. The proposed cost-effective way to indirectly quantify P in real-time is through commercially available sensor array. This project aims to building algorithms to automatically extract useful information from available sensors data sheets, thus help build machine learning algorithms for P prediction.

Motivation

- Online sensors for P do not exist. The Mueller lab is bridging this gap by studying chemistry of a P removal reactor.
- This REU project creates tools that automates data extraction to support development of an online P sensor.

Goals

- Creation of a data processing/visualizing tool for Atomic Absorption Spectroscopy (AAS) log files.
- Creation of a tool to extract useful information from logged sensor data.
- Creation of a linear model for P prediction to assess data complexity.



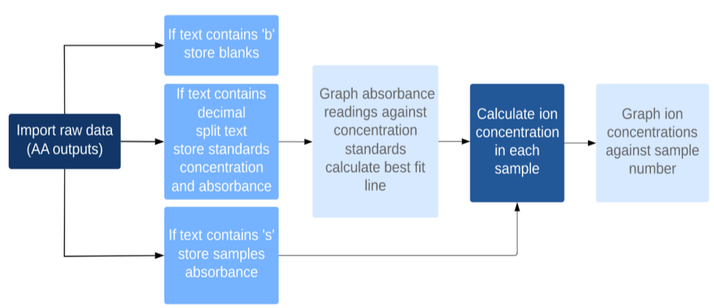
- Sensors include: electrodes for pH, DO, NH_4^+, Na^+, K^+, Ca^{2+}, ClO_4^-, Cl^-, Mg^{2+}.

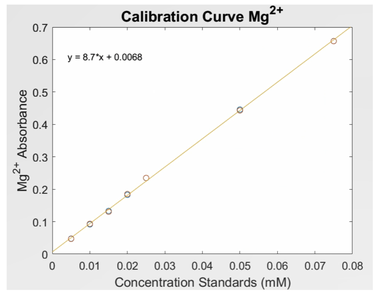
Methodology and Results

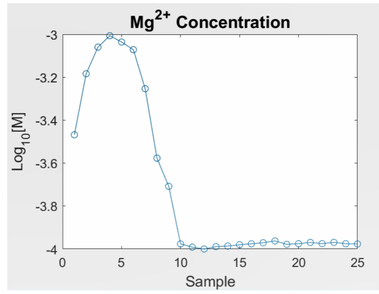
1. Data Processing/Visualizing Tool (AA Data)

Inputs → Algorithm → Outputs

Nab	UNCALp	p	mg/L	0	0.0022	0.0022
W4502:	Sample	uncalibrated				
Nas1	UNCAL	L	mg/L	0	0.2567	0.2567
W4502:	Sample	uncalibrated				
Nab	UNCAL	L	mg/L	7	0.0021	0.0021
W4502:	Sample	uncalibrated				
Nas1	UNCAL	L	mg/L	0	0.2588	0.2588
W4502:	Sample	uncalibrated				
Nab	UNCAL	L	mg/L	3	0.002	0.002
W4502:	Sample	uncalibrated				
Nas2	UNCAL	L	mg/L	0	0.2075	0.2075
W4502:	Sample	uncalibrated				
Nab	UNCAL	L	mg/L	1	0.0025	0.0025
W4502:	Sample	uncalibrated				
Nas2	UNCAL	L	mg/L	0	0.2065	0.2065
W4502:	Sample	uncalibrated				
Nab	UNCAL	L	mg/L	1	0.0025	0.0025
W4502:	Sample	uncalibrated				
Nas2	UNCAL	L	mg/L	0	0.2043	0.2043
W4502:	Sample	uncalibrated				
Nab	UNCAL	L	mg/L	6	0.0022	0.0022

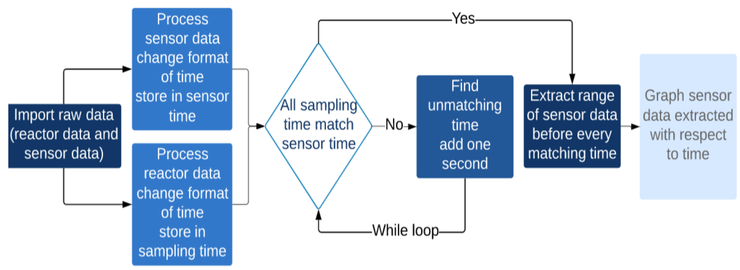


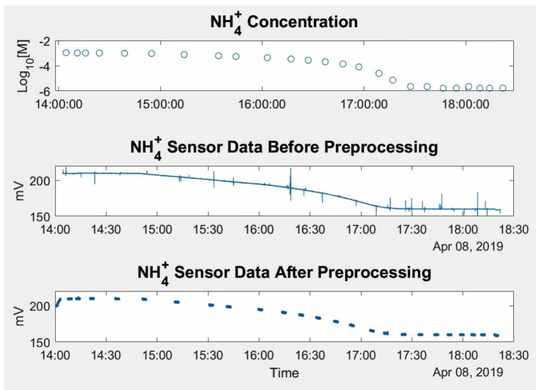




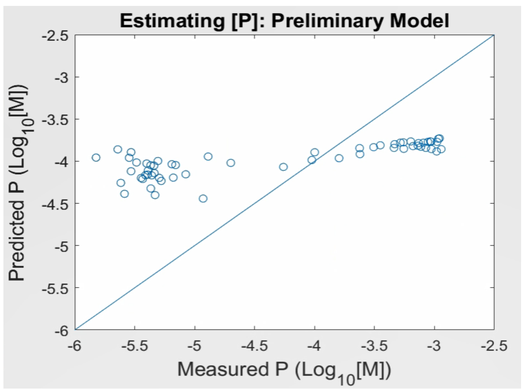
2. Data Extraction Tool (Sensor Data)

20190408	1.555E+09	0	0.19863	0.34698	0.42906	0.34103
20190408	1.555E+09	1	0.19912	0.34714	0.42987	0.34239
20190408	1.555E+09	2	0.199	0.34705	0.42958	0.34201
20190408	1.555E+09	3	0.19887	0.34706	0.42986	0.3418
20190408	1.555E+09	4	0.19787	0.34719	0.42904	0.34122
20190408	1.555E+09	5	0.19791	0.34611	0.4295	0.34169
20190408	1.555E+09	6	0.19838	0.34601	0.43004	0.34128
20190408	1.555E+09	7	0.19838	0.34596	0.42874	0.34096
20190408	1.555E+09	8	0.1992	0.34649	0.42985	0.3414
20190408	1.555E+09	9	0.198	0.34711	0.42877	0.341
20190408	1.555E+09	10	0.19871	0.34591	0.42937	0.34106
20190408	1.555E+09	11	0.19895	0.34648	0.43031	0.3423
20190408	1.555E+09	12	0.19858	0.3472	0.42927	0.3411
20190408	1.555E+09	13	0.19899	0.34623	0.42995	0.34237
20190408	1.555E+09	14	0.1989	0.34697	0.42945	0.3419
20190408	1.555E+09	15	0.19772	0.34674	0.42972	0.34173
20190408	1.555E+09	16	0.19891	0.34617	0.42899	0.34147
20190408	1.555E+09	17	0.19856	0.34704	0.42907	0.34205
20190408	1.555E+09	18	0.19837	0.34699	0.43021	0.34194
20190408	1.555E+09	19	0.19816	0.34687	0.43016	0.34213
20190408	1.555E+09	20	0.19879	0.34617	0.43004	0.34099





3. Preliminary first-order analysis using MLR



- MLR is only valid when the input variables are uncorrelated – sensor data may be correlated.
- Relationship of P to other ions could be non-linear.
- Relationship of P to other ions may be a function of time in the reactor cycle.

$$[P] = B0 + B1 \times ISE_K + B2 \times ISE_{Mg} + E$$

Discussion and Conclusions

- AA sheets have different number of entries. Text processor has been built to extract useful AA data automatically.
- In order to match timestamps in sensor data to sampling data from 10 cycles, loops have been used to deliver this task.
- MLR is a baseline to study the relationship between P concentration and sensor data but it is not robust to capture the non-linear dynamic, in the future advanced models need to be used.

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