Analysis of Low-energy Ammonia Sensors

RUTGERS
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Introduction

- Ammonia sensors have a wide range of uses, and are particularly indispensable for laboratory animal studies.
- Common metal-oxide based ammonia gas sensors are often expensive and inconvenient to operate.
- To tackle this problem, Winlab used LSTM neural network that predicts the equilibrium resistance using the sensor's initial resistance response.

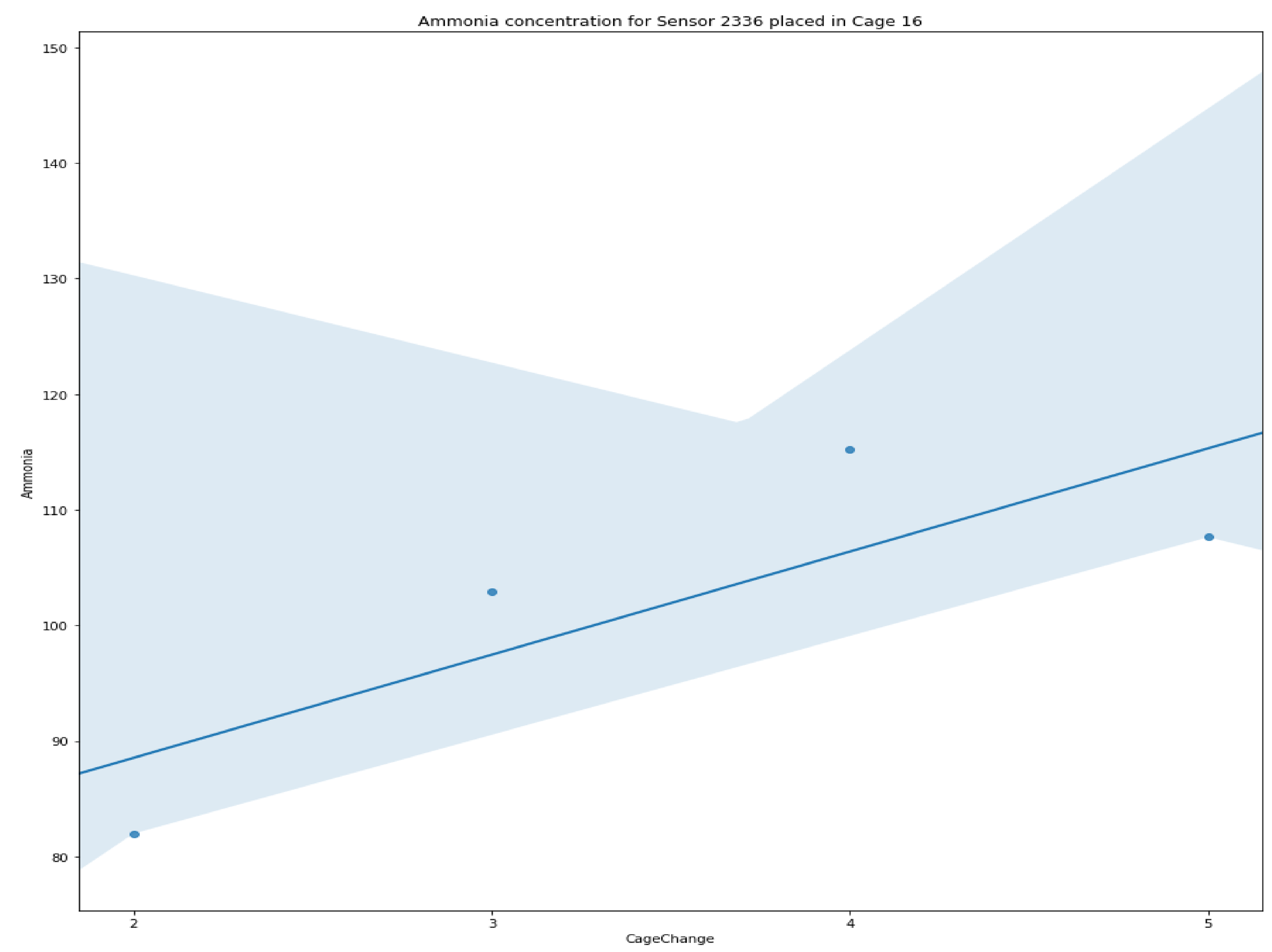
Objective

- Find the hidden variables that cause drift in the value read by ammonia sensors.
- Use statistical models to predict the drift.
- Test the 'gunk' hypothesis, which states that sensor accumulates a layer of aqueous ammonia as a function of rest time and ambient ammonia concentration

Data

- Uncontrolled Environment data
  - Winlab and NIH rat cage data including bedding types, CO2 levels, humidity etc.
- Controlled Environment data
  - Data with constant and changing ammonia levels.

Analysis & Visualization



Sensor 2336 when placed in Cage 16 shows the gunk hypothesis

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Slope :  [[0.11794159]]
Intercept :  [-11.59500866]
Mean Squared Error : 6.06
Variance Score : 0.96
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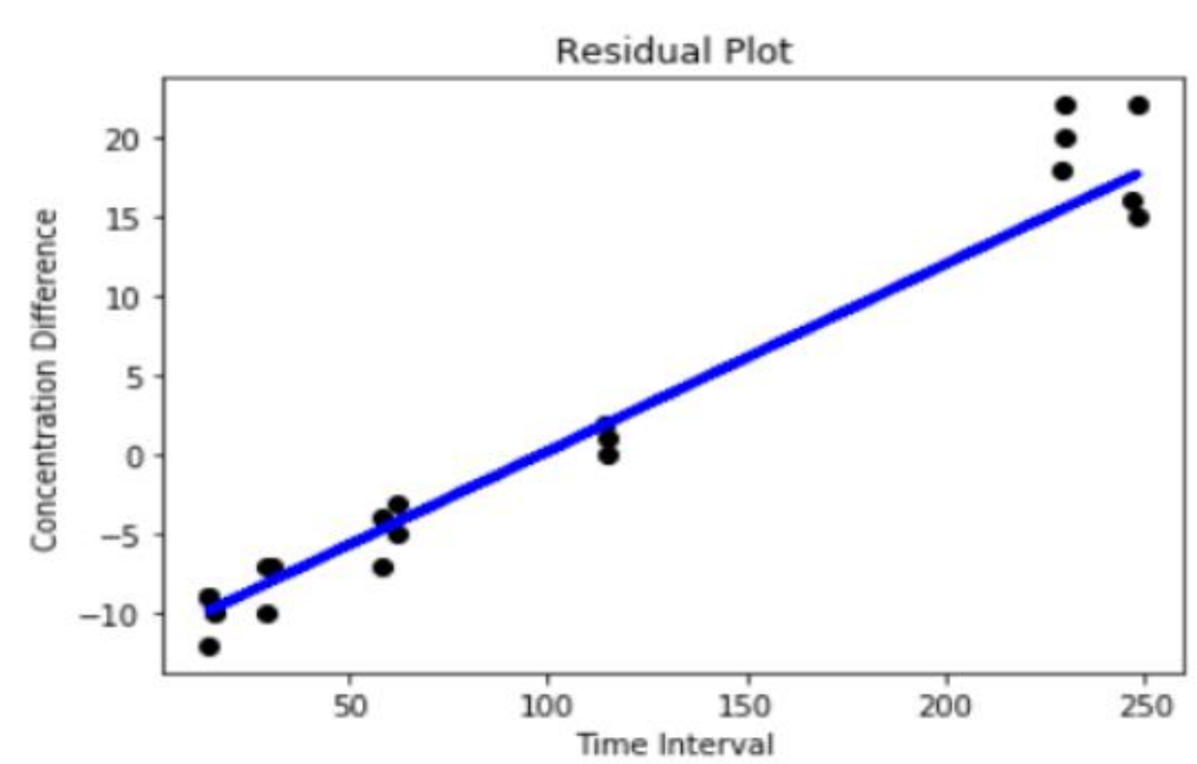

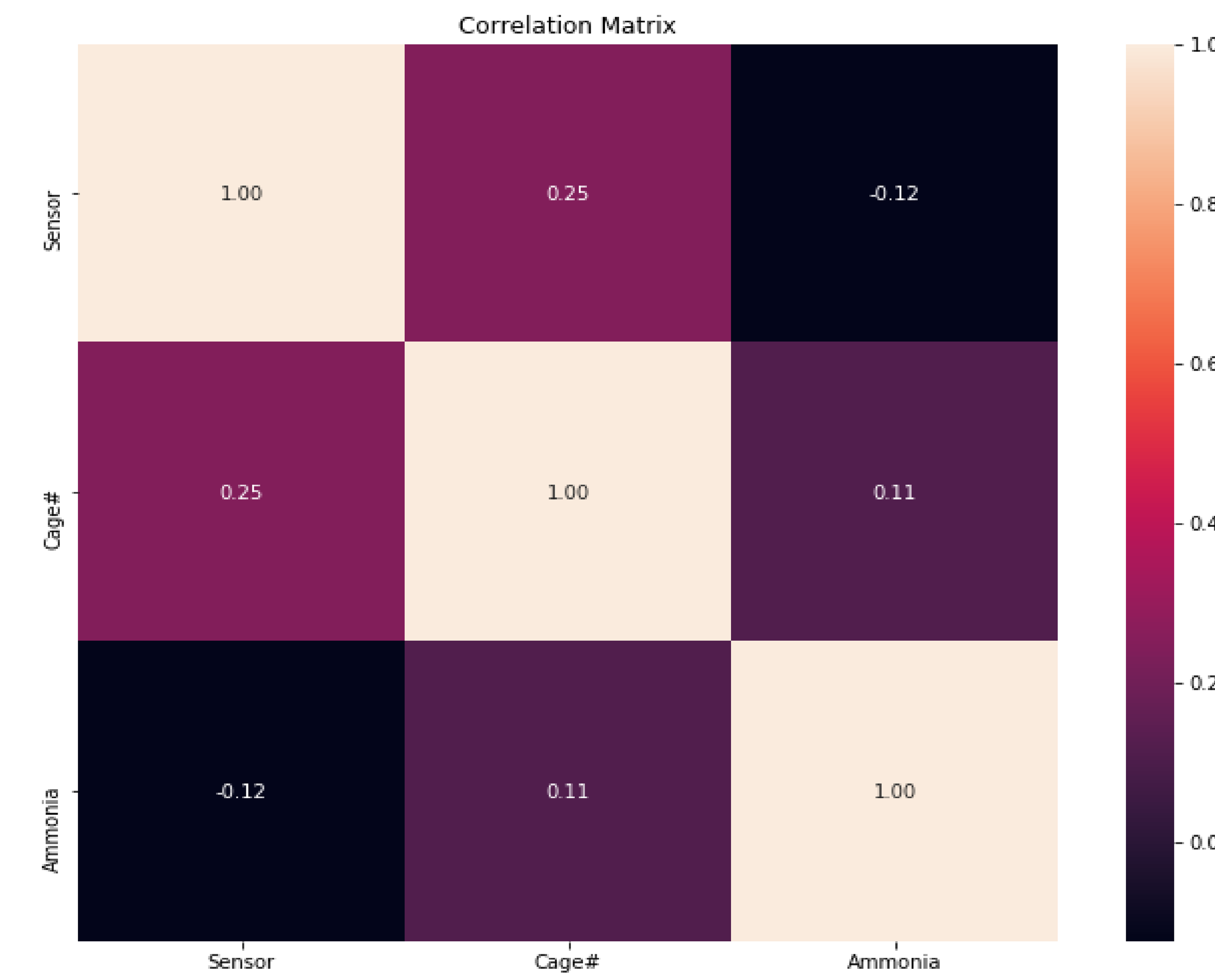

Correlation matrix shows that on an average, sensors have a more significant effect than the cages themselves on NH3 levels.

- The plot on the left shows that ammonia concentration drift with time interval between readings can be modeled linearly.
- Predicted values lie on the blue line, while actual values are dots.

Future Work

- We are exploring the drift among sensors using log-linear and log-log models.
- We will be conducting more controlled experiments with humidity as a variable for drawing conclusions about the nature of drift.

References

[1] Zhenhua Jia et al., 2018. Continuous Low-power Ammonia Monitoring using LSTM neural networks. .
[2] Causal models with hidden variables. https://www.stats.ox.ac.uk/~evans/qbns_evans.pdf

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