

# Bandwidth Locators for User Evaluation



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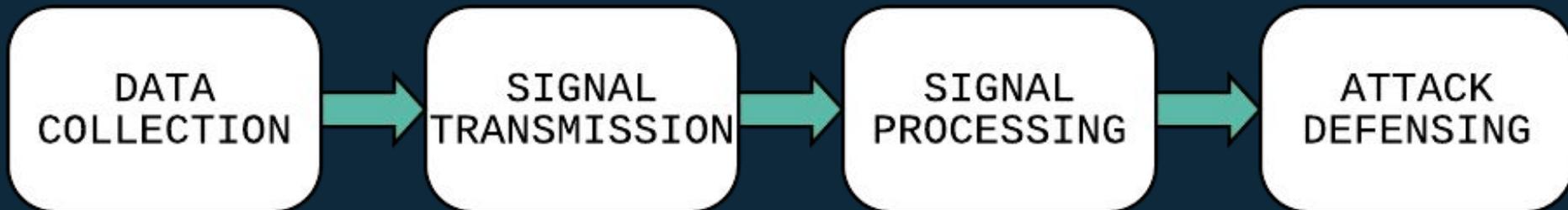
Daniel Like



Joshua Guo

# OBJECTIVES

1. build an end-to-end IoT framework to collect & analyze sensor data from devices
2. implement machine learning techniques to predict future behaviors
3. detect if and how system is compromised by **Red Team's** attacks

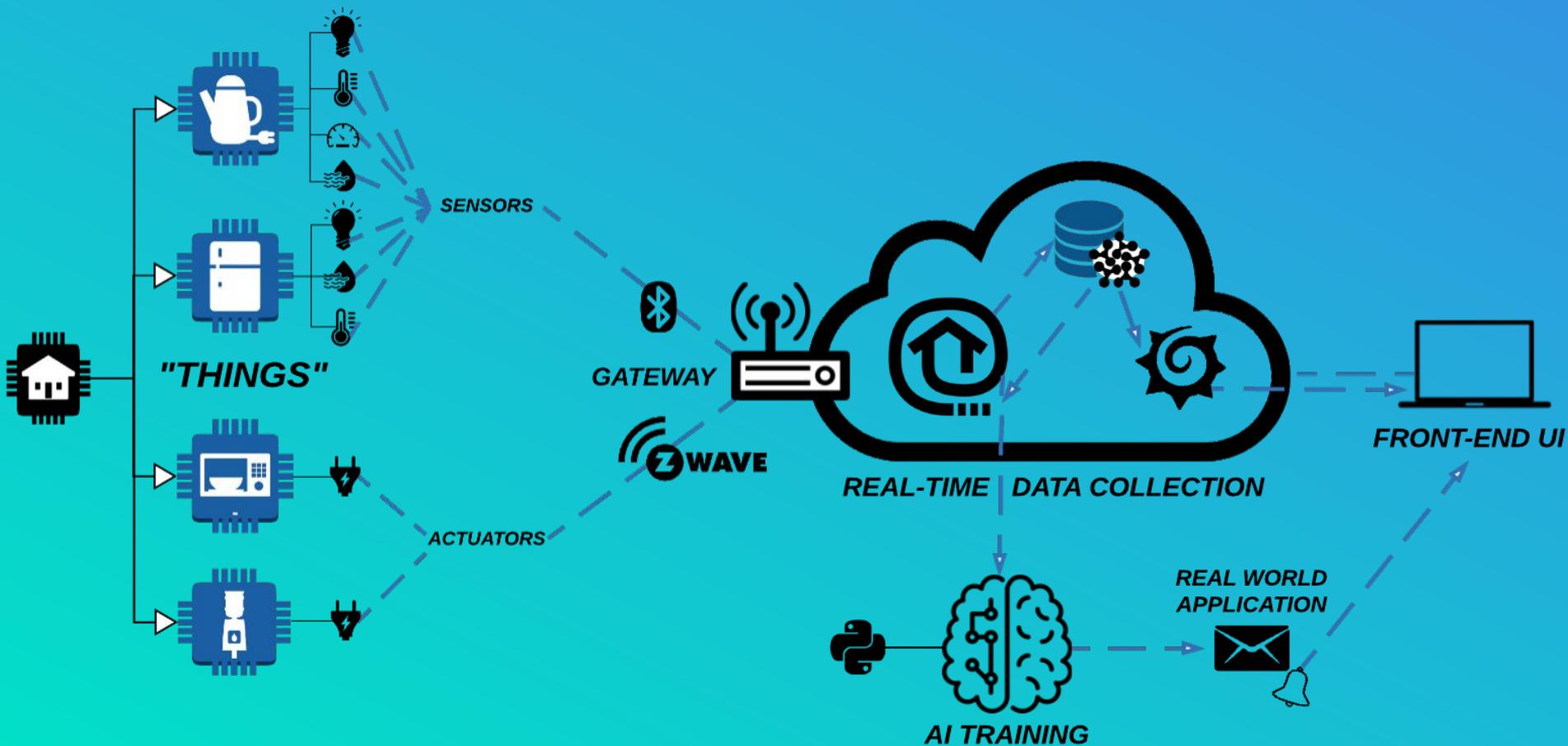




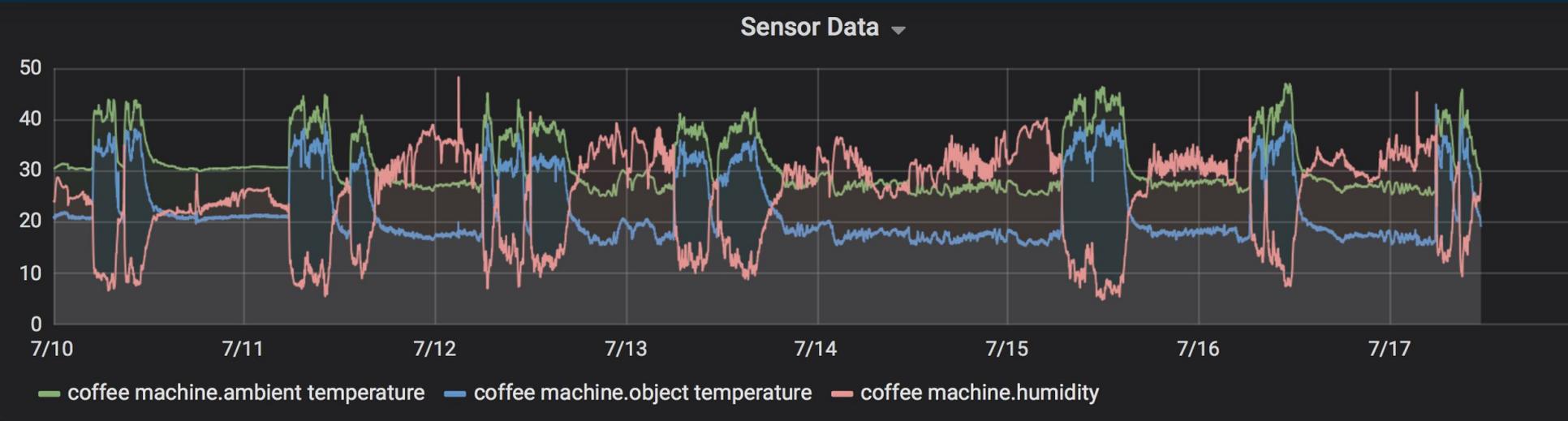
# WEEKLY SUMMARY

1. made a visual representation of our system
2. trained Elastic net to predict temperature 15 minutes in future
3. began working on logging anomalies & gaps
4. improved anomaly detection with LARS regression
5. began first draft of research paper
6. able to notify user if coffee is ready through email

# End-to-End IoT Framework Architecture



- Grafana & InfluxDB configured



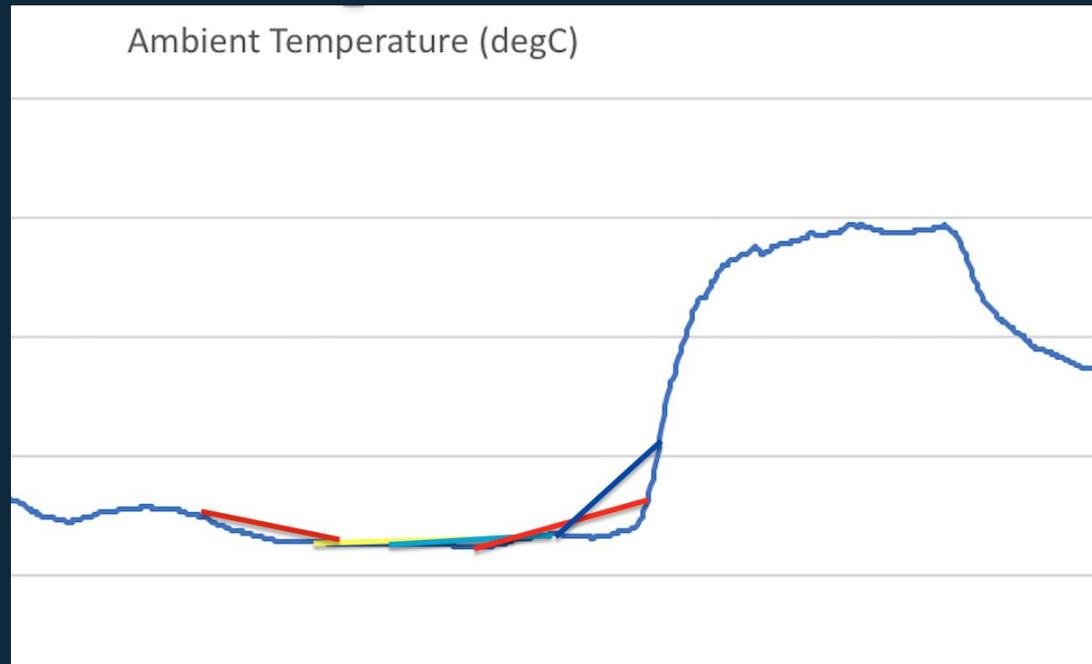
JUL 10 -- JUL 17 : ambient temp, object temp, humidity

▼ D	FROM	default	WHERE	+
	SELECT	field (valu		
	GROUP BY	time (\$_		
	FORMAT AS	Time se		
	ALIAS BY	Naming		
▼ E	Add Query			

- CC2650\_Sensor01\_AccelerometerXG
- CC2650\_Sensor01\_AccelerometerYG
- CC2650\_Sensor01\_AccelerometerZG
- CC2650\_Sensor01\_AmbientTempDegC
- CC2650\_Sensor01\_BarometerMillibars
- CC2650\_Sensor01\_Connected
- CC2650\_Sensor01\_GyroscopeXDegSec
- CC2650\_Sensor01\_GyroscopeYDegSec
- CC2650\_Sensor01\_GyroscopeZDegSec
- CC2650\_Sensor01\_HumidityRH
- CC2650\_Sensor01\_LightLux
- CC2650\_Sensor01\_MagnetometerXUT

# Email Notification

1. takes derivatives every 5 minutes using a sliding window



2. derivatives  $>$  threshold  $\rightarrow$  send email notification
3. created separate data analyzer server for real time analysis

# Data Analyzer

Control

COFFEE MACHINE

CC2650\_Sensor01



State

Making Coffee



Connected

ON



Object Temp (degC)

36.5



Ambient Temp (degC)

42.7



Humidity (RH)

10.9



Light (lux)

51



Barometer (millibars)

1013.4

Data Analyzer



Current Derivative (deg/sec)

0.0125382262997



Current Time Interval

147.0



Derivative Threshold

0.003



# REGRESSION

1. elastic net model to predict temperature 15 minutes in future
  - a. RMSE loss of 1.83
2. fine-tuned elastic net parameters to improve prediction
3. could be used to predict when coffee will be finished

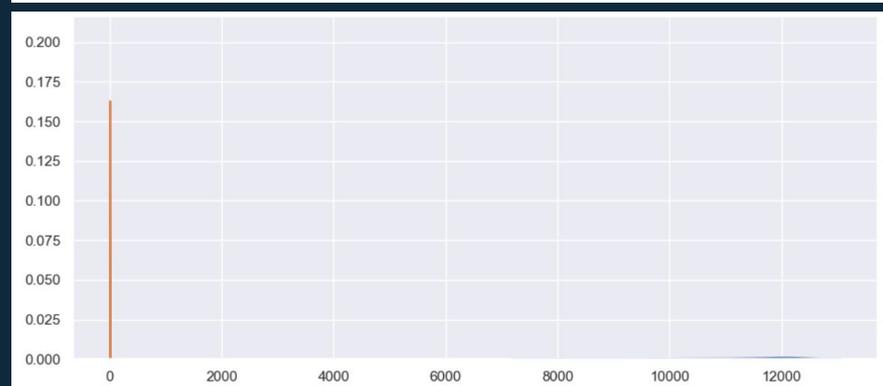
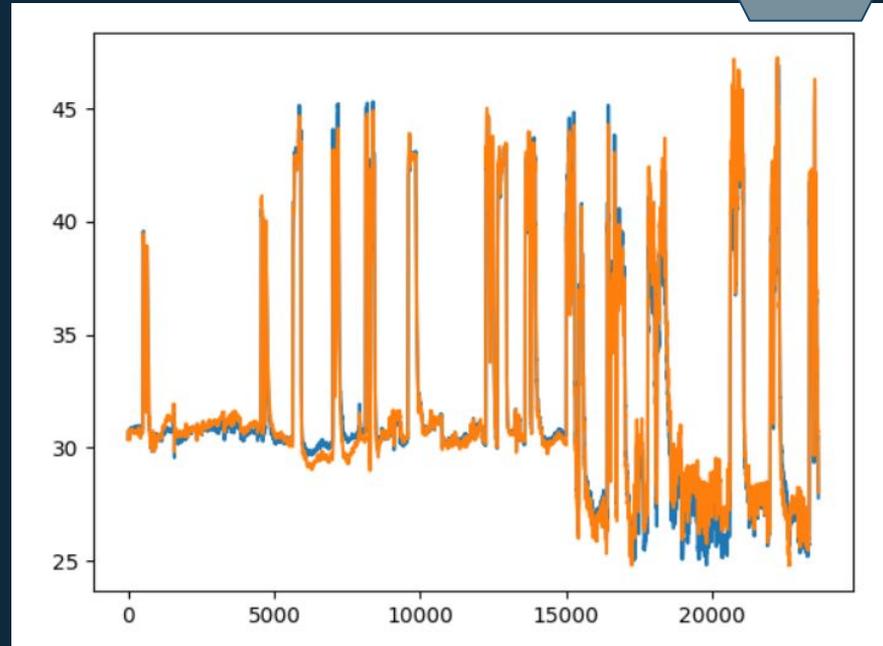
# LOGGING

1. created real-time updating log of gaps in data
2. began working on real-time log of anomalies

# Anomaly Detection- LARS Regression



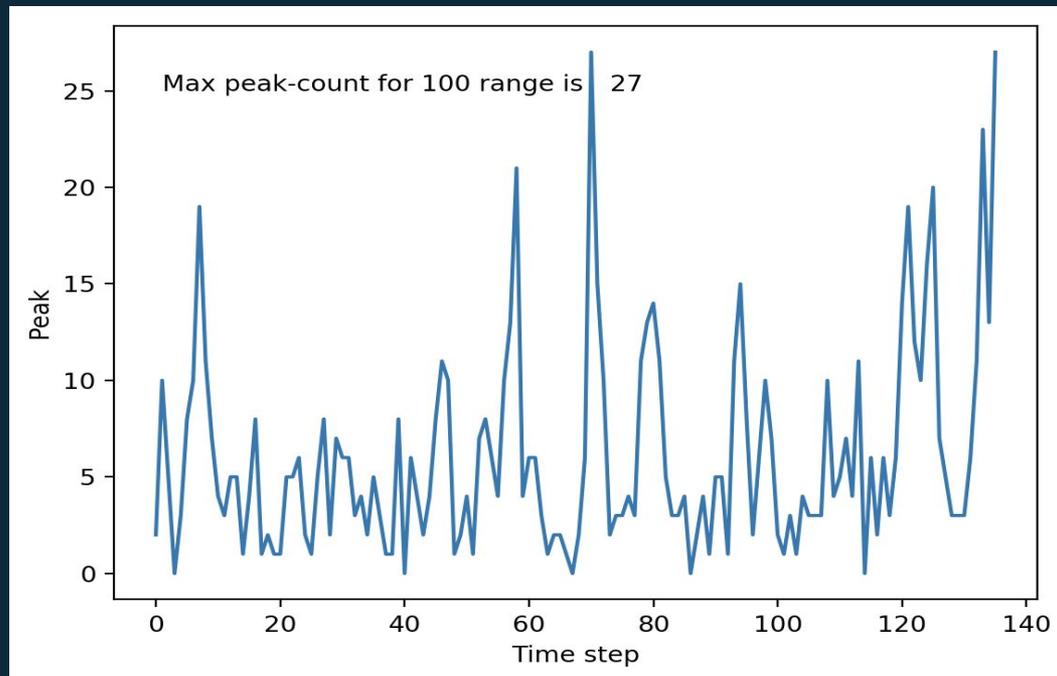
- (1) extremely large differences in RMSE loss between fake and real data, even when the difference between fake and real data is very small
- (2) used 2 minutes of data to predict 15 minutes into future to generate loss values
- (3) 100% accuracy with randomized data generated



# Anomaly Detection



## 1. zero-crossing problem for GRADIENT



## 2. build “hash table” to check repeat “data slice”

- (1) May have bad time complexity
- (2) Combination with other judgement



# FUTURE WORK

1. test other models and optimize prediction accuracy
2. work on email notifier to send when coffee is ready
3. Edit the firmware of the second 2650 to advertise it indefinitely and place it in the fridge.
4. finish our first rough draft of experience paper





QUESTIONS?

