# IoT Elderly Care Solution

Group sddec19-18: Ameliorate
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Client: Optical Solutions
Advisor: Daji Qiao
Team Website: http://sddec19-18.sd.ece.iastate.edu/

# Outline

- Focus and Goal
- Research
- Implementation
- Testing
- Results

# Members

- Jared Griffin
  - Web Application Engineer, Project Website Maintainer, GitLab Administrator
- Nidhi Dalvi
  - Hardware Engineer, Meeting Facilitator
- Tyler Borchert
  - Hardware Engineer
- Siyuan Zeng
  - Behavioral Logic Server Engineer
- Robert Guetzlaff
  - Behavioral Logic Server Engineer and Database Management

# Complications

- Sixth Group Member

# Focus & Goal

# Problem Statement

- How can senior citizens stay in their homes longer?

[1]

# Previous Groups

Autonomous Animals

- Built the initial system prototype for collecting kitchen usage data
- Ran into a number of issues reliably collecting kitchen data

Guardians of the Grandparents

- Created an Android application consuming stored data
- Installed flow meter and smart outlet

[20]

# Functional Requirements

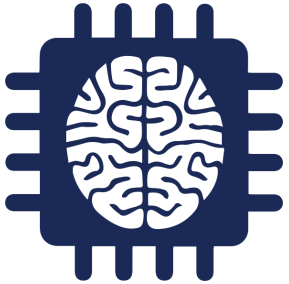
- Sensors must be wireless and have a lifespan of 1-2 years.
- The data from the sensors must be transmitted to our server.
- The logic system can take in a set of recorded sensor data and determine to a degree of certainty if a meal has been prepared.
- The resident events, meals prepared or skipped, must be displayed on a web application.

[9]

# Non-functional Requirements

[21]

Reuse

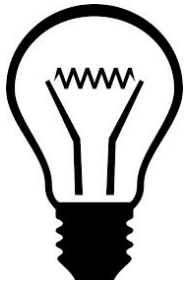


[22]

Non-Invasive

[19]

Timely



[18]

Loss of Power

# Constraints & Considerations

[2]

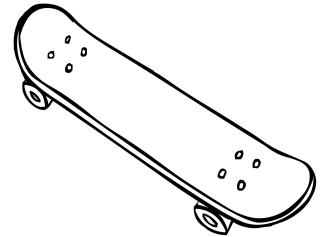
Cost

[3]

Sensor limitations

[4]

Inherited components



[24]

Minimum Viable Product

# Research

# Market Survey

[5]

# Potential Risks & Mitigation

Connection to the Cloud Environment [6]

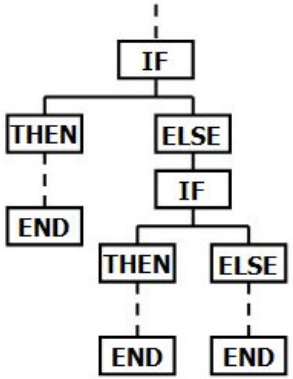
Remote Test Environment [7]

# Implementation

# Functional Decomposition

[9]

Sensors/hardware



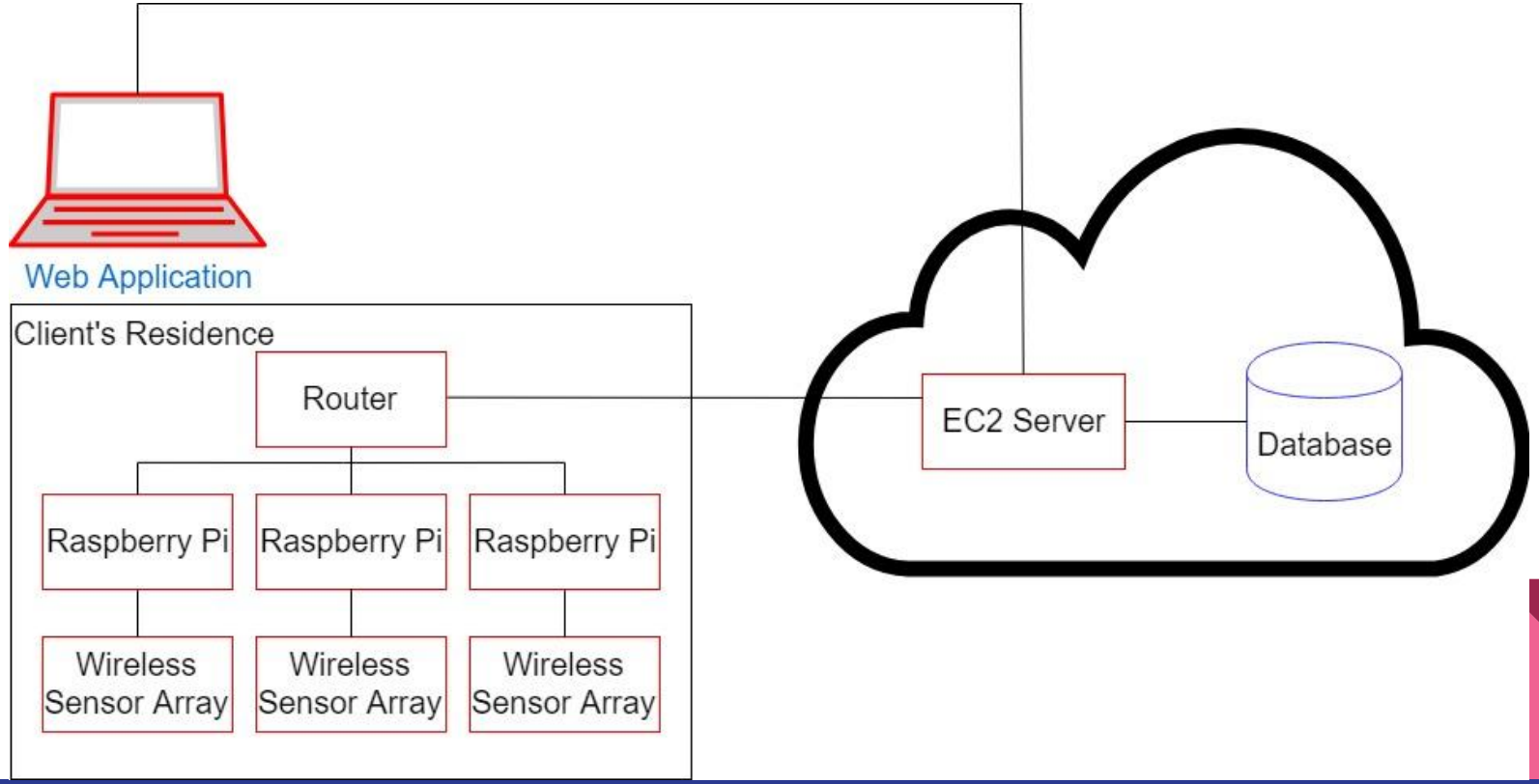

[10]

Behavioral Logic

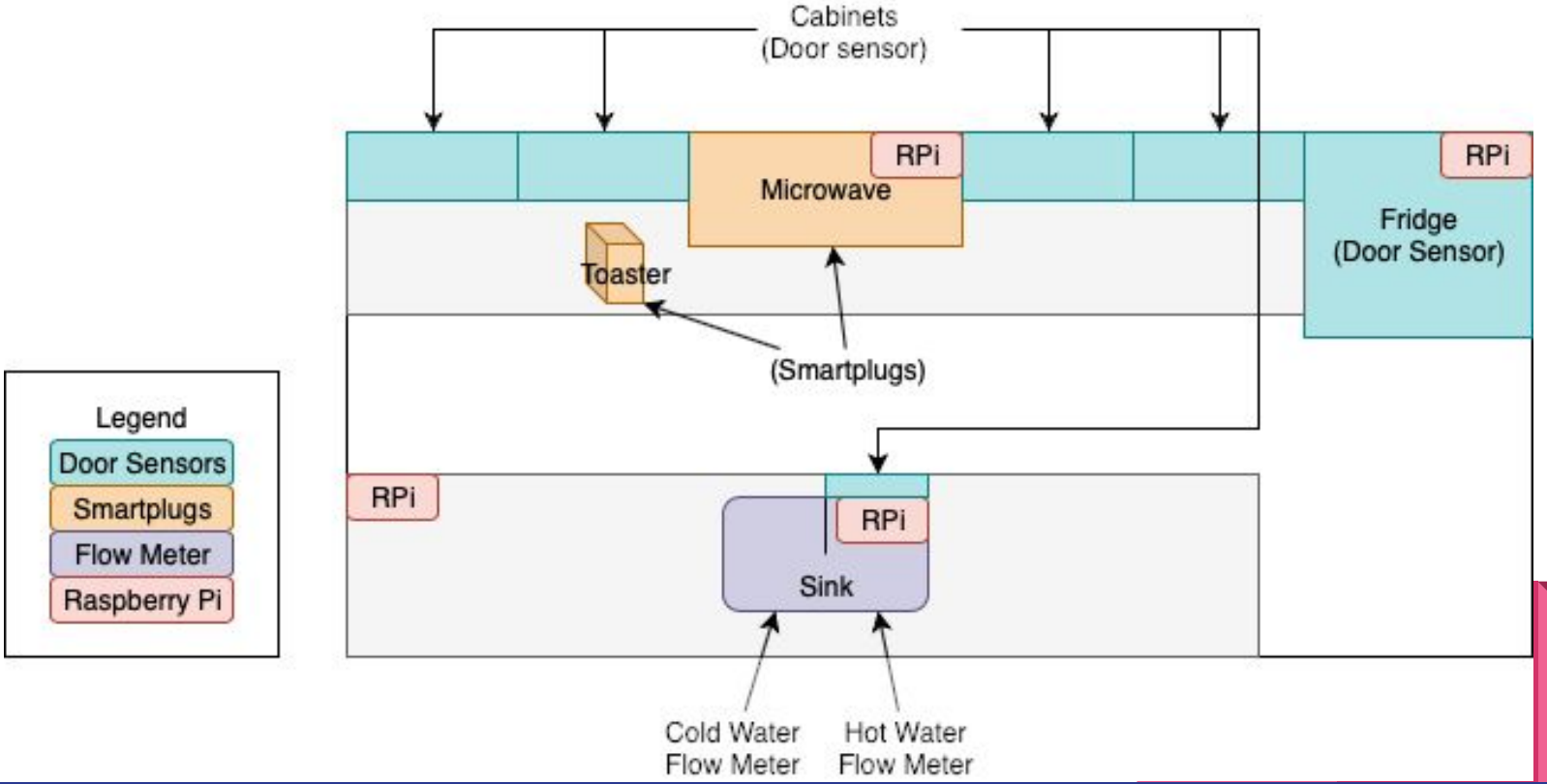
[11]

Web Application

# Detailed Design



# Test Environment



# Technology Used

- Technology Platforms
  - AWS
    - EC2
    - RDS
- Hardware
  - Raspberry Pi
  - TP-Link Smart Outlets

TI sensor tag

[12]

[13]

- Software
  - Web Application
    - React
    - Jest
  - Logic Server
    - Spring Boot
    - Java
  - Hardware
    - VNC
    - Python

# Resource/Cost Estimate

- AWS Cloud Resources
  - EC2 Server: $0.0208/hr [11]
  - RDS Database: $0.017/hr [12]
- Sensors:
  - $29 per TI Sensor Tag [27]
  - $35 per Raspberry Pi 3 [25]
  - $21.96 Smart Outlet [26]

[8]

# Design Tradeoffs

Hardware:

- Off the shelf solution
  - Costs more than a DIY solution.
- TI
  - Cheaper, but has bad documentation
- Open/Close sensing
  - Looked at peaks and valleys in data.
  - Not as accurate as integration techniques.

Logic:

- Machine learning
  - Not enough sensor data to implement a machine learning feature
  - Client wanted us to use hard-coded boolean logic

# Hardware Implementation

Sensors

- Sensor tags are connected through a python script which is running on a raspberry pi.

Outlets

- Plugged in to the microwave, toaster, and electric kettle.
- Communicates to raspberry pi via HTTP requests

Data Relay

- Set up as a task to be run every 10 minutes.

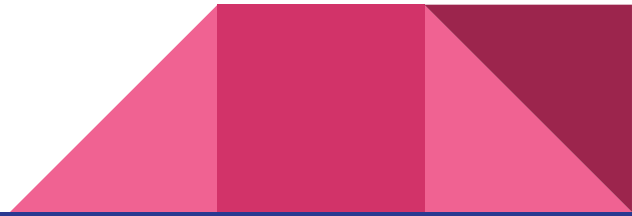
# Logic Implementation

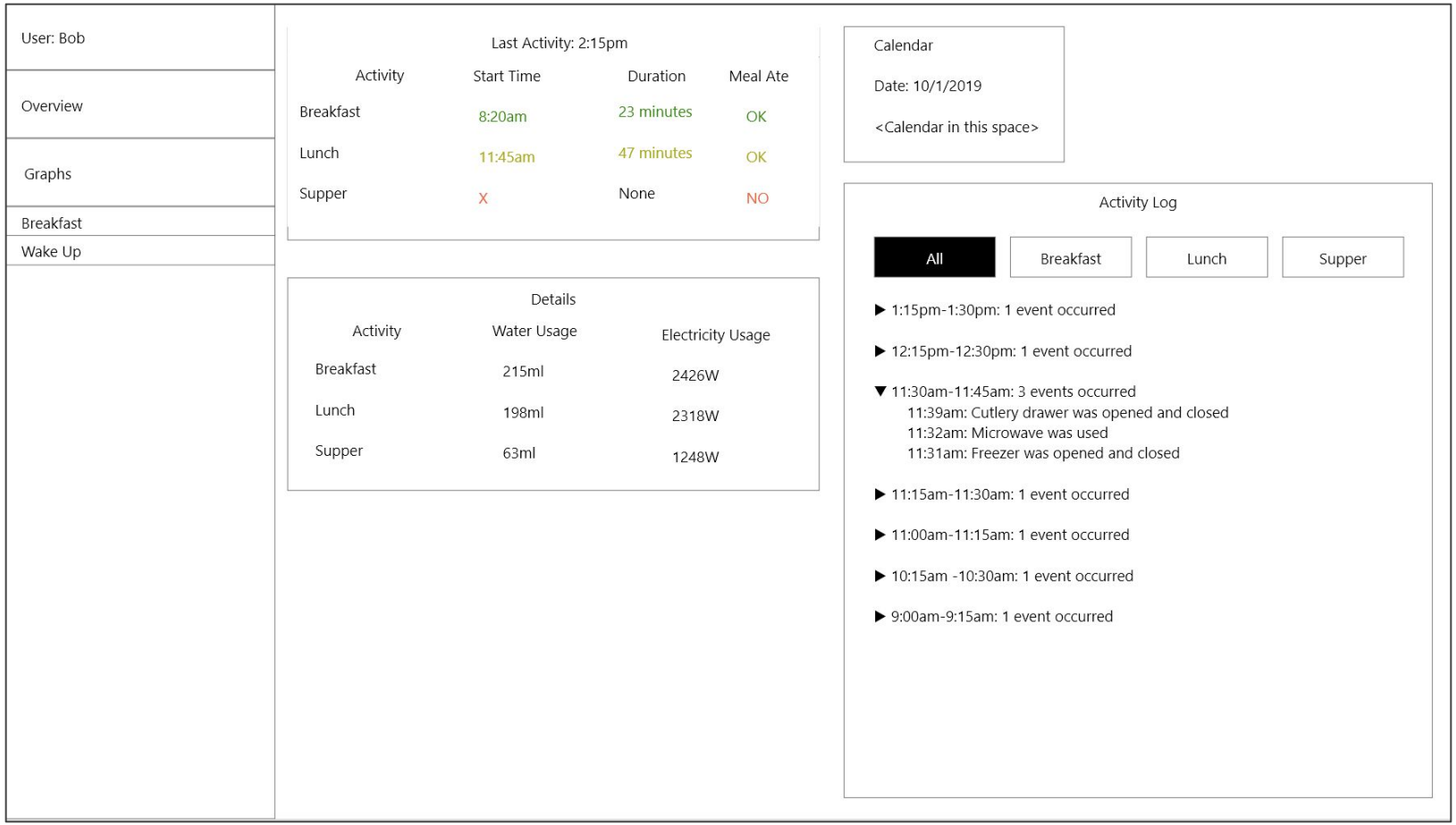
Spring MVC Project

- Interpret data in database to human readable format.
- Analyze the data using the logic algorithm.
- Provides the services for web application to use.

Logic Algorithm

- Implemented by the survey collected from Bob.
- Implemented by the data collected by sensor.

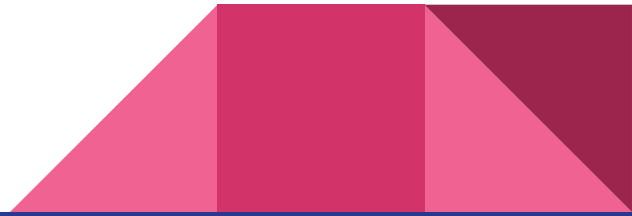



User: Bob
Overview
Graphs
Breakfast
Wake Up
Last Activity: 2:15pm
Activity
Start Time
Duration
Meal Ate
Breakfast
8:20am
23 minutes
OK
Lunch
11:45am
47 minutes
OK
Supper
X
None
NO
Details
Activity
Water Usage
Electricity Usage
Breakfast
215ml
2426W
Lunch
198ml
2318W
Supper
63ml
1248W
Calendar
Date: 10/1/2019
<Calendar in this space>
Activity Log
All
Breakfast
Lunch
Supper
▶ 1:15pm-1:30pm: 1 event occurred
▶ 12:15pm-12:30pm: 1 event occurred
▼ 11:30am-11:45am: 3 events occurred
11:39am: Cutlery drawer was opened and closed
11:32am: Microwave was used
11:31am: Freezer was opened and closed
▶ 11:15am-11:30am: 1 event occurred
▶ 11:00am-11:15am: 1 event occurred
▶ 10:15am -10:30am: 1 event occurred
▶ 9:00am-9:15am: 1 event occurred

# Problems

Hardware

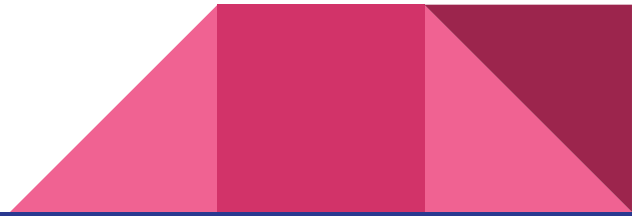
- Bluetooth connection issues
  - Worked for x amount of time and then disconnects on its own (Resolved).
- Loss of a group member
  - Got us behind on the implementation of hardware.
  - Battery Life



# Problems

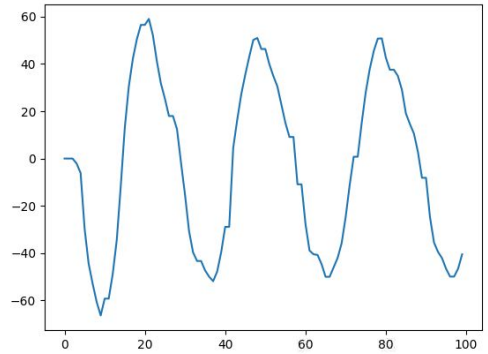
Web Application

- Intense Focus on Prototypes
- Lacking CI Infrastructure from ETG



# Testing

# Testing - Kitchen Sensors




TI Sensor Tags:

- Iteration Testing with prototypes
  - Creating a prototype that served a smaller function and physically testing it.
  - Once it passed physical tests, then it would get added to the overall program.
- Physical Testing
  - This involved placing the sensors into a testing environment and driving the code.
  - If the output was expected, then we would say it passed.

Data Relay:

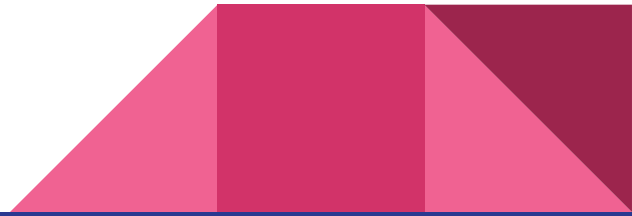
- Created Test data to verify local entries are transmitted and deleted

# Testing - Smart Outlet

- POST Request Testing
  - Generated POST requests and ensured data stored matched sent
- Stability Testing
  - Plugged outlets in and monitored for two weeks
  - Monitored reported usage

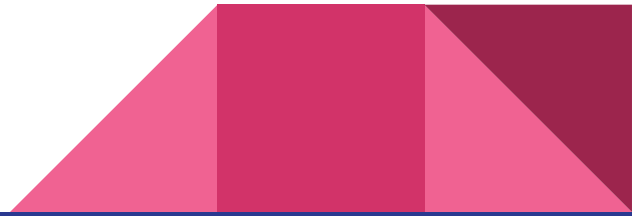
# Testing - Logic

- JUnit Tests & Mockito Tests
  - They are used to make sure each line of the code works properly. They are used to test independent and dependent classes respectively.
- Postman
  - Postman is used to test the communication between frontend and the logic server.



# Testing - Web Application

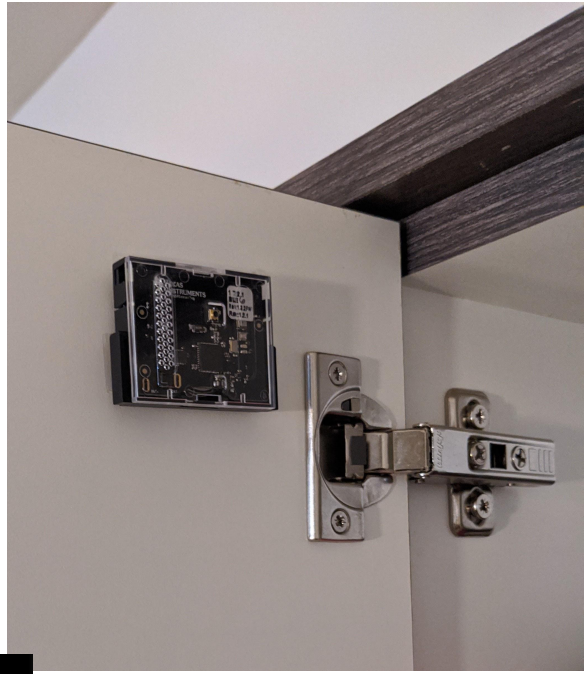
- Unit Testing
  - Built using test-driven development
- Unit test suite ran on continuous integration
  - Tests run every time we make changes to the web application



# Results

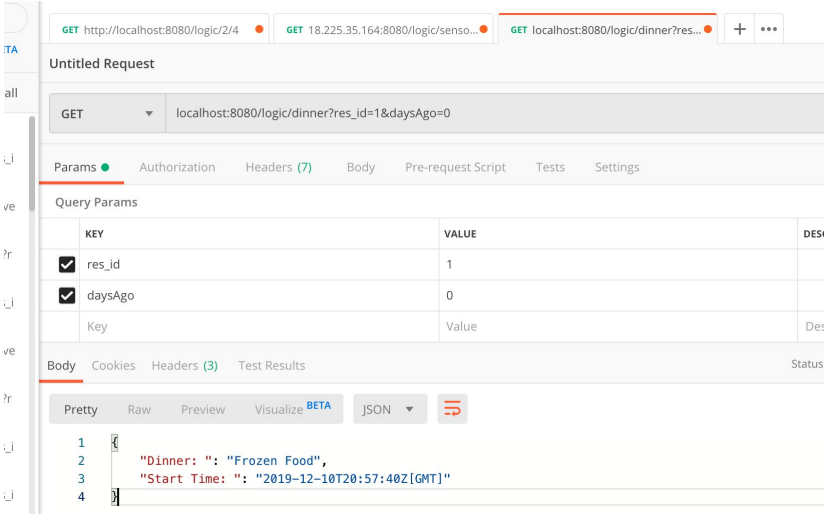
# Results - Hardware Screenshot

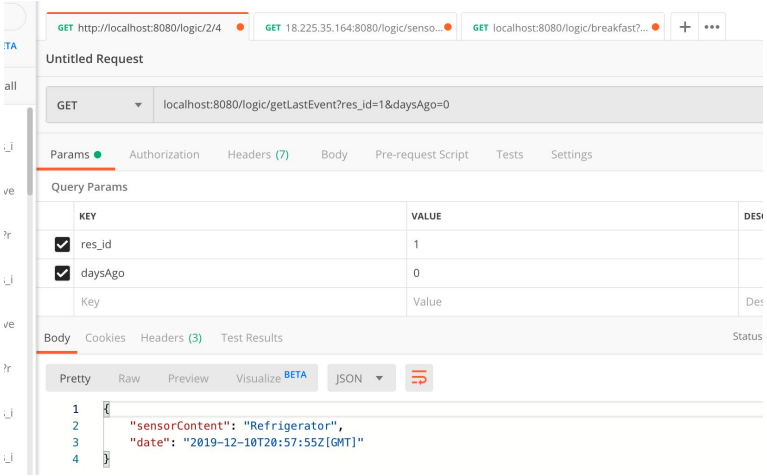
```
Looking up:  5   {'MAC': '24:71:89:CC:50:80', 'sensor_id': 21}
Acc Device 24:71:89:CC:50:80 reported
*******
Max G:  70.1751708984375
Min G:  -58.89892578125
4.777399301528931
*******
Gyro Device B0:91:22:F6:85:04 reported
Looking up:  2   {'MAC': 'B0:91:22:F6:85:04', 'sensor_id': 17}
*******
Max G:  173.45428466796875
Min G:  -173.7518310546875
55.77027344703674
*******
Gyro Device B0:91:22:EA:3B:80 reported
Looking up:  1   {'MAC': 'B0:91:22:EA:3B:80', 'sensor_id': 14}
```



```
pi@raspberrypi:~/Desktop/Relay $ python3 relay.py
(1, 1576033060.5177836, 4.58227276802063, 1, 21)
INSERT INTO nxgenDb.time_stamp (`time_stamp`, `information`, `resident_id`, `sen
sor_id`) VALUES (%s, %s, %s, %s)
(2, 1576033063.2462099, 0.7311911582946777, 1, 21)
INSERT INTO nxgenDb.time_stamp (`time_stamp`, `information`, `resident_id`, `sen
sor_id`) VALUES (%s, %s, %s, %s)
(3, 1576033075.9155908, 4.777399301528931, 1, 17)
INSERT INTO nxgenDb.time_stamp (`time_stamp`, `information`, `resident_id`, `sen
sor_id`) VALUES (%s, %s, %s, %s)
[1, 2, 3]
pi@raspberrypi:~/Desktop/Relay $
```

# Results - Logic Server Screenshot



# Results - Web Application

- Have an overview section
- Built to integrate cleanly with the logic server's data

# Summary

- Helping monitor the health of senior citizens
- System addresses this by:
  - Collecting data from the seniors' homes
  - Analyzing their behavior
  - Displaying health information in a web application

[14]

# Questions?

# Plan for next semester

[23]

# References


[1] Image from Guardians of the Grandparents
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[12] https://www.raspberrypi.org/homepage-9df4b/static/54b93bdabde1e5c5361c4a0ba1ee400e/bc3a8/79f578c2ef5c98c09bc85b69fac1e68e6c5a80aa_raspberry-pi-4-model-b.jpg
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[16] https://www.digikey.com/product-detail/en/texas-instruments/CC1350STKEU/296-45490-ND/6821172
[17] http://www.ti.com/tools-software/sensortag.html
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[21] http://clipart-library.com/image_gallery/15754.png
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# References

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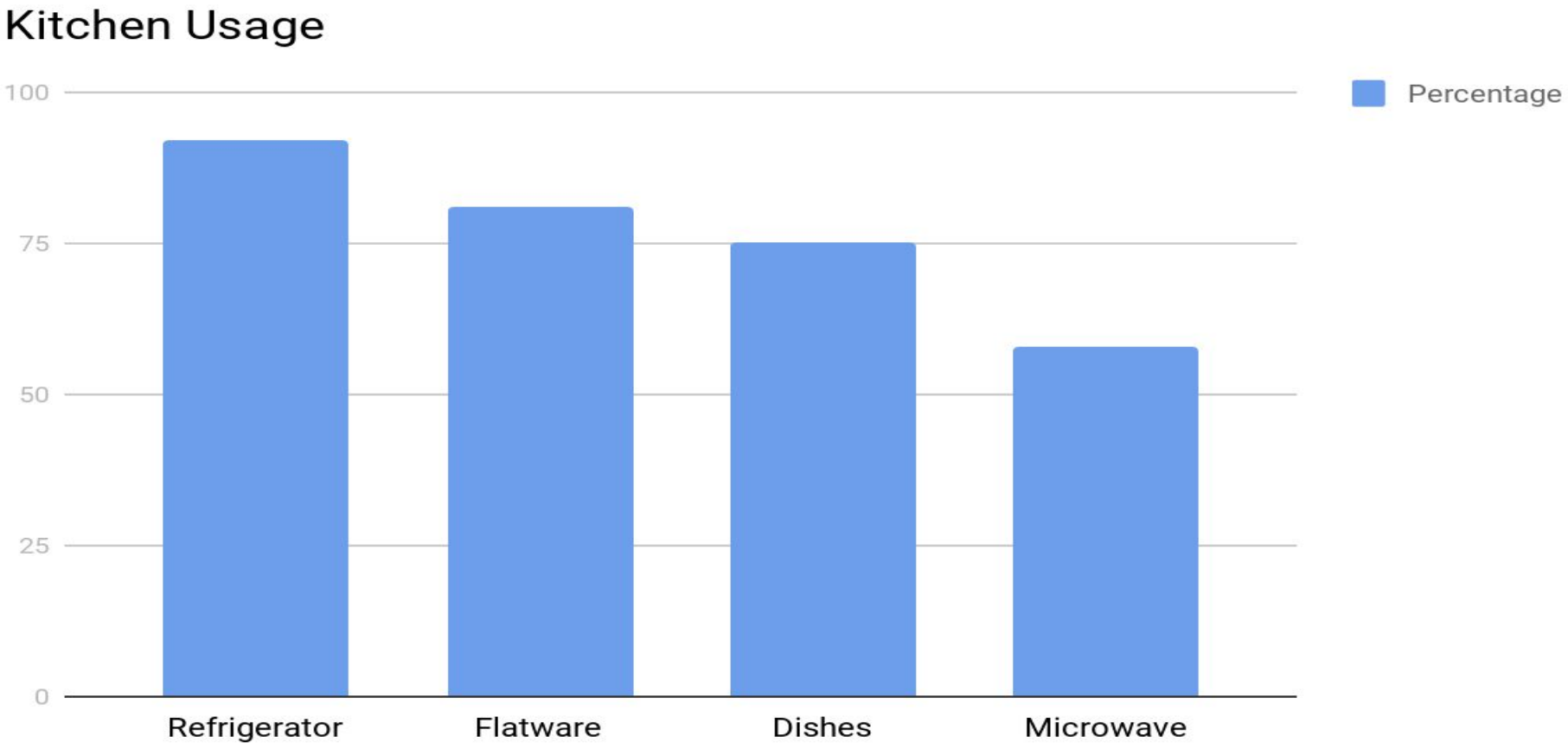
[26] https://www.amazon.com/TP-Link-HS110-Monitoring-Required-Assistant/dp/B0178IC5ZY/ref=sr_1_3?keywords=hs110&qid=1576024131&sr=8-3
[27] https://www.digikey.com/product-detail/en/texas-instruments/CC2650STK/296-38831-ND/5130740

# Appendix A


Kitchen Usage
100
75
50
25
0
Refrigerator
Flatware
Dishes
Microwave
Percentage