



TEMPERATURE GRADIENTS OF LOOMIS LABORATORY OF PHYSICS

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Introduction

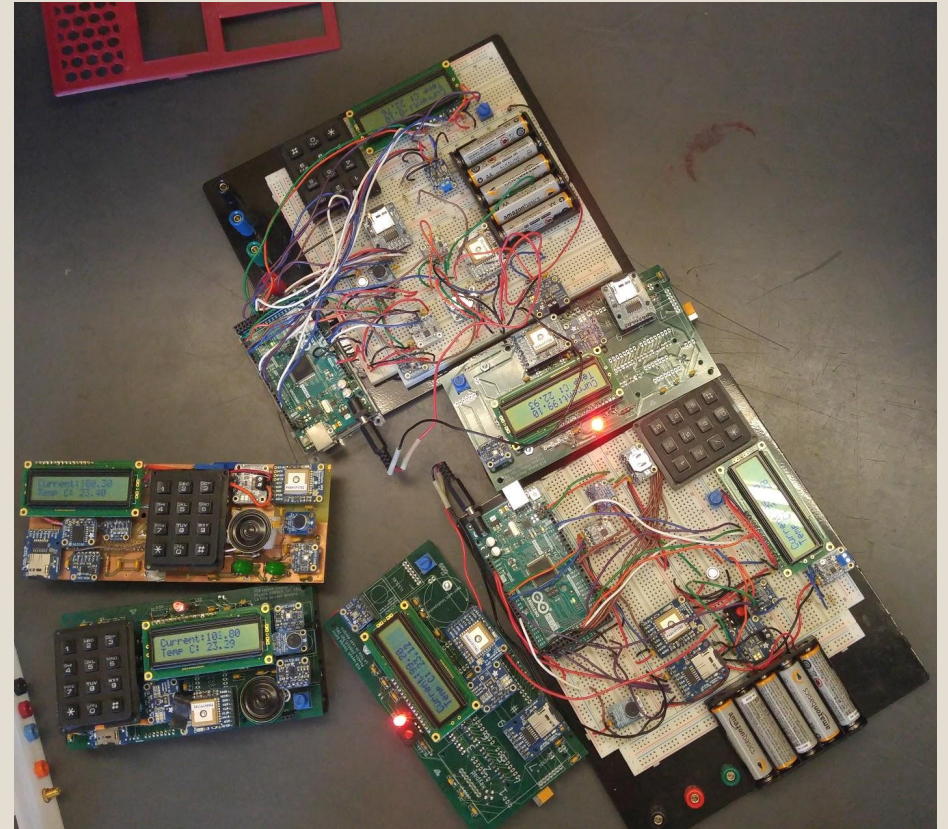
We took temperature data inside and outside Loomis

Inside, we measured temperature at different heights over time in 141

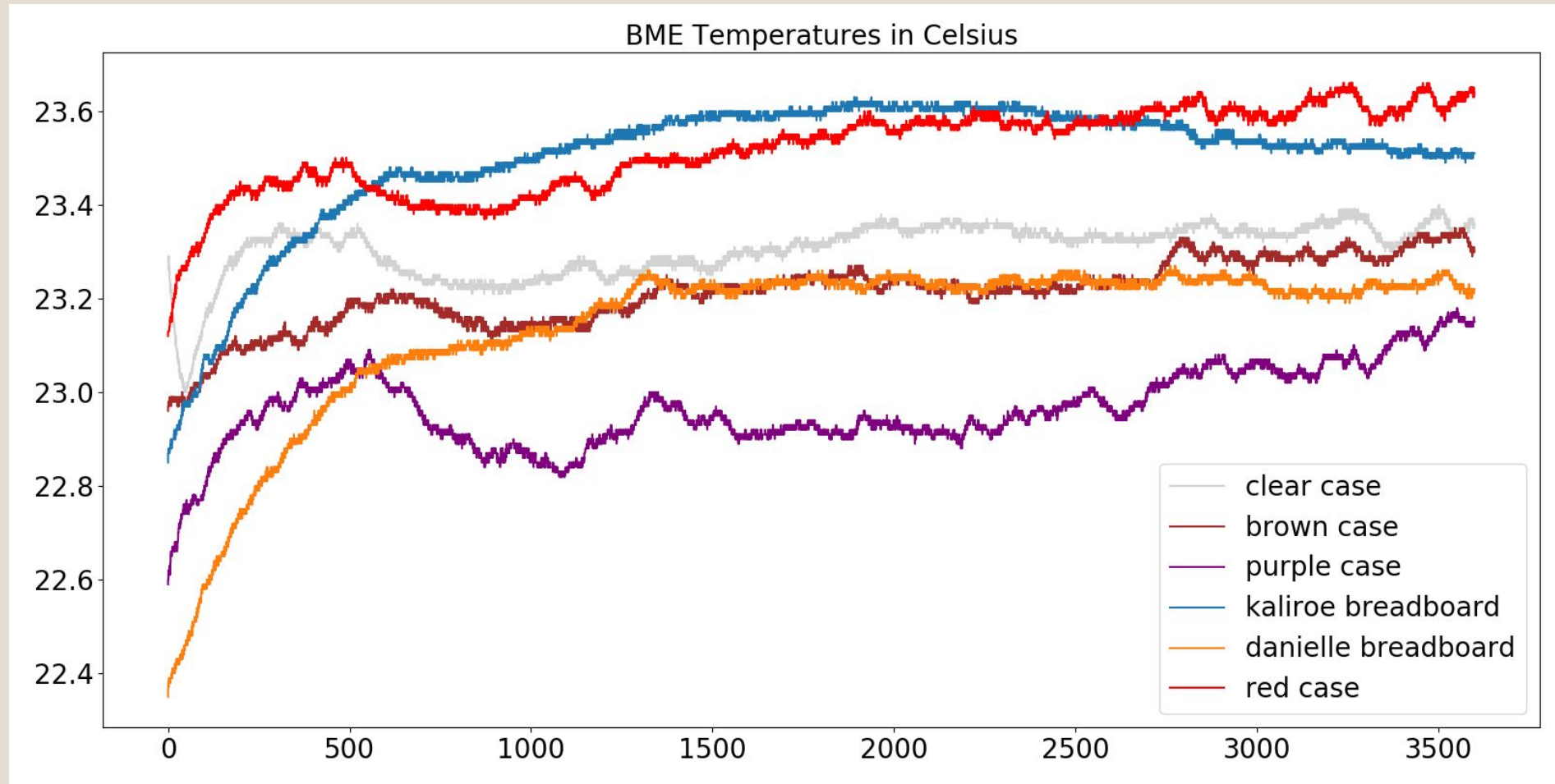
Outside, we measured the heat escaping through different building materials

Device

- microSD card breakout board
- BME680
- IR sensor
- INA219
- LCD screen
- Arduino
- LED
- on-off button



Calibration (raw data)



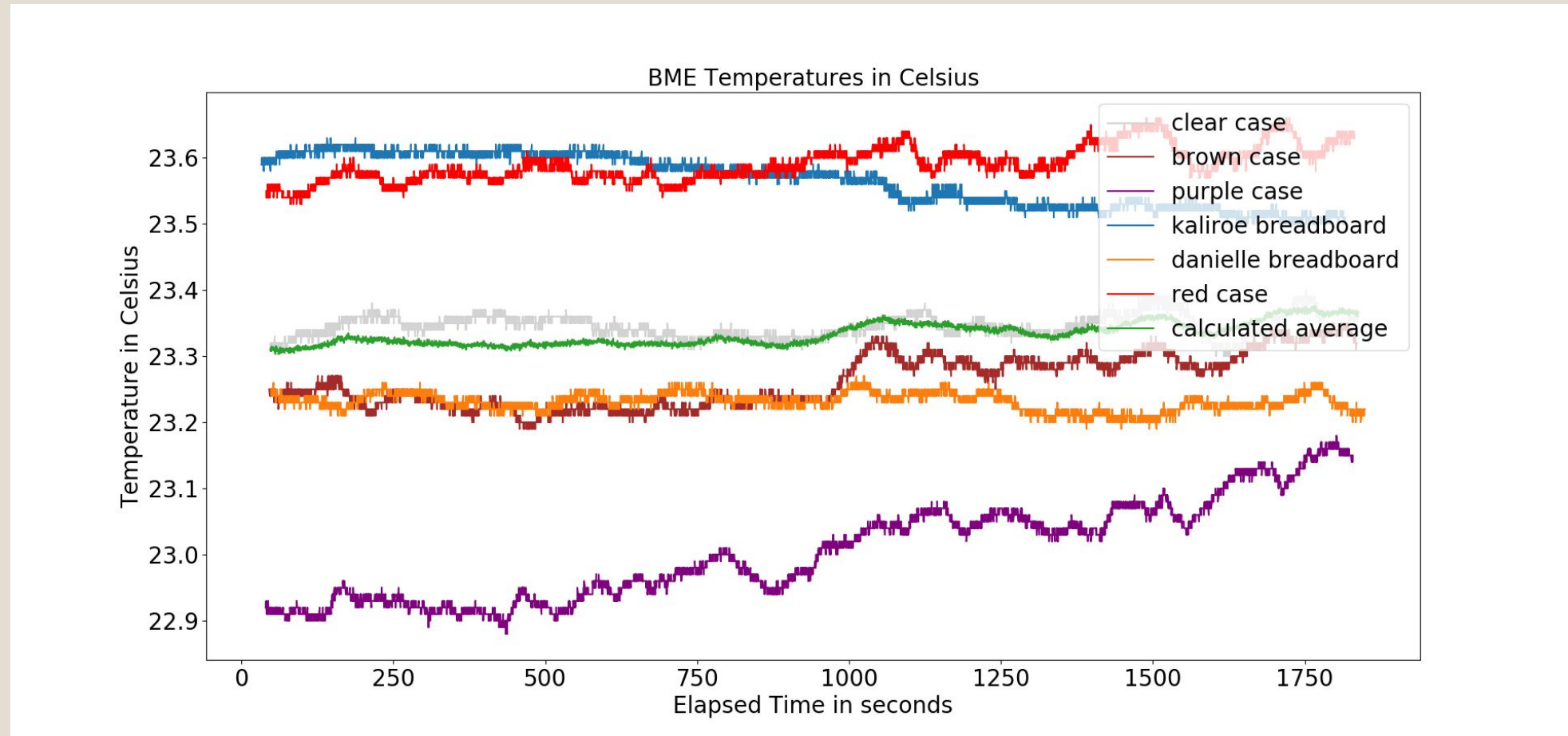
Calibration (calculations)

These calibrations were done for each sensor.

1. Cut data
2. Find average temperature over all data collected

$$\langle T_1 + T_2 + T_3 + \dots + T_N \rangle = \frac{\sum_{n=1}^N T_n}{N}$$

Calibration (with average)



Calibration (calculations)

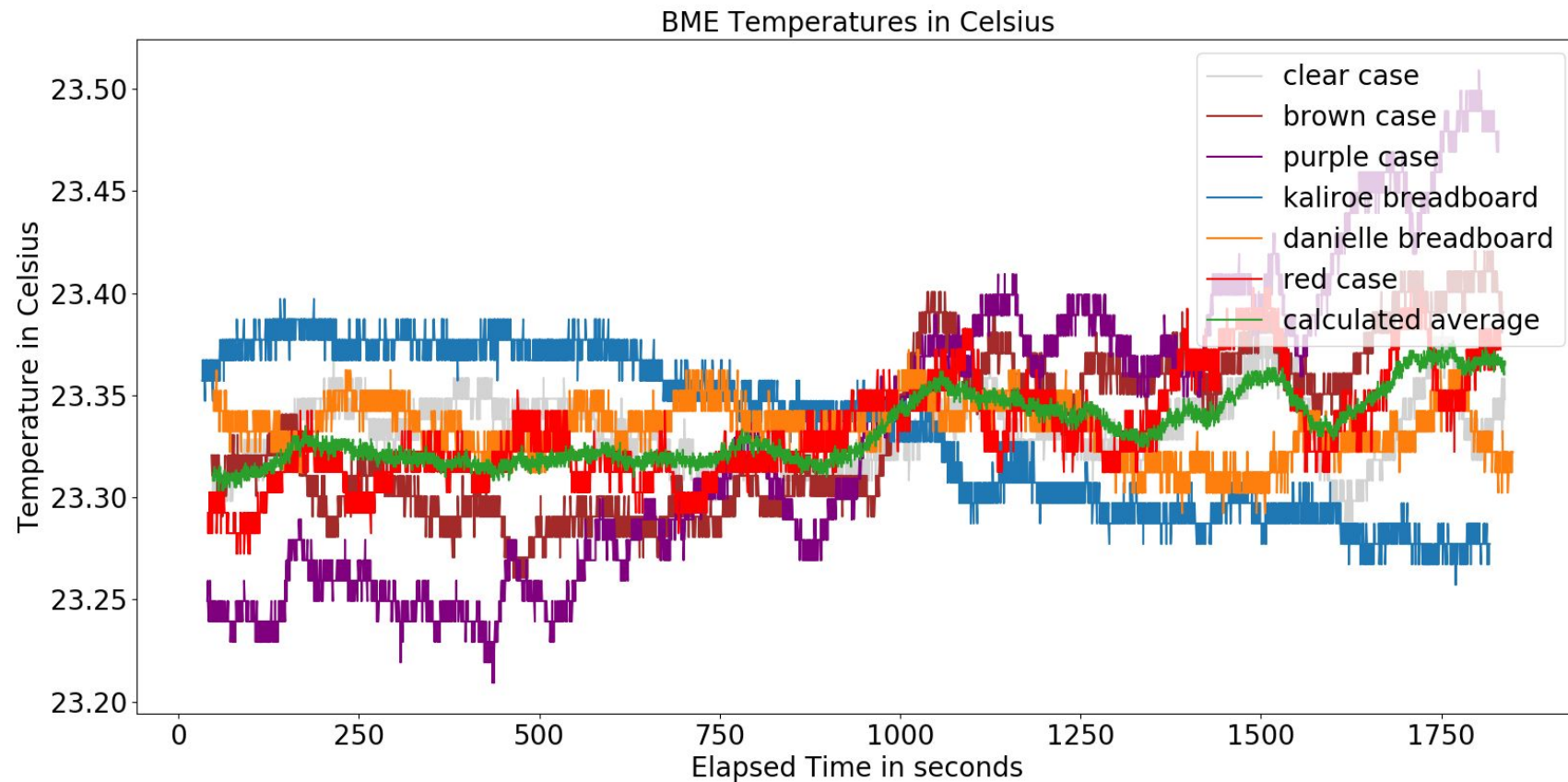
3. Find the average distance from the calculated average for each sensor
4. Shift data accordingly
5. Find RMS for each sensor

$$RMS = \sqrt{\langle (T' - T_{avg})^2 \rangle - \langle (T' - T_{avg}) \rangle^2}$$

Calibration Results

Sensor	Average Distance from Calculated Average Temperature	Root Mean Square Value
Clear Case	-0.0116859903382	0.0182753042149
Brown Case	0.0705942028985	0.0252187766847
Purple Case	0.329208695652	0.058751121592
Kaliroe's Breadboard	-0.232806763285	0.05252697814
Danielle's Breadboard	0.102256038647	0.0222151059809
Red Case	-0.257566183575	0.0152955073159

Calibration Results



DAQ



Our DAQ collected data from the sensors

Uploaded the data to the SD card and saved in a CSV file

Printed data sample onto LCD screen

Operated using a timer

Ran in $\approx .33$ seconds

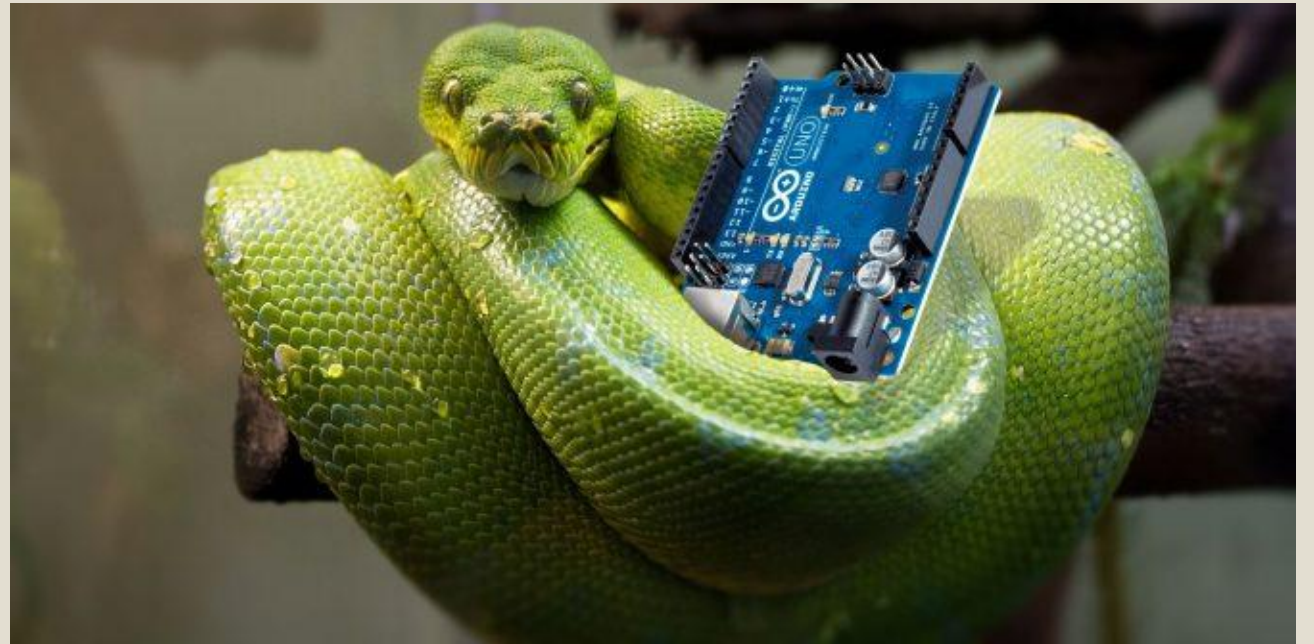
Off-line analysis



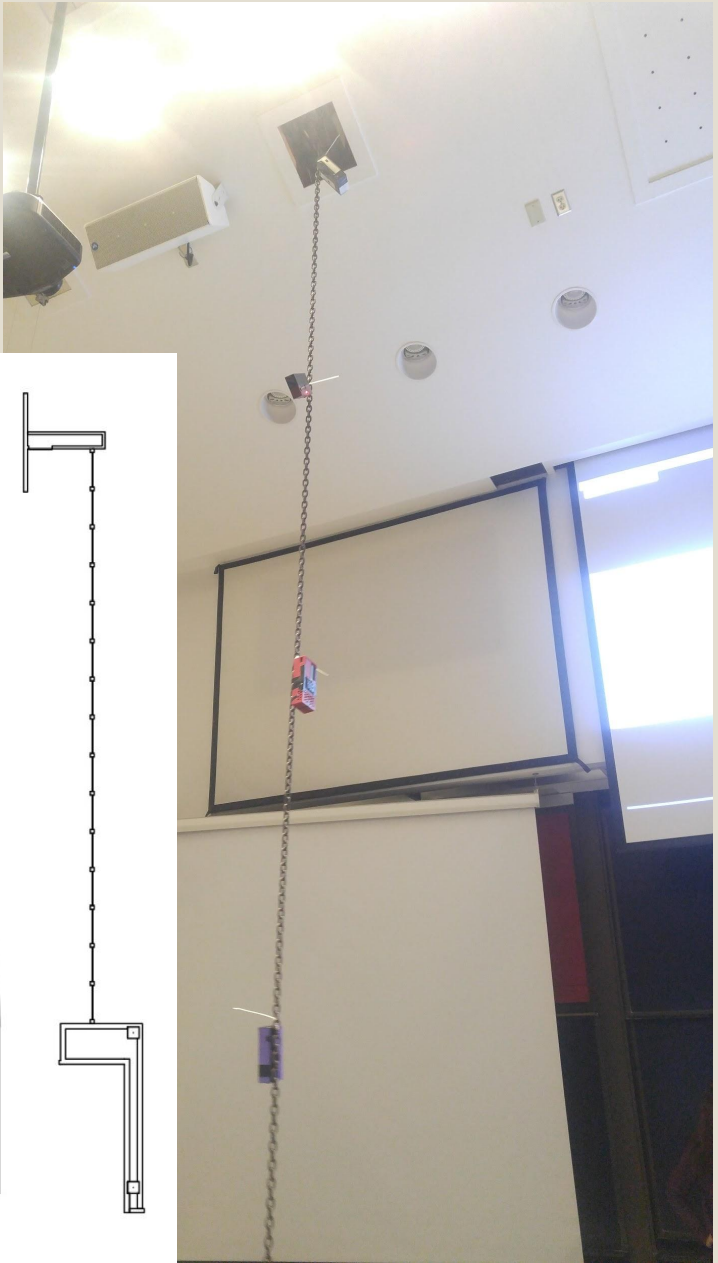
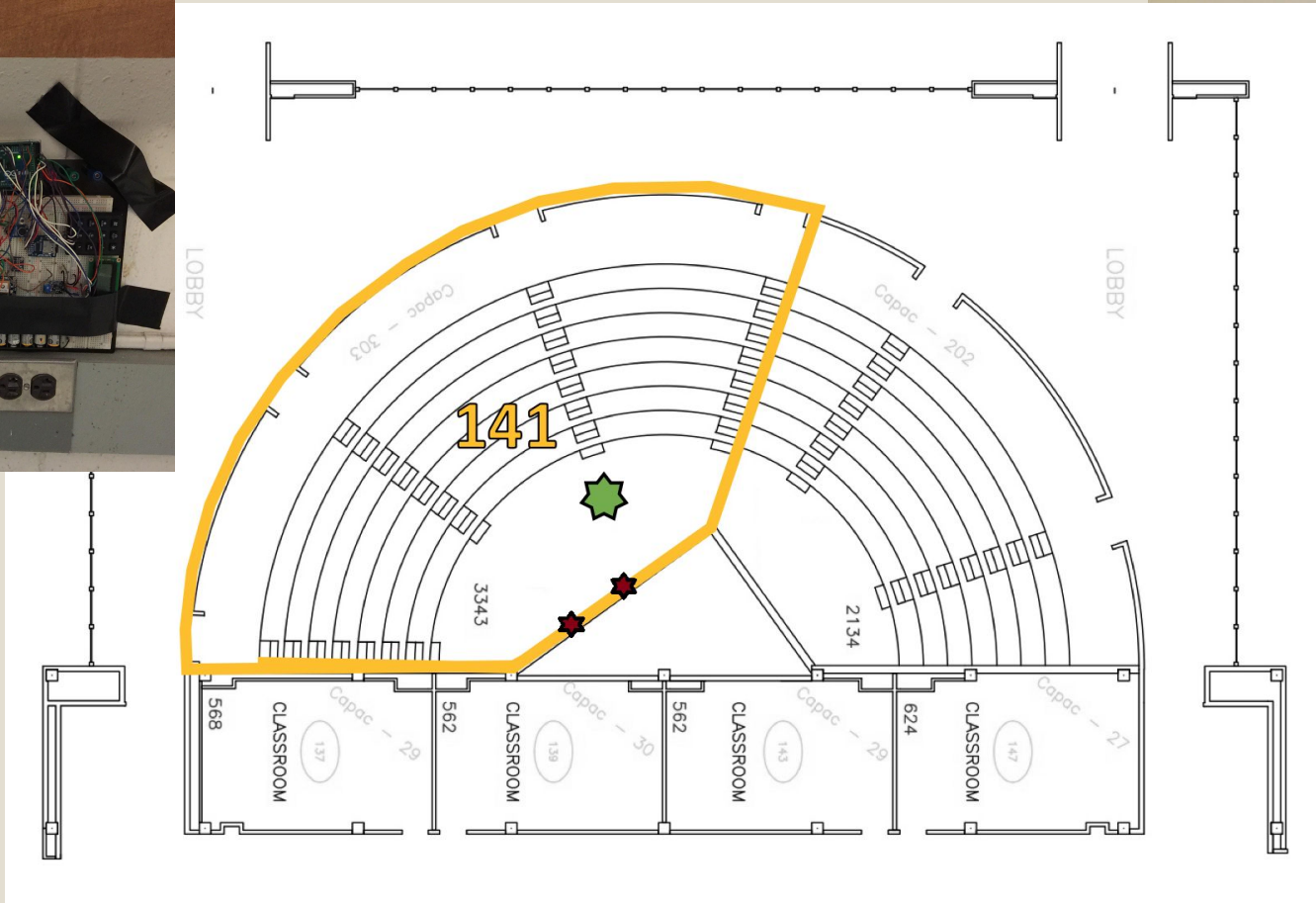
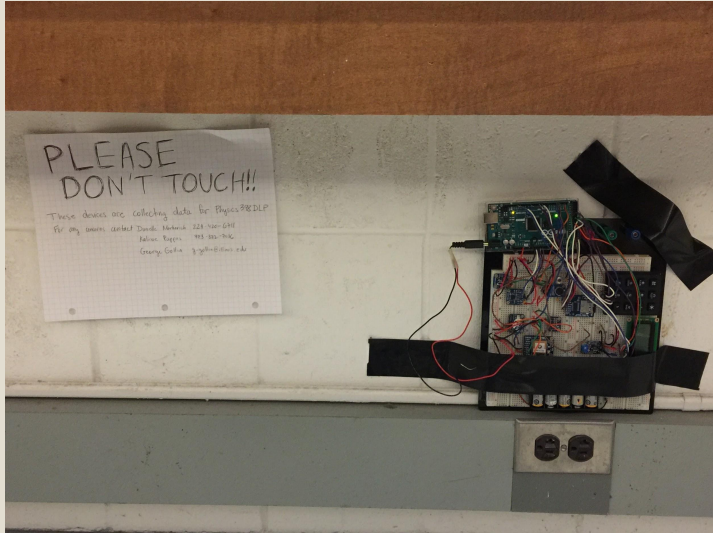
Imported CSV files into Python

Libraries used:

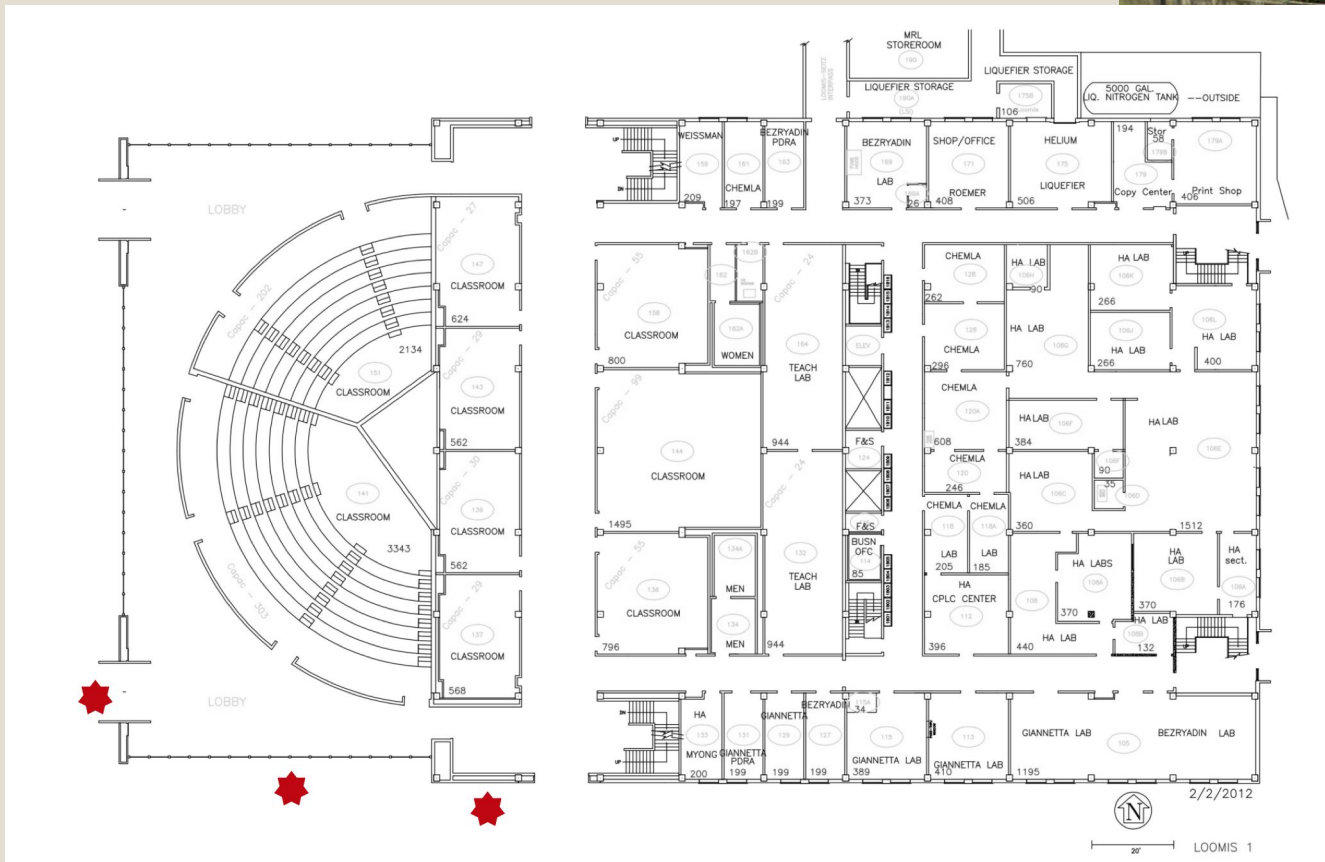
- Numpy
- Datetime
- Matplotlib



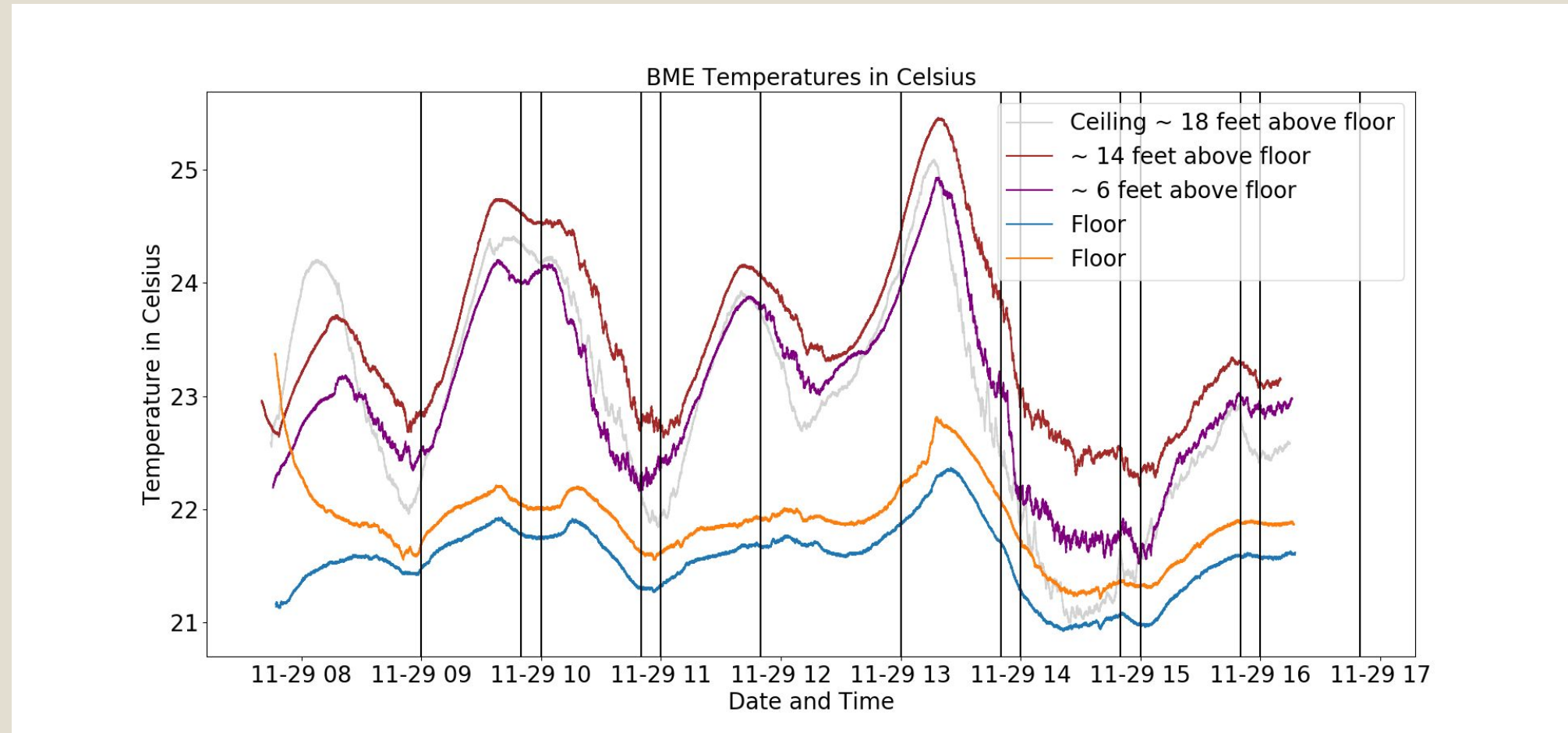
Method (inside)



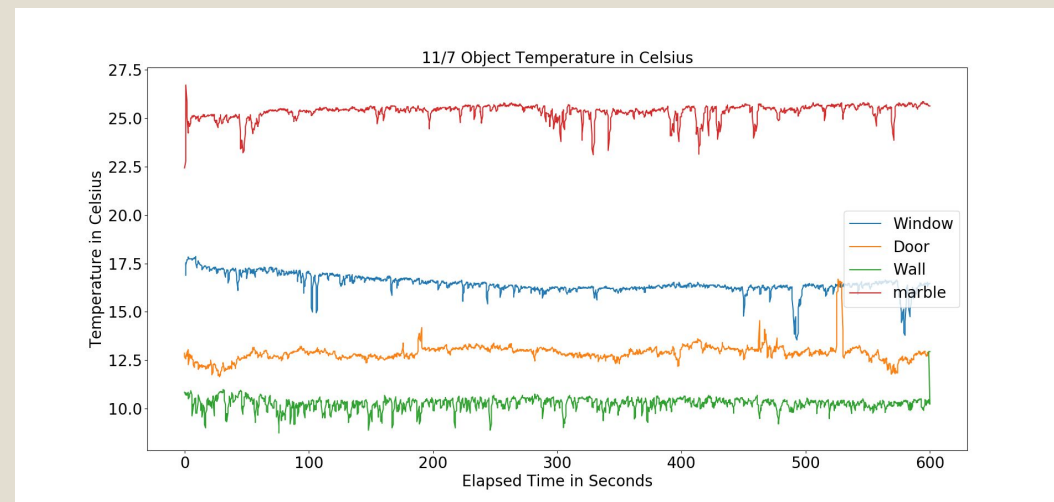
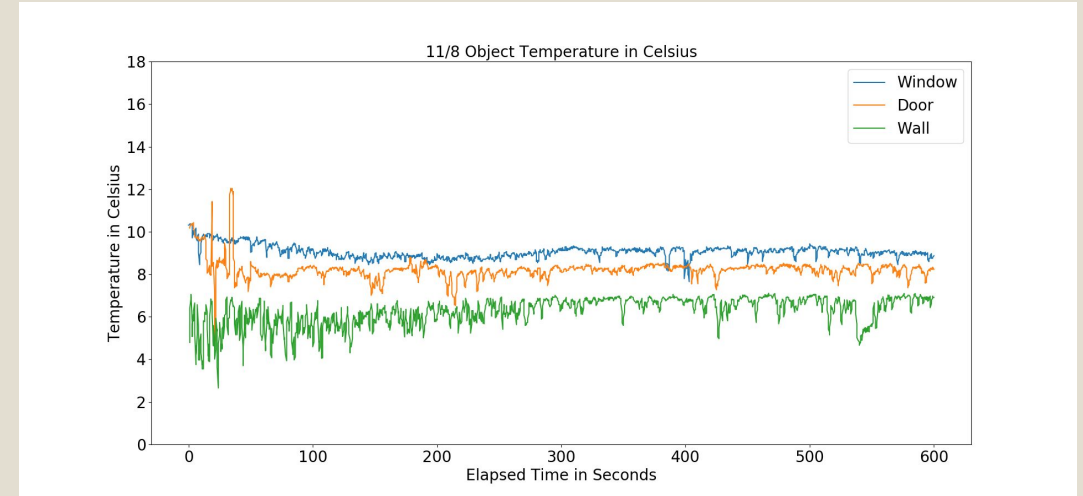
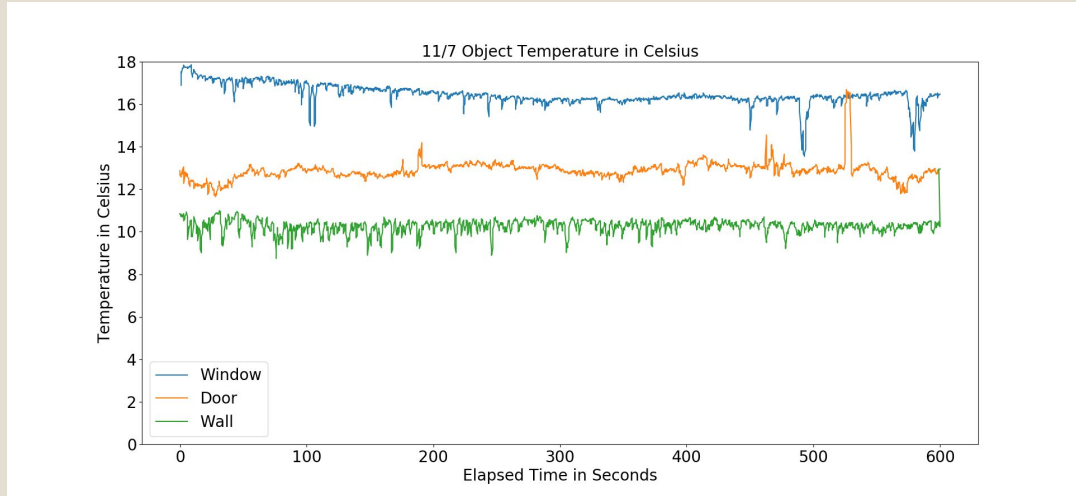
Method (outside)



Data (inside)



Data (outside)



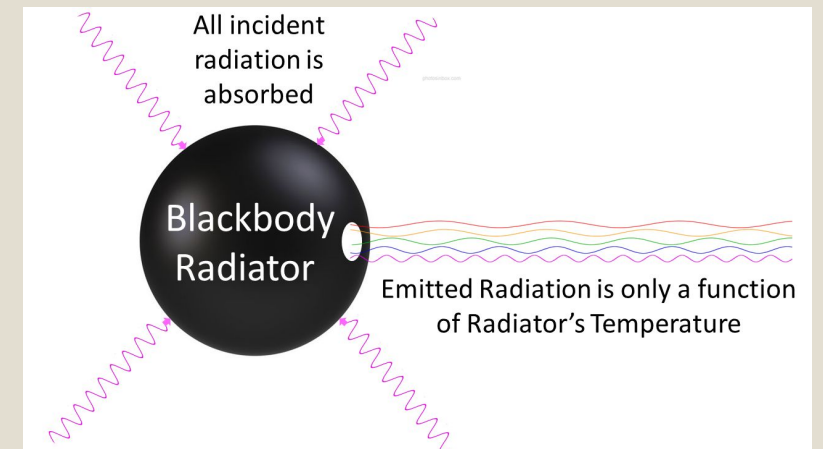
Emissivity



The property of a material that defines the ratio of the material's radiated light to that of a black body

IR sensor does not account for emissivity

Object vs Ambient



Conclusion

If Loomis were to heat based on flow of people, it would be more efficient

More emissivity tests should be done in order to draw conclusions from the IR data