Experience with MPC
Triumphs and Failings

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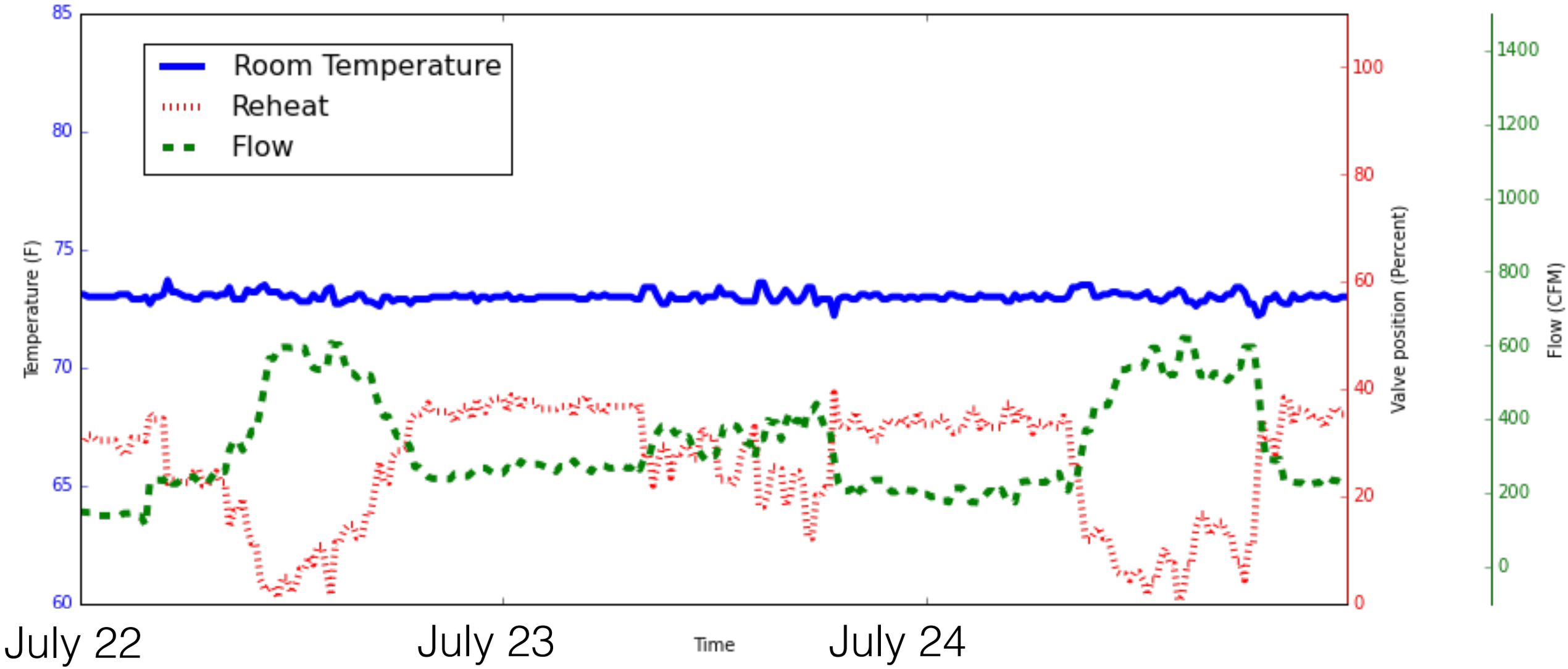
SDB Winter Retreat


Room Temperature
Reheat
Flow
85
80
75
70
65
60
100
80
60
40
20
0
1400
1200
1000
800
600
400
200
0
Temperature (F)
Valve position (Percent)
Flow (CFM)
July 22
July 23
July 24
Time

Motivation

- Zone thermal model is needed for MPC
- Anomaly detection
- Occupancy detection

Model

$$T[n+1] = a_0T[n] + a_1W[n] + a_2R[n] + a_3V[n] + a_4A[n] + Q[n] + \varepsilon$$

T: zone temperature

W: outside temperature

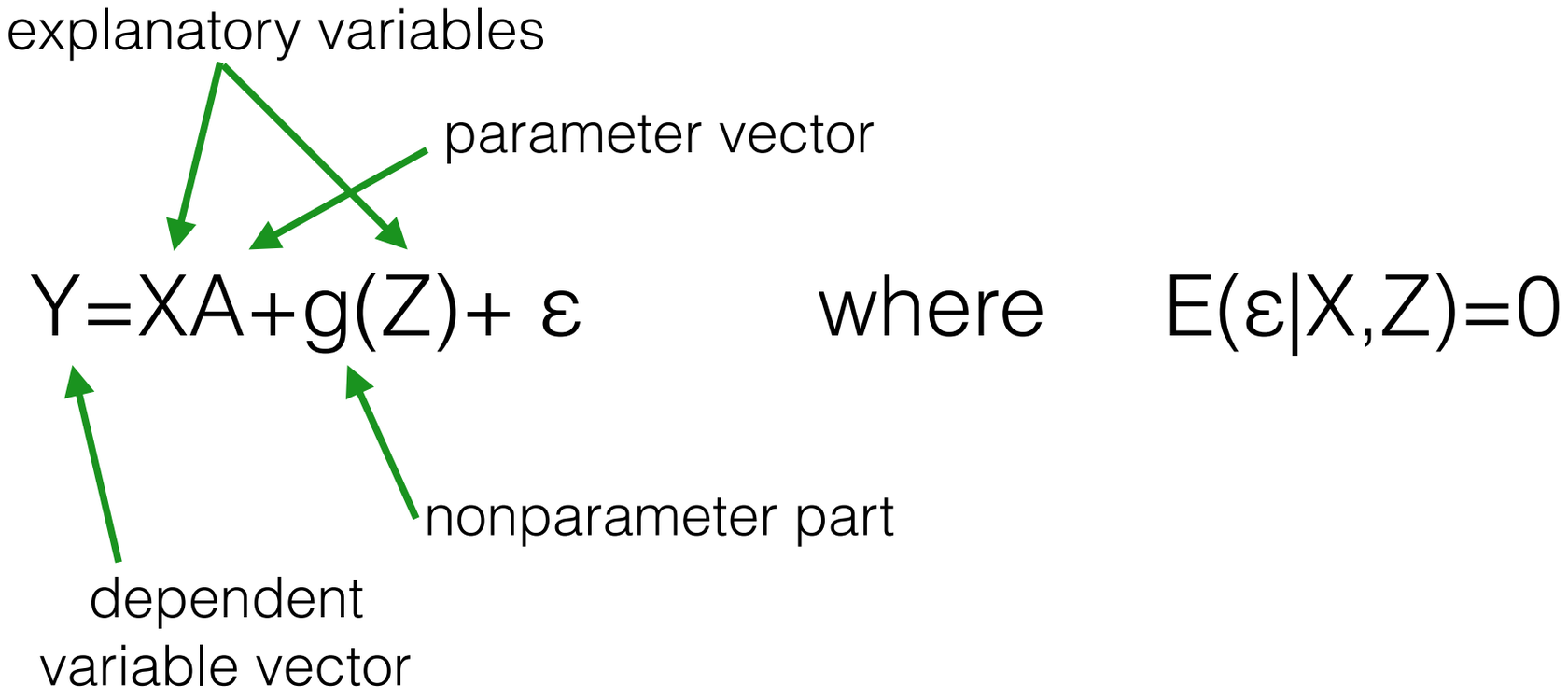
R: reheat valve position

V: supply air velocity

A: supply air temperature

Q: heat load from other sources including occupancy

Partially Linear Model



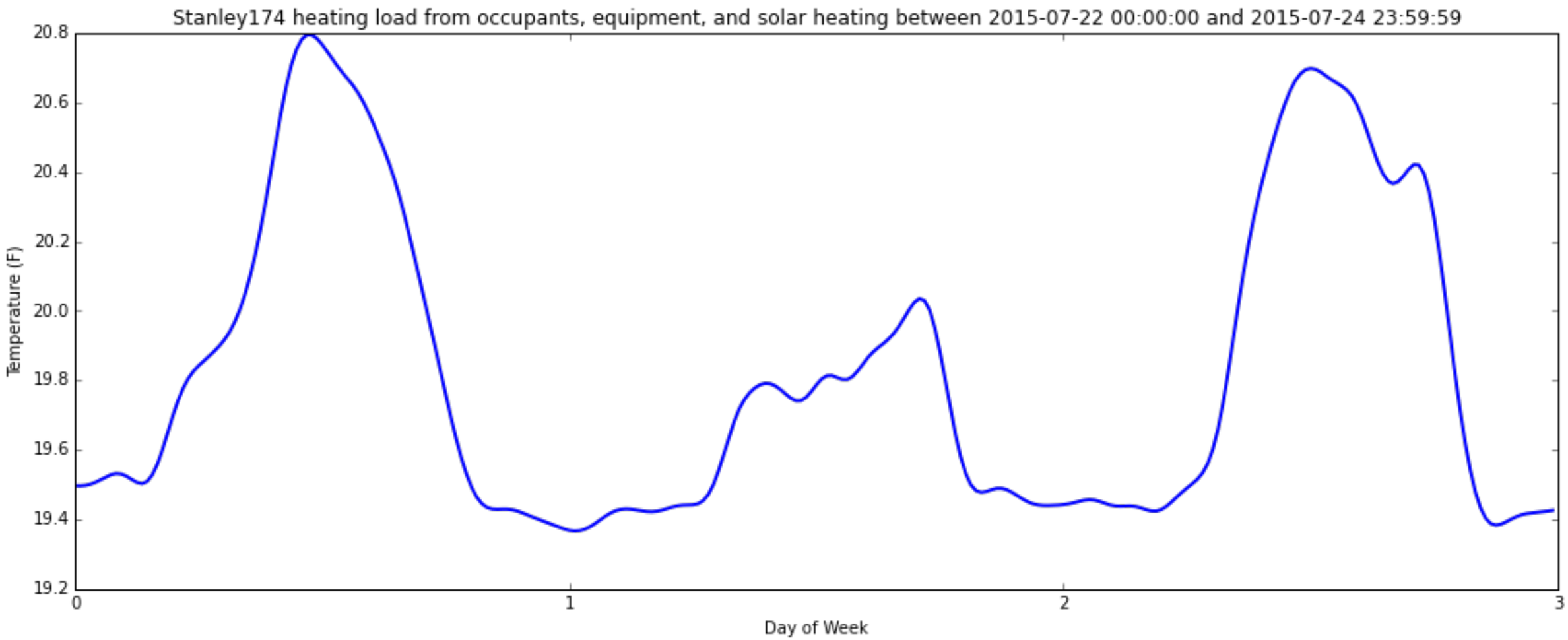
Non-Parametric Regression

$$T[n+1] = a_0 T[n] + a_1 W[n] + a_2 R[n] + a_3 V[n] + a_4 A[n] + Q[n] + \varepsilon$$

$$E(T[n+1]|n) = a_0 E(T[n]|n) + a_1 E(W[n]|n) + a_2 E(R[n]|n) + a_3 E(V[n]|n) + a_4 E(A[n]|n) + Q[n]$$

$$T[n+1] - E(T[n+1]|n) = a_0(T[n]-E(T[n]|n)) + a_1(W[n]-E(W[n]|n)) + a_2(R[n]-E(R[n]|n))$$
$$+ a_3(V[n]-E(V[n]|n)) + a_4(A[n]-E(A[n]|n)) + \varepsilon$$

Estimating the Unknown Function

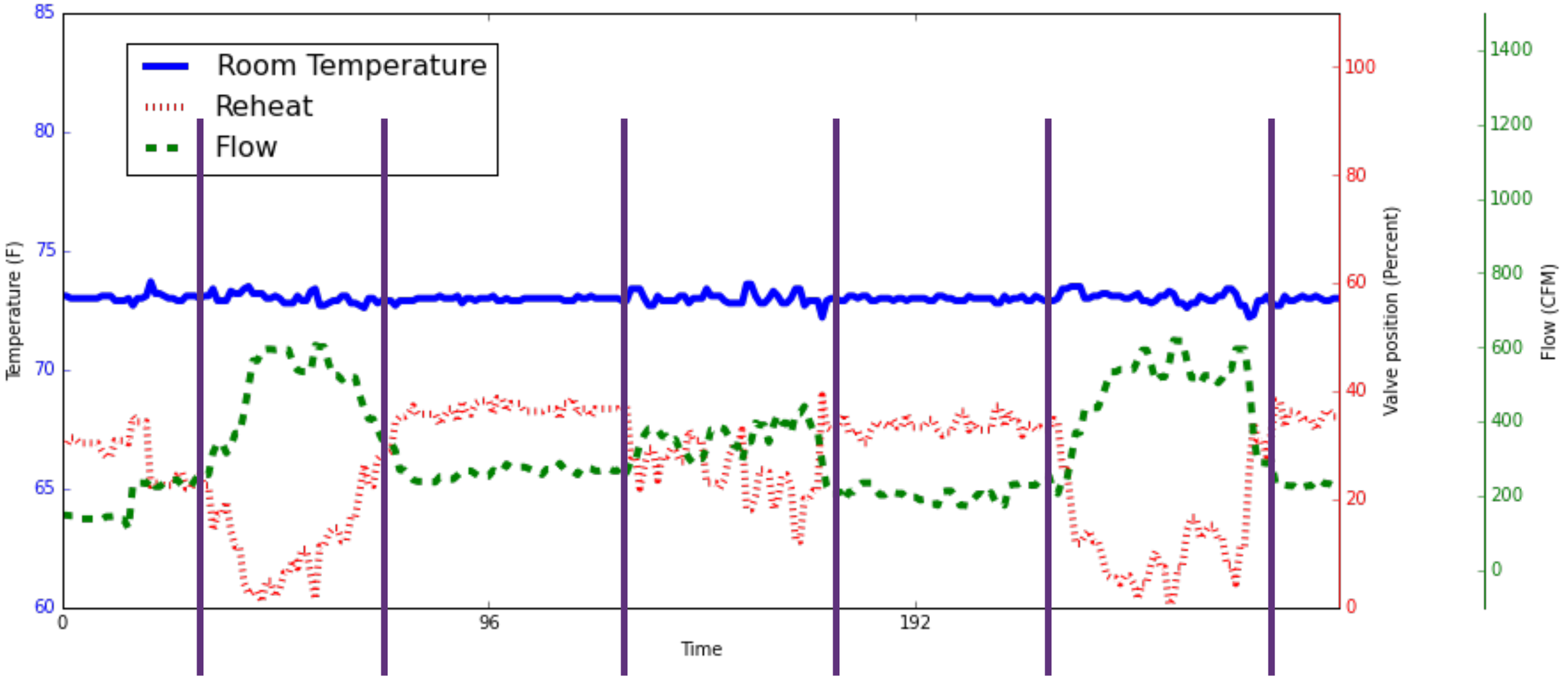


Challenges

- Lack of ground truth
- Overfitting
- Effect of surrounding zones
- Occupancy quantification vs detection

Work in Progress

- Classification of different types of rooms
- Segmentation



Work in Progress

- An iterative approach to identify model parameters and the unknown function for unoccupied intervals
  - guess the unknown function, estimate coefficients, update the unknown function, repeat
- Compute the unknown function for occupied intervals