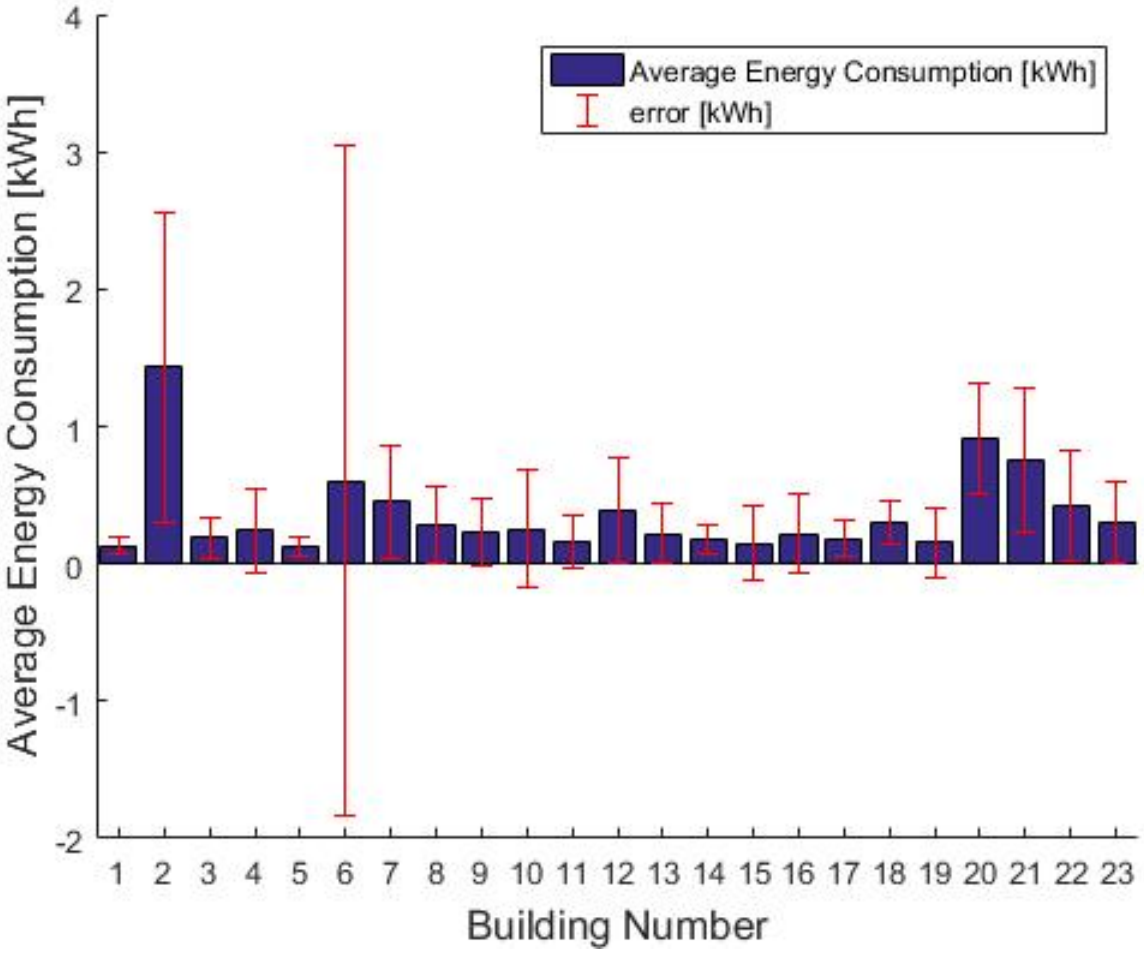
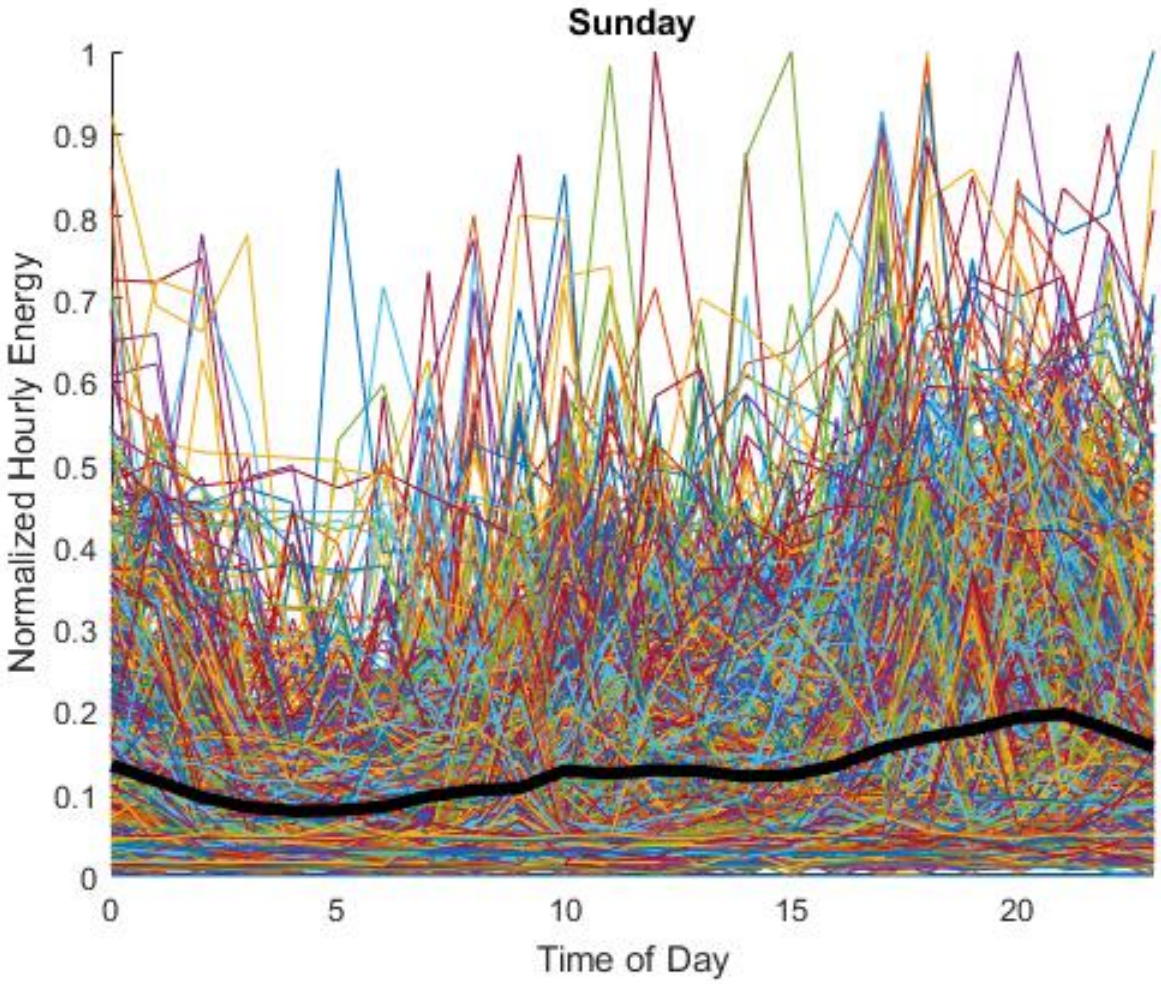
1 Problem 1: Exploratory Data Analysis

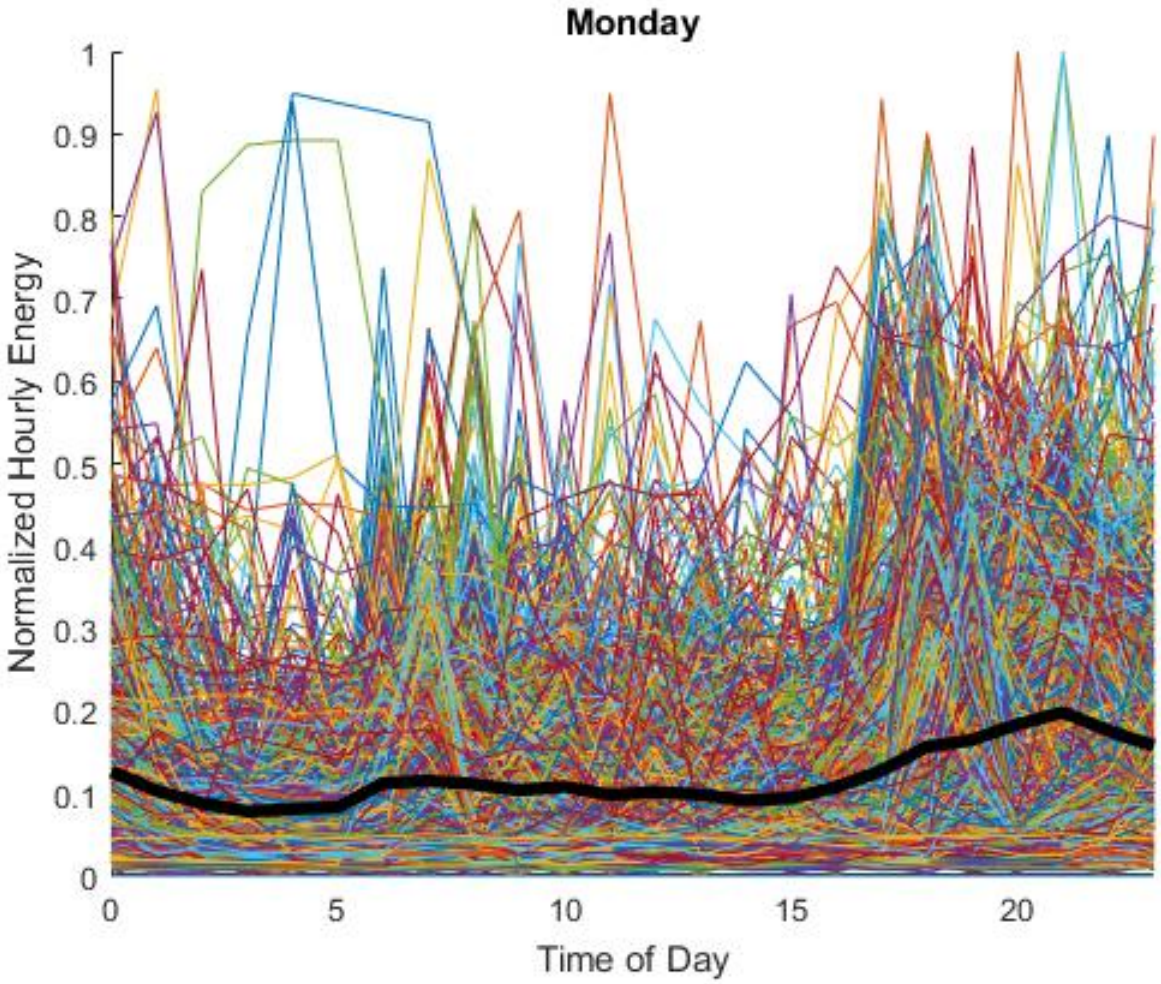


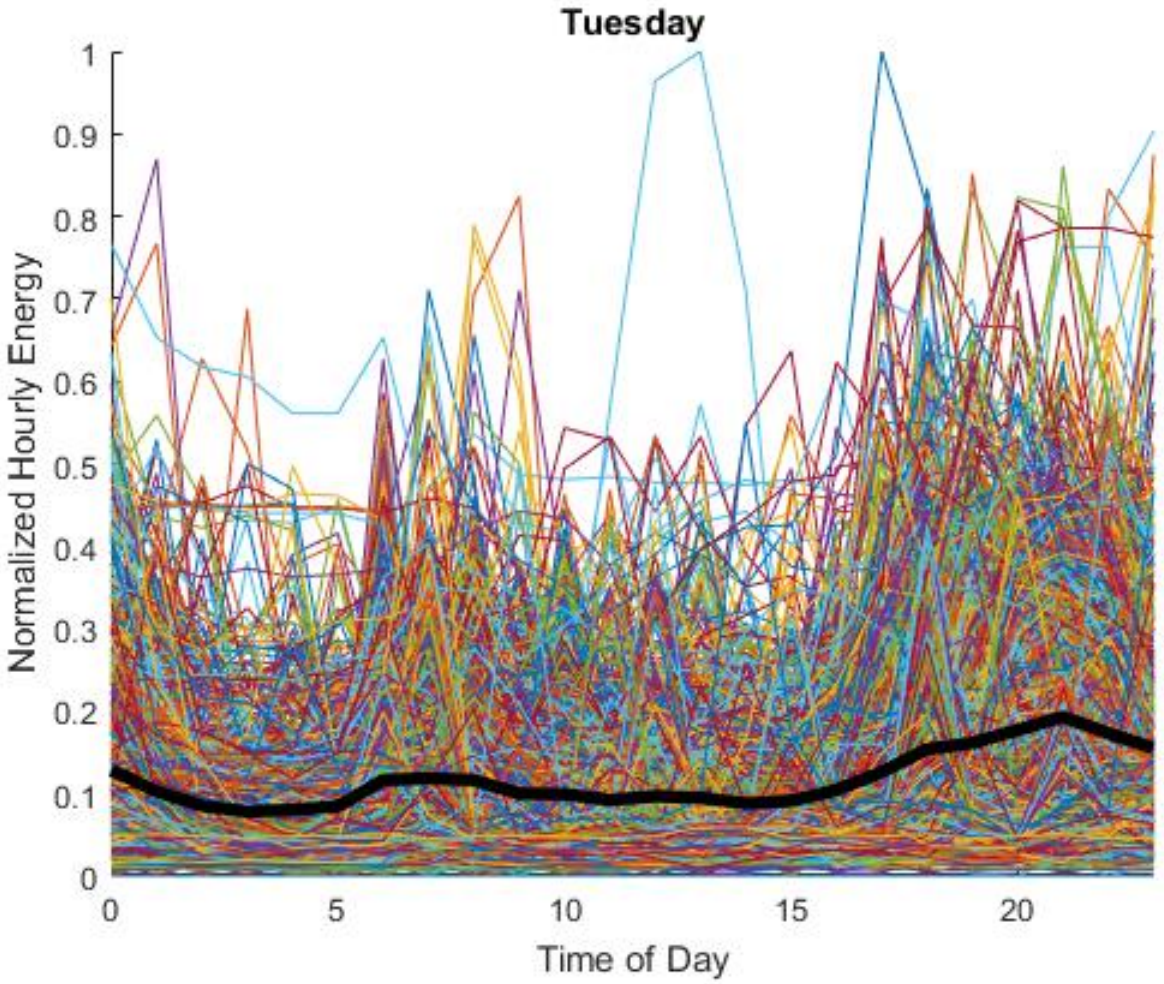
(a)

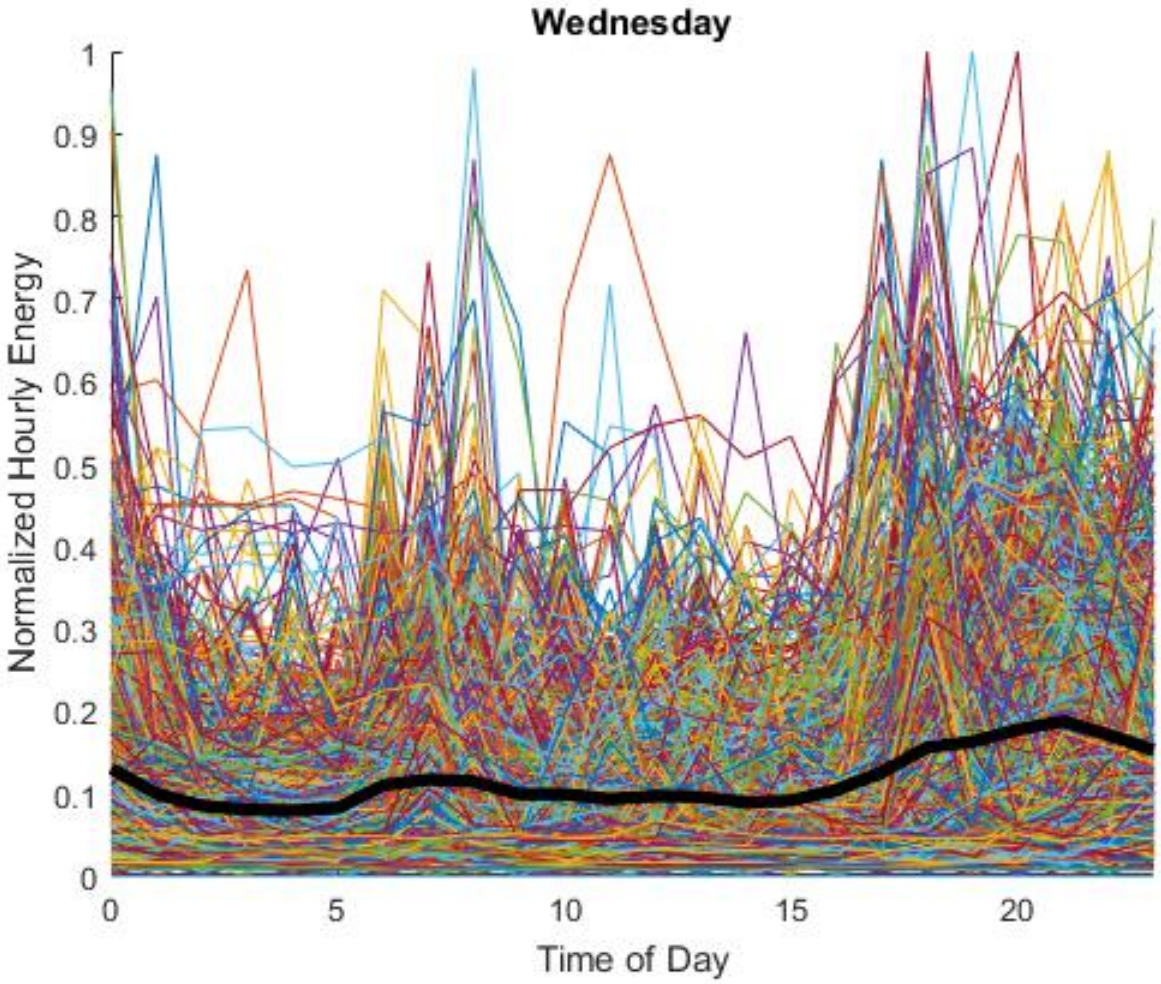
(b) Building 6 has an abnormally high variance. It also has negative energy consumption which is the cause for high variance.

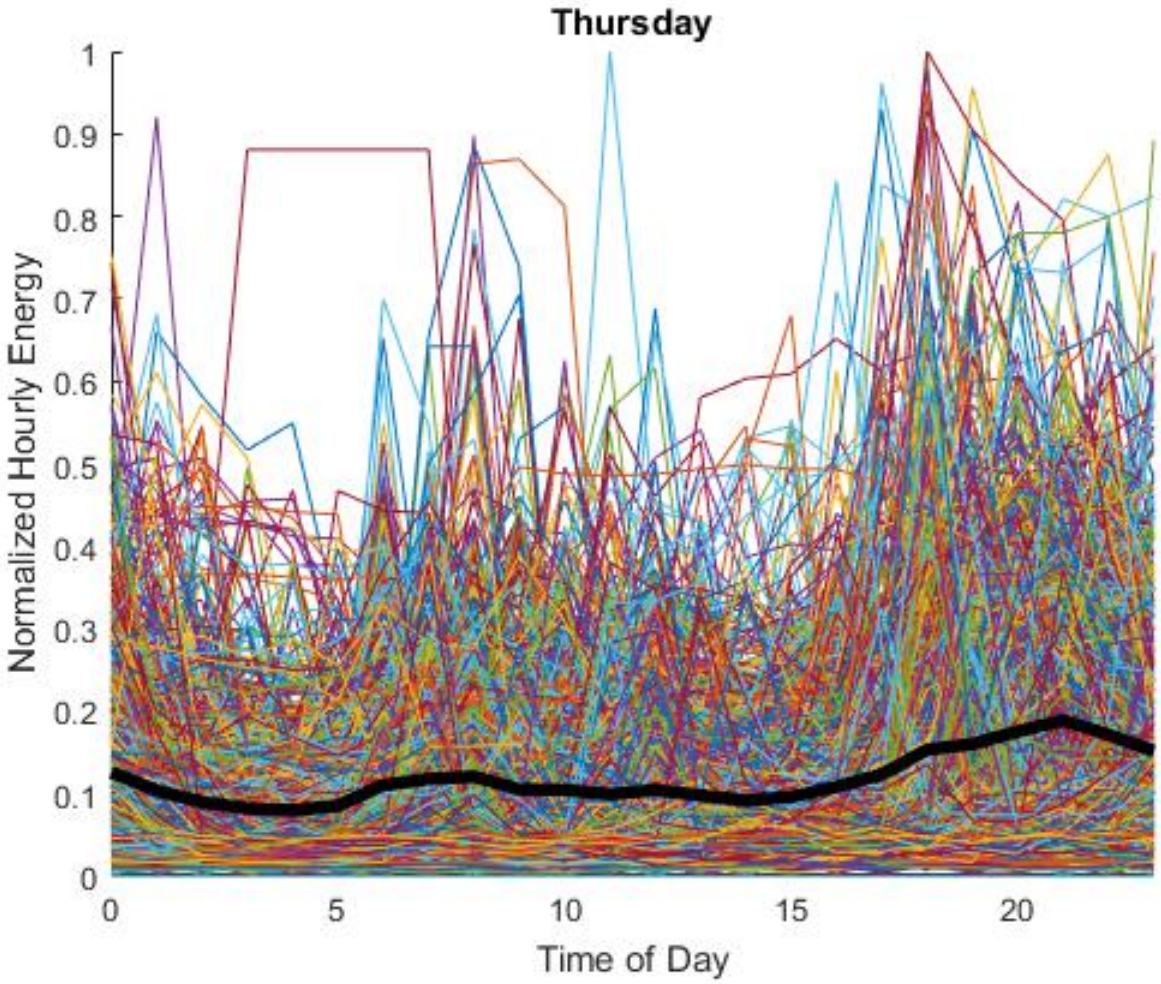
(c) Energy Plots are below:

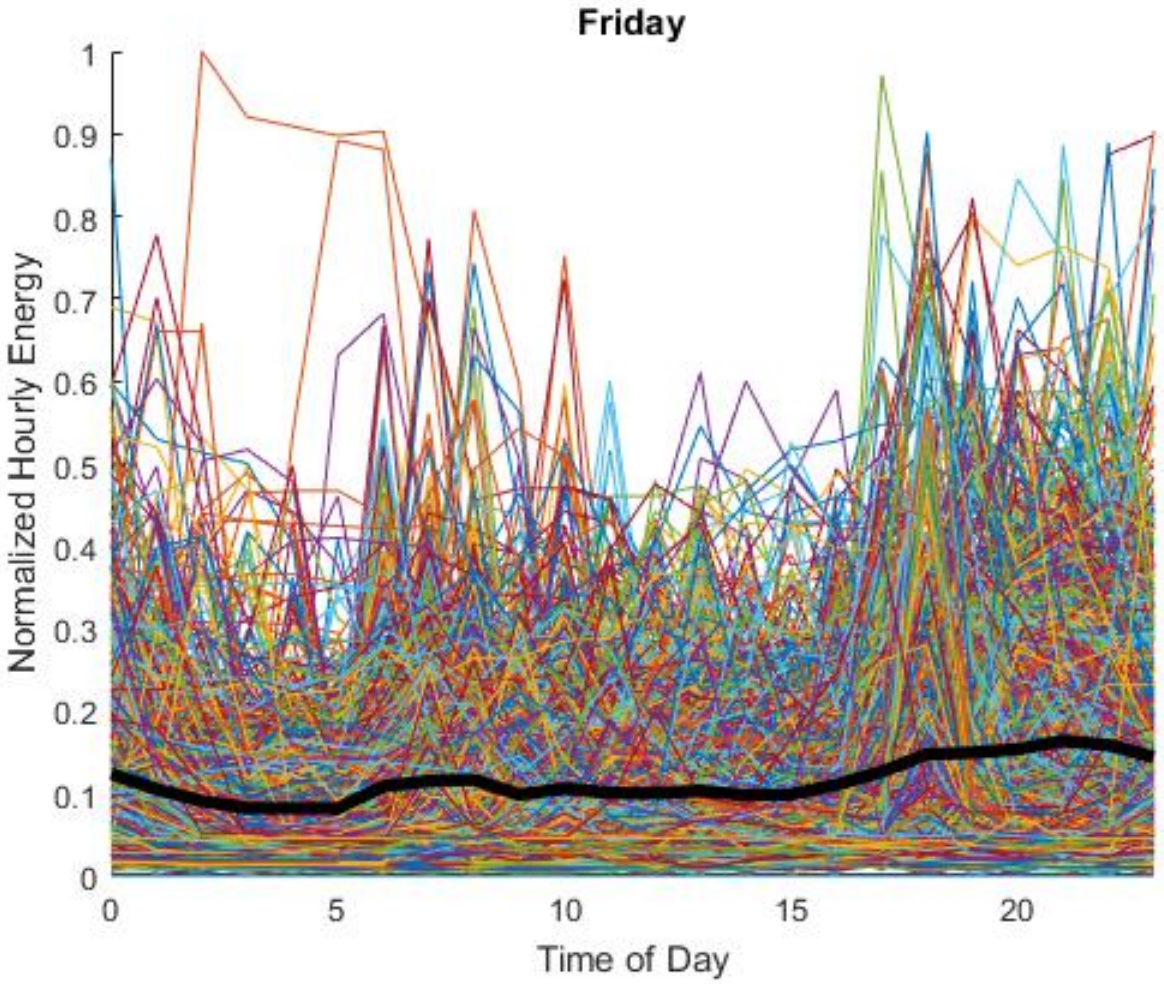

Sunday
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20

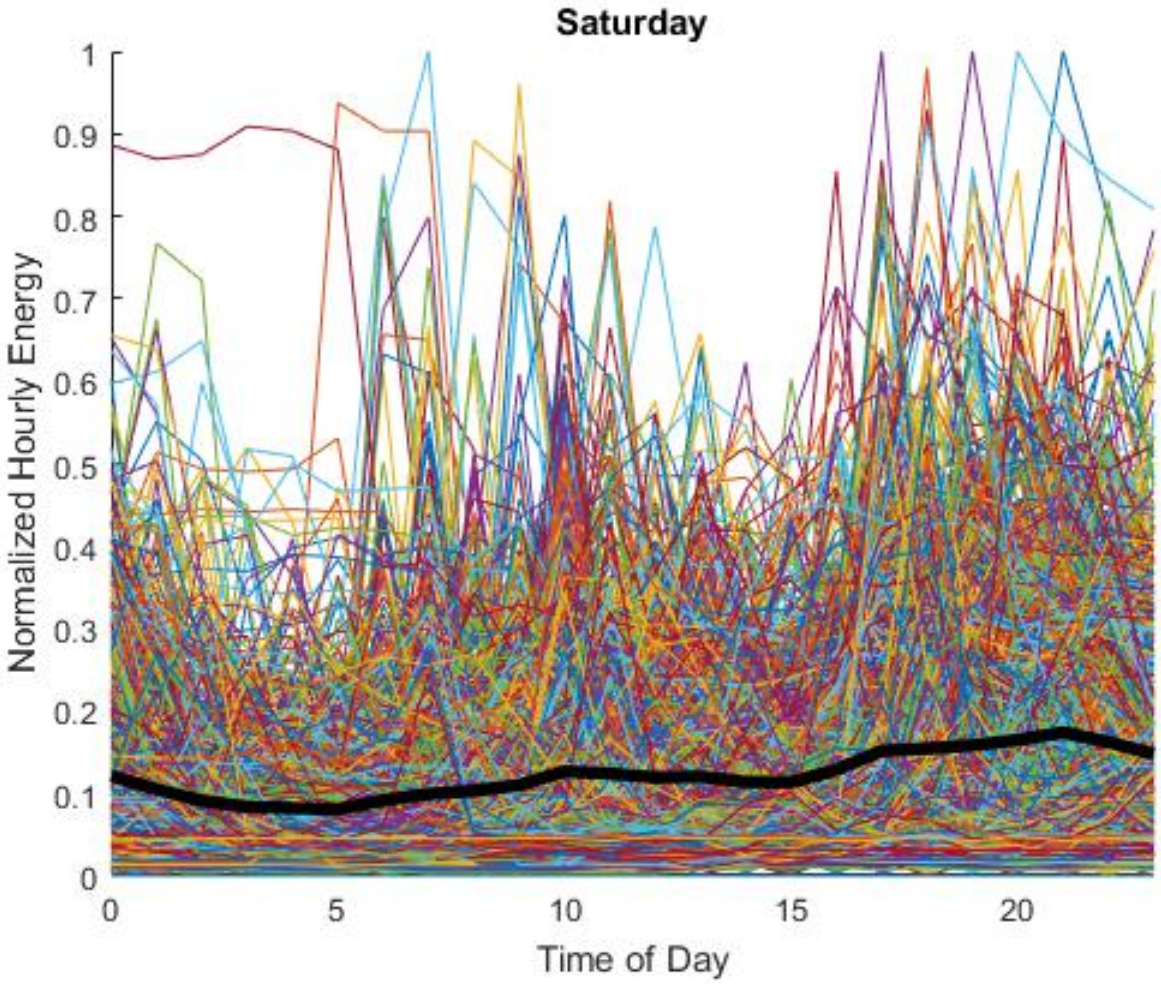

Monday
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20


Tuesday
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20

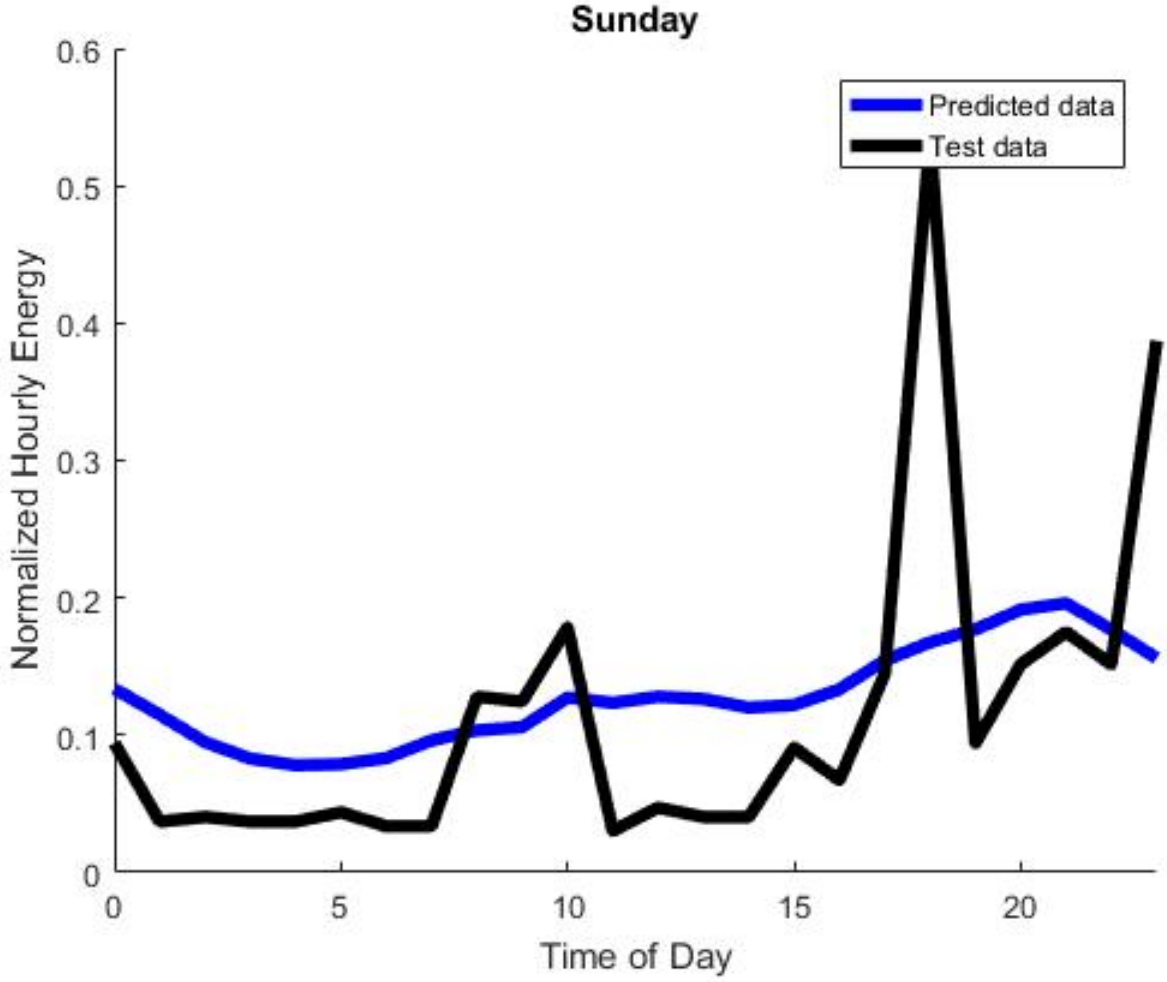

Wednesday
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20


Thursday
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20

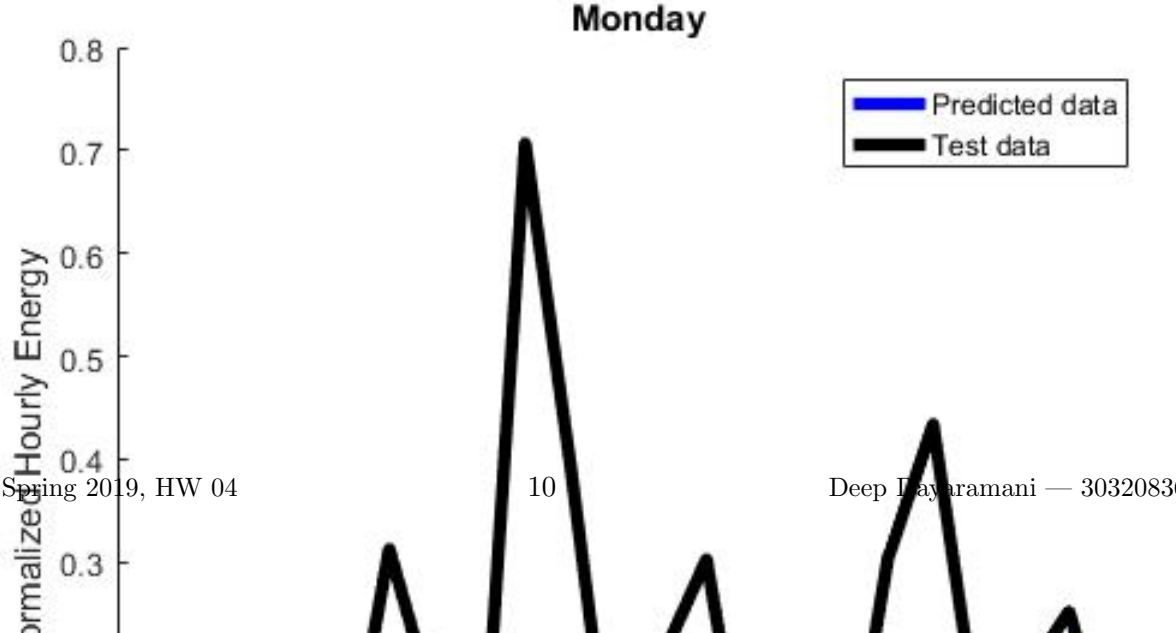

Friday
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20

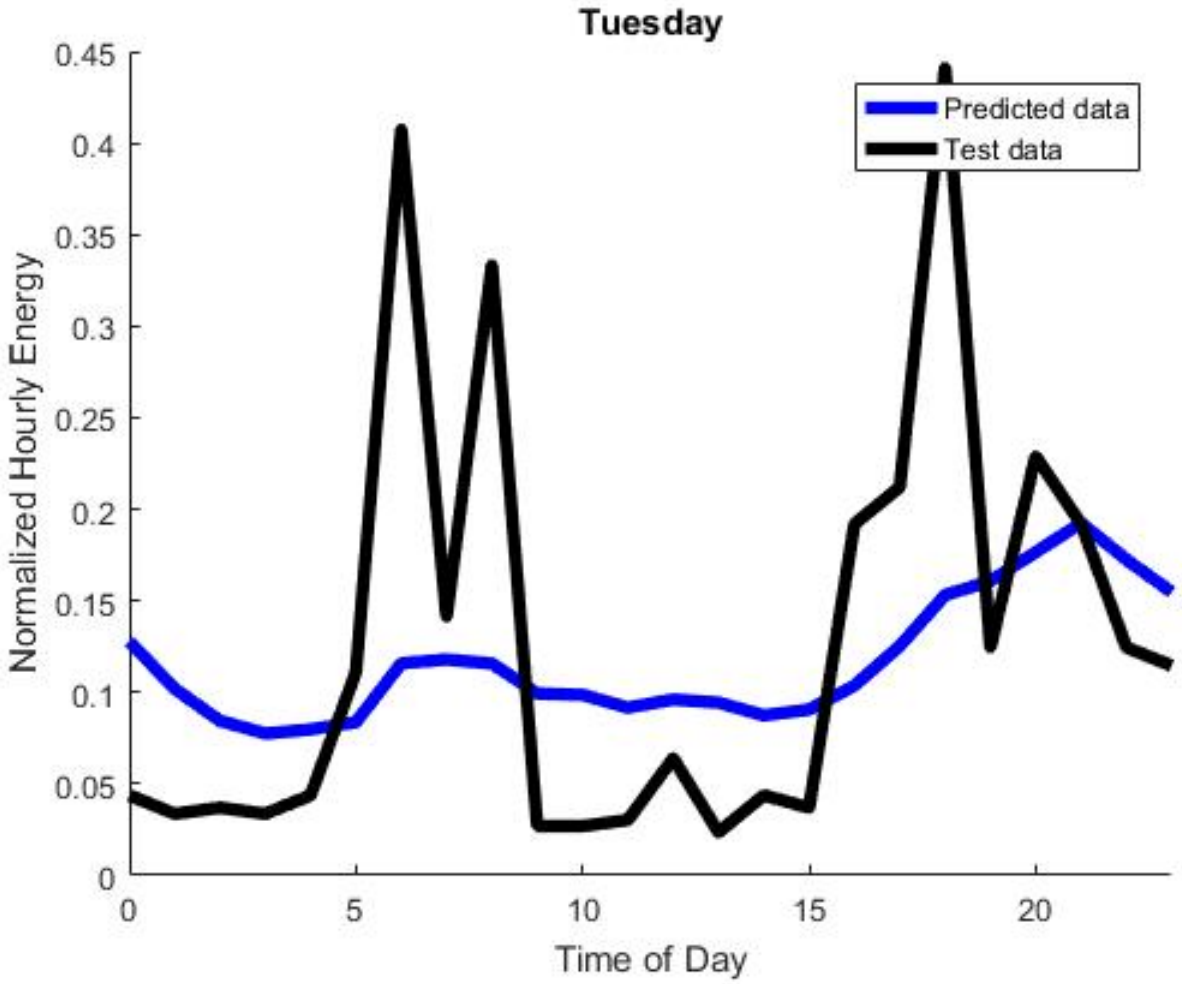

Saturday
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20

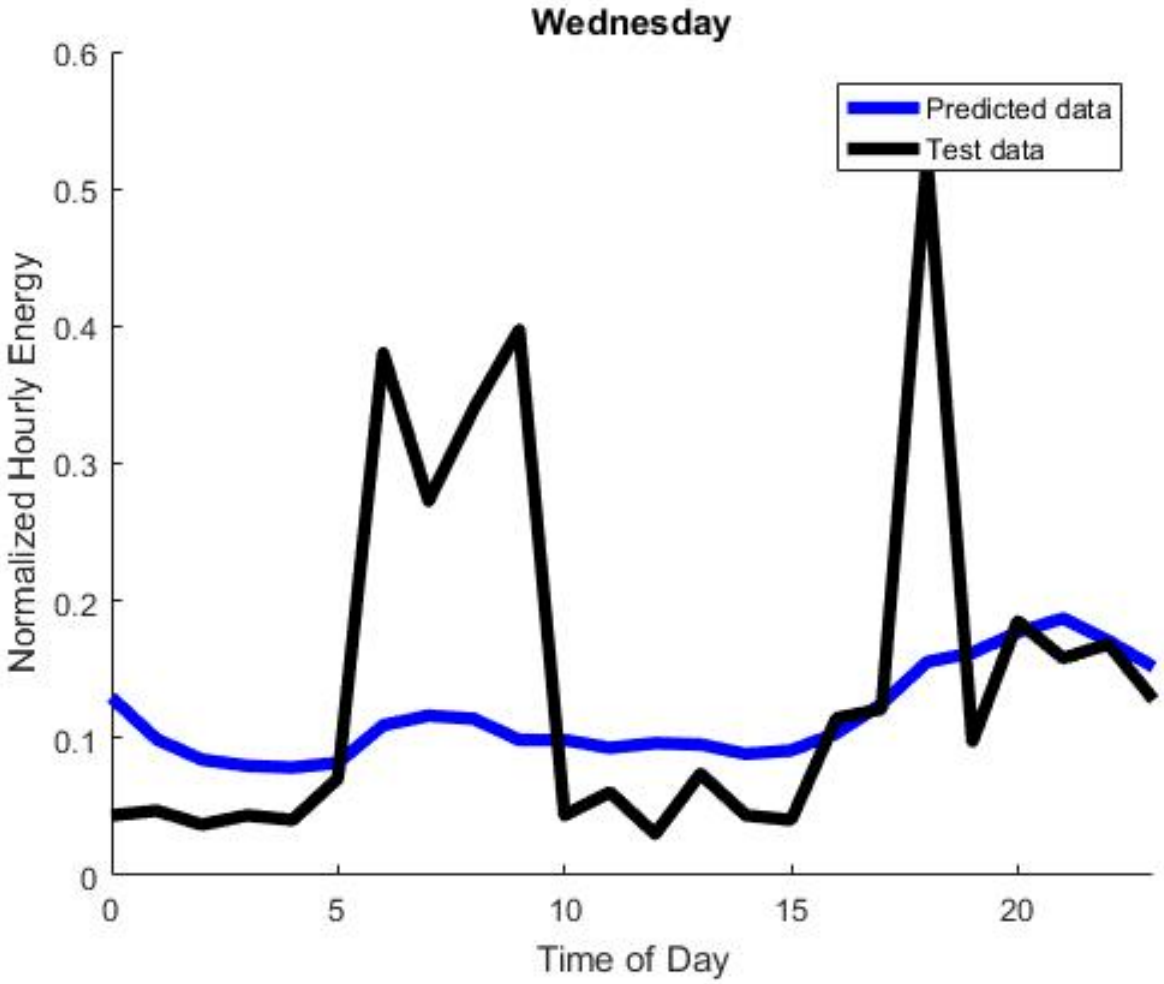
2 Problem 2: Average Model

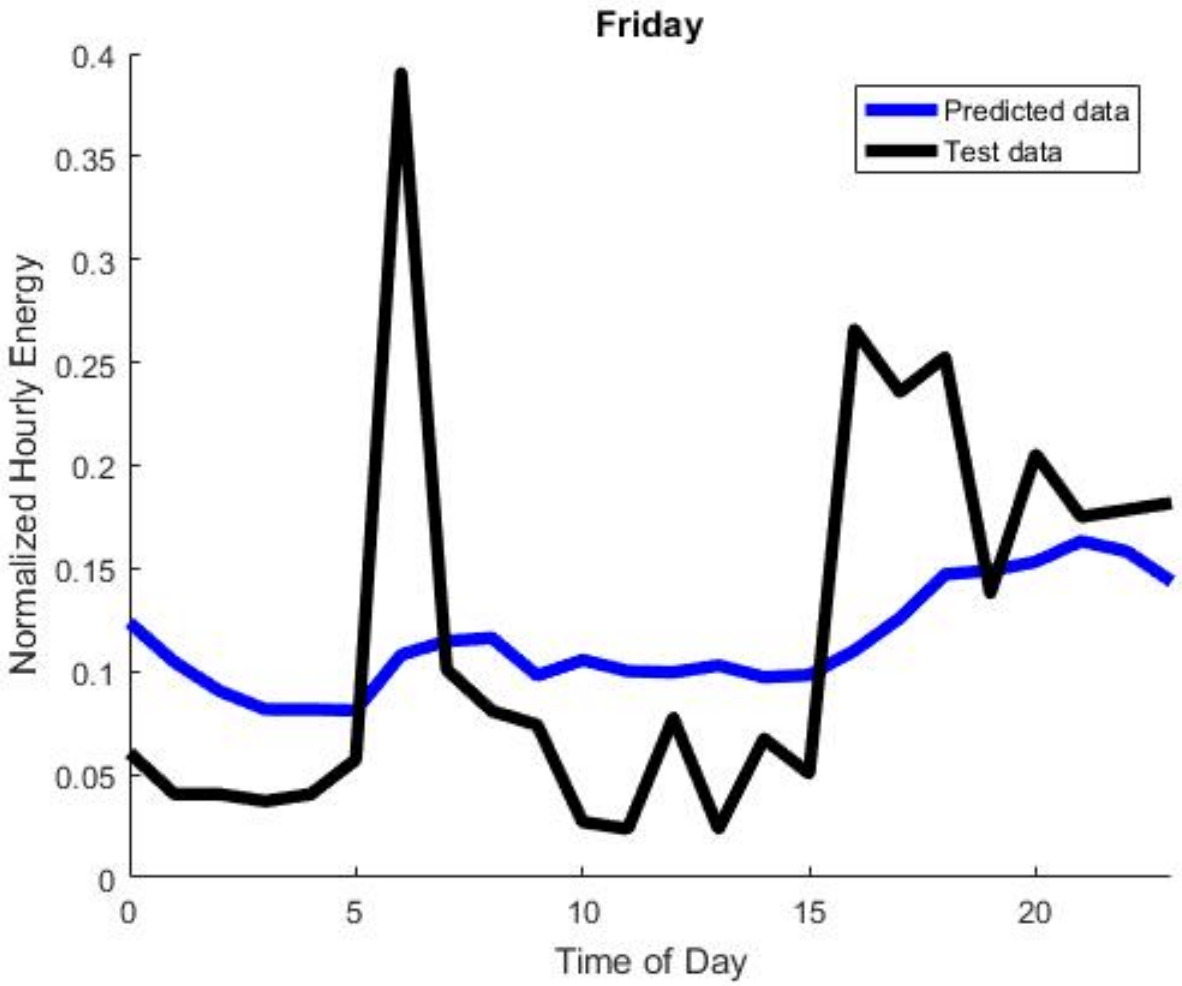


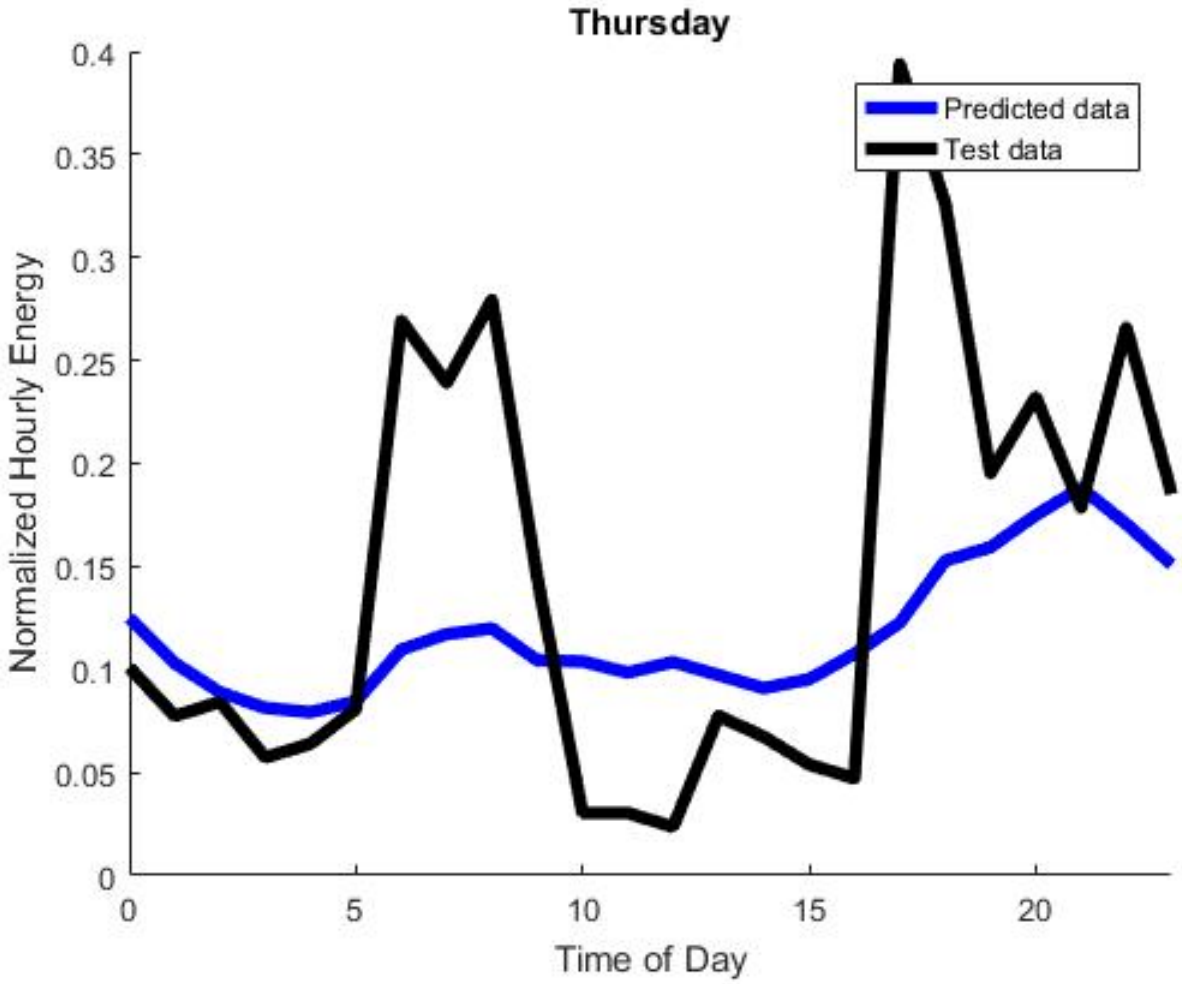
(a)

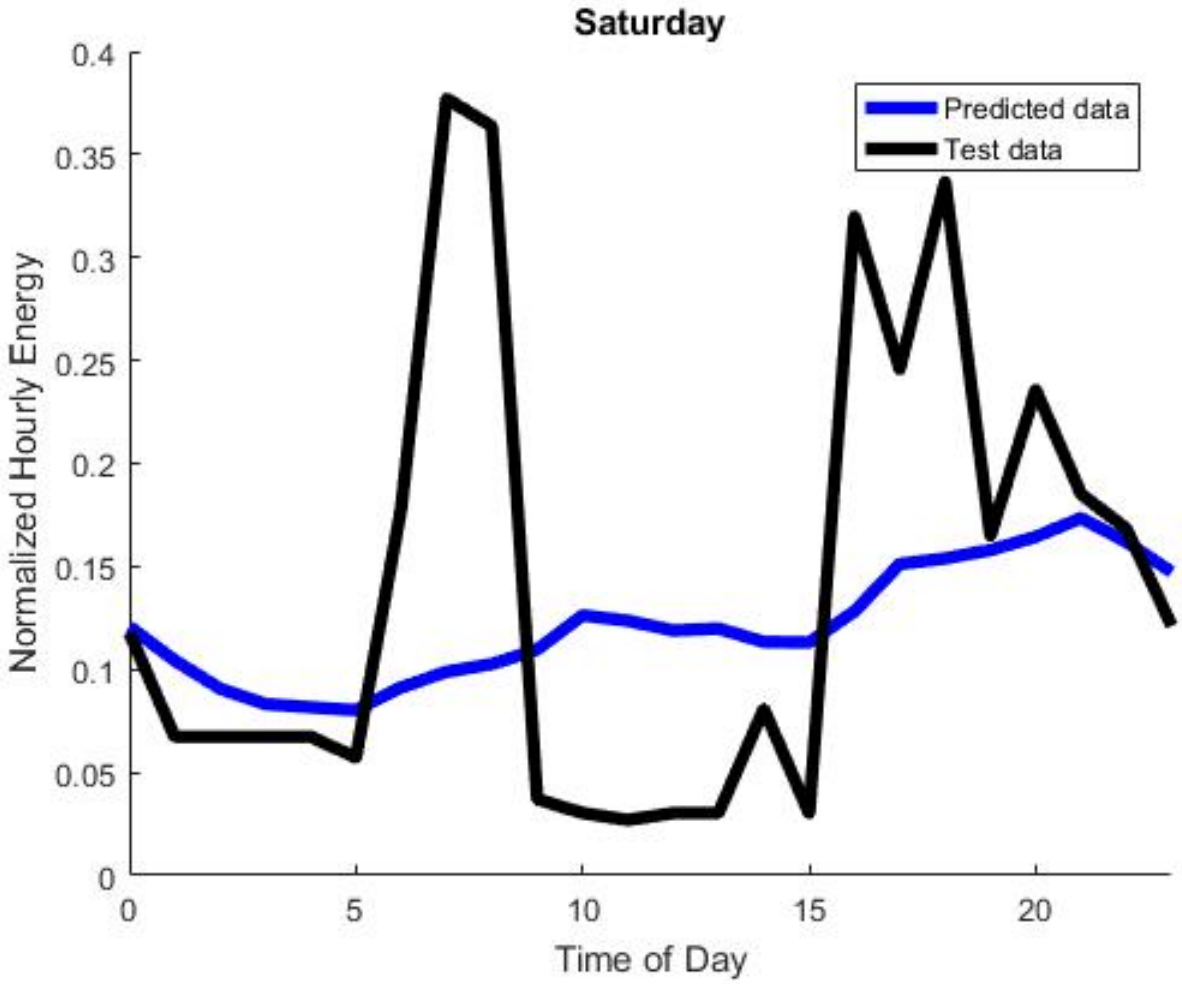



Tuesday
Predicted data
Test data
Normalized Hourly Energy
Time of Day
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20


Wednesday
Predicted data
Test data
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0
5
10
15
20


Friday
Predicted data
Test data
Normalized Hourly Energy
Time of Day
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
5
10
15
20

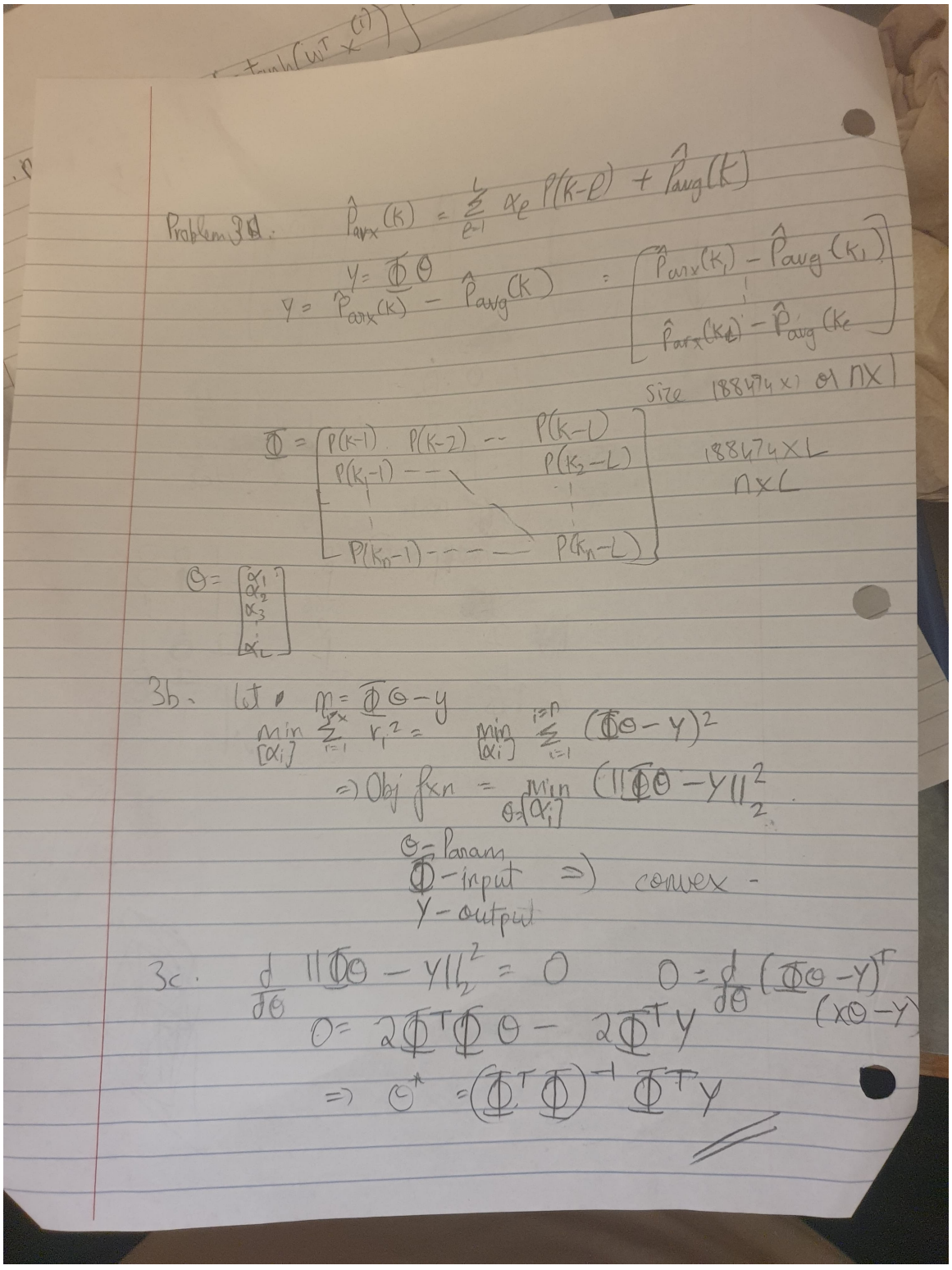

Thursday
Predicted data
Test data
Normalized Hourly Energy
Time of Day
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20



(b) The MAE of (Sun) + is about 0.071 The MAE of (Mon) + is about 0.109 The MAE of (Tue) + is about 0.079 The MAE of (Wed) + is about 0.083 The MAE of (Thu) + is about 0.068 The MAE of (Fri) + is about 0.062 The MAE of (Sat) + is about 0.079 Monday has the largest MAE whereas Friday has the smallest MAE.

3 Problem 3: Autoregressive with eXogeneous Inputs Model (ARX)

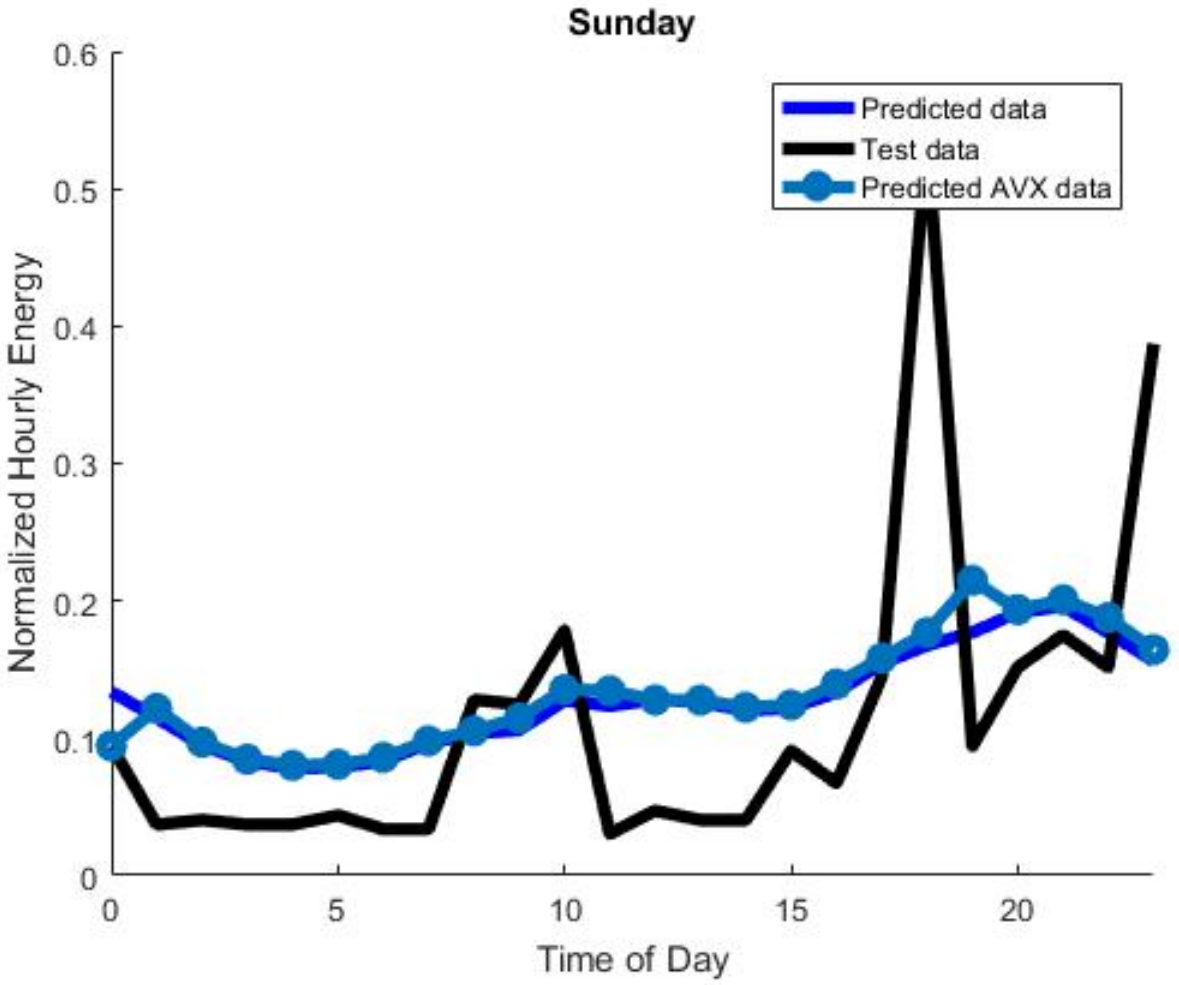
(a) Done by hand- 3a-c

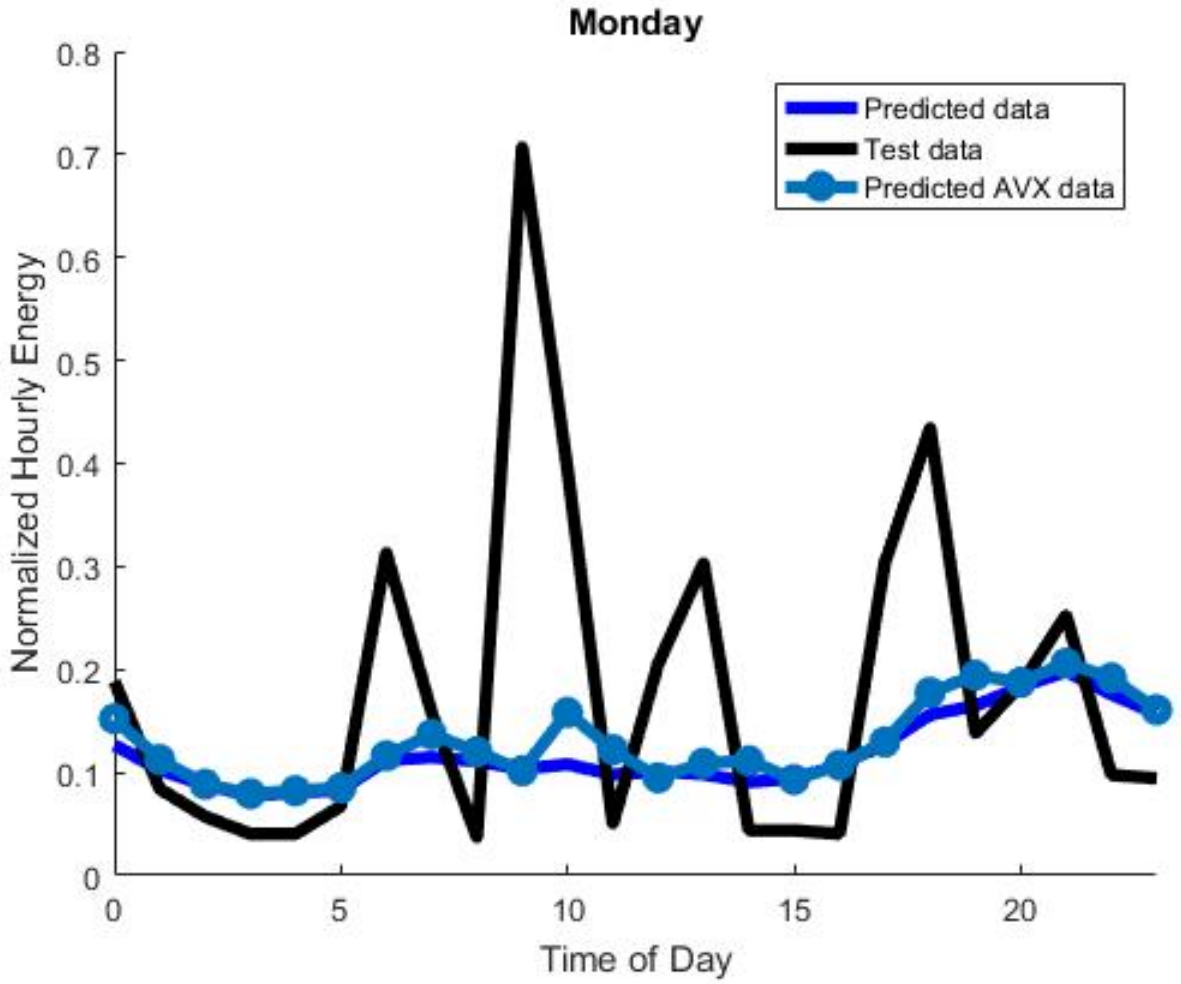


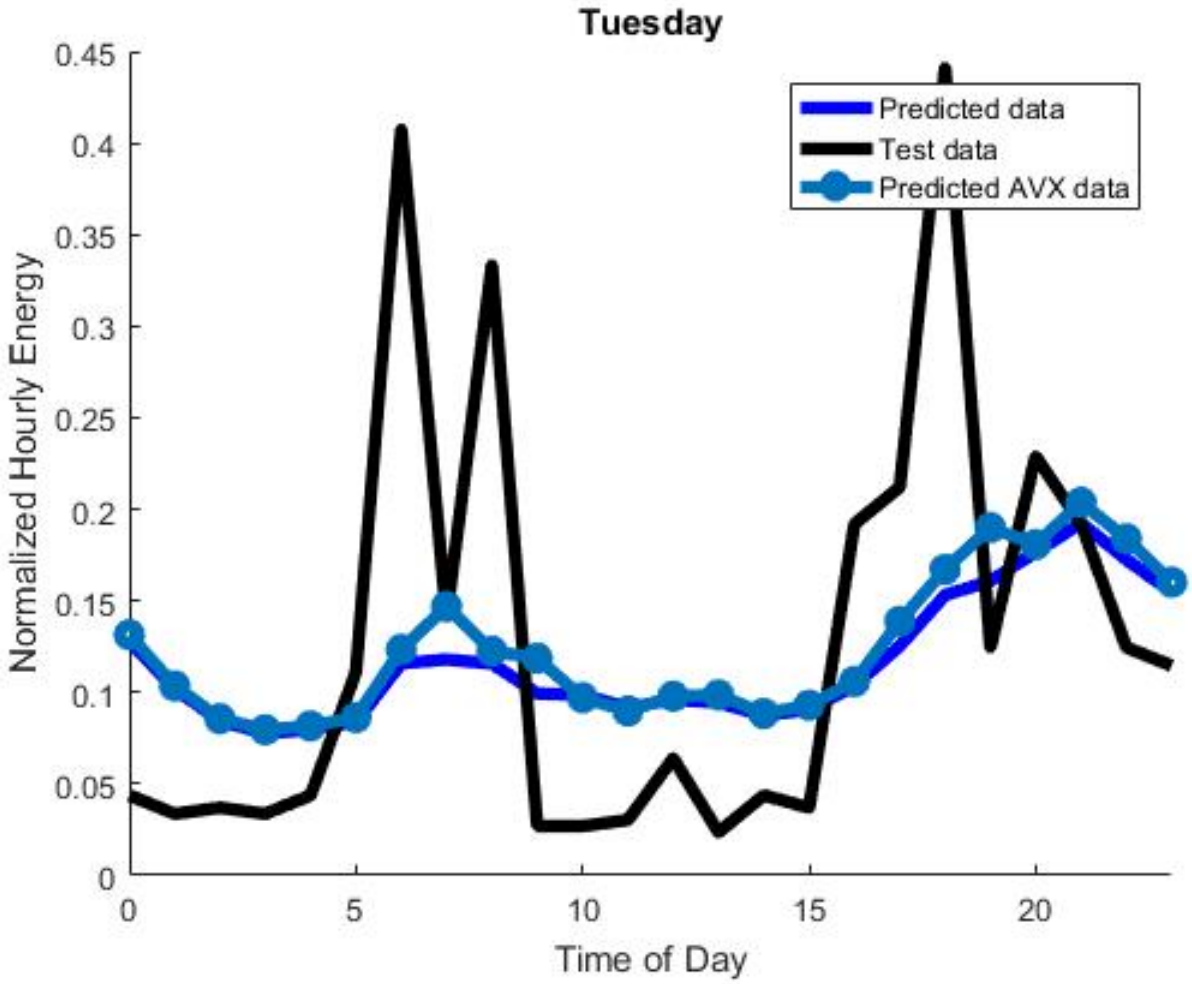
alpha$_1$ *is about* 0.074*a*

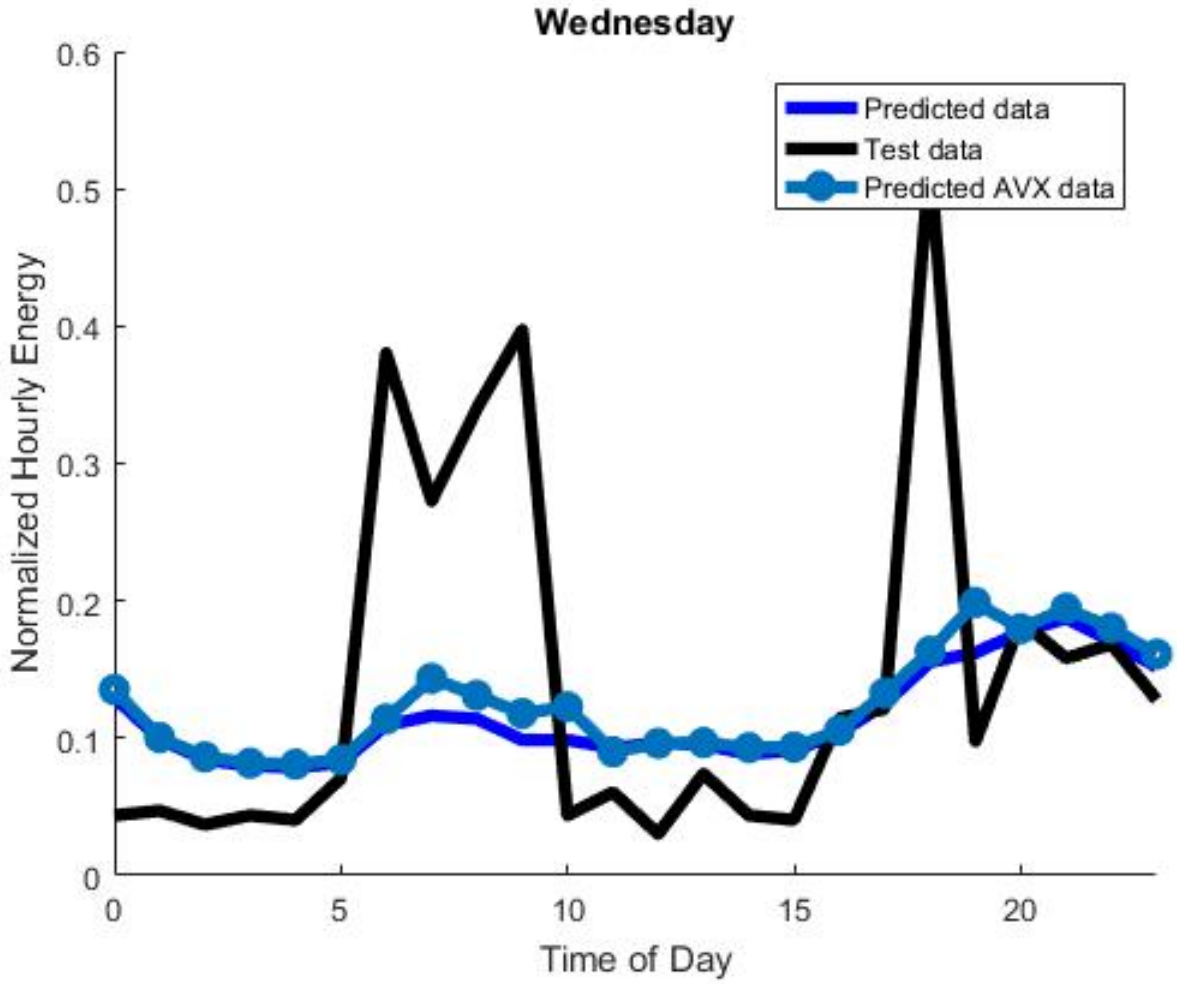
$0.006 alpha_3 is about -0.011$

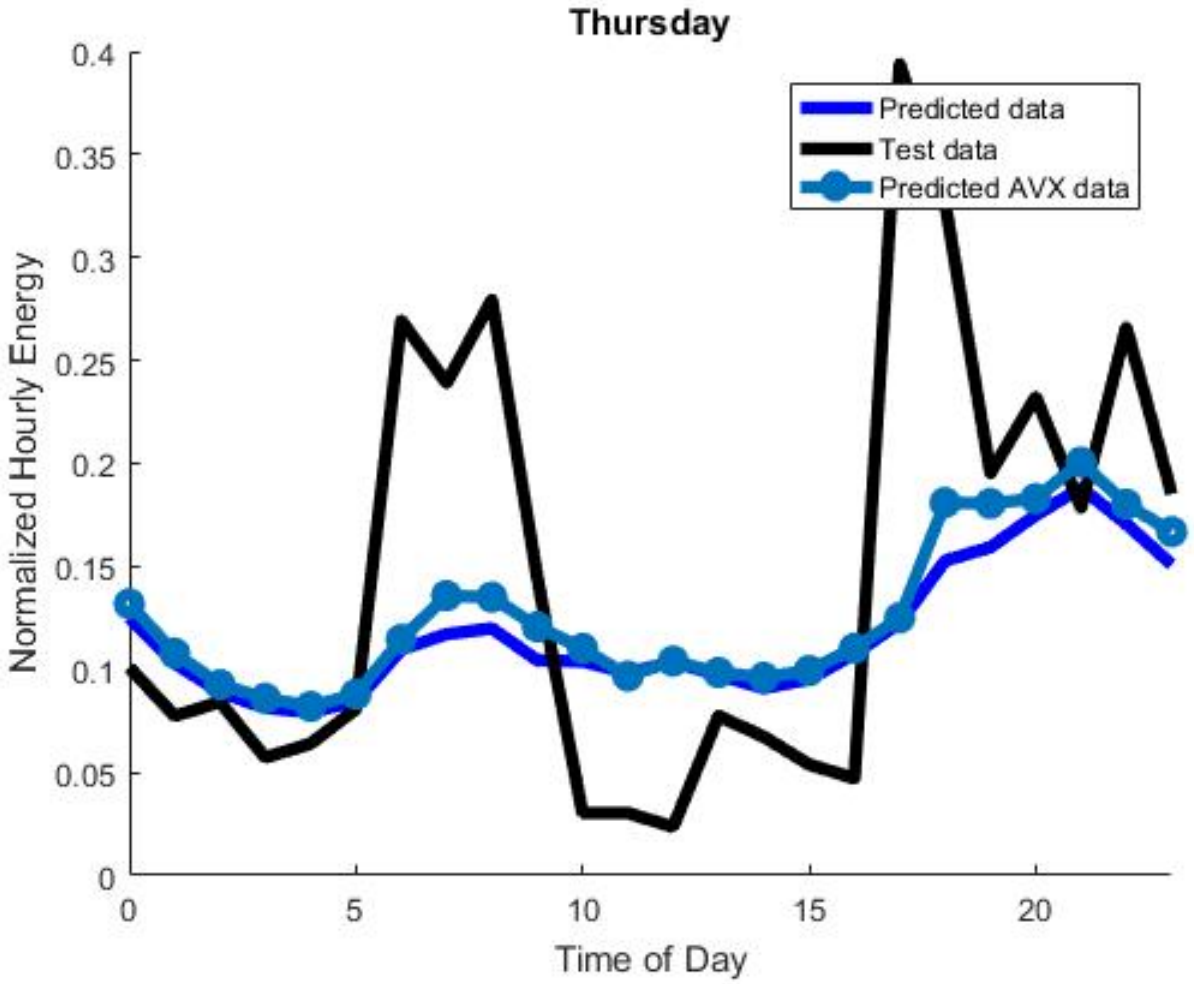
(b)

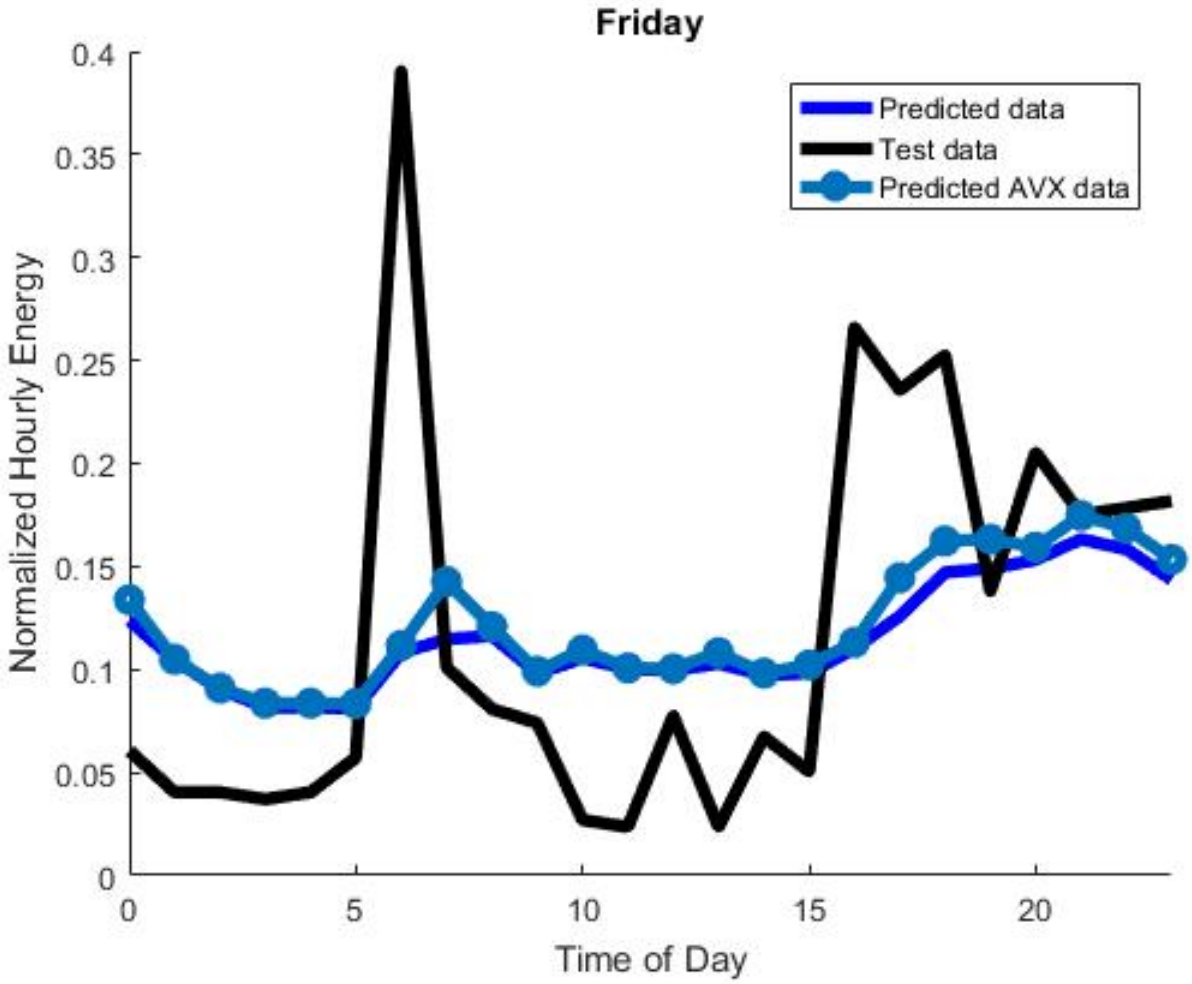


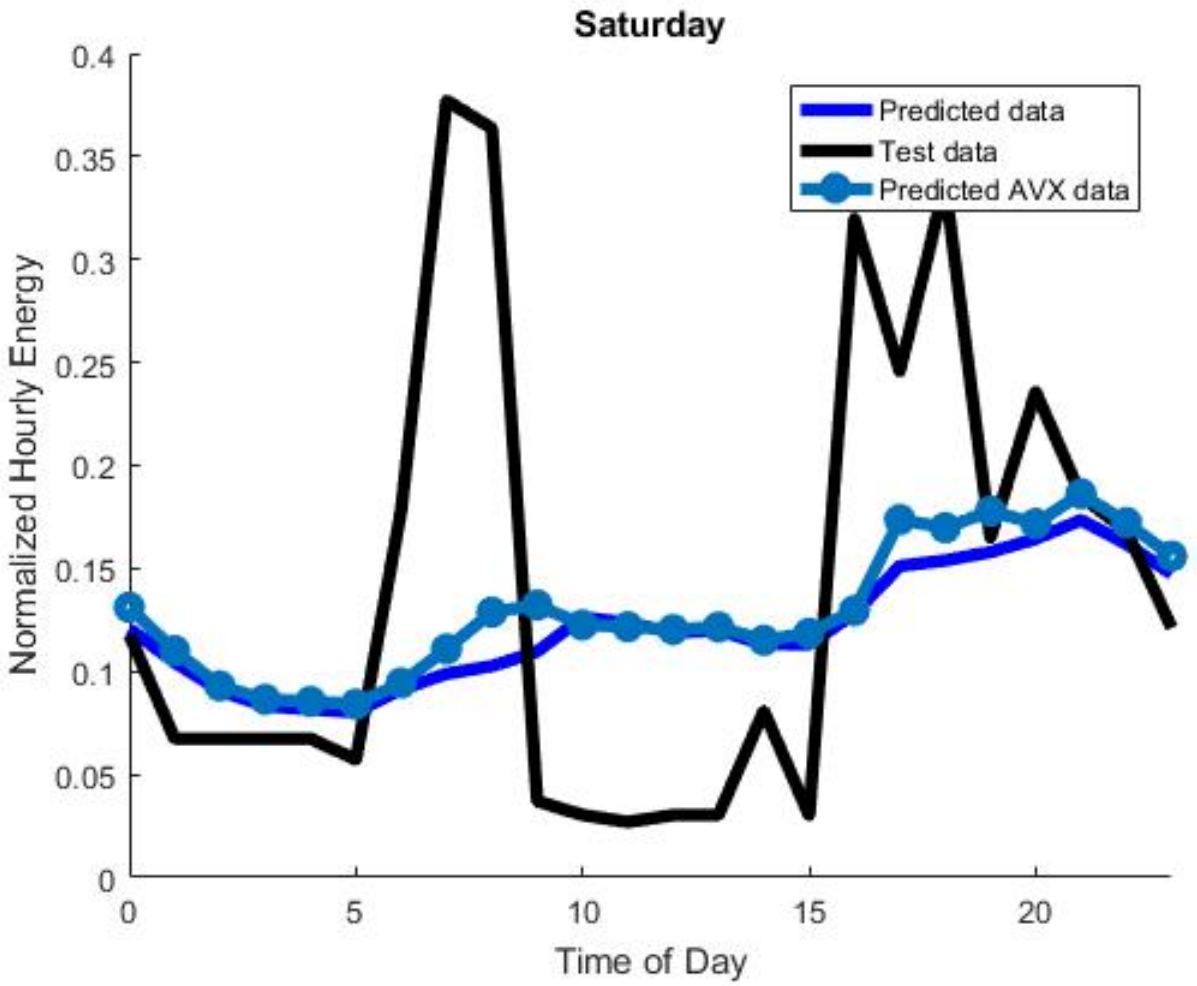

Monday
Predicted data
Test data
Predicted AVX data
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
5
10
15
20


Tuesday
Predicted data
Test data
Predicted AVX data
Normalized Hourly Energy
Time of Day
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20


Wednesday
Predicted data
Test data
Predicted AVX data
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0
5
10
15
20


Thursday
Predicted data
Test data
Predicted AVX data
Normalized Hourly Energy
Time of Day
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
5
10
15
20


Friday
Predicted data
Test data
Predicted AVX data
Normalized Hourly Energy
Time of Day
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
5
10
15
20

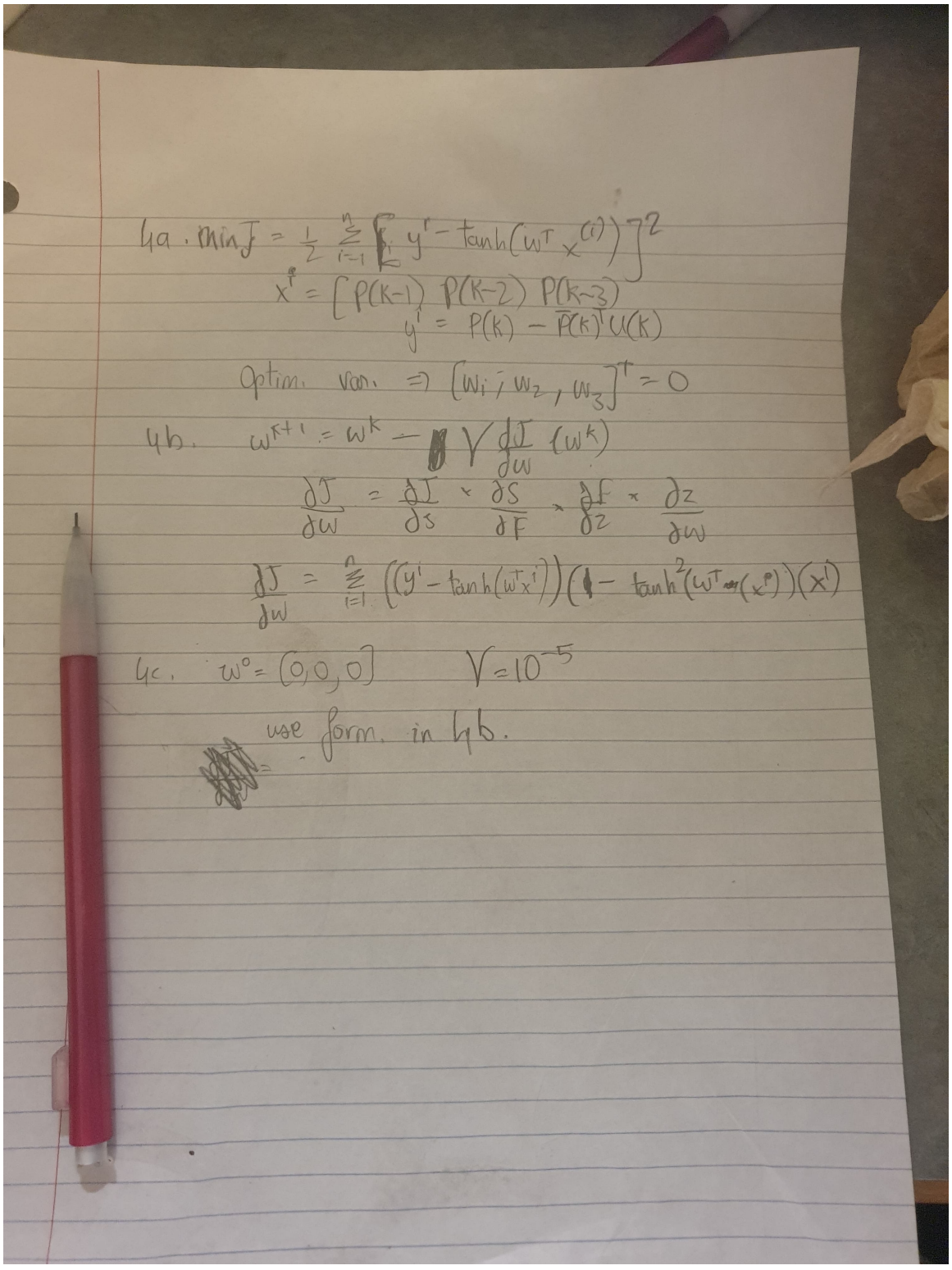


The MAE of (Sun) + is about 0.073 The MAE of (Mon) + is about 0.108 The MAE of (Tue) + is about 0.080 The MAE of (Wed) + is about 0.085 The MAE of (Thu) + is about 0.064 The MAE of (Fri) + is about 0.062 The MAE of (Sat) + is about 0.078

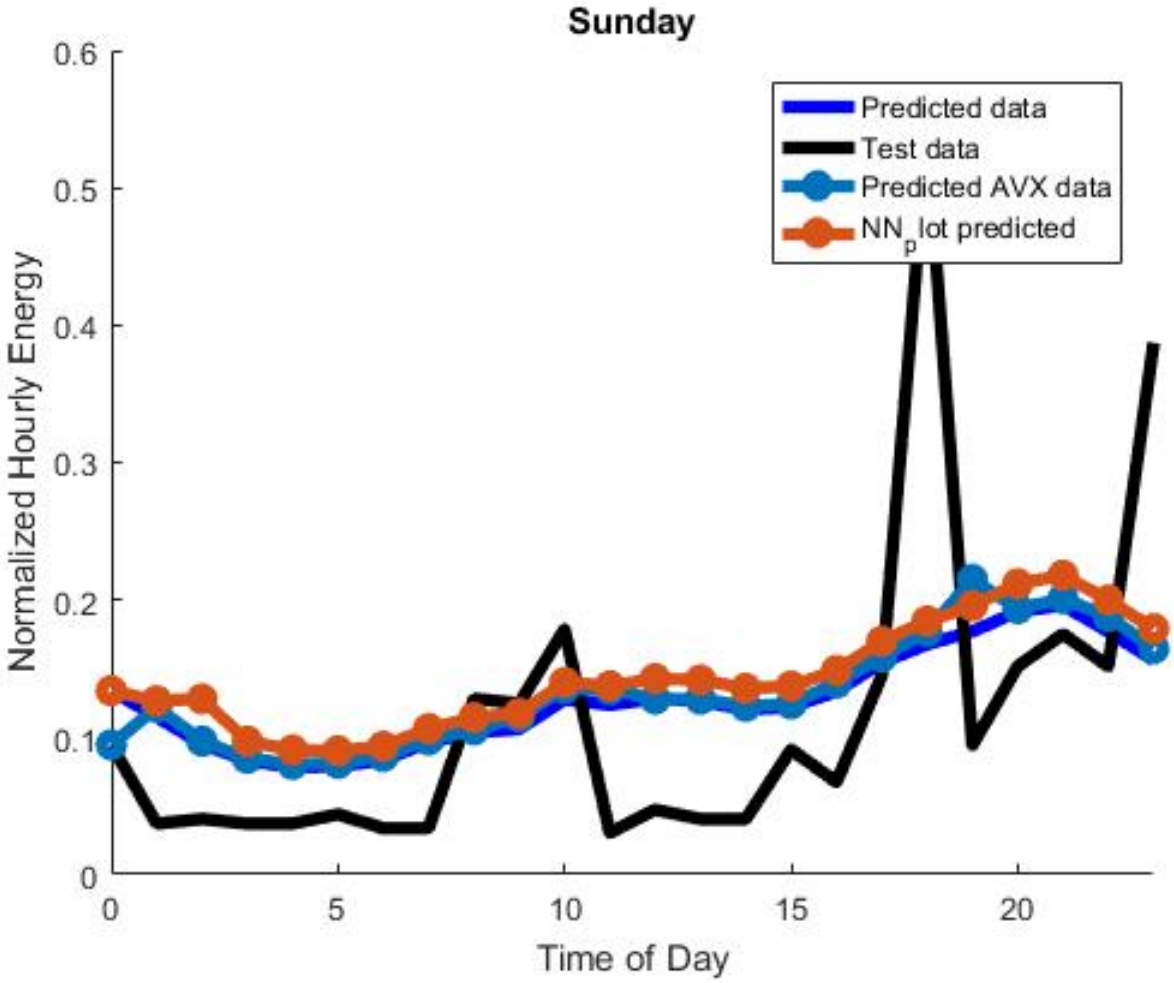
Monday has the largest MAE whereas Friday has the smallest MAE.

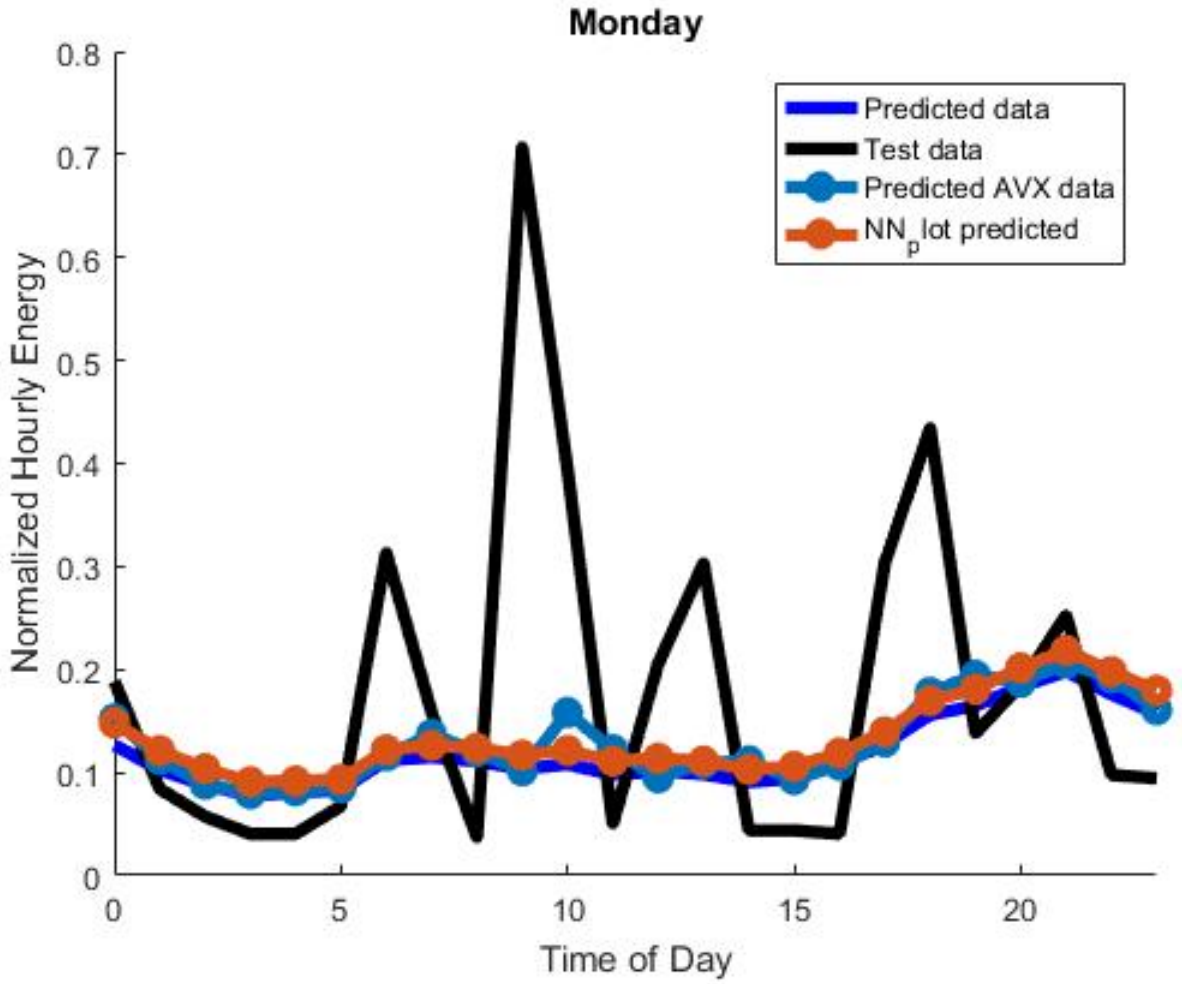
4 Problem 4: Neural Network Model

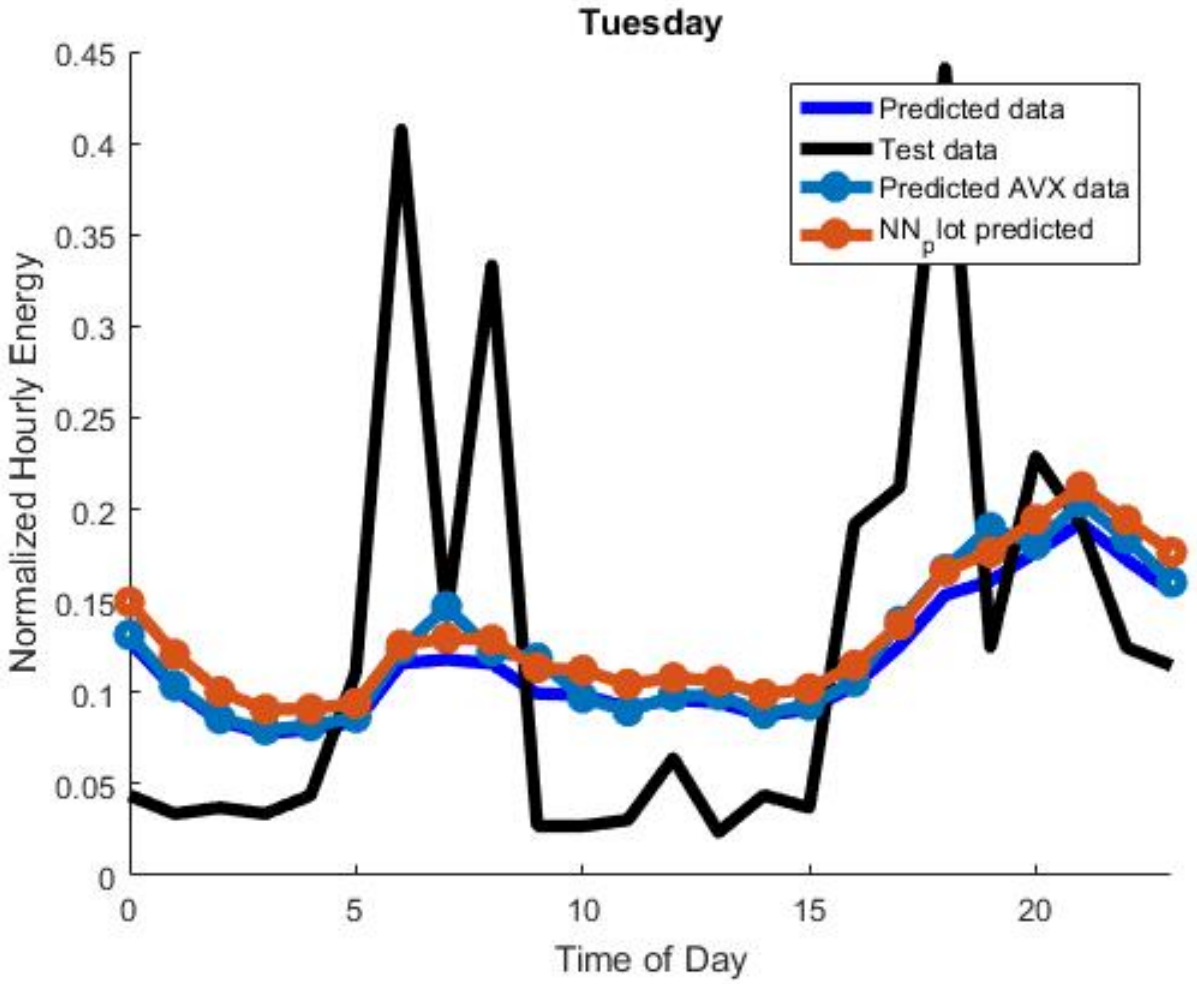
(a) 4a-b done by hand

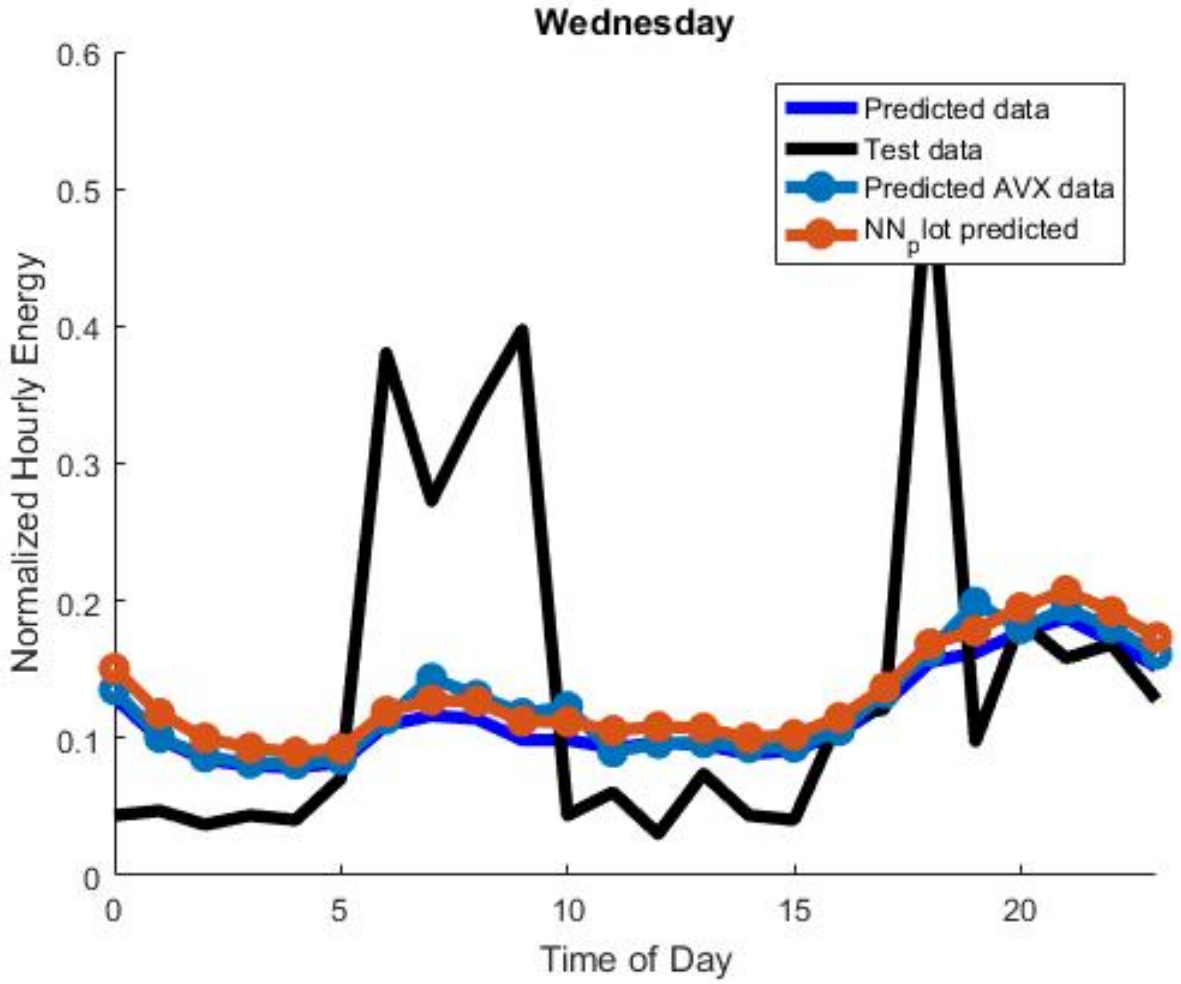

4a. $\min J = \frac{1}{2}\sum_{i=1}^{n}\left[y^i - \tanh(w^T x^{(i)})\right]^2$
$x^i = [P(k-1)\ P(k-2)\ P(k-3)]$
$y^i = P(k) - \overline{P(k)}^T U(k)$
Optim. con. $\Rightarrow [w_1, w_2, w_3]^T = 0$
4b. $w^{k+1} = w^k - \gamma \nabla \frac{\partial J}{\partial w}(w^k)$
$\frac{\partial J}{\partial w} = \frac{\partial J}{\partial s} \times \frac{\partial s}{\partial F} \times \frac{\partial F}{\partial z} \times \frac{\partial z}{\partial w}$
$\frac{\partial J}{\partial w} = \sum_{i=1}^{n}\left((y^i - \tanh(w^T x^i))\right)\left(1 - \tanh^2(w^T x^i)\right)(x^i)$
4c. $w^0 = [0,0,0]$ $\gamma = 10^{-5}$
use form. in 4b.

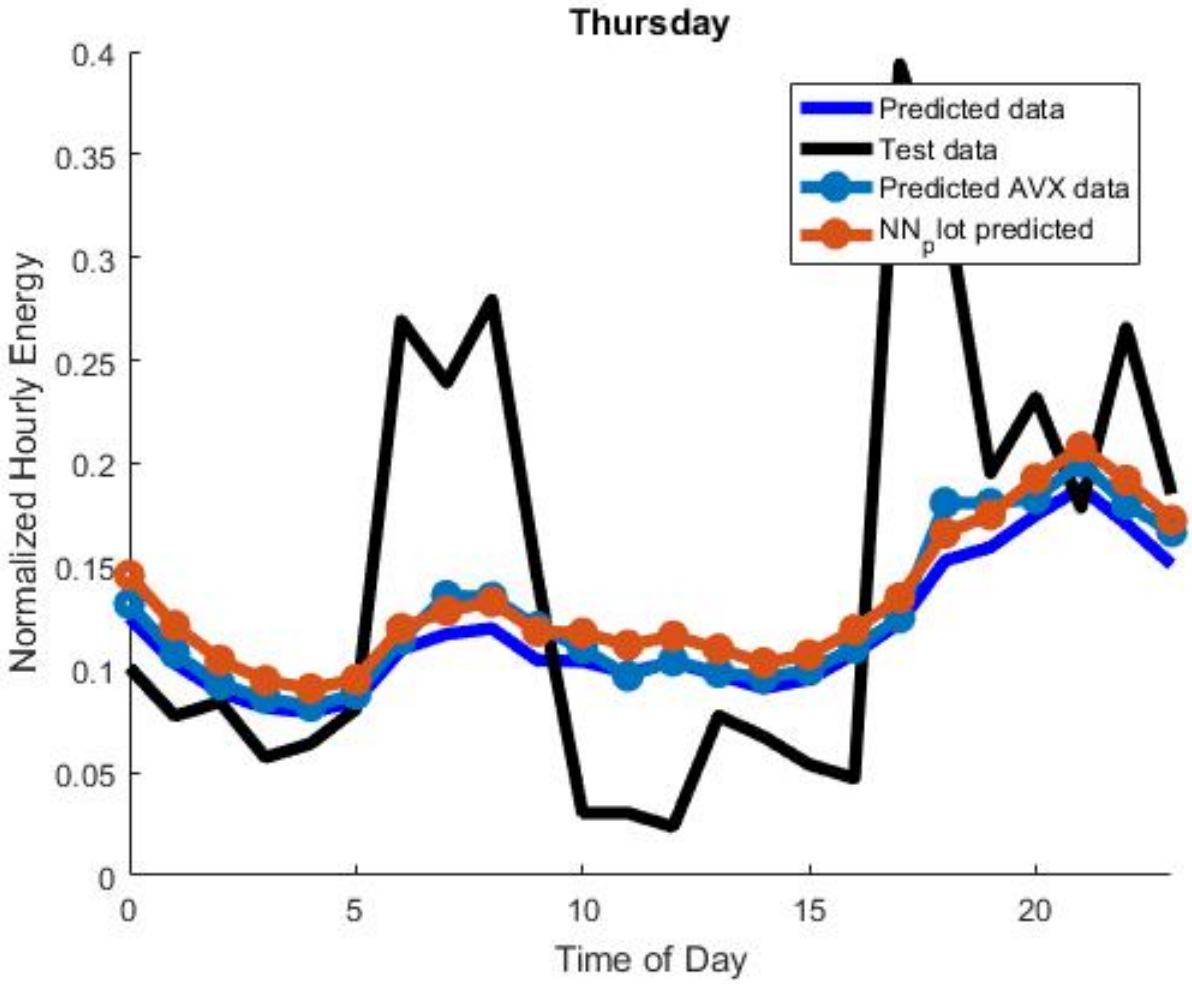
(b) $\mathrm{w}_1 isabout 0.046 w_2 isabout 0.035 w_3 isabout 0.029 MAEof(Sun) + isabout 0.073 TheMAEof(Mon) + isabout 0.108 The$
$isabout 0.080 TheMAEof(Wed) + isabout 0.085 TheMAEof(Thu) + isabout 0.064 TheMAEof(Fri) +$
$isabout 0.062 TheMAEof(Sat) + isabout 0.078$

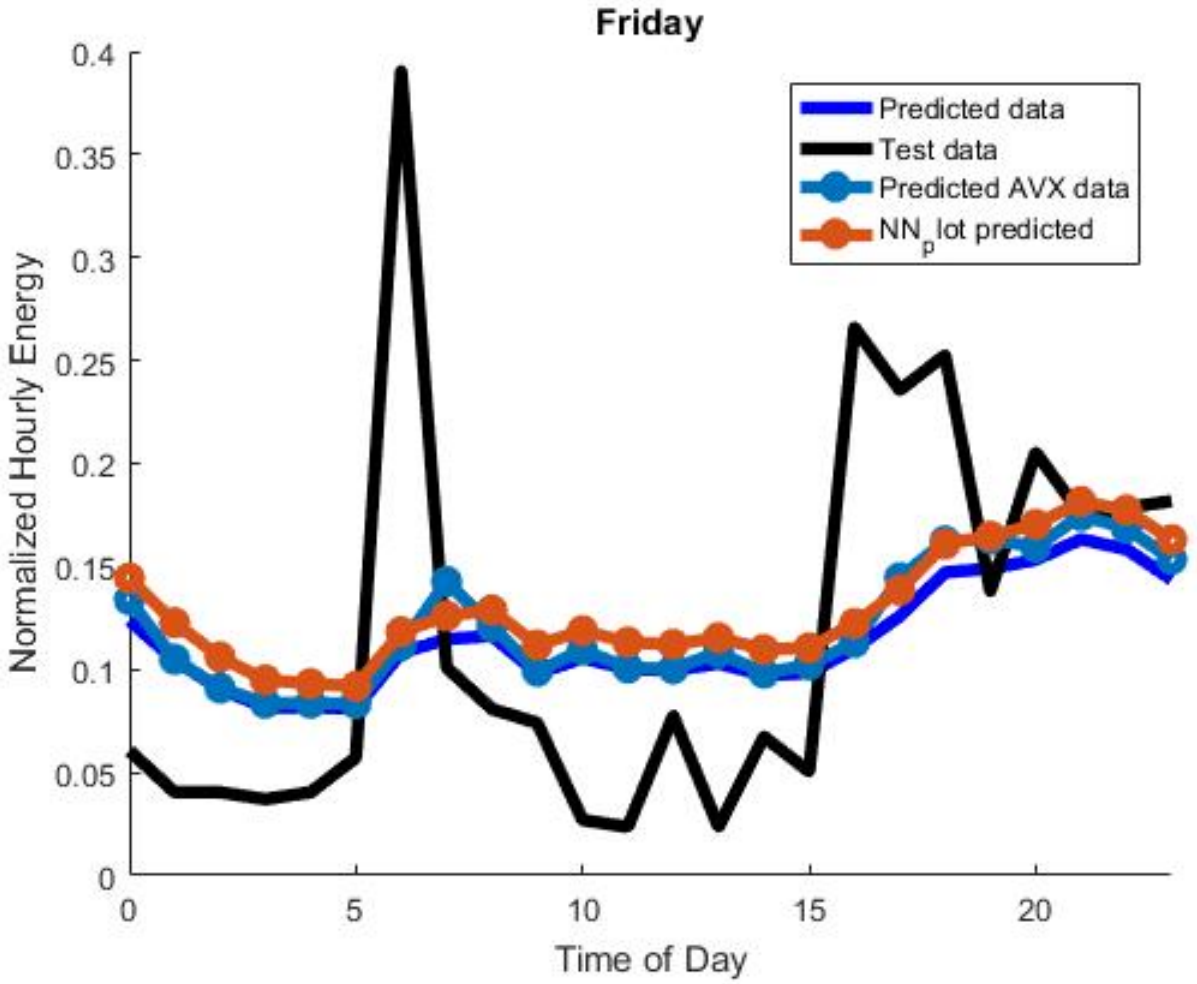


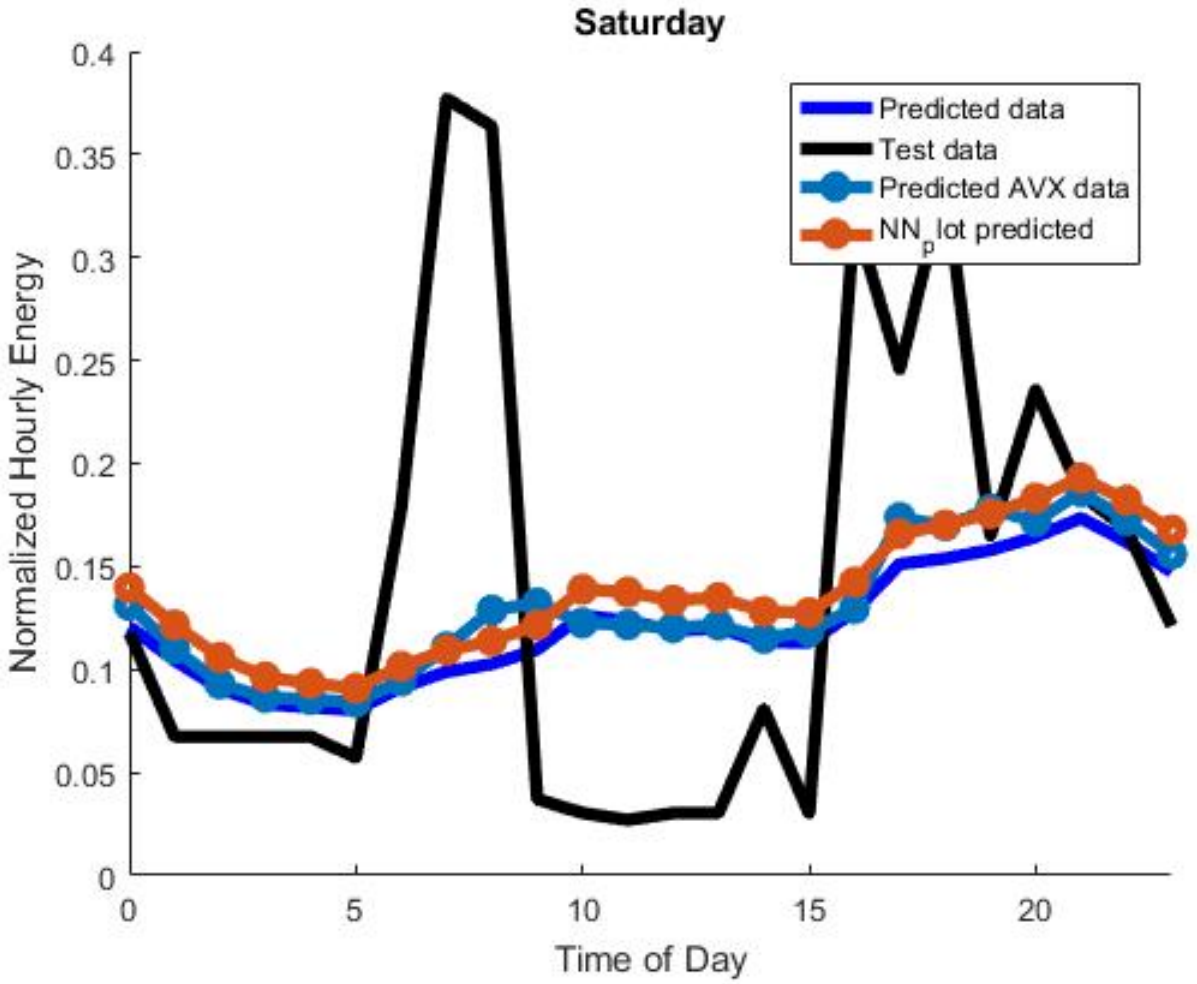

Monday
Predicted data
Test data
Predicted AVX data
NN_plot predicted
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
5
10
15
20


Tuesday
Predicted data
Test data
Predicted AVX data
NN_plot predicted
Normalized Hourly Energy
Time of Day
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20


Wednesday
Predicted data
Test data
Predicted AVX data
NN_plot predicted
Normalized Hourly Energy
Time of Day
0
0.1
0.2
0.3
0.4
0.5
0.6
0
5
10
15
20


Thursday
Predicted data
Test data
Predicted AVX data
NN_plot predicted
Normalized Hourly Energy
Time of Day
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
5
10
15
20


Friday
Predicted data
Test data
Predicted AVX data
NN_plot predicted
Normalized Hourly Energy
Time of Day
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20


Saturday
Predicted data
Test data
Predicted AVX data
NN_plot predicted
Normalized Hourly Energy
Time of Day
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
5
10
15
20