Predicting Appliance Energy Consumption

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DATS 6450 - Multivariate Modeling
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Term Project

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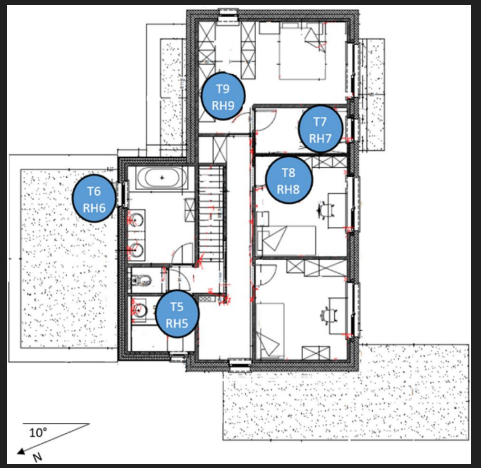
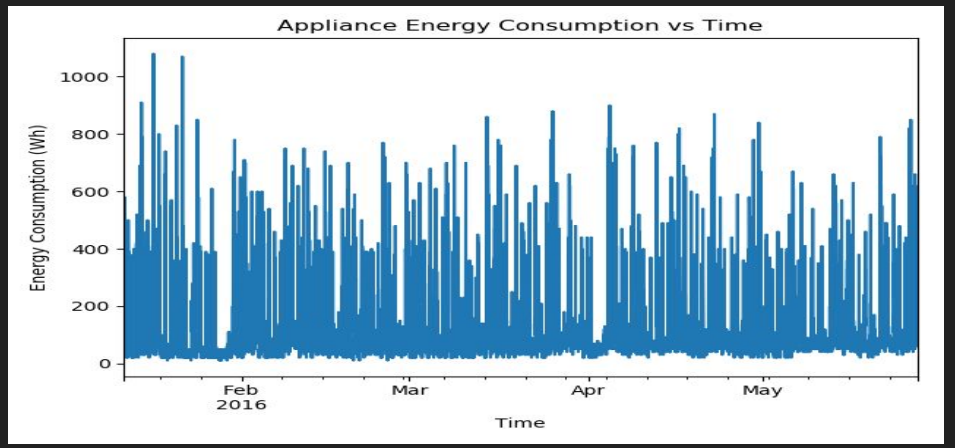
Dataset

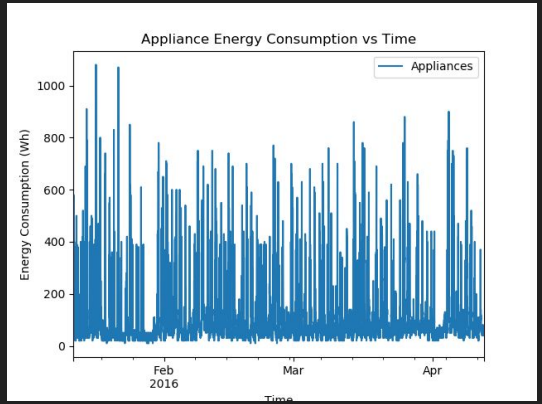
- Collected by:
  - Thermal Engineering and Combustion Laboratory, University of Mons
- Summary:
  - 26 Features (10 min. Sample Rate)
    - *Appliance Energy Use (Wh)
    - Temperature and Humidity
      - Indoor (9 wireless sensors)
    - Lighting Energy Use (Wh)
    - Local Weather Station
      - Temp. and Humidity
      - Hourly, Interpolated
    - NSM (seconds since Midnight)
  - 19,735 Observations
    - No Missing Values

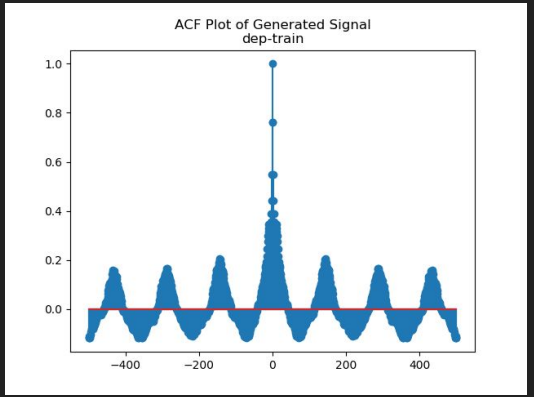




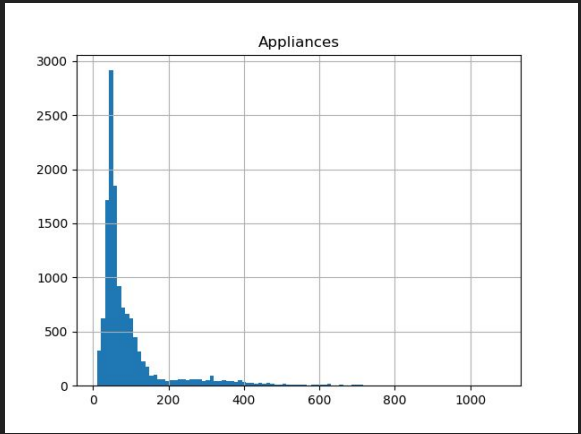
Stationarity

- ADF-Test
  - Statistic: -17.2
  - p-value: 6.47e-30
- No Unit Root
  - Likely Stationary



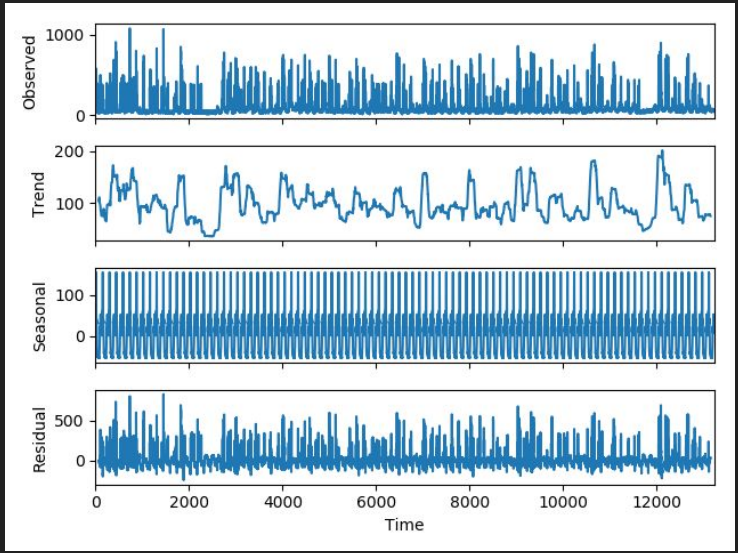


Apparent Seasonality

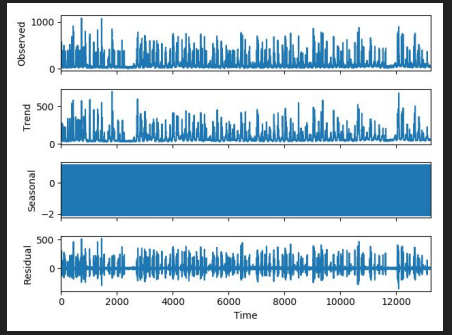


Distribution is
- Skewed

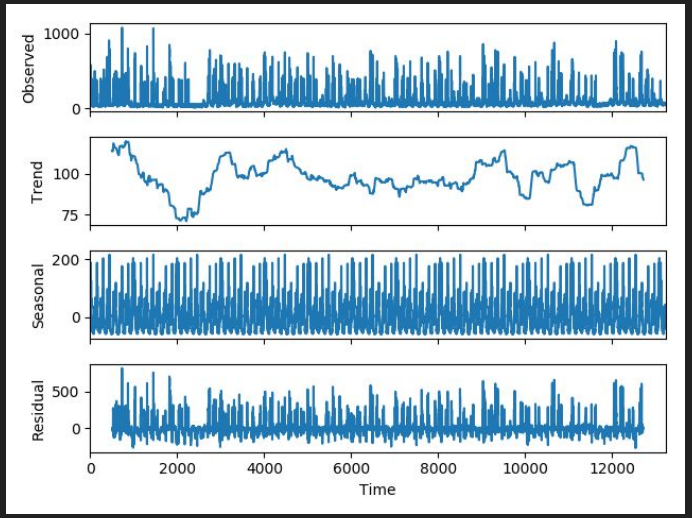
Time Series Decomposition



Daily Decomp



Hourly Decomp

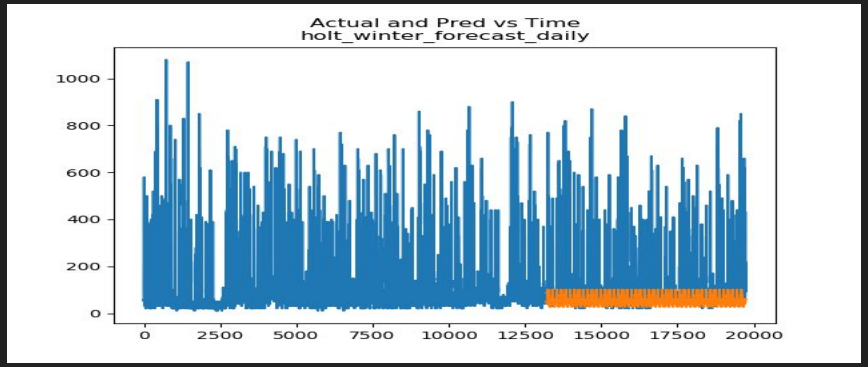


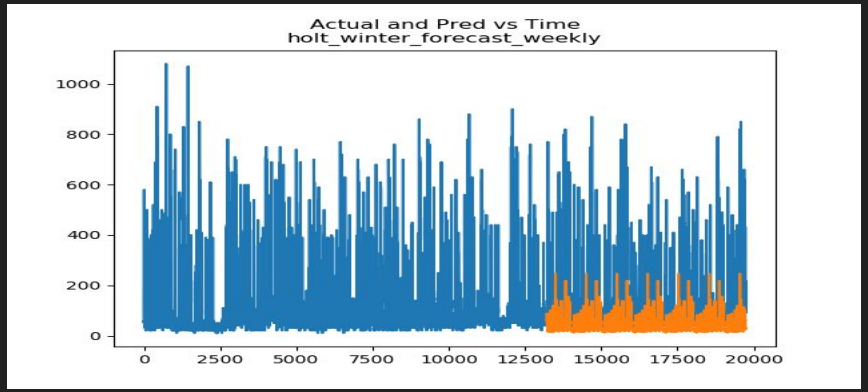
Weekly Decomp

Holt-Winter and Related Methods

Note: Models using both log, and norm transforms

Model	Avg.	Holt-Winter Daily	Holt-Winter Weekly
Adj R2	0.000	0.058	0.040
AIC	110883	113433	114319
BIC	110898	113493	114379
Q	22585	19445	19637
RMSE	94.4	103.9	107.4
Residual Mean	1.15	-48.5	-52.8
Residual Std. Dev.	94.3	91.8	93.5

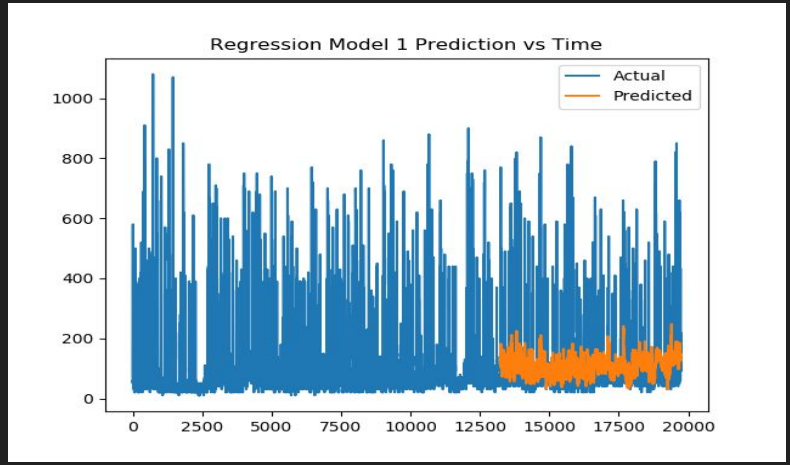


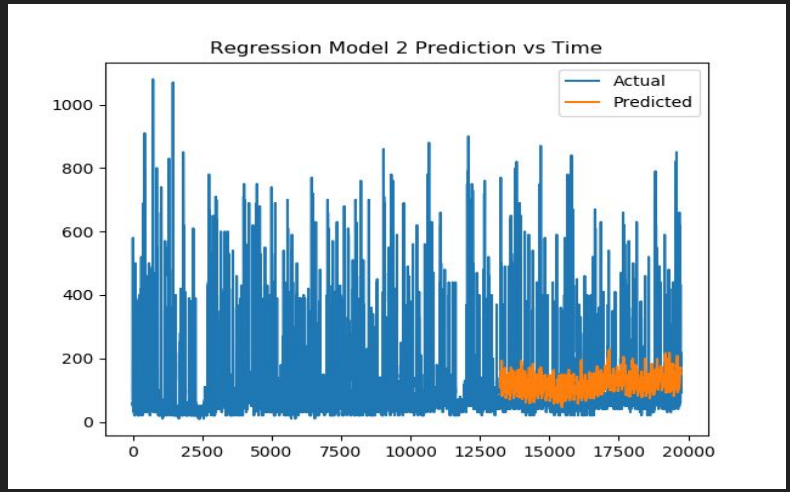


Linear Regression

NOTE: Both models using sklearn StandardScaler

Model	1	2
Adj R2	0.078	0.048
AIC	109958	110820
BIC	110018	110880
Q	16662	18794
RMSE	91.1	94.1
Residual Mean	5.4	18.1
Residual Std. Dev.	18.1	92.3

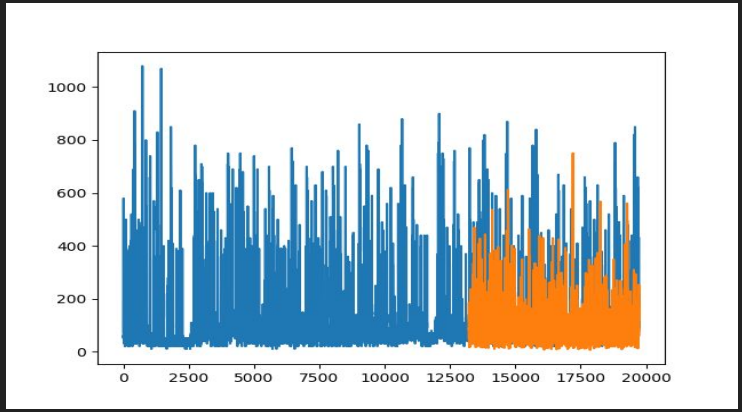




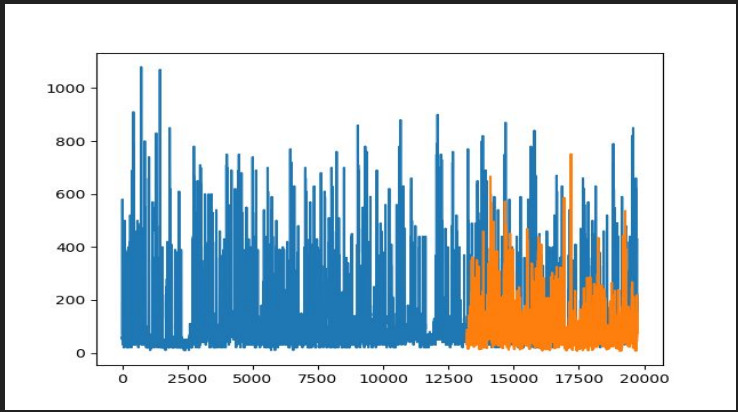
ARMA

Note: Models using both log, and norm transforms

Model	ARMA(1,0)	ARMA(4,3)
Adj R2	0.000	0.001
AIC	116159	116101
BIC	116182	116168
Q	21739	25832
RMSE	115.2	114.9
Residual Mean	7.1	6.8
Residual Std. Dev.	114.9	114.7



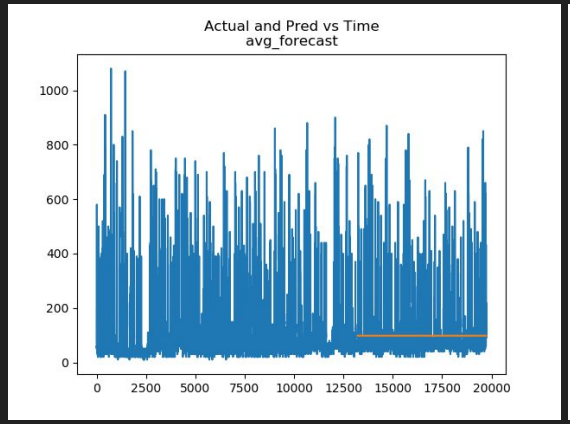
ARMA(1,0)



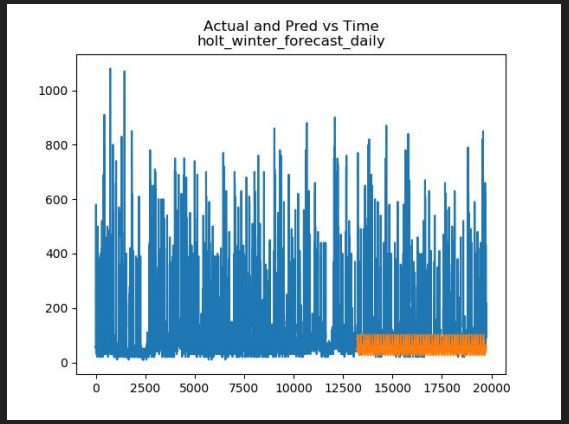
ARMA(4,3)

Final Model Selection

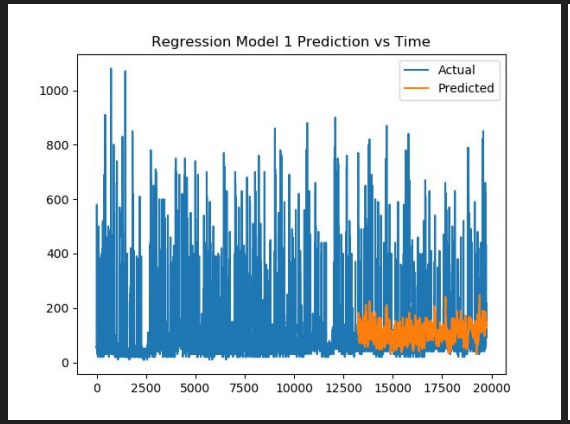
Model	Avg. Method	Holt-Winter Daily	Linear Reg. 1	ARMA (4, 3)
Adj R2	0.000	0.058	0.078	0.001
AIC	110883	113433	109958	116101
BIC	110898	113493	110018	116168
Q	22585	19445	16662	25832
RMSE	94.4	103.9	91.1	114.9
Residual Mean	1.15	-48.5	5.4	6.8
Residual Std. Dev.	94.3	91.8	18.1	114.7



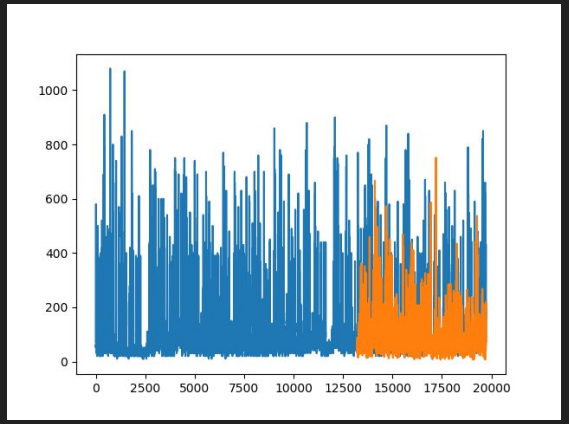
Avg. Method



Holt-Winter



Linear Reg. 1



ARMA(4,3)

Conclusion

- Model Selection
  - Best Model
    - Linear Regression 1
  - Best Forecast
    - Average Method
- Future Work/Next Steps
  - Better Seasonality Handling
    - Dynamic Regression Model
      - Combines Regression and ARMA
    - Forecast Seasonal and Seasonally Adjusted Component Separately
  - LMA Parameters Estimation for
    - SES, Holt-Linear, and Holt-Winter
  - Better Skew Handling