

# Energy Consumption

Time Series Analysis

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ICT2017

# Outline

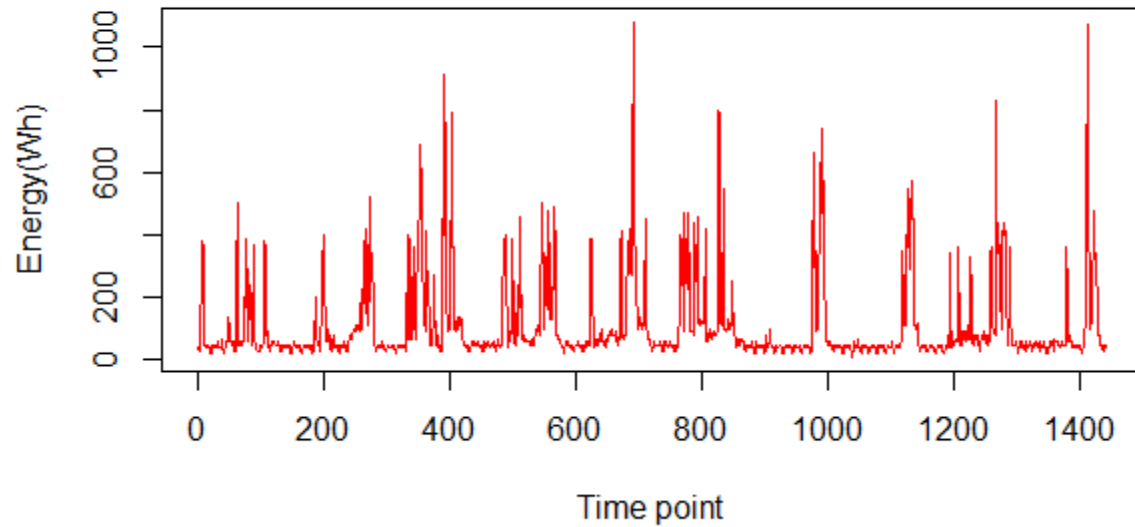
- Data exploration
- Methods
- Results
- Conclusions

# Energy consumption

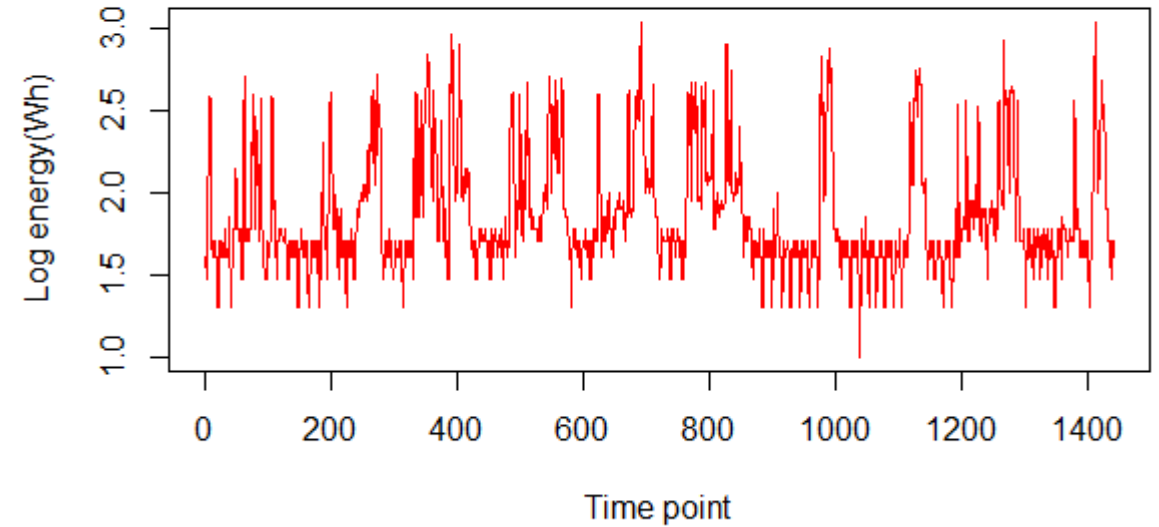
date	index	Appliances	lights	T1	RH_1	T2	RH_2	T3	RH_3	T4
1/11/2016 17:00	1	60	30	19.89	47.5967	19.2	44.79	19.79	44.73	19
1/11/2016 17:10	2	60	30	19.89	46.6933	19.2	44.7225	19.79	44.79	19
1/11/2016 17:20	3	50	30	19.89	46.3	19.2	44.6267	19.79	44.9333	18.9267
1/11/2016 17:30	4	50	40	19.89	46.0667	19.2	44.59	19.79	45	18.89
1/11/2016 17:40	5	60	40	19.89	46.3333	19.2	44.53	19.79	45	18.89
1/11/2016 17:50	6	50	40	19.89	46.0267	19.2	44.5	19.79	44.9333	18.89
1/11/2016 18:00	7	60	50	19.89	45.7667	19.2	44.5	19.79	44.9	18.89
1/11/2016 18:10	8	60	50	19.8567	45.56	19.2	44.5	19.73	44.9	18.89
1/11/2016 18:20	9	60	40	19.79	45.5975	19.2	44.4333	19.73	44.79	18.89
1/11/2016 18:30	10	70	40	19.8567	46.09	19.23	44.4	19.79	44.8633	18.89
1/11/2016 18:40	11	230	70	19.9267	45.8633	19.3567	44.4	19.79	44.9	18.89
1/11/2016 18:50	12	580	60	20.0667	46.3967	19.4267	44.4	19.79	44.8267	19
1/11/2016 19:00	13	430	50	20.1333	48	19.5667	44.4	19.89	44.9	19

# Data exploration

**Energy Consumption - The first ten days**

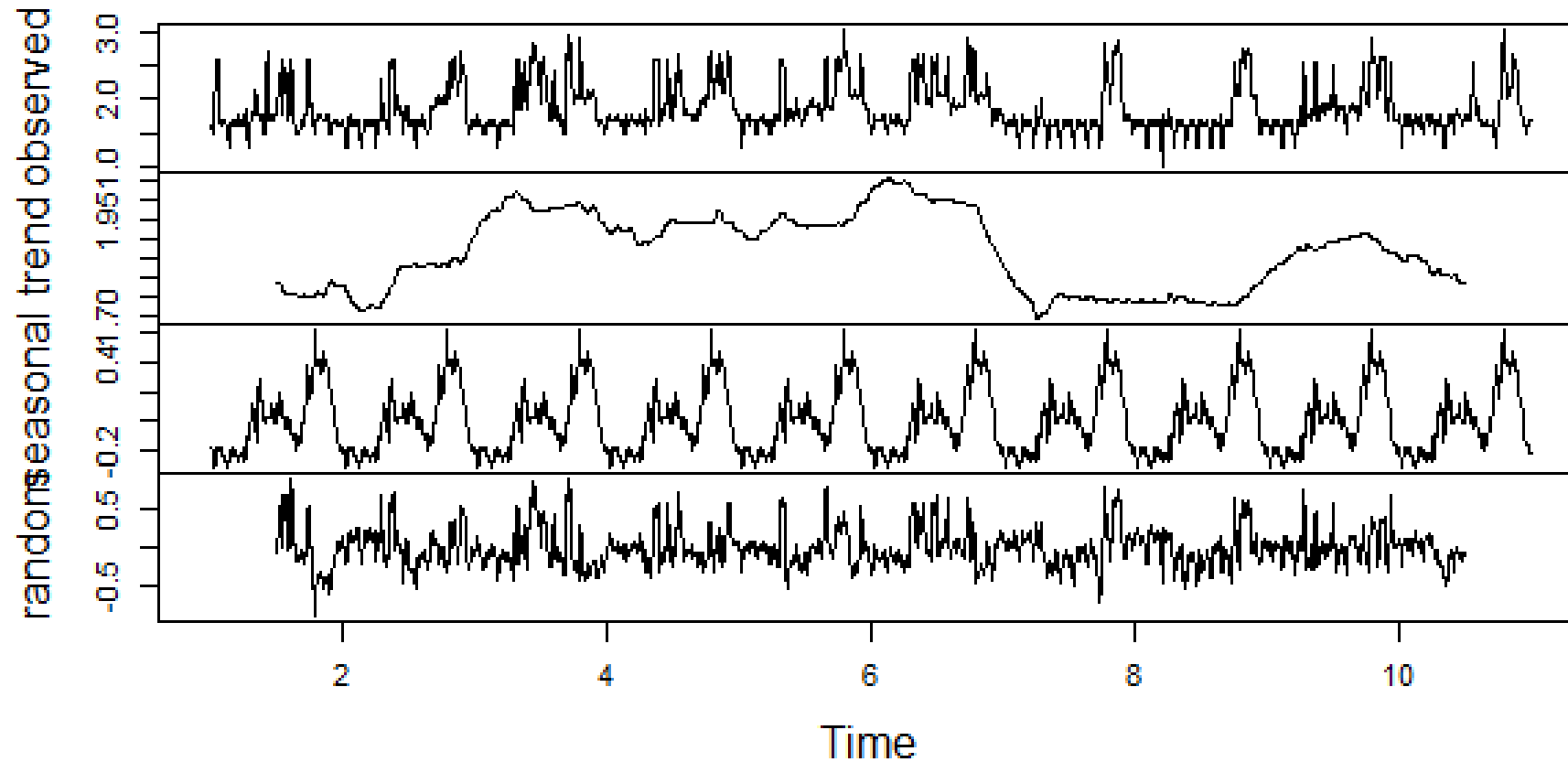


**Log Energy Consumption - The first ten days**



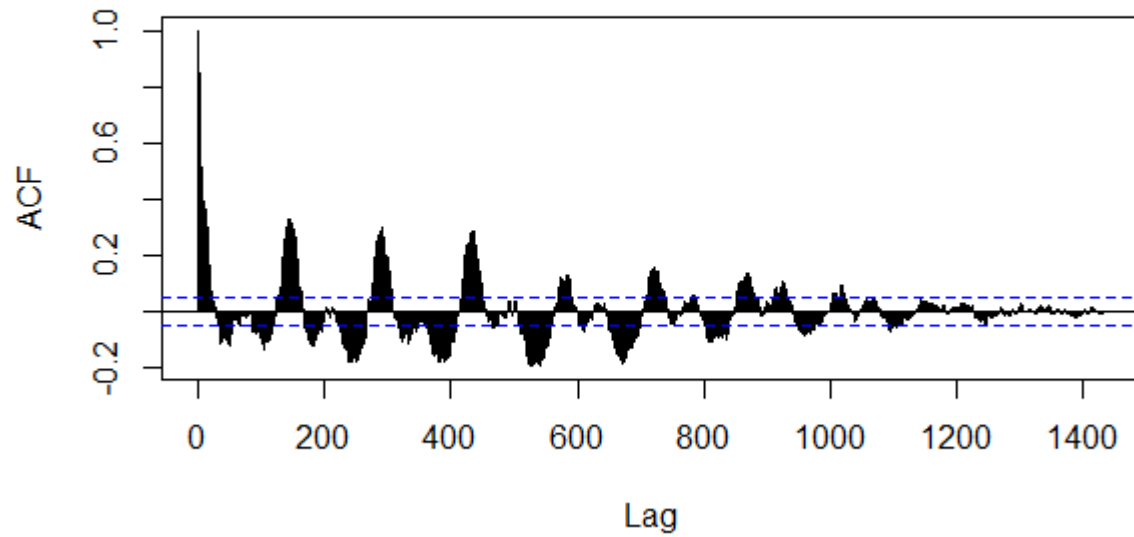
# Data exploration

## Decomposition of additive time series

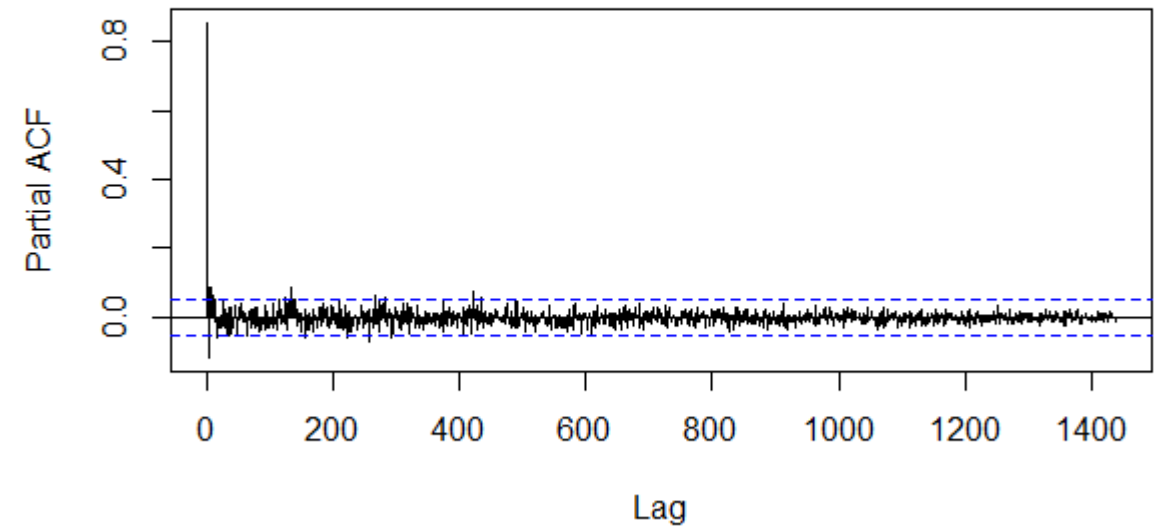


# Data exploration

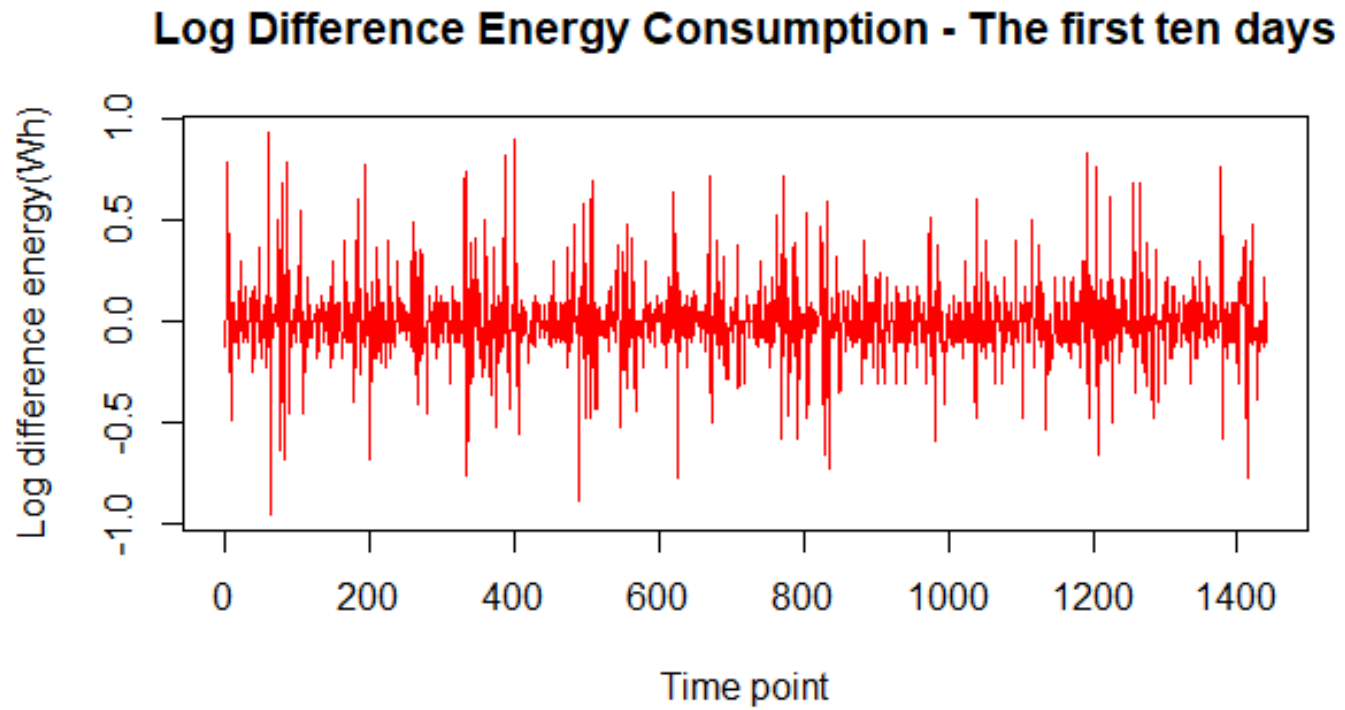
ACF plot



PACF plot

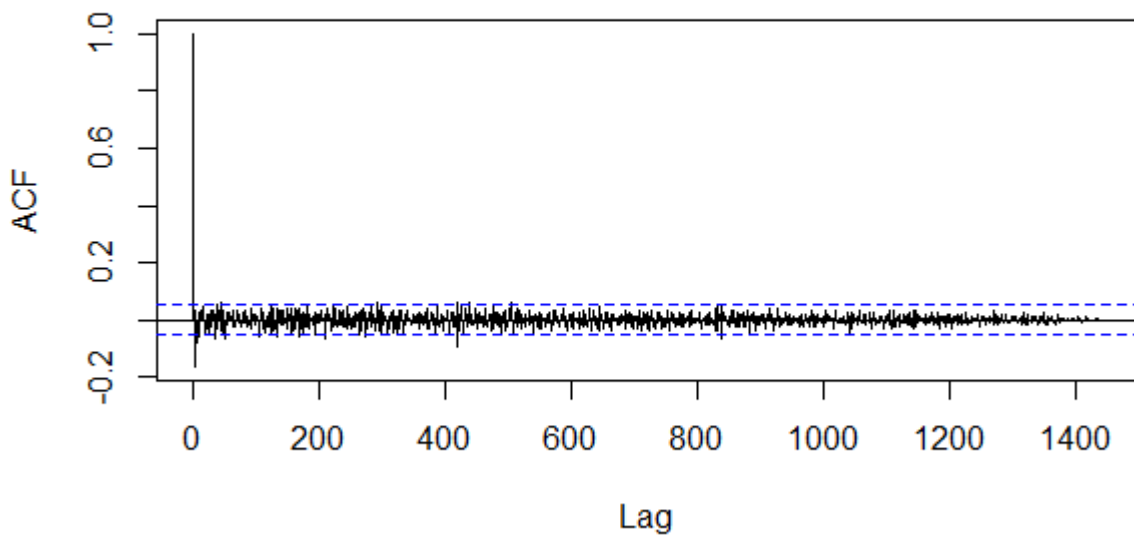


# Stationarizing

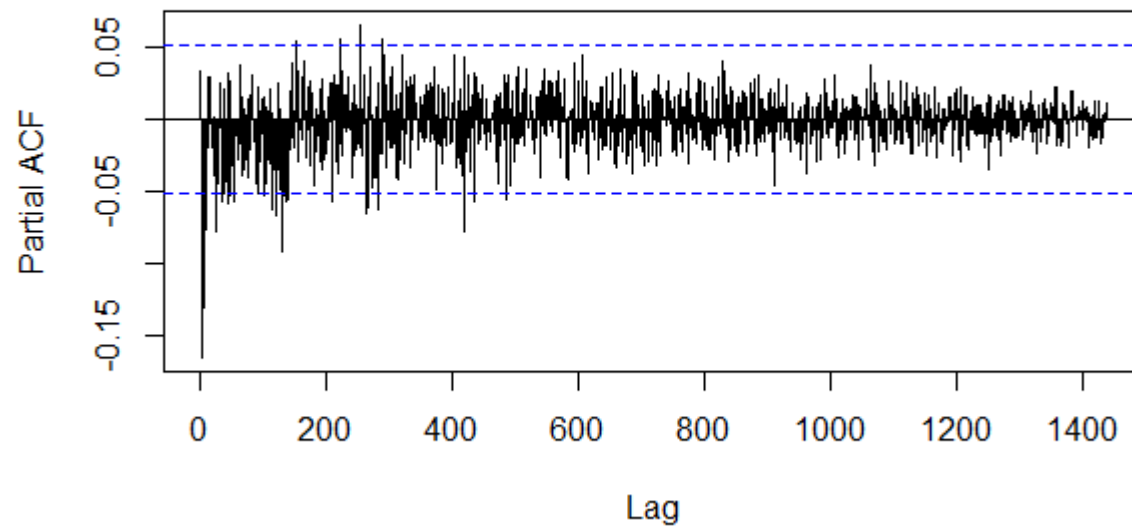


# Stationarizing

**ACF plot**



**PACF plot**



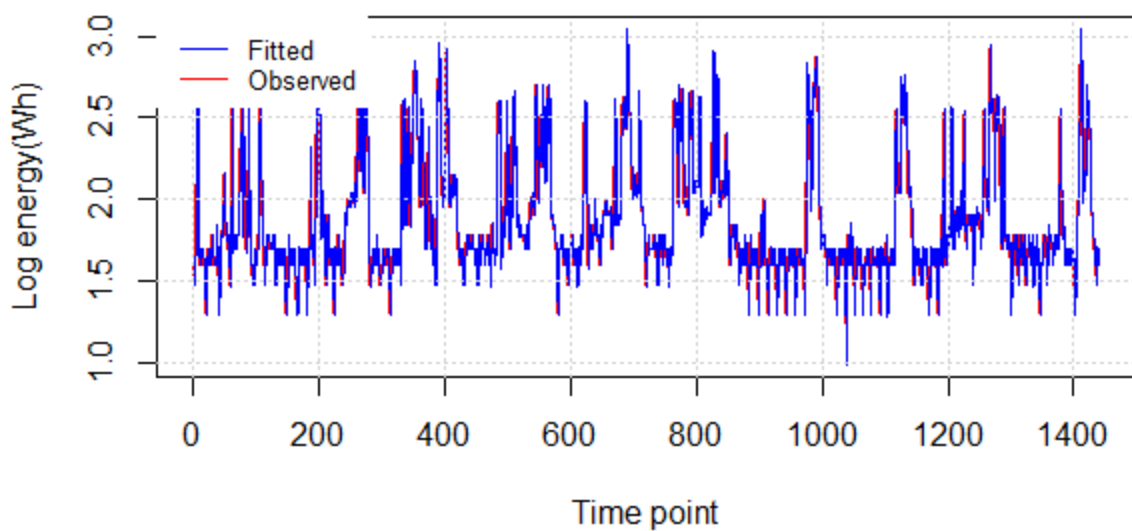


# Methods

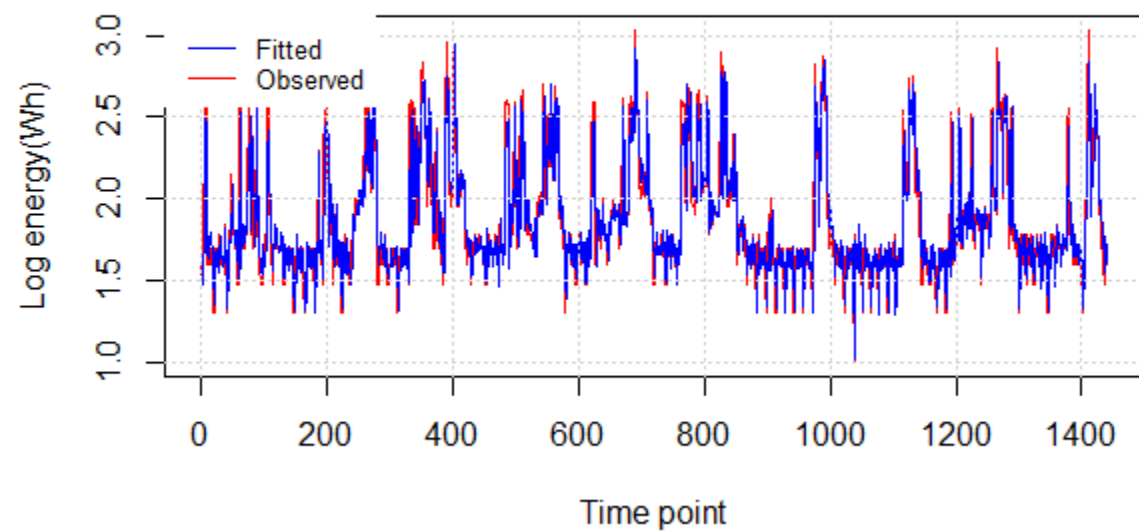
- AR1
- ARMA(6,6)
- ARIMA(6,2,6)
- ARIMA(3,0,3)
- Exponential Smoothing
- Holt Winter
- GARCH(6,6) – ARMA(6,6)

# Models for Stationary

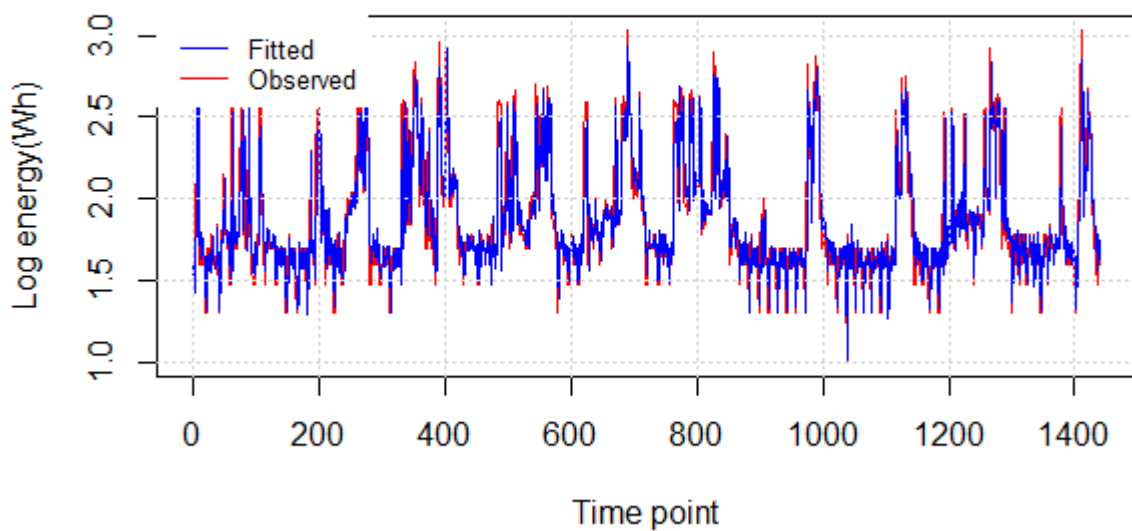
**AR1 model**



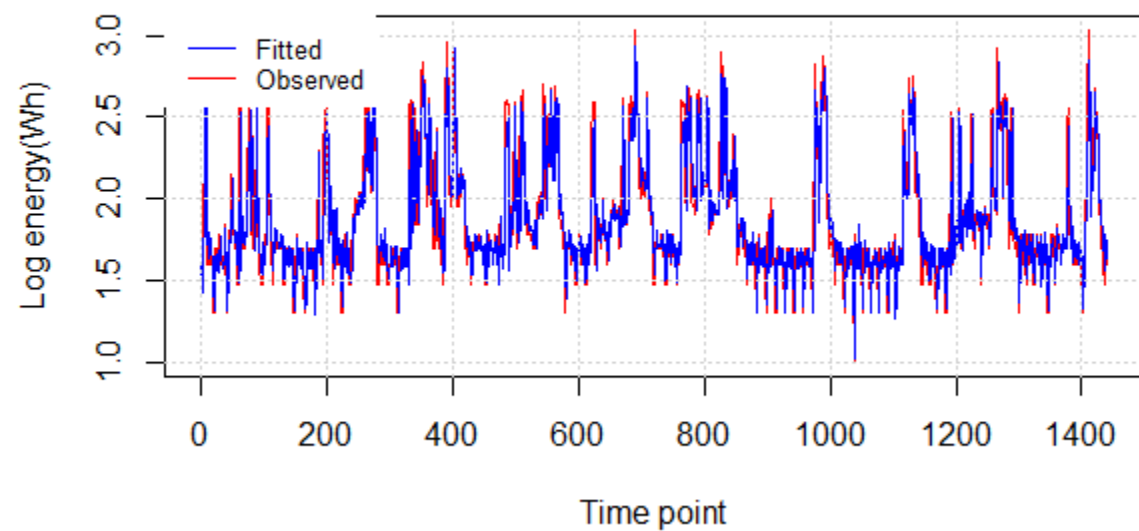
**ARMA(6,6) model**



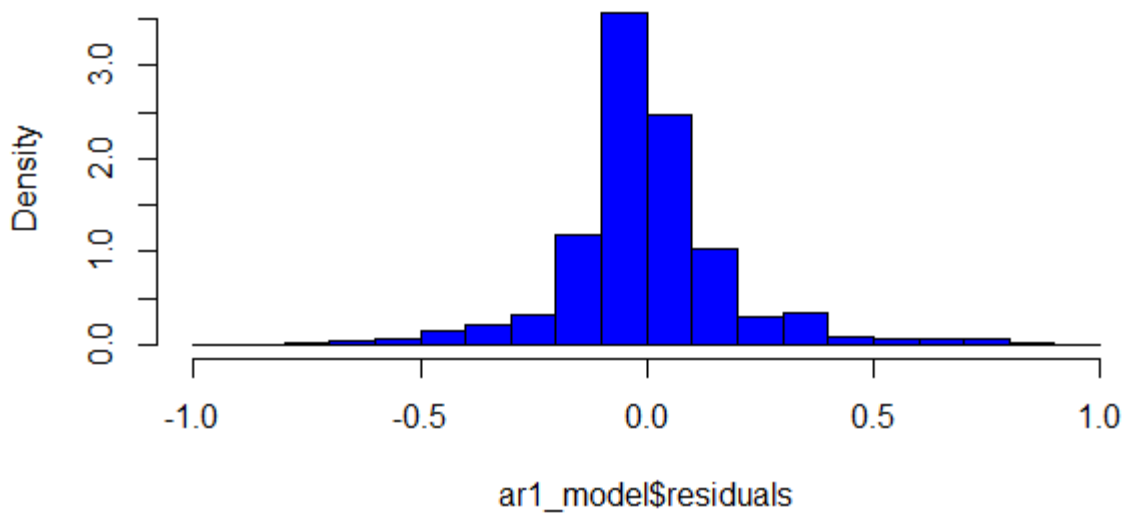
**ARIMA(6,2,6) model**



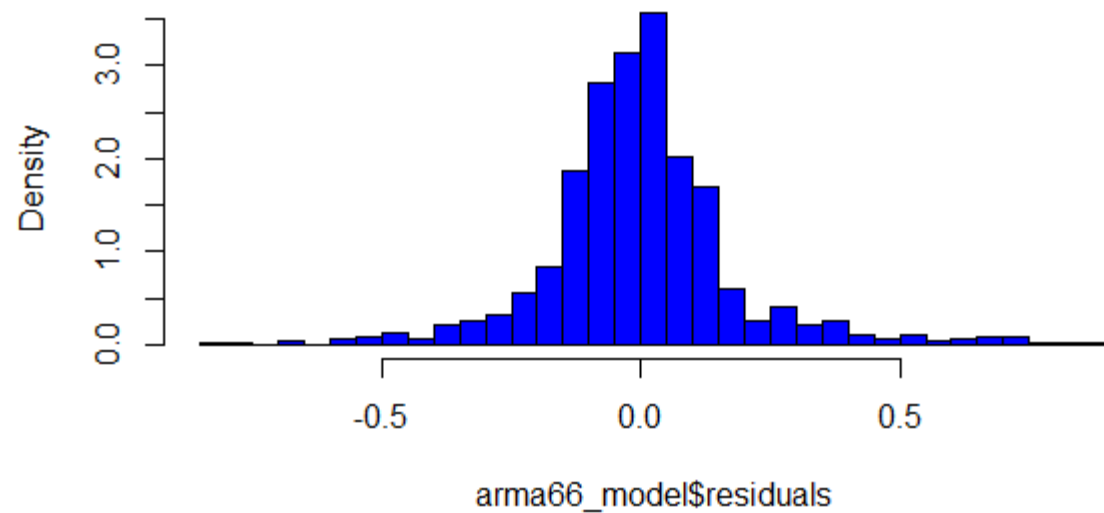
**ARIMA(3,0,3) model**



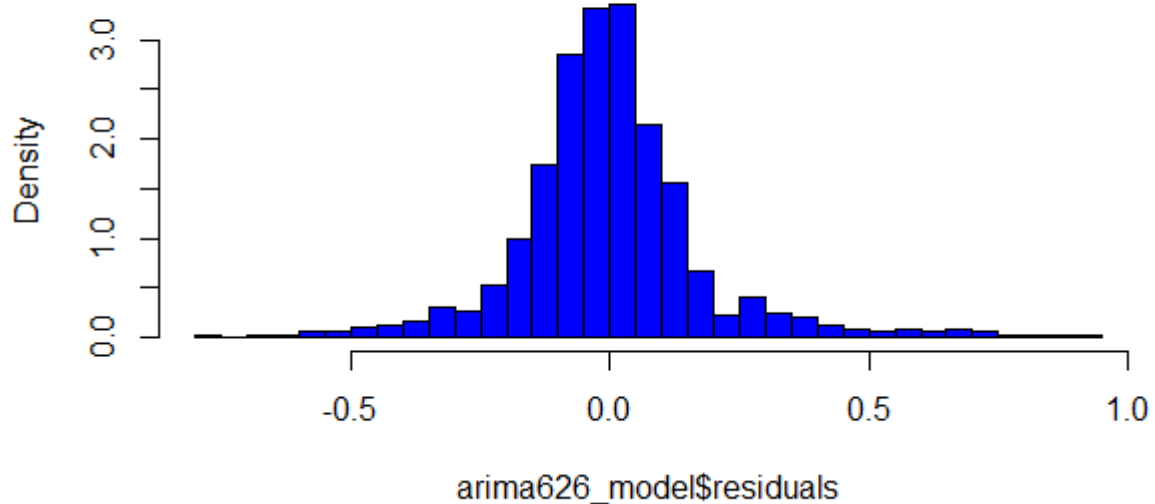
**Residual Plot - AR(1)**



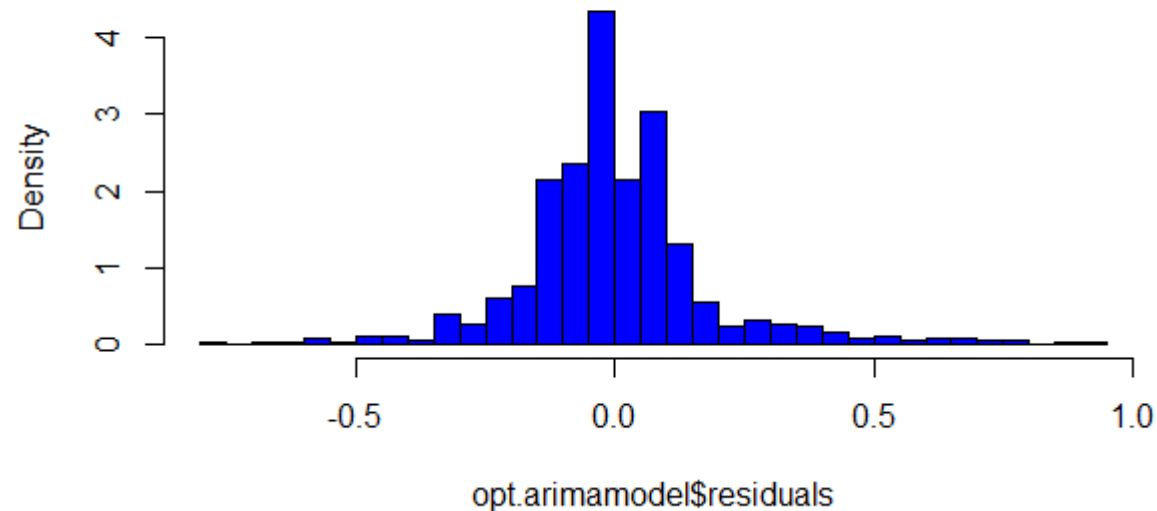
**Residual Plot - ARMA(6,6)**



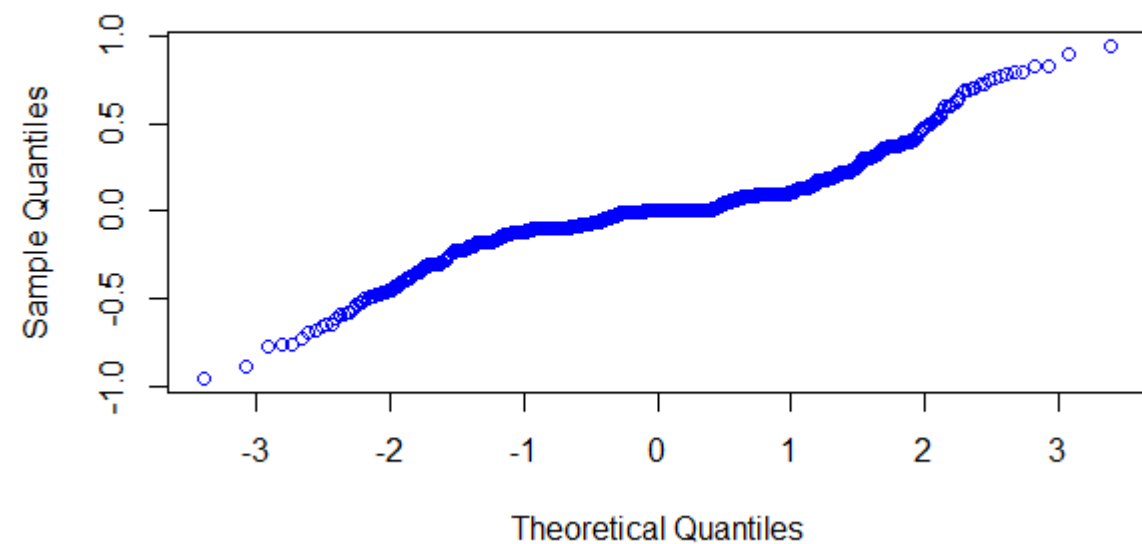
**Residual Plot - ARIMA(6,2,6)**



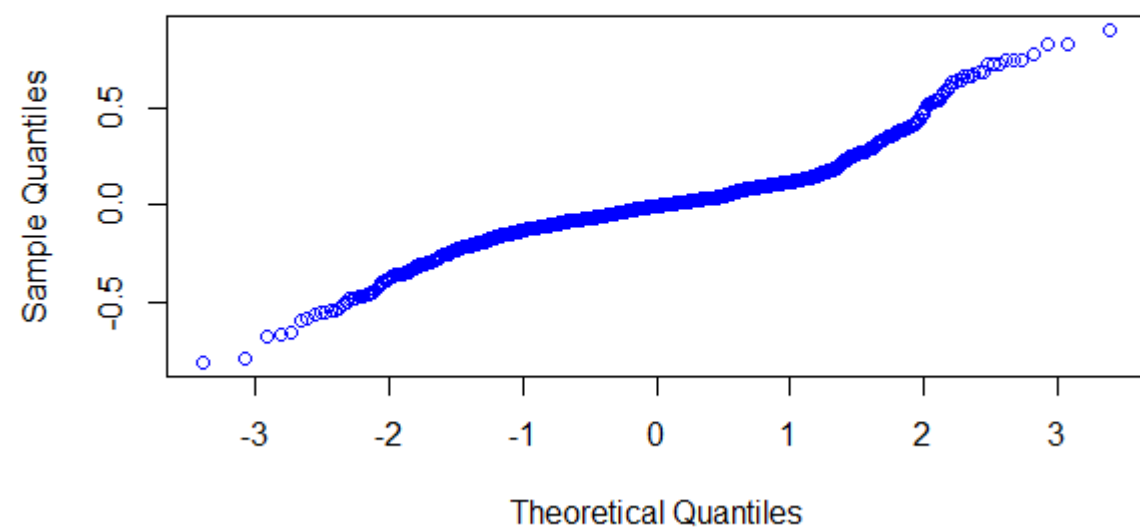
**Residual Plot - ARIMA(3,0,3)**



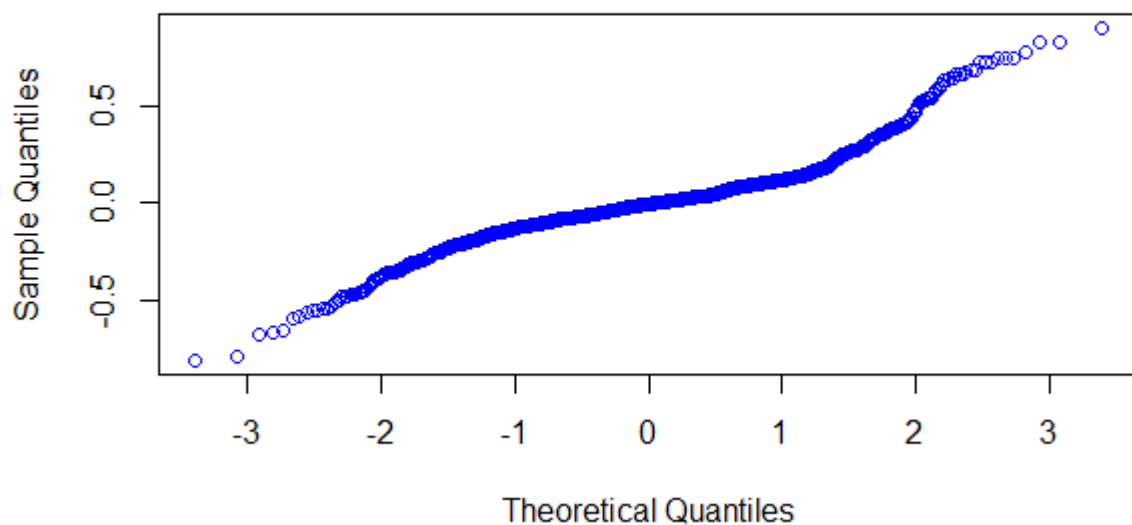
**Quantile-Quantile plot - AR(1)**



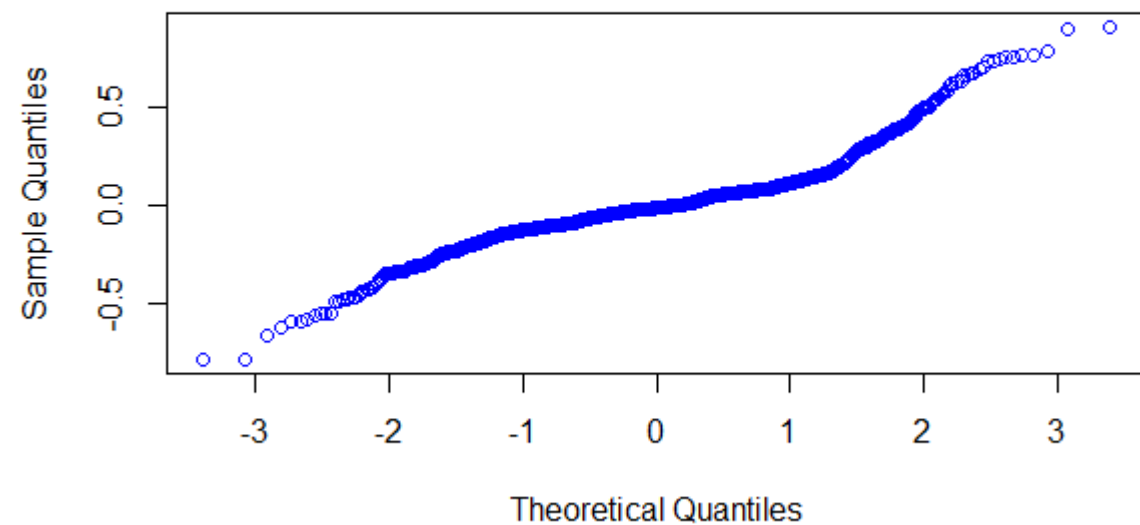
**Quantile-Quantile plot - ARMA(6,6)**



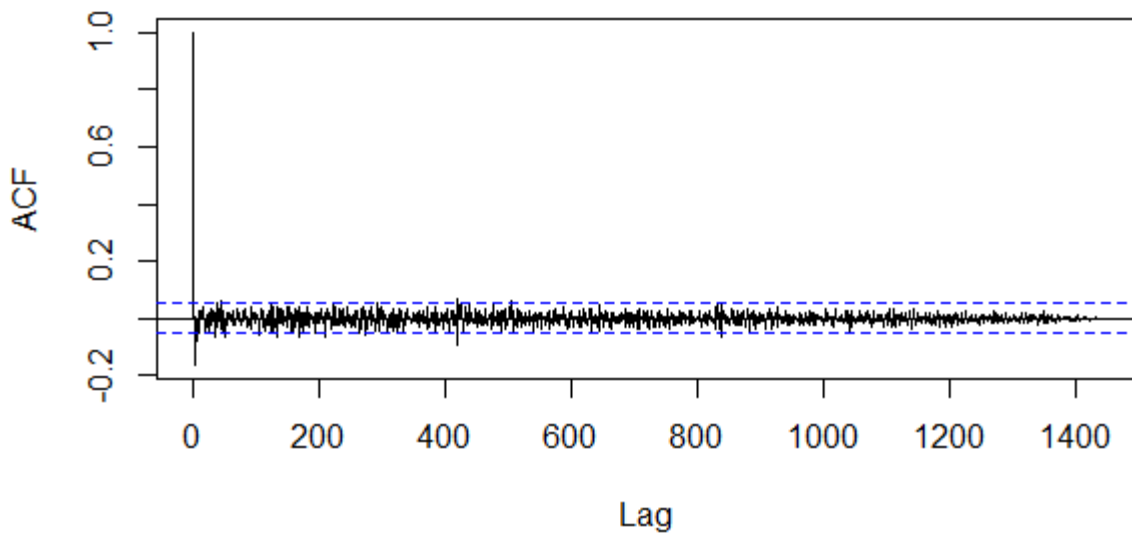
**Quantile-Quantile plot - ARIMA(6,2,6)**



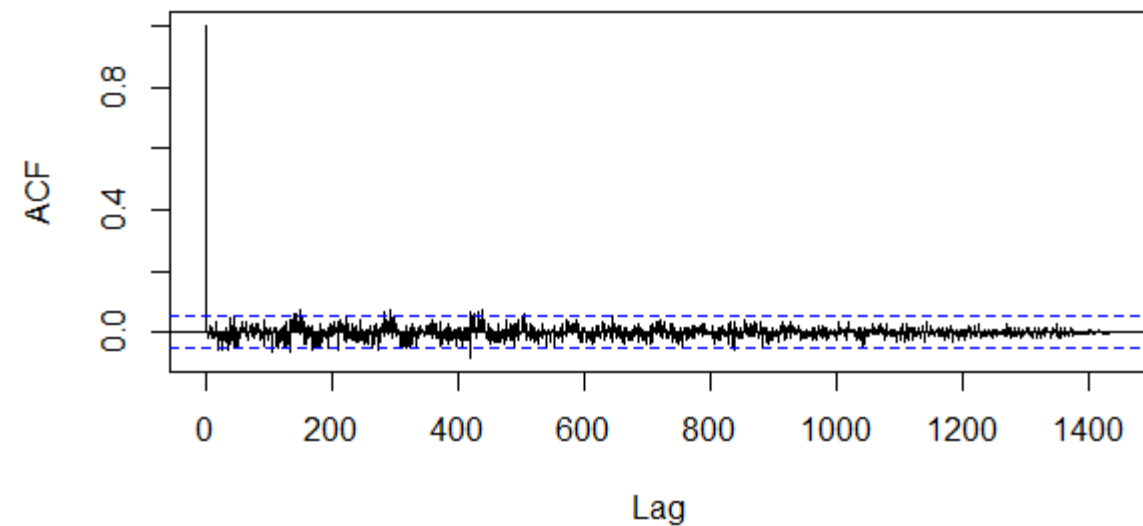
**Quantile-Quantile plot - ARIMA(3,0,3)**



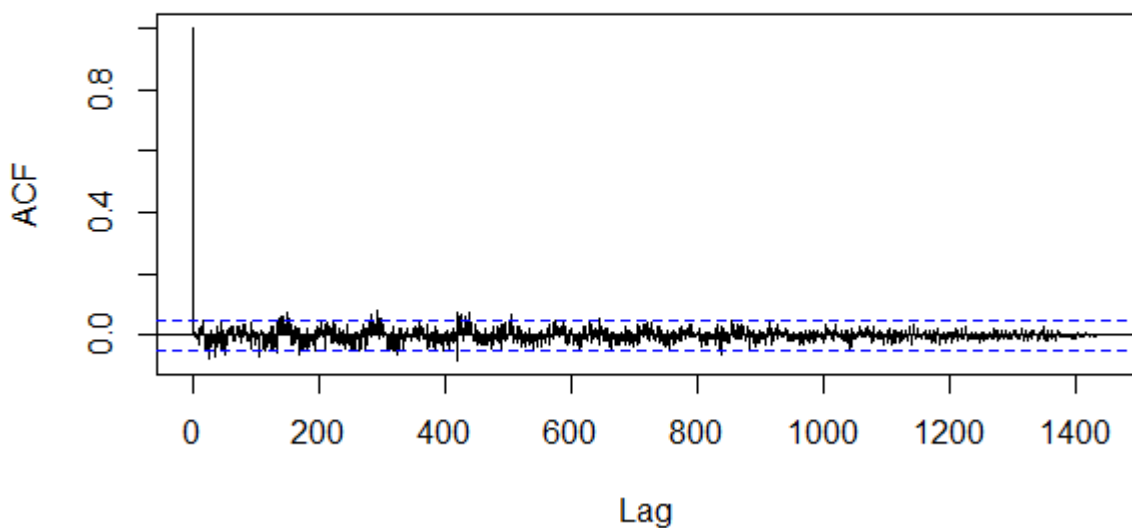
**ACF residual plot-AR1**



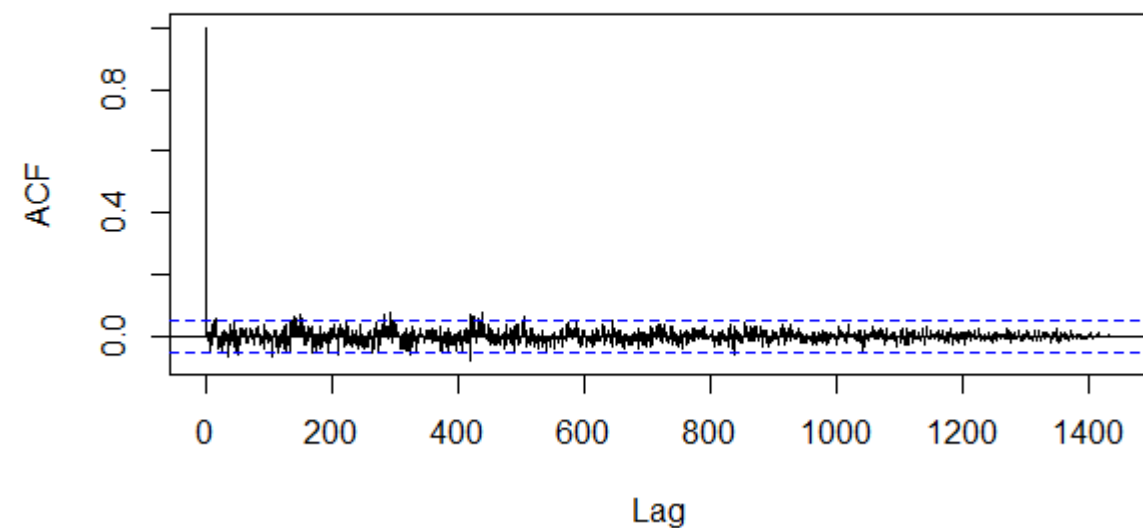
**ACF residual plot-ARMA66**



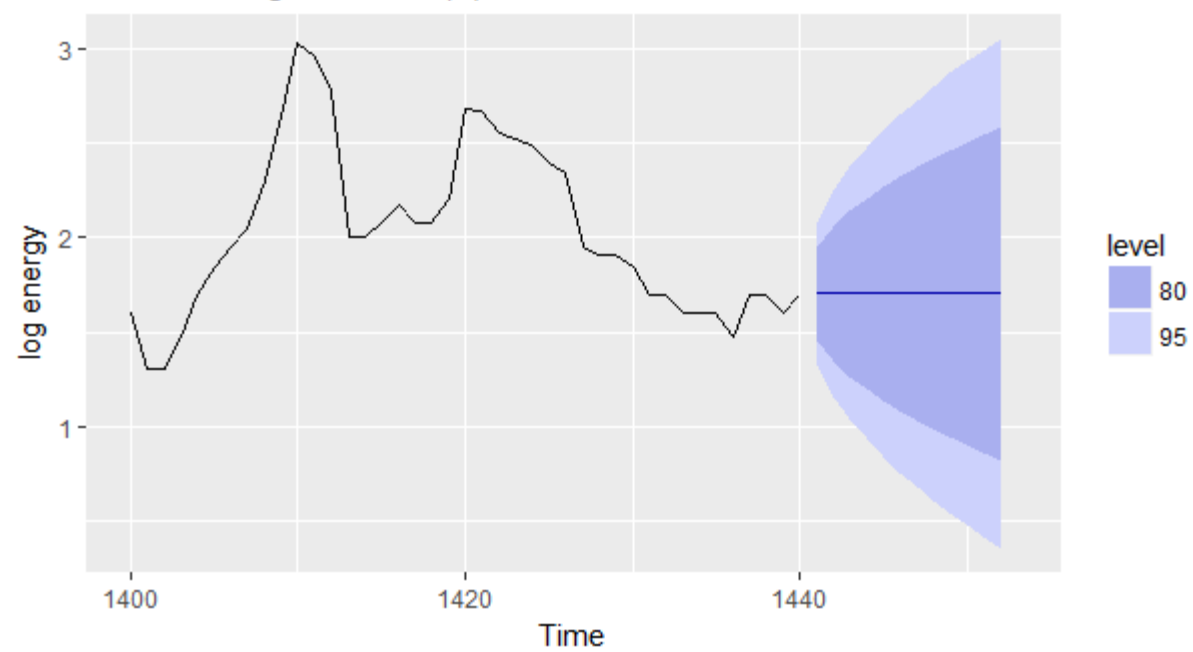
**ACF residual plot-ARIMA626**



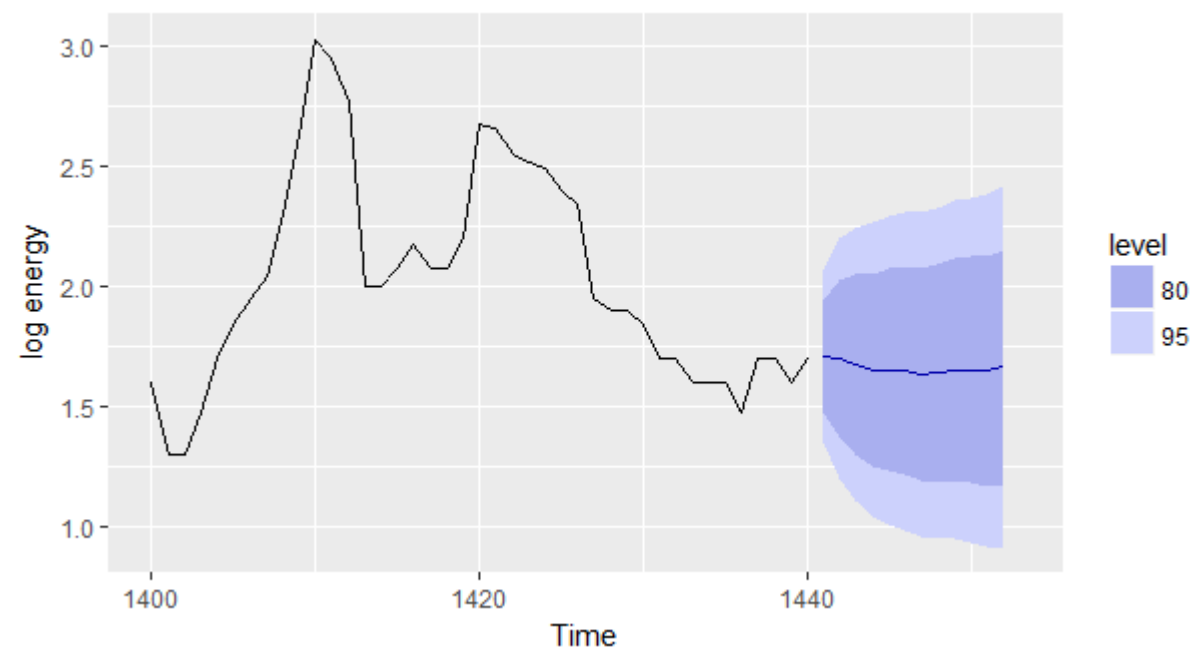
**ACF residual plot-ARIMA(3,0,3)**



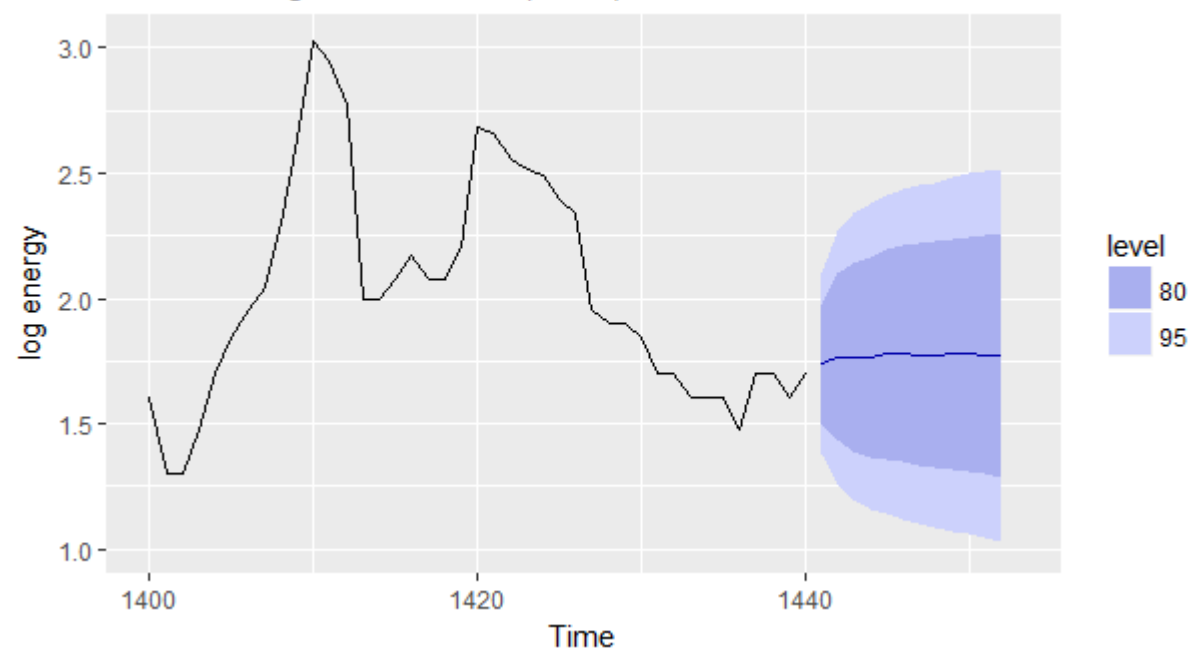
Forecast-log scale-AR(1)



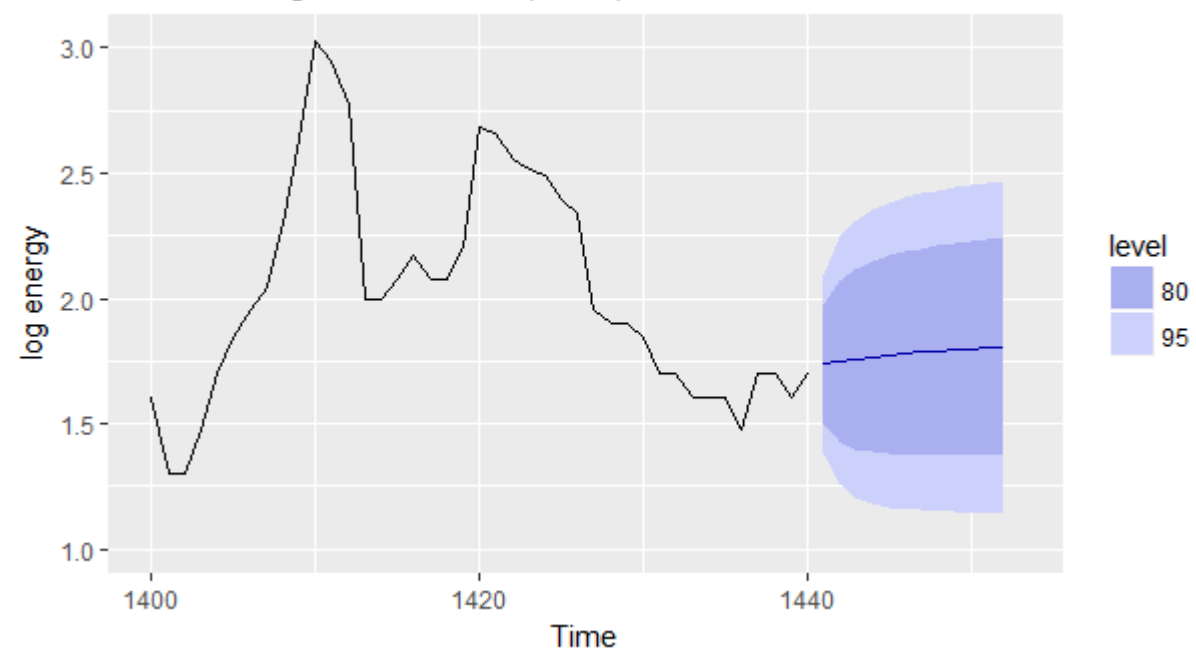
Forecast-log scale-ARMA(6,6)



Forecast-log scale-ARIMA(6,2,6)



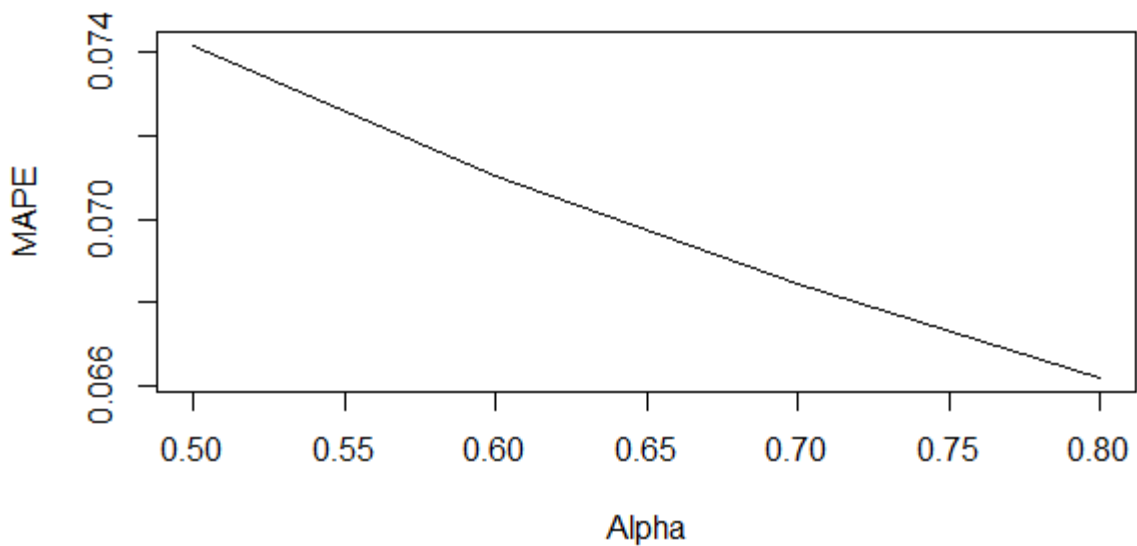
Forecast-log scale-ARIMA(3,0,3)



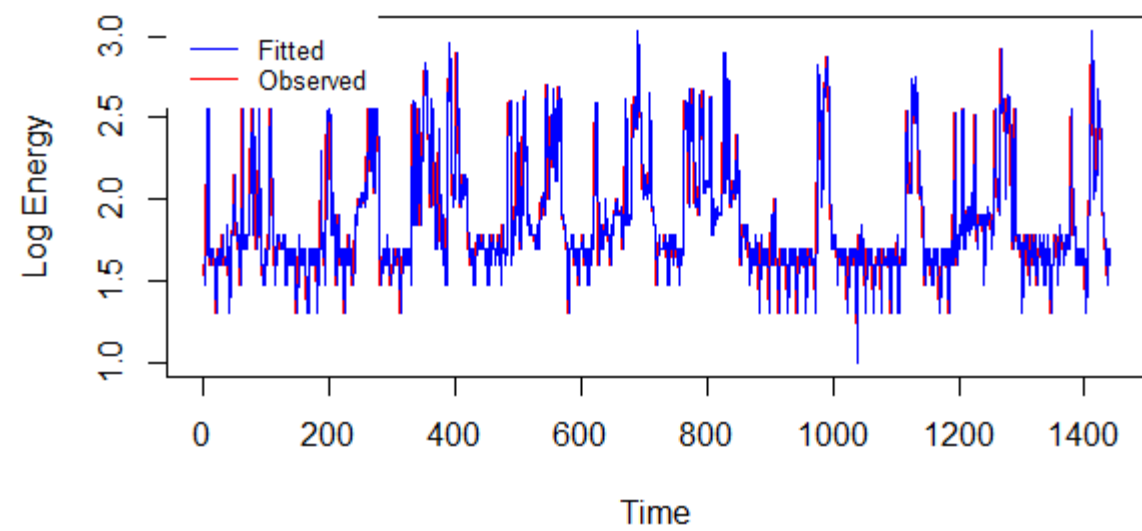
# Exponential Smoothing



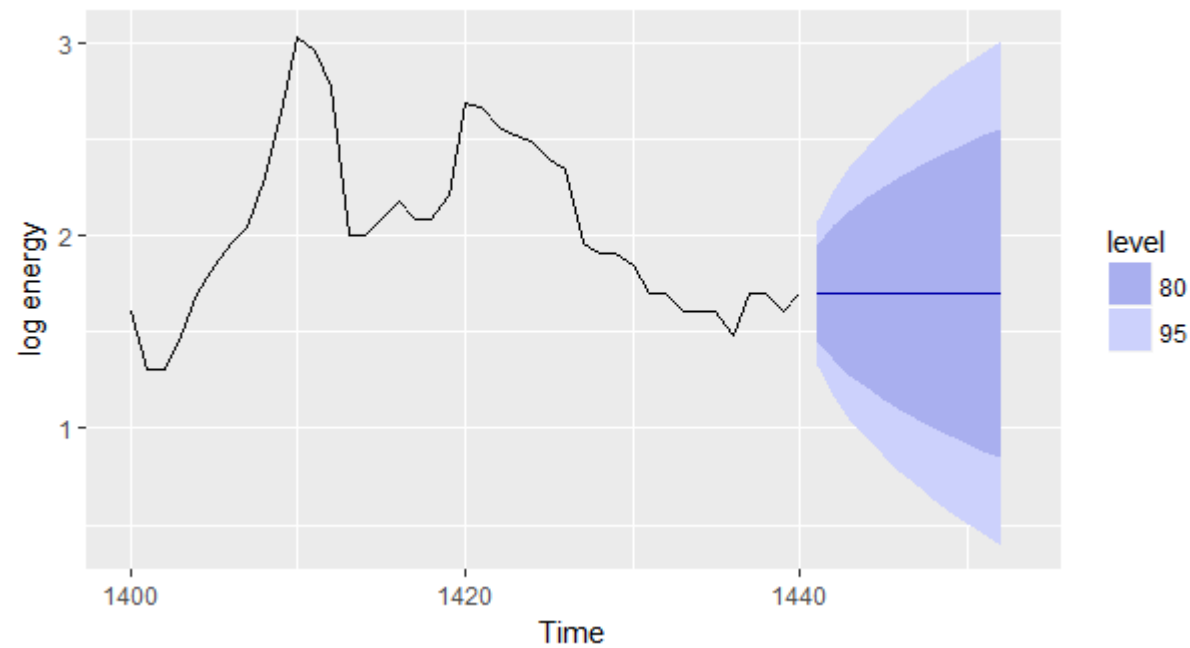
### Exponential Smoothing - Alpha



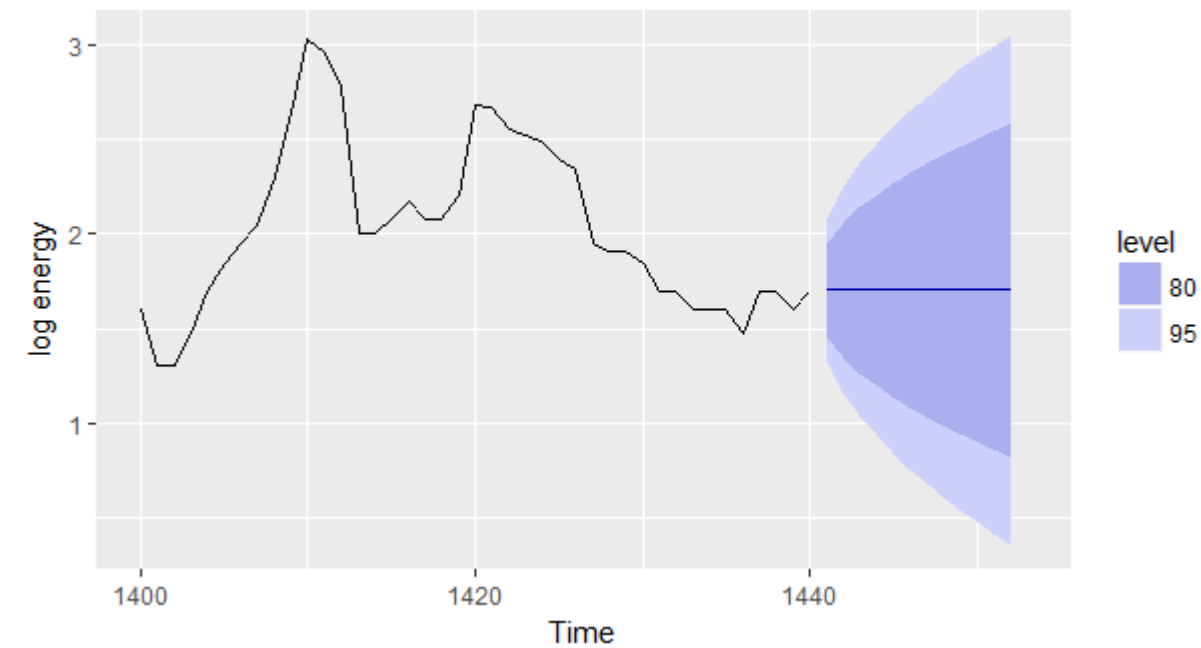
### Exponential Smoothing



### Forecast-log scale-Exponential smoothing

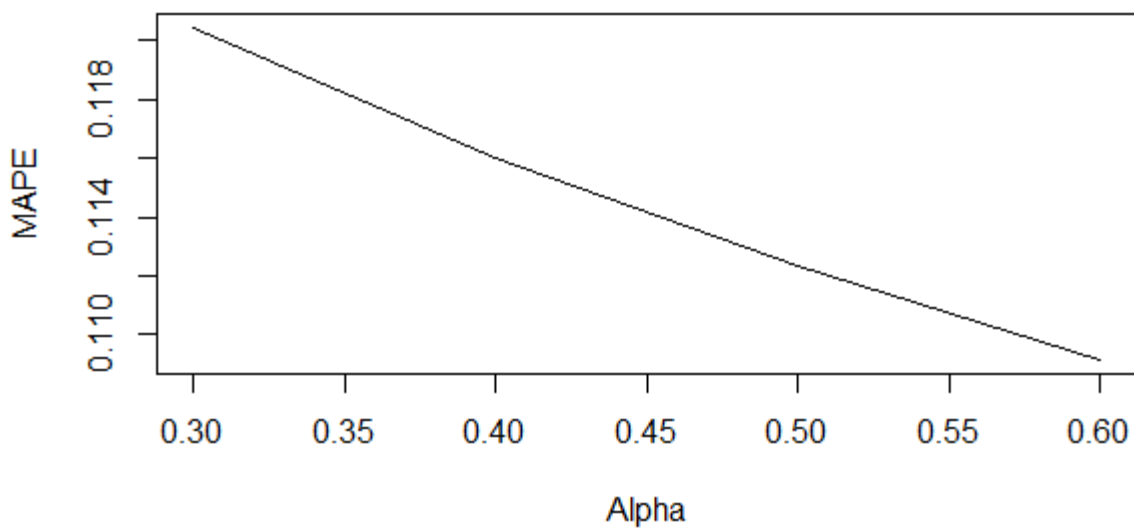


### Forecast-log scale-AR(1)

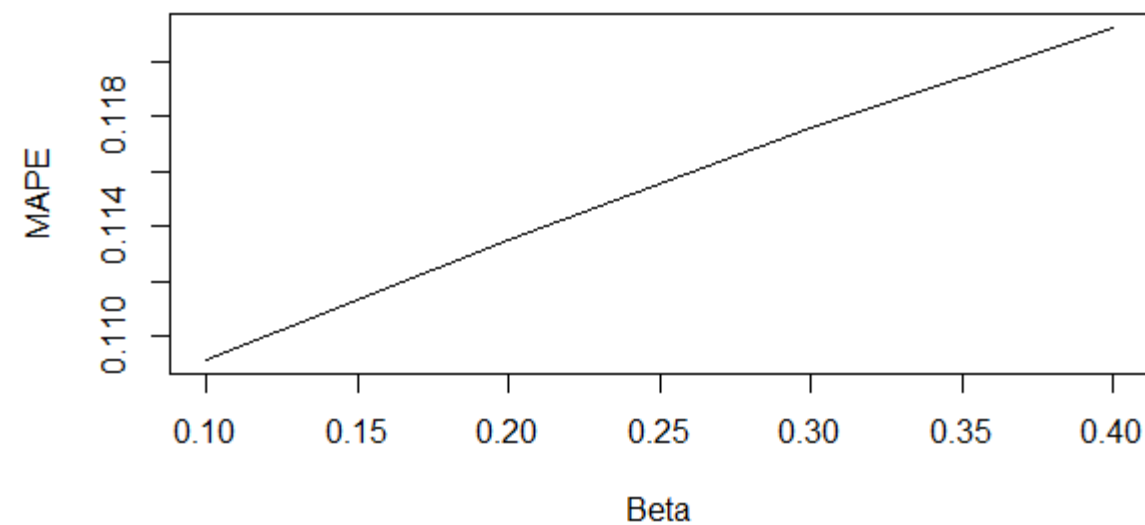


Holt Winter

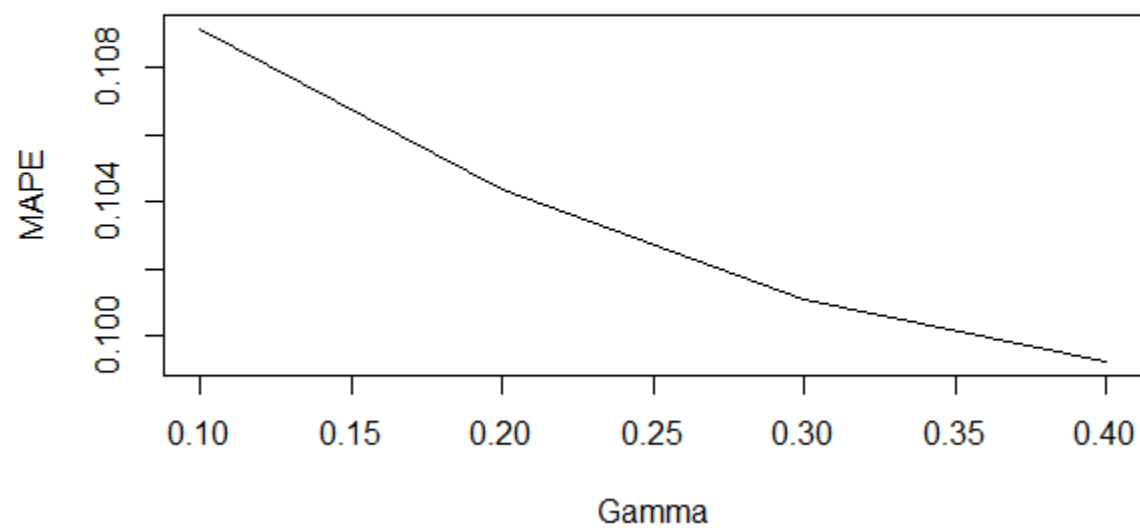
**Alpha-beta=0.1, gamma=0.1**



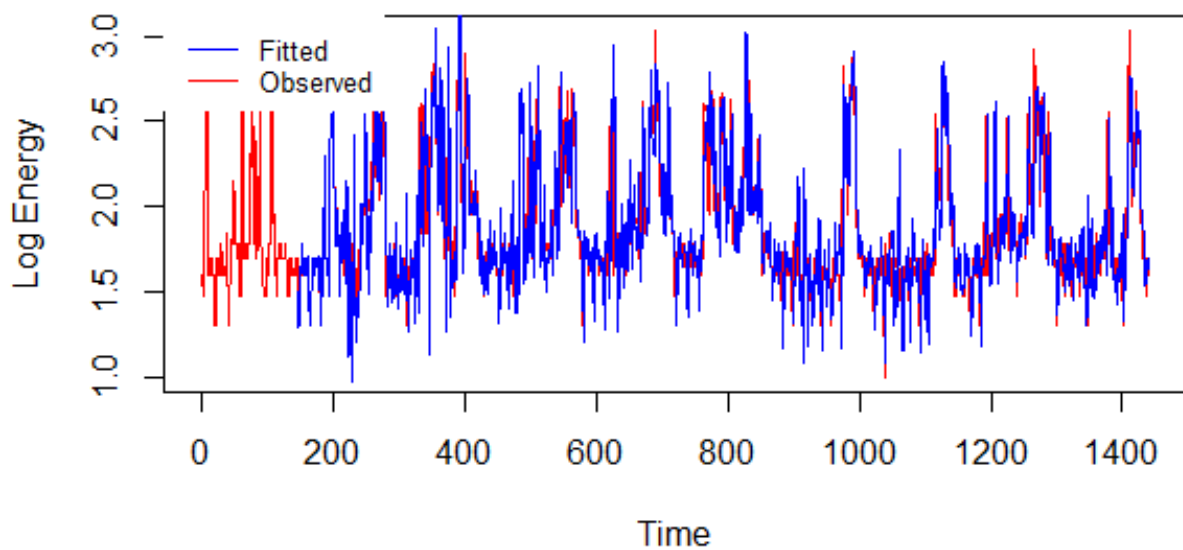
**alpha=0.6-Beta-gamma=0.1**



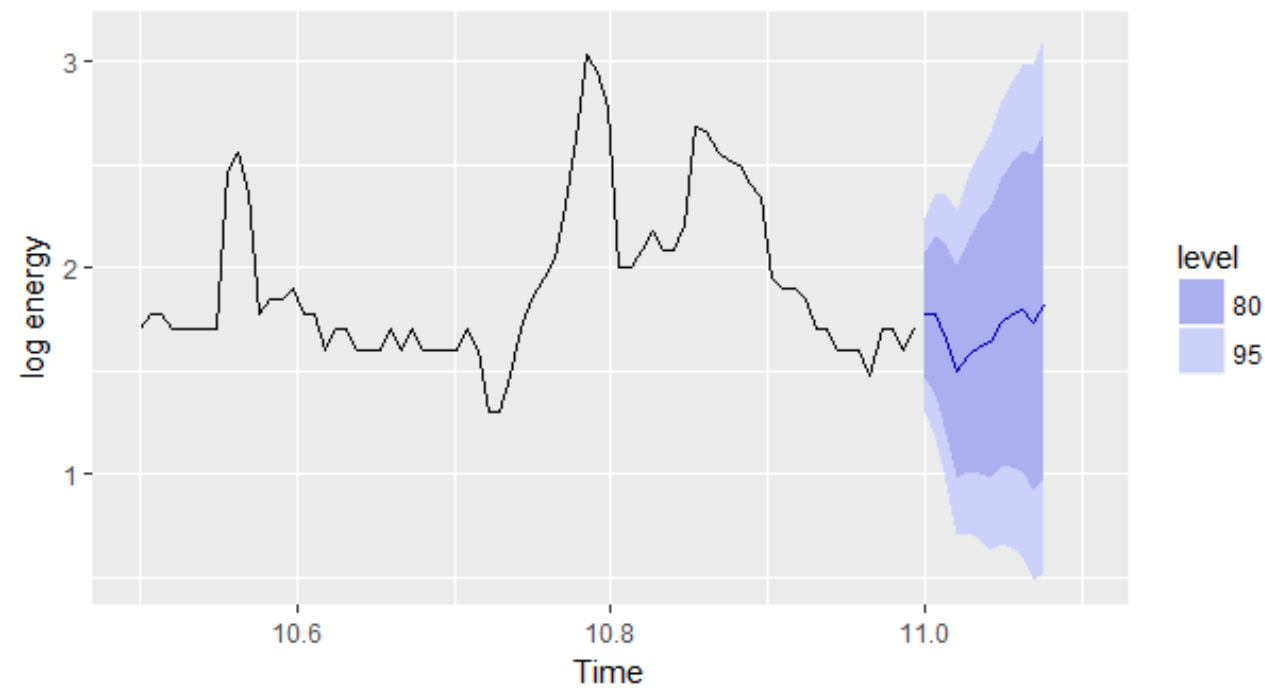
**alpha=0.6-beta=0.1-Gamma**



HW\_ADDITIVE model

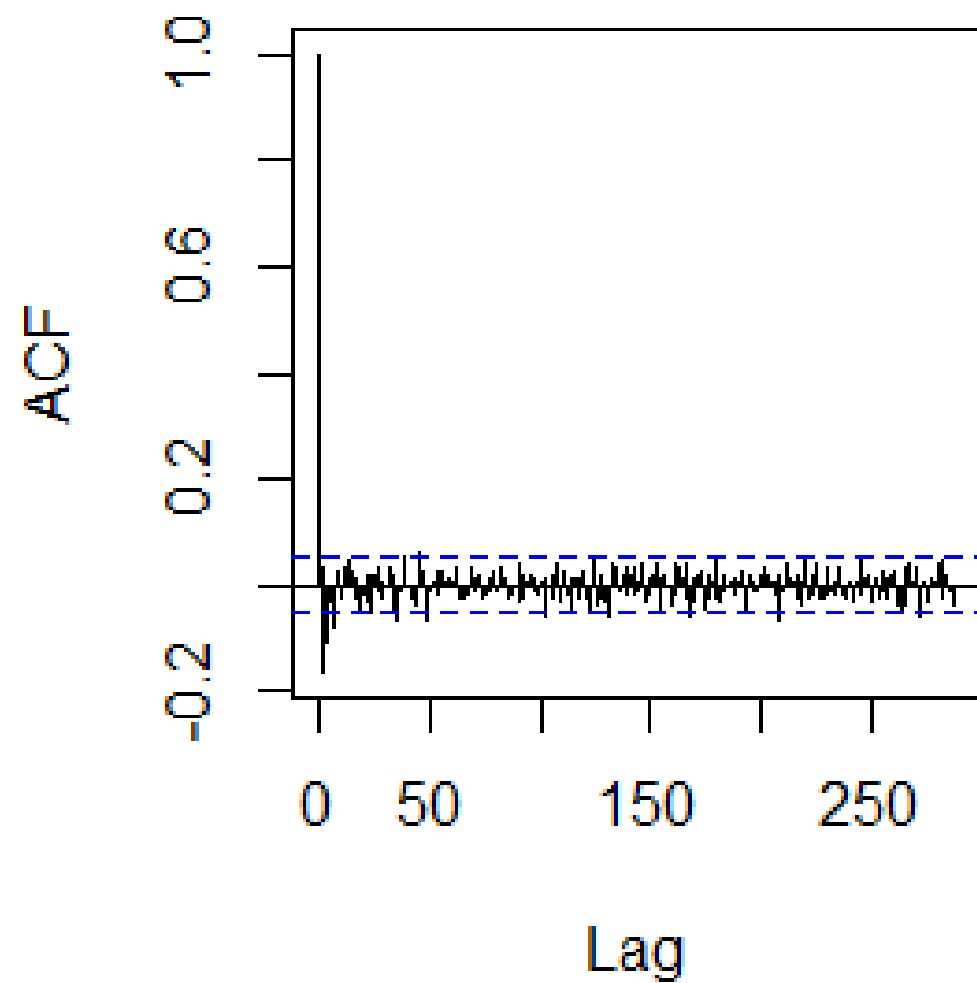


Forecast-log scale-HW\_ADDITIVE model

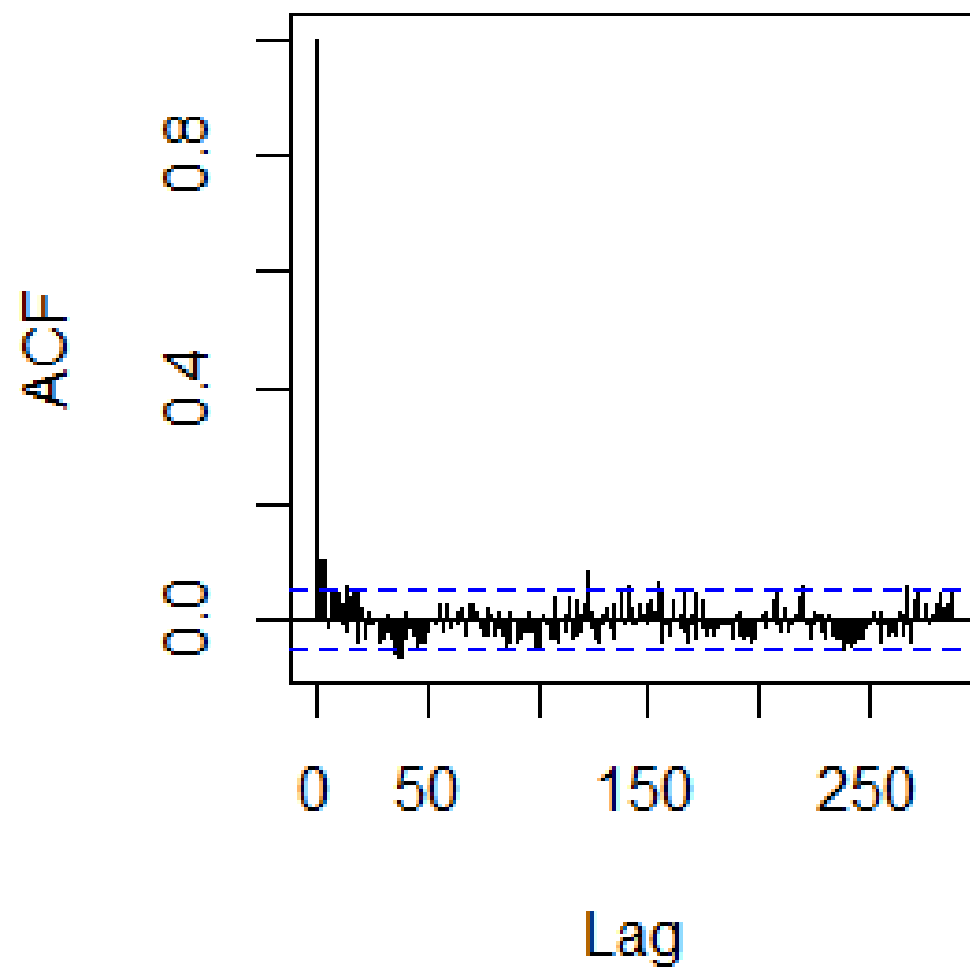


GARCH-ARMA-6,6

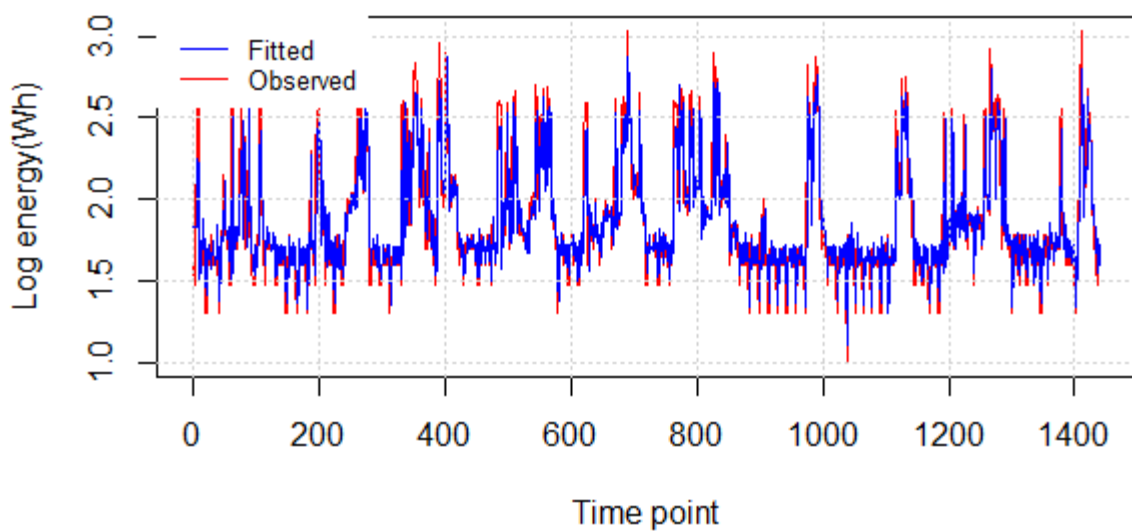
**xt ACF plot**



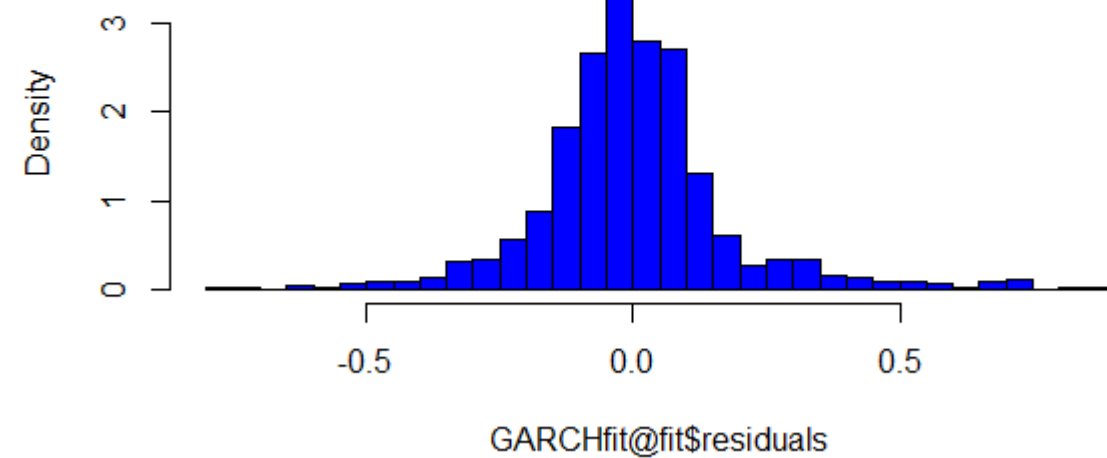
**xt squared ACF plot**



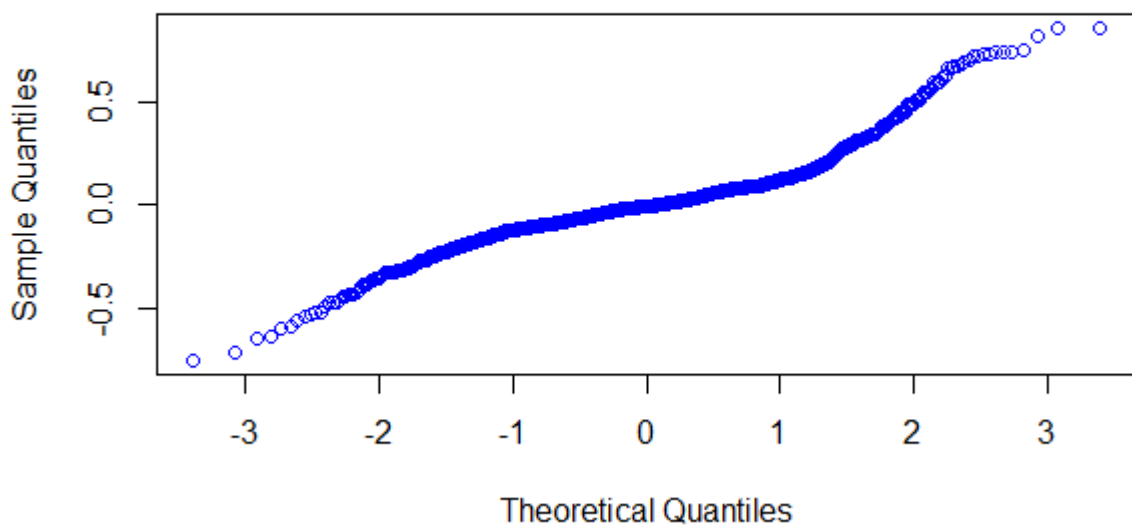
**GARCH-ARMA(6,6)**



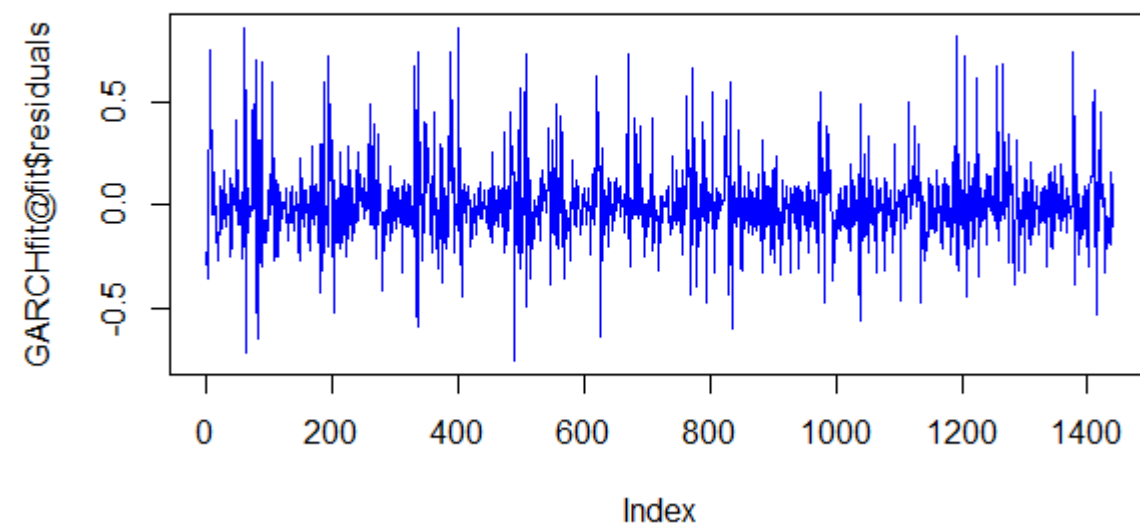
**Residual Plot - GARCH-ARMA(6,6)**



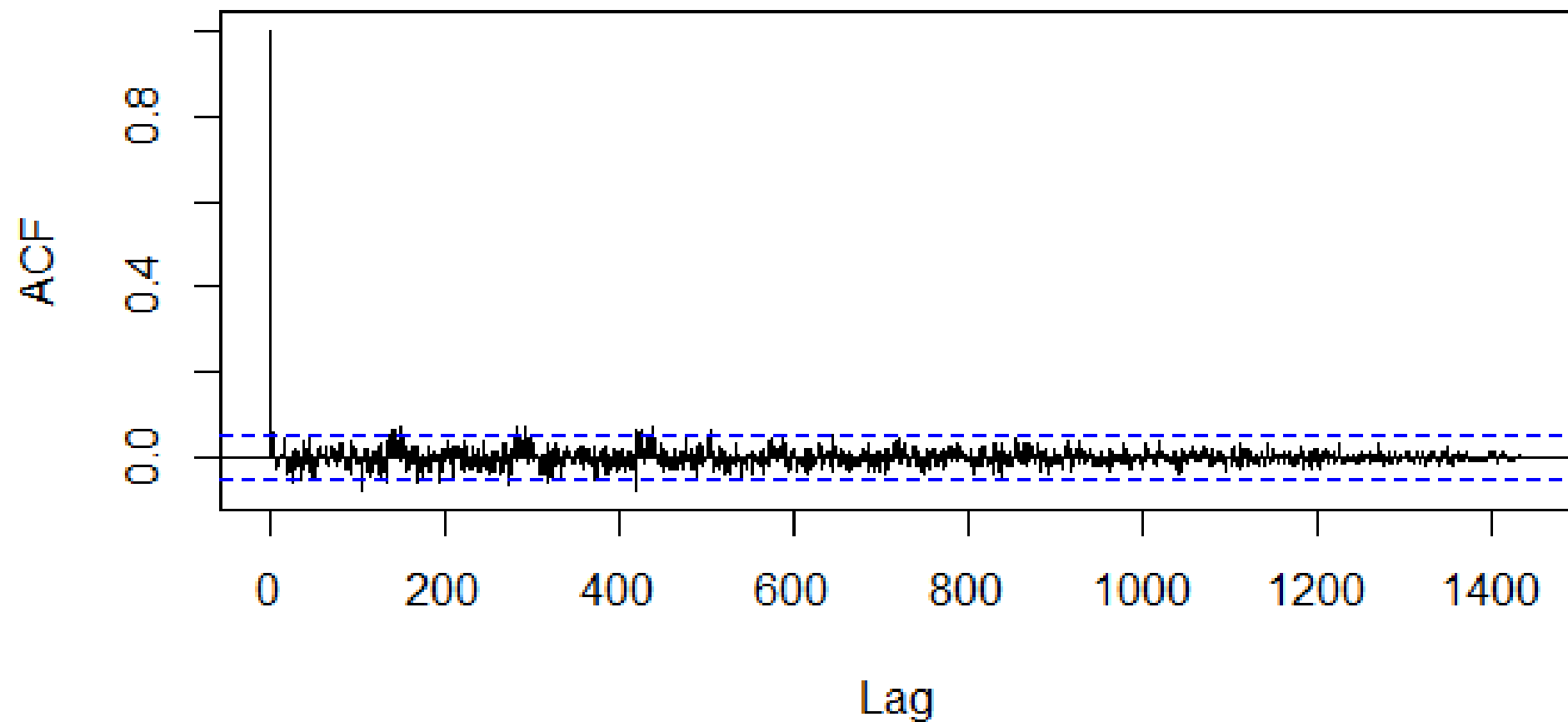
**Quantile-Quantile plot - GARCH-ARMA(6,6)**



**Residual Plot - GARCH-ARMA(6,6)**

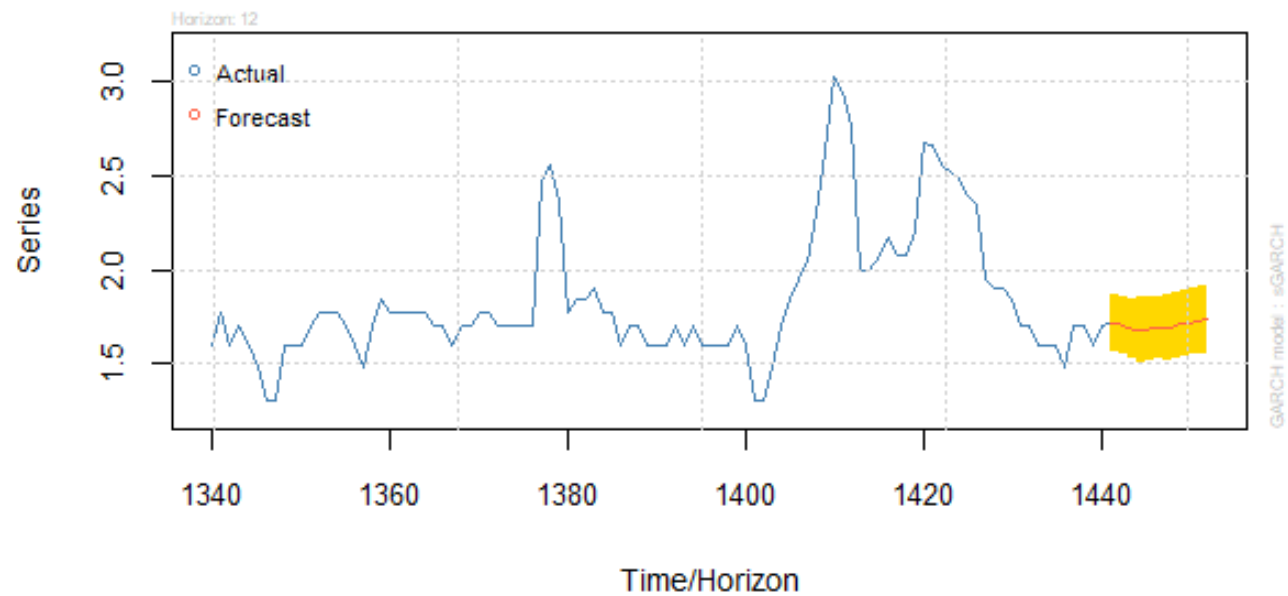


**ACF residual plot-GARCH-ARMA(6,6)**

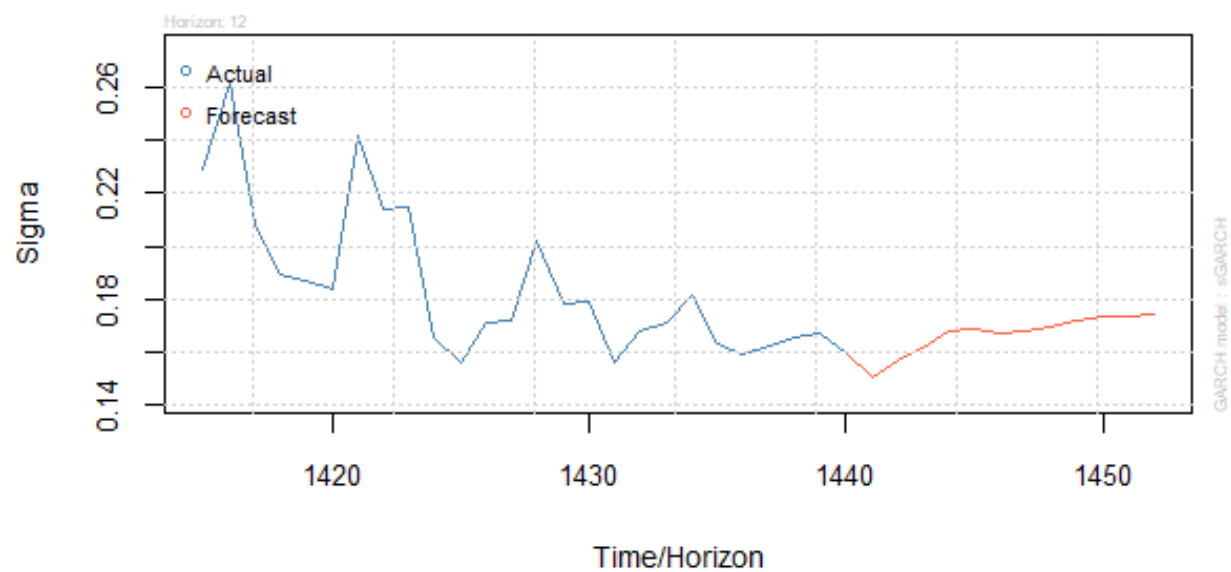




**Forecast Series  
with unconditional 1-Sigma bands**



**Forecast Unconditional Sigma  
(n.roll = 0)**



# Results

MODELS	MAPE	AIC
AR(1)	0.06328462	-664.2
EXPONENTIAL SMOOTHING (OPTIMAL ALPHA=0.999922)	0.06273692	—
HOLT-WINTERS – ADDITIVE (0.7759488,0,1)	0.08821809	—
ARMA(6,6)	0.06524994	-775.5
ARIMA(6,2,6)	0.06489309	-755.13
ARIMA(3,0,3) (OPTIMAL)	0.06448967	-803.36
GARCH(6,6) – ARMA(6,6)	0.06465604	8

Thank You!