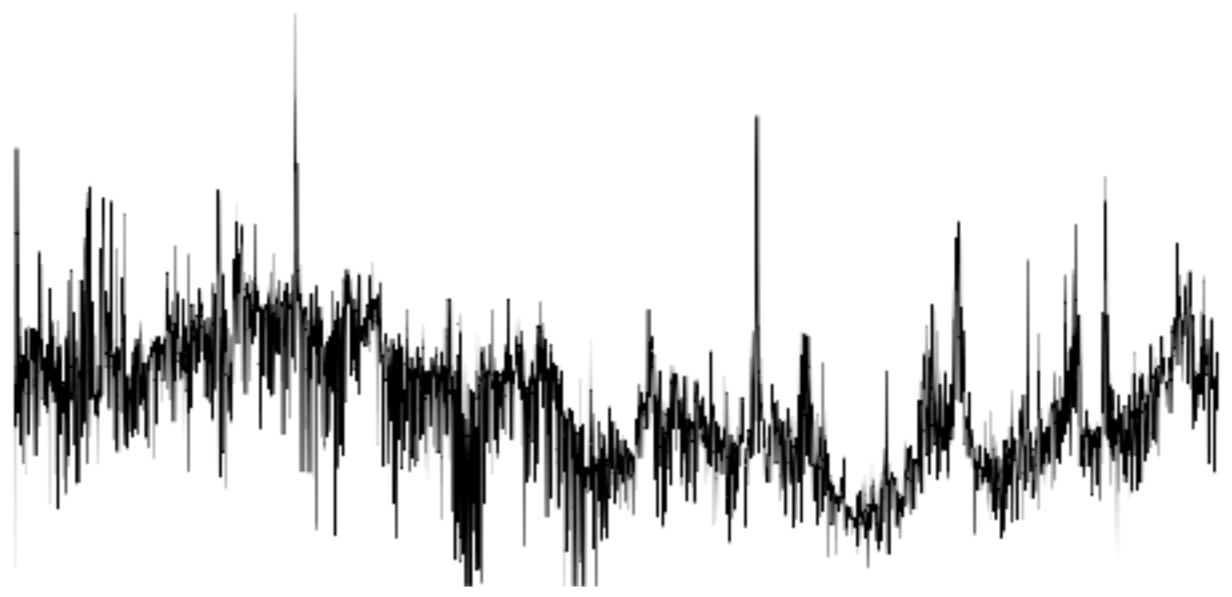
ELECTRICITY PRICE FORECASTING



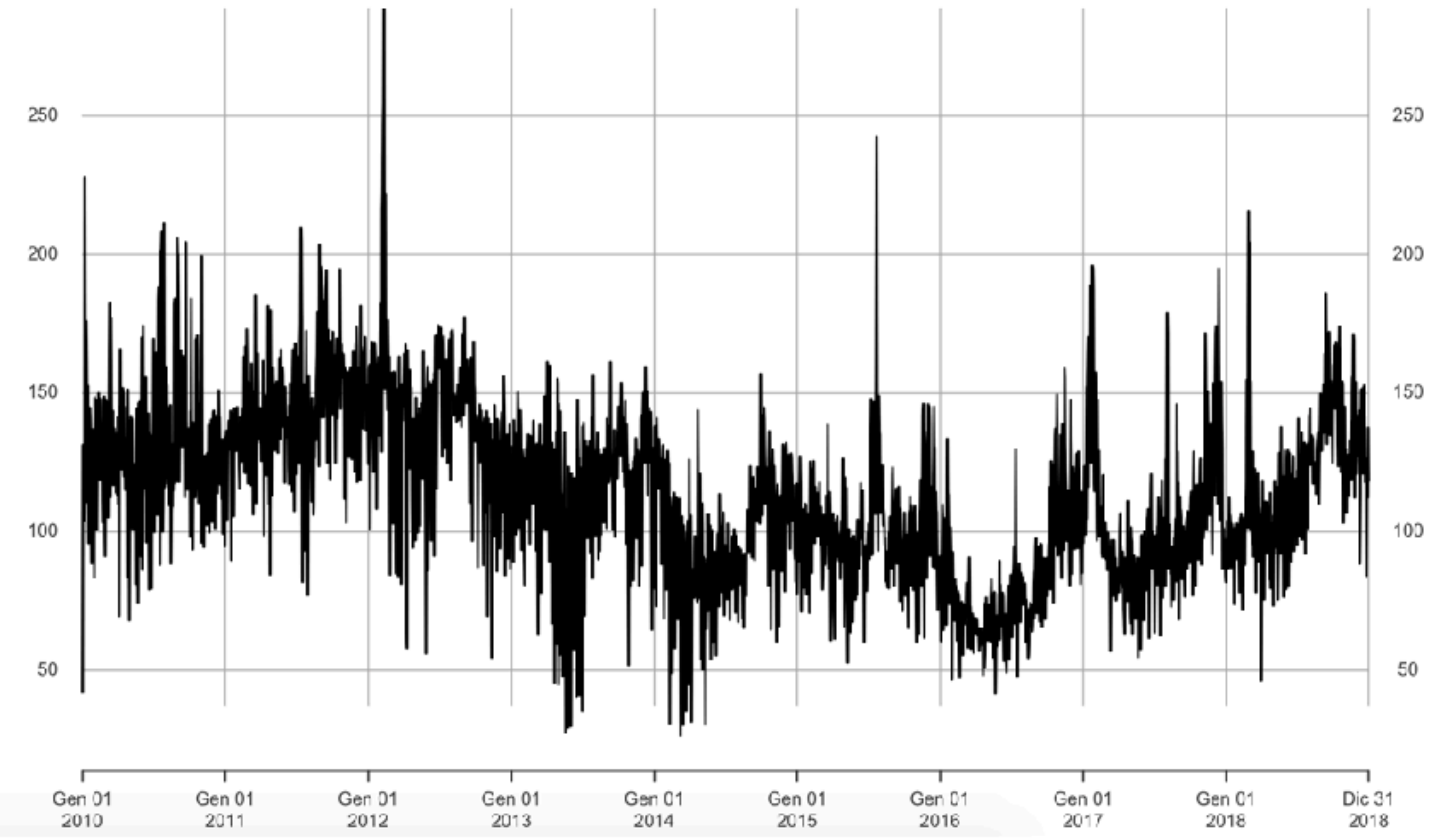
Streaming Data Management and Time Series Analysis

Academic Year 2019/2020

PROJECT WORKFLOW

THE TASK

The goal is the daily prediction over a 11 months horizon using 9-years price data with ARIMA, UCM and Machine Leaning models



PREPROCESSING

- Logarithmic Transformation
- Train-Val Split (90% - 10%)

METRICS

- MAE

MODELS

ARIMA

UCM

KNN

LSTM RNN

COMPARISON AND CONCLUSIONS

MODELS

ARIMA

UCM

KNN

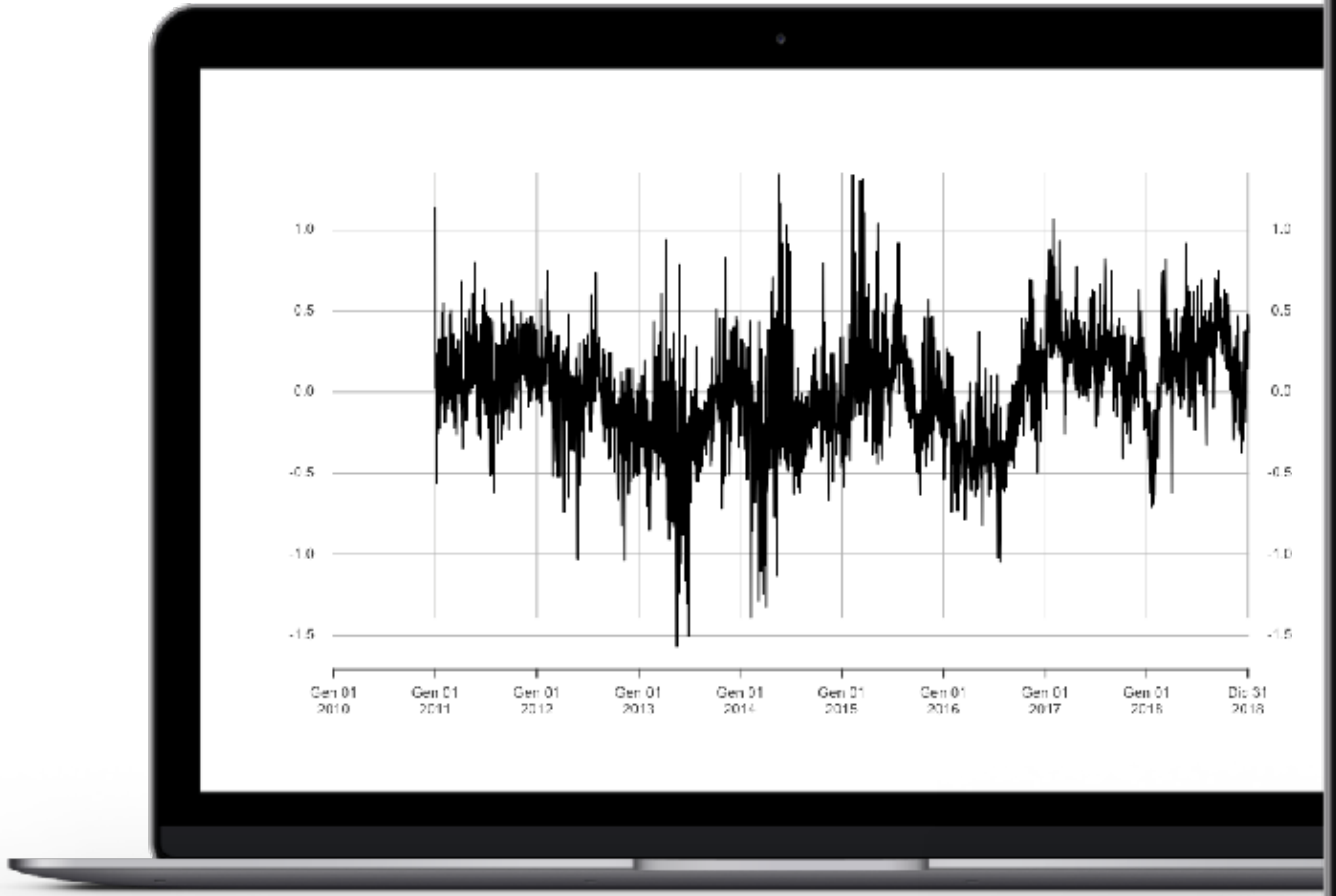
LSTM RNN

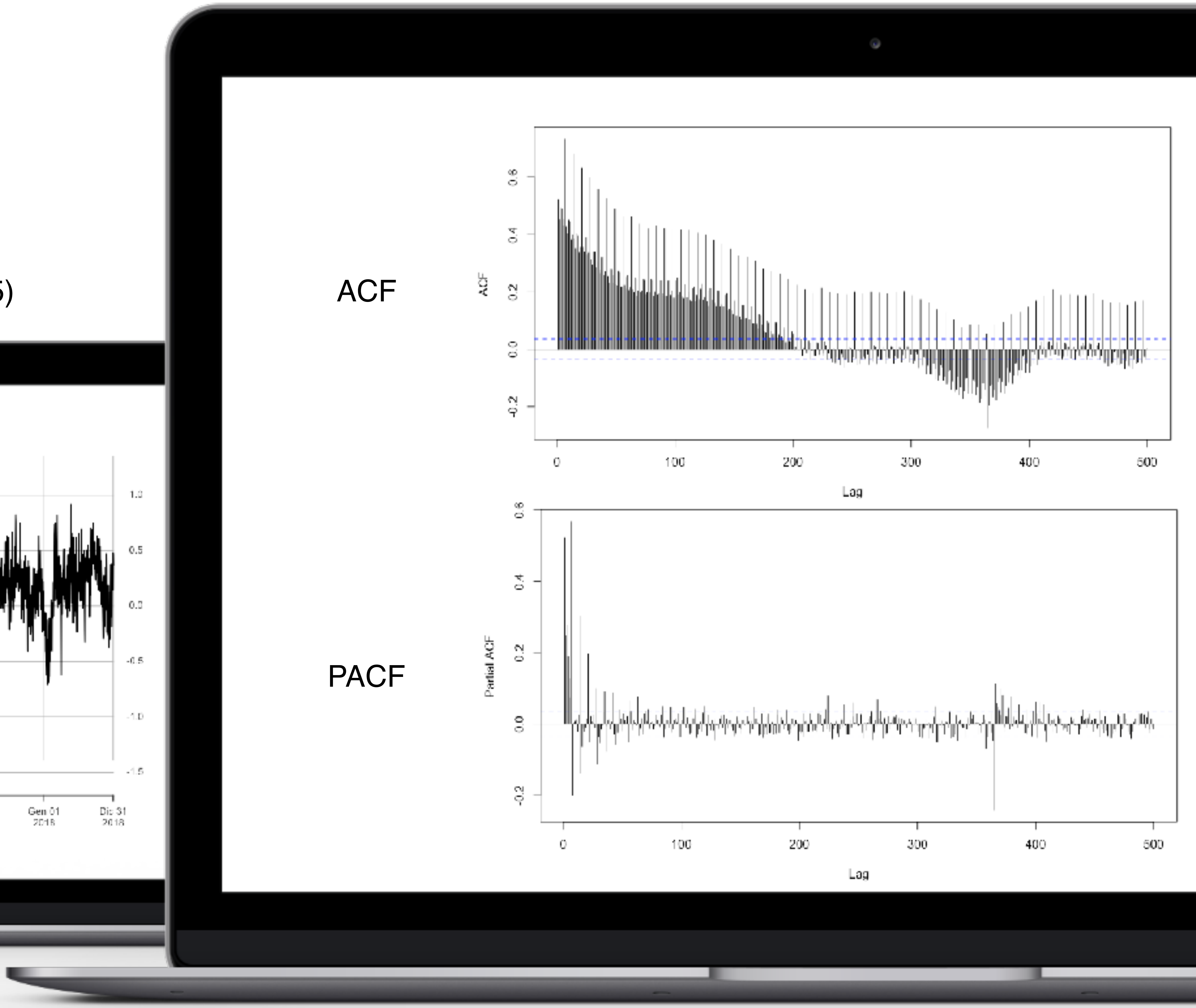
COMPARISON AND CONCLUSIONS

ARIMA

Identification

Ly with differences (order 365.25)





MODELS

ARIMA

UCM

KNN

LSTM RNN

COMPARISON AND CONCLUSIONS

ARIMA

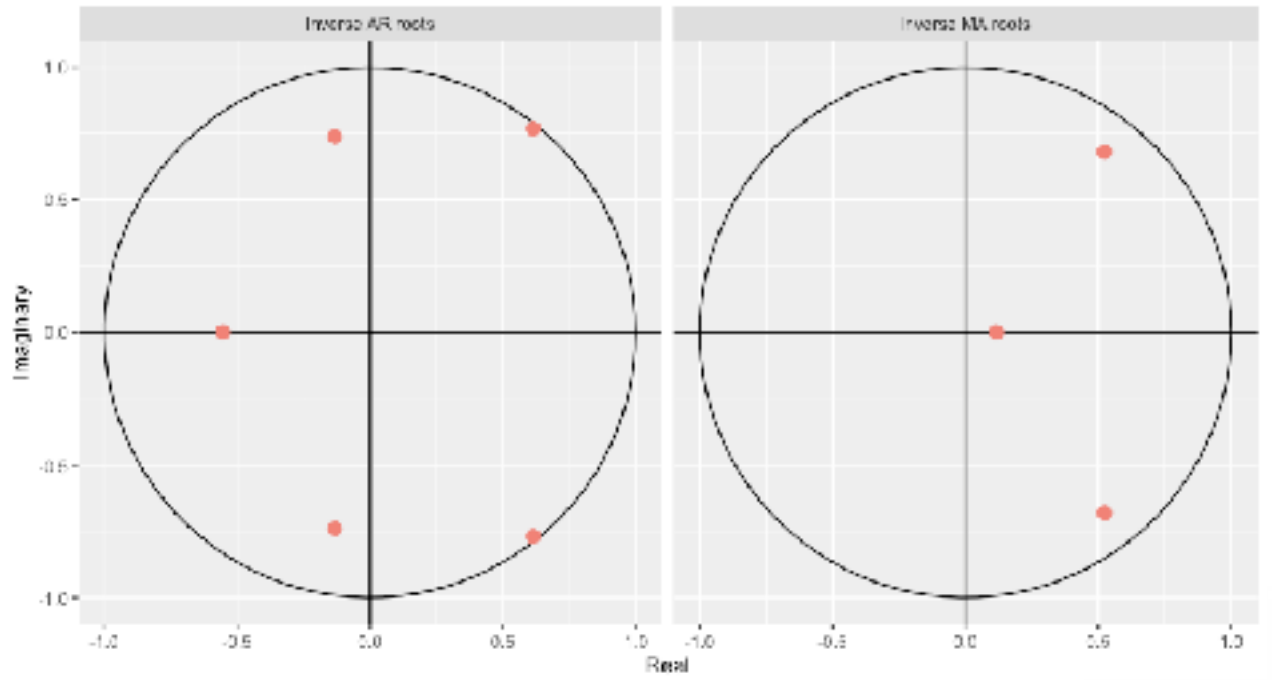
Estimation

ISSUES

- R can’t handle differences of order greater than 350. SARIMA is not applicable for daily data

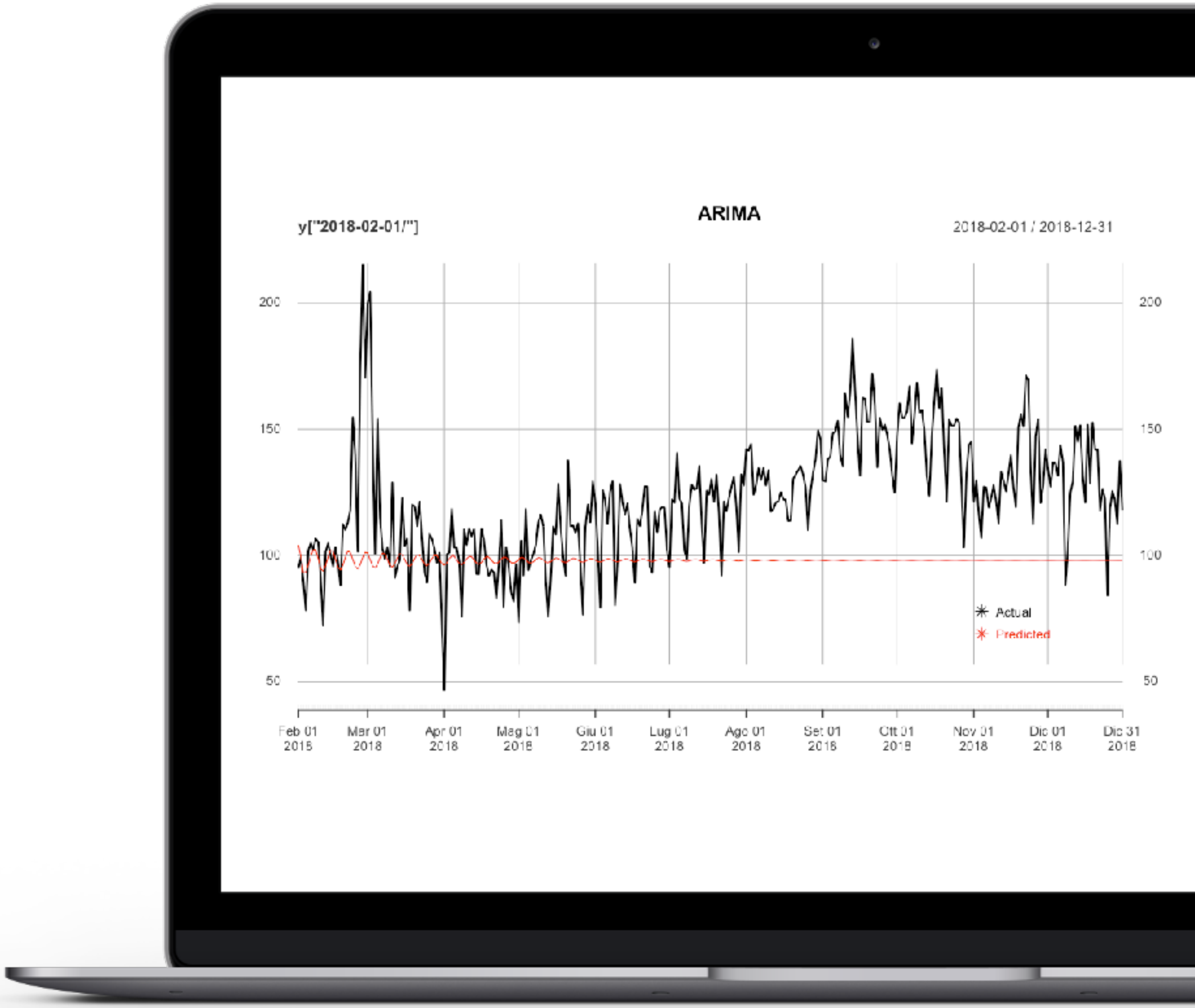
MODEL

- AutoARIMA is deployed for the identification
- ARIMA(5,1,3) is used for forecasting



EVALUATION

- MAE = 0.236165



UCM

Overview

MODEL	COMPONENTS
1	LLT + DUMMY SEASONALITY (7)
2	IRW + CYCLE + DUMMY SEASONALITY (7)
3	IRW + CYCLE + TRIG DETERMINISTIC SEASONALITY (365)
4	LLT + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)
5	IRW + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)
6	IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG DETERMINISTIC SEASONALITY (365)
7	IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)
8	LLT + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)

MODELS

ARIMA

UCM

KNN

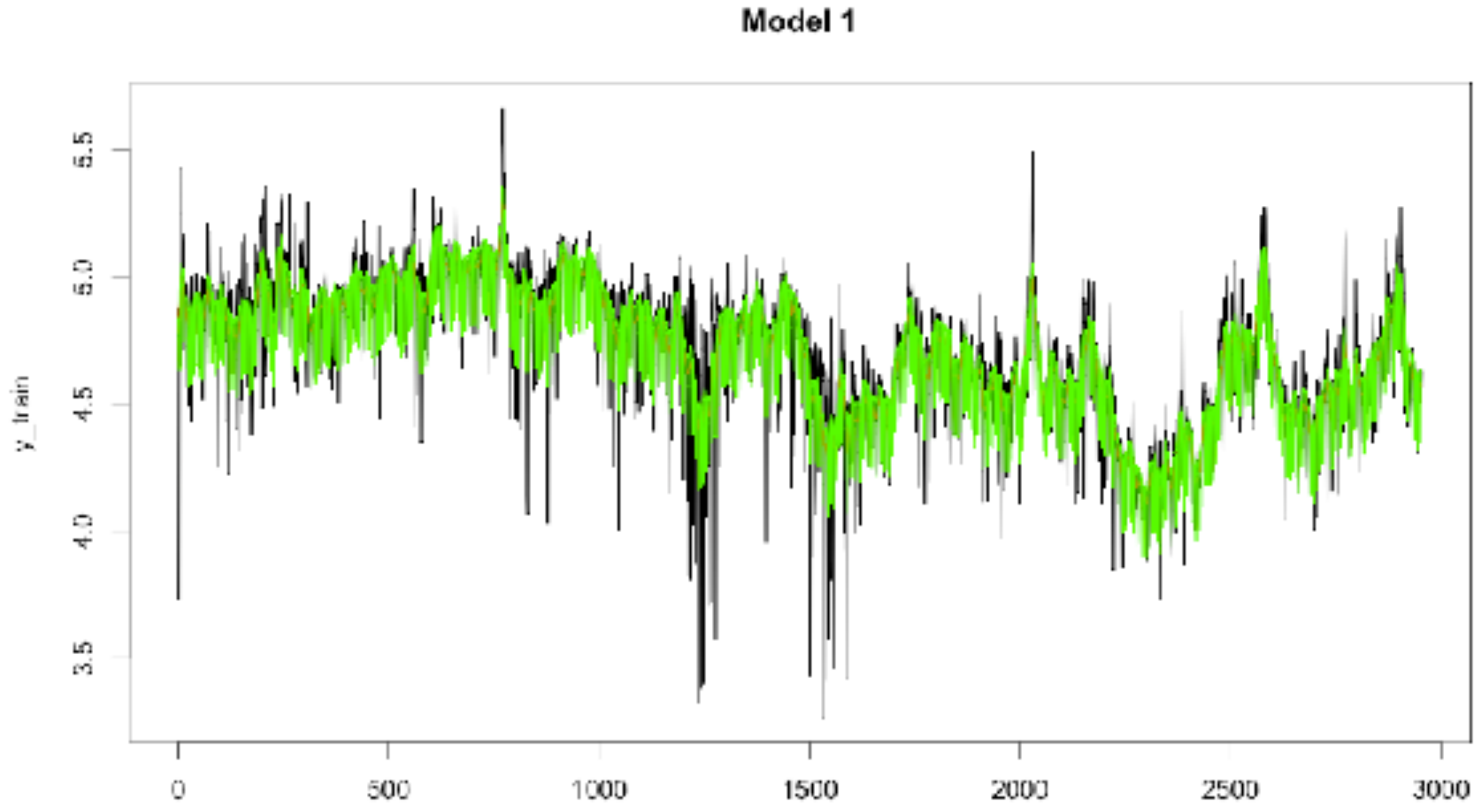
LSTM RNN

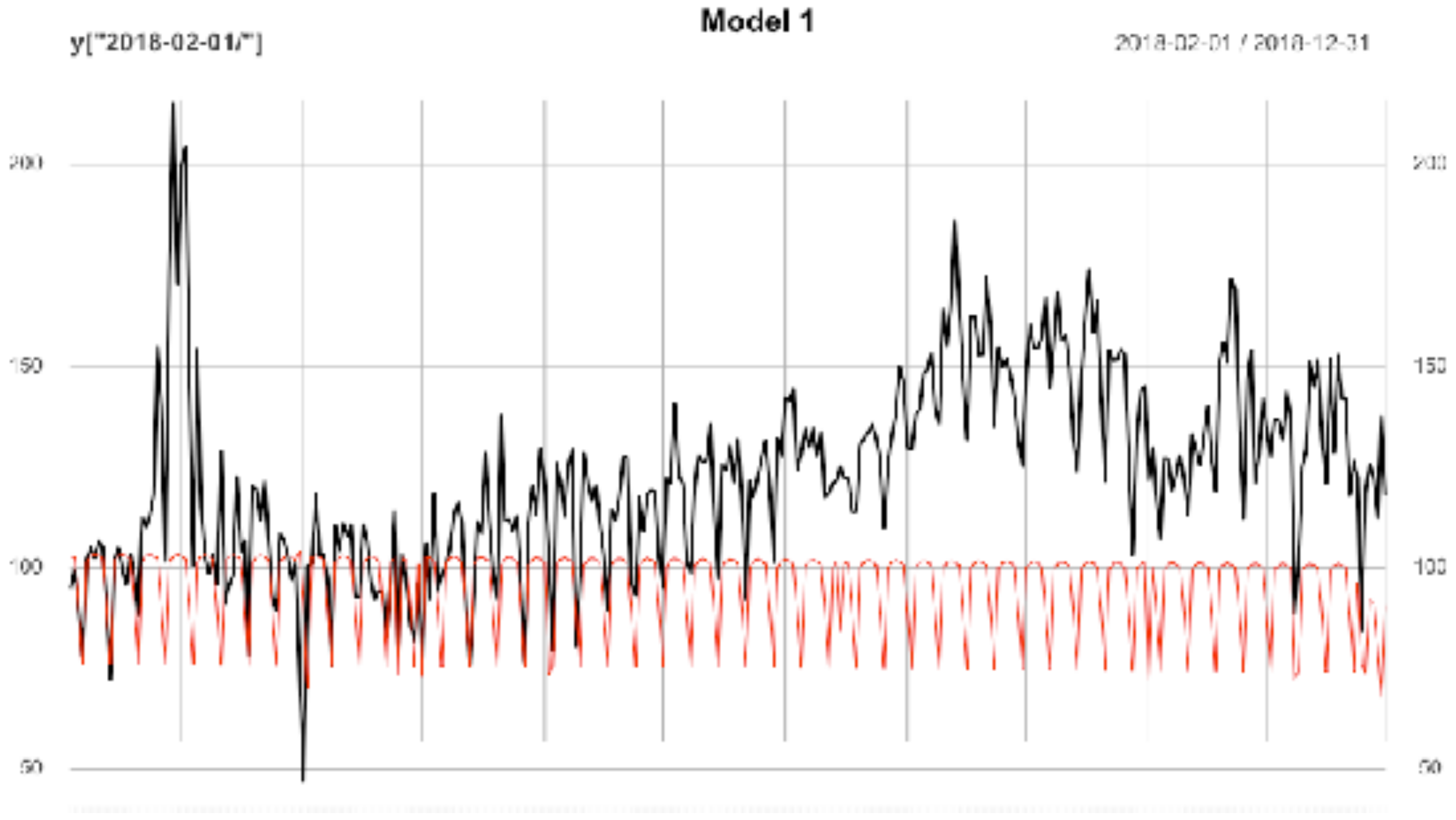
COMPARISON AND CONCLUSIONS

U C M

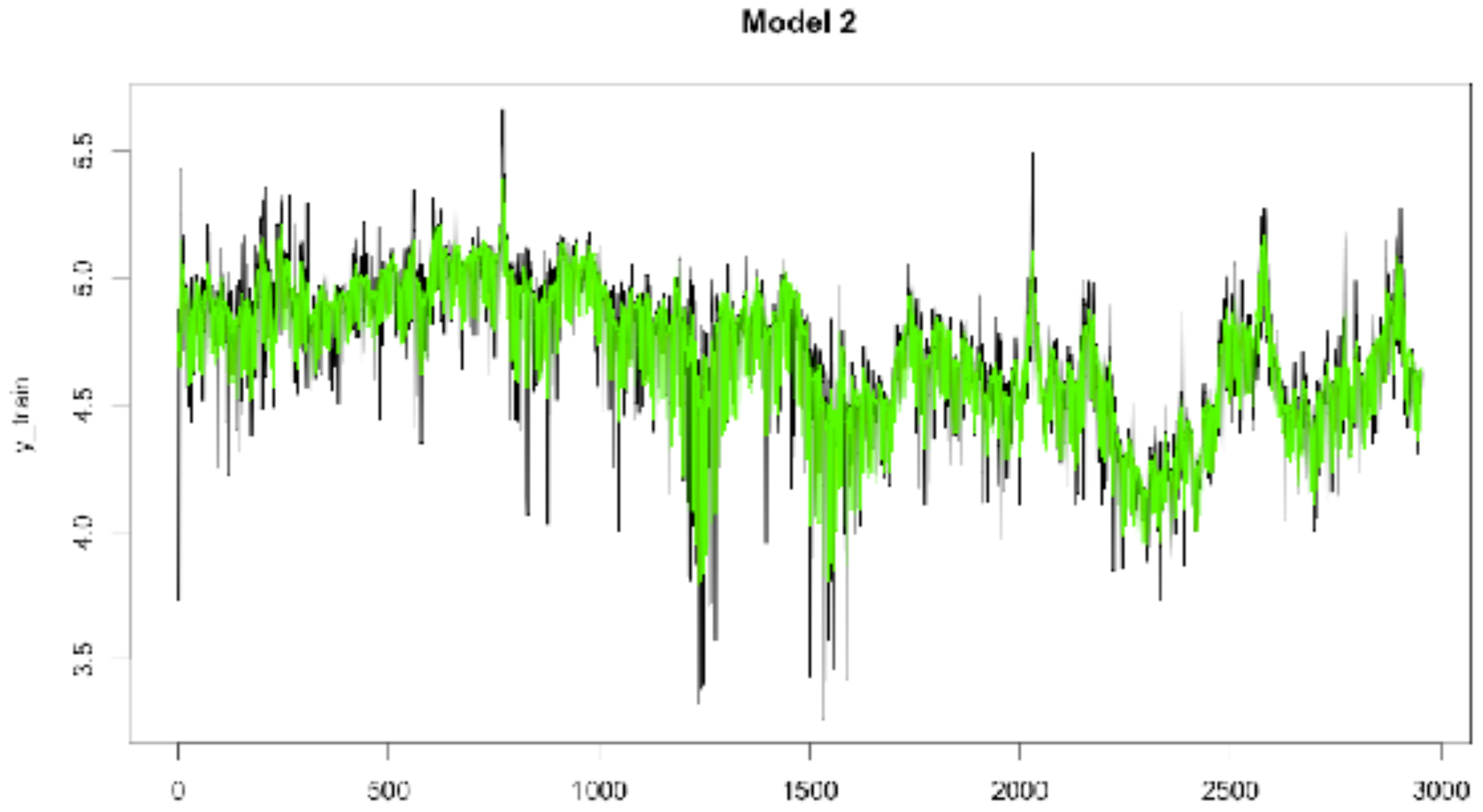
MODELS 1-2

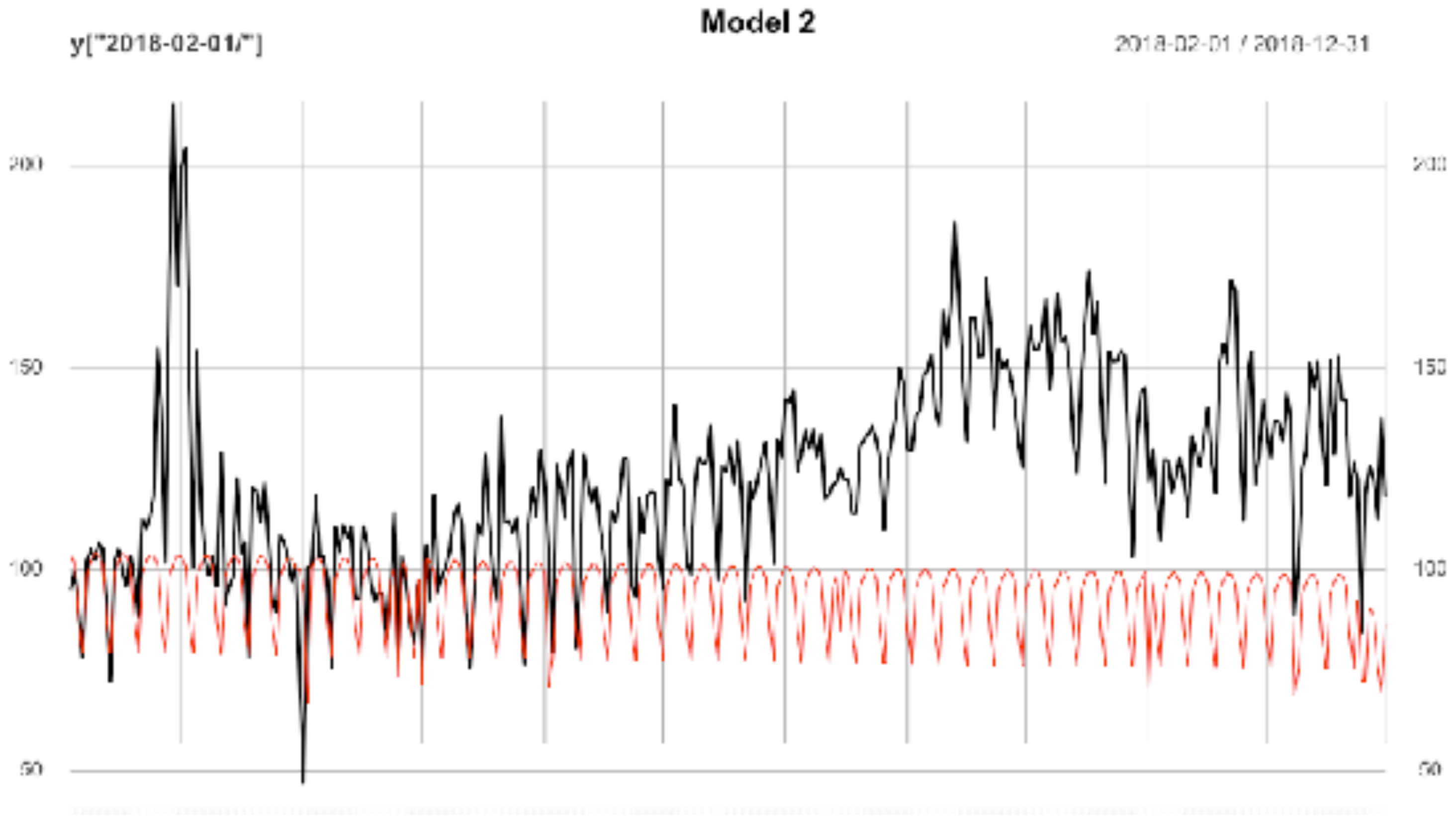
LLT + DUMMY SEASONALITY (7)





IRW + CYCLE + DUMMY SEASONALITY (7)





MODELS

ARIMA

UCM

KNN

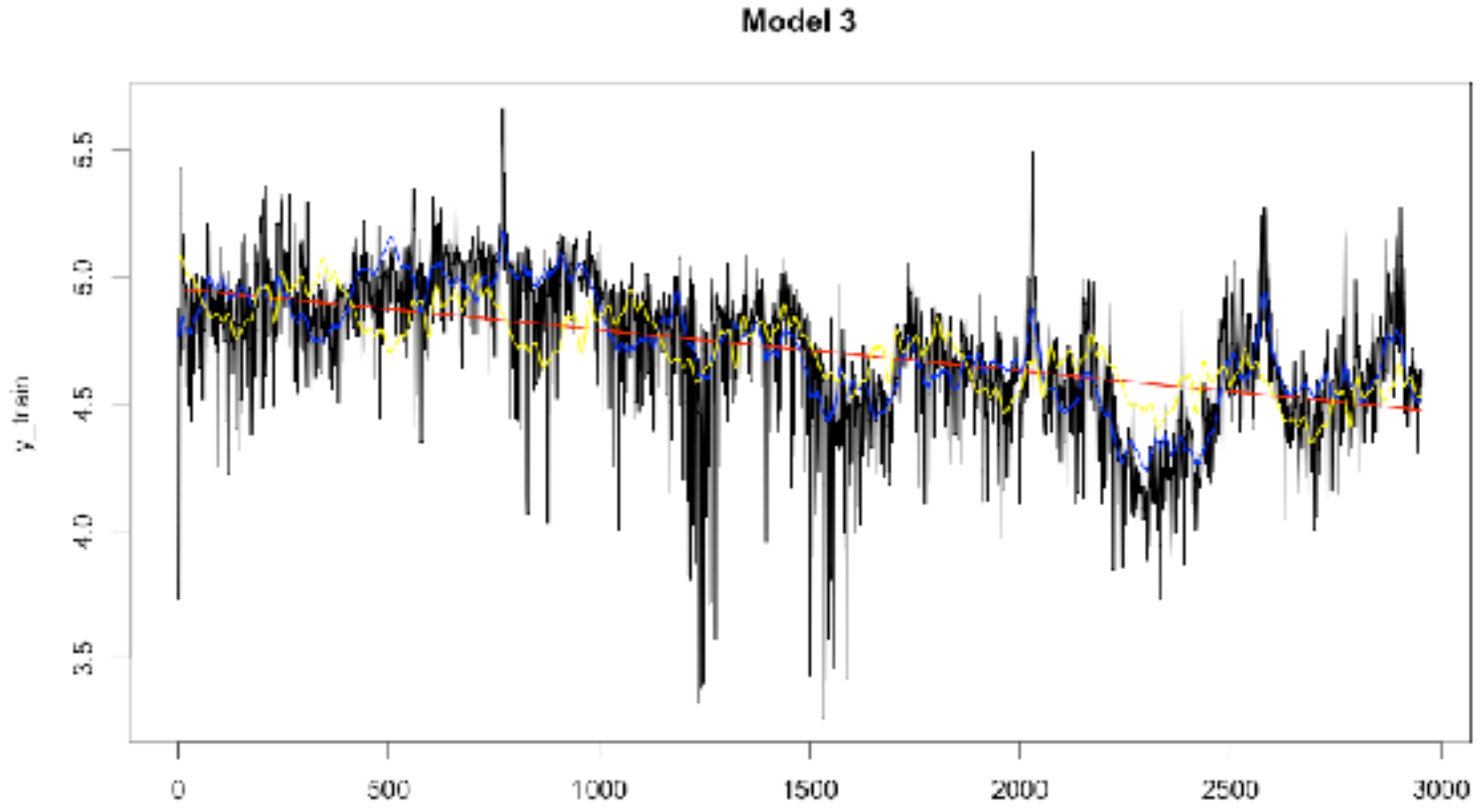
LSTM RNN

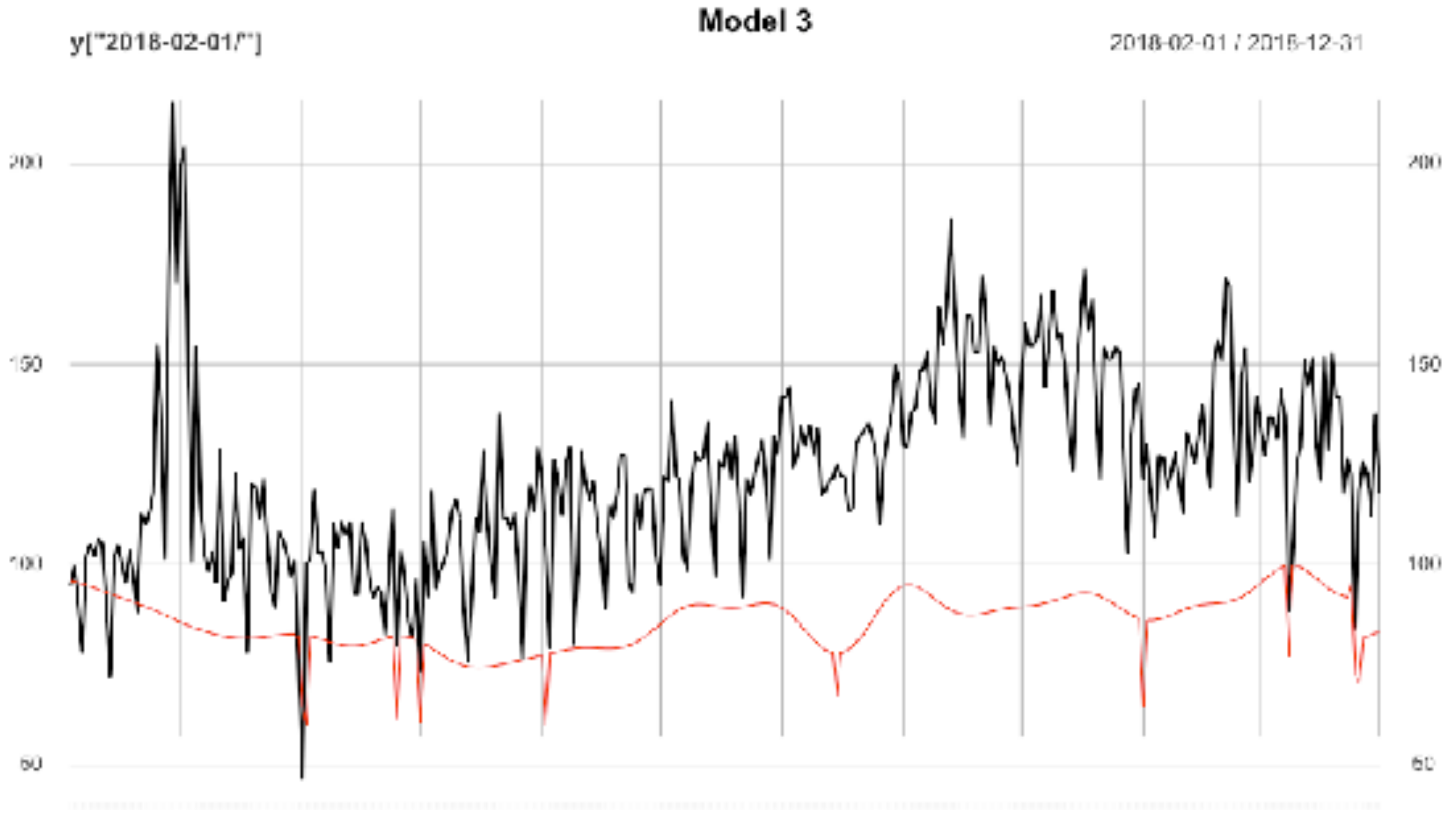
COMPARISON AND CONCLUSIONS

U C M

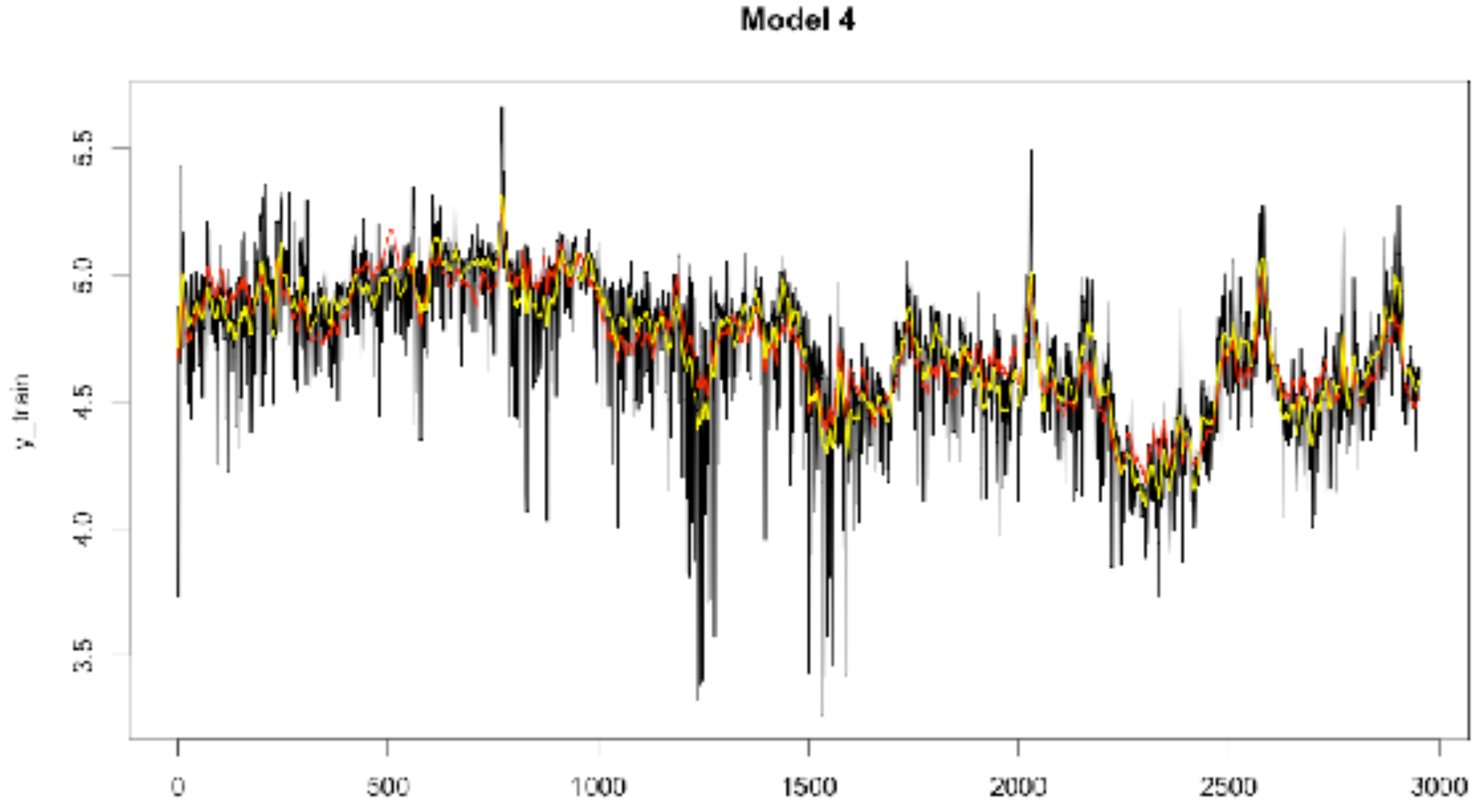
MODELS 3-4

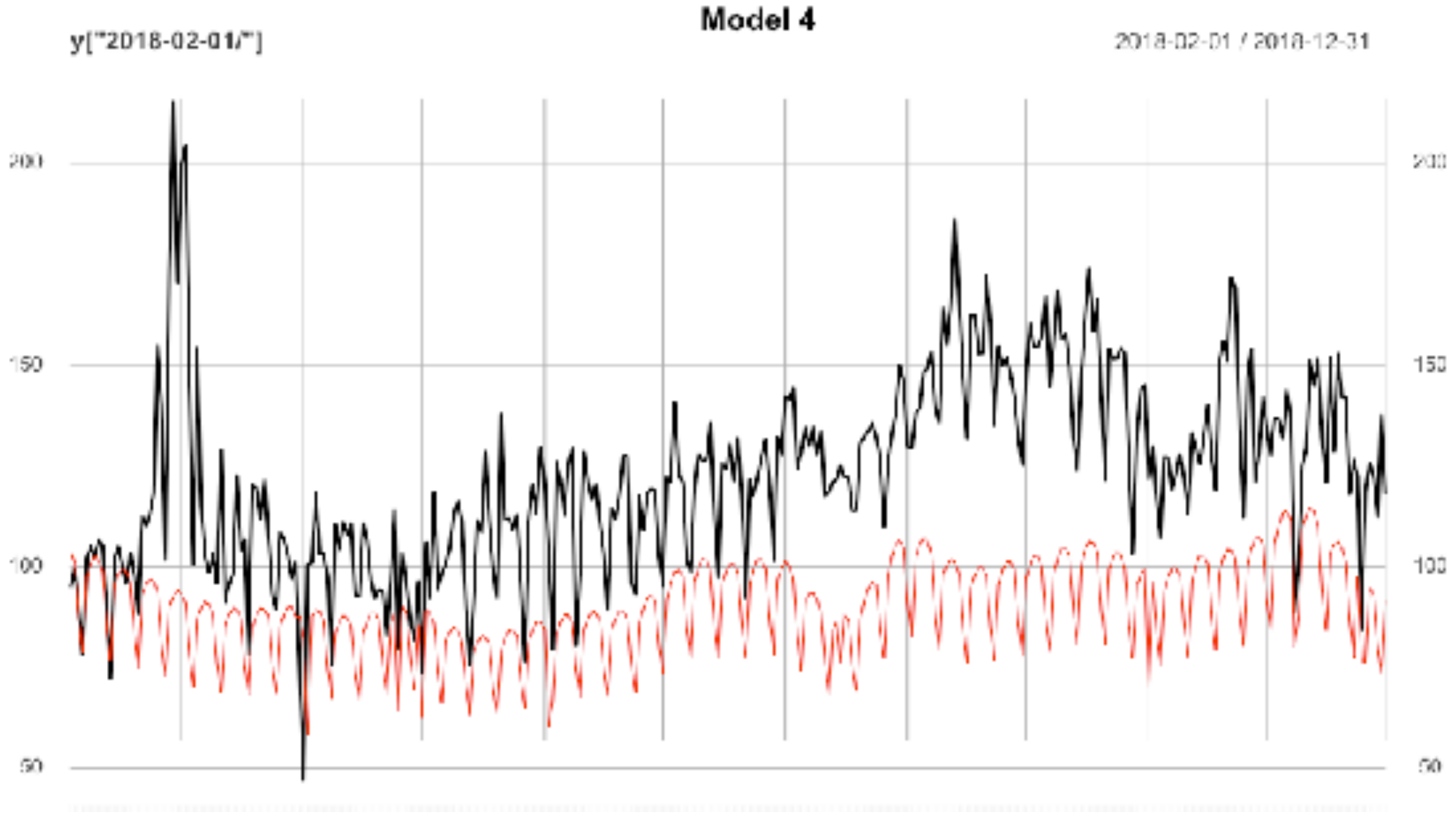
IRW + CYCLE + TRIG DETERMINISTIC SEASONALITY (365)





LLT + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)





MODELS

ARIMA

UCM

KNN

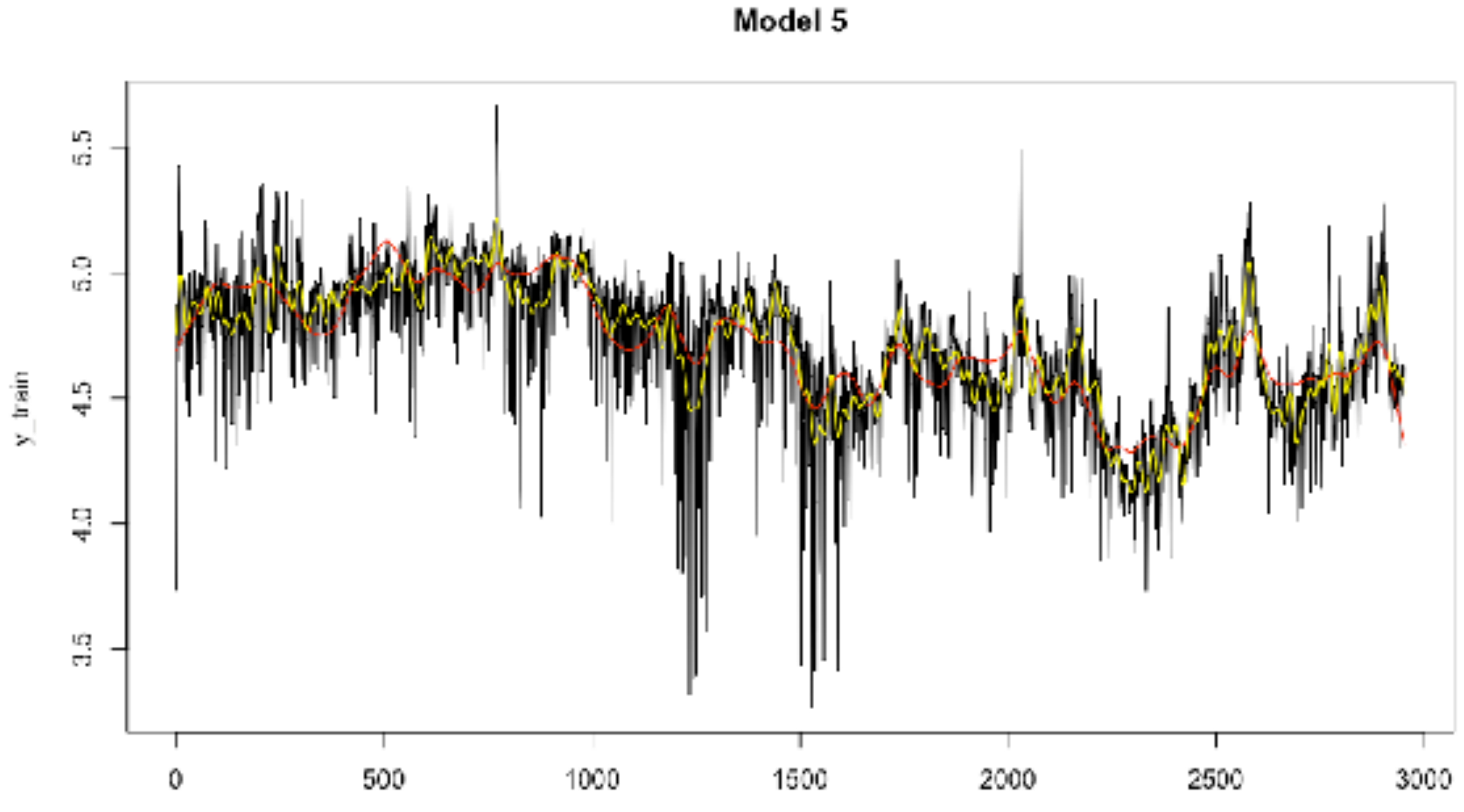
LSTM RNN

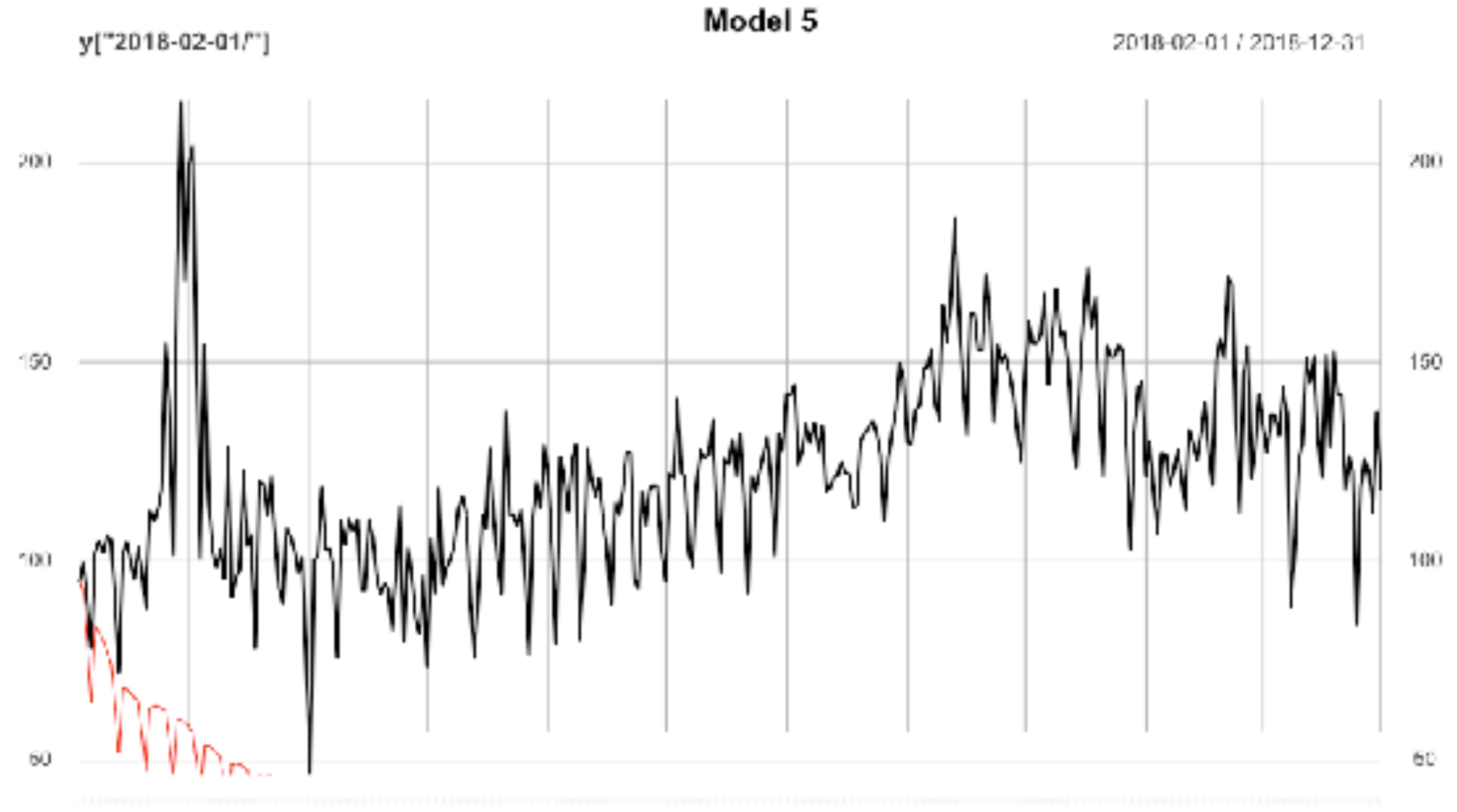
COMPARISON AND CONCLUSIONS

U C M

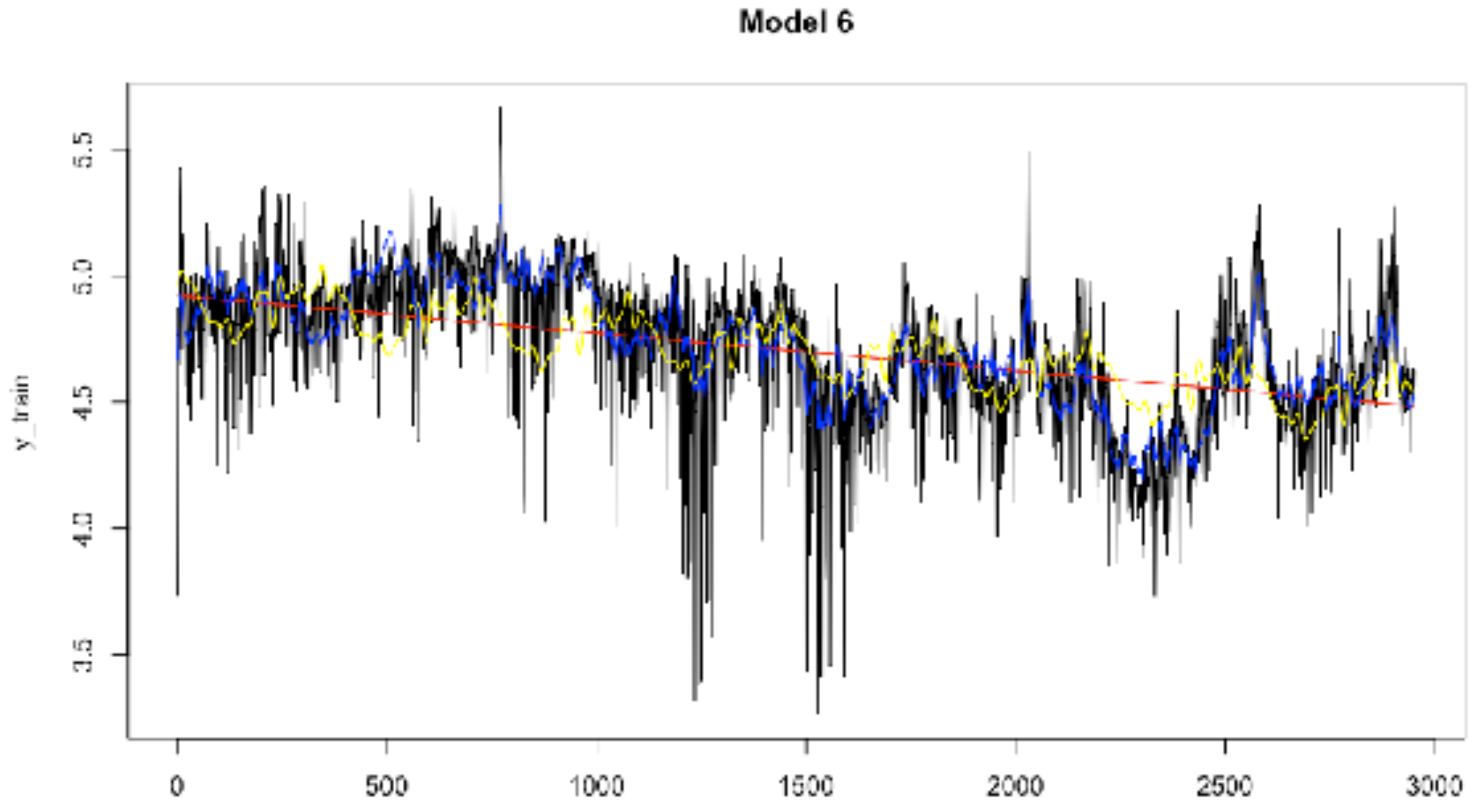
MODELS 5-6

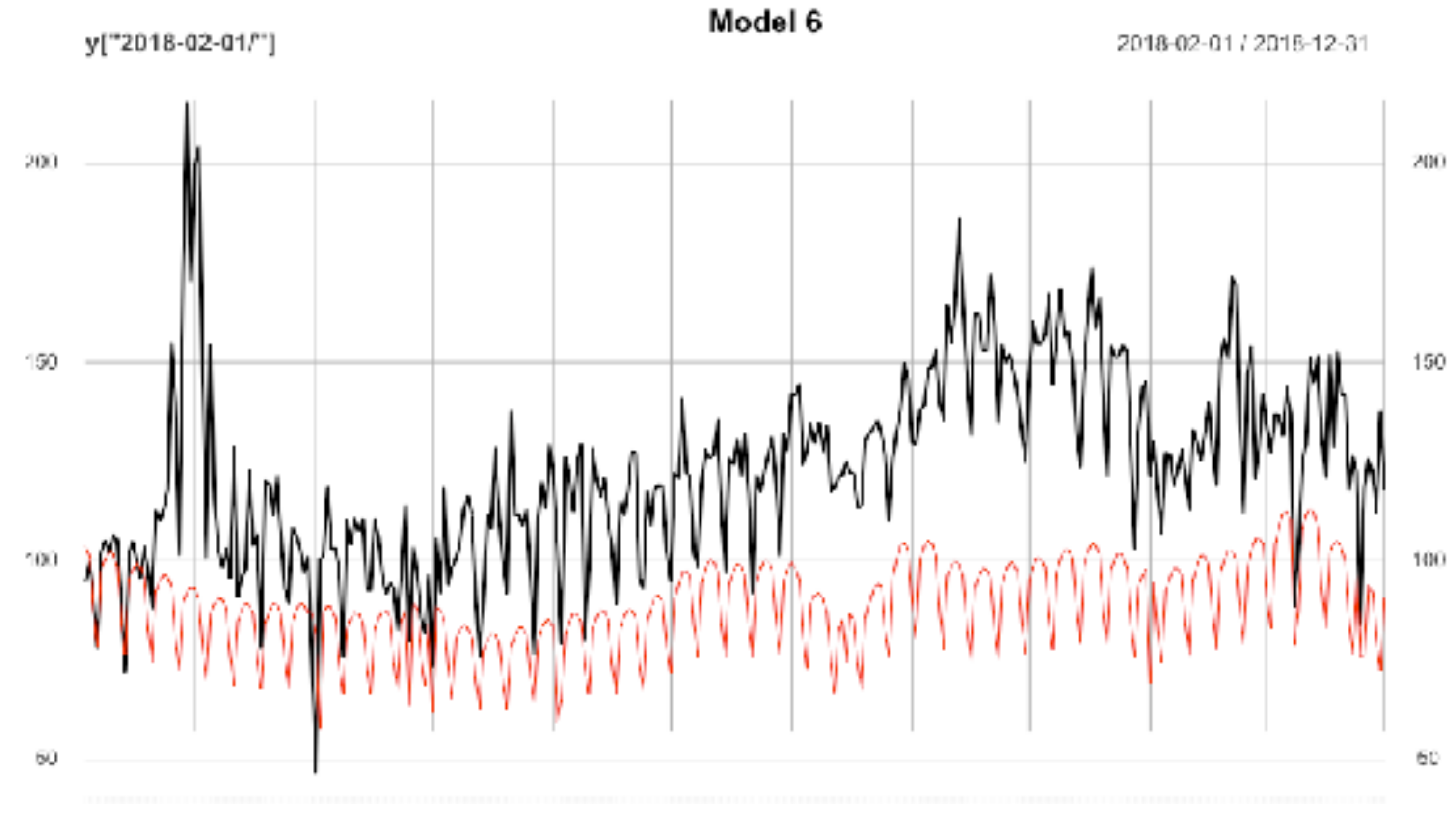
IRW + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)





IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG DETERMINISTIC SEASONALITY (365)





MODELS

ARIMA

UCM

KNN

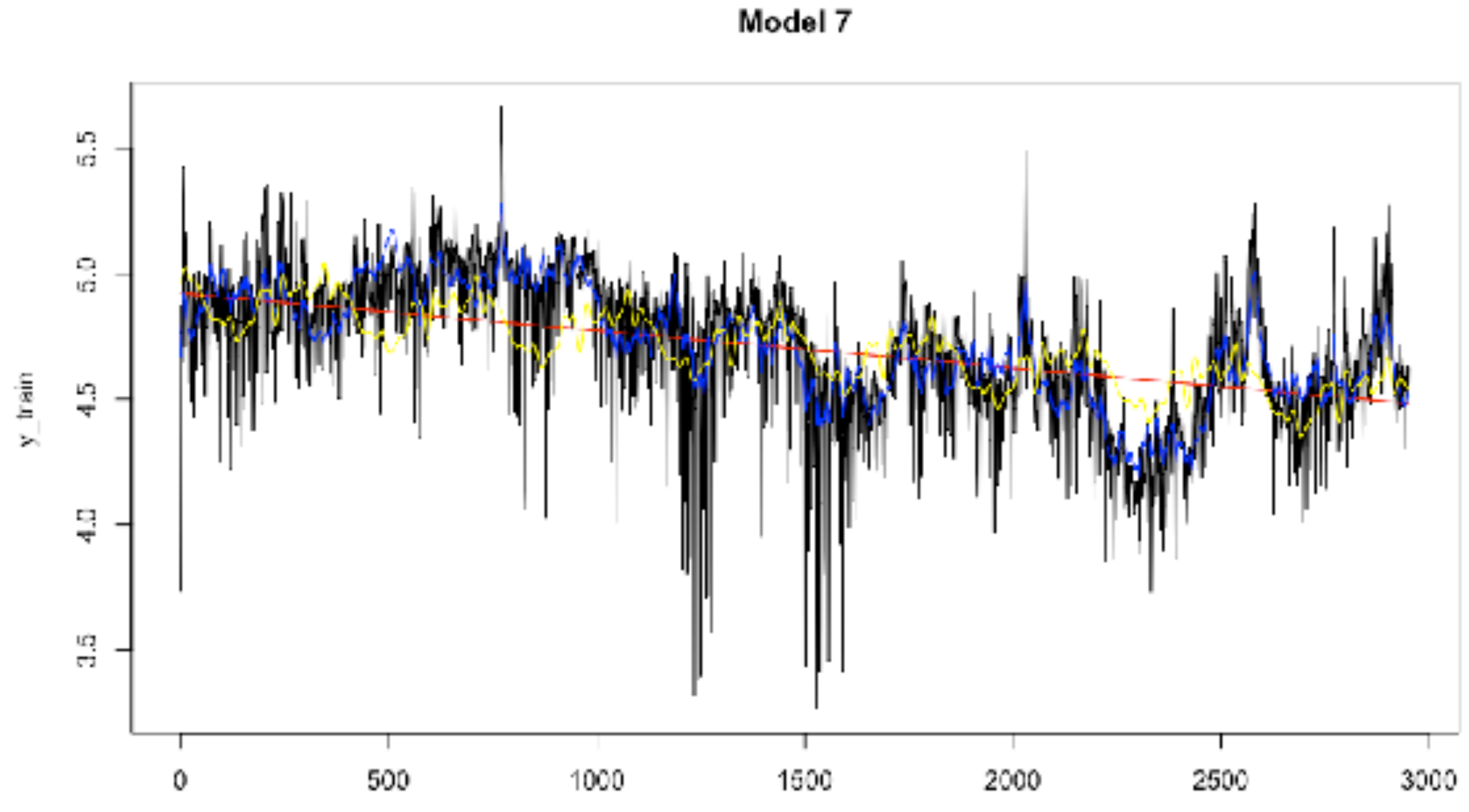
LSTM RNN

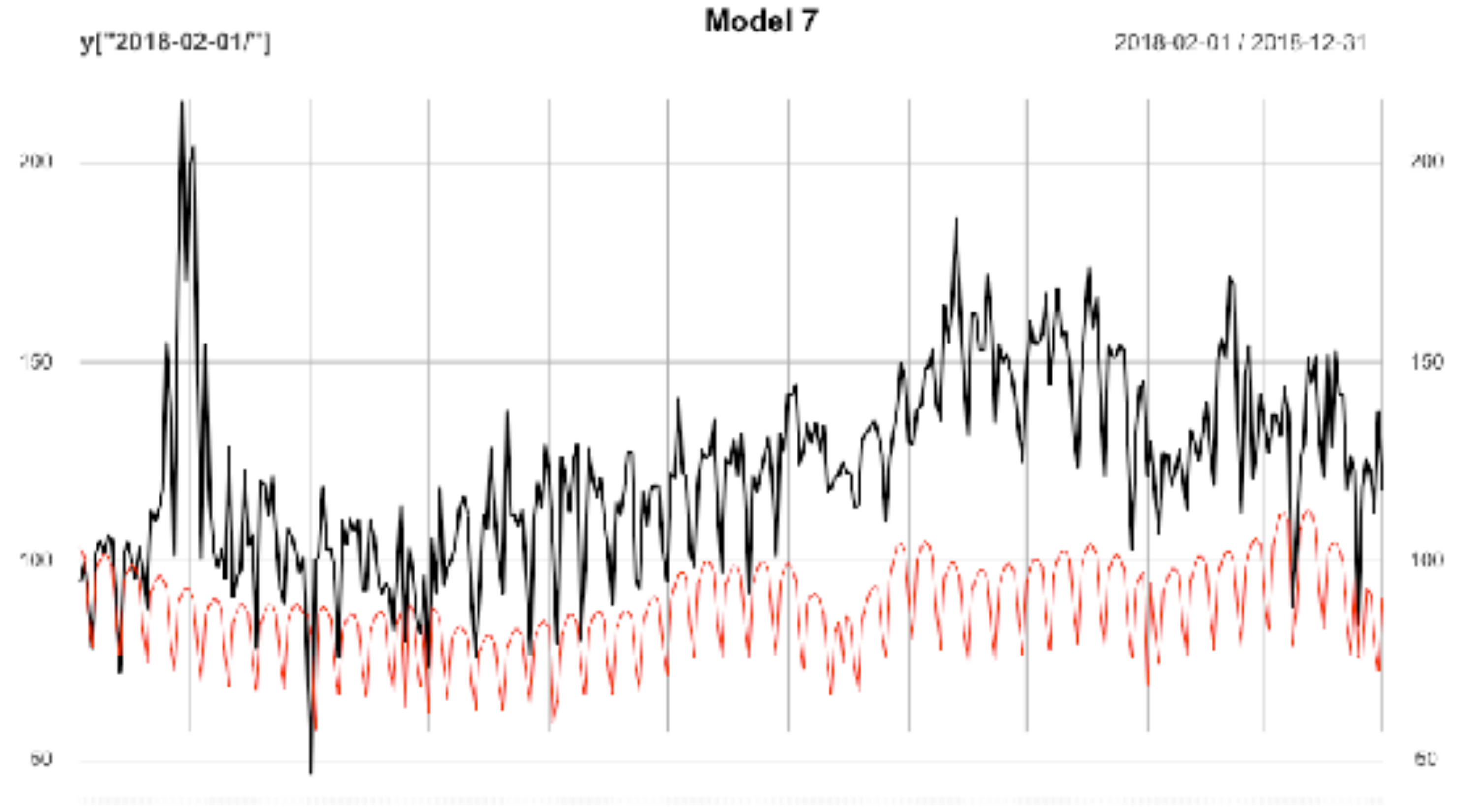
COMPARISON AND CONCLUSIONS

U C M

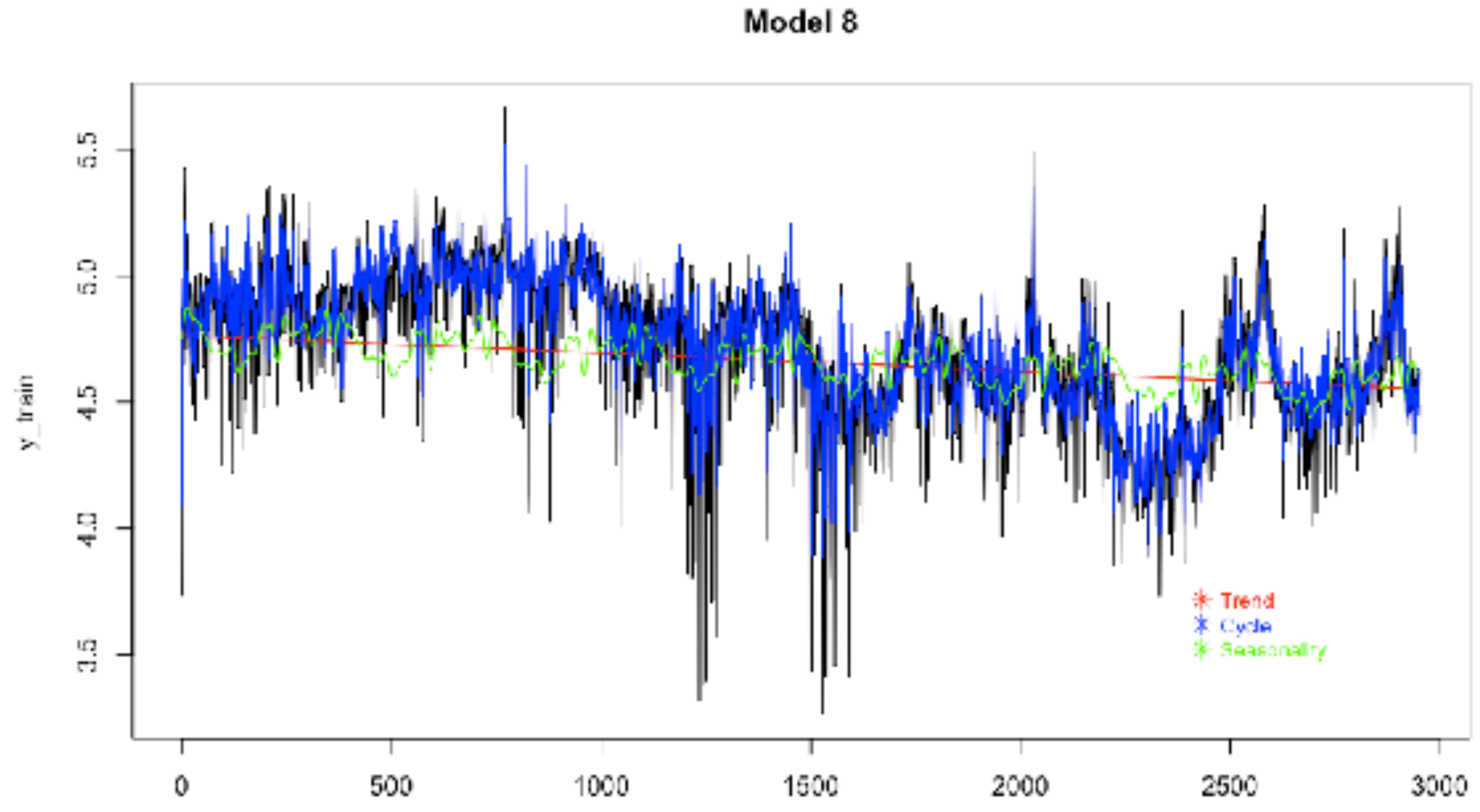
MODELS 7-8

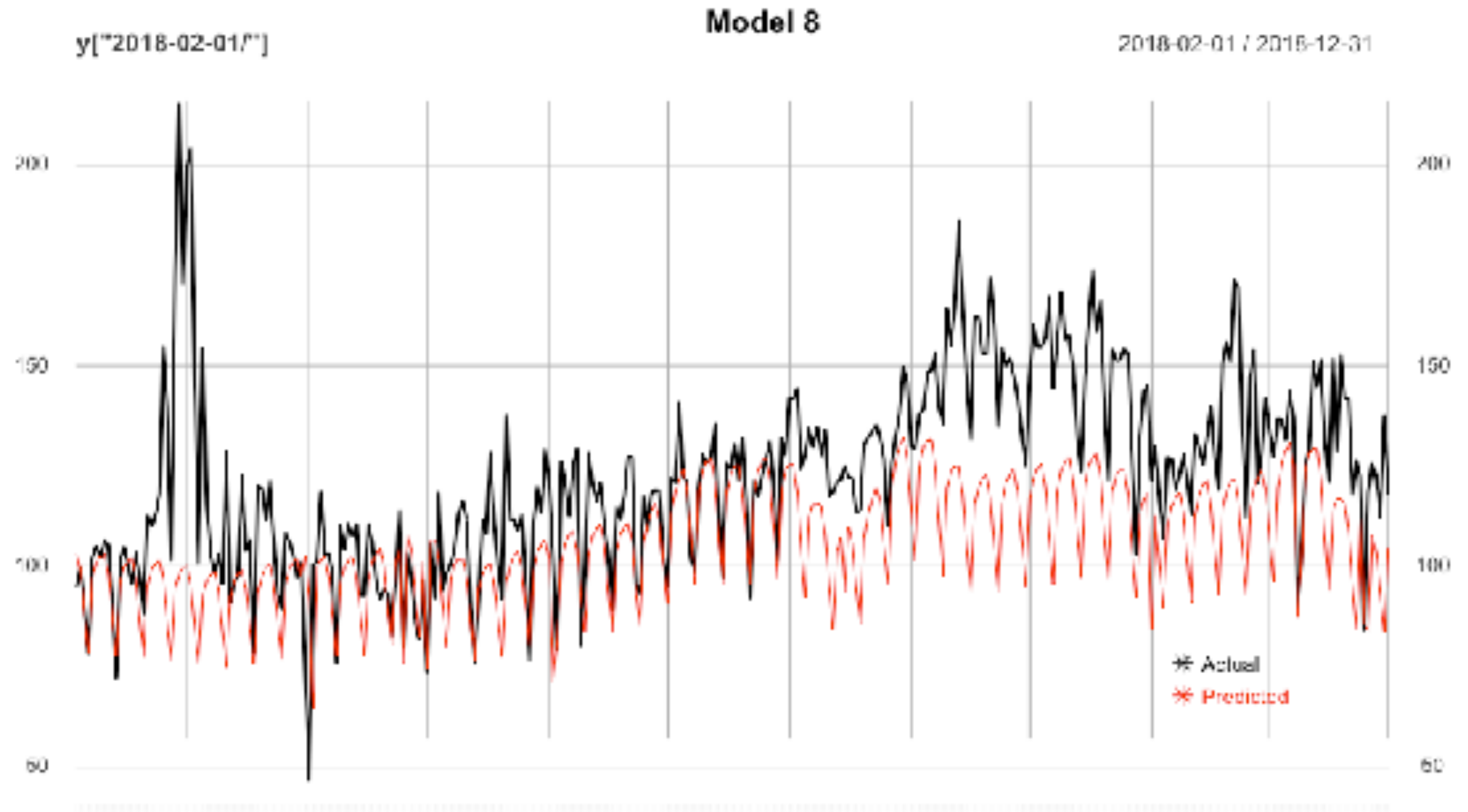
IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)





LLT + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)





MODELS

ARIMA

UCM

KNN

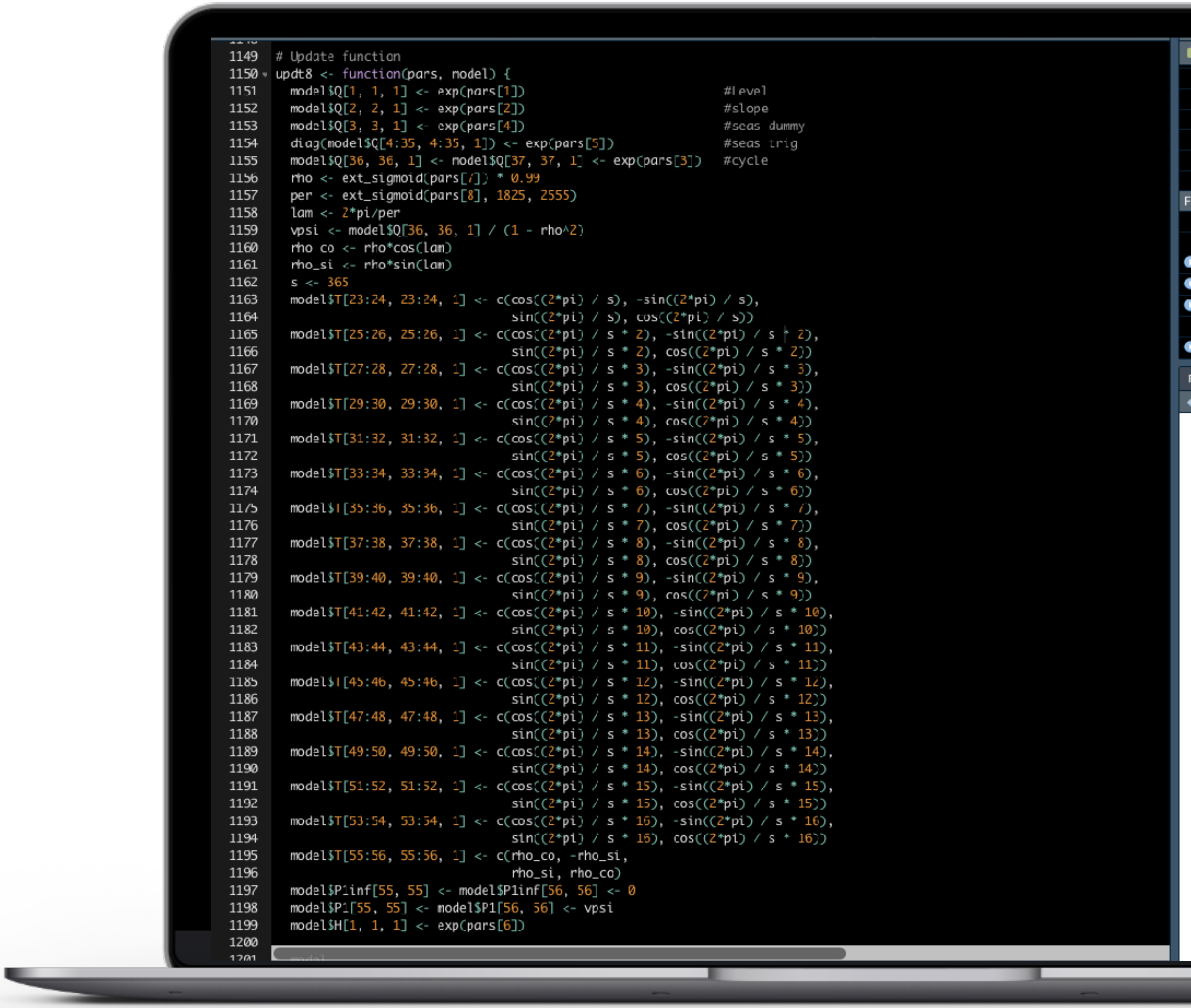
LSTM RNN

COMPARISON
AND
CONCLUSIONS

U C M

MODEL 8

UPDATE FUNCTION



MODELS

ARIMA

UCM

KNN

LSTM RNN

COMPARISON AND CONCLUSIONS

UCM

COMPARISON

MODEL	COMPONENTS	TRAIN MAE	VAL MAE
1	LLT + DUMMY SEASONALITY (7)	0.073	0.255
2	IRW + CYCLE + DUMMY SEASONALITY (7)	0.062	0.273
3	IRW + CYCLE + TRIG DETERMINISTIC SEASONALITY (365)	0.106	0.349
4	LLT + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	0.064	0.309
5	IRW + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	0.080	1.906
6	IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG DETERMINISTIC SEASONALITY (365)	0.063	0.322
7	IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	0.063	0.323
8	LLT + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	1.9e-15	0.158

MODELS

ARIMA

UCM

KNN

LSTM RNN

COMPARISON AND CONCLUSIONS

KNN

MULTIPLE INPUT MULTIPLE OUTPUT

HYPERPARAMETERS

- Lags = 1:1500
- K = 2

EVALUATION

- MAE = 0.243

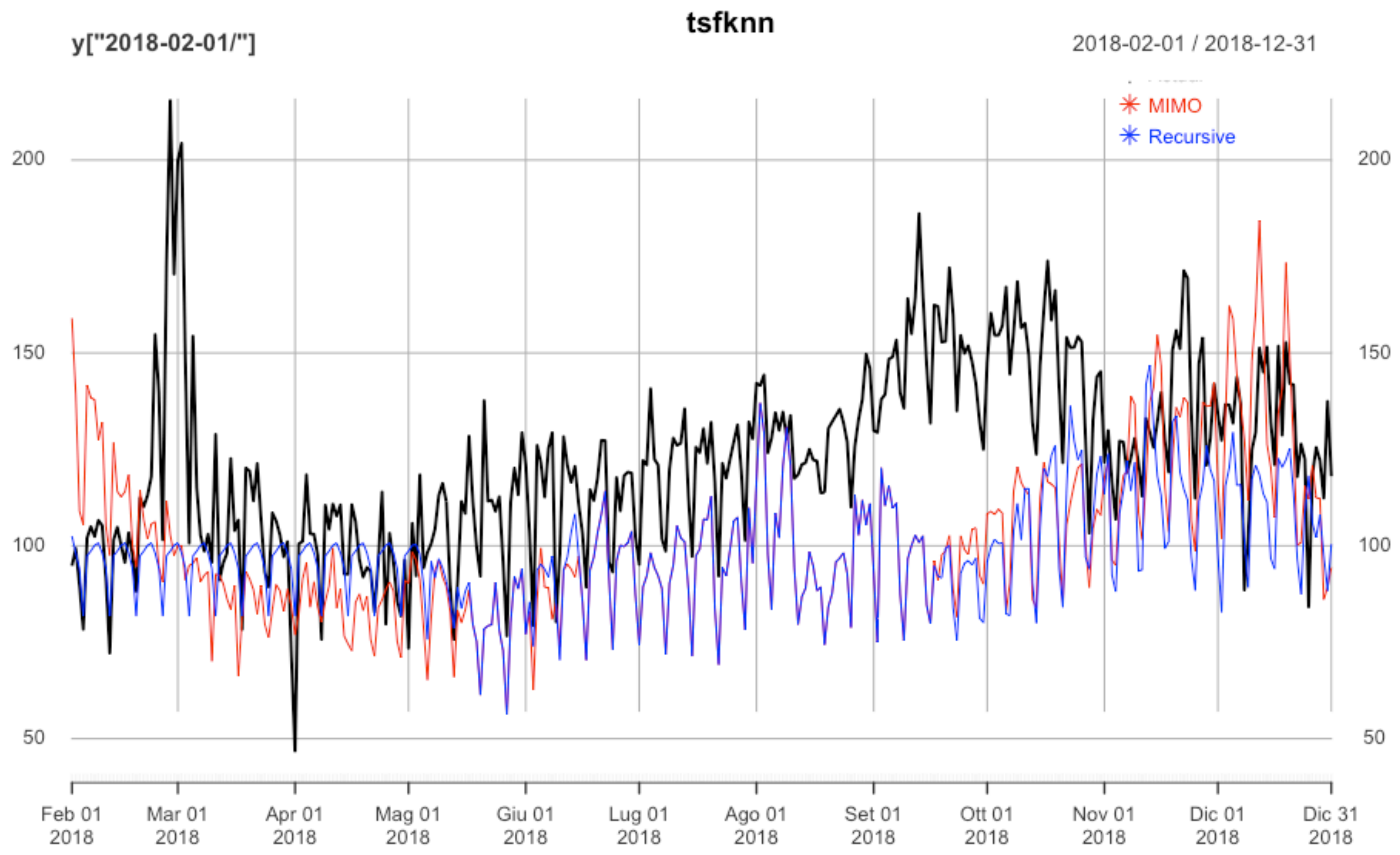
RECURSIVE

HYPERPARAMETERS

- Lags = 1:1500
- K = 2

EVALUATION

- MAE = 0.229



MODELS

ARIMA

UCM

KNN

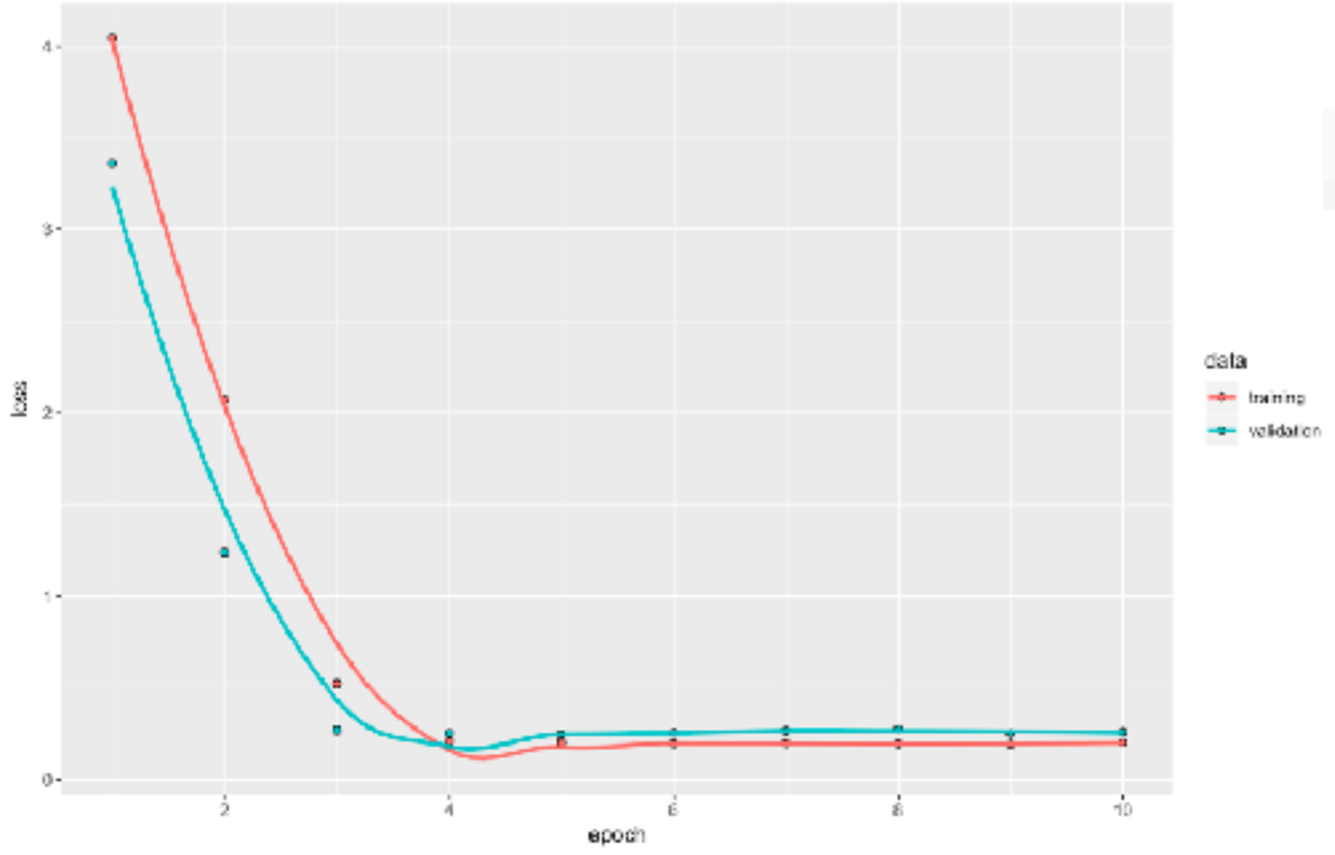
LSTM RNN

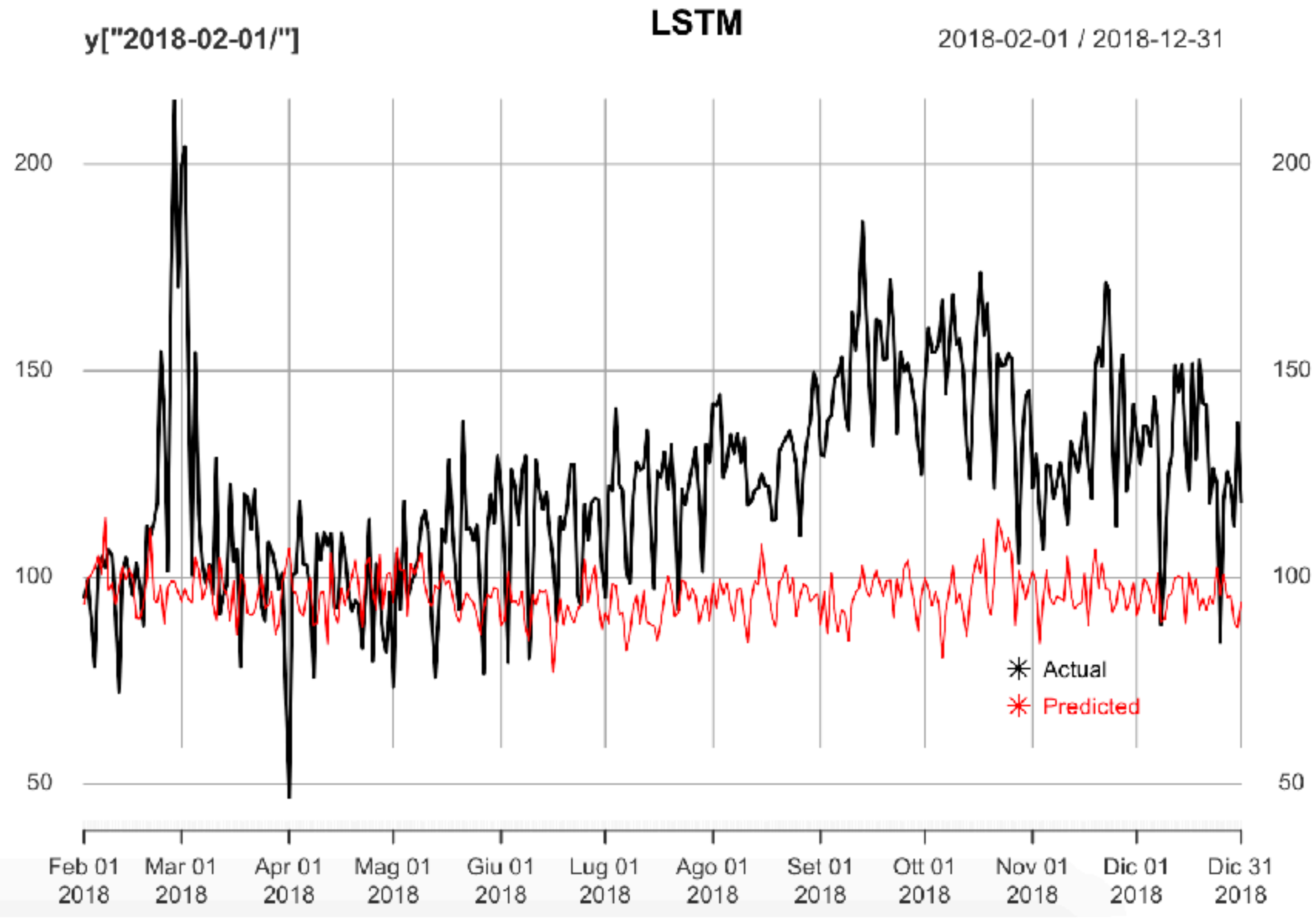
COMPARISON AND CONCLUSIONS

LSTM

HYPERPARAMETERS

- Lookback = 1500
- Batch size = 128
- LSTM Layer = 1
- LSTM neurons = 32
- Dropout = 0.3
- Recurrent Dropout = 0.3
- Activation function = “tanh”
- Dense Layer = 1 (334 neurons
- Optimizer = “rmsprop£
- Loss = “mae”
- Steps per epoch = 50
- Epochs = 10





EVALUATION

- MAE = 0.26

MODELS

ARIMA

UCM

KNN

LSTM RNN

COMPARISON AND CONCLUSIONS

COMPARISON

MODEL	COMPONENTS	TRAIN MAE	VAL MAE
ARIMA	/	0.110	0.236
UCM 1	LLT + DUMMY SEASONALITY (7)	0.073	0.255
UCM 2	IRW + CYCLE + DUMMY SEASONALITY (7)	0.062	0.273
UCM 3	IRW + CYCLE + TRIG DETERMINISTIC SEASONALITY (365)	0.106	0.349
UCM 4	LLT + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	0.064	0.309
UCM 5	IRW + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	0.080	1.906
UCM 6	IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG DETERMINISTIC SEASONALITY (365)	0.063	0.322
UCM 7	IRW + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	0.063	0.323
UCM 8	LLT + CYCLE + DUMMY SEASONALITY (7) + TRIG SEASONALITY (365)	1.9e-15	0.158
KNN MIMO	/	NA	0.243
KNN REC	/	NA	0.229
LSTM	/	0.2	0.26

MODELS

ARIMA

UCM

KNN

LSTM RNN

COMPARISON AND CONCLUSIONS

CONCLUSIONS

ADVANTAGES

- ARIMA captures the trend but less oscillations for many steps ahead
- UCM: the freedom of KFAS package allows to design specific models
- KNN: extremely fast to train
- RNN: design of ad-hoc models

ISSUES

- ARIMA: can’t handle yearly seasonality for daily data
- UCM: identification of the best model
- KNN: distance metric
- RNN: training costs

NEXT STEPS

- ARIMA: handle yearly seasonality for daily data
- UCM: use of alternative models
- KNN: distance metric that weights more recent observations
- RNN: deeper network

THANKS FOR YOUR ATTENTION

Raffaele Anselmo - 846842