

# Forecast Time Series



STREAMING DATA  
MANAGEMENT AND  
TIME SERIES  
ANALYSIS

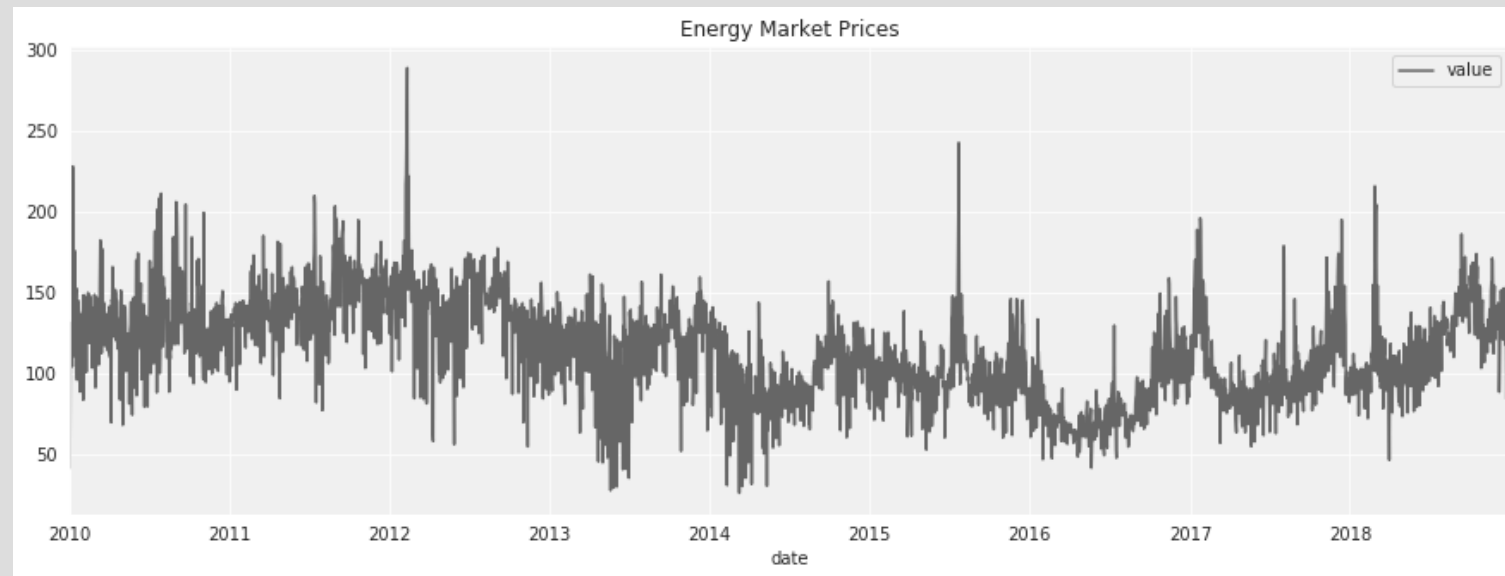
split – metric evaluation



# introduction

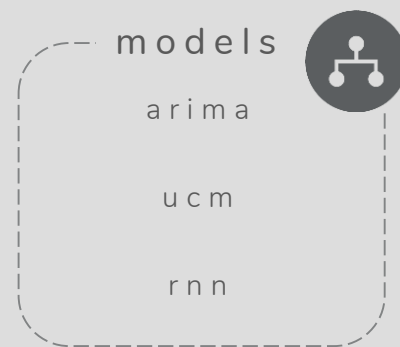


# energy market prices

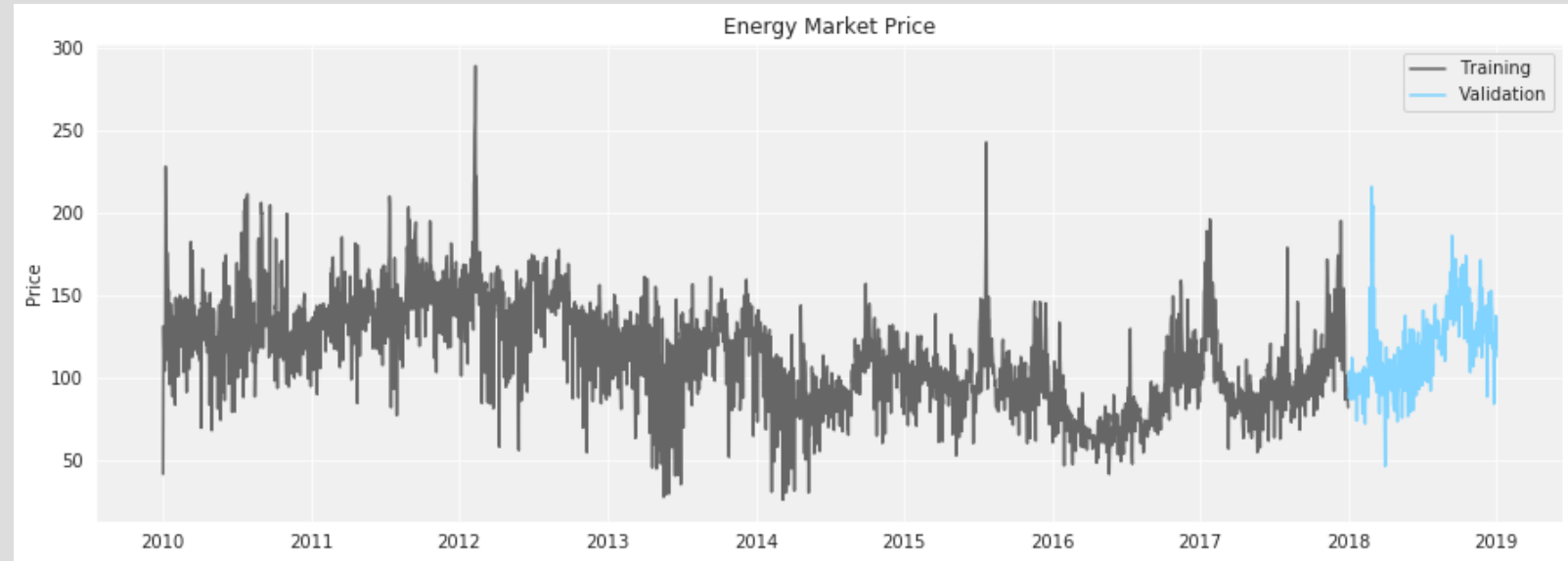


period  
1-Jan-2010  
31-Dec-2018

Objective: predict 334 day (1-Jan-2019 to 30-Nov-2019)



# energy market prices



split

training

validation

8 years

1 years

88,9%

11,1%



## evaluation metric

MAPE



good human  
interpretability



graphic

real values  
vs predict  
values



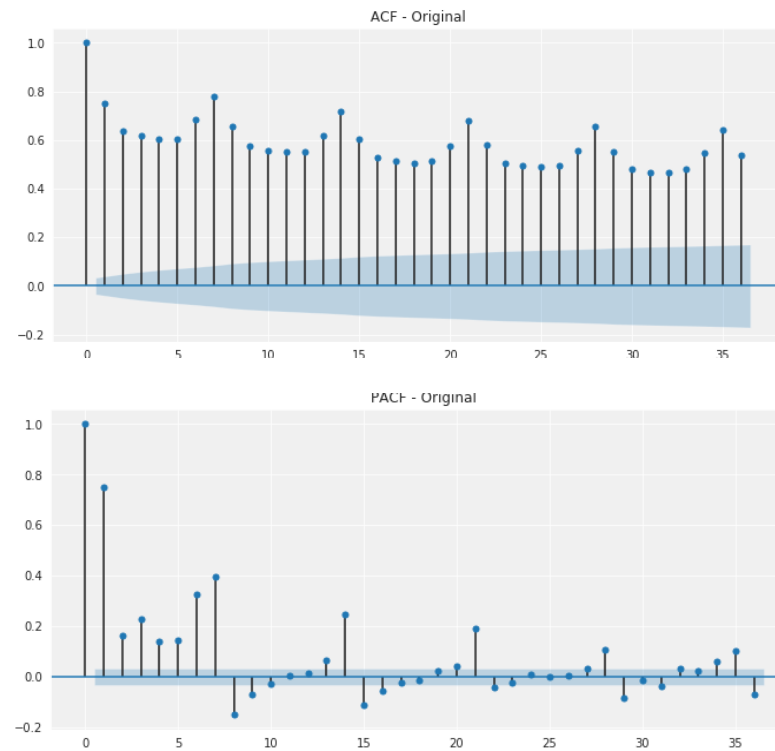
models

**arima**



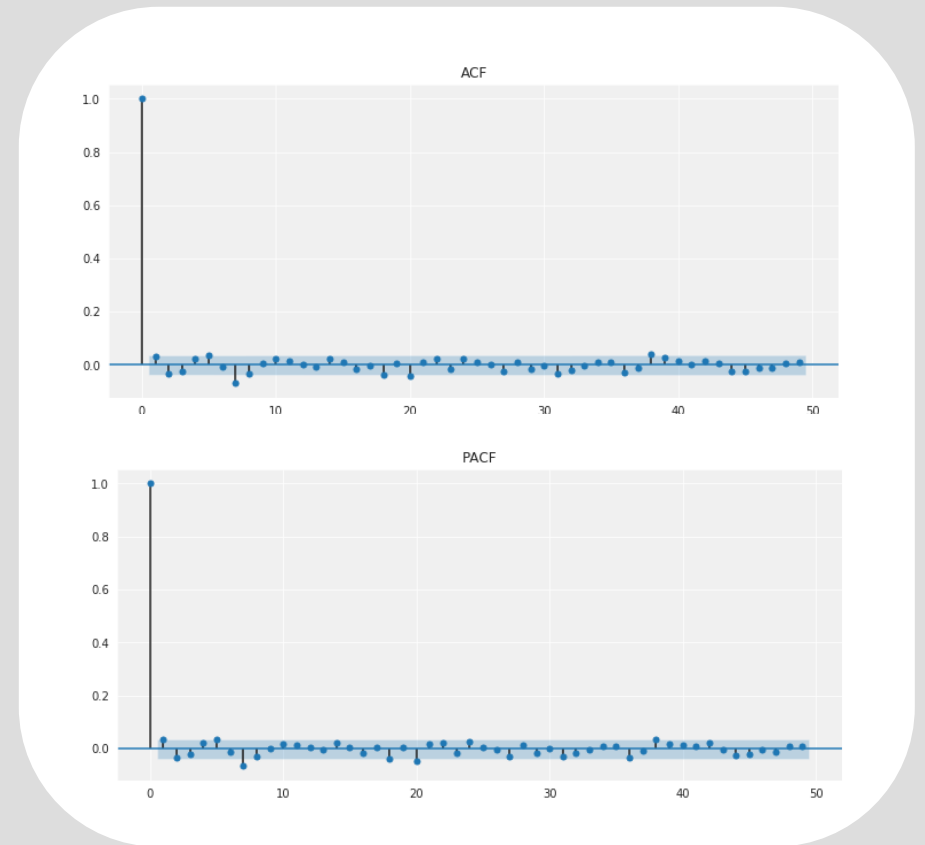
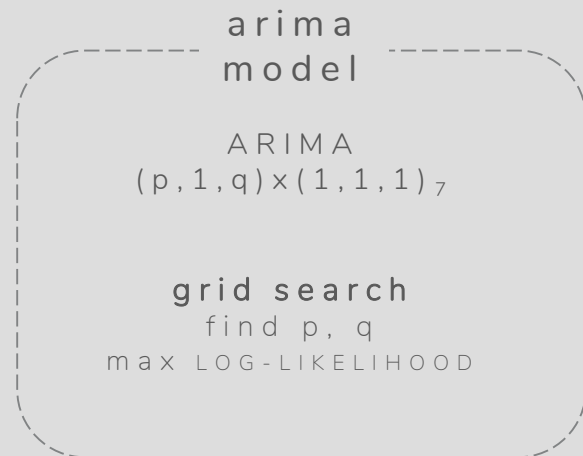


# initial analysis



arima  
model  
all seasonal  
component  
7  
periodicity

# configuration model



ARIMA  
 $(6, 1, 6) \times (1, 1, 1)_7$   
final model





# external regressor

ARIMA  
(6,1,6)×(1,1,1)<sub>7</sub>

## regressor

### holidays

(12 holidays italian calendar)

### freq

$\sin(2\pi \times \text{seq}(\text{dayOftheMonth})/365,25)$   
 $\cos(2\pi \times \text{seq}(\text{dayOftheMonth})/365,25)$

holidays  
+  
freq

1  
13,83  
%

13,88  
%

14,41  
%

mape

# prediction on validation

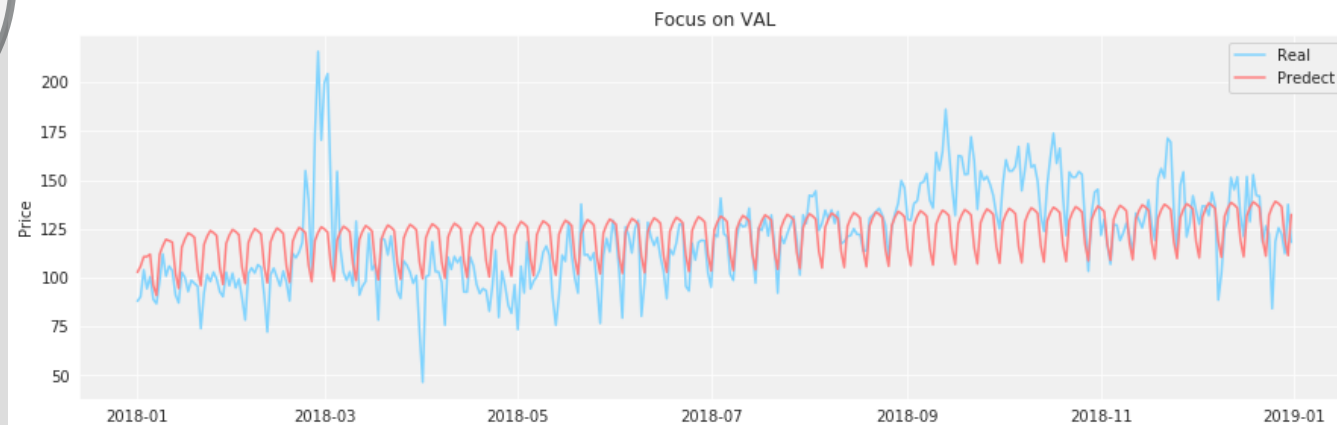
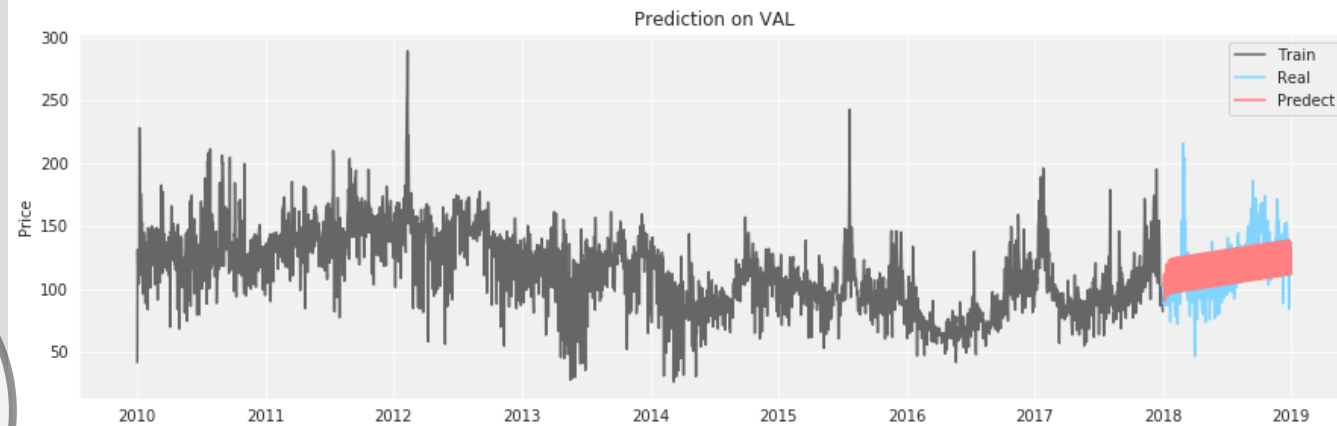
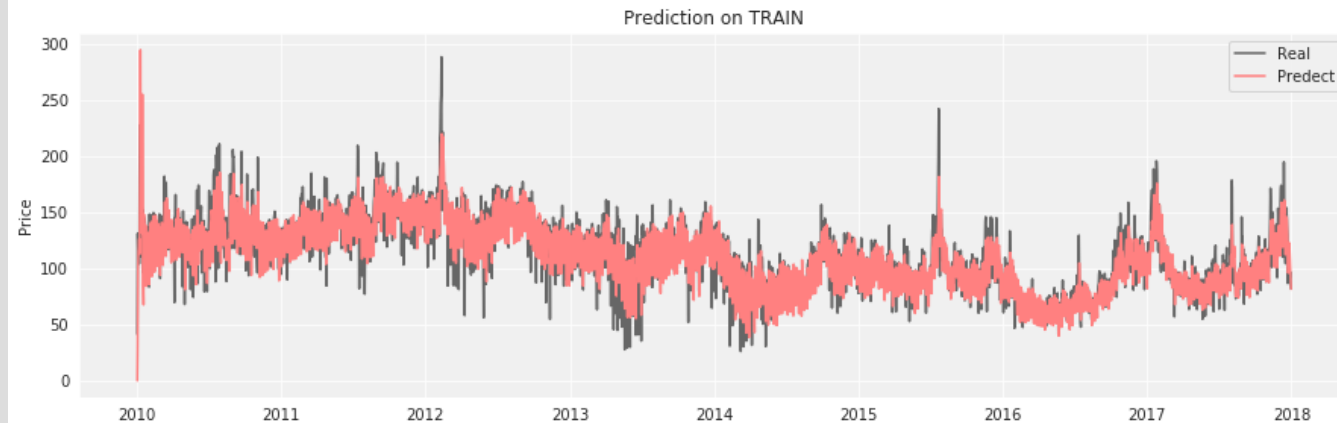


ARIMA  
(6,1,6)×(1,1,1)<sub>7</sub>

regressor  
holidays  
(12 holidays italian calendar)

1  
13,83  
%

mape  
(9,78 %  
on training)



models

**ucm**





## initial configuration

### UCM model

trend: local level

cycle

seasonal: weekly (7-dummy)



p-value components



19,44% mape  
on validation





## improve configuration



### UCM model

grid search  
find trend  
best mape on validation

cycle

seasonal: weekly (7-dummy)

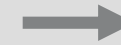


### trend

Random  
Walk with  
Drift

19,44  
%

mape



15,31  
%

mape



## different seasonal component

1

cycle  
seasonal  
weekly (7-dummy)  
yearly (trig -24 harm)

2

cycle  
seasonal  
weekly (7-dummy)  
monthly (trig -12 harm)  
yearly (trig -24 harm)

3

no cycle  
seasonal  
weekly (7-dummy)  
monthly (trig -12 harm)  
yearly (trig -24 harm)

4

cycle  
seasonal  
weekly (7-dummy)  
monthly (trig -12 harm)



14,95  
%

16,16  
%

16,17  
%

16,32  
%

## UCM

trend: rwdrift  
cycle  
seasonal: weekly (7-dummy)  
initial model

mape

# prediction on validation



UCM

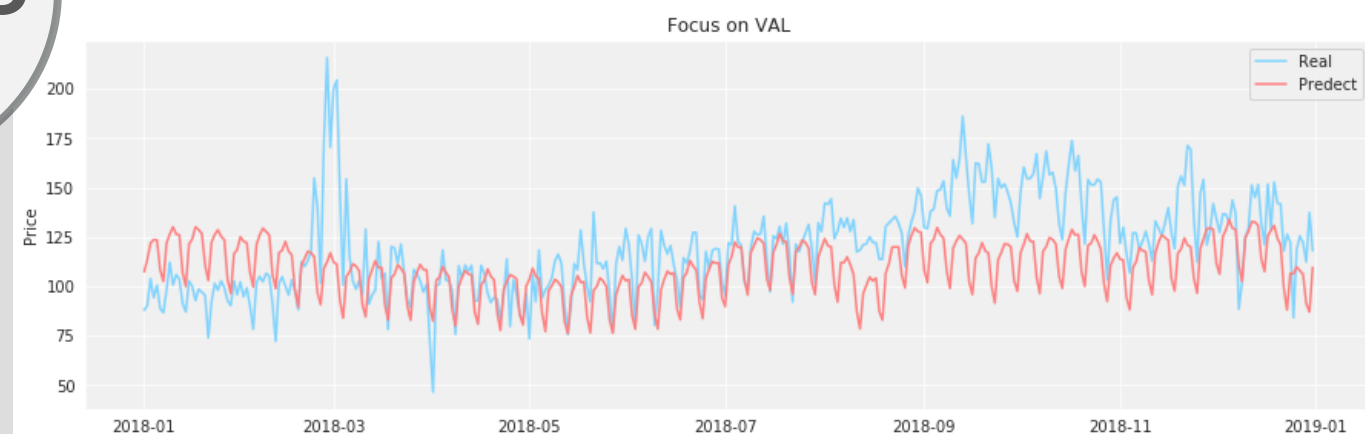
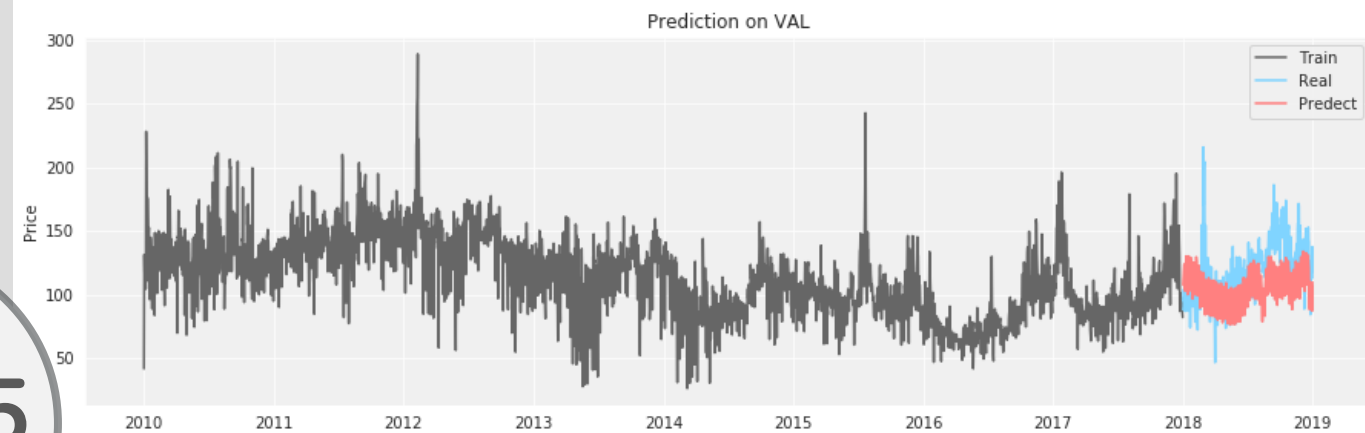
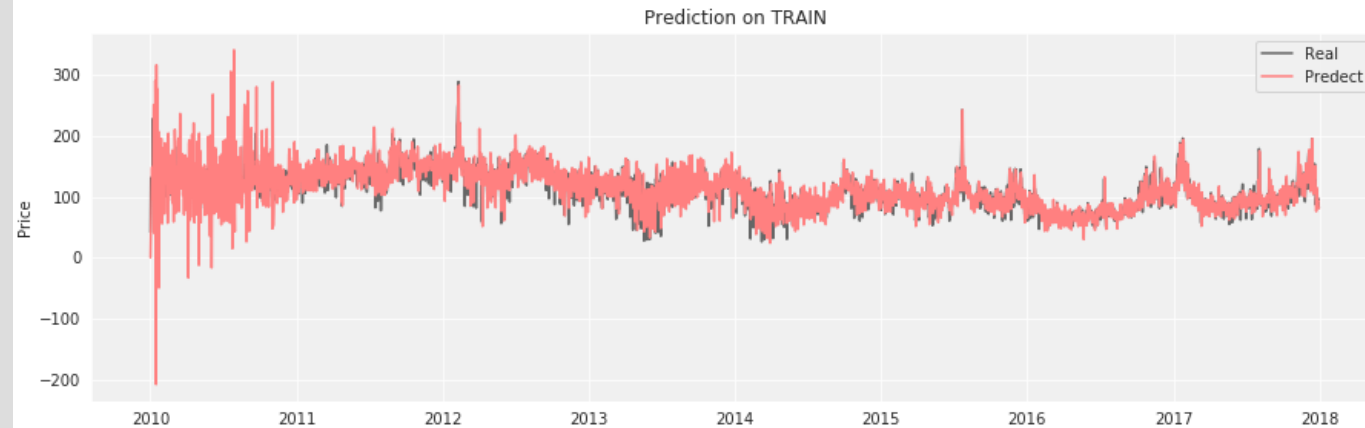
trend: rwdrift  
cycle  
seasonal  
weekly (7-dummy)  
yearly (trig -24 harm)

final model

test regressor   
no improvement

1  
14,95  
%

mape  
(13,03 %  
on training)



models

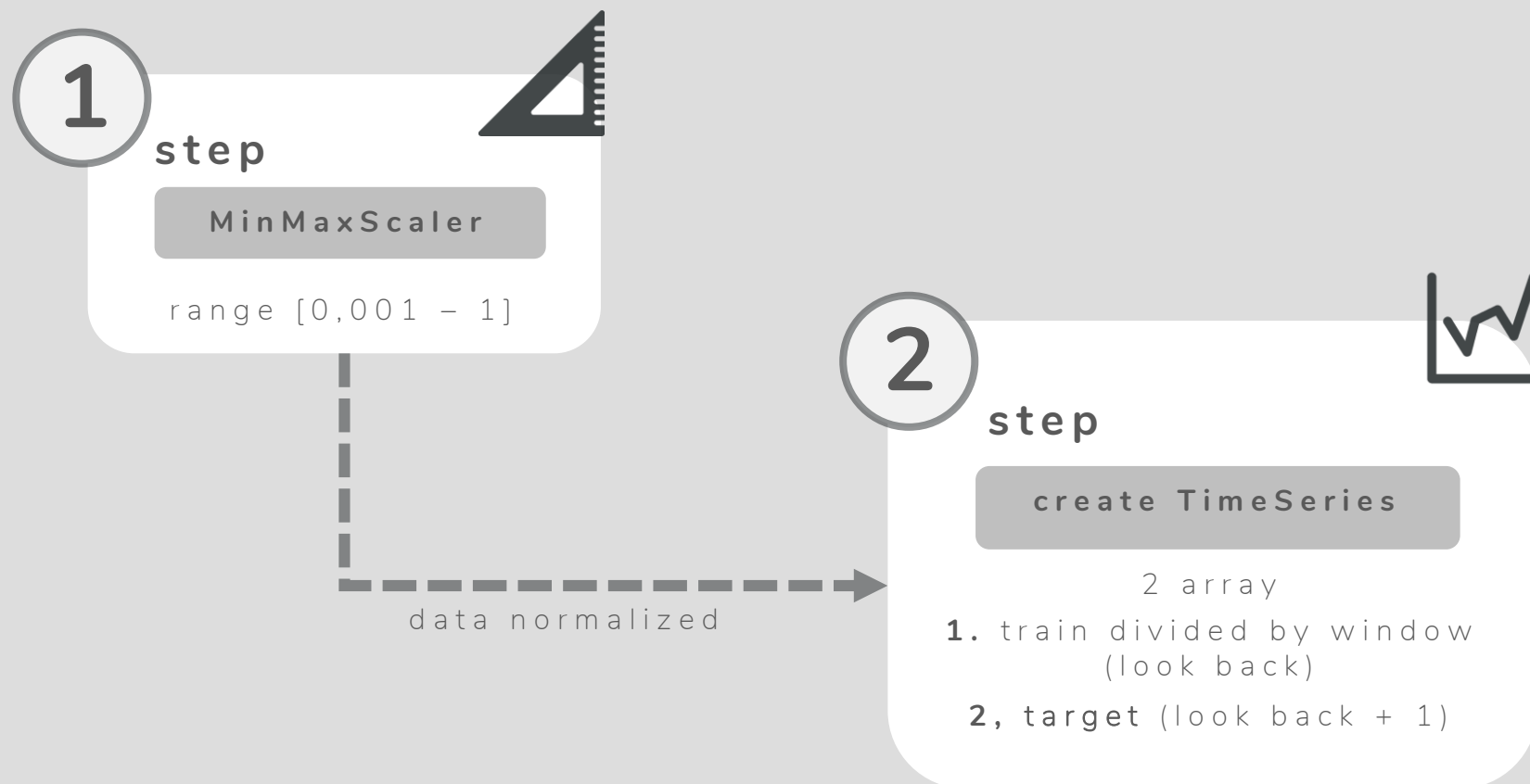
**rnn**





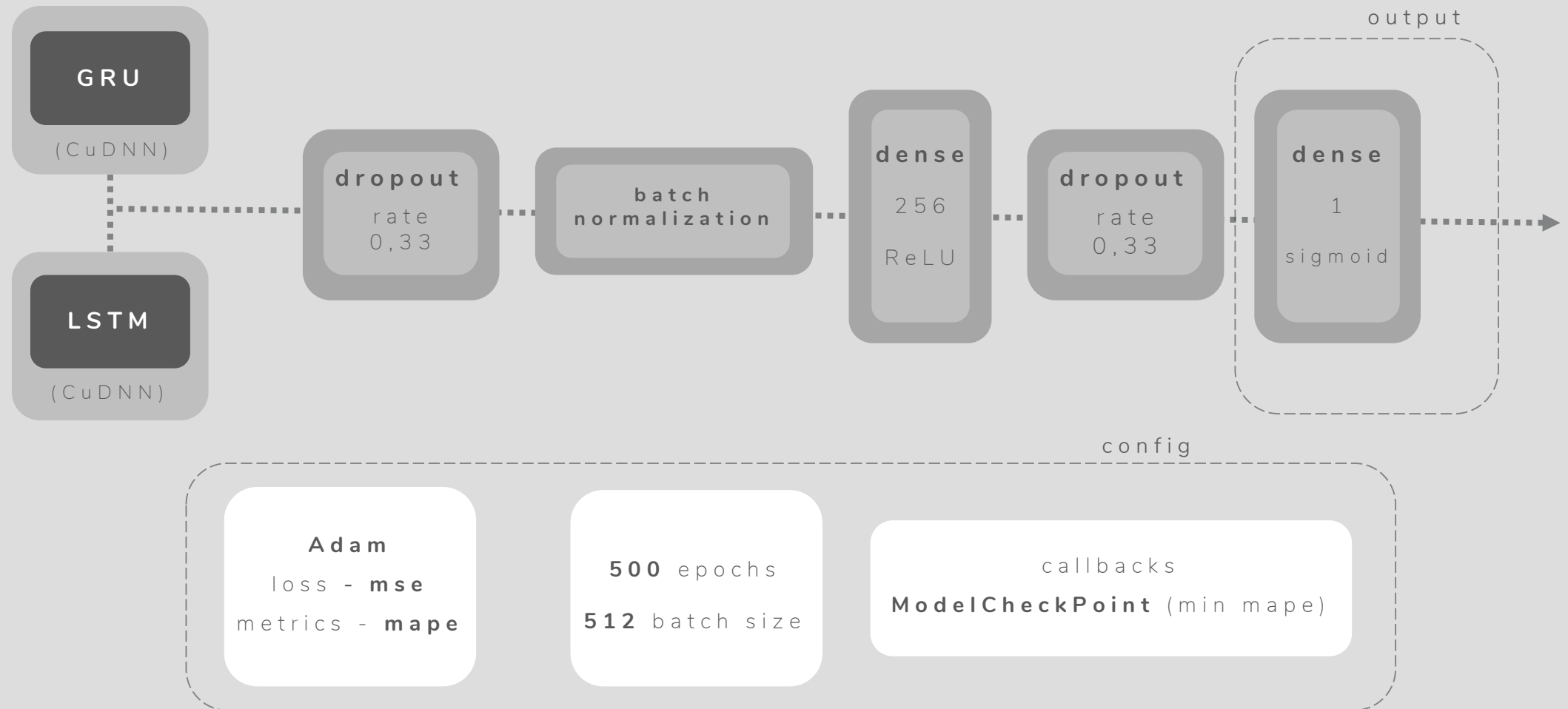


## pre-processing



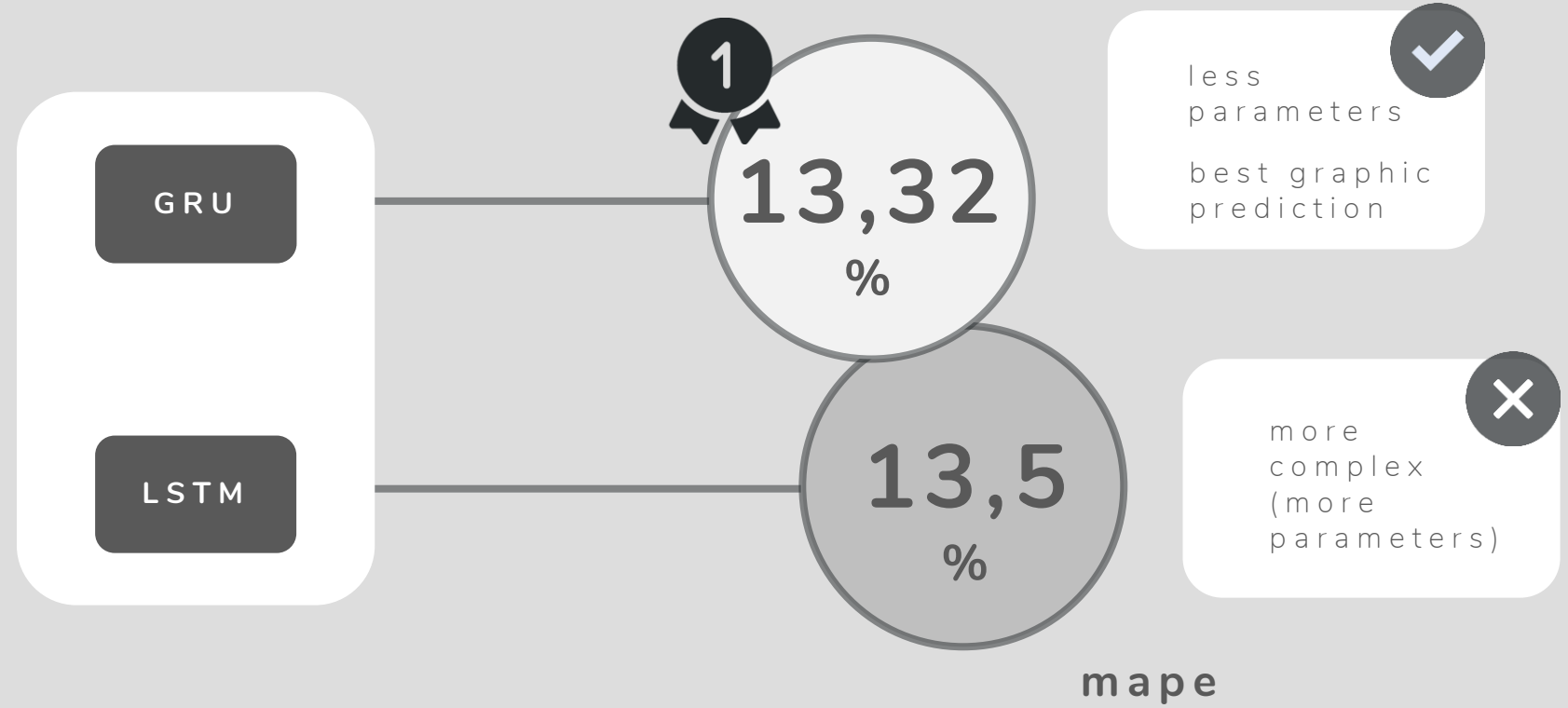


# architecture





## results



# prediction on validation

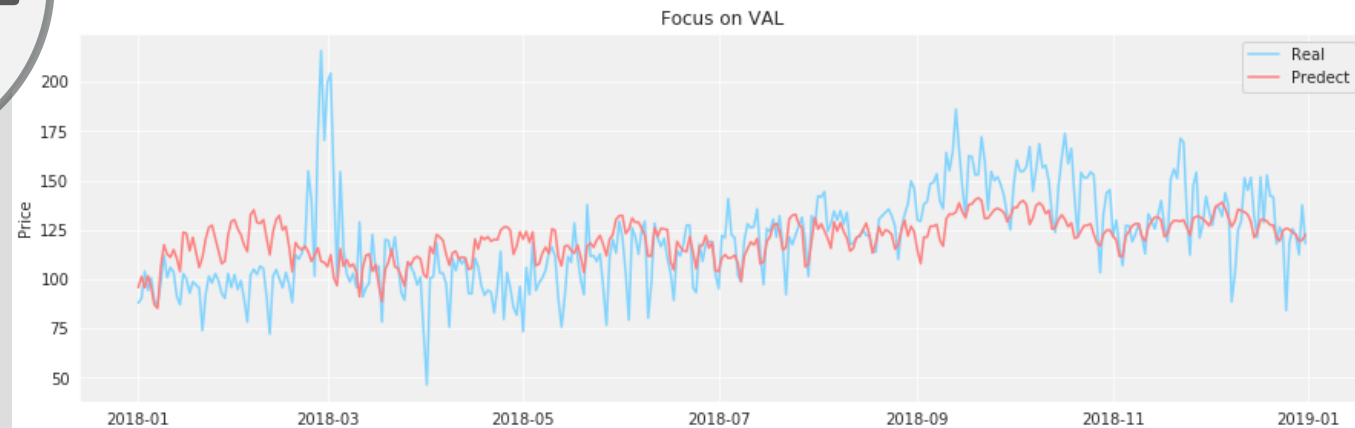
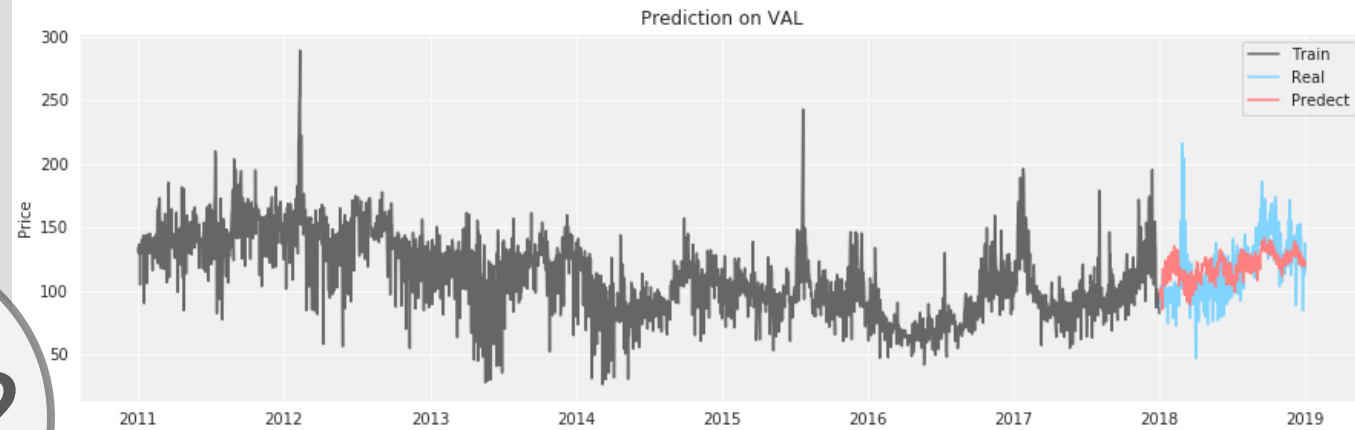
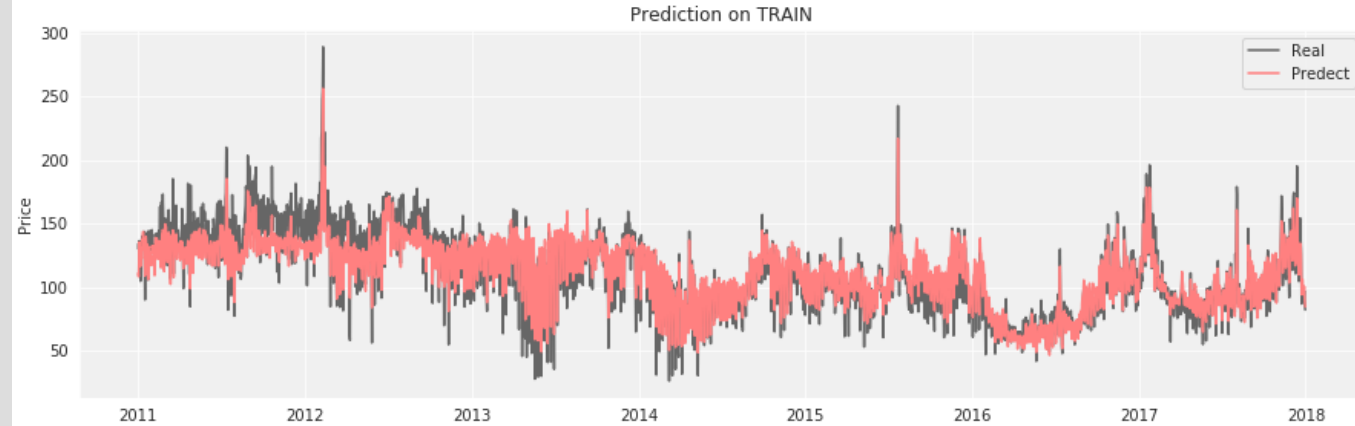


final model

GRU

1  
13,32  
%

mape  
(8,65 %  
on training)



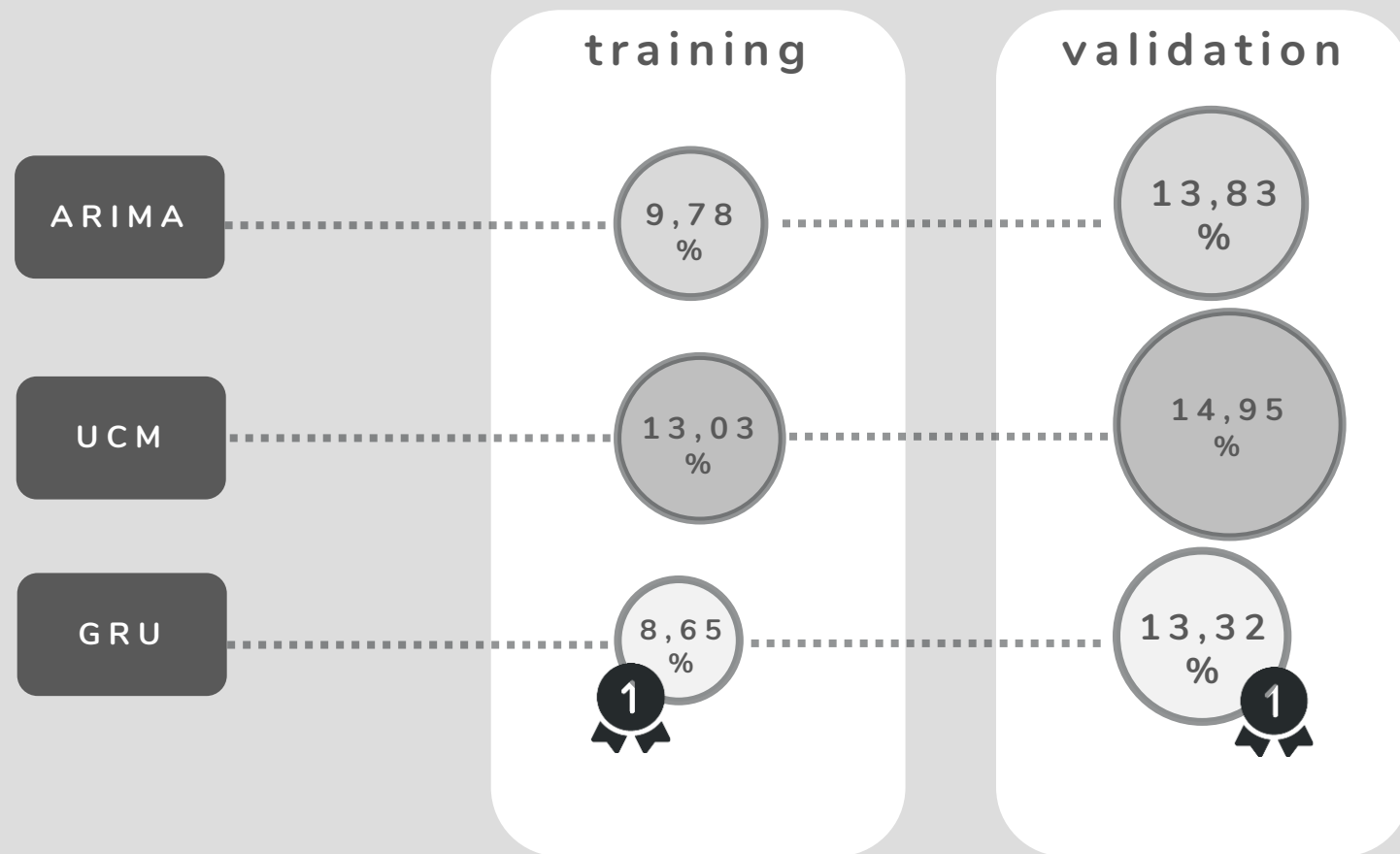
comparison



**results**



## comparison



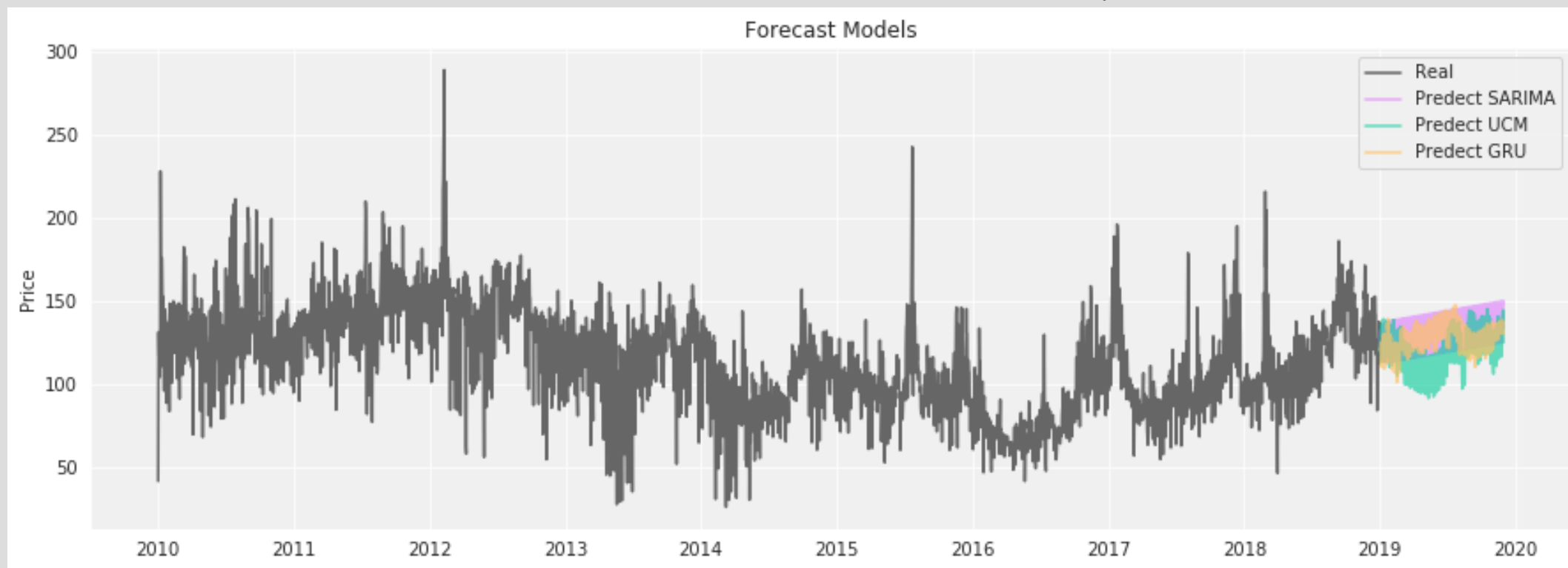
# prediction on validation



re-train  
models

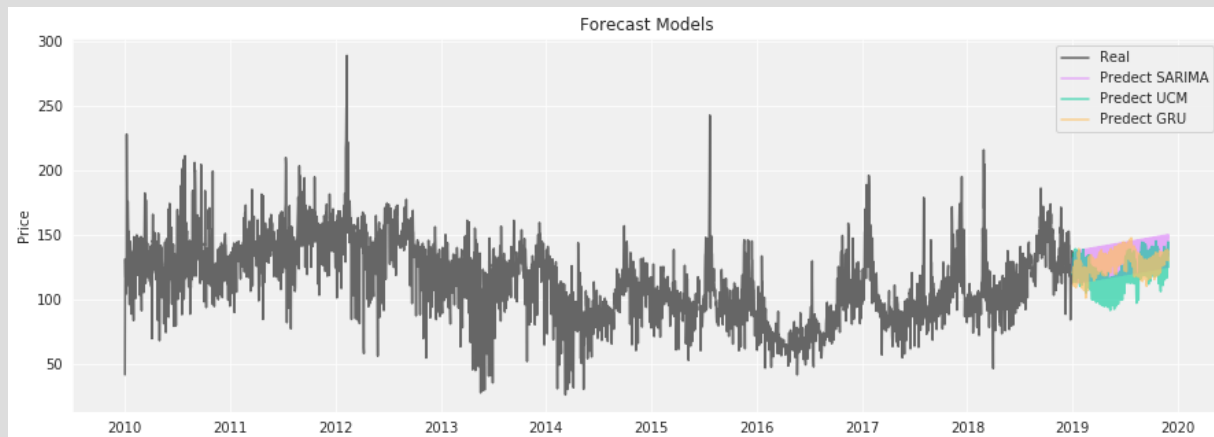
all data!

final prediction

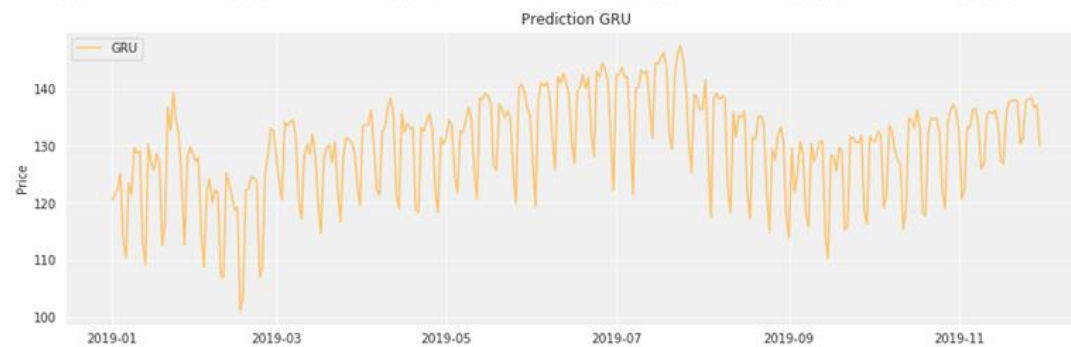
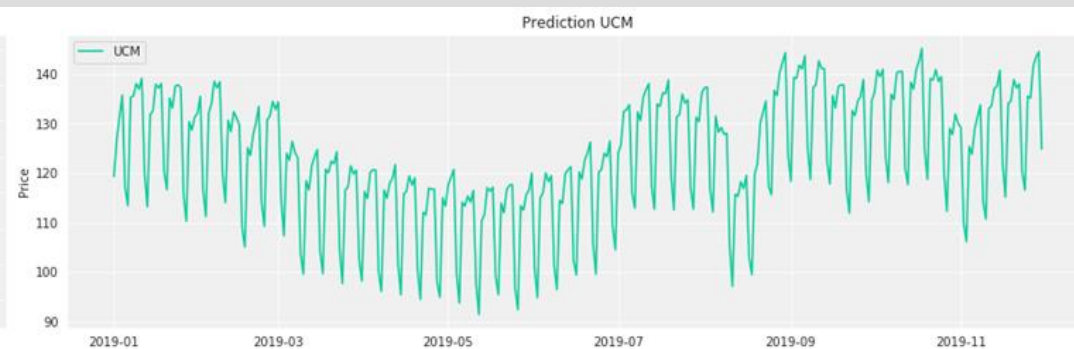
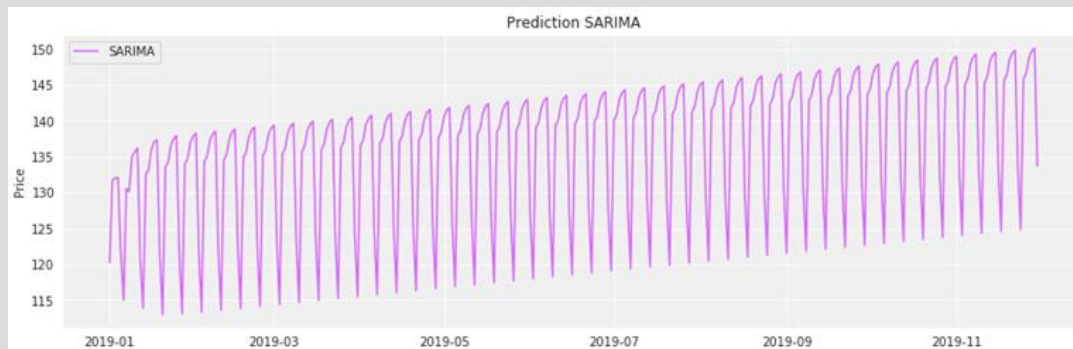




# prediction on validation



final prediction







# THANK YOU