Financial time series forecasting with deep learning

Pilyugina Polina

Shvetsov Nikolay

Vlasov Andrei

Talitsky Alexandr

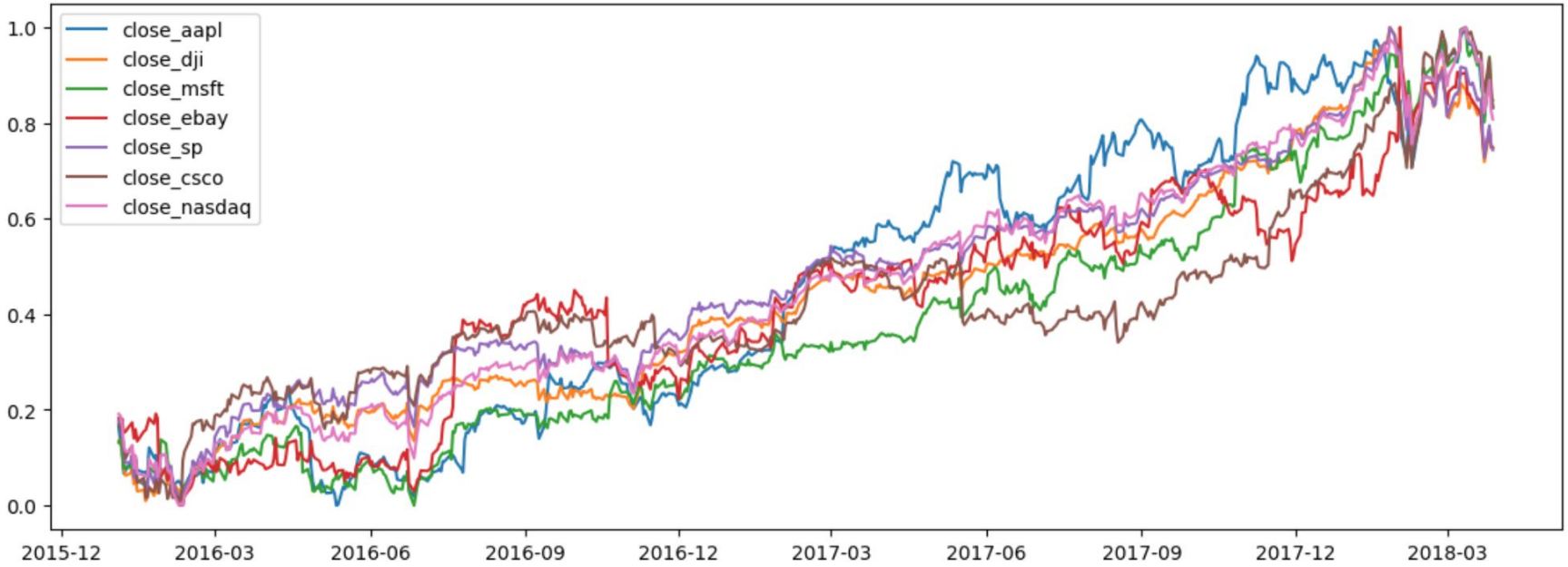
Skoltech

Skolkovo Institute of Science and Technology

Problem description

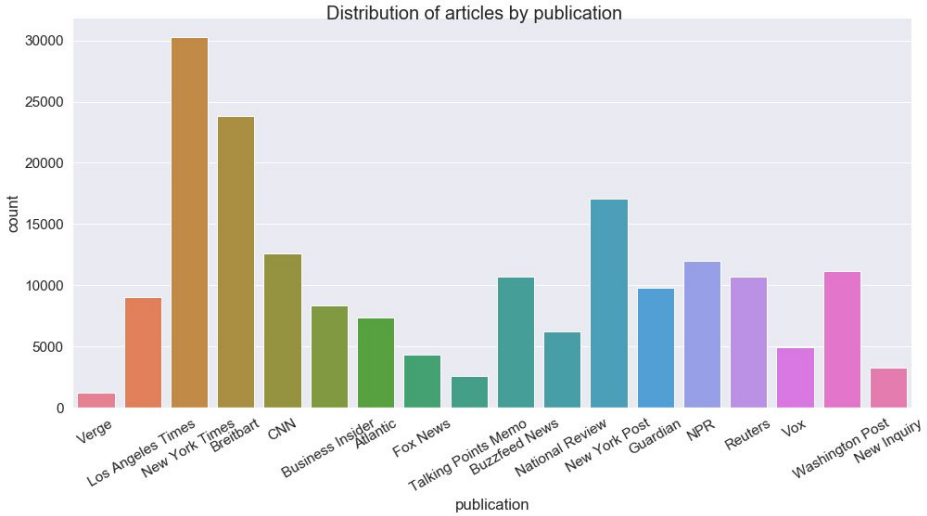
1. Predict financial time series **40 days in advance**
2. Try and compare **different networks**
3. Using some **composite model** predict **NASDAQ**
4. Add **sentiment analysis** of news to the **composite model**
5. Compare all the models with **baseline regression** with rolling lagged predictions

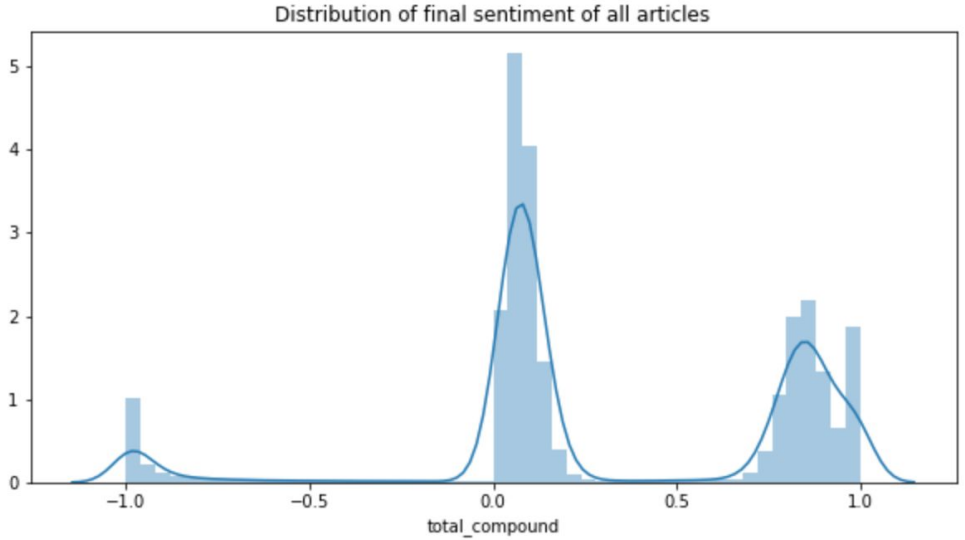
Data description



Skoltech
Skolkovo Institute of Science and Technology

Data description

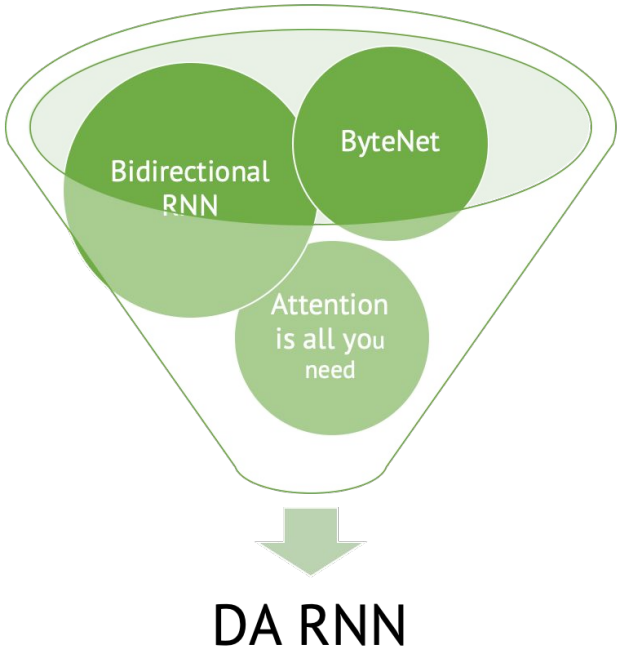




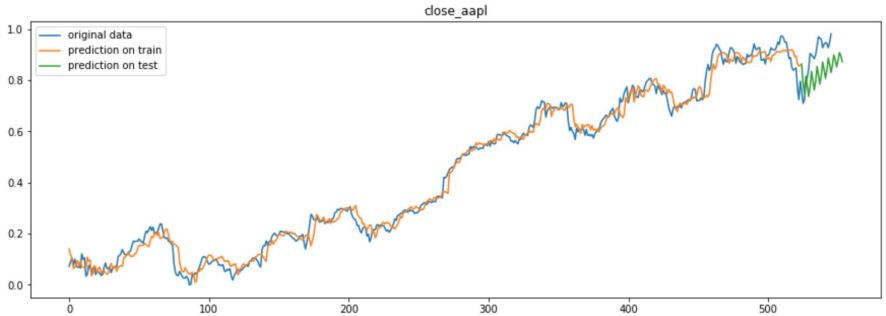
Skoltech
Skolkovo Institute of Science and Technology

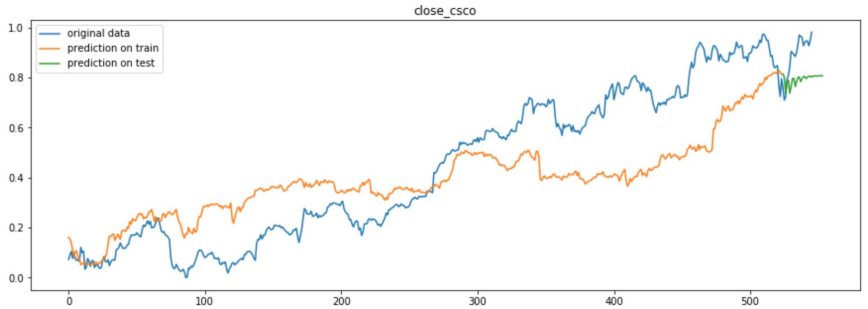
Proposed solution

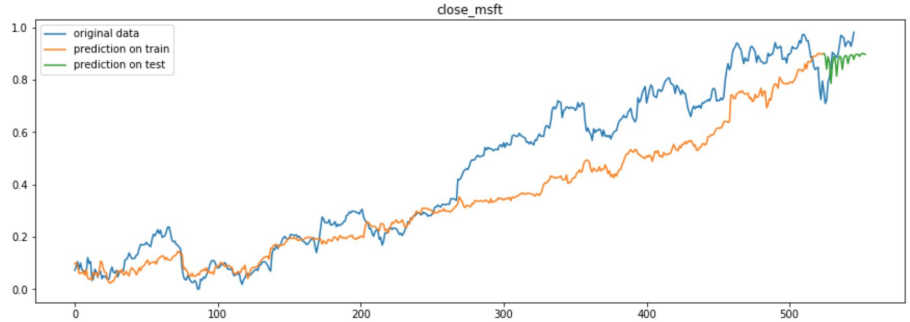
1. Predict each of the selected companies' **closing prices** using three NNs
2. Input this stock prices as features into **Dual-Stage Attention-Based Recurrent Neural Network**
3. Add **sentiment analysis** of news with nltk to the final model

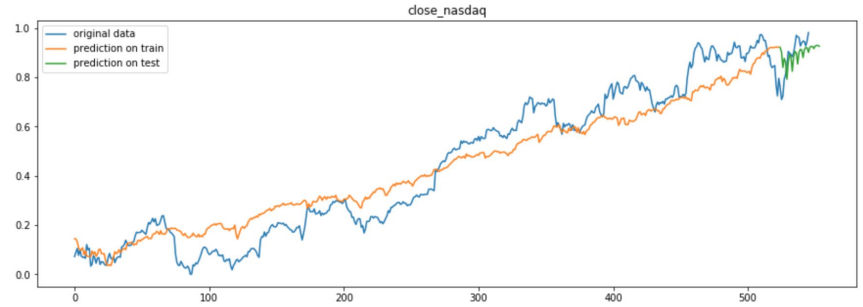


Regression



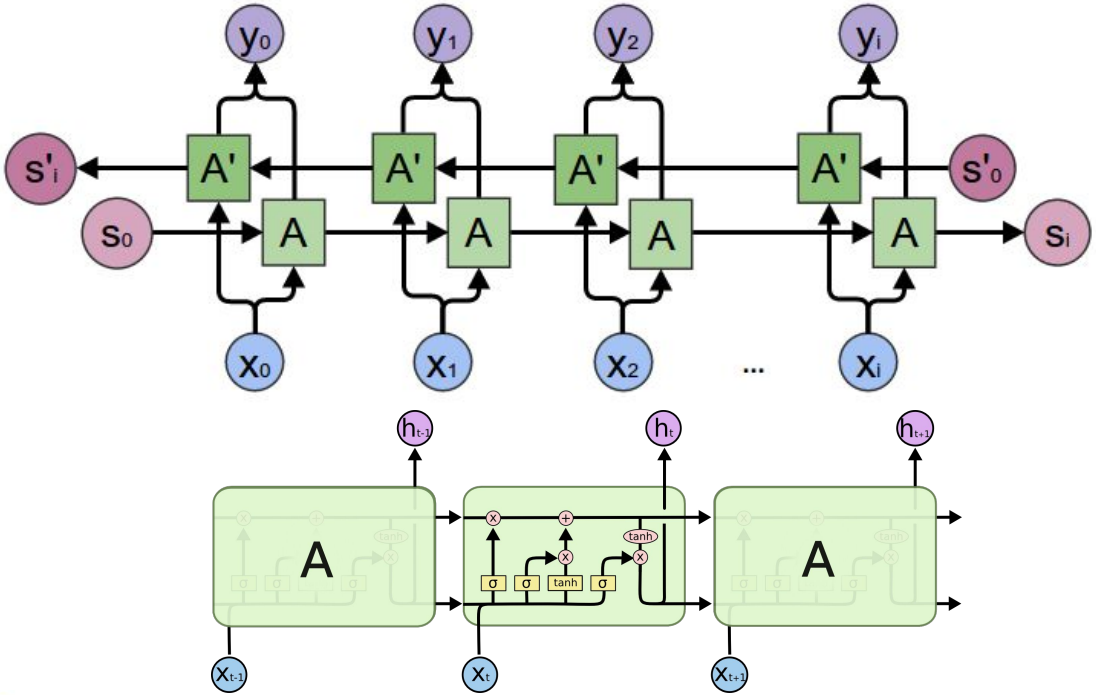




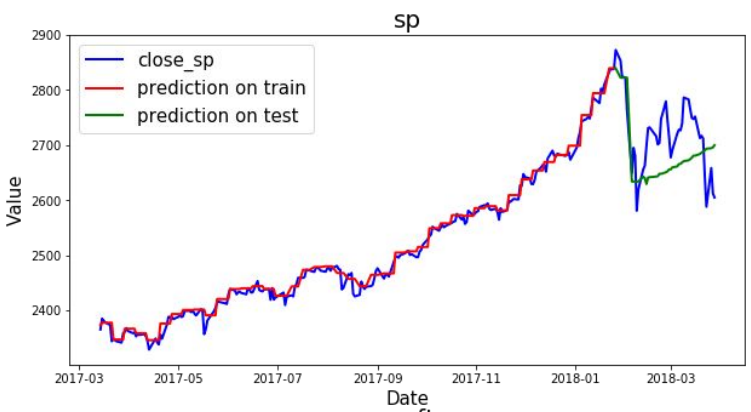


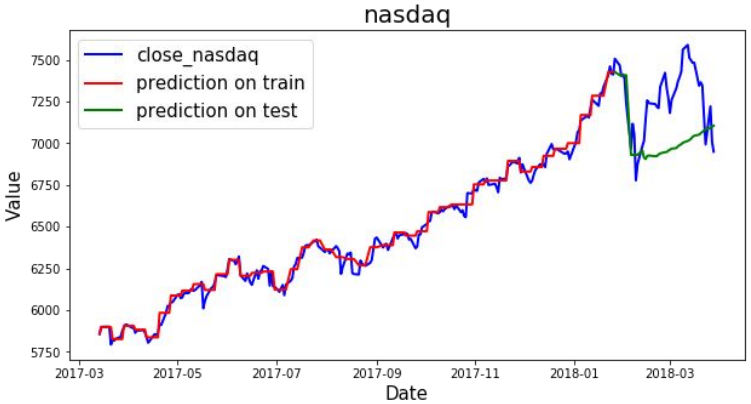
Skoltech
Skolkovo Institute of Science and Technology

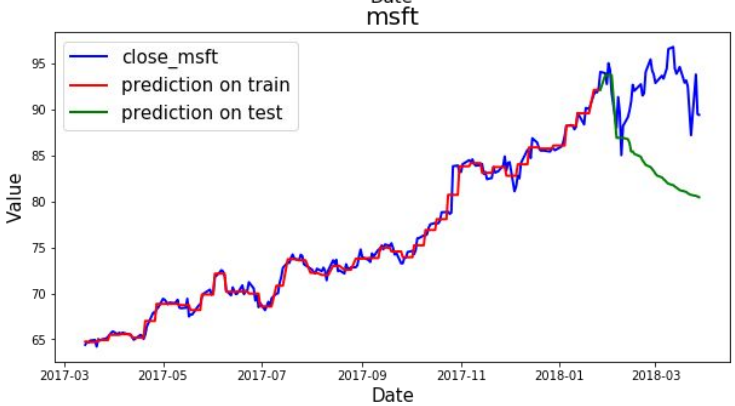
Bidirectional RNN

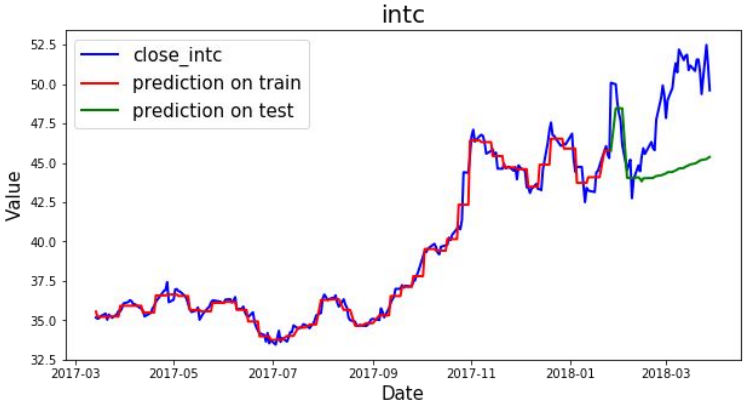


Bidirectional RNN

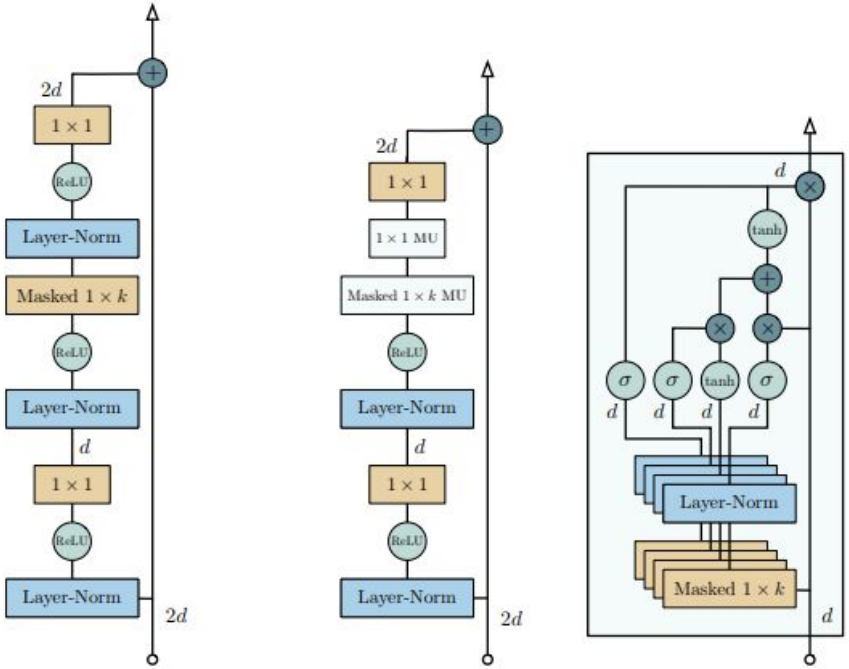


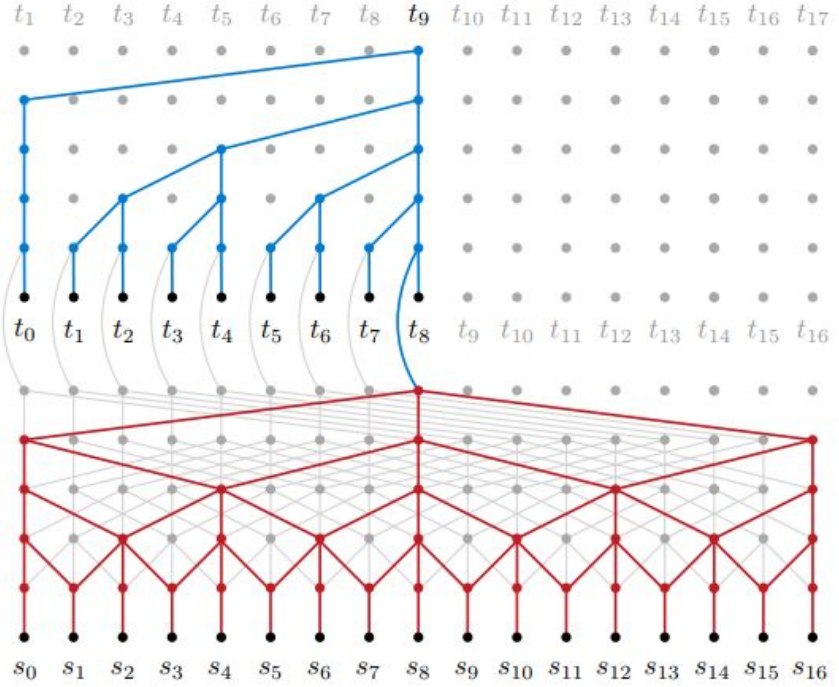






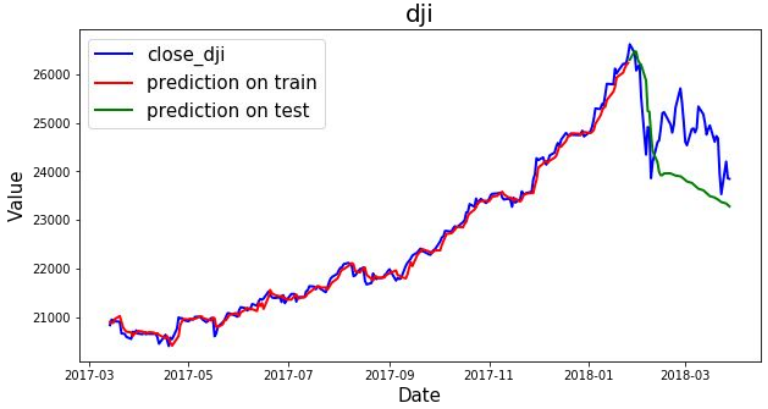
ByteNet

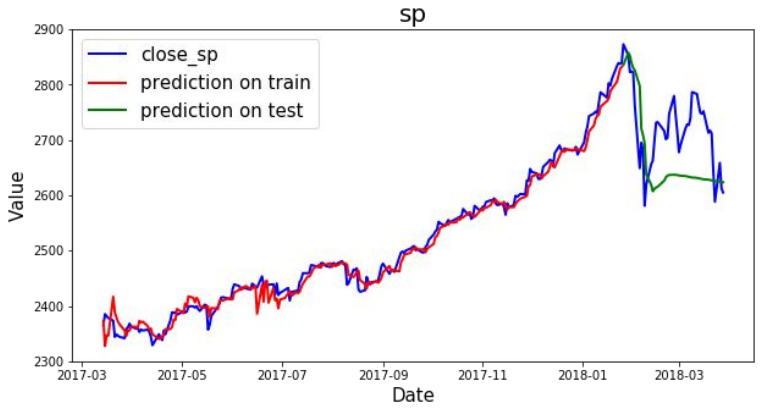


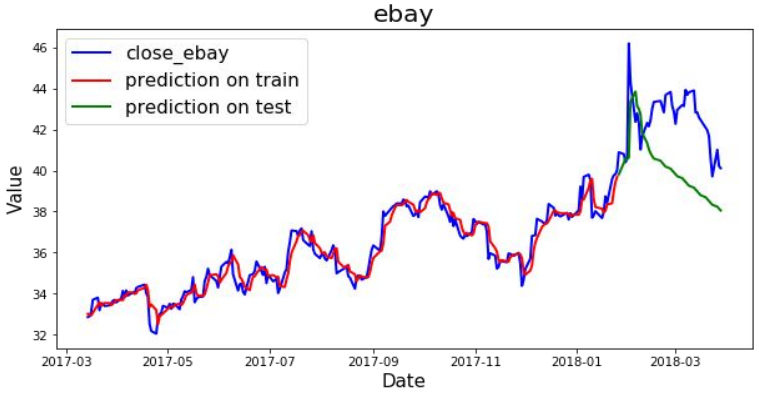


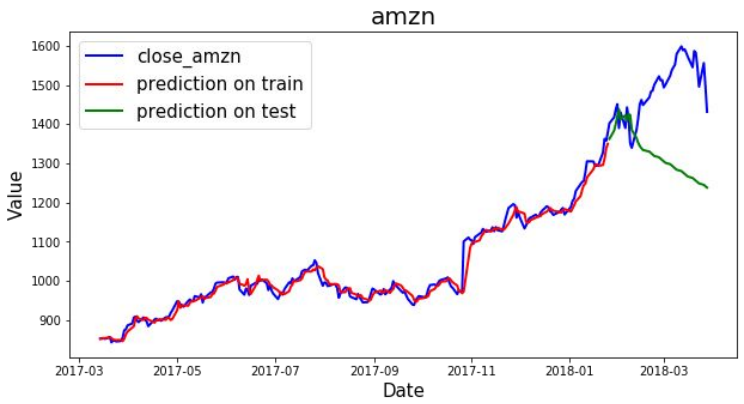
Skoltech
Skolkovo Institute of Science and Technology

ByteNet


dji
close_dji
prediction on train
prediction on test
Value
Date
26000
25000
24000
23000
22000
21000
2017-03
2017-05
2017-07
2017-09
2017-11
2018-01
2018-03

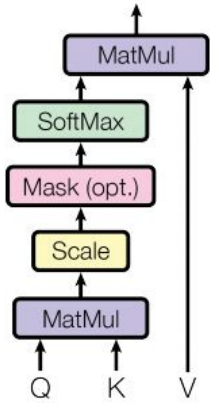

sp
close_sp
prediction on train
prediction on test
Value
Date
2900
2800
2700
2600
2500
2400
2300
2017-03
2017-05
2017-07
2017-09
2017-11
2018-01
2018-03


ebay
close_ebay
prediction on train
prediction on test
Value
Date
46
44
42
40
38
36
34
32
2017-03
2017-05
2017-07
2017-09
2017-11
2018-01
2018-03

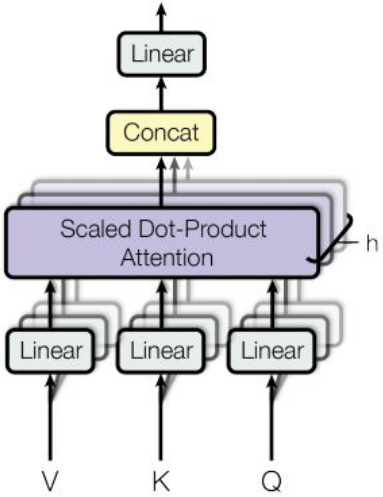

amzn
close_amzn
prediction on train
prediction on test
Value
Date
1600
1500
1400
1300
1200
1100
1000
900
2017-03
2017-05
2017-07
2017-09
2017-11
2018-01
2018-03

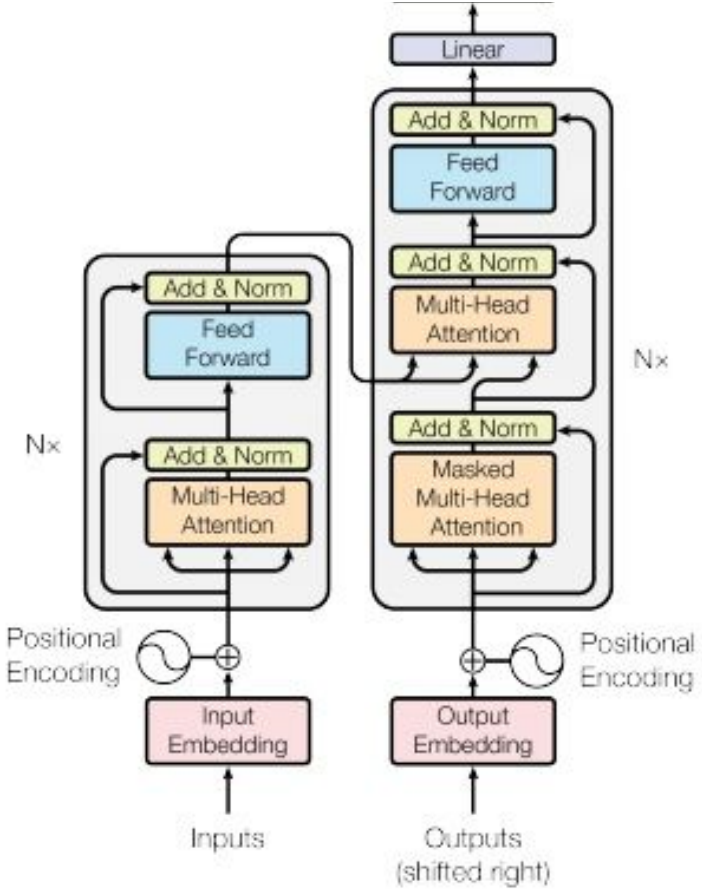
Attention is all you need

Scaled Dot-Product Attention

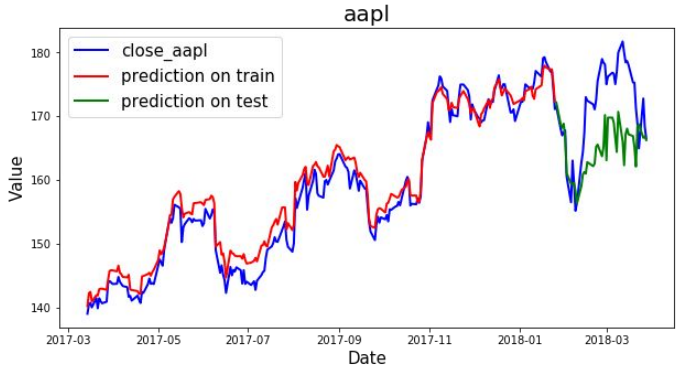


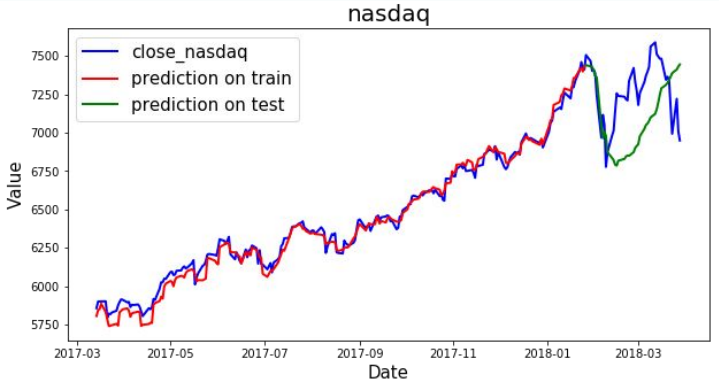
Multi-Head Attention

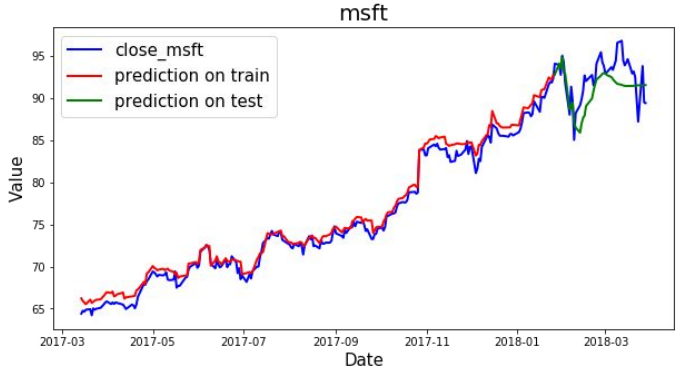


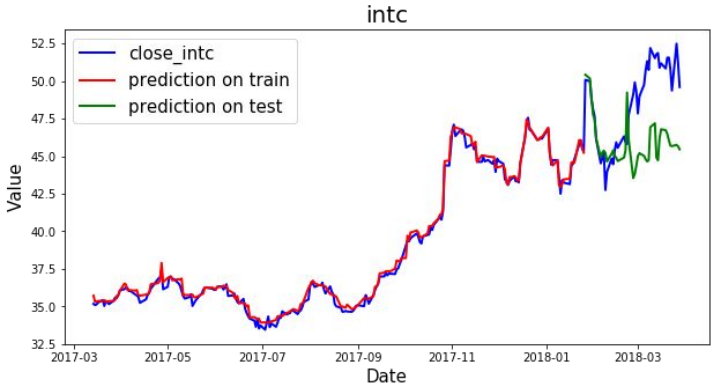


Attention is all you need

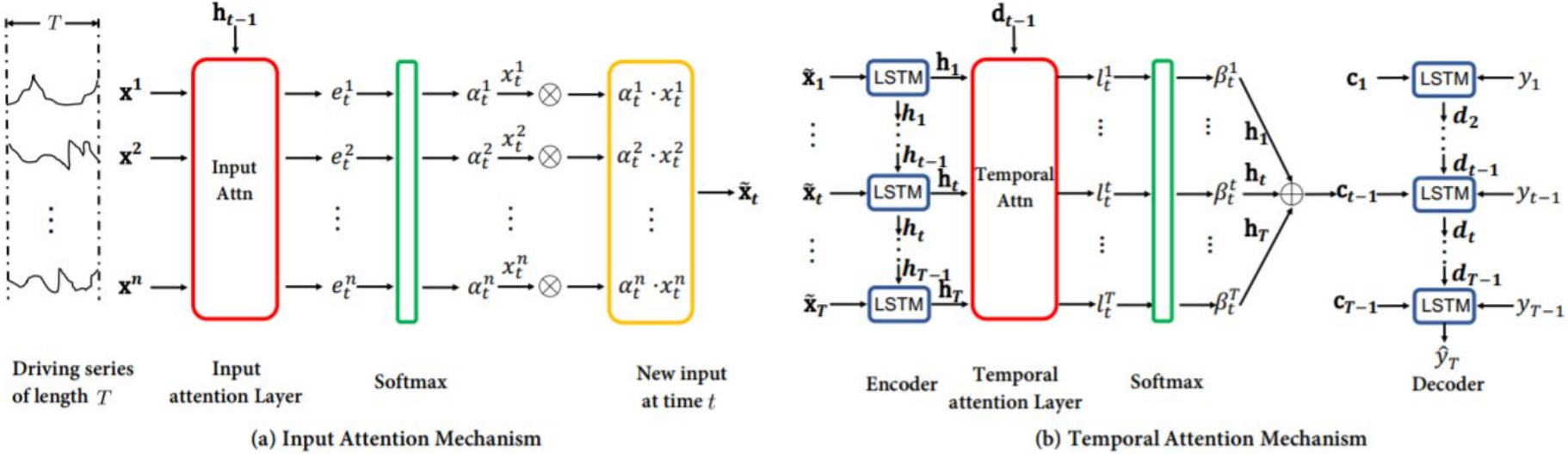






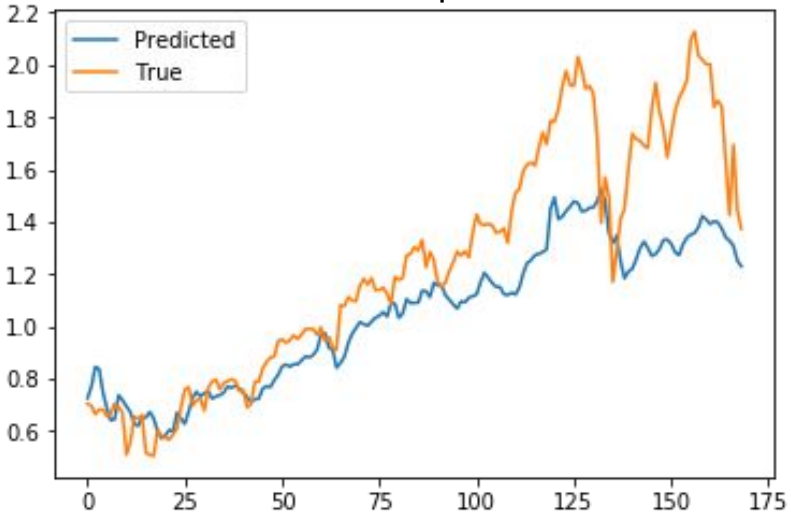


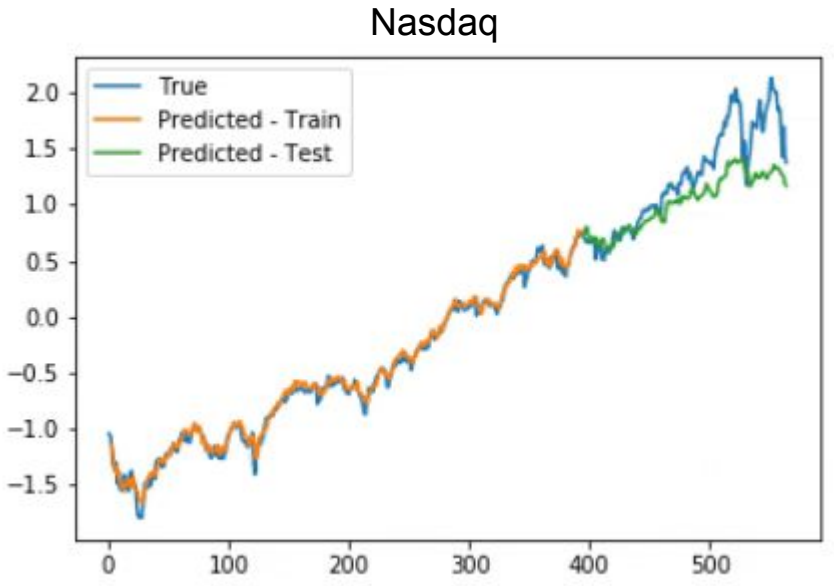
Dual-Stage Attention-Based Recurrent Neural Network



Skoltech
Skolkovo Institute of Science and Technology

Dual-Stage Attention-Based Recurrent Neural Network





MSE before news = 0.5
MSE after news = 0.19

after 200 epochs

Conclusions and remarks

1. Forecasting financial time series is **tricky**
2. The best model for the prediction of the closing prices was **Attention is all you need**
3. Composite DA RNN was **improved** with addition of the news analysis
4. Each models requires at least **1000 epochs** to train which takes at least **30 minutes on GPU**

Thank you for attention!

Skoltech

Skolkovo Institute of Science and Technology

Emergency slide

AAAAAAAAAAAAAAAAAAAAAAAAAAA