In [1]:
```
%config InlineBackend.figure_format = 'retina'
import pandas as pd
import os
```

Benchmarking the System Performance

In [2]:
```
run_id = 'BP_2Predictors_live_training_Horizon30'
```

In [3]:
```
os.mkdir(run_id)
```

In [4]:
```
dir_ = './' + run_id + '/'
```

This Jupyter notebook serves to benchmark the performance of the prototype system.

Loading and importing the system

In [5]:
```
%run ../tools/dataloader.py
%run ../system/activate.py
```

Loading and importing financial data to forecast and to benchmark the system on

Prophet and Neural prophet training set-up

In [6]:
```
training_data = DataLoader('BP', '2010-02-01', '2018-02-01')
training_data = training_data.get_adjclose()
```

In [7]:
```
predict = DataLoader('BP', '2018-02-02', '2018-05-01')
predict = predict.get_adjclose()
```

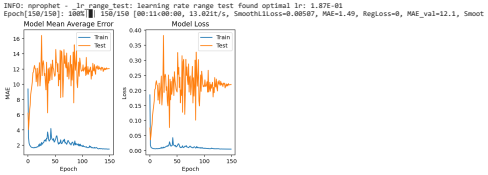
In [8]:
```
predict_req, real = data_prep(predict, 0, 30) # dividing data into predictor input and real data
```

Individual predictor forecasts

In [9]:
```
#individual_predictors_forecasts = individual_predictors_pretrained_SP500_40_5(predict_req, 40)
```

In [10]:
```
individual_predictors_forecasts = individual_predictors_template2(training_data, 30)
```

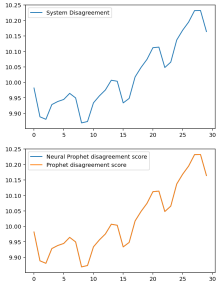
```
INFO: nprophet.config - set_auto_batch_epoch: Auto-set batch_size to 32

INFO: nprophet - _lr_range_test: learning rate range test found optimal lr: 1.87E-01
Epoch[150/150]: 100%|| 150/150 [00:11<00:00, 13.02it/s, SmoothLoss=0.00507, MAE=1.49, RegLoss=0, MAE_val=12.1, Smoot
```




```
INFO:fbprophet:Disabling daily seasonality. Run prophet with daily_seasonality=True to override this.
INFO:fbprophet:Making 86 forecasts with cutoffs between 2014-07-07 00:00:00 and 2018-01-02 00:00:00
```

System disagreement between individual predictor forecasts

In [11]:
```
system_disagreement(individual_predictors_forecasts)
```



Building consensus forecast values

In [12]:
```
consensus_forecasts = consensus(individual_predictors_forecasts, real)
```

In [13]:
```
all_forecasts = combined_frame(individual_predictors_forecasts, consensus_forecasts, real)
```

In [14]:
```
summary = all_stats_frame(all_forecasts, individual_predictors_forecasts) # combining individual predictor forecasts, consensus forecasts and disagreement scores
summary
```

Out[14]:

Date	Average	NoMemory	Memory	Focus	Anchor	Correcting	Correcting Memory	Real Value	Neural Prophet	Prophet	System Disagreement	Neural Prophet disagreement score	Prophet disagreement score
2018-02-02	22.648533	22.648533	22.648533	22.648533	35.125541	22.648533	22.648533	33.056301	12.666926	32.630139	9.981607	9.981607	9.981607
2018-02-05	22.572417	32.055915	27.314166	32.460810	28.178017	32.992840	27.782629	31.947998	12.684024	32.460810	9.888393	9.888393	9.888393
2018-02-06	22.580700	31.948548	28.861875	32.460937	27.835495	31.968764	29.187940	32.582458	12.700463	32.460937	9.880237	9.880237	9.880237
2018-02-07	22.644153	32.451482	29.829618	32.572107	28.158935	32.658437	30.109270	32.124687	12.716200	32.572107	9.927954	9.927954	9.927954
2018-02-08	22.669054	32.159060	30.321170	32.606926	27.982471	32.160782	30.546529	31.763285	12.731182	32.606926	9.937872	9.937872	9.937872
2018-02-09	22.689844	31.790110	30.587550	32.634312	27.874011	31.794329	30.779148	31.409916	12.745376	32.634312	9.944468	9.944468	9.944468

Date	Average	NoMemory	Memory	Focus	Anchor	Correcting	Correcting Memory	Real Value	Neural Prophet	Prophet	System Disagreement	Neural Prophet disagreement score	Prophet disagreement score
2018-02-12	22.722912	31.460272	30.753990	32.687095	27.793049	31.451770	30.910794	32.020275	12.758728	32.687095	9.964184	9.964184	9.964184
2018-02-13	22.720639	32.004258	30.897896	32.670092	27.963108	32.027581	31.055633	31.875723	12.771187	32.670092	9.949453	9.949453	9.949453
2018-02-14	22.651359	31.732088	30.869967	32.520005	27.792158	31.816888	31.086284	32.421844	12.782713	32.520005	9.868646	9.868646	9.868646
2018-02-15	22.666387	32.441313	31.043989	32.539518	28.050414	32.444943	31.241981	32.478912	12.793257	32.539518	9.873131	9.873131	9.873131
2018-02-16	22.736315	32.608897	31.296437	32.669874	28.177505	32.556027	31.430201	32.299561	12.802756	32.669874	9.933559	9.933559	9.933559
2018-02-20	22.767261	32.352192	31.430577	32.723345	28.114487	32.336616	31.539177	32.218033	12.811177	32.723345	9.956084	9.956084	9.956084
2018-02-21	22.793501	32.262259	31.533994	32.768533	28.106979	32.249446	31.622503	31.663675	12.818468	32.768533	9.975033	9.975033	9.975033
2018-02-22	22.831277	31.729610	31.608809	32.837976	27.965810	31.704772	31.667072	31.997921	12.824578	32.837976	10.006699	10.006699	10.006699
2018-02-23	22.832848	31.996446	31.633396	32.836221	28.049920	32.003175	31.694183	32.690872	12.829475	32.836221	10.003373	10.003373	10.003373
2018-02-26	22.766426	32.555406	31.570965	32.699737	28.162420	32.627569	31.693570	32.845764	12.833115	32.699737	9.933311	9.933311	9.933311
2018-02-27	22.783229	32.586883	31.658606	32.731004	28.310124	32.864460	31.779630	32.201725	12.835453	32.731004	9.947776	9.947776	9.947776
2018-02-28	22.853784	32.338120	31.821588	32.871099	28.191126	32.271915	31.873480	31.679977	12.836470	32.871099	10.017315	10.017315	10.017315
2018-03-01	22.884149	31.737395	31.871964	32.932167	28.016068	31.708986	31.892991	31.745197	12.836130	32.932167	10.048019	10.048019	10.048019
2018-03-02	22.908565	31.792664	31.913405	32.982721	28.058425	31.767435	31.908398	31.549549	12.834409	32.982721	10.074156	10.074156	10.074156
2018-03-05	22.943274	31.616698	31.964528	33.055250	28.036566	31.580413	31.923181	31.924553	12.831297	33.055250	10.111977	10.111977	10.111977
2018-03-06	22.940535	31.923397	31.961562	33.054294	28.133038	31.918468	31.917250	32.242489	12.826777	33.054294	10.113759	10.113759	10.113759
2018-03-07	22.868601	32.109843	31.842884	32.916350	28.118825	32.167766	31.856378	32.046844	12.820853	32.916350	10.047748	10.047748	10.047748
2018-03-08	22.878746	32.072948	31.877147	32.943965	28.130030	32.051131	31.868904	32.169121	12.813527	32.943965	10.065219	10.065219	10.065219
2018-03-09	22.941563	32.297969	32.015682	33.078321	28.276501	32.223770	31.936183	32.332169	12.804805	33.078321	10.136758	10.136758	10.136758
2018-03-12	22.963208	32.383210	32.077944	33.131699	28.324840	32.345519	31.965235	32.487061	12.794717	33.131699	10.168491	10.168491	10.168491
2018-03-13	22.978034	32.526475	32.131493	33.172777	28.390756	32.492695	31.990686	32.242489	12.783292	33.172777	10.194743	10.194743	10.194743
2018-03-14	23.002396	32.300566	32.193145	33.234240	28.345684	32.256292	32.014167	31.688131	12.770552	33.234240	10.231844	10.231844	10.231844
2018-03-15	22.988702	31.674691	32.162305	33.220845	28.124540	31.664384	31.979142	31.818569	12.756558	33.220845	10.232143	10.232143	10.232143
2018-03-16	22.905344	31.676393	32.006457	33.069327	28.040561	31.727056	31.880869	32.185429	12.741362	33.069327	10.163983	10.163983	10.163983

In [15]:
```
summary.to_csv(dir_ + run_id + '_Forecast_Summary.csv')
```

Absolute error analysis of individual predictors and consensus forecasts

In [16]:
```
prediction_error = absolute_error_analytics(individual_predictors_forecasts, consensus_forecasts, real)
prediction_error
```

Out[16]:

Date	Neural Prophet absolute error	Prophet absolute error	Average absolute error	NoMemory absolute error	Memory absolute error	Focus absolute error	Anchor absolute error	Correcting absolute error	Correcting Memory absolute error	Neural Prophet disagreement score	Prophet disagreement score	System Disagreement
2018-02-02	20.389375	0.426162	10.407768	10.407768	10.407768	10.407768	2.069240	10.407768	10.407768	9.981607	9.981607	9.981607
2018-02-05	19.263974	0.512812	9.375581	0.107917	4.633832	0.512812	3.769981	1.044842	4.165369	9.888393	9.888393	9.888393
2018-02-06	19.881995	0.121521	10.001758	0.633911	3.720584	0.121521	4.746963	0.613695	3.394519	9.880237	9.880237	9.880237
2018-02-07	19.408487	0.447420	9.480534	0.326795	2.295069	0.447420	3.965752	0.533750	2.015417	9.927954	9.927954	9.927954
2018-02-08	19.032103	0.843642	9.094230	0.395775	1.442115	0.843642	3.780814	0.397498	1.216756	9.937872	9.937872	9.937872
2018-02-09	18.664540	1.224396	8.720072	0.380194	0.822366	1.224396	3.535905	0.384413	0.630768	9.944468	9.944468	9.944468
2018-02-12	19.261547	0.666820	9.297363	0.560003	1.266286	0.666820	4.227226	0.568505	1.109481	9.964184	9.964184	9.964184
2018-02-13	19.104536	0.794369	9.155083	0.128535	0.977827	0.794369	3.912614	0.151858	0.820090	9.949453	9.949453	9.949453
2018-02-14	19.639132	0.098161	9.770485	0.689757	1.551877	0.098161	4.629686	0.604956	1.335561	9.868646	9.868646	9.868646
2018-02-15	19.685656	0.060606	9.812525	0.037599	1.434924	0.060606	4.428498	0.033969	1.236931	9.873131	9.873131	9.873131
2018-02-16	19.496804	0.370313	9.563245	0.309337	1.003124	0.370313	4.122056	0.256467	0.869359	9.933559	9.933559	9.933559
2018-02-20	19.406856	0.505312	9.450772	0.134159	0.787456	0.505312	4.103545	0.118583	0.678855	9.956084	9.956084	9.956084
2018-02-21	18.845207	1.104858	8.870175	0.598584	0.129682	1.104858	3.556696	0.585770	0.041173	9.975033	9.975033	9.975033
2018-02-22	19.173343	0.840055	9.166644	0.268311	0.389112	0.840055	4.032111	0.293149	0.330849	10.006699	10.006699	10.006699
2018-02-23	19.861397	0.145349	9.858024	0.694426	1.057477	0.145349	4.640952	0.687697	0.996689	10.003373	10.003373	10.003373
2018-02-26	20.012650	0.146027	10.079338	0.290358	1.274799	0.146027	4.683344	0.218195	1.152194	9.933311	9.933311	9.933311
2018-02-27	19.366272	0.529279	9.418496	0.385158	0.543119	0.529279	3.891601	0.662735	0.422095	9.947776	9.947776	9.947776
2018-02-28	18.843508	1.191122	8.826193	0.658143	0.141611	1.191122	3.488851	0.591938	0.193502	10.017315	10.017315	10.017315
2018-03-01	18.909067	1.186970	8.861049	0.007803	0.126766	1.186970	3.729129	0.036211	0.147793	10.048019	10.048019	10.048019
2018-03-02	18.715140	1.433172	8.640984	0.243114	0.363856	1.433172	3.491124	0.217886	0.358849	10.074156	10.074156	10.074156
2018-03-05	19.093256	1.130697	8.981279	0.307855	0.039975	1.130697	3.887987	0.344140	0.001372	10.111977	10.111977	10.111977
2018-03-06	19.415712	0.811805	9.301954	0.319091	0.280927	0.811805	4.109451	0.324021	0.325239	10.113759	10.113759	10.113759
2018-03-07	19.225991	0.869505	9.178243	0.062998	0.203960	0.869505	3.928019	0.120921	0.190466	10.047748	10.047748	10.047748
2018-03-08	19.355594	0.774845	9.290375	0.096172	0.291974	0.774845	4.039091	0.117989	0.300217	10.065219	10.065219	10.065219
2018-03-09	19.527364	0.746153	9.390606	0.034199	0.316486	0.746153	4.055667	0.108399	0.395985	10.136758	10.136758	10.136758
2018-03-12	19.692344	0.644638	9.523853	0.103850	0.409117	0.644638	4.162221	0.141541	0.521826	10.168491	10.168491	10.168491
2018-03-13	19.459197	0.930288	9.264454	0.283986	0.110996	0.930288	3.851733	0.250207	0.251803	10.194743	10.194743	10.194743
2018-03-14	18.917580	1.546108	8.685736	0.612435	0.505014	1.546108	3.342448	0.568160	0.326036	10.231844	10.231844	10.231844
2018-03-15	19.062011	1.402276	8.829868	0.143878	0.343735	1.402276	3.694029	0.154185	0.160573	10.232143	10.232143	10.232143
2018-03-16	19.444067	0.883899	9.280084	0.509036	0.178971	0.883899	4.144868	0.458373	0.304560	10.163983	10.163983	10.163983

In [17]:
```
prediction_error.to_csv(dir_ + run_id + '_Prediction_Errors.csv')
```

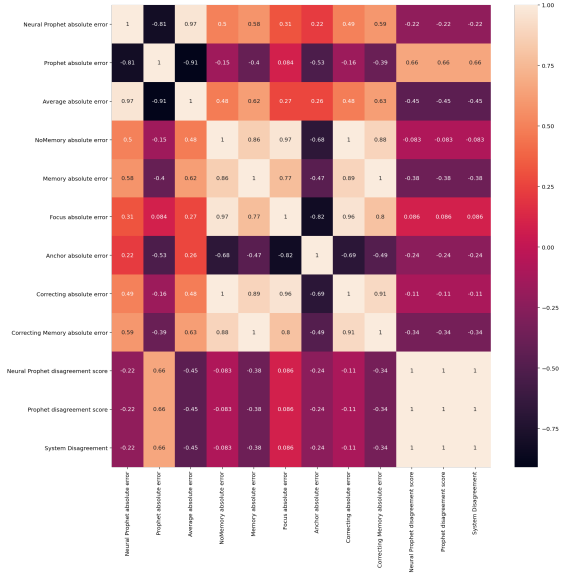
Correlation matrix of individual predictor and consensus forecast absolute errors

In [18]:
```
correlation_ = correlation(prediction_error, True)
correlation_
```

Out[18]:

	Neural Prophet absolute error	Prophet absolute error	Average absolute error	NoMemory absolute error	Memory absolute error	Focus absolute error	Anchor absolute error	Correcting absolute error	Correcting Memory absolute error	Neural Prophet disagreement score	Prophet disagreement score	System Disagreement
Neural Prophet absolute error	1.000000	-0.814216	0.970123	0.497623	0.577726	0.314438	0.222734	0.494279	0.591862	-0.219804	-0.219804	-0.219804
Prophet absolute error	-0.814216	1.000000	-0.909244	-0.152371	-0.403057	0.084467	-0.528787	-0.164270	-0.389496	0.658893	0.658893	0.658893

	Neural Prophet absolute error	Prophet absolute error	Average absolute error	NoMemory absolute error	Memory absolute error	Focus absolute error	Anchor absolute error	Correcting absolute error	Correcting Memory absolute error	Neural Prophet disagreement score	Prophet disagreement score	System Disagreement
Average absolute error	0.970123	-0.909244	1.000000	0.476135	0.622907	0.266561	0.263744	0.478951	0.626502	-0.449915	-0.449915	-0.449915
NoMemory absolute error	0.497623	-0.152371	0.476135	1.000000	0.856148	0.965158	-0.679512	0.995049	0.881213	-0.082758	-0.082758	-0.082758
Memory absolute error	0.577726	-0.403057	0.622907	0.856148	1.000000	0.769035	-0.466702	0.886803	0.997731	-0.378061	-0.378061	-0.378061
Focus absolute error	0.314438	0.084467	0.266561	0.965158	0.769035	1.000000	-0.821760	0.960661	0.798618	0.085622	0.085622	0.085622
Anchor absolute error	0.222734	-0.528787	0.263744	-0.679512	-0.466702	-0.821760	1.000000	-0.689764	-0.487843	-0.240616	-0.240616	-0.240616
Correcting absolute error	0.494279	-0.164270	0.478951	0.995049	0.886803	0.960661	-0.689764	1.000000	0.908977	-0.106388	-0.106388	-0.106388
Correcting Memory absolute error	0.591862	-0.389496	0.626502	0.881213	0.997731	0.798618	-0.487843	0.908977	1.000000	-0.340485	-0.340485	-0.340485
Neural Prophet disagreement score	-0.219804	0.658893	-0.449915	-0.082758	-0.378061	0.085622	-0.240616	-0.106388	-0.340485	1.000000	1.000000	1.000000
Prophet disagreement score	-0.219804	0.658893	-0.449915	-0.082758	-0.378061	0.085622	-0.240616	-0.106388	-0.340485	1.000000	1.000000	1.000000
System Disagreement	-0.219804	0.658893	-0.449915	-0.082758	-0.378061	0.085622	-0.240616	-0.106388	-0.340485	1.000000	1.000000	1.000000



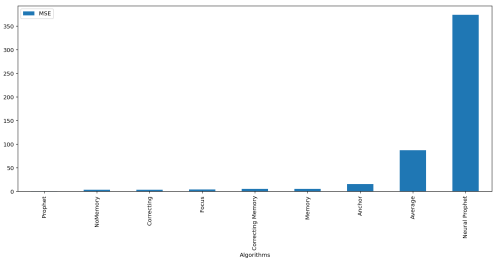
In [19]:
```
correlation_.to_csv(dir_ + run_id + '_Error_Correlation.csv')
```

MSE, MSE log and MAE scores

In [20]:
```
mse = mse_score(all_forecasts, True)
mse
```

Out[20]:

	Algorithms	MSE
0	Average	87.030775
1	NoMemory	3.755297
2	Memory	5.486031
3	Focus	4.329744
4	Anchor	15.725047
5	Correcting	3.795496
6	Correcting Memory	5.110556
7	Neural Prophet	374.130404
8	Prophet	0.725076



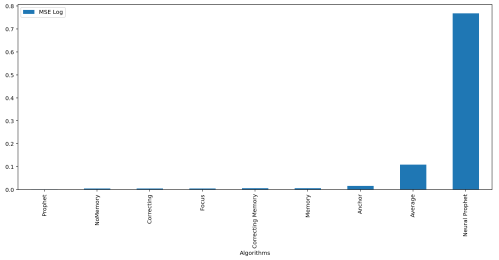
In [21]:
```
mse.to_csv(dir_ + run_id + '_MSE_score.csv')
```

In [22]:
```
mse_log = mse_log_score(all_forecasts, True)
mse_log
```

Out[22]:

	Algorithms	MSE Log
0	Average	0.109301
1	NoMemory	0.004566
2	Memory	0.006321
3	Focus	0.005079

	Algorithms	MSE Log
4	Anchor	0.016258
5	Correcting	0.004602
6	Correcting Memory	0.005927
7	Neural Prophet	0.768572
8	Prophet	0.000650

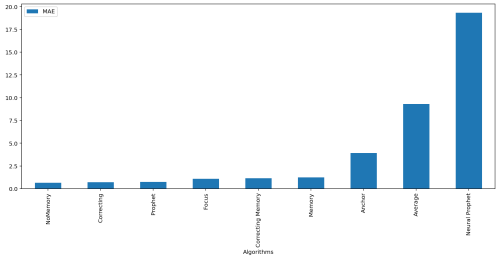


In [23]:
```
mse_log.to_csv(dir_ + run_id + '_MSE_log_score.csv')
```

In [24]:
```
mae = mae_score(all_forecasts, True)
mae
```

Out[24]:

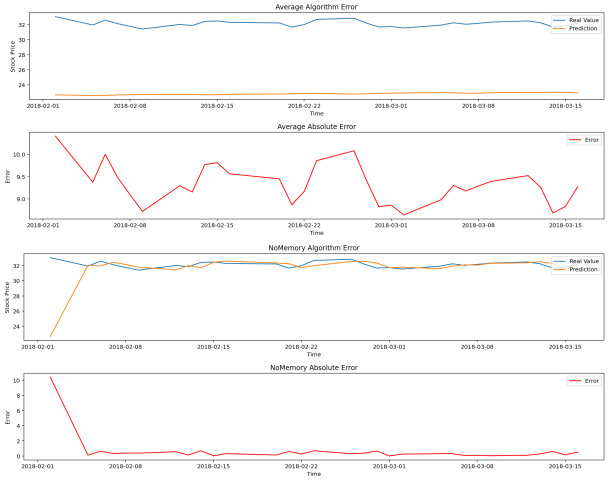
	Algorithms	MAE
0	Average	9.319226
1	NoMemory	0.657705
2	Memory	1.235027
3	Focus	1.079006
4	Anchor	3.934053
5	Correcting	0.699927
6	Correcting Memory	1.143403
7	Neural Prophet	19.338490
8	Prophet	0.746286

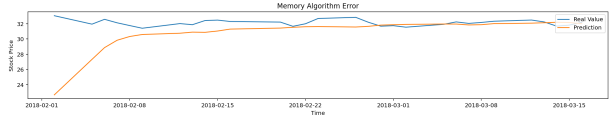


In [25]:
```
mae.to_csv(dir_ + run_id + '_MAE_score.csv')
```

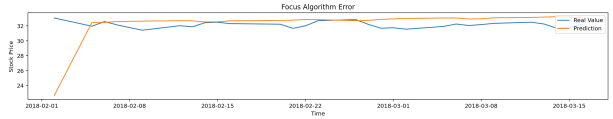
Performance plotting of all forecasting algorithms

In [26]:
```
plot_performance(all_forecasts)
```

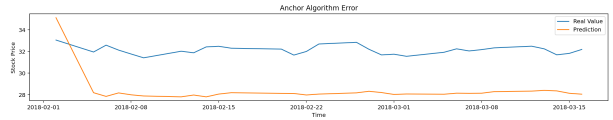


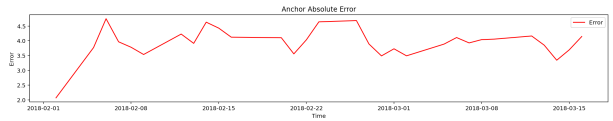

Memory Algorithm Error
Real Value
Prediction
Stock Price
Time

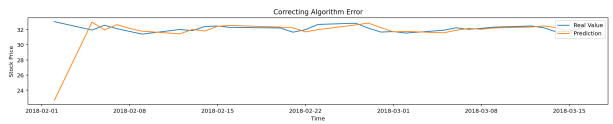

Memory Absolute Error
Error
Time

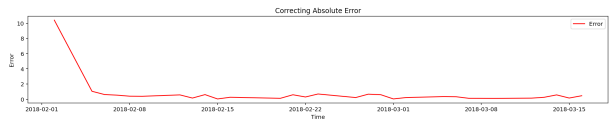

Focus Algorithm Error
Real Value
Prediction
Stock Price
Time

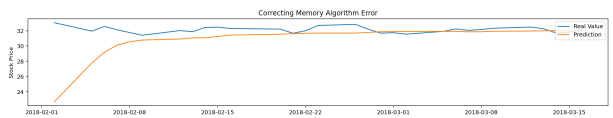

Focus Absolute Error
Error
Time

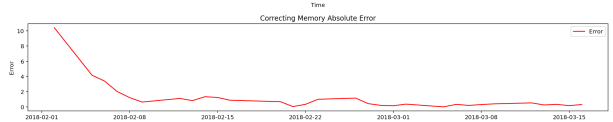

Anchor Algorithm Error
Real Value
Prediction
Stock Price
Time

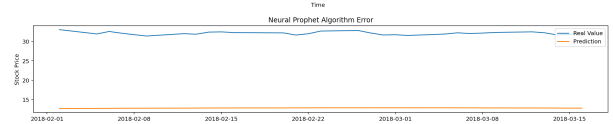

Anchor Absolute Error
Error
Time

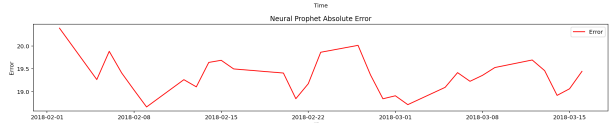

Correcting Algorithm Error
Real Value
Prediction
Stock Price
Time

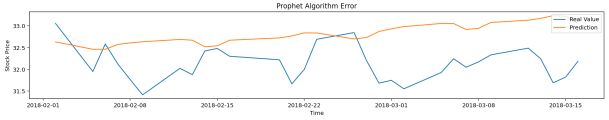

Correcting Absolute Error
Error
Time


Correcting Memory Algorithm Error
Real Value
Prediction
Stock Price
Time


Correcting Memory Absolute Error
Error
Time


Neural Prophet Algorithm Error
Real Value
Prediction
Stock Price
Time


Neural Prophet Absolute Error
Error
Time


Prophet Algorithm Error
Real Value
Prediction
Stock Price
Time


Prophet Absolute Error
Error
Time