DEEP LEARNING FINAL PROJECT

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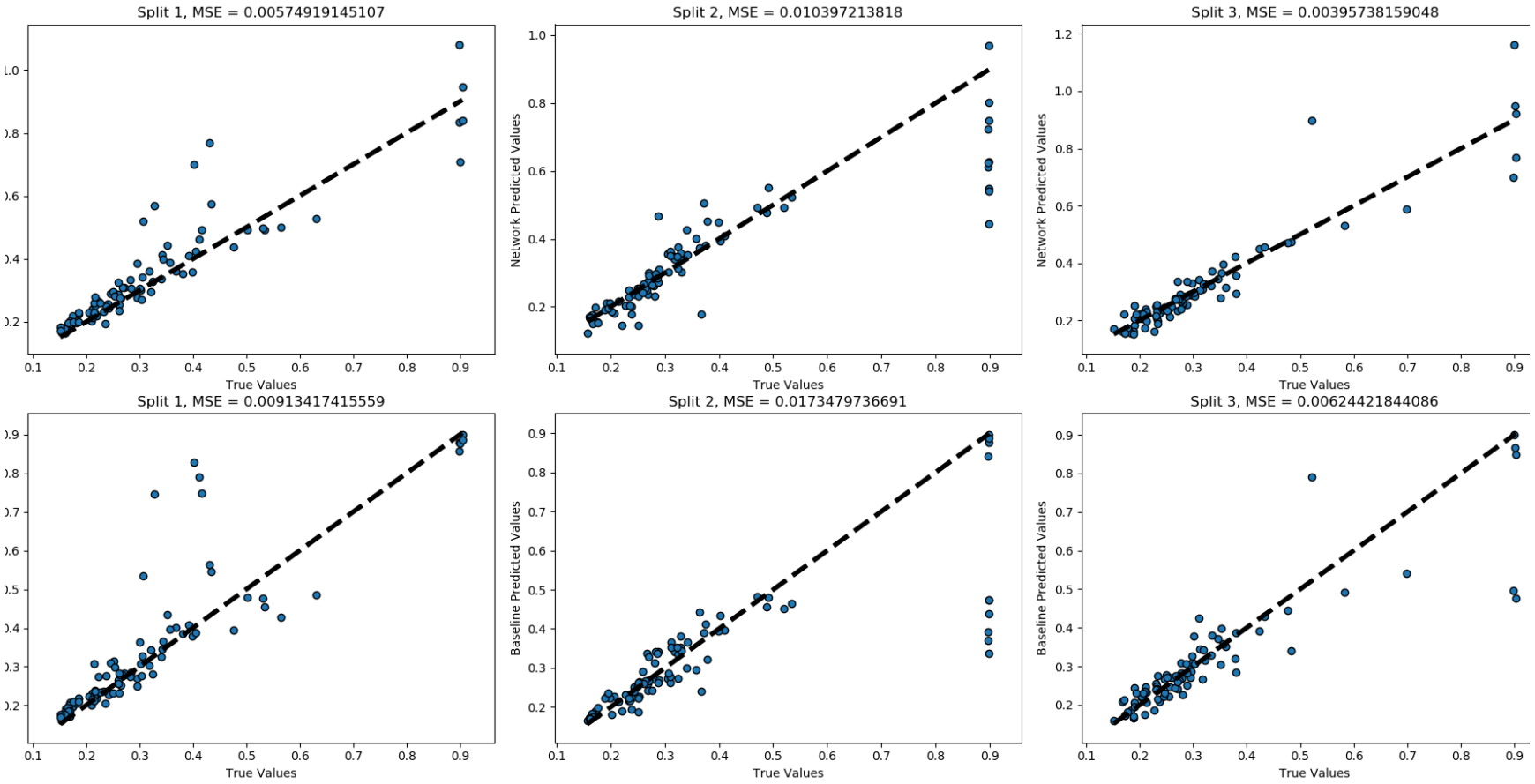
Task 1: Prediction of the final error using MLP

Two hidden layers with 64 units each, and ReLU activation functions

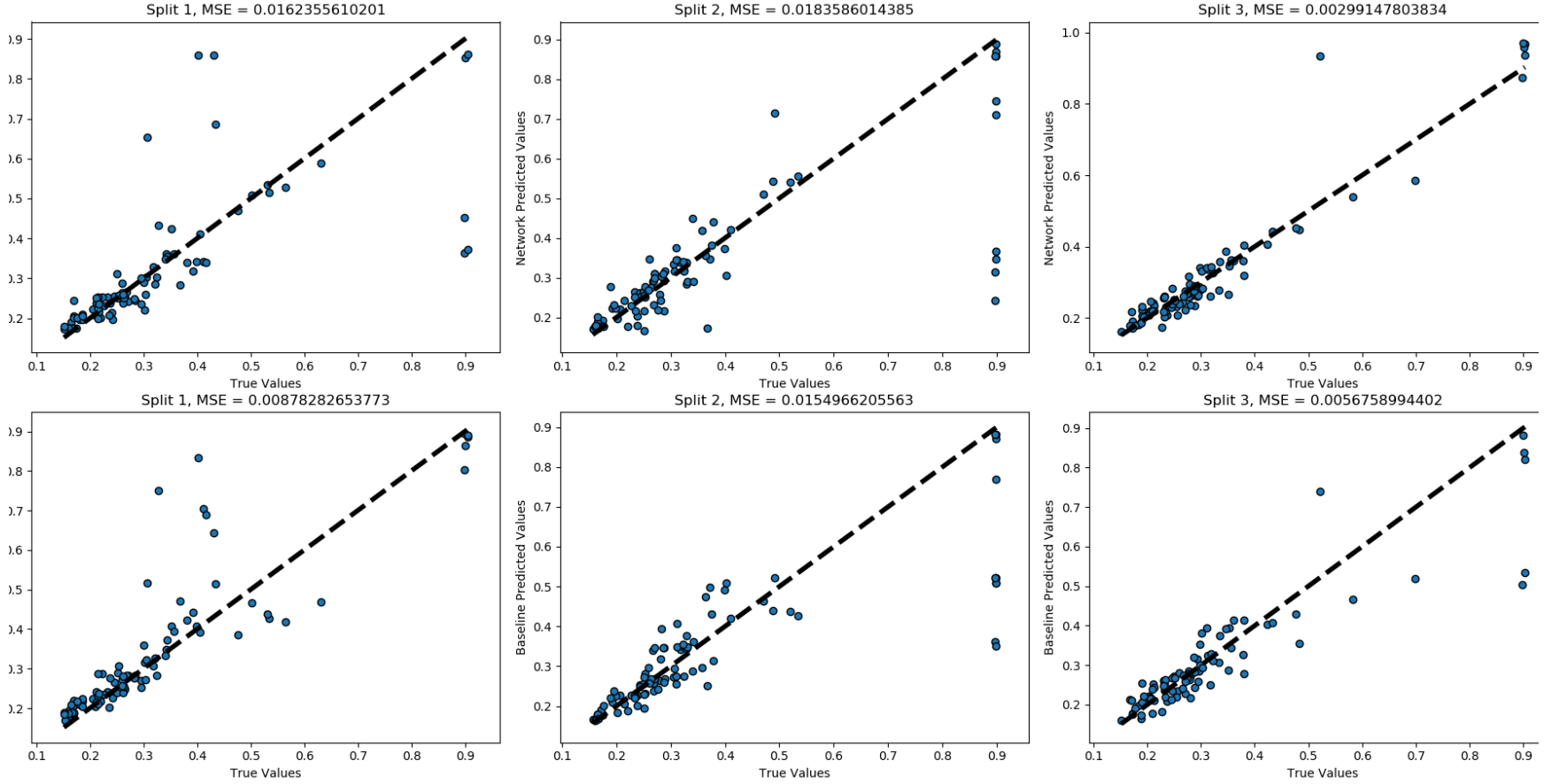
Parameter	Min Value	Max Value	Log
Batch size	32	512	No
Learning rate	10^{-6}	10^{0}	Yes
# units in layer 1	16	1024	Yes
# units in layer 2	16	1024	Yes
# units in layer 3	16	1024	Yes

MLP and Random Forest results for raw data

	Network					Baseline			
Experiment	LR	Alpha	Batch size	Noise	Mean MSE of 3 splits	Max depth	# Estimators	Min leaf	Mean MSE of 3 splits
w/out reg.	0.001	0	265	0	**0.0067**	32	32	2	0.0109
L1	1e-5	0.0001	64	0	0.007	32	16	4	0.0101
L2	1e-5	0.0001	64	0	0.009	32	16	4	0.0101
Noise	1e-4	1e-5	8	0.02	**0.012**	16	32	4	0.0099
Decay	1e-4 – 1e-6	0	128	0	0.0083	16	8	4	0.0101
L1-Noise	1e-4	0.001	128	0.02	0.0076	8	16	4	0.0101
L2-Noise	1e-5	1e-5	128	0.02	0.0084	8	16	4	0.0101
L1-Decay	0.01 – 1e-6	1e-4	265	0	0.0087	8	16	4	0.0101
L2-Decay	0.001 – 1e-6	1e-5	265	0	0.0090	8	16	4	0.0101
Noise-Decay	0.001 – 1e-6	0	128	0.02	0.0082	16	8	4	0.0101
L1-Noise-Decay	0.001 – 1e-6	1e-5	265	0.02	0.0071	8	16	4	0.0101
L2-Noise-Decay	0.01 – 1e-6	1e-4	265	0.02	0.0079	8	16	4	0.0101

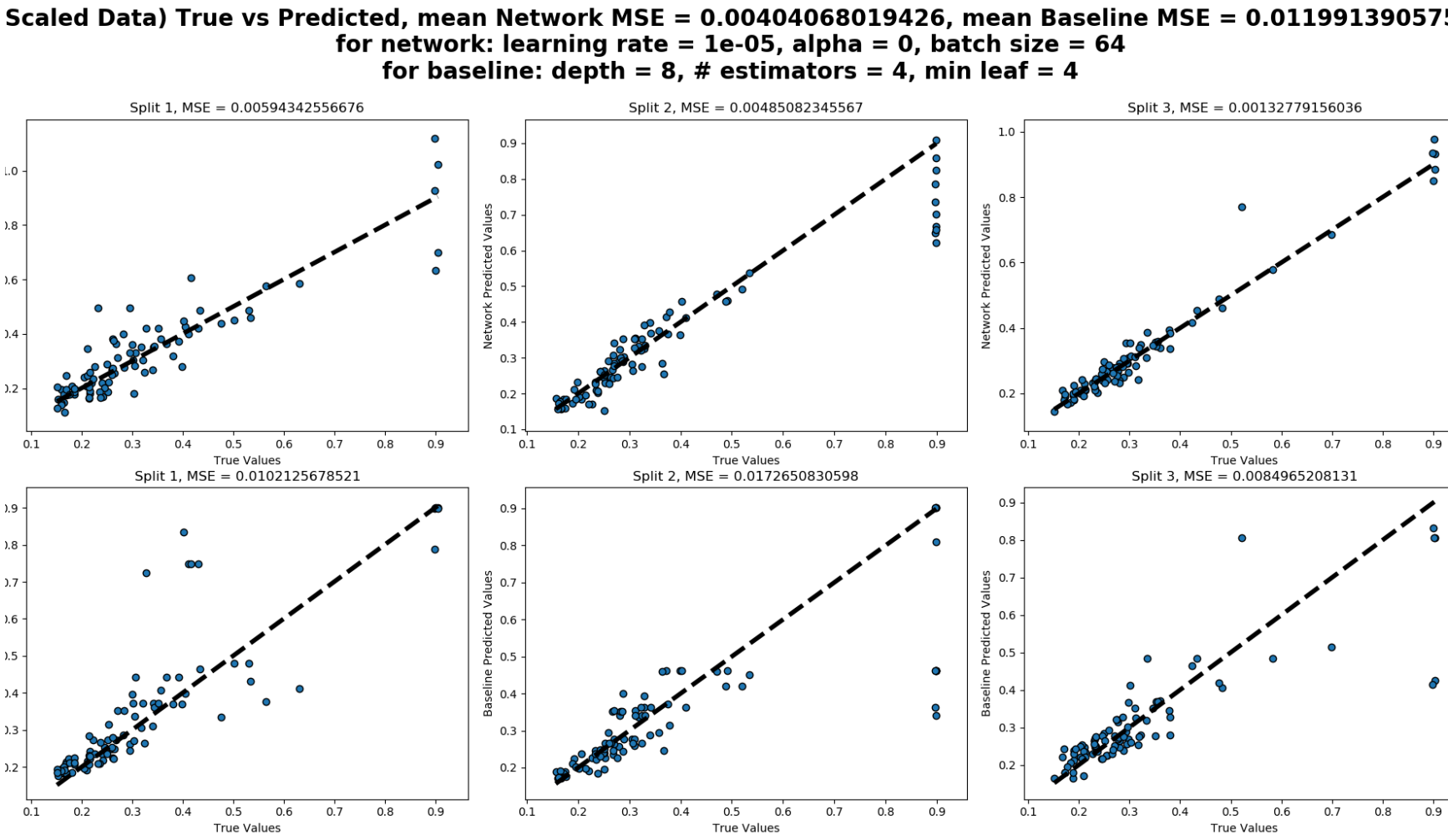

(Raw Data) True vs Predicted, mean Network MSE = 0.00670126228651, mean Baseline MSE = 0.0109087887552
for network: learning rate = 0.001, alpha = 0, batch size = 265
for baseline: depth = 32, # estimators = 32, min leaf = 2
Split 1, MSE = 0.00574919145107
Split 2, MSE = 0.010397213818
Split 3, MSE = 0.00395738159048
Network Predicted Values
True Values
Split 1, MSE = 0.00913417415559
Split 2, MSE = 0.0173479736691
Split 3, MSE = 0.00624421844086
Baseline Predicted Values
True Values

(Raw Data) True vs Predicted, mean Network MSE = 0.0125285468323, mean Baseline MSE = 0.00998511551141
for network: learning rate = 0.0001, alpha = 1e-05, batch size = 8
for baseline: depth = 16, # estimators = 32, min leaf = 4

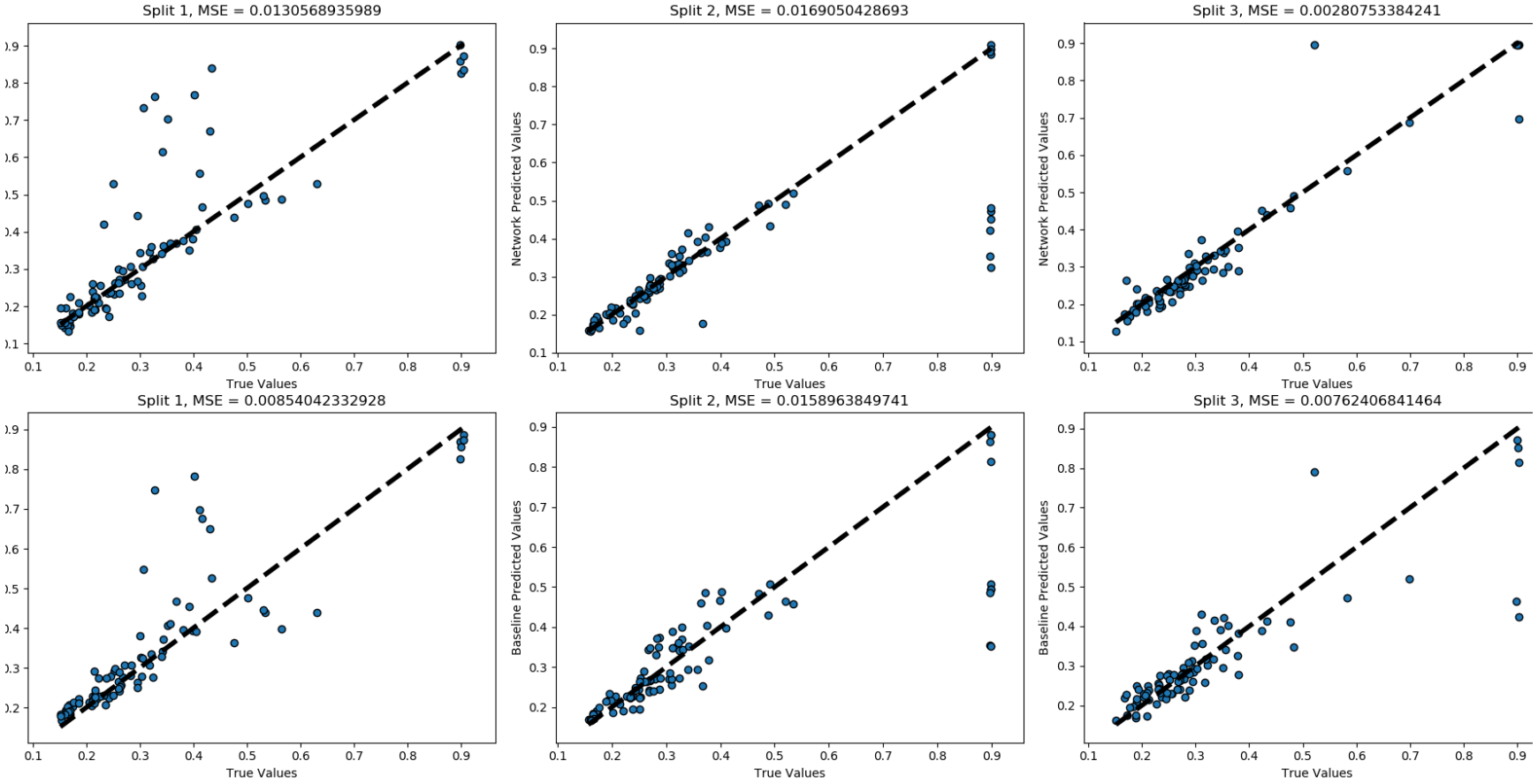


MLP and Random Forest results for scaled data

	Network					Baseline			
	LR	Alpha	Batch size	Noise	Mean MSE of 3 splits	Max depth	# Estimators	Min leaf	Mean MSE of 3 splits
w/out reg.	1e-5	0	64	0	**0.0040**	8	4	4	0.0119
L1	1e-5	0.0001	64	0	**0.0109**	16	32	4	0.0106
L2	1e-5	0.0001	0.0080	0	0.009	16	32	4	0.0106
Noise	1e-4	1e-5	8	0.02	0.0084	16	32	4	0.0099
Decay	1e-4 – 1e-6	0	128	0	0.0051	16	4	4	0.0123
L1-Noise	1e-5	1e-5	32	0.02	0.0080	32	32	4	0.0106
L2-Noise	1e-6	1e-4	64	0.02	0.0078	32	32	4	0.0106
L1-Decay	0.01 – 1e-6	1e-5	8	0	0.0102	8	16	4	0.0105
L2-Decay	0.001 – 1e-6	1e-5	265	0	0.0087	8	16	4	0.0105
Noise-Decay	1e-4 – 1e-6	0	128	0.02	0.0072	16	4	4	0.0123
L1-Noise-Decay	0.001 – 1e-6	1e-5	265	0.02	0.0059	8	16	4	0.0105
L2-Noise-Decay	0.001 – 1e-6	1e-5	265	0.02	0.0055	8	16	4	0.0105


Scaled Data) True vs Predicted, mean Network MSE = 0.00404068019426, mean Baseline MSE = 0.011991390575
for network: learning rate = 1e-05, alpha = 0, batch size = 64
for baseline: depth = 8, # estimators = 4, min leaf = 4
Split 1, MSE = 0.00594342556676
Split 2, MSE = 0.00485082345567
Split 3, MSE = 0.00132779156036
Split 1, MSE = 0.0102125678521
Split 2, MSE = 0.0172650830598
Split 3, MSE = 0.0084965208131
True Values
Network Predicted Values
Baseline Predicted Values

(Scaled Data) True vs Predicted, mean Network MSE = 0.0109231567702, mean Baseline MSE = 0.010686958906
for network: learning rate = 1e-05, alpha = 0.0001, batch size = 64
for baseline: depth = 16, # estimators = 32, min leaf = 4



Task 2: Extrapolation of learning curves

Architecture

- 2 LSTM layers, 64 units each
- 2 Dense layers, 64 units each, ReLu activation

Regularizations:

- Gaussian Noise of 0.02 between layers, except before the output layer
- L2 regularization of kernels

Optimizations:

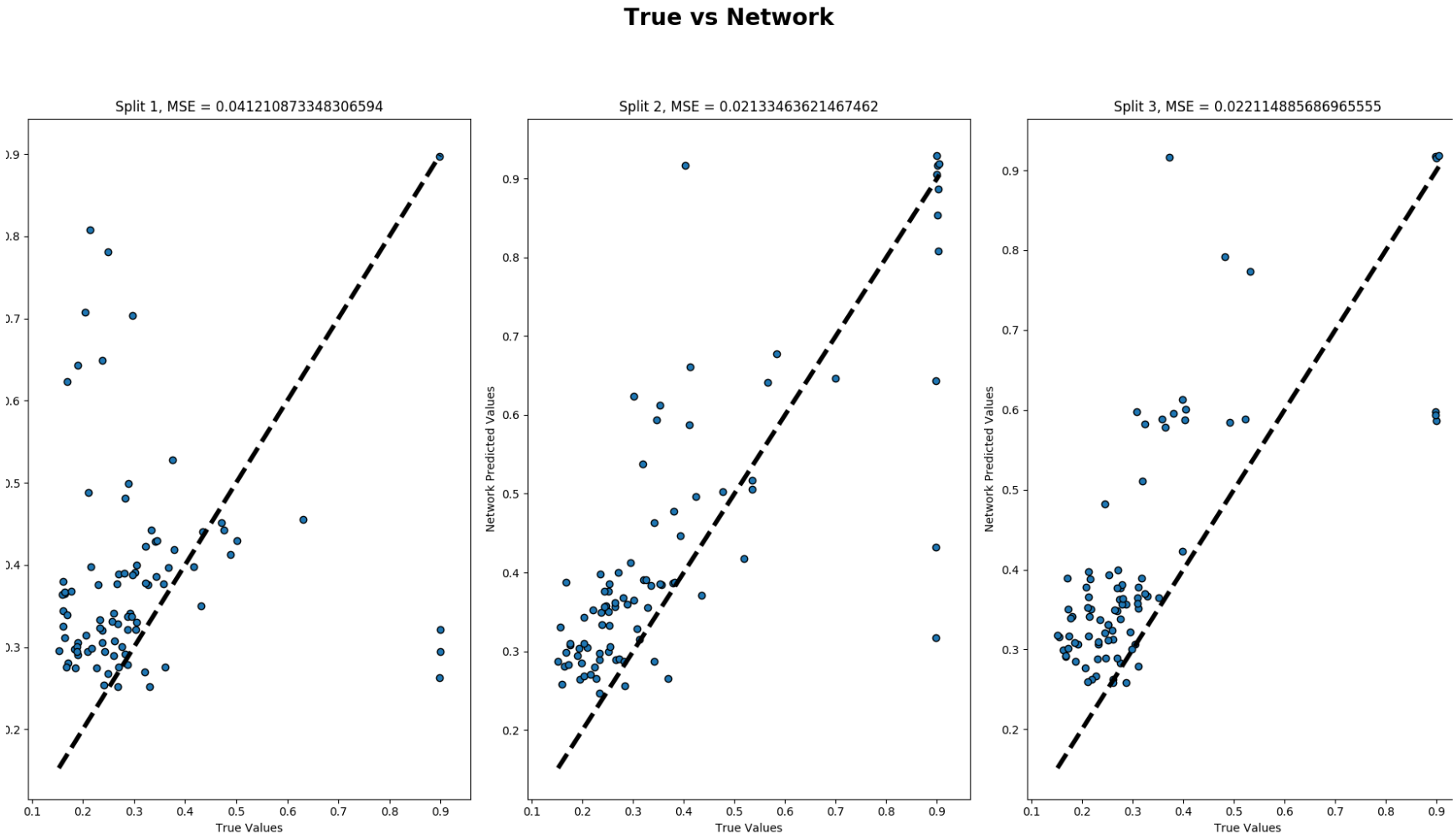
- Adam
- Kernel initialization: random uniform [0.01, 0.05]
- Bias initialization: constant 0.1

Results of task 2: RNN's and baselines

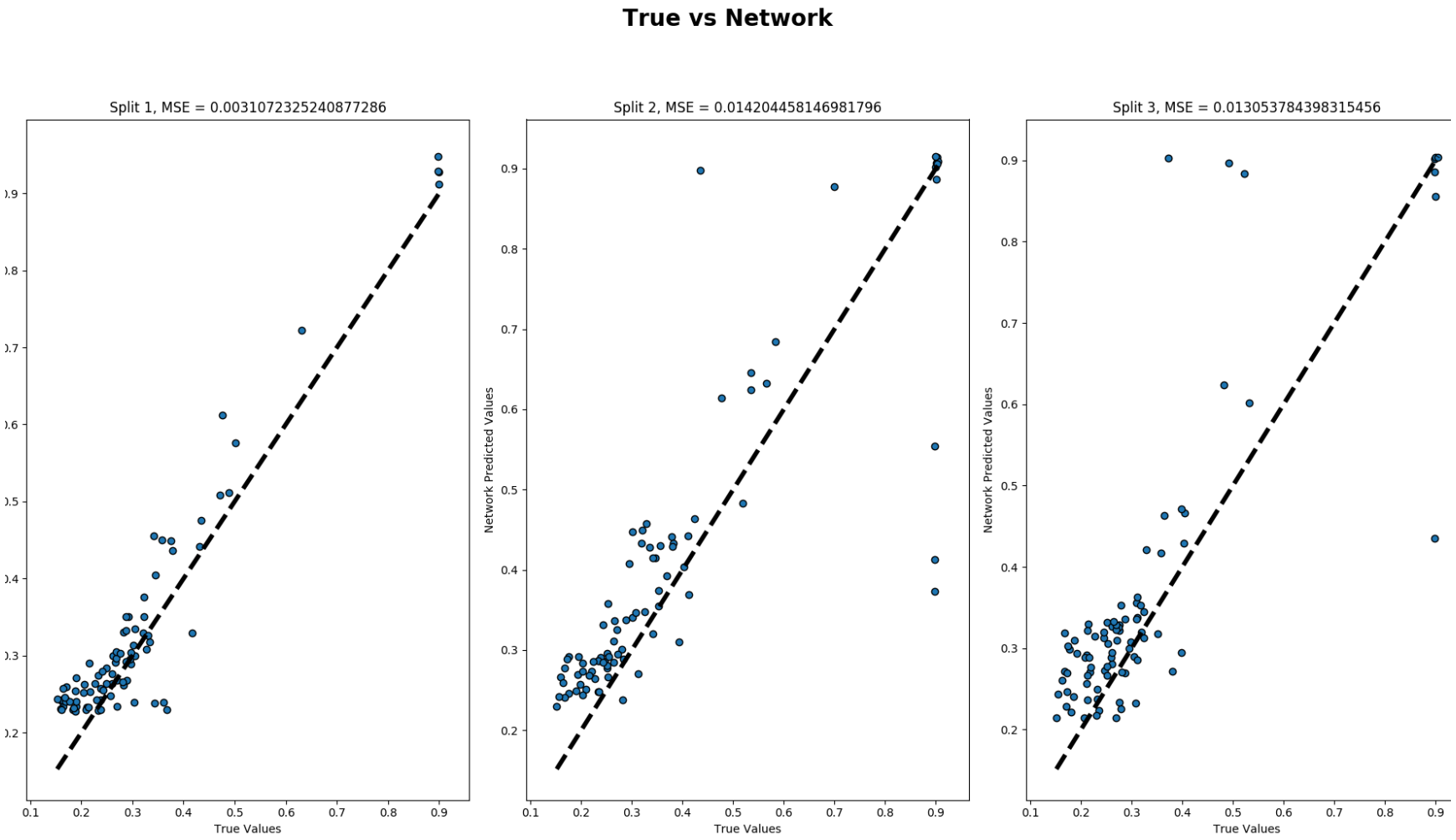
	LR	Alpha	Pred 5 MSE	Pred 10 MSE	Pred 20 MSE	Pred 30 MSE
Train 5	0.001 – 1e-6	1e-7	0.0282	0.0267	0.0257	0.0272
Train 10	1e-4 – 1e-6	1e-5	0.0228	0.01011	0.0272	0.0264
Train 20	0.001 – 1e-6	1e-6	0.0279	0.0260	0.0068	0.0283
Random	1e-4 – 1e-7	1e-5	0.0089	0.0066	0.0056	0.0046

	Max depth	# Estimators	Min leaf	MSE
Train 5	32	16	1	0.0015
Train 10	32	32	4	0.0010
Train 20	32	16	1	0.0004
Last 4 point prediction	32	16	8	0.0003

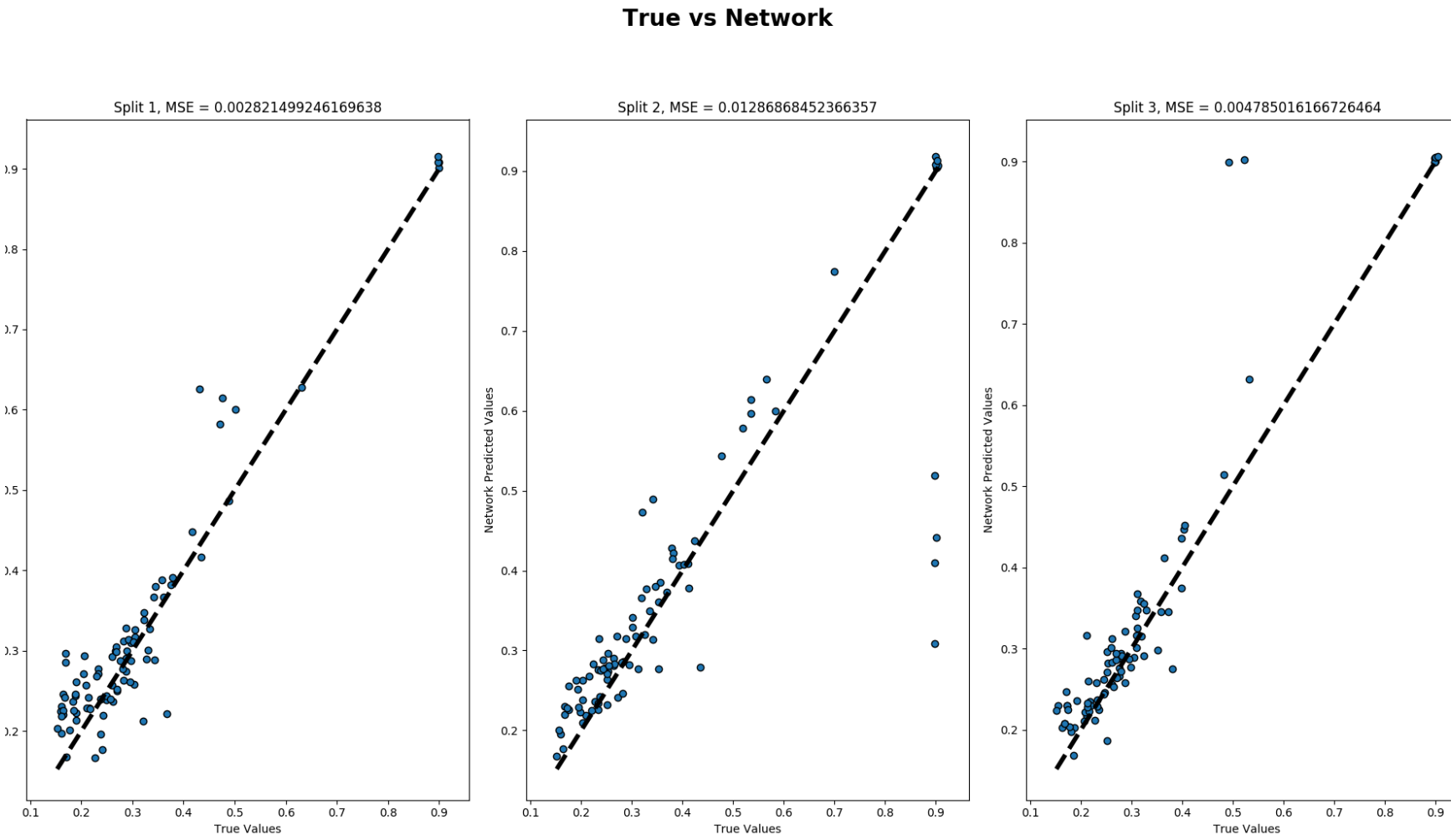
RNN trained with fixed input length: 5



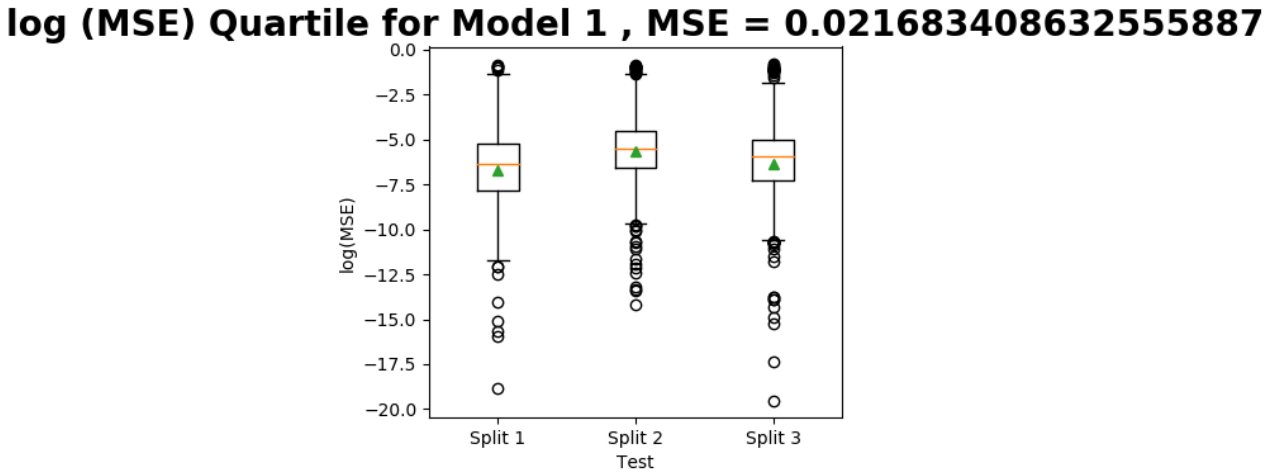
RNN trained with fixed input length: 10

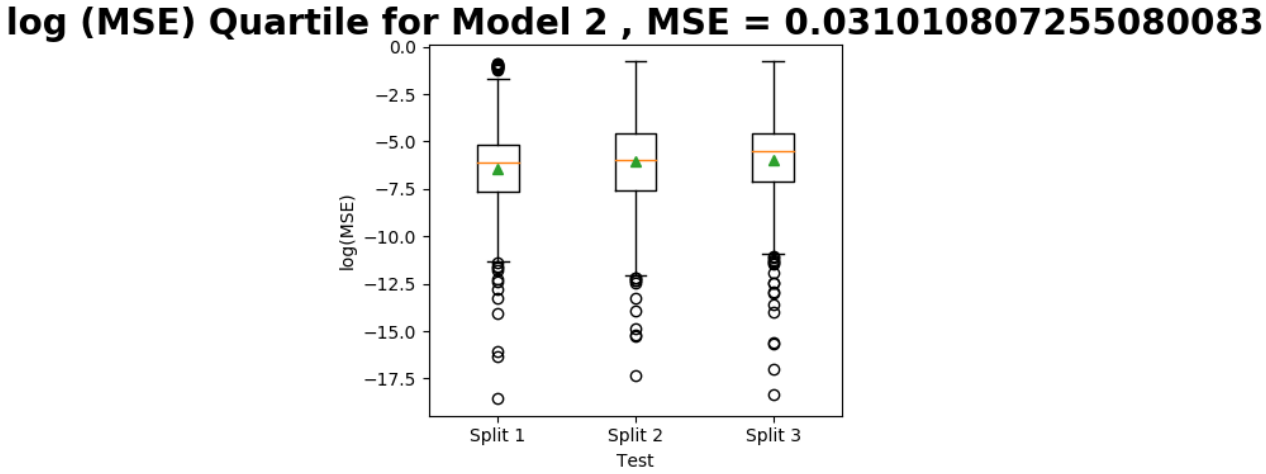


RNN trained with fixed input length: 20

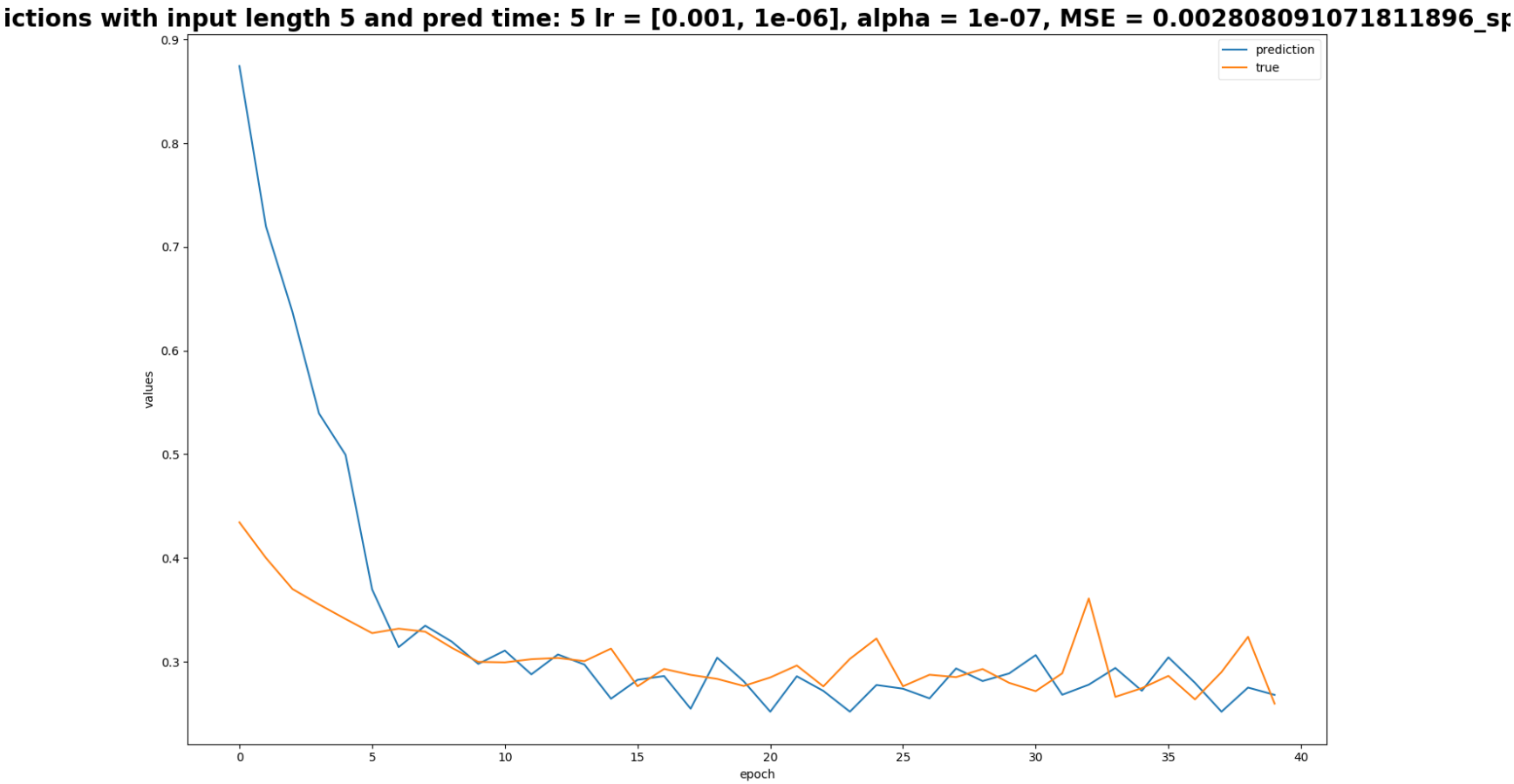


Boxplot for Train on 10 with two models

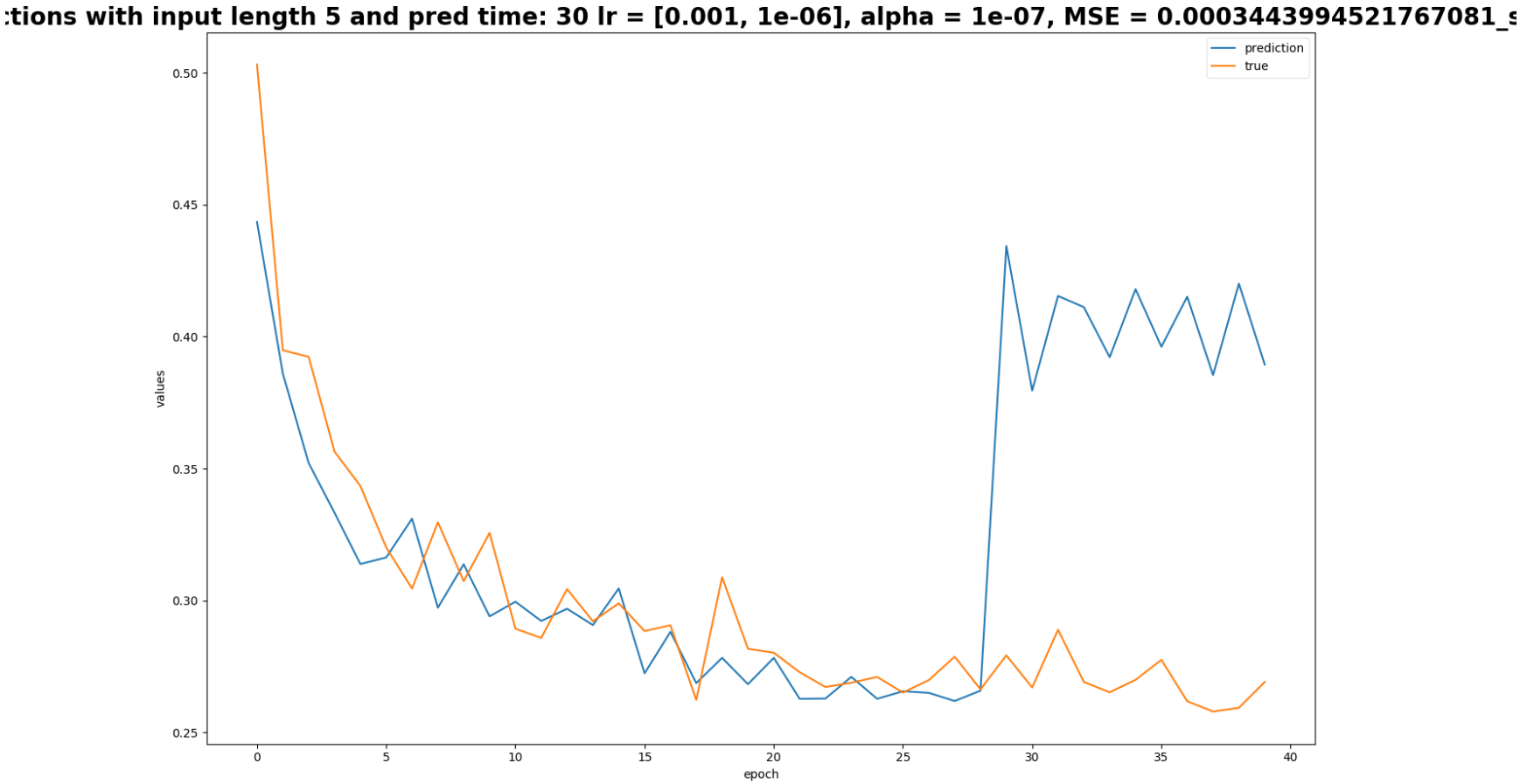




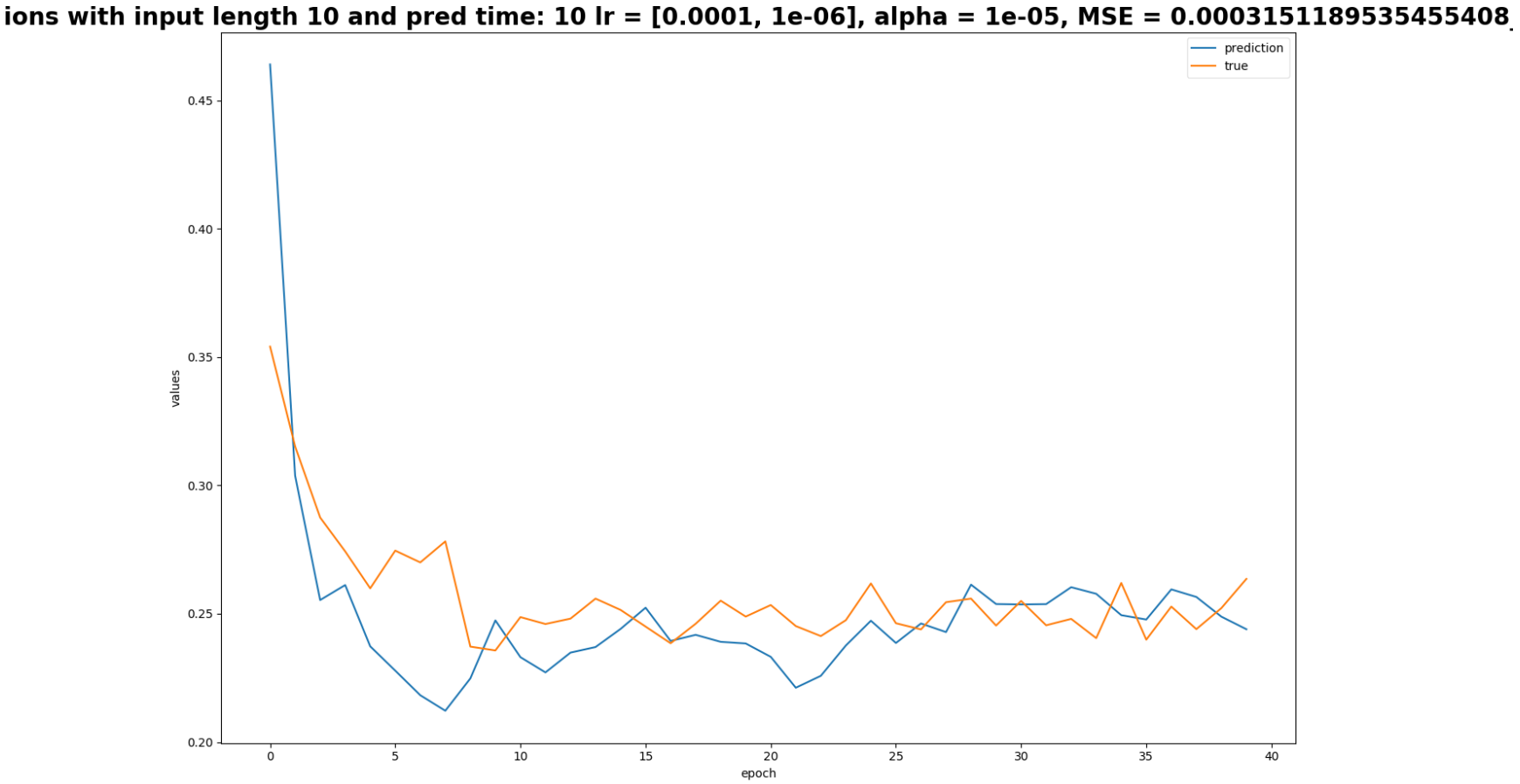
Train on 5, predictions of split 1



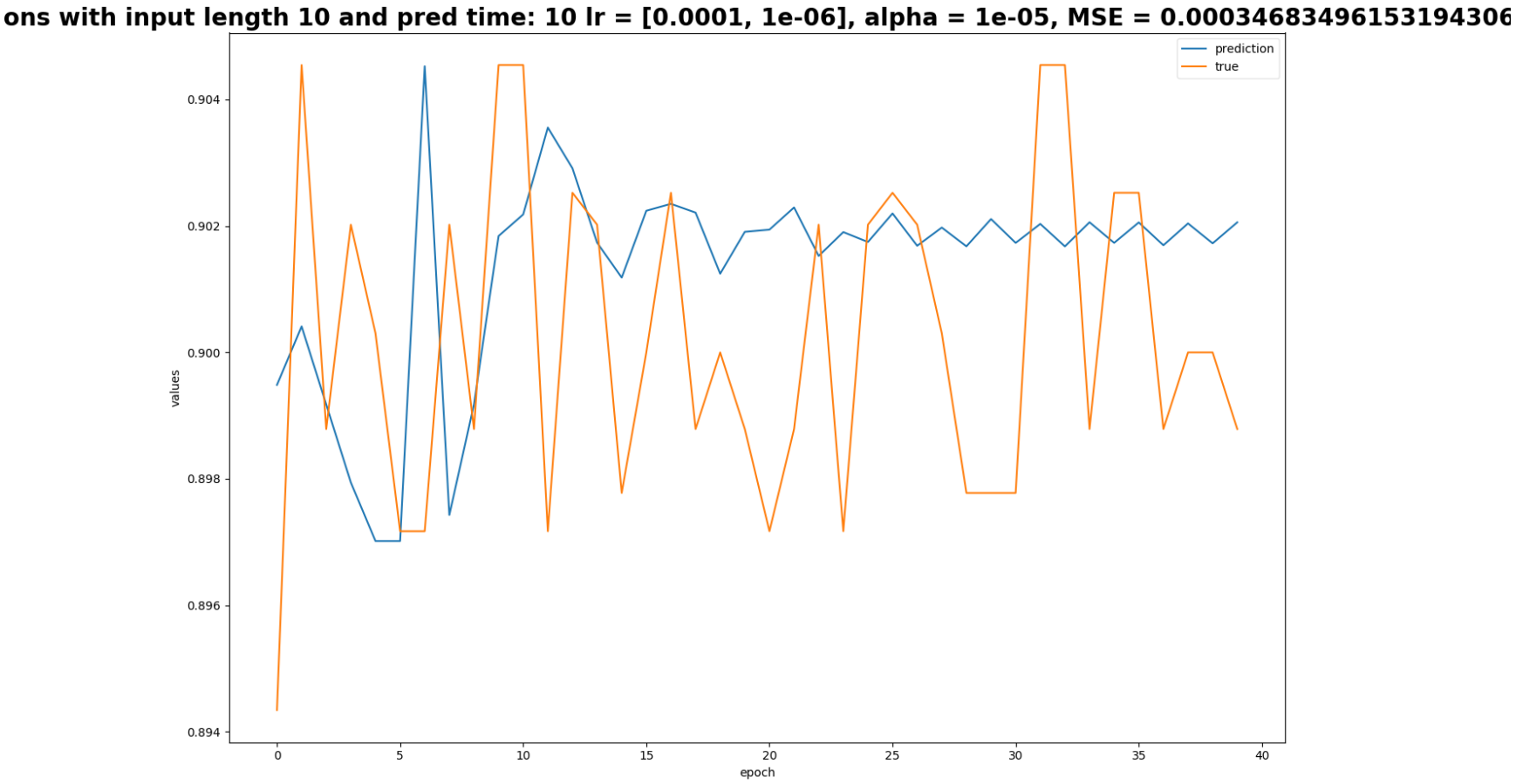
Train on 5, predictions of split 3



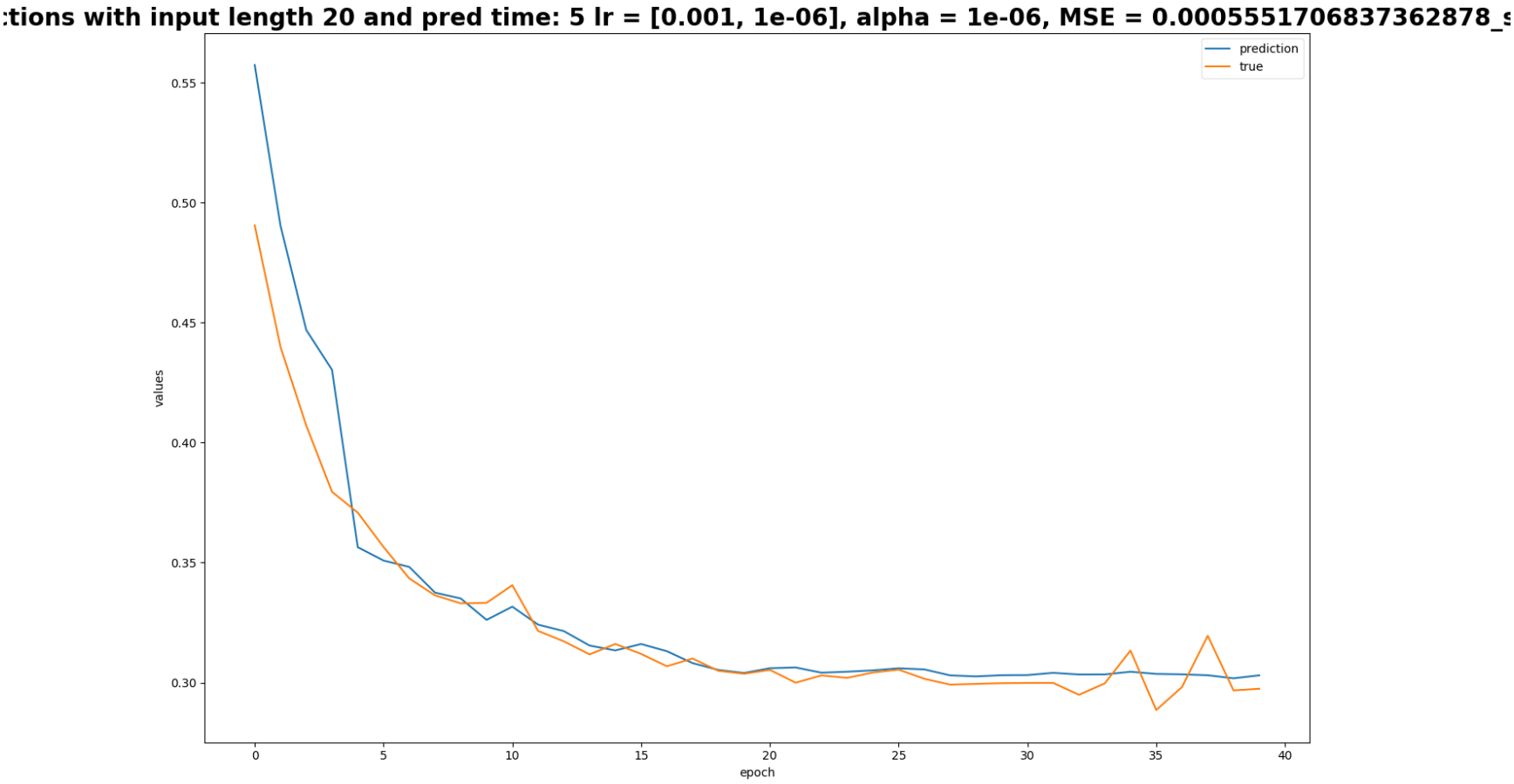
Train on 10, predictions of split 2



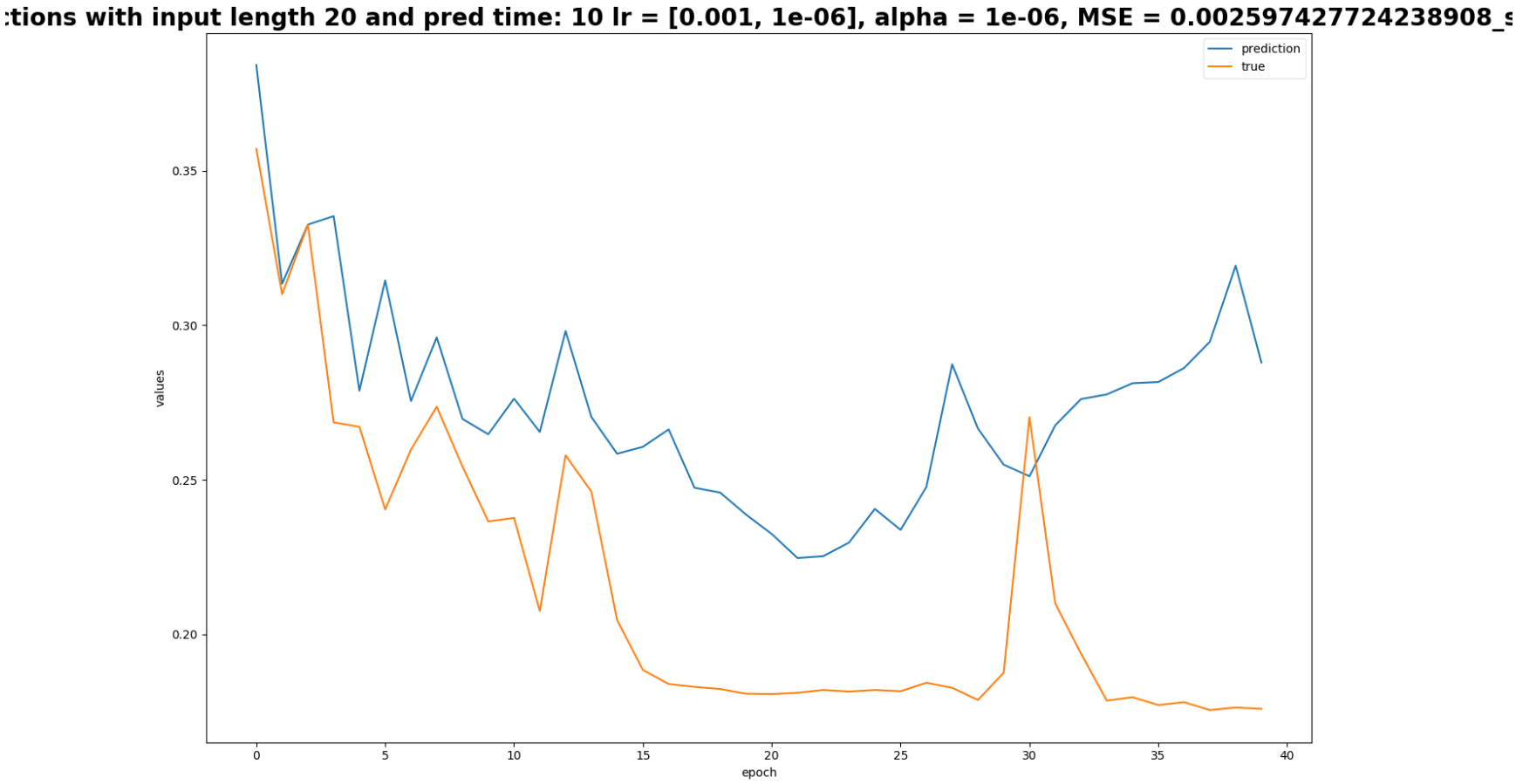
Train on 10, predictions of split 3



Train on 20, predictions of split 1

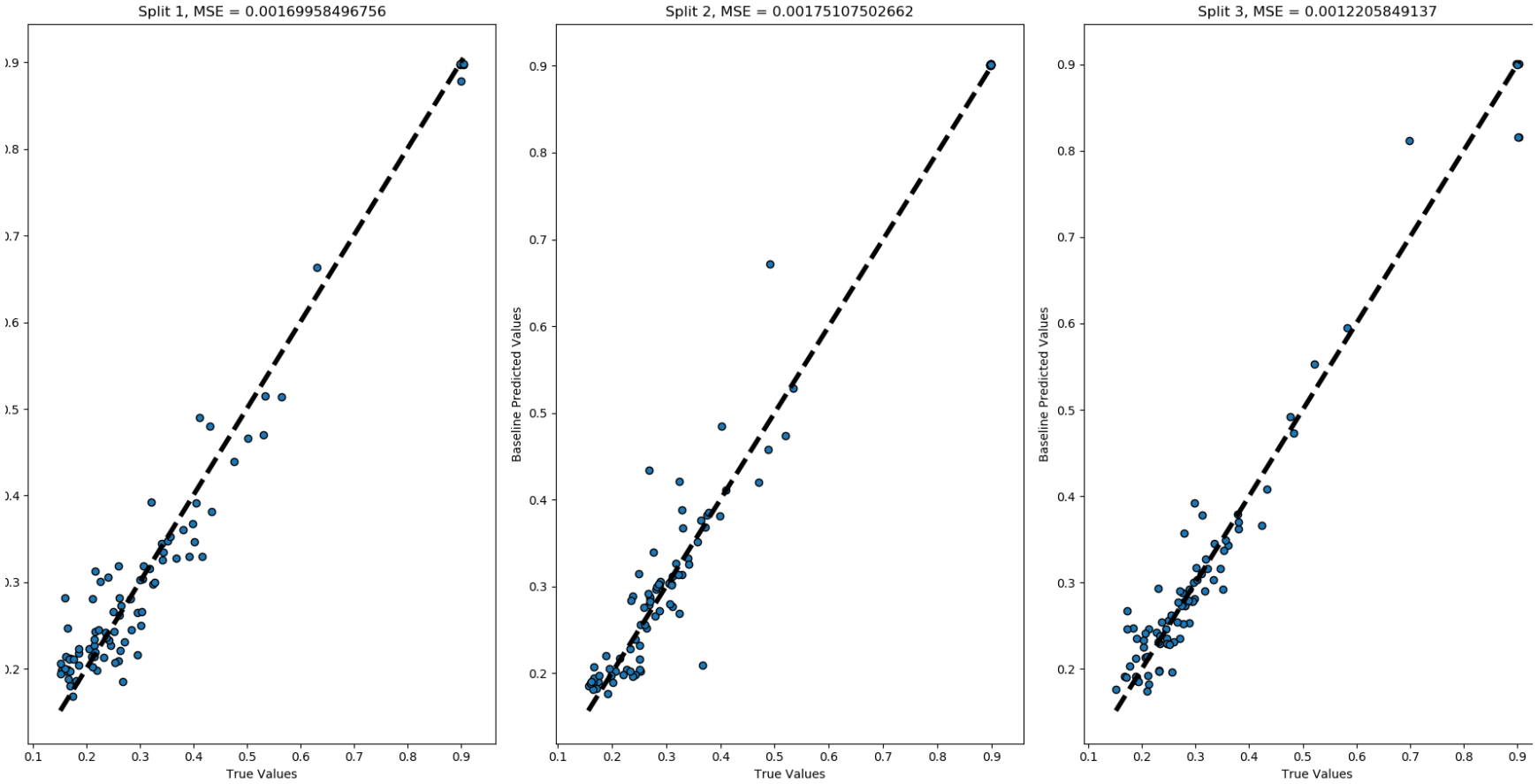


Train on 20, predictions of split 2



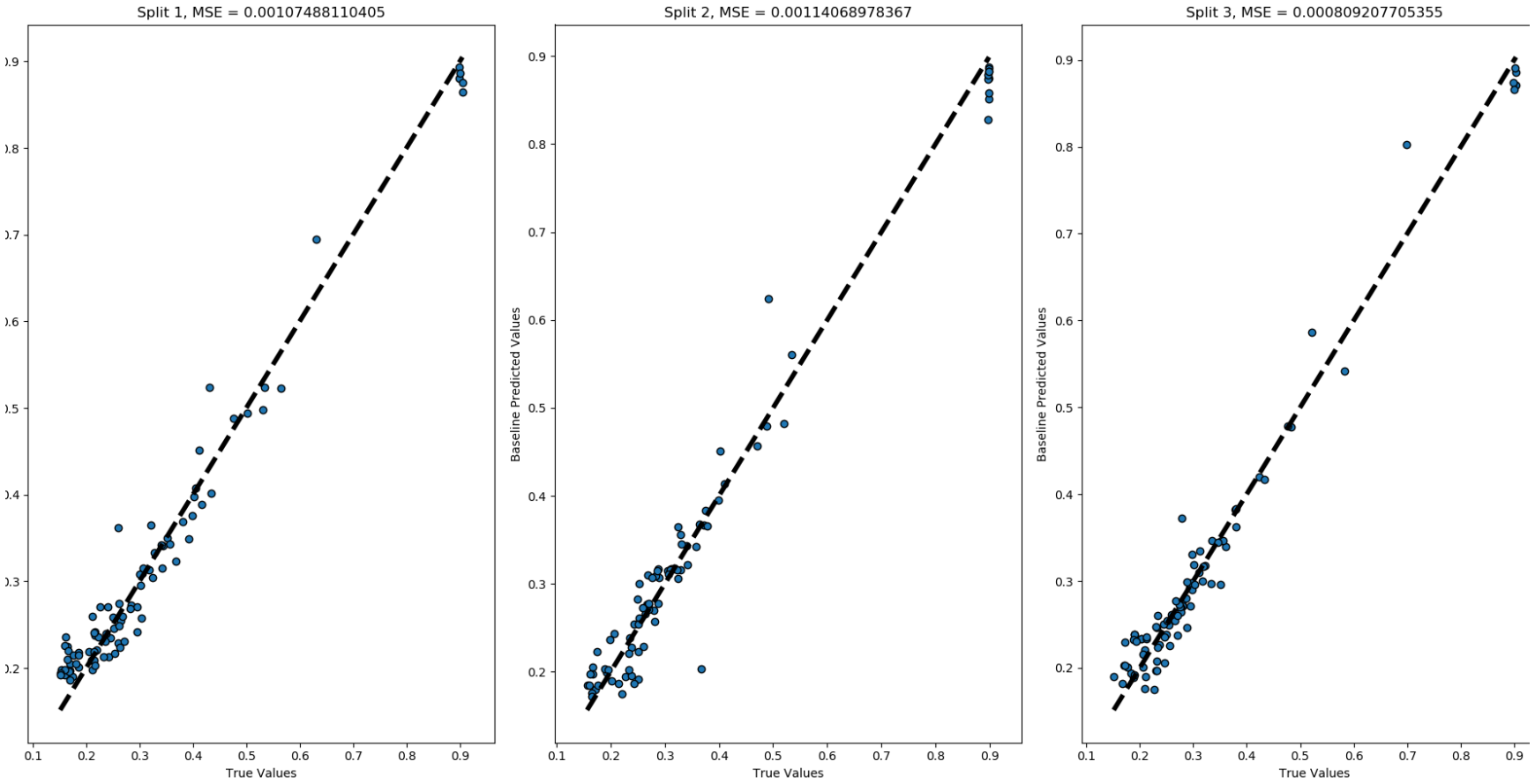
Baseline with fixed number of observations: 5

True vs Baseline with depth = 32, # estimators = 16, min leaf = 1, Mean MSE = 0.00155708163596



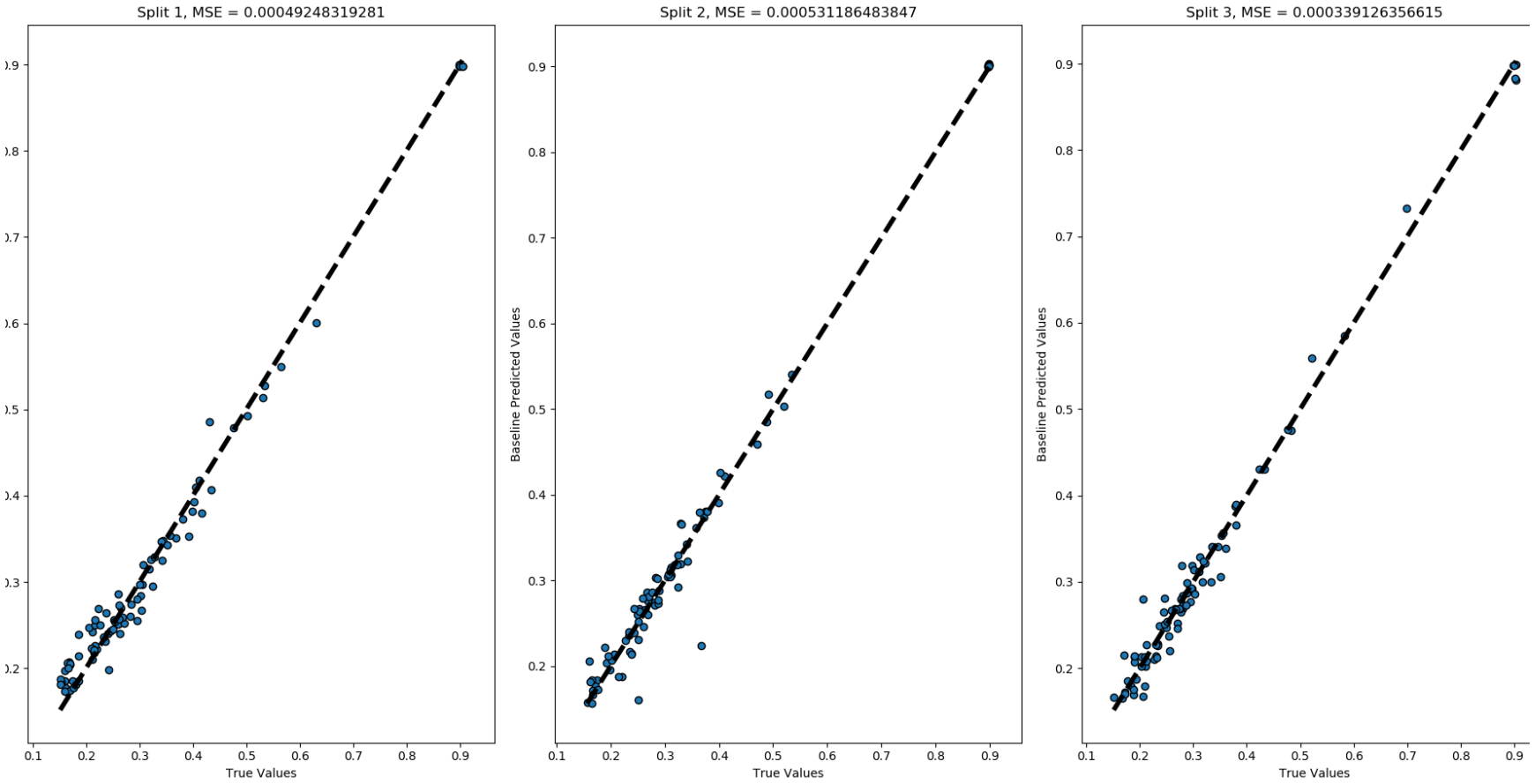
Baseline with fixed number of observations: 10

True vs Baseline with depth = 32, # estimators = 32, min leaf = 4, Mean MSE = 0.00100825953103

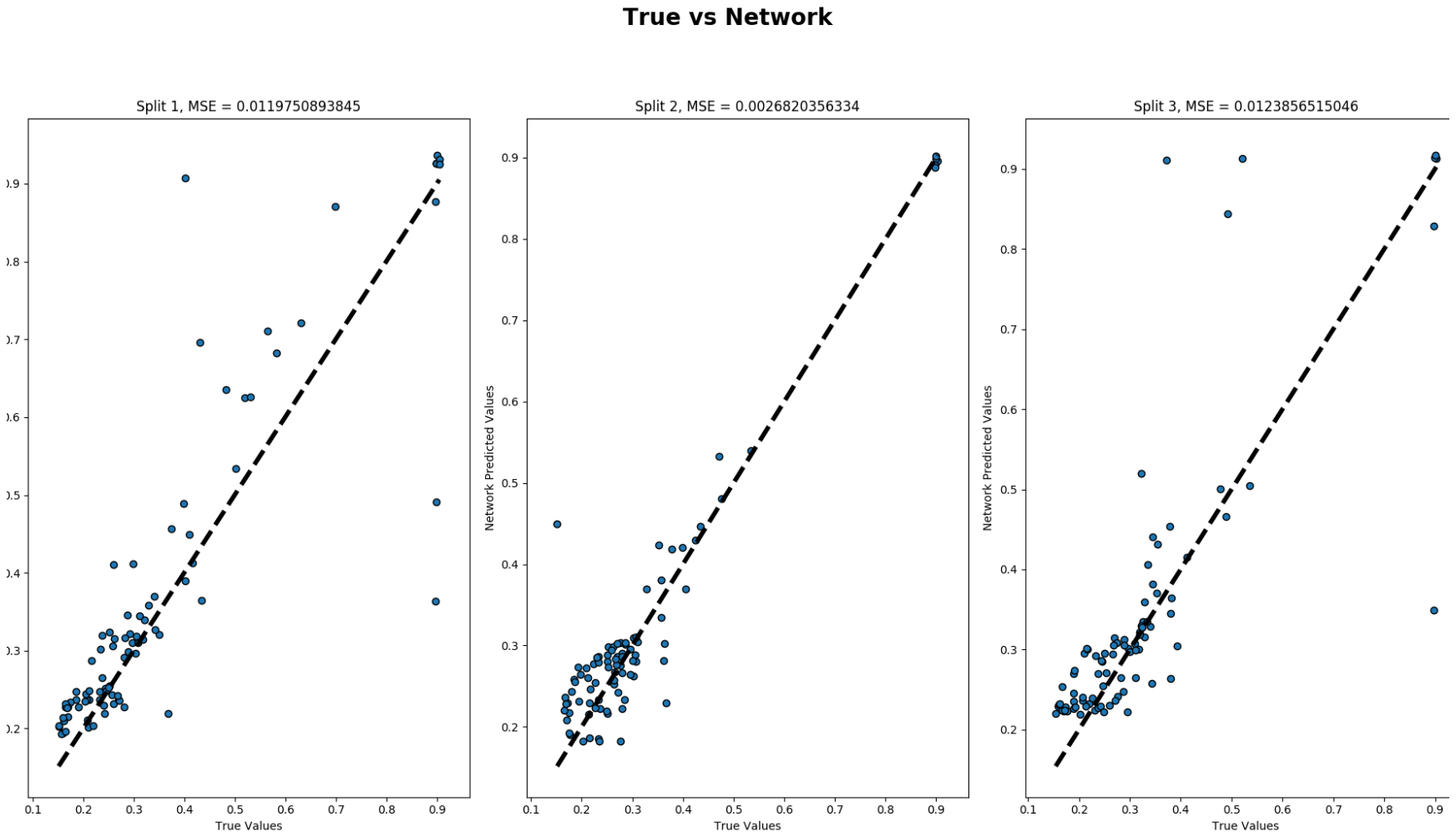


Baseline with fixed number of observations: 20

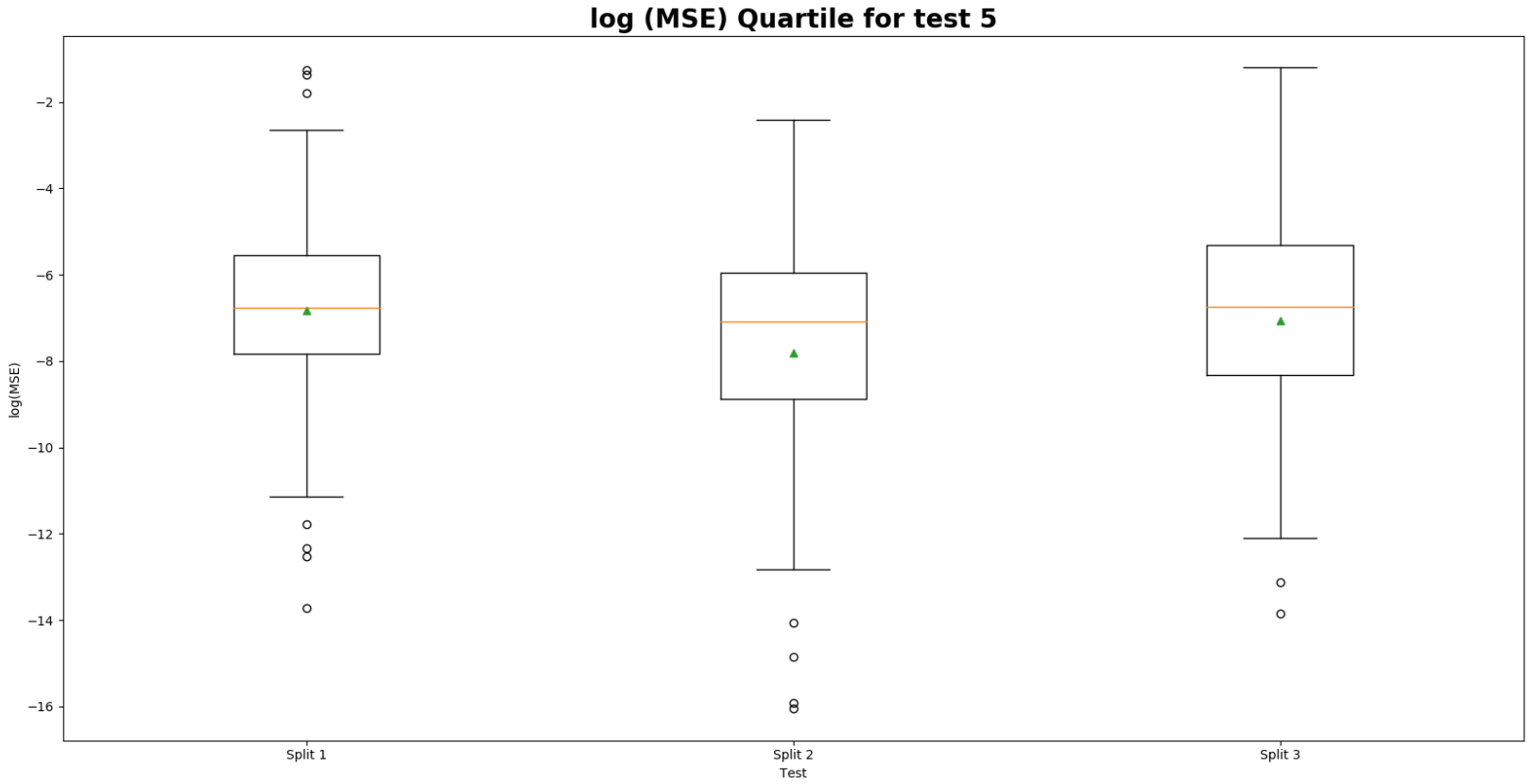
True vs Baseline with depth = 32, # estimators = 16, min leaf = 1, Mean MSE = 0.000454265344424

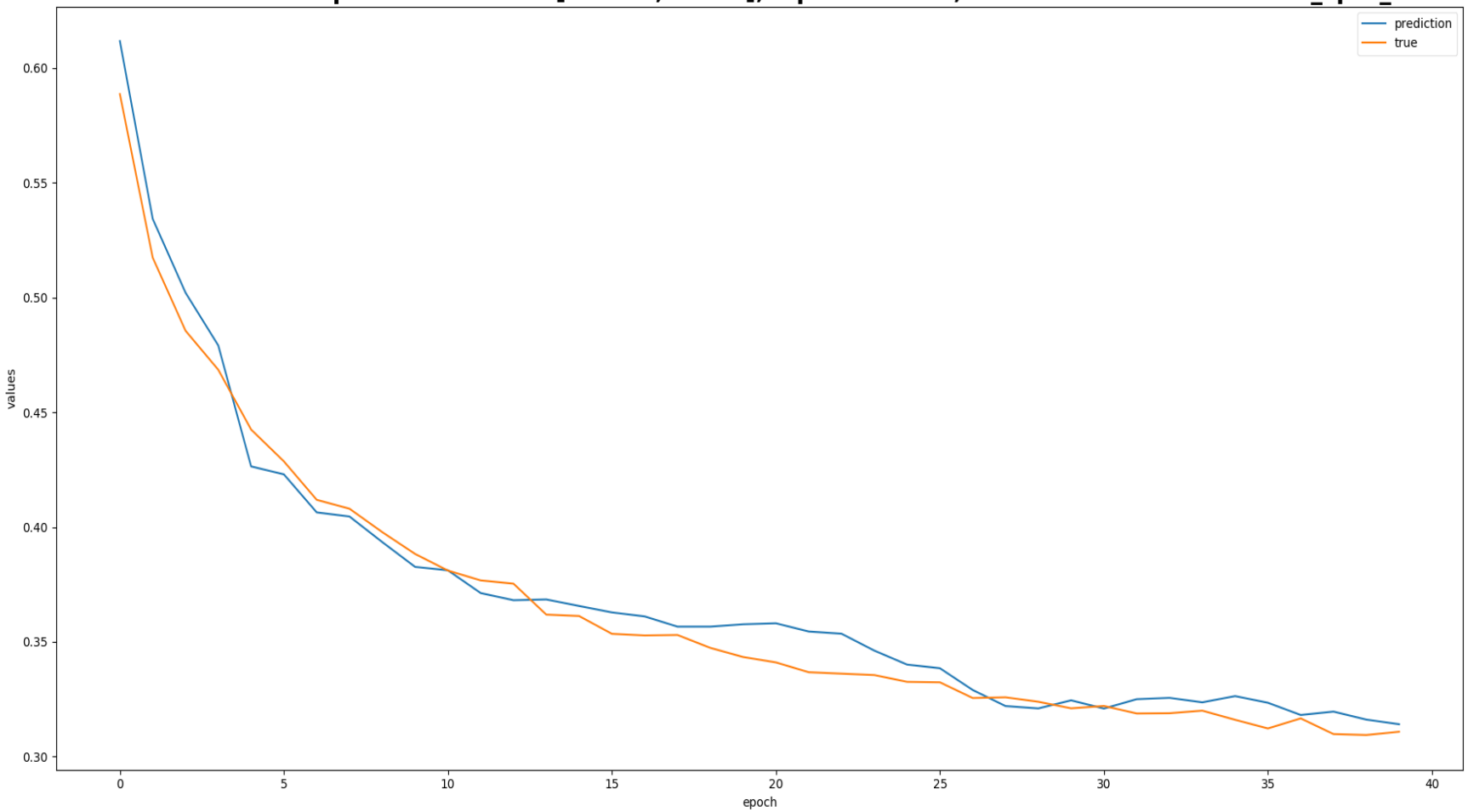


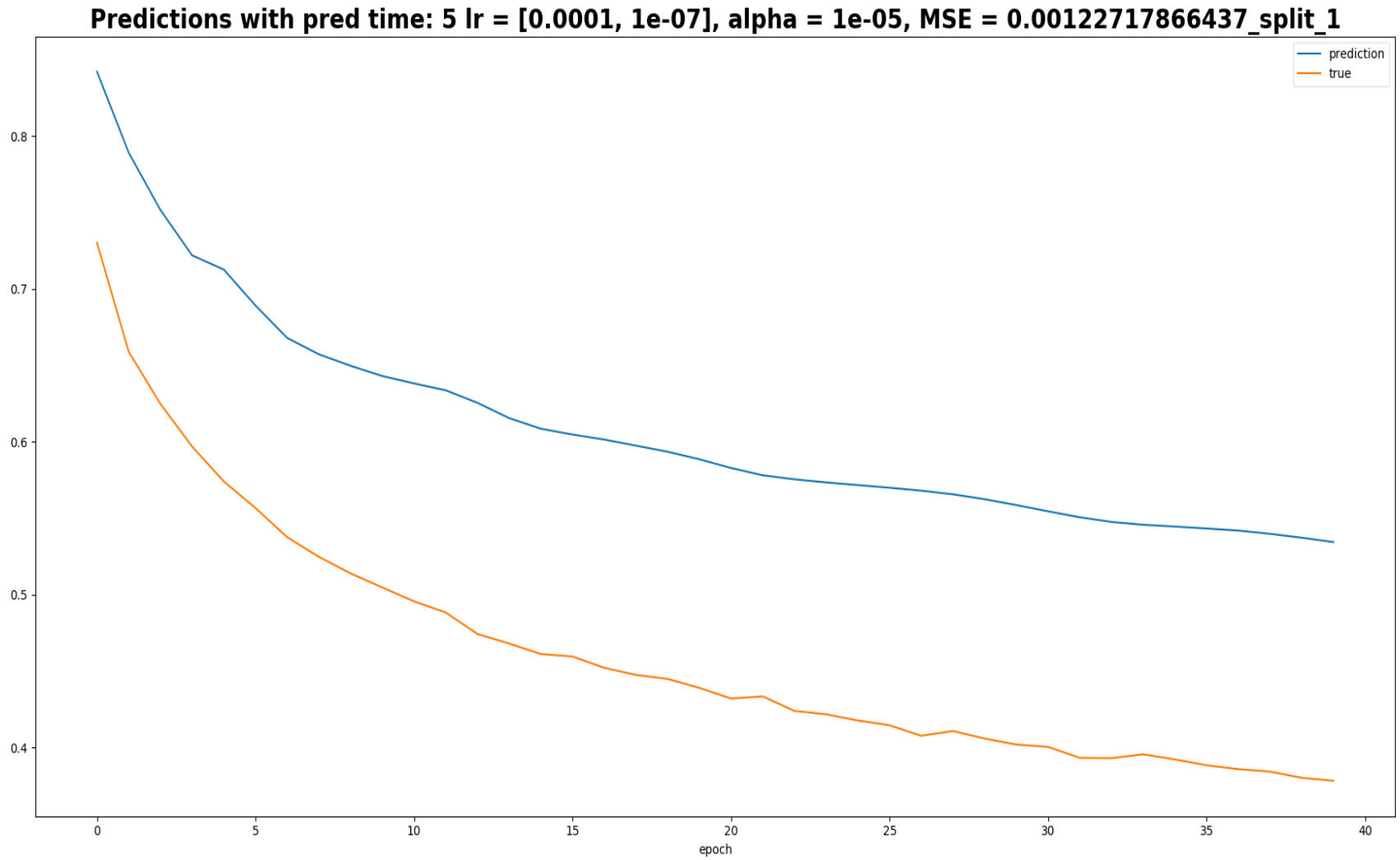
RNN trained with random input length, predictions after 5th epoch



RNN trained with random input length, predictions after 5th epoch

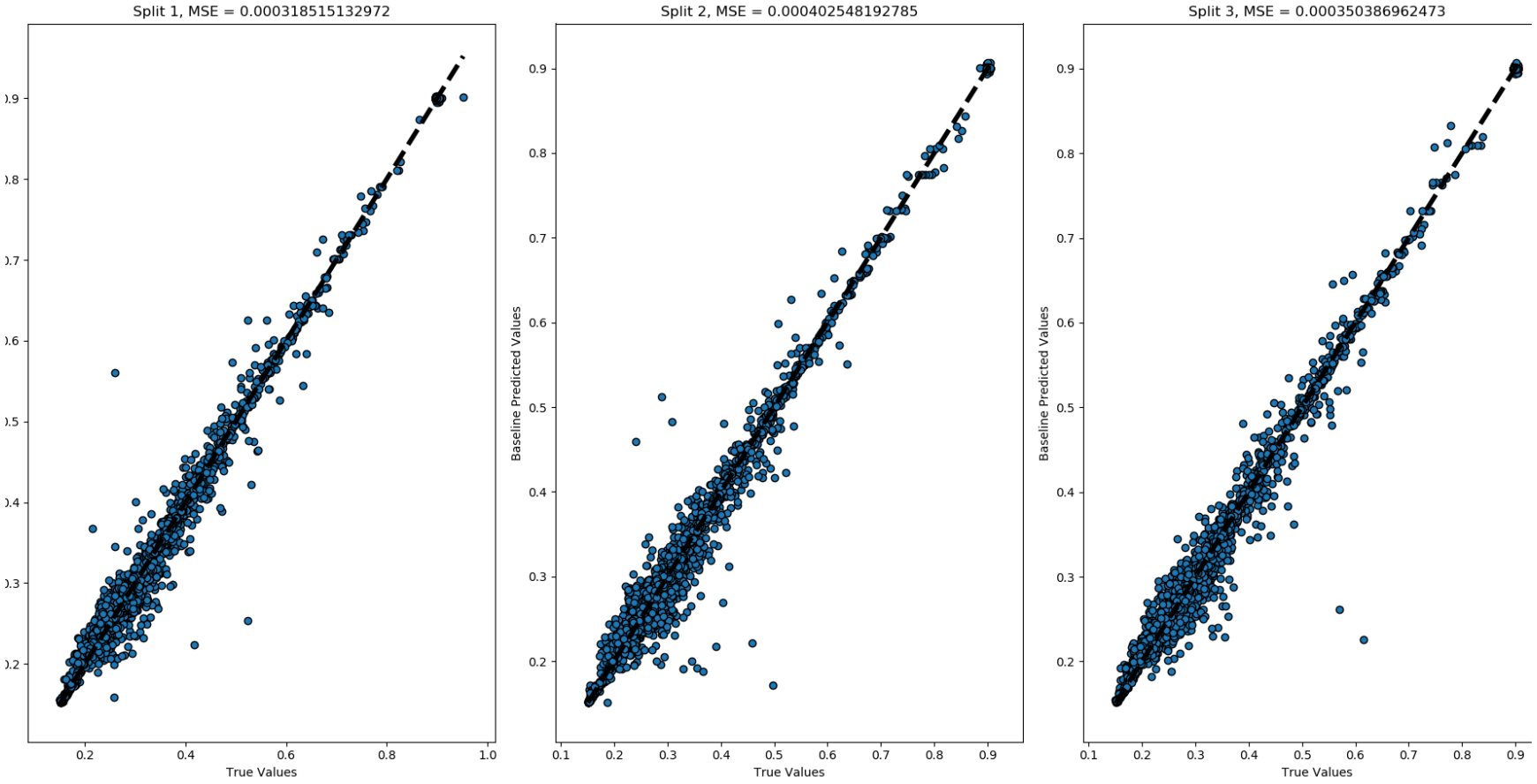



Predictions with pred time: 5 lr = [0.0001, 1e-07], alpha = 1e-05, MSE = 0.00122717866437_split_1
prediction
true
values
epoch
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0
5
10
15
20
25
30
35
40


Predictions with pred time: 5 lr = [0.0001, 1e-07], alpha = 1e-05, MSE = 0.00122717866437_split_1
prediction
true
0.8
0.7
0.6
0.5
0.4
0
5
10
15
20
25
30
35
40
epoch

Baseline to predict next point given previous four

True vs Baseline with depth = 32, # estimators = 16, min leaf = 8, Mean MSE = 0.000357150096076



Comparison between RNN's and last baseline

	LR	Alpha	Pred 5 MSE	Pred 10 MSE	Pred 20 MSE	Pred 30 MSE
Train 5	0.001 – 1e-6	1e-7	0.0282	0.0267	0.0257	0.0272
Train 10	1e-4 – 1e-6	1e-5	0.0228	0.01011	0.0272	0.0264
Train 20	0.001 – 1e-6	1e-6	0.0279	0.0260	0.0068	0.0283
Random	1e-4 – 1e-7	1e-5	0.0089	0.0066	0.0056	0.0046

	Max depth	# Estimators	Min leaf	MSE
Last 4 point prediction	32	16	8	0.0003