

(8760, 1, 17) (8760,) (2442105, 1, 17) (2442105,)

Train on 8760 samples, validate on 2442105 samples

Epoch 1/40

- 14s - loss: 0.0200 - val_loss: 0.0719

Epoch 2/40

- 14s - loss: 0.0190 - val_loss: 0.0519

Epoch 3/40

- 15s - loss: 0.0128 - val_loss: 0.0497

Epoch 4/40

- 16s - loss: 0.0099 - val_loss: 0.0344

Epoch 5/40

- 16s - loss: 0.0106 - val_loss: 0.0395

Epoch 6/40

- 16s - loss: 0.0091 - val_loss: 0.0482

Epoch 7/40

- 17s - loss: 0.0082 - val_loss: 0.0483

Epoch 8/40

- 16s - loss: 0.0118 - val_loss: 0.0495

Epoch 9/40

- 16s - loss: 0.0170 - val_loss: 0.0513

Epoch 10/40

- 17s - loss: 0.0150 - val_loss: 0.0482

Epoch 11/40

- 17s - loss: 0.0138 - val_loss: 0.0511

Epoch 12/40

- 16s - loss: 0.0106 - val_loss: 0.0517

Epoch 13/40

- 16s - loss: 0.0180 - val_loss: 0.0441

Epoch 14/40

- 18s - loss: 0.0116 - val_loss: 0.0467

Epoch 15/40

- 17s - loss: 0.0088 - val_loss: 0.0459

Epoch 16/40

- 17s - loss: 0.0127 - val_loss: 0.0498

Epoch 17/40

- 19s - loss: 0.0136 - val_loss: 0.0421

Epoch 18/40

- 18s - loss: 0.0073 - val_loss: 0.0425

Epoch 19/40

- 17s - loss: 0.0065 - val_loss: 0.0421

Epoch 20/40

- 17s - loss: 0.0057 - val_loss: 0.0444

Epoch 21/40

- 17s - loss: 0.0067 - val_loss: 0.0425

Epoch 22/40

- 17s - loss: 0.0068 - val_loss: 0.0438

Epoch 23/40

- 17s - loss: 0.0079 - val_loss: 0.0446

Epoch 24/40

- 18s - loss: 0.0060 - val_loss: 0.0428

Epoch 25/40

- 17s - loss: 0.0072 - val_loss: 0.0448

Epoch 26/40

- 17s - loss: 0.0068 - val_loss: 0.0422

Epoch 27/40

- 16s - loss: 0.0062 - val_loss: 0.0431

Epoch 28/40

- 17s - loss: 0.0059 - val_loss: 0.0430

Epoch 29/40

- 17s - loss: 0.0054 - val_loss: 0.0430

Epoch 30/40

- 17s - loss: 0.0048 - val_loss: 0.0428

Epoch 31/40

- 16s - loss: 0.0056 - val_loss: 0.0430

Epoch 32/40

- 17s - loss: 0.0054 - val_loss: 0.0428

Epoch 33/40

- 17s - loss: 0.0045 - val_loss: 0.0429

Epoch 34/40

- 17s - loss: 0.0046 - val_loss: 0.0433

Epoch 35/40

- 17s - loss: 0.0047 - val_loss: 0.0435

Epoch 36/40

- 18s - loss: 0.0044 - val_loss: 0.0431

Epoch 37/40

- 19s - loss: 0.0041 - val_loss: 0.0429

Epoch 38/40

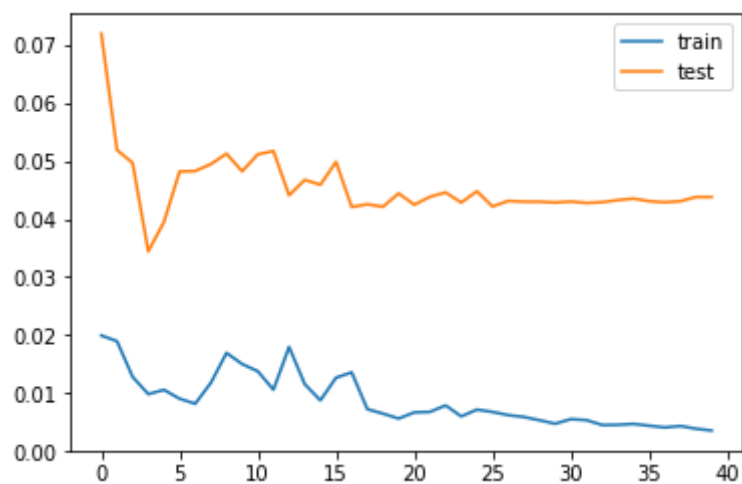
- 17s - loss: 0.0044 - val_loss: 0.0431

Epoch 39/40

- 18s - loss: 0.0039 - val_loss: 0.0438

Epoch 40/40

- 18s - loss: 0.0036 - val_loss: 0.0438



50 epochs met een batch size van 72

Train on 8760 samples, validate on 2442105 samples

Epoch 1/50

- 18s - loss: 0.0389 - val_loss: 0.0615

Epoch 2/50

- 18s - loss: 0.0210 - val_loss: 0.0531

Epoch 3/50

- 19s - loss: 0.0129 - val_loss: 0.0585

Epoch 4/50

- 18s - loss: 0.0089 - val_loss: 0.0643

Epoch 5/50

- 18s - loss: 0.0072 - val_loss: 0.0601

Epoch 6/50

- 19s - loss: 0.0080 - val_loss: 0.0405

Epoch 7/50

- 18s - loss: 0.0092 - val_loss: 0.0497

Epoch 8/50

- 18s - loss: 0.0095 - val_loss: 0.0569

Epoch 9/50

- 18s - loss: 0.0134 - val_loss: 0.0496

Epoch 10/50

- 18s - loss: 0.0108 - val_loss: 0.0487

Epoch 11/50

- 18s - loss: 0.0092 - val_loss: 0.0484

Epoch 12/50

- 19s - loss: 0.0090 - val_loss: 0.0485

Epoch 13/50

- 19s - loss: 0.0128 - val_loss: 0.0525

Epoch 14/50

- 18s - loss: 0.0166 - val_loss: 0.0506

Epoch 15/50

- 18s - loss: 0.0142 - val_loss: 0.0488

Epoch 16/50

- 18s - loss: 0.0110 - val_loss: 0.0507

Epoch 17/50

- 18s - loss: 0.0110 - val_loss: 0.0518

Epoch 18/50

- 18s - loss: 0.0123 - val_loss: 0.0531

Epoch 19/50

- 19s - loss: 0.0113 - val_loss: 0.0503

Epoch 20/50

- 18s - loss: 0.0073 - val_loss: 0.0480

Epoch 21/50

- 18s - loss: 0.0072 - val_loss: 0.0453

Epoch 22/50

- 18s - loss: 0.0069 - val_loss: 0.0448

Epoch 23/50

- 18s - loss: 0.0093 - val_loss: 0.0495

Epoch 24/50

- 18s - loss: 0.0080 - val_loss: 0.0491

Epoch 25/50

- 19s - loss: 0.0081 - val_loss: 0.0478

Epoch 26/50

- 18s - loss: 0.0058 - val_loss: 0.0467

Epoch 27/50

- 17s - loss: 0.0065 - val_loss: 0.0461

Epoch 28/50

- 18s - loss: 0.0068 - val_loss: 0.0465

Epoch 29/50

- 18s - loss: 0.0066 - val_loss: 0.0457

Epoch 30/50

- 17s - loss: 0.0053 - val_loss: 0.0448

Epoch 31/50

- 18s - loss: 0.0049 - val_loss: 0.0446

Epoch 32/50

- 18s - loss: 0.0057 - val_loss: 0.0453

Epoch 33/50

- 18s - loss: 0.0064 - val_loss: 0.0462

Epoch 34/50

- 18s - loss: 0.0060 - val_loss: 0.0447

Epoch 35/50

- 17s - loss: 0.0041 - val_loss: 0.0448

Epoch 36/50

- 18s - loss: 0.0047 - val_loss: 0.0444

Epoch 37/50

- 17s - loss: 0.0049 - val_loss: 0.0440

Epoch 38/50

- 18s - loss: 0.0049 - val_loss: 0.0443

Epoch 39/50

- 18s - loss: 0.0048 - val_loss: 0.0445

Epoch 40/50

- 18s - loss: 0.0046 - val_loss: 0.0449

Epoch 41/50

- 18s - loss: 0.0047 - val_loss: 0.0449

Epoch 42/50

- 17s - loss: 0.0049 - val_loss: 0.0447

Epoch 43/50

- 18s - loss: 0.0042 - val_loss: 0.0451

Epoch 44/50

- 18s - loss: 0.0042 - val_loss: 0.0454

Epoch 45/50

- 18s - loss: 0.0044 - val_loss: 0.0455

Epoch 46/50

- 18s - loss: 0.0043 - val_loss: 0.0457

Epoch 47/50

- 18s - loss: 0.0038 - val_loss: 0.0467

Epoch 48/50

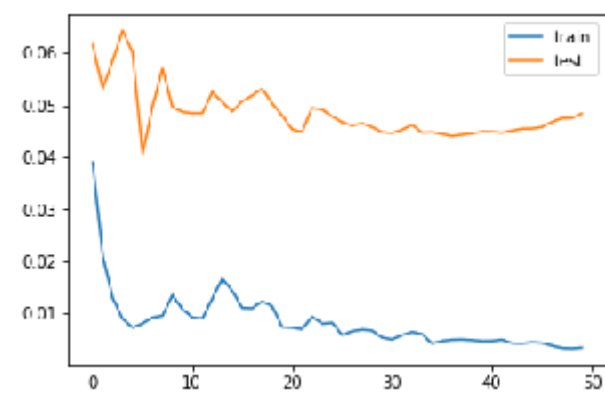
- 18s - loss: 0.0033 - val_loss: 0.0475

Epoch 49/50

- 18s - loss: 0.0032 - val_loss: 0.0475

Epoch 50/50

- 18s - loss: 0.0034 - val_loss: 0.0484



60 epoch 72 size batch

```
model = Sequential()

model.add(LSTM(60, input_shape=(train_X.shape[1], train_X.shape[2])))

model.add(Dense(1))

model.compile(loss='mae', optimizer='adam')

# fit network

history = model.fit(train_X, train_y, epochs=60, batch_size=72, validation_data=(test_X, test_y),
                    verbose=2, shuffle=False)

# plot history

pyplot.plot(history.history['loss'], label='train')

pyplot.plot(history.history['val_loss'], label='test')

pyplot.legend()

pyplot.show()

Train on 8760 samples, validate on 2442105 samples

Epoch 1/60
- 20s - loss: 0.0113 - val_loss: 0.0580

Epoch 2/60
- 19s - loss: 0.0092 - val_loss: 0.0711

Epoch 3/60
- 20s - loss: 0.0131 - val_loss: 0.0760

Epoch 4/60
- 20s - loss: 0.0140 - val_loss: 0.0740

Epoch 5/60
- 19s - loss: 0.0122 - val_loss: 0.0664

Epoch 6/60
- 19s - loss: 0.0102 - val_loss: 0.0562

Epoch 7/60
- 19s - loss: 0.0114 - val_loss: 0.0641

Epoch 8/60
- 19s - loss: 0.0127 - val_loss: 0.0494

Epoch 9/60
```


- 19s - loss: 0.0074 - val_loss: 0.0539

Epoch 10/60

- 20s - loss: 0.0034 - val_loss: 0.0541

Epoch 11/60

- 20s - loss: 0.0073 - val_loss: 0.0538

Epoch 12/60

- 19s - loss: 0.0070 - val_loss: 0.0577

Epoch 13/60

- 20s - loss: 0.0064 - val_loss: 0.0545

Epoch 14/60

- 20s - loss: 0.0056 - val_loss: 0.0490

Epoch 15/60

- 19s - loss: 0.0060 - val_loss: 0.0474

Epoch 16/60

- 20s - loss: 0.0054 - val_loss: 0.0448

Epoch 17/60

- 20s - loss: 0.0054 - val_loss: 0.0438

Epoch 18/60

- 19s - loss: 0.0052 - val_loss: 0.0478

Epoch 19/60

- 20s - loss: 0.0078 - val_loss: 0.0462

Epoch 20/60

- 20s - loss: 0.0071 - val_loss: 0.0448

Epoch 21/60

- 19s - loss: 0.0085 - val_loss: 0.0450

Epoch 22/60

- 19s - loss: 0.0079 - val_loss: 0.0424

Epoch 23/60

- 19s - loss: 0.0064 - val_loss: 0.0454

Epoch 24/60

- 19s - loss: 0.0088 - val_loss: 0.0435

Epoch 25/60

- 20s - loss: 0.0069 - val_loss: 0.0447

Epoch 26/60

- 20s - loss: 0.0060 - val_loss: 0.0453

Epoch 27/60

- 20s - loss: 0.0055 - val_loss: 0.0448

Epoch 28/60

- 20s - loss: 0.0056 - val_loss: 0.0448

Epoch 29/60

- 20s - loss: 0.0055 - val_loss: 0.0446

Epoch 30/60

- 21s - loss: 0.0053 - val_loss: 0.0446

Epoch 31/60

- 20s - loss: 0.0052 - val_loss: 0.0444

Epoch 32/60

- 19s - loss: 0.0049 - val_loss: 0.0444

Epoch 33/60

- 20s - loss: 0.0052 - val_loss: 0.0441

Epoch 34/60

- 21s - loss: 0.0048 - val_loss: 0.0441

Epoch 35/60

- 20s - loss: 0.0044 - val_loss: 0.0444

Epoch 36/60

- 20s - loss: 0.0047 - val_loss: 0.0442

Epoch 37/60

- 20s - loss: 0.0044 - val_loss: 0.0444

Epoch 38/60

- 20s - loss: 0.0042 - val_loss: 0.0440

Epoch 39/60

- 20s - loss: 0.0041 - val_loss: 0.0443

Epoch 40/60

- 19s - loss: 0.0040 - val_loss: 0.0446

Epoch 41/60

- 19s - loss: 0.0040 - val_loss: 0.0446

Epoch 42/60

- 19s - loss: 0.0040 - val_loss: 0.0447

Epoch 43/60

- 19s - loss: 0.0038 - val_loss: 0.0448

Epoch 44/60

- 19s - loss: 0.0039 - val_loss: 0.0449

Epoch 45/60

- 20s - loss: 0.0037 - val_loss: 0.0451

Epoch 46/60

- 20s - loss: 0.0037 - val_loss: 0.0446

Epoch 47/60

- 20s - loss: 0.0037 - val_loss: 0.0448

Epoch 48/60

- 20s - loss: 0.0038 - val_loss: 0.0454

Epoch 49/60

- 20s - loss: 0.0034 - val_loss: 0.0463

Epoch 50/60

- 20s - loss: 0.0032 - val_loss: 0.0472

Epoch 51/60

- 19s - loss: 0.0032 - val_loss: 0.0483

Epoch 52/60

- 19s - loss: 0.0029 - val_loss: 0.0472

Epoch 53/60

- 19s - loss: 0.0032 - val_loss: 0.0475

Epoch 54/60

- 19s - loss: 0.0033 - val_loss: 0.0478

Epoch 55/60

- 19s - loss: 0.0034 - val_loss: 0.0478

Epoch 56/60

- 19s - loss: 0.0036 - val_loss: 0.0476

Epoch 57/60

- 19s - loss: 0.0039 - val_loss: 0.0465

Epoch 58/60

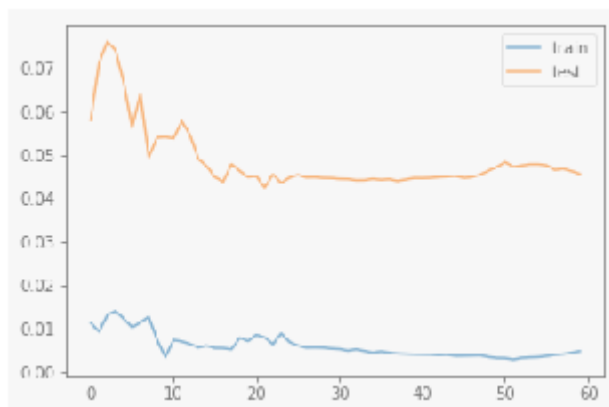
- 20s - loss: 0.0041 - val_loss: 0.0467

Epoch 59/60

- 20s - loss: 0.0044 - val_loss: 0.0462

Epoch 60/60

- 20s - loss: 0.0047 - val_loss: 0.0456



50 epochs 150 size batch

Train on 8760 samples, validate on 2442105 samples

Epoch 1/50

- 11s - loss: 0.0280 - val_loss: 0.0767

Epoch 2/50

- 11s - loss: 0.0268 - val_loss: 0.0775

Epoch 3/50

- 11s - loss: 0.0224 - val_loss: 0.0534

Epoch 4/50

- 11s - loss: 0.0313 - val_loss: 0.0565

Epoch 5/50

- 11s - loss: 0.0336 - val_loss: 0.0607

Epoch 6/50

- 11s - loss: 0.0312 - val_loss: 0.0600

Epoch 7/50

- 11s - loss: 0.0201 - val_loss: 0.0559

Epoch 8/50

- 12s - loss: 0.0167 - val_loss: 0.0530

Epoch 9/50

- 13s - loss: 0.0183 - val_loss: 0.0605

Epoch 10/50

- 14s - loss: 0.0142 - val_loss: 0.0549

Epoch 11/50

- 13s - loss: 0.0137 - val_loss: 0.0594

Epoch 12/50

- 14s - loss: 0.0103 - val_loss: 0.0531

Epoch 13/50

- 13s - loss: 0.0157 - val_loss: 0.0586

Epoch 14/50

- 13s - loss: 0.0104 - val_loss: 0.0547

Epoch 15/50

- 13s - loss: 0.0118 - val_loss: 0.0579

Epoch 16/50

- 13s - loss: 0.0218 - val_loss: 0.0560

Epoch 17/50

- 14s - loss: 0.0191 - val_loss: 0.0557

Epoch 18/50

- 13s - loss: 0.0124 - val_loss: 0.0544

Epoch 19/50

- 13s - loss: 0.0156 - val_loss: 0.0557

Epoch 20/50

- 14s - loss: 0.0123 - val_loss: 0.0567

Epoch 21/50

- 13s - loss: 0.0159 - val_loss: 0.0564

Epoch 22/50

- 13s - loss: 0.0142 - val_loss: 0.0573

Epoch 23/50

- 13s - loss: 0.0136 - val_loss: 0.0553

Epoch 24/50

- 13s - loss: 0.0135 - val_loss: 0.0576

Epoch 25/50

- 13s - loss: 0.0087 - val_loss: 0.0566

Epoch 26/50

- 14s - loss: 0.0077 - val_loss: 0.0545

Epoch 27/50

- 13s - loss: 0.0123 - val_loss: 0.0574

Epoch 28/50

- 13s - loss: 0.0081 - val_loss: 0.0563

Epoch 29/50

- 13s - loss: 0.0068 - val_loss: 0.0546

Epoch 30/50

- 13s - loss: 0.0053 - val_loss: 0.0510

Epoch 31/50

- 13s - loss: 0.0062 - val_loss: 0.0499

Epoch 32/50

- 14s - loss: 0.0050 - val_loss: 0.0471

Epoch 33/50

- 14s - loss: 0.0063 - val_loss: 0.0483

Epoch 34/50

- 13s - loss: 0.0066 - val_loss: 0.0488

Epoch 35/50

- 14s - loss: 0.0081 - val_loss: 0.0473

Epoch 36/50

- 13s - loss: 0.0041 - val_loss: 0.0500

Epoch 37/50

- 14s - loss: 0.0045 - val_loss: 0.0507

Epoch 38/50

- 14s - loss: 0.0061 - val_loss: 0.0476

Epoch 39/50

- 13s - loss: 0.0060 - val_loss: 0.0504

Epoch 40/50

- 13s - loss: 0.0072 - val_loss: 0.0490

Epoch 41/50

- 13s - loss: 0.0070 - val_loss: 0.0479

Epoch 42/50

- 14s - loss: 0.0083 - val_loss: 0.0489

Epoch 43/50

- 13s - loss: 0.0056 - val_loss: 0.0482

Epoch 44/50

- 13s - loss: 0.0064 - val_loss: 0.0479

Epoch 45/50

- 13s - loss: 0.0046 - val_loss: 0.0468

Epoch 46/50

- 13s - loss: 0.0032 - val_loss: 0.0482

Epoch 47/50

- 13s - loss: 0.0051 - val_loss: 0.0476

Epoch 48/50

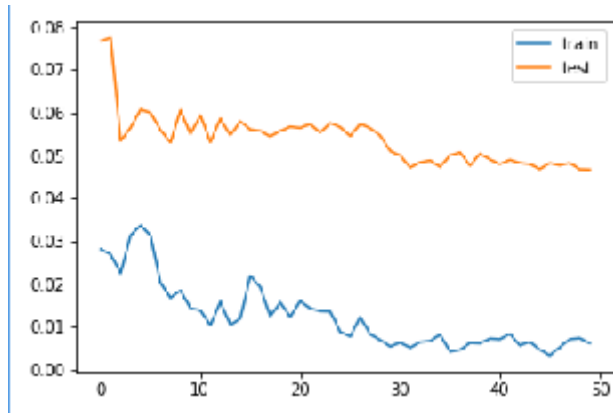
- 13s - loss: 0.0070 - val_loss: 0.0482

Epoch 49/50

- 14s - loss: 0.0073 - val_loss: 0.0467

Epoch 50/50

- 13s - loss: 0.0061 - val_loss: 0.0467



Epoch 55 batchsize 500

Train on 8760 samples, validate on 2442105 samples

Epoch 1/50

Epoch 2/50

Epoch 3/50

Epoch 4/50

Epoch 5/50

Epoch 6/50

Epoch 7/50

Epoch 8/50

Epoch 9/50

Epoch 10/50

Epoch 11/50

Epoch 12/50

Epoch 13/50

Epoch 14/50

Epoch 15/50

Epoch 16/50

Epoch 17/50

Epoch 18/50

Epoch 19/50

Epoch 20/50

Epoch 21/50

Epoch 22/50

Epoch 23/50

Epoch 24/50

Epoch 25/50

Epoch 26/50

Epoch 27/50

Epoch 28/50

Epoch 29/50

Epoch 30/50

Epoch 31/50

Epoch 32/50

Epoch 33/50

Epoch 34/50

Epoch 35/50

Epoch 36/50

Epoch 37/50

Epoch 38/50

Epoch 39/50

Epoch 40/50

Epoch 41/50

Epoch 42/50

Epoch 43/50

Epoch 44/50

Epoch 45/50

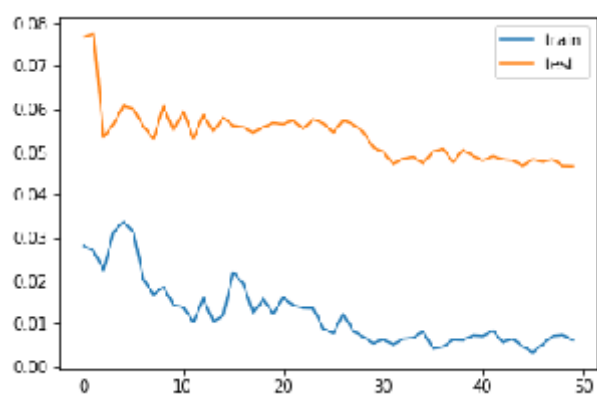
Epoch 46/50

Epoch 47/50

Epoch 48/50

Epoch 49/50

Epoch 50/50



De RMSE

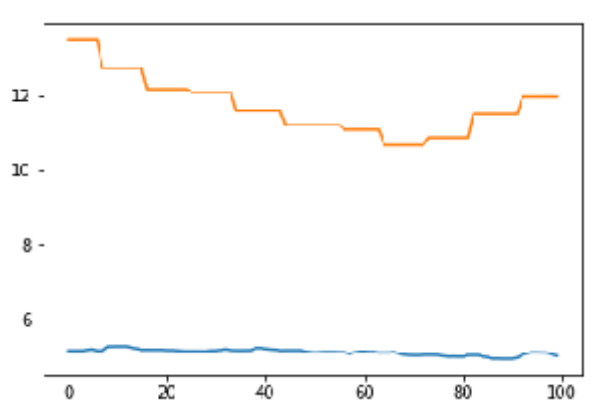
```
yhat = model.predict(test_X)
test_X = test_X.reshape((test_X.shape[0], test_X.shape[2]))
# invert scaling for forecast
inv_yhat = concatenate((yhat, test_X[:, 1:]), axis=1)
inv_yhat = scaler.inverse_transform(inv_yhat)
inv_yhat = inv_yhat[:,0]
# invert scaling for actual
test_y = test_y.reshape((len(test_y), 1))
inv_y = concatenate((test_y, test_X[:, 1:]), axis=1)
inv_y = scaler.inverse_transform(inv_y)
inv_y = inv_y[:,0]

print(test_X)
# calculate RMSE
rmse = sqrt(mean_squared_error(inv_y, inv_yhat))
print('Test RMSE: %.3f' % rmse)
# visualize last 100 timesteps of prediction:
pyplot.plot(inv_yhat[-100:])
pyplot.plot(inv_y[-100:])
pyplot.show()

[[ 0.      0.0097257  0.      ..., 0.      0.09999999  0.      ]
 [ 0.      0.0094151  0.      ..., 0.      0.09999999  0.      ]
 [ 0.      0.0094151  0.      ..., 0.      0.09999999  0.      ]
 ...,
 [ 0.09999999  0.14581755  0.37211645 ..., 1.      0.09999999
    0.38635099]
 [ 0.09999999  0.16672491  0.37211645 ..., 1.      0.09999999
    0.38635099]
 [ 0.09999999  0.16672491  0.39693961 ..., 1.      0.09999999
```

0.38635099]]

Test RMSE: 8.321



De beste uitslag dat ik heb kunnen krijgen is door:

```
# design network
model = Sequential()
model.add(LSTM(55, input_shape=(train_X.shape[1], train_X.shape[2])))
model.add(Dense(1))
model.compile(loss='mae', optimizer='adam')
# fit network
history = model.fit(train_X, train_y, epochs=50, batch_size=500, validation_data=(test_X, test_y),
verbose=4, shuffle=False)
# plot history
pyplot.plot(history.history['loss'], label='train')
pyplot.plot(history.history['val_loss'], label='test')
pyplot.legend()
pyplot.show()
```