ASSIGNMENT – 3
WETHER FORECASTING – TIME SERIES DATA

INTRODUCTION:

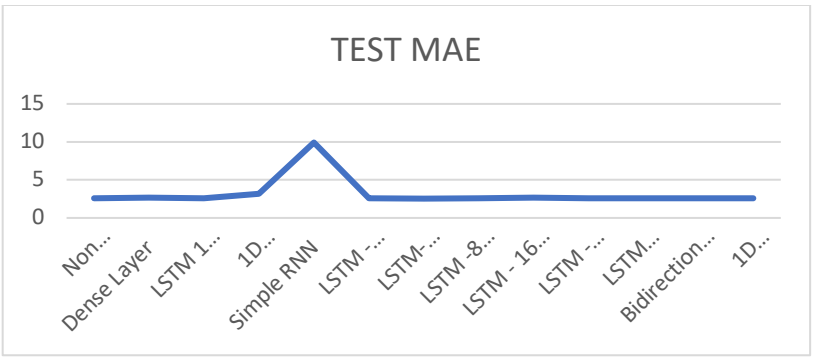
The purpose of this report is to analyze time series data using various machine learning models and techniques. The data used in this analysis is the "jena_climate_2009_2016.csv" dataset. The dataset contains 420,451 data points with 14 a feature, including temperature, pressure, humidity, wind speed, and more.

MODEL COMPARISION:

MODEL	TEST MAE
Non Machine learning	2.62
Dense Layer	2.66
LSTM 1 Layer	2.57
1D Convolution Model	3.2
Simple RNN	9.92
LSTM - SIMPLE	2.59
LSTM- DROPOUT	2.54
LSTM -8 Layers	2.6
LSTM - 16 Layers	2.68
LSTM - 32Layers	2.62
LSTM dropout regularized stack	2.6
Bidirectional LSTM	2.61
1D Convolution Model & RNN	2.62

BEST MODEL:

This report concludes that the **LSTM- DROPOUT** layer is the best-performing model for the given time series data. It achieved the lowest Test MAE, which is a key indicator of its predictive accuracy. However, it's important to note that model selection should be based on the specific requirements and characteristics of the dataset and problem.



TEST MAE -NON-MACHINE LAERNING BASELINE:

```python
def evaluate_naive_method(dataset):
    total_abs_err = 0.
    samples_seen = 0
    for samples, targets in dataset:
        preds = samples[:, -1, 1] * std[1] + mean[1]
        total_abs_err += np.sum(np.abs(preds - targets))
        samples_seen += samples.shape[0]
    return total_abs_err / samples_seen

print(f"Validation MAE: {evaluate_naive_method(val_dataset):.2f}")
print(f"Test MAE: {evaluate_naive_method(test_dataset):.2f}")
```

```
Validation MAE: 2.44
Test MAE: 2.62
```

Test MAE DENSE Model – 2.66

```
Epoch 1/7
819/819 [==============================] - 27s 31ms/step - loss: 13.2995 - mae:
2.8032 - val_loss: 13.0390 - val_mae: 2.8677
Epoch 2/7
819/819 [==============================] - 26s 31ms/step - loss: 9.2294 - mae:
2.3870 - val_loss: 12.6537 - val_mae: 2.8345
Epoch 3/7
819/819 [==============================] - 26s 31ms/step - loss: 8.5313 - mae:
2.2947 - val_loss: 11.6588 - val_mae: 2.6997
Epoch 4/7
819/819 [==============================] - 24s 29ms/step - loss: 8.0392 - mae:
2.2305 - val_loss: 10.8673 - val_mae: 2.6056
Epoch 5/7
819/819 [==============================] - 25s 30ms/step - loss: 7.6449 - mae:
2.1748 - val_loss: 10.3317 - val_mae: 2.5345
Epoch 6/7
819/819 [==============================] - 24s 30ms/step - loss: 7.4097 - mae:
2.1405 - val_loss: 10.2984 - val_mae: 2.5230
Epoch 7/7
819/819 [==============================] - 24s 29ms/step - loss: 7.1609 - mae:
2.1038 - val_loss: 10.8197 - val_mae: 2.5883
405/405 [==============================] - 8s 19ms/step - loss: 11.4269 - mae:
2.6639
Test MAE: 2.66
```

Test MAE 1D Convolution model- 3.20

```
Epoch 1/7
819/819 [==============================] - 60s 72ms/step - loss: 23.6116 - mae:
3.8005 - val_loss: 16.3333 - val_mae: 3.2228
Epoch 2/7
819/819 [==============================] - 59s 72ms/step - loss: 16.3726 - mae:
3.2044 - val_loss: 14.7552 - val_mae: 3.0325
Epoch 3/7
819/819 [==============================] - 58s 71ms/step - loss: 14.7005 - mae:
3.0401 - val_loss: 14.9092 - val_mae: 3.0411
Epoch 4/7
819/819 [==============================] - 58s 71ms/step - loss: 13.7397 - mae:
2.9408 - val_loss: 14.6412 - val_mae: 3.0347
Epoch 5/7
819/819 [==============================] - 59s 72ms/step - loss: 12.9683 - mae:
2.8536 - val_loss: 16.2347 - val_mae: 3.1999
Epoch 6/7
819/819 [==============================] - 58s 71ms/step - loss: 12.3403 - mae:
2.7831 - val_loss: 16.9989 - val_mae: 3.2390
Epoch 7/7
819/819 [==============================] - 58s 70ms/step - loss: 11.7086 - mae:
2.7085 - val_loss: 15.7274 - val_mae: 3.1138
405/405 [==============================] - 12s 29ms/step - loss: 16.3334 - mae:
3.1985
Test MAE: 3.20
```

Test MAE LSTM MODEL (1 LAYER) -2.57

```
819/819 [==============================] - 64s 78ms/step - loss: 10.9491 - mae:
2.5706 - val_loss: 9.9731 - val_mae: 2.4607
Epoch 3/7
819/819 [==============================] - 62s 75ms/step - loss: 9.7183 - mae:
2.4295 - val_loss: 9.7276 - val_mae: 2.4247
Epoch 4/7
819/819 [==============================] - 65s 80ms/step - loss: 9.2310 - mae:
2.3651 - val_loss: 9.7745 - val_mae: 2.4259
Epoch 5/7
819/819 [==============================] - 65s 80ms/step - loss: 8.9661 - mae:
2.3311 - val_loss: 9.7748 - val_mae: 2.4305
Epoch 6/7
819/819 [==============================] - 65s 80ms/step - loss: 8.6958 - mae:
2.2943 - val_loss: 9.7569 - val_mae: 2.4362
Epoch 7/7
819/819 [==============================] - 65s 80ms/step - loss: 8.4829 - mae:
2.2664 - val_loss: 9.7781 - val_mae: 2.4370
405/405 [==============================] - 13s 32ms/step - loss: 10.5993 - mae:
2.5655
Test MAE: 2.57
```

TEST MAE SIMPLE RNN MODEL -9.92

```
Epoch 3/7
819/819 [==============================] - 43s 53ms/step - loss: 136.2950 - mae:
9.5525 - val_loss: 143.6657 - val_mae: 9.8670
Epoch 4/7
819/819 [==============================] - 43s 52ms/step - loss: 136.2354 - mae:
9.5472 - val_loss: 143.6259 - val_mae: 9.8634
Epoch 5/7
819/819 [==============================] - 43s 52ms/step - loss: 136.2116 - mae:
9.5427 - val_loss: 143.5809 - val_mae: 9.8537
Epoch 6/7
819/819 [==============================] - 42s 52ms/step - loss: 136.1713 - mae:
9.5382 - val_loss: 143.5684 - val_mae: 9.8526
Epoch 7/7
819/819 [==============================] - 41s 50ms/step - loss: 136.1624 - mae:
9.5378 - val_loss: 143.5494 - val_mae: 9.8509
405/405 [==============================] - 10s 25ms/step - loss: 151.2899 - mae:
9.9169
Test MAE: 9.92
```

TEST MAE LSTM SIMPLE – 2.59

```
Epoch 1/7
819/819 [==============================] - 56s 66ms/step - loss: 47.0226 - mae:
5.0047 - val_loss: 13.5562 - val_mae: 2.7893
Epoch 2/7
819/819 [==============================] - 53s 65ms/step - loss: 11.0616 - mae:
2.5803 - val_loss: 9.7256 - val_mae: 2.4234
Epoch 3/7
819/819 [==============================] - 54s 65ms/step - loss: 9.4351 - mae:
2.3981 - val_loss: 9.9041 - val_mae: 2.4479
Epoch 4/7
819/819 [==============================] - 51s 63ms/step - loss: 8.8802 - mae:
2.3278 - val_loss: 9.9444 - val_mae: 2.4627
Epoch 5/7
819/819 [==============================] - 51s 62ms/step - loss: 8.4791 - mae:
2.2742 - val_loss: 9.9536 - val_mae: 2.4617
Epoch 6/7
819/819 [==============================] - 52s 63ms/step - loss: 8.2030 - mae:
2.2396 - val_loss: 10.0402 - val_mae: 2.4709
Epoch 7/7
819/819 [==============================] - 51s 62ms/step - loss: 7.9682 - mae:
2.2083 - val_loss: 10.0586 - val_mae: 2.469868 - mae:
405/405 [==============================] - 11s 27ms/step - loss: 10.9719 - mae:
2.5921
Test MAE: 2.59
```

TEST MAE LSTM WITH DROPOUT REGULARIZATION – 2.54

```
Epoch 1/10
819/819 [==============================] - 61s 71ms/step - loss: 45.2395 - mae: 5.0054 - val_loss: 12.7789 - val_ma
e: 2.7251
Epoch 2/10
819/819 [==============================] - 59s 71ms/step - loss: 20.1363 - mae: 3.4513 - val_loss: 10.3101 - val_ma
e: 2.5083
Epoch 3/10
819/819 [==============================] - 59s 73ms/step - loss: 18.6436 - mae: 3.3246 - val_loss: 9.6511 - val_ma
e: 2.4311
Epoch 4/10
819/819 [==============================] - 59s 72ms/step - loss: 17.5215 - mae: 3.2274 - val_loss: 9.2659 - val_ma
e: 2.3774
Epoch 5/10
819/819 [==============================] - 59s 72ms/step - loss: 16.9218 - mae: 3.1666 - val_loss: 9.3421 - val_ma
e: 2.3843
Epoch 6/10
819/819 [==============================] - 59s 72ms/step - loss: 16.5315 - mae: 3.1332 - val_loss: 9.1740 - val_ma
e: 2.3679
Epoch 7/10
819/819 [==============================] - 61s 74ms/step - loss: 16.0297 - mae: 3.0895 - val_loss: 9.2736 - val_ma
e: 2.3787
Epoch 8/10
819/819 [==============================] - 61s 75ms/step - loss: 15.7503 - mae: 3.0587 - val_loss: 9.1283 - val_ma
e: 2.3579
Epoch 9/10
819/819 [==============================] - 62s 76ms/step - loss: 15.4204 - mae: 3.0296 - val_loss: 9.2480 - val_ma
e: 2.3752
Epoch 10/10
819/819 [==============================] - 61s 75ms/step - loss: 15.1377 - mae: 3.0031 - val_loss: 9.2272 - val_ma
e: 2.3662
405/405 [==============================] - 7s 17ms/step - loss: 10.5760 - mae: 2.5415
Test MAE: 2.54
```

TEST MAE LSTM WITH 8 LAYERS -2. 6

```
819/819 [==============================] - 73s 86ms/step - loss: 66.5505 - mae:
6.1977 - val_loss: 32.5827 - val_mae: 4.2437
Epoch 2/7
819/819 [==============================] - 73s 89ms/step - loss: 19.6884 - mae:
3.2833 - val_loss: 13.0442 - val_mae: 2.7470
Epoch 3/7
819/819 [==============================] - 68s 83ms/step - loss: 10.8644 - mae:
2.5553 - val_loss: 10.7928 - val_mae: 2.5670
Epoch 4/7
819/819 [==============================] - 75s 91ms/step - loss: 9.7278 - mae:
2.4324 - val_loss: 10.1817 - val_mae: 2.4860
Epoch 5/7
819/819 [==============================] - 78s 95ms/step - loss: 9.4322 - mae:
2.3940 - val_loss: 9.9864 - val_mae: 2.4638
Epoch 6/7
819/819 [==============================] - 82s 100ms/step - loss: 9.2045 - mae:
2.3646 - val_loss: 10.0388 - val_mae: 2.4600
Epoch 7/7
819/819 [==============================] - 74s 90ms/step - loss: 9.0564 - mae:
2.3464 - val_loss: 9.8563 - val_mae: 2.4532
405/405 [==============================] - 10s 24ms/step - loss: 10.8690 - mae:
2.5984
Test MAE: 2.60
```

TEST MAE LSTM WITH 16 LAYERS – 2.68

```
Epoch 1/7
819/819 [==============================] - 95s 112ms/step - loss: 40.4396 - mae:
4.5995 - val_loss: 13.0213 - val_mae: 2.7410
Epoch 2/7
819/819 [==============================] - 93s 113ms/step - loss: 10.1922 - mae:
2.4755 - val_loss: 9.5310 - val_mae: 2.3967
Epoch 3/7
819/819 [==============================] - 93s 113ms/step - loss: 8.8859 - mae:
2.3198 - val_loss: 9.4881 - val_mae: 2.4008
Epoch 4/7
819/819 [==============================] - 93s 114ms/step - loss: 8.3576 - mae:
2.2506 - val_loss: 10.1544 - val_mae: 2.4799
Epoch 5/7
819/819 [==============================] - 92s 112ms/step - loss: 7.9404 - mae:
2.1958 - val_loss: 10.2832 - val_mae: 2.5040
Epoch 6/7
819/819 [==============================] - 85s 104ms/step - loss: 7.6751 - mae:
2.1572 - val_loss: 10.0266 - val_mae: 2.4688
Epoch 7/7
819/819 [==============================] - 91s 111ms/step - loss: 7.5017 - mae:
2.1343 - val_loss: 9.8490 - val_mae: 2.4500
405/405 [==============================] - 15s 36ms/step - loss: 11.5874 - mae:
2.6785
Test MAE: 2.68
```

TEST MAE LSTM WITH 32 LAYERS – 2.62

```
Epoch 1/7
819/819 [==============================] - 123s 147ms/step - loss: 19.0733 -
mae: 3.1502 - val_loss: 10.5564 - val_mae: 2.5522
Epoch 2/7
819/819 [==============================] - 121s 148ms/step - loss: 7.9323 - mae:
2.2019 - val_loss: 10.7405 - val_mae: 2.5648
Epoch 3/7
819/819 [==============================] - 120s 146ms/step - loss: 6.3938 - mae:
1.9750 - val_loss: 11.7384 - val_mae: 2.6851
Epoch 4/7
819/819 [==============================] - 116s 141ms/step - loss: 5.2708 - mae:
1.7918 - val_loss: 12.1749 - val_mae: 2.7385
Epoch 5/7
819/819 [==============================] - 118s 144ms/step - loss: 4.3911 - mae:
1.6336 - val_loss: 13.1748 - val_mae: 2.8172
Epoch 6/7
819/819 [==============================] - 119s 145ms/step - loss: 3.7401 - mae:
1.5048 - val_loss: 14.1781 - val_mae: 2.9448
Epoch 7/7
819/819 [==============================] - 121s 147ms/step - loss: 3.2272 - mae:
1.3953 - val_loss: 14.2355 - val_mae: 2.9600
405/405 [==============================] - 20s 47ms/step - loss: 11.2179 - mae:
2.6228
Test MAE: 2.62
```

TEST MAE LSTM WITH DROPOUT,REGULARIZATION ANS STACKED MODEL-2.60

```
Epoch 1/7
819/819 [==============================] - 232s 279ms/step - loss: 68.9645 -
mae: 6.3491 - val_loss: 31.1883 - val_mae: 4.1217
Epoch 2/7
819/819 [==============================] - 231s 282ms/step - loss: 30.4259 -
mae: 4.1343 - val_loss: 13.4328 - val_mae: 2.7466
Epoch 3/7
819/819 [==============================] - 230s 281ms/step - loss: 24.3147 -
mae: 3.7318 - val_loss: 11.7295 - val_mae: 2.6444
Epoch 4/7
819/819 [==============================] - 229s 279ms/step - loss: 22.4774 -
mae: 3.5878 - val_loss: 10.4721 - val_mae: 2.4977
Epoch 5/7
819/819 [==============================] - 229s 280ms/step - loss: 21.1514 -
mae: 3.4877 - val_loss: 10.0972 - val_mae: 2.4605
Epoch 6/7
819/819 [==============================] - 229s 279ms/step - loss: 20.2269 -
mae: 3.4134 - val_loss: 10.0748 - val_mae: 2.4606
Epoch 7/7
819/819 [==============================] - 224s 274ms/step - loss: 19.3759 -
mae: 3.3508 - val_loss: 9.7040 - val_mae: 2.4182
405/405 [==============================] - 20s 48ms/step - loss: 11.1056 - mae:
2.5970
Test MAE: 2.60
```

TEST MAE BIDIRECTIONAL LSTM – 2.61

```
Epoch 1/7
819/819 [==============================] - 115s 137ms/step - loss: 26.0296 -
mae: 3.6744 - val_loss: 10.1256 - val_mae: 2.4739
Epoch 2/7
819/819 [==============================] - 115s 140ms/step - loss: 9.6192 - mae:
2.4264 - val_loss: 10.0175 - val_mae: 2.4432
Epoch 3/7
819/819 [==============================] - 115s 140ms/step - loss: 8.4948 - mae:
2.2761 - val_loss: 9.7029 - val_mae: 2.4051
Epoch 4/7
819/819 [==============================] - 115s 140ms/step - loss: 7.8801 - mae:
2.1936 - val_loss: 9.9285 - val_mae: 2.4333
Epoch 5/7
819/819 [==============================] - 115s 141ms/step - loss: 7.5119 - mae:
2.1421 - val_loss: 10.0455 - val_mae: 2.4487
Epoch 6/7
819/819 [==============================] - 115s 140ms/step - loss: 7.2317 - mae:
2.1007 - val_loss: 10.0826 - val_mae: 2.4536
Epoch 7/7
819/819 [==============================] - 115s 140ms/step - loss: 6.9835 - mae:
2.0610 - val_loss: 10.4525 - val_mae: 2.4956
405/405 [==============================] - 19s 46ms/step - loss: 11.4603 - mae:
2.6055
Test MAE: 2.61
```

TEST MAE – COMBINATION OF 1D CONVENT AND RNN – 2.62

```
Epoch 1/7
819/819 [==============================] - 118s 141ms/step - loss: 26.2874 -
mae: 3.6911 - val_loss: 10.5428 - val_mae: 2.5172
Epoch 2/7
819/819 [==============================] - 115s 141ms/step - loss: 9.5115 - mae:
2.4100 - val_loss: 9.9082 - val_mae: 2.4252
Epoch 3/7
819/819 [==============================] - 115s 141ms/step - loss: 8.5254 - mae:
2.2753 - val_loss: 9.9273 - val_mae: 2.4359
Epoch 4/7
819/819 [==============================] - 115s 140ms/step - loss: 7.9265 - mae:
2.1944 - val_loss: 10.3498 - val_mae: 2.4872
Epoch 5/7
819/819 [==============================] - 115s 141ms/step - loss: 7.5152 - mae:
2.1347 - val_loss: 10.8683 - val_mae: 2.5475
Epoch 6/7
819/819 [==============================] - 115s 140ms/step - loss: 7.1626 - mae:
2.0819 - val_loss: 11.0660 - val_mae: 2.5724
Epoch 7/7
819/819 [==============================] - 115s 140ms/step - loss: 6.8987 - mae:
2.0417 - val_loss: 10.5593 - val_mae: 2.5235
405/405 [==============================] - 19s 46ms/step - loss: 10.9262 - mae:
2.61541s
Test MAE: 2.62
```

CONCLUSION:

From our evaluation, we can conclude that the 'LSTM - Dropout' model performed the best, achieving the lowest MAE of 2.54. This model balances complexity with regularization, resulting in improved predictive accuracy.

That model performance may vary depending on the specific dataset and task. Further fine-tuning and hyperparameter optimization may be necessary for optimal results. However, based on this analysis, the 'LSTM - Dropout' model stands out as the preferred choice for this particular task."