PM_RNN

November 30, 2017

```python
In [1]: import numpy as np
        import pandas as pd
        import os
        import matplotlib.pyplot as plt

In [2]: df = pd.read_pickle('data/micro_sud3_normalized.pkl')
        df = df.reset_index()


        def split_dataframe(dataframe, percent):
            nb_rows = int(np.floor(percent * len(dataframe)))
            return dataframe[:nb_rows], dataframe[nb_rows:]

        def dataframe_to_xy(df):
            return (np.array(df[['PM_6182', 'PM_6179', 'PM_617B', 'PM25_6182', 'PM25_6179',\
                                 'PM25_617B', 'temp', 'rh',\
                                 'tgrad', 'pressure', 'pluvio']]),\
                    np.array(df['PM_ref']))


        df_train, df_test = split_dataframe(df, 0.5)
        df_valid, df_test = split_dataframe(df_test, 0.5)

        X_train, y_train = dataframe_to_xy(df_train)
        X_valid, y_valid = dataframe_to_xy(df_valid)
        X_test, y_test = dataframe_to_xy(df_test)

        X_train = X_train.reshape((X_train.shape[0], 1, X_train.shape[1]))
        X_valid= X_valid.reshape((X_valid.shape[0], 1,  X_valid.shape[1]))
        X_test = X_test.reshape((X_test.shape[0], 1, X_test.shape[1]))

        def dataframe_to_xy_sequences(df, sequence_size):
            out_X = np.zeros((len(df)//sequence_size, sequence_size, 8))
            out_y = np.zeros((len(df)//sequence_size, sequence_size))
            i = 0
            while i + sequence_size < len(df):
                sequence = df.iloc[i:i+sequence_size]
                out_X[i//sequence_size] =  np.array(sequence[['NO2_61FD', 'NO2_61F0', 'NO2_61E
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                                  'tgrad', 'pressure', 'pluvio']])
            out_y[i//sequence_size] = np.array(sequence['NO2_ref'])
            i += sequence_size

        return out_X, out_y

In [3]: from keras.layers import SimpleRNN, Dense, LSTM, GRU
        from keras.models import Sequential
        from keras.callbacks import EarlyStopping

        def simple_rnn_model(nb_units, input_dim, loss='mean_squared_error', optimizer='adam')
            model = Sequential()
            model.add(SimpleRNN(nb_units, activation='relu', input_shape=input_dim))#input_dim
            model.add(Dense(1, kernel_initializer='normal'))
            model.compile(loss=loss, optimizer=optimizer)
            model.summary()
            return model

        def lstm_model(nb_units, input_dim, loss='mean_squared_error', optimizer='adam'):
            model = Sequential()
            model.add(LSTM(nb_units, activation='relu', input_shape=input_dim))#input_dim=inpu
            model.add(Dense(1, kernel_initializer='normal'))
            model.compile(loss=loss, optimizer=optimizer)
            model.summary()
            return model

        def gru_model(nb_units, input_dim, loss='mean_squared_error', optimizer='adam'):
            model = Sequential()
            model.add(GRU(nb_units, activation='relu', input_shape=input_dim))#input_dim=input_
            model.add(Dense(1, kernel_initializer='normal'))
            model.compile(loss=loss, optimizer=optimizer)
            model.summary()
            return model

Using TensorFlow backend.


In [4]: model = simple_rnn_model(32, X_train.shape[1:])


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Layer (type)                 Output Shape              Param #
=================================================================
simple_rnn_1 (SimpleRNN)     (None, 32)                1408

_____
dense_1 (Dense)              (None, 1)                 33
=================================================================
Total params: 1,441
Trainable params: 1,441
Non-trainable params: 0
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In [5]: early_stopping = EarlyStopping(monitor='val_loss', verbose=1, mode='auto', patience=10)
        history = model.fit(X_train, y_train, batch_size=32, epochs=10000, validation_data=(X_v

Train on 1126 samples, validate on 563 samples
Epoch 1/10000
1126/1126 [==============================] - 1s 519us/step - loss: 528.9152 - val_loss: 789.52
Epoch 2/10000
1126/1126 [==============================] - 0s 44us/step - loss: 523.3770 - val_loss: 786.426
Epoch 3/10000
1126/1126 [==============================] - 0s 44us/step - loss: 517.5020 - val_loss: 782.039
Epoch 4/10000
1126/1126 [==============================] - 0s 43us/step - loss: 509.9353 - val_loss: 775.587
Epoch 5/10000
1126/1126 [==============================] - 0s 41us/step - loss: 499.8403 - val_loss: 766.2888
Epoch 6/10000
1126/1126 [==============================] - 0s 44us/step - loss: 486.4888 - val_loss: 753.395
Epoch 7/10000
1126/1126 [==============================] - 0s 44us/step - loss: 469.3921 - val_loss: 736.340
Epoch 8/10000
1126/1126 [==============================] - 0s 41us/step - loss: 448.4519 - val_loss: 714.8528
Epoch 9/10000
1126/1126 [==============================] - 0s 39us/step - loss: 423.9639 - val_loss: 689.0180
Epoch 10/10000
1126/1126 [==============================] - 0s 39us/step - loss: 396.5467 - val_loss: 659.2985
Epoch 11/10000
1126/1126 [==============================] - 0s 40us/step - loss: 367.0613 - val_loss: 626.5385
Epoch 12/10000
1126/1126 [==============================] - 0s 43us/step - loss: 336.5562 - val_loss: 591.8920
Epoch 13/10000
1126/1126 [==============================] - 0s 40us/step - loss: 306.1537 - val_loss: 556.5977
Epoch 14/10000
1126/1126 [==============================] - 0s 39us/step - loss: 276.8478 - val_loss: 521.7275
Epoch 15/10000
1126/1126 [==============================] - 0s 39us/step - loss: 249.3616 - val_loss: 488.0838
Epoch 16/10000
1126/1126 [==============================] - 0s 43us/step - loss: 224.1323 - val_loss: 456.2465
Epoch 17/10000
1126/1126 [==============================] - 0s 41us/step - loss: 201.3817 - val_loss: 426.5957
Epoch 18/10000
1126/1126 [==============================] - 0s 41us/step - loss: 181.1636 - val_loss: 399.2840
Epoch 19/10000
1126/1126 [==============================] - 0s 42us/step - loss: 163.3892 - val_loss: 374.3183
Epoch 20/10000
1126/1126 [==============================] - 0s 39us/step - loss: 147.8913 - val_loss: 351.6223
Epoch 21/10000
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1126/1126 [==============================] - 0s 39us/step - loss: 134.4646 - val_loss: 331.0714
Epoch 22/10000
1126/1126 [==============================] - 0s 39us/step - loss: 122.8919 - val_loss: 312.5196
Epoch 23/10000
1126/1126 [==============================] - 0s 39us/step - loss: 112.9557 - val_loss: 295.8059
Epoch 24/10000
1126/1126 [==============================] - 0s 39us/step - loss: 104.4479 - val_loss: 280.7660
Epoch 25/10000
1126/1126 [==============================] - 0s 39us/step - loss: 97.1754 - val_loss: 267.2421
Epoch 26/10000
1126/1126 [==============================] - 0s 39us/step - loss: 90.9643 - val_loss: 255.0816
Epoch 27/10000
1126/1126 [==============================] - 0s 39us/step - loss: 85.6605 - val_loss: 244.1435
Epoch 28/10000
1126/1126 [==============================] - 0s 39us/step - loss: 81.1297 - val_loss: 234.2977
Epoch 29/10000
1126/1126 [==============================] - 0s 40us/step - loss: 77.2564 - val_loss: 225.4264
Epoch 30/10000
1126/1126 [==============================] - 0s 47us/step - loss: 73.9421 - val_loss: 217.4238
Epoch 31/10000
1126/1126 [==============================] - 0s 44us/step - loss: 71.1031 - val_loss: 210.1956
Epoch 32/10000
1126/1126 [==============================] - 0s 45us/step - loss: 68.6680 - val_loss: 203.6582
Epoch 33/10000
1126/1126 [==============================] - 0s 46us/step - loss: 66.5762 - val_loss: 197.7379
Epoch 34/10000
1126/1126 [==============================] - 0s 44us/step - loss: 64.7757 - val_loss: 192.3693
Epoch 35/10000
1126/1126 [==============================] - 0s 40us/step - loss: 63.2220 - val_loss: 187.4952
Epoch 36/10000
1126/1126 [==============================] - 0s 39us/step - loss: 61.8771 - val_loss: 183.0651
Epoch 37/10000
1126/1126 [==============================] - 0s 43us/step - loss: 60.7082 - val_loss: 179.0341
Epoch 38/10000
1126/1126 [==============================] - 0s 44us/step - loss: 59.6873 - val_loss: 175.3621
Epoch 39/10000
1126/1126 [==============================] - 0s 44us/step - loss: 58.7906 - val_loss: 172.0137
Epoch 40/10000
1126/1126 [==============================] - 0s 45us/step - loss: 57.9978 - val_loss: 168.9570
Epoch 41/10000
1126/1126 [==============================] - 0s 39us/step - loss: 57.2915 - val_loss: 166.1636
Epoch 42/10000
1126/1126 [==============================] - 0s 40us/step - loss: 56.6572 - val_loss: 163.6080
Epoch 43/10000
1126/1126 [==============================] - 0s 40us/step - loss: 56.0825 - val_loss: 161.2674
Epoch 44/10000
1126/1126 [==============================] - 0s 40us/step - loss: 55.5569 - val_loss: 159.1215
Epoch 45/10000
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1126/1126 [==============================] - 0s 39us/step - loss: 55.0719 - val_loss: 157.1519
Epoch 46/10000
1126/1126 [==============================] - 0s 39us/step - loss: 54.6201 - val_loss: 155.3426
Epoch 47/10000
1126/1126 [==============================] - 0s 39us/step - loss: 54.1953 - val_loss: 153.6790
Epoch 48/10000
1126/1126 [==============================] - 0s 39us/step - loss: 53.7925 - val_loss: 152.1484
Epoch 49/10000
1126/1126 [==============================] - 0s 39us/step - loss: 53.4074 - val_loss: 150.7393
Epoch 50/10000
1126/1126 [==============================] - 0s 38us/step - loss: 53.0361 - val_loss: 149.4415
Epoch 51/10000
1126/1126 [==============================] - 0s 39us/step - loss: 52.6757 - val_loss: 148.2459
Epoch 52/10000
1126/1126 [==============================] - 0s 39us/step - loss: 52.3233 - val_loss: 147.1443
Epoch 53/10000
1126/1126 [==============================] - 0s 47us/step - loss: 51.9765 - val_loss: 146.1291
Epoch 54/10000
1126/1126 [==============================] - 0s 52us/step - loss: 51.6332 - val_loss: 145.1933
Epoch 55/10000
1126/1126 [==============================] - 0s 43us/step - loss: 51.2914 - val_loss: 144.3303
Epoch 56/10000
1126/1126 [==============================] - 0s 43us/step - loss: 50.9496 - val_loss: 143.5332
Epoch 57/10000
1126/1126 [==============================] - 0s 40us/step - loss: 50.6065 - val_loss: 142.7953
Epoch 58/10000
1126/1126 [==============================] - 0s 46us/step - loss: 50.2613 - val_loss: 142.1092
Epoch 59/10000
1126/1126 [==============================] - 0s 47us/step - loss: 49.9137 - val_loss: 141.4667
Epoch 60/10000
1126/1126 [==============================] - 0s 48us/step - loss: 49.5640 - val_loss: 140.8592
Epoch 61/10000
1126/1126 [==============================] - 0s 44us/step - loss: 49.2134 - val_loss: 140.2772
Epoch 62/10000
1126/1126 [==============================] - 0s 40us/step - loss: 48.8635 - val_loss: 139.7111
Epoch 63/10000
1126/1126 [==============================] - 0s 40us/step - loss: 48.5164 - val_loss: 139.1518
Epoch 64/10000
1126/1126 [==============================] - 0s 41us/step - loss: 48.1743 - val_loss: 138.5911
Epoch 65/10000
1126/1126 [==============================] - 0s 43us/step - loss: 47.8393 - val_loss: 138.0230
Epoch 66/10000
1126/1126 [==============================] - 0s 45us/step - loss: 47.5130 - val_loss: 137.4433
Epoch 67/10000
1126/1126 [==============================] - 0s 43us/step - loss: 47.1964 - val_loss: 136.8502
Epoch 68/10000
1126/1126 [==============================] - 0s 45us/step - loss: 46.8902 - val_loss: 136.2436
Epoch 69/10000
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1126/1126 [==============================] - 0s 42us/step - loss: 46.5946 - val_loss: 135.6249
Epoch 70/10000
1126/1126 [==============================] - 0s 41us/step - loss: 46.3096 - val_loss: 134.9965
Epoch 71/10000
1126/1126 [==============================] - 0s 40us/step - loss: 46.0348 - val_loss: 134.3608
Epoch 72/10000
1126/1126 [==============================] - 0s 43us/step - loss: 45.7700 - val_loss: 133.7209
Epoch 73/10000
1126/1126 [==============================] - 0s 42us/step - loss: 45.5148 - val_loss: 133.0792
Epoch 74/10000
1126/1126 [==============================] - 0s 42us/step - loss: 45.2689 - val_loss: 132.4383
Epoch 75/10000
1126/1126 [==============================] - 0s 42us/step - loss: 45.0318 - val_loss: 131.8001
Epoch 76/10000
1126/1126 [==============================] - 0s 40us/step - loss: 44.8034 - val_loss: 131.1666
Epoch 77/10000
1126/1126 [==============================] - 0s 40us/step - loss: 44.5832 - val_loss: 130.5391
Epoch 78/10000
1126/1126 [==============================] - 0s 39us/step - loss: 44.3710 - val_loss: 129.9190
Epoch 79/10000
1126/1126 [==============================] - 0s 39us/step - loss: 44.1665 - val_loss: 129.3073
Epoch 80/10000
1126/1126 [==============================] - 0s 38us/step - loss: 43.9695 - val_loss: 128.7049
Epoch 81/10000
1126/1126 [==============================] - 0s 39us/step - loss: 43.7798 - val_loss: 128.1125
Epoch 82/10000
1126/1126 [==============================] - 0s 38us/step - loss: 43.5971 - val_loss: 127.5307
Epoch 83/10000
1126/1126 [==============================] - 0s 38us/step - loss: 43.4212 - val_loss: 126.9601
Epoch 84/10000
1126/1126 [==============================] - 0s 39us/step - loss: 43.2518 - val_loss: 126.4011
Epoch 85/10000
1126/1126 [==============================] - 0s 40us/step - loss: 43.0889 - val_loss: 125.8541
Epoch 86/10000
1126/1126 [==============================] - 0s 40us/step - loss: 42.9320 - val_loss: 125.3196
Epoch 87/10000
1126/1126 [==============================] - 0s 39us/step - loss: 42.7811 - val_loss: 124.7977
Epoch 88/10000
1126/1126 [==============================] - 0s 39us/step - loss: 42.6359 - val_loss: 124.2888
Epoch 89/10000
1126/1126 [==============================] - 0s 39us/step - loss: 42.4961 - val_loss: 123.7929
Epoch 90/10000
1126/1126 [==============================] - 0s 39us/step - loss: 42.3616 - val_loss: 123.3102
Epoch 91/10000
1126/1126 [==============================] - 0s 39us/step - loss: 42.2321 - val_loss: 122.8408
Epoch 92/10000
1126/1126 [==============================] - 0s 40us/step - loss: 42.1073 - val_loss: 122.3847
Epoch 93/10000
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1126/1126 [==============================] - 0s 38us/step - loss: 41.9871 - val_loss: 121.9418
Epoch 94/10000
1126/1126 [==============================] - 0s 38us/step - loss: 41.8712 - val_loss: 121.5120
Epoch 95/10000
1126/1126 [==============================] - 0s 40us/step - loss: 41.7594 - val_loss: 121.0953
Epoch 96/10000
1126/1126 [==============================] - 0s 39us/step - loss: 41.6515 - val_loss: 120.6914
Epoch 97/10000
1126/1126 [==============================] - 0s 39us/step - loss: 41.5472 - val_loss: 120.3000
Epoch 98/10000
1126/1126 [==============================] - 0s 39us/step - loss: 41.4464 - val_loss: 119.9211
Epoch 99/10000
1126/1126 [==============================] - 0s 38us/step - loss: 41.3489 - val_loss: 119.5542
Epoch 100/10000
1126/1126 [==============================] - 0s 38us/step - loss: 41.2543 - val_loss: 119.1991
Epoch 101/10000
1126/1126 [==============================] - 0s 40us/step - loss: 41.1627 - val_loss: 118.8555
Epoch 102/10000
1126/1126 [==============================] - 0s 40us/step - loss: 41.0737 - val_loss: 118.5231
Epoch 103/10000
1126/1126 [==============================] - 0s 39us/step - loss: 40.9873 - val_loss: 118.2016
Epoch 104/10000
1126/1126 [==============================] - 0s 39us/step - loss: 40.9033 - val_loss: 117.8906
Epoch 105/10000
1126/1126 [==============================] - 0s 40us/step - loss: 40.8215 - val_loss: 117.5900
Epoch 106/10000
1126/1126 [==============================] - 0s 41us/step - loss: 40.7418 - val_loss: 117.2993
Epoch 107/10000
1126/1126 [==============================] - 0s 39us/step - loss: 40.6641 - val_loss: 117.0184
Epoch 108/10000
1126/1126 [==============================] - 0s 39us/step - loss: 40.5882 - val_loss: 116.7470
Epoch 109/10000
1126/1126 [==============================] - 0s 40us/step - loss: 40.5141 - val_loss: 116.4848
Epoch 110/10000
1126/1126 [==============================] - 0s 40us/step - loss: 40.4417 - val_loss: 116.2316
Epoch 111/10000
1126/1126 [==============================] - 0s 39us/step - loss: 40.3709 - val_loss: 115.9871
Epoch 112/10000
1126/1126 [==============================] - 0s 41us/step - loss: 40.3016 - val_loss: 115.7511
Epoch 113/10000
1126/1126 [==============================] - 0s 39us/step - loss: 40.2337 - val_loss: 115.5233
Epoch 114/10000
1126/1126 [==============================] - 0s 40us/step - loss: 40.1671 - val_loss: 115.3036
Epoch 115/10000
1126/1126 [==============================] - 0s 44us/step - loss: 40.1018 - val_loss: 115.0917
Epoch 116/10000
1126/1126 [==============================] - 0s 41us/step - loss: 40.0377 - val_loss: 114.8874
Epoch 117/10000
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1126/1126 [==============================] - 0s 42us/step - loss: 39.9748 - val_loss: 114.6903
Epoch 118/10000
1126/1126 [==============================] - 0s 46us/step - loss: 39.9130 - val_loss: 114.5002
Epoch 119/10000
1126/1126 [==============================] - ETA: 0s - loss: 76.03 - 0s 46us/step - loss: 39.85
Epoch 120/10000
1126/1126 [==============================] - 0s 39us/step - loss: 39.7926 - val_loss: 114.1401
Epoch 121/10000
1126/1126 [==============================] - 0s 43us/step - loss: 39.7338 - val_loss: 113.9696
Epoch 122/10000
1126/1126 [==============================] - 0s 40us/step - loss: 39.6760 - val_loss: 113.8050
Epoch 123/10000
1126/1126 [==============================] - 0s 44us/step - loss: 39.6191 - val_loss: 113.6462
Epoch 124/10000
1126/1126 [==============================] - 0s 39us/step - loss: 39.5631 - val_loss: 113.4928
Epoch 125/10000
1126/1126 [==============================] - 0s 42us/step - loss: 39.5079 - val_loss: 113.3446
Epoch 126/10000
1126/1126 [==============================] - 0s 40us/step - loss: 39.4536 - val_loss: 113.2013
Epoch 127/10000
1126/1126 [==============================] - 0s 40us/step - loss: 39.4000 - val_loss: 113.0628
Epoch 128/10000
1126/1126 [==============================] - 0s 39us/step - loss: 39.3472 - val_loss: 112.9286
Epoch 129/10000
1126/1126 [==============================] - 0s 41us/step - loss: 39.2952 - val_loss: 112.7987
Epoch 130/10000
1126/1126 [==============================] - 0s 40us/step - loss: 39.2439 - val_loss: 112.6727
Epoch 131/10000
1126/1126 [==============================] - 0s 41us/step - loss: 39.1933 - val_loss: 112.5506
Epoch 132/10000
1126/1126 [==============================] - 0s 39us/step - loss: 39.1434 - val_loss: 112.4320
Epoch 133/10000
1126/1126 [==============================] - 0s 39us/step - loss: 39.0942 - val_loss: 112.3167
Epoch 134/10000
1126/1126 [==============================] - 0s 39us/step - loss: 39.0456 - val_loss: 112.2046
Epoch 135/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.9977 - val_loss: 112.0955
Epoch 136/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.9505 - val_loss: 111.9893
Epoch 137/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.9038 - val_loss: 111.8857
Epoch 138/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.8578 - val_loss: 111.7846
Epoch 139/10000
1126/1126 [==============================] - 0s 48us/step - loss: 38.8123 - val_loss: 111.6858
Epoch 140/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.7675 - val_loss: 111.5893
Epoch 141/10000
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8

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1126/1126 [==============================] - 0s 39us/step - loss: 38.7232 - val_loss: 111.4948
Epoch 142/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.6794 - val_loss: 111.4024
Epoch 143/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.6362 - val_loss: 111.3118
Epoch 144/10000
1126/1126 [==============================] - 0s 43us/step - loss: 38.5935 - val_loss: 111.2229
Epoch 145/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.5513 - val_loss: 111.1358
Epoch 146/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.5096 - val_loss: 111.0502
Epoch 147/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.4685 - val_loss: 110.9660
Epoch 148/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.4278 - val_loss: 110.8833
Epoch 149/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.3875 - val_loss: 110.8020
Epoch 150/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.3478 - val_loss: 110.7219
Epoch 151/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.3085 - val_loss: 110.6430
Epoch 152/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.2696 - val_loss: 110.5654
Epoch 153/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.2312 - val_loss: 110.4888
Epoch 154/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.1932 - val_loss: 110.4133
Epoch 155/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.1556 - val_loss: 110.3388
Epoch 156/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.1185 - val_loss: 110.2654
Epoch 157/10000
1126/1126 [==============================] - 0s 40us/step - loss: 38.0817 - val_loss: 110.1929
Epoch 158/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.0454 - val_loss: 110.1213
Epoch 159/10000
1126/1126 [==============================] - 0s 39us/step - loss: 38.0094 - val_loss: 110.0507
Epoch 160/10000
1126/1126 [==============================] - 0s 42us/step - loss: 37.9738 - val_loss: 109.9810
Epoch 161/10000
1126/1126 [==============================] - 0s 41us/step - loss: 37.9386 - val_loss: 109.9121
Epoch 162/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.9038 - val_loss: 109.8441
Epoch 163/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.8693 - val_loss: 109.7770
Epoch 164/10000
1126/1126 [==============================] - 0s 41us/step - loss: 37.8352 - val_loss: 109.7107
Epoch 165/10000
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1126/1126 [==============================] - 0s 40us/step - loss: 37.8014 - val_loss: 109.6451
Epoch 166/10000
1126/1126 [==============================] - 0s 40us/step - loss: 37.7680 - val_loss: 109.5804
Epoch 167/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.7348 - val_loss: 109.5165
Epoch 168/10000
1126/1126 [==============================] - 0s 38us/step - loss: 37.7021 - val_loss: 109.4534
Epoch 169/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.6696 - val_loss: 109.3911
Epoch 170/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.6375 - val_loss: 109.3295
Epoch 171/10000
1126/1126 [==============================] - 0s 38us/step - loss: 37.6057 - val_loss: 109.2687
Epoch 172/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.5741 - val_loss: 109.2087
Epoch 173/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.5429 - val_loss: 109.1494
Epoch 174/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.5120 - val_loss: 109.0908
Epoch 175/10000
1126/1126 [==============================] - 0s 40us/step - loss: 37.4813 - val_loss: 109.0330
Epoch 176/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.4510 - val_loss: 108.9759
Epoch 177/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.4209 - val_loss: 108.9196
Epoch 178/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.3910 - val_loss: 108.8639
Epoch 179/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.3615 - val_loss: 108.8090
Epoch 180/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.3321 - val_loss: 108.7548
Epoch 181/10000
1126/1126 [==============================] - 0s 40us/step - loss: 37.3031 - val_loss: 108.7012
Epoch 182/10000
1126/1126 [==============================] - 0s 42us/step - loss: 37.2742 - val_loss: 108.6483
Epoch 183/10000
1126/1126 [==============================] - 0s 42us/step - loss: 37.2456 - val_loss: 108.5961
Epoch 184/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.2173 - val_loss: 108.5446
Epoch 185/10000
1126/1126 [==============================] - 0s 40us/step - loss: 37.1891 - val_loss: 108.4937
Epoch 186/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.1612 - val_loss: 108.4434
Epoch 187/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.1335 - val_loss: 108.3938
Epoch 188/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.1059 - val_loss: 108.3448
Epoch 189/10000
```

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1126/1126 [==============================] - 0s 39us/step - loss: 37.0786 - val_loss: 108.2964
Epoch 190/10000
1126/1126 [==============================] - 0s 39us/step - loss: 37.0515 - val_loss: 108.2486
Epoch 191/10000
1126/1126 [==============================] - 0s 38us/step - loss: 37.0246 - val_loss: 108.2013
Epoch 192/10000
1126/1126 [==============================] - 0s 38us/step - loss: 36.9978 - val_loss: 108.1546
Epoch 193/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.9712 - val_loss: 108.1085
Epoch 194/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.9448 - val_loss: 108.0629
Epoch 195/10000
1126/1126 [==============================] - 0s 49us/step - loss: 36.9185 - val_loss: 108.0179
Epoch 196/10000
1126/1126 [==============================] - 0s 44us/step - loss: 36.8924 - val_loss: 107.9734
Epoch 197/10000
1126/1126 [==============================] - 0s 51us/step - loss: 36.8665 - val_loss: 107.9293
Epoch 198/10000
1126/1126 [==============================] - 0s 40us/step - loss: 36.8407 - val_loss: 107.8858
Epoch 199/10000
1126/1126 [==============================] - 0s 40us/step - loss: 36.8150 - val_loss: 107.8427
Epoch 200/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.7895 - val_loss: 107.8001
Epoch 201/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.7641 - val_loss: 107.7580
Epoch 202/10000
1126/1126 [==============================] - 0s 38us/step - loss: 36.7389 - val_loss: 107.7163
Epoch 203/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.7137 - val_loss: 107.6750
Epoch 204/10000
1126/1126 [==============================] - 0s 41us/step - loss: 36.6887 - val_loss: 107.6341
Epoch 205/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.6638 - val_loss: 107.5937
Epoch 206/10000
1126/1126 [==============================] - 0s 40us/step - loss: 36.6390 - val_loss: 107.5536
Epoch 207/10000
1126/1126 [==============================] - 0s 40us/step - loss: 36.6143 - val_loss: 107.5140
Epoch 208/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.5897 - val_loss: 107.4747
Epoch 209/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.5652 - val_loss: 107.4357
Epoch 210/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.5407 - val_loss: 107.3971
Epoch 211/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.5164 - val_loss: 107.3589
Epoch 212/10000
1126/1126 [==============================] - 0s 38us/step - loss: 36.4922 - val_loss: 107.3210
Epoch 213/10000
```

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1126/1126 [==============================] - 0s 39us/step - loss: 36.4680 - val_loss: 107.2834
Epoch 214/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.4439 - val_loss: 107.2461
Epoch 215/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.4199 - val_loss: 107.2091
Epoch 216/10000
1126/1126 [==============================] - 0s 38us/step - loss: 36.3959 - val_loss: 107.1724
Epoch 217/10000
1126/1126 [==============================] - 0s 41us/step - loss: 36.3720 - val_loss: 107.1359
Epoch 218/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.3482 - val_loss: 107.0997
Epoch 219/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.3244 - val_loss: 107.0638
Epoch 220/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.3007 - val_loss: 107.0282
Epoch 221/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.2770 - val_loss: 106.9928
Epoch 222/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.2534 - val_loss: 106.9576
Epoch 223/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.2298 - val_loss: 106.9226
Epoch 224/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.2063 - val_loss: 106.8879
Epoch 225/10000
1126/1126 [==============================] - 0s 42us/step - loss: 36.1828 - val_loss: 106.8533
Epoch 226/10000
1126/1126 [==============================] - 0s 41us/step - loss: 36.1594 - val_loss: 106.8190
Epoch 227/10000
1126/1126 [==============================] - 0s 41us/step - loss: 36.1360 - val_loss: 106.7849
Epoch 228/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.1126 - val_loss: 106.7509
Epoch 229/10000
1126/1126 [==============================] - 0s 40us/step - loss: 36.0893 - val_loss: 106.7171
Epoch 230/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.0660 - val_loss: 106.6835
Epoch 231/10000
1126/1126 [==============================] - 0s 40us/step - loss: 36.0428 - val_loss: 106.6500
Epoch 232/10000
1126/1126 [==============================] - 0s 39us/step - loss: 36.0195 - val_loss: 106.6167
Epoch 233/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.9963 - val_loss: 106.5836
Epoch 234/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.9731 - val_loss: 106.5505
Epoch 235/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.9499 - val_loss: 106.5177
Epoch 236/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.9268 - val_loss: 106.4849
Epoch 237/10000
```

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1126/1126 [==============================] - 0s 39us/step - loss: 35.9037 - val_loss: 106.4523
Epoch 238/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.8806 - val_loss: 106.4197
Epoch 239/10000
1126/1126 [==============================] - 0s 40us/step - loss: 35.8575 - val_loss: 106.3873
Epoch 240/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.8344 - val_loss: 106.3550
Epoch 241/10000
1126/1126 [==============================] - 0s 41us/step - loss: 35.8114 - val_loss: 106.3228
Epoch 242/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.7884 - val_loss: 106.2907
Epoch 243/10000
1126/1126 [==============================] - 0s 40us/step - loss: 35.7653 - val_loss: 106.2587
Epoch 244/10000
1126/1126 [==============================] - 0s 40us/step - loss: 35.7423 - val_loss: 106.2267
Epoch 245/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.7193 - val_loss: 106.1949
Epoch 246/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.6963 - val_loss: 106.1631
Epoch 247/10000
1126/1126 [==============================] - 0s 42us/step - loss: 35.6733 - val_loss: 106.1313
Epoch 248/10000
1126/1126 [==============================] - 0s 42us/step - loss: 35.6504 - val_loss: 106.0997
Epoch 249/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.6274 - val_loss: 106.0681
Epoch 250/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.6044 - val_loss: 106.0366
Epoch 251/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.5815 - val_loss: 106.0051
Epoch 252/10000
1126/1126 [==============================] - 0s 40us/step - loss: 35.5585 - val_loss: 105.9736
Epoch 253/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.5356 - val_loss: 105.9423
Epoch 254/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.5126 - val_loss: 105.9109
Epoch 255/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.4897 - val_loss: 105.8796
Epoch 256/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.4668 - val_loss: 105.8484
Epoch 257/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.4438 - val_loss: 105.8171
Epoch 258/10000
1126/1126 [==============================] - 0s 40us/step - loss: 35.4209 - val_loss: 105.7860
Epoch 259/10000
1126/1126 [==============================] - 0s 43us/step - loss: 35.3979 - val_loss: 105.7548
Epoch 260/10000
1126/1126 [==============================] - 0s 40us/step - loss: 35.3750 - val_loss: 105.7237
Epoch 261/10000
```

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1126/1126 [==============================] - 0s 40us/step - loss: 35.3520 - val_loss: 105.6926
Epoch 262/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.3291 - val_loss: 105.6615
Epoch 263/10000
1126/1126 [==============================] - 0s 40us/step - loss: 35.3061 - val_loss: 105.6305
Epoch 264/10000
1126/1126 [==============================] - 0s 38us/step - loss: 35.2831 - val_loss: 105.5995
Epoch 265/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.2602 - val_loss: 105.5685
Epoch 266/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.2372 - val_loss: 105.5375
Epoch 267/10000
1126/1126 [==============================] - 0s 39us/step - loss: 35.2142 - val_loss: 105.5065
Epoch 268/10000
1126/1126 [==============================] - 0s 43us/step - loss: 35.1912 - val_loss: 105.4756
Epoch 269/10000
1126/1126 [==============================] - 0s 42us/step - loss: 35.1682 - val_loss: 105.4447
Epoch 270/10000
1126/1126 [==============================] - 0s 49us/step - loss: 35.1452 - val_loss: 105.4138
Epoch 271/10000
1126/1126 [==============================] - 0s 44us/step - loss: 35.1222 - val_loss: 105.3829
Epoch 272/10000
1126/1126 [==============================] - 0s 47us/step - loss: 35.0991 - val_loss: 105.3521
Epoch 273/10000
1126/1126 [==============================] - 0s 43us/step - loss: 35.0761 - val_loss: 105.3212
Epoch 274/10000
1126/1126 [==============================] - 0s 41us/step - loss: 35.0530 - val_loss: 105.2904
Epoch 275/10000
1126/1126 [==============================] - 0s 42us/step - loss: 35.0300 - val_loss: 105.2596
Epoch 276/10000
1126/1126 [==============================] - 0s 41us/step - loss: 35.0069 - val_loss: 105.2288
Epoch 277/10000
1126/1126 [==============================] - 0s 48us/step - loss: 34.9838 - val_loss: 105.1981
Epoch 278/10000
1126/1126 [==============================] - 0s 46us/step - loss: 34.9607 - val_loss: 105.1673
Epoch 279/10000
1126/1126 [==============================] - 0s 46us/step - loss: 34.9376 - val_loss: 105.1366
Epoch 280/10000
1126/1126 [==============================] - 0s 41us/step - loss: 34.9144 - val_loss: 105.1059
Epoch 281/10000
1126/1126 [==============================] - 0s 45us/step - loss: 34.8913 - val_loss: 105.0752
Epoch 282/10000
1126/1126 [==============================] - 0s 43us/step - loss: 34.8681 - val_loss: 105.0446
Epoch 283/10000
1126/1126 [==============================] - 0s 43us/step - loss: 34.8449 - val_loss: 105.0140
Epoch 284/10000
1126/1126 [==============================] - 0s 43us/step - loss: 34.8217 - val_loss: 104.9834
Epoch 285/10000
```

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1126/1126 [==============================] - 0s 46us/step - loss: 34.7984 - val_loss: 104.9528
Epoch 286/10000
1126/1126 [==============================] - 0s 50us/step - loss: 34.7752 - val_loss: 104.9223
Epoch 287/10000
1126/1126 [==============================] - 0s 47us/step - loss: 34.7519 - val_loss: 104.8918
Epoch 288/10000
1126/1126 [==============================] - 0s 44us/step - loss: 34.7286 - val_loss: 104.8614
Epoch 289/10000
1126/1126 [==============================] - 0s 43us/step - loss: 34.7053 - val_loss: 104.8309
Epoch 290/10000
1126/1126 [==============================] - 0s 52us/step - loss: 34.6820 - val_loss: 104.8006
Epoch 291/10000
1126/1126 [==============================] - 0s 44us/step - loss: 34.6586 - val_loss: 104.7702
Epoch 292/10000
1126/1126 [==============================] - 0s 44us/step - loss: 34.6352 - val_loss: 104.7400
Epoch 293/10000
1126/1126 [==============================] - 0s 43us/step - loss: 34.6118 - val_loss: 104.7097
Epoch 294/10000
1126/1126 [==============================] - 0s 44us/step - loss: 34.5883 - val_loss: 104.6796
Epoch 295/10000
1126/1126 [==============================] - 0s 42us/step - loss: 34.5648 - val_loss: 104.6494
Epoch 296/10000
1126/1126 [==============================] - 0s 47us/step - loss: 34.5413 - val_loss: 104.6194
Epoch 297/10000
1126/1126 [==============================] - ETA: 0s - loss: 66.47 - 0s 40us/step - loss: 34.5
Epoch 298/10000
1126/1126 [==============================] - 0s 40us/step - loss: 34.4942 - val_loss: 104.5595
Epoch 299/10000
1126/1126 [==============================] - 0s 40us/step - loss: 34.4706 - val_loss: 104.5297
Epoch 300/10000
1126/1126 [==============================] - 0s 41us/step - loss: 34.4469 - val_loss: 104.4999
Epoch 301/10000
1126/1126 [==============================] - 0s 42us/step - loss: 34.4232 - val_loss: 104.4703
Epoch 302/10000
1126/1126 [==============================] - 0s 42us/step - loss: 34.3995 - val_loss: 104.4407
Epoch 303/10000
1126/1126 [==============================] - 0s 40us/step - loss: 34.3757 - val_loss: 104.4113
Epoch 304/10000
1126/1126 [==============================] - 0s 40us/step - loss: 34.3518 - val_loss: 104.3820
Epoch 305/10000
1126/1126 [==============================] - 0s 42us/step - loss: 34.3280 - val_loss: 104.3527
Epoch 306/10000
1126/1126 [==============================] - 0s 41us/step - loss: 34.3040 - val_loss: 104.3236
Epoch 307/10000
1126/1126 [==============================] - 0s 41us/step - loss: 34.2800 - val_loss: 104.2947
Epoch 308/10000
1126/1126 [==============================] - 0s 39us/step - loss: 34.2560 - val_loss: 104.2659
Epoch 309/10000
```

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1126/1126 [==============================] - 0s 40us/step - loss: 34.2319 - val_loss: 104.2373
Epoch 310/10000
1126/1126 [==============================] - 0s 42us/step - loss: 34.2077 - val_loss: 104.2088
Epoch 311/10000
1126/1126 [==============================] - 0s 41us/step - loss: 34.1835 - val_loss: 104.1805
Epoch 312/10000
1126/1126 [==============================] - 0s 41us/step - loss: 34.1591 - val_loss: 104.1524
Epoch 313/10000
1126/1126 [==============================] - 0s 43us/step - loss: 34.1348 - val_loss: 104.1245
Epoch 314/10000
1126/1126 [==============================] - 0s 39us/step - loss: 34.1103 - val_loss: 104.0968
Epoch 315/10000
1126/1126 [==============================] - 0s 39us/step - loss: 34.0857 - val_loss: 104.0693
Epoch 316/10000
1126/1126 [==============================] - 0s 42us/step - loss: 34.0611 - val_loss: 104.0421
Epoch 317/10000
1126/1126 [==============================] - 0s 45us/step - loss: 34.0363 - val_loss: 104.0152
Epoch 318/10000
1126/1126 [==============================] - 0s 41us/step - loss: 34.0115 - val_loss: 103.9885
Epoch 319/10000
1126/1126 [==============================] - 0s 41us/step - loss: 33.9865 - val_loss: 103.9621
Epoch 320/10000
1126/1126 [==============================] - 0s 41us/step - loss: 33.9614 - val_loss: 103.9360
Epoch 321/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.9362 - val_loss: 103.9103
Epoch 322/10000
1126/1126 [==============================] - 0s 44us/step - loss: 33.9109 - val_loss: 103.8849
Epoch 323/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.8855 - val_loss: 103.8598
Epoch 324/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.8599 - val_loss: 103.8351
Epoch 325/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.8341 - val_loss: 103.8108
Epoch 326/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.8082 - val_loss: 103.7869
Epoch 327/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.7821 - val_loss: 103.7634
Epoch 328/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.7559 - val_loss: 103.7403
Epoch 329/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.7295 - val_loss: 103.7177
Epoch 330/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.7029 - val_loss: 103.6956
Epoch 331/10000
1126/1126 [==============================] - 0s 45us/step - loss: 33.6761 - val_loss: 103.6738
Epoch 332/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.6491 - val_loss: 103.6526
Epoch 333/10000
```

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1126/1126 [==============================] - 0s 42us/step - loss: 33.6219 - val_loss: 103.6318
Epoch 334/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.5945 - val_loss: 103.6115
Epoch 335/10000
1126/1126 [==============================] - 0s 48us/step - loss: 33.5669 - val_loss: 103.5916
Epoch 336/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.5391 - val_loss: 103.5722
Epoch 337/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.5111 - val_loss: 103.5532
Epoch 338/10000
1126/1126 [==============================] - 0s 48us/step - loss: 33.4828 - val_loss: 103.5346
Epoch 339/10000
1126/1126 [==============================] - 0s 48us/step - loss: 33.4543 - val_loss: 103.5164
Epoch 340/10000
1126/1126 [==============================] - 0s 46us/step - loss: 33.4257 - val_loss: 103.4987
Epoch 341/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.3967 - val_loss: 103.4812
Epoch 342/10000
1126/1126 [==============================] - 0s 46us/step - loss: 33.3676 - val_loss: 103.4641
Epoch 343/10000
1126/1126 [==============================] - 0s 57us/step - loss: 33.3383 - val_loss: 103.4473
Epoch 344/10000
1126/1126 [==============================] - 0s 60us/step - loss: 33.3087 - val_loss: 103.4308
Epoch 345/10000
1126/1126 [==============================] - 0s 46us/step - loss: 33.2790 - val_loss: 103.4144
Epoch 346/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.2491 - val_loss: 103.3983
Epoch 347/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.2189 - val_loss: 103.3822
Epoch 348/10000
1126/1126 [==============================] - 0s 44us/step - loss: 33.1886 - val_loss: 103.3663
Epoch 349/10000
1126/1126 [==============================] - 0s 41us/step - loss: 33.1582 - val_loss: 103.3505
Epoch 350/10000
1126/1126 [==============================] - 0s 45us/step - loss: 33.1276 - val_loss: 103.3347
Epoch 351/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.0968 - val_loss: 103.3188
Epoch 352/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.0659 - val_loss: 103.3029
Epoch 353/10000
1126/1126 [==============================] - 0s 43us/step - loss: 33.0349 - val_loss: 103.2870
Epoch 354/10000
1126/1126 [==============================] - 0s 42us/step - loss: 33.0038 - val_loss: 103.2709
Epoch 355/10000
1126/1126 [==============================] - 0s 42us/step - loss: 32.9725 - val_loss: 103.2547
Epoch 356/10000
1126/1126 [==============================] - 0s 45us/step - loss: 32.9412 - val_loss: 103.2384
Epoch 357/10000
```

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1126/1126 [==============================] - 0s 53us/step - loss: 32.9098 - val_loss: 103.2219
Epoch 358/10000
1126/1126 [==============================] - 0s 44us/step - loss: 32.8784 - val_loss: 103.2052
Epoch 359/10000
1126/1126 [==============================] - 0s 45us/step - loss: 32.8469 - val_loss: 103.1883
Epoch 360/10000
1126/1126 [==============================] - 0s 45us/step - loss: 32.8154 - val_loss: 103.1712
Epoch 361/10000
1126/1126 [==============================] - 0s 46us/step - loss: 32.7839 - val_loss: 103.1538
Epoch 362/10000
1126/1126 [==============================] - 0s 53us/step - loss: 32.7523 - val_loss: 103.1363
Epoch 363/10000
1126/1126 [==============================] - 0s 49us/step - loss: 32.7208 - val_loss: 103.1185
Epoch 364/10000
1126/1126 [==============================] - 0s 41us/step - loss: 32.6893 - val_loss: 103.1005
Epoch 365/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.6578 - val_loss: 103.0823
Epoch 366/10000
1126/1126 [==============================] - 0s 39us/step - loss: 32.6264 - val_loss: 103.0638
Epoch 367/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.5950 - val_loss: 103.0452
Epoch 368/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.5636 - val_loss: 103.0263
Epoch 369/10000
1126/1126 [==============================] - 0s 43us/step - loss: 32.5323 - val_loss: 103.0072
Epoch 370/10000
1126/1126 [==============================] - 0s 45us/step - loss: 32.5011 - val_loss: 102.9880
Epoch 371/10000
1126/1126 [==============================] - 0s 42us/step - loss: 32.4700 - val_loss: 102.9686
Epoch 372/10000
1126/1126 [==============================] - 0s 41us/step - loss: 32.4390 - val_loss: 102.9490
Epoch 373/10000
1126/1126 [==============================] - 0s 42us/step - loss: 32.4080 - val_loss: 102.9292
Epoch 374/10000
1126/1126 [==============================] - 0s 42us/step - loss: 32.3772 - val_loss: 102.9093
Epoch 375/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.3465 - val_loss: 102.8893
Epoch 376/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.3158 - val_loss: 102.8692
Epoch 377/10000
1126/1126 [==============================] - 0s 41us/step - loss: 32.2853 - val_loss: 102.8489
Epoch 378/10000
1126/1126 [==============================] - 0s 41us/step - loss: 32.2548 - val_loss: 102.8286
Epoch 379/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.2245 - val_loss: 102.8082
Epoch 380/10000
1126/1126 [==============================] - 0s 41us/step - loss: 32.1943 - val_loss: 102.7877
Epoch 381/10000
```

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1126/1126 [==============================] - 0s 39us/step - loss: 32.1642 - val_loss: 102.7671
Epoch 382/10000
1126/1126 [==============================] - 0s 41us/step - loss: 32.1342 - val_loss: 102.7466
Epoch 383/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.1043 - val_loss: 102.7260
Epoch 384/10000
1126/1126 [==============================] - 0s 41us/step - loss: 32.0745 - val_loss: 102.7053
Epoch 385/10000
1126/1126 [==============================] - 0s 43us/step - loss: 32.0448 - val_loss: 102.6847
Epoch 386/10000
1126/1126 [==============================] - 0s 40us/step - loss: 32.0152 - val_loss: 102.6641
Epoch 387/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.9856 - val_loss: 102.6435
Epoch 388/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.9562 - val_loss: 102.6229
Epoch 389/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.9269 - val_loss: 102.6024
Epoch 390/10000
1126/1126 [==============================] - 0s 46us/step - loss: 31.8977 - val_loss: 102.5819
Epoch 391/10000
1126/1126 [==============================] - 0s 43us/step - loss: 31.8685 - val_loss: 102.5615
Epoch 392/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.8395 - val_loss: 102.5412
Epoch 393/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.8105 - val_loss: 102.5209
Epoch 394/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.7816 - val_loss: 102.5007
Epoch 395/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.7528 - val_loss: 102.4806
Epoch 396/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.7240 - val_loss: 102.4606
Epoch 397/10000
1126/1126 [==============================] - 0s 44us/step - loss: 31.6954 - val_loss: 102.4406
Epoch 398/10000
1126/1126 [==============================] - 0s 43us/step - loss: 31.6668 - val_loss: 102.4208
Epoch 399/10000
1126/1126 [==============================] - 0s 44us/step - loss: 31.6382 - val_loss: 102.4011
Epoch 400/10000
1126/1126 [==============================] - 0s 44us/step - loss: 31.6098 - val_loss: 102.3814
Epoch 401/10000
1126/1126 [==============================] - 0s 40us/step - loss: 31.5814 - val_loss: 102.3619
Epoch 402/10000
1126/1126 [==============================] - 0s 40us/step - loss: 31.5530 - val_loss: 102.3424
Epoch 403/10000
1126/1126 [==============================] - 0s 40us/step - loss: 31.5247 - val_loss: 102.3231
Epoch 404/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.4965 - val_loss: 102.3038
Epoch 405/10000
```

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1126/1126 [==============================] - 0s 40us/step - loss: 31.4684 - val_loss: 102.2846
Epoch 406/10000
1126/1126 [==============================] - 0s 40us/step - loss: 31.4403 - val_loss: 102.2656
Epoch 407/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.4122 - val_loss: 102.2466
Epoch 408/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.3843 - val_loss: 102.2277
Epoch 409/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.3563 - val_loss: 102.2088
Epoch 410/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.3285 - val_loss: 102.1900
Epoch 411/10000
1126/1126 [==============================] - 0s 44us/step - loss: 31.3007 - val_loss: 102.1713
Epoch 412/10000
1126/1126 [==============================] - 0s 43us/step - loss: 31.2730 - val_loss: 102.1527
Epoch 413/10000
1126/1126 [==============================] - 0s 40us/step - loss: 31.2453 - val_loss: 102.1341
Epoch 414/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.2177 - val_loss: 102.1156
Epoch 415/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.1902 - val_loss: 102.0971
Epoch 416/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.1627 - val_loss: 102.0786
Epoch 417/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.1353 - val_loss: 102.0602
Epoch 418/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.1080 - val_loss: 102.0417
Epoch 419/10000
1126/1126 [==============================] - 0s 42us/step - loss: 31.0807 - val_loss: 102.0234
Epoch 420/10000
1126/1126 [==============================] - 0s 40us/step - loss: 31.0535 - val_loss: 102.0050
Epoch 421/10000
1126/1126 [==============================] - 0s 41us/step - loss: 31.0264 - val_loss: 101.9866
Epoch 422/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.9993 - val_loss: 101.9683
Epoch 423/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.9724 - val_loss: 101.9499
Epoch 424/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.9455 - val_loss: 101.9316
Epoch 425/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.9186 - val_loss: 101.9132
Epoch 426/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.8919 - val_loss: 101.8948
Epoch 427/10000
1126/1126 [==============================] - 0s 39us/step - loss: 30.8652 - val_loss: 101.8765
Epoch 428/10000
1126/1126 [==============================] - 0s 44us/step - loss: 30.8386 - val_loss: 101.8581
Epoch 429/10000
```

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1126/1126 [==============================] - 0s 43us/step - loss: 30.8121 - val_loss: 101.8397
Epoch 430/10000
1126/1126 [==============================] - 0s 42us/step - loss: 30.7857 - val_loss: 101.8213
Epoch 431/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.7594 - val_loss: 101.8029
Epoch 432/10000
1126/1126 [==============================] - 0s 43us/step - loss: 30.7331 - val_loss: 101.7845
Epoch 433/10000
1126/1126 [==============================] - 0s 43us/step - loss: 30.7070 - val_loss: 101.7661
Epoch 434/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.6809 - val_loss: 101.7477
Epoch 435/10000
1126/1126 [==============================] - 0s 42us/step - loss: 30.6549 - val_loss: 101.7293
Epoch 436/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.6289 - val_loss: 101.7108
Epoch 437/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.6031 - val_loss: 101.6924
Epoch 438/10000
1126/1126 [==============================] - 0s 44us/step - loss: 30.5773 - val_loss: 101.6740
Epoch 439/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.5517 - val_loss: 101.6556
Epoch 440/10000
1126/1126 [==============================] - 0s 43us/step - loss: 30.5261 - val_loss: 101.6372
Epoch 441/10000
1126/1126 [==============================] - 0s 45us/step - loss: 30.5006 - val_loss: 101.6188
Epoch 442/10000
1126/1126 [==============================] - 0s 42us/step - loss: 30.4751 - val_loss: 101.6004
Epoch 443/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.4498 - val_loss: 101.5821
Epoch 444/10000
1126/1126 [==============================] - 0s 43us/step - loss: 30.4245 - val_loss: 101.5637
Epoch 445/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.3993 - val_loss: 101.5454
Epoch 446/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.3742 - val_loss: 101.5272
Epoch 447/10000
1126/1126 [==============================] - 0s 43us/step - loss: 30.3492 - val_loss: 101.5089
Epoch 448/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.3243 - val_loss: 101.4907
Epoch 449/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.2994 - val_loss: 101.4726
Epoch 450/10000
1126/1126 [==============================] - 0s 43us/step - loss: 30.2746 - val_loss: 101.4544
Epoch 451/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.2499 - val_loss: 101.4363
Epoch 452/10000
1126/1126 [==============================] - 0s 39us/step - loss: 30.2252 - val_loss: 101.4183
Epoch 453/10000
```

```
1126/1126 [==============================] - 0s 48us/step - loss: 30.2006 - val_loss: 101.4003
Epoch 454/10000
1126/1126 [==============================] - 0s 44us/step - loss: 30.1761 - val_loss: 101.3824
Epoch 455/10000
1126/1126 [==============================] - 0s 42us/step - loss: 30.1517 - val_loss: 101.3645
Epoch 456/10000
1126/1126 [==============================] - 0s 43us/step - loss: 30.1274 - val_loss: 101.3467
Epoch 457/10000
1126/1126 [==============================] - 0s 42us/step - loss: 30.1031 - val_loss: 101.3289
Epoch 458/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.0788 - val_loss: 101.3112
Epoch 459/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.0547 - val_loss: 101.2935
Epoch 460/10000
1126/1126 [==============================] - 0s 40us/step - loss: 30.0306 - val_loss: 101.2760
Epoch 461/10000
1126/1126 [==============================] - 0s 41us/step - loss: 30.0066 - val_loss: 101.2584
Epoch 462/10000
1126/1126 [==============================] - 0s 40us/step - loss: 29.9826 - val_loss: 101.2410
Epoch 463/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.9587 - val_loss: 101.2236
Epoch 464/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.9349 - val_loss: 101.2063
Epoch 465/10000
1126/1126 [==============================] - 0s 49us/step - loss: 29.9111 - val_loss: 101.1890
Epoch 466/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.8874 - val_loss: 101.1718
Epoch 467/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.8638 - val_loss: 101.1547
Epoch 468/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.8402 - val_loss: 101.1377
Epoch 469/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.8166 - val_loss: 101.1207
Epoch 470/10000
1126/1126 [==============================] - 0s 40us/step - loss: 29.7932 - val_loss: 101.1038
Epoch 471/10000
1126/1126 [==============================] - 0s 40us/step - loss: 29.7697 - val_loss: 101.0870
Epoch 472/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.7463 - val_loss: 101.0702
Epoch 473/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.7230 - val_loss: 101.0536
Epoch 474/10000
1126/1126 [==============================] - 0s 48us/step - loss: 29.6997 - val_loss: 101.0370
Epoch 475/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.6765 - val_loss: 101.0204
Epoch 476/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.6533 - val_loss: 101.0040
Epoch 477/10000
```

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1126/1126 [==============================] - 0s 40us/step - loss: 29.6302 - val_loss: 100.9876
Epoch 478/10000
1126/1126 [==============================] - 0s 40us/step - loss: 29.6071 - val_loss: 100.9713
Epoch 479/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.5841 - val_loss: 100.9552
Epoch 480/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.5611 - val_loss: 100.9390
Epoch 481/10000
1126/1126 [==============================] - 0s 40us/step - loss: 29.5381 - val_loss: 100.9230
Epoch 482/10000
1126/1126 [==============================] - 0s 40us/step - loss: 29.5152 - val_loss: 100.9070
Epoch 483/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.4923 - val_loss: 100.8912
Epoch 484/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.4694 - val_loss: 100.8754
Epoch 485/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.4466 - val_loss: 100.8597
Epoch 486/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.4238 - val_loss: 100.8441
Epoch 487/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.4011 - val_loss: 100.8286
Epoch 488/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.3783 - val_loss: 100.8132
Epoch 489/10000
1126/1126 [==============================] - 0s 40us/step - loss: 29.3556 - val_loss: 100.7979
Epoch 490/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.3330 - val_loss: 100.7827
Epoch 491/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.3103 - val_loss: 100.7676
Epoch 492/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.2877 - val_loss: 100.7526
Epoch 493/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.2651 - val_loss: 100.7377
Epoch 494/10000
1126/1126 [==============================] - 0s 43us/step - loss: 29.2425 - val_loss: 100.7229
Epoch 495/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.2199 - val_loss: 100.7082
Epoch 496/10000
1126/1126 [==============================] - 0s 45us/step - loss: 29.1974 - val_loss: 100.6937
Epoch 497/10000
1126/1126 [==============================] - 0s 44us/step - loss: 29.1748 - val_loss: 100.6792
Epoch 498/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.1523 - val_loss: 100.6649
Epoch 499/10000
1126/1126 [==============================] - 0s 44us/step - loss: 29.1297 - val_loss: 100.6507
Epoch 500/10000
1126/1126 [==============================] - 0s 42us/step - loss: 29.1072 - val_loss: 100.6367
Epoch 501/10000
```

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1126/1126 [==============================] - 0s 41us/step - loss: 29.0847 - val_loss: 100.6227
Epoch 502/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.0622 - val_loss: 100.6089
Epoch 503/10000
1126/1126 [==============================] - 0s 41us/step - loss: 29.0397 - val_loss: 100.5953
Epoch 504/10000
1126/1126 [==============================] - 0s 44us/step - loss: 29.0172 - val_loss: 100.5818
Epoch 505/10000
1126/1126 [==============================] - 0s 41us/step - loss: 28.9947 - val_loss: 100.5685
Epoch 506/10000
1126/1126 [==============================] - 0s 45us/step - loss: 28.9722 - val_loss: 100.5553
Epoch 507/10000
1126/1126 [==============================] - 0s 42us/step - loss: 28.9496 - val_loss: 100.5422
Epoch 508/10000
1126/1126 [==============================] - 0s 42us/step - loss: 28.9271 - val_loss: 100.5294
Epoch 509/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.9046 - val_loss: 100.5167
Epoch 510/10000
1126/1126 [==============================] - 0s 42us/step - loss: 28.8820 - val_loss: 100.5041
Epoch 511/10000
1126/1126 [==============================] - 0s 41us/step - loss: 28.8595 - val_loss: 100.4918
Epoch 512/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.8369 - val_loss: 100.4797
Epoch 513/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.8143 - val_loss: 100.4677
Epoch 514/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.7917 - val_loss: 100.4559
Epoch 515/10000
1126/1126 [==============================] - 0s 48us/step - loss: 28.7691 - val_loss: 100.4444
Epoch 516/10000
1126/1126 [==============================] - 0s 53us/step - loss: 28.7465 - val_loss: 100.4330
Epoch 517/10000
1126/1126 [==============================] - 0s 50us/step - loss: 28.7239 - val_loss: 100.4219
Epoch 518/10000
1126/1126 [==============================] - 0s 53us/step - loss: 28.7012 - val_loss: 100.4110
Epoch 519/10000
1126/1126 [==============================] - 0s 48us/step - loss: 28.6785 - val_loss: 100.4003
Epoch 520/10000
1126/1126 [==============================] - 0s 47us/step - loss: 28.6558 - val_loss: 100.3898
Epoch 521/10000
1126/1126 [==============================] - 0s 46us/step - loss: 28.6331 - val_loss: 100.3796
Epoch 522/10000
1126/1126 [==============================] - 0s 50us/step - loss: 28.6104 - val_loss: 100.3696
Epoch 523/10000
1126/1126 [==============================] - 0s 47us/step - loss: 28.5876 - val_loss: 100.3599
Epoch 524/10000
1126/1126 [==============================] - 0s 41us/step - loss: 28.5649 - val_loss: 100.3504
Epoch 525/10000
```

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1126/1126 [==============================] - 0s 40us/step - loss: 28.5421 - val_loss: 100.3412
Epoch 526/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.5193 - val_loss: 100.3322
Epoch 527/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.4965 - val_loss: 100.3235
Epoch 528/10000
1126/1126 [==============================] - 0s 39us/step - loss: 28.4737 - val_loss: 100.3151
Epoch 529/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.4508 - val_loss: 100.3070
Epoch 530/10000
1126/1126 [==============================] - 0s 41us/step - loss: 28.4280 - val_loss: 100.2991
Epoch 531/10000
1126/1126 [==============================] - 0s 41us/step - loss: 28.4052 - val_loss: 100.2916
Epoch 532/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.3824 - val_loss: 100.2843
Epoch 533/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.3595 - val_loss: 100.2773
Epoch 534/10000
1126/1126 [==============================] - 0s 41us/step - loss: 28.3367 - val_loss: 100.2707
Epoch 535/10000
1126/1126 [==============================] - 0s 42us/step - loss: 28.3139 - val_loss: 100.2643
Epoch 536/10000
1126/1126 [==============================] - 0s 41us/step - loss: 28.2911 - val_loss: 100.2582
Epoch 537/10000
1126/1126 [==============================] - 0s 39us/step - loss: 28.2683 - val_loss: 100.2524
Epoch 538/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.2456 - val_loss: 100.2469
Epoch 539/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.2228 - val_loss: 100.2417
Epoch 540/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.2001 - val_loss: 100.2368
Epoch 541/10000
1126/1126 [==============================] - 0s 40us/step - loss: 28.1774 - val_loss: 100.2322
Epoch 542/10000
1126/1126 [==============================] - 0s 42us/step - loss: 28.1548 - val_loss: 100.2280
Epoch 543/10000
1126/1126 [==============================] - 0s 44us/step - loss: 28.1322 - val_loss: 100.2240
Epoch 544/10000
1126/1126 [==============================] - 0s 45us/step - loss: 28.1096 - val_loss: 100.2203
Epoch 545/10000
1126/1126 [==============================] - 0s 44us/step - loss: 28.0871 - val_loss: 100.2168
Epoch 546/10000
1126/1126 [==============================] - 0s 43us/step - loss: 28.0647 - val_loss: 100.2137
Epoch 547/10000
1126/1126 [==============================] - 0s 43us/step - loss: 28.0423 - val_loss: 100.2109
Epoch 548/10000
1126/1126 [==============================] - 0s 42us/step - loss: 28.0199 - val_loss: 100.2083
Epoch 549/10000
```

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1126/1126 [==============================] - 0s 40us/step - loss: 27.9976 - val_loss: 100.2060
Epoch 550/10000
1126/1126 [==============================] - 0s 40us/step - loss: 27.9754 - val_loss: 100.2040
Epoch 551/10000
1126/1126 [==============================] - 0s 40us/step - loss: 27.9533 - val_loss: 100.2022
Epoch 552/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.9312 - val_loss: 100.2006
Epoch 553/10000
1126/1126 [==============================] - 0s 45us/step - loss: 27.9092 - val_loss: 100.1993
Epoch 554/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.8873 - val_loss: 100.1983
Epoch 555/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.8654 - val_loss: 100.1975
Epoch 556/10000
1126/1126 [==============================] - 0s 43us/step - loss: 27.8437 - val_loss: 100.1969
Epoch 557/10000
1126/1126 [==============================] - 0s 42us/step - loss: 27.8220 - val_loss: 100.1965
Epoch 558/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.8004 - val_loss: 100.1963
Epoch 559/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.7789 - val_loss: 100.1963
Epoch 560/10000
1126/1126 [==============================] - 0s 42us/step - loss: 27.7575 - val_loss: 100.1964
Epoch 561/10000
1126/1126 [==============================] - 0s 42us/step - loss: 27.7362 - val_loss: 100.1968
Epoch 562/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.7150 - val_loss: 100.1973
Epoch 563/10000
1126/1126 [==============================] - 0s 42us/step - loss: 27.6939 - val_loss: 100.1980
Epoch 564/10000
1126/1126 [==============================] - 0s 42us/step - loss: 27.6729 - val_loss: 100.1988
Epoch 565/10000
1126/1126 [==============================] - 0s 42us/step - loss: 27.6519 - val_loss: 100.1998
Epoch 566/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.6311 - val_loss: 100.2009
Epoch 567/10000
1126/1126 [==============================] - 0s 40us/step - loss: 27.6104 - val_loss: 100.2021
Epoch 568/10000
1126/1126 [==============================] - 0s 41us/step - loss: 27.5897 - val_loss: 100.2035
Epoch 569/10000
1126/1126 [==============================] - 0s 40us/step - loss: 27.5692 - val_loss: 100.2049
Epoch 00569: early stopping


In [6]: y_pred = model.predict(X_test)
        plt.title('Coût et coût de validation')
        line1,=plt.plot(history.history['loss'], label="Loss", linestyle='-', color='r')
        line2,=plt.plot(history.history['val_loss'], label="Val loss", linestyle='-', color='b
```
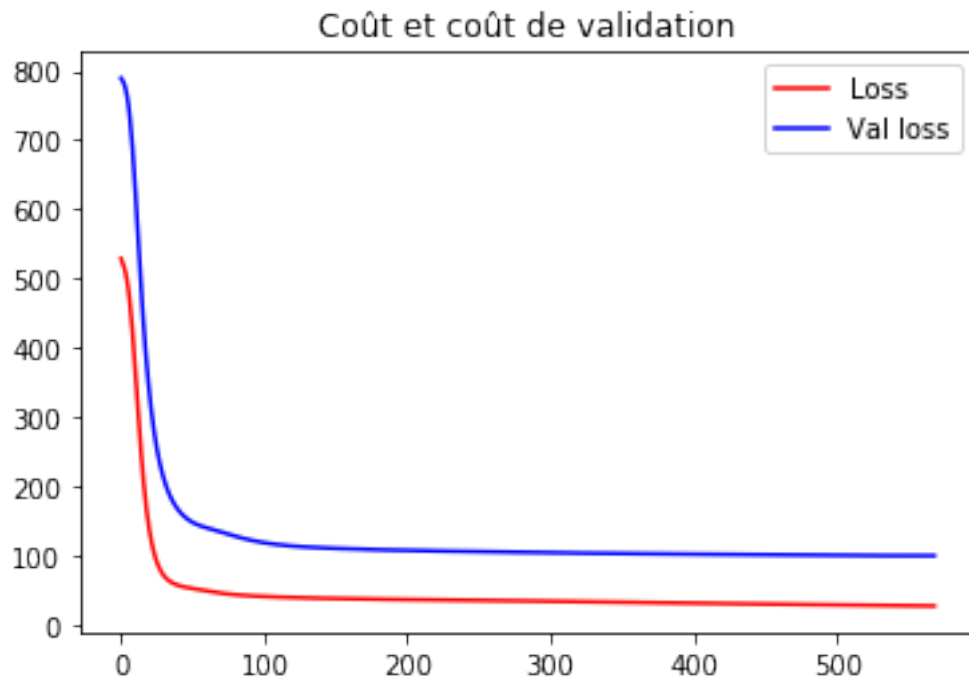
```
first_legend = plt.legend(handles=[line1, line2], loc=1)

plt.show()

plt.title('y_pred en fonction de y_test')

plt.plot(y_pred[:], y_test[:], '+')
plt.ylabel('Test')
plt.xlabel('Prédiction')
plt.show()
```
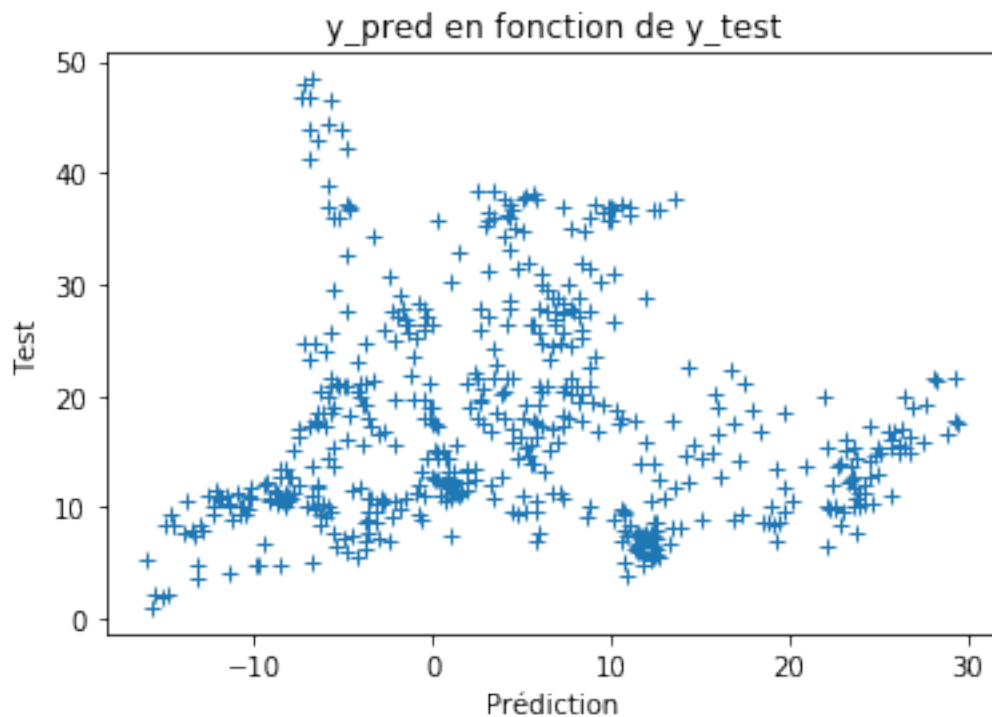

Coût et coût de validation

y_pred en fonction de y_test

```
In [7]: model = lstm_model(32, X_train.shape[1:])
```

```
_____
Layer (type)                 Output Shape              Param #
=================================================================
lstm_1 (LSTM)                (None, 32)                5632
_____
dense_2 (Dense)              (None, 1)                 33
=================================================================
Total params: 5,665
Trainable params: 5,665
Non-trainable params: 0
_____
```

```
In [8]: early_stopping = EarlyStopping(monitor='val_loss', verbose=1, mode='auto', patience=10)
        history = model.fit(X_train, y_train, batch_size=32, epochs=10000, validation_data=(X_
```

```
Train on 1126 samples, validate on 563 samples
Epoch 1/10000
1126/1126 [==============================] - 1s 892us/step - loss: 529.0126 - val_loss: 789.51
Epoch 2/10000
1126/1126 [==============================] - 0s 74us/step - loss: 525.7961 - val_loss: 785.398
Epoch 3/10000
```

```
1126/1126 [==============================] - 0s 73us/step - loss: 521.2918 - val_loss: 778.9629
Epoch 4/10000
1126/1126 [==============================] - 0s 65us/step - loss: 514.0987 - val_loss: 768.7310
Epoch 5/10000
1126/1126 [==============================] - 0s 68us/step - loss: 503.1723 - val_loss: 753.9765
Epoch 6/10000
1126/1126 [==============================] - 0s 65us/step - loss: 488.3414 - val_loss: 735.1484
Epoch 7/10000
1126/1126 [==============================] - 0s 65us/step - loss: 470.3011 - val_loss: 713.2950
Epoch 8/10000
1126/1126 [==============================] - 0s 66us/step - loss: 450.1946 - val_loss: 689.6009
Epoch 9/10000
1126/1126 [==============================] - 0s 69us/step - loss: 429.0750 - val_loss: 665.1455
Epoch 10/10000
1126/1126 [==============================] - 0s 79us/step - loss: 407.7323 - val_loss: 640.6904
Epoch 11/10000
1126/1126 [==============================] - 0s 73us/step - loss: 386.8479 - val_loss: 616.7206
Epoch 12/10000
1126/1126 [==============================] - 0s 65us/step - loss: 366.7849 - val_loss: 593.3804
Epoch 13/10000
1126/1126 [==============================] - 0s 65us/step - loss: 347.5686 - val_loss: 570.7593
Epoch 14/10000
1126/1126 [==============================] - 0s 64us/step - loss: 329.1643 - val_loss: 548.8923
Epoch 15/10000
1126/1126 [==============================] - 0s 64us/step - loss: 311.5611 - val_loss: 527.8051
Epoch 16/10000
1126/1126 [==============================] - 0s 65us/step - loss: 294.7329 - val_loss: 507.4807
Epoch 17/10000
1126/1126 [==============================] - 0s 63us/step - loss: 278.6379 - val_loss: 487.9263
Epoch 18/10000
1126/1126 [==============================] - 0s 63us/step - loss: 263.2722 - val_loss: 469.1867
Epoch 19/10000
1126/1126 [==============================] - 0s 67us/step - loss: 248.6342 - val_loss: 451.2761
Epoch 20/10000
1126/1126 [==============================] - 0s 67us/step - loss: 234.7043 - val_loss: 434.1754
Epoch 21/10000
1126/1126 [==============================] - 0s 64us/step - loss: 221.4716 - val_loss: 417.8806
Epoch 22/10000
1126/1126 [==============================] - 0s 64us/step - loss: 208.9320 - val_loss: 402.3934
Epoch 23/10000
1126/1126 [==============================] - 0s 65us/step - loss: 197.0762 - val_loss: 387.6839
Epoch 24/10000
1126/1126 [==============================] - 0s 65us/step - loss: 185.8815 - val_loss: 373.7303
Epoch 25/10000
1126/1126 [==============================] - 0s 71us/step - loss: 175.3283 - val_loss: 360.5208
Epoch 26/10000
1126/1126 [==============================] - 0s 64us/step - loss: 165.3983 - val_loss: 348.0505
Epoch 27/10000
```

```
1126/1126 [==============================] - 0s 65us/step - loss: 156.0770 - val_loss: 336.294
Epoch 28/10000
1126/1126 [==============================] - 0s 65us/step - loss: 147.3370 - val_loss: 325.2171
Epoch 29/10000
1126/1126 [==============================] - 0s 66us/step - loss: 139.1344 - val_loss: 314.7638
Epoch 30/10000
1126/1126 [==============================] - 0s 68us/step - loss: 131.4346 - val_loss: 304.876
Epoch 31/10000
1126/1126 [==============================] - 0s 67us/step - loss: 124.1867 - val_loss: 295.492
Epoch 32/10000
1126/1126 [==============================] - 0s 70us/step - loss: 117.3833 - val_loss: 286.579
Epoch 33/10000
1126/1126 [==============================] - 0s 70us/step - loss: 111.0343 - val_loss: 278.142
Epoch 34/10000
1126/1126 [==============================] - 0s 71us/step - loss: 105.1315 - val_loss: 270.165
Epoch 35/10000
1126/1126 [==============================] - 0s 72us/step - loss: 99.6583 - val_loss: 262.6494
Epoch 36/10000
1126/1126 [==============================] - 0s 64us/step - loss: 94.6047 - val_loss: 255.6127
Epoch 37/10000
1126/1126 [==============================] - 0s 63us/step - loss: 89.9860 - val_loss: 249.0150
Epoch 38/10000
1126/1126 [==============================] - 0s 64us/step - loss: 85.7391 - val_loss: 242.7952
Epoch 39/10000
1126/1126 [==============================] - 0s 64us/step - loss: 81.8315 - val_loss: 236.9057
Epoch 40/10000
1126/1126 [==============================] - 0s 65us/step - loss: 78.2592 - val_loss: 231.3473
Epoch 41/10000
1126/1126 [==============================] - 0s 64us/step - loss: 75.0166 - val_loss: 226.1064
Epoch 42/10000
1126/1126 [==============================] - 0s 65us/step - loss: 72.0704 - val_loss: 221.1739
Epoch 43/10000
1126/1126 [==============================] - 0s 65us/step - loss: 69.4136 - val_loss: 216.5390
Epoch 44/10000
1126/1126 [==============================] - 0s 64us/step - loss: 67.0495 - val_loss: 212.2128
Epoch 45/10000
1126/1126 [==============================] - 0s 64us/step - loss: 64.9837 - val_loss: 208.2033
Epoch 46/10000
1126/1126 [==============================] - 0s 66us/step - loss: 63.1783 - val_loss: 204.4848
Epoch 47/10000
1126/1126 [==============================] - 0s 65us/step - loss: 61.5946 - val_loss: 201.0159
Epoch 48/10000
1126/1126 [==============================] - 0s 68us/step - loss: 60.1963 - val_loss: 197.7880
Epoch 49/10000
1126/1126 [==============================] - 0s 67us/step - loss: 58.9641 - val_loss: 194.7826
Epoch 50/10000
1126/1126 [==============================] - 0s 69us/step - loss: 57.8718 - val_loss: 191.9791
Epoch 51/10000
```

```
1126/1126 [==============================] - 0s 70us/step - loss: 56.8953 - val_loss: 189.3618
Epoch 52/10000
1126/1126 [==============================] - 0s 72us/step - loss: 56.0261 - val_loss: 186.9165
Epoch 53/10000
1126/1126 [==============================] - 0s 67us/step - loss: 55.2534 - val_loss: 184.6414
Epoch 54/10000
1126/1126 [==============================] - 0s 63us/step - loss: 54.5639 - val_loss: 182.5159
Epoch 55/10000
1126/1126 [==============================] - 0s 65us/step - loss: 53.9432 - val_loss: 180.5388
Epoch 56/10000
1126/1126 [==============================] - 0s 63us/step - loss: 53.3792 - val_loss: 178.6934
Epoch 57/10000
1126/1126 [==============================] - 0s 65us/step - loss: 52.8587 - val_loss: 176.9659
Epoch 58/10000
1126/1126 [==============================] - 0s 64us/step - loss: 52.3757 - val_loss: 175.3629
Epoch 59/10000
1126/1126 [==============================] - 0s 64us/step - loss: 51.9298 - val_loss: 173.8800
Epoch 60/10000
1126/1126 [==============================] - 0s 65us/step - loss: 51.5165 - val_loss: 172.5054
Epoch 61/10000
1126/1126 [==============================] - 0s 70us/step - loss: 51.1312 - val_loss: 171.2416
Epoch 62/10000
1126/1126 [==============================] - 0s 71us/step - loss: 50.7725 - val_loss: 170.0698
Epoch 63/10000
1126/1126 [==============================] - 0s 71us/step - loss: 50.4315 - val_loss: 168.9738
Epoch 64/10000
1126/1126 [==============================] - 0s 71us/step - loss: 50.1026 - val_loss: 167.9443
Epoch 65/10000
1126/1126 [==============================] - 0s 70us/step - loss: 49.7815 - val_loss: 166.9717
Epoch 66/10000
1126/1126 [==============================] - 0s 68us/step - loss: 49.4692 - val_loss: 166.0307
Epoch 67/10000
1126/1126 [==============================] - 0s 64us/step - loss: 49.1664 - val_loss: 165.1320
Epoch 68/10000
1126/1126 [==============================] - 0s 68us/step - loss: 48.8696 - val_loss: 164.2594
Epoch 69/10000
1126/1126 [==============================] - 0s 69us/step - loss: 48.5799 - val_loss: 163.4297
Epoch 70/10000
1126/1126 [==============================] - 0s 66us/step - loss: 48.2962 - val_loss: 162.6291
Epoch 71/10000
1126/1126 [==============================] - 0s 69us/step - loss: 48.0177 - val_loss: 161.8648
Epoch 72/10000
1126/1126 [==============================] - 0s 65us/step - loss: 47.7424 - val_loss: 161.1045
Epoch 73/10000
1126/1126 [==============================] - 0s 70us/step - loss: 47.4711 - val_loss: 160.3630
Epoch 74/10000
1126/1126 [==============================] - 0s 69us/step - loss: 47.2051 - val_loss: 159.6296
Epoch 75/10000
```

```
1126/1126 [==============================] - 0s 66us/step - loss: 46.9433 - val_loss: 158.8963
Epoch 76/10000
1126/1126 [==============================] - 0s 65us/step - loss: 46.6876 - val_loss: 158.1885
Epoch 77/10000
1126/1126 [==============================] - 0s 66us/step - loss: 46.4357 - val_loss: 157.4860
Epoch 78/10000
1126/1126 [==============================] - 0s 69us/step - loss: 46.1875 - val_loss: 156.7880
Epoch 79/10000
1126/1126 [==============================] - 0s 70us/step - loss: 45.9434 - val_loss: 156.0910
Epoch 80/10000
1126/1126 [==============================] - 0s 67us/step - loss: 45.7064 - val_loss: 155.3847
Epoch 81/10000
1126/1126 [==============================] - 0s 67us/step - loss: 45.4773 - val_loss: 154.6587
Epoch 82/10000
1126/1126 [==============================] - 0s 65us/step - loss: 45.2544 - val_loss: 153.9327
Epoch 83/10000
1126/1126 [==============================] - 0s 67us/step - loss: 45.0379 - val_loss: 153.2163
Epoch 84/10000
1126/1126 [==============================] - 0s 70us/step - loss: 44.8277 - val_loss: 152.4923
Epoch 85/10000
1126/1126 [==============================] - 0s 71us/step - loss: 44.6247 - val_loss: 151.7646
Epoch 86/10000
1126/1126 [==============================] - 0s 67us/step - loss: 44.4263 - val_loss: 151.0584
Epoch 87/10000
1126/1126 [==============================] - 0s 66us/step - loss: 44.2326 - val_loss: 150.3587
Epoch 88/10000
1126/1126 [==============================] - 0s 66us/step - loss: 44.0424 - val_loss: 149.6704
Epoch 89/10000
1126/1126 [==============================] - 0s 64us/step - loss: 43.8562 - val_loss: 148.9955
Epoch 90/10000
1126/1126 [==============================] - 0s 63us/step - loss: 43.6739 - val_loss: 148.3210
Epoch 91/10000
1126/1126 [==============================] - 0s 64us/step - loss: 43.4936 - val_loss: 147.6755
Epoch 92/10000
1126/1126 [==============================] - 0s 66us/step - loss: 43.3170 - val_loss: 147.0453
Epoch 93/10000
1126/1126 [==============================] - 0s 63us/step - loss: 43.1431 - val_loss: 146.4364
Epoch 94/10000
1126/1126 [==============================] - 0s 65us/step - loss: 42.9725 - val_loss: 145.8249
Epoch 95/10000
1126/1126 [==============================] - 0s 67us/step - loss: 42.8050 - val_loss: 145.2215
Epoch 96/10000
1126/1126 [==============================] - 0s 64us/step - loss: 42.6396 - val_loss: 144.6162
Epoch 97/10000
1126/1126 [==============================] - 0s 65us/step - loss: 42.4776 - val_loss: 144.0203
Epoch 98/10000
1126/1126 [==============================] - 0s 66us/step - loss: 42.3185 - val_loss: 143.4266
Epoch 99/10000
```

```
1126/1126 [==============================] - 0s 67us/step - loss: 42.1624 - val_loss: 142.8329
Epoch 100/10000
1126/1126 [==============================] - 0s 72us/step - loss: 42.0084 - val_loss: 142.2515
Epoch 101/10000
1126/1126 [==============================] - 0s 76us/step - loss: 41.8576 - val_loss: 141.6747
Epoch 102/10000
1126/1126 [==============================] - 0s 65us/step - loss: 41.7089 - val_loss: 141.1121
Epoch 103/10000
1126/1126 [==============================] - 0s 64us/step - loss: 41.5628 - val_loss: 140.5528
Epoch 104/10000
1126/1126 [==============================] - 0s 64us/step - loss: 41.4204 - val_loss: 139.9903
Epoch 105/10000
1126/1126 [==============================] - 0s 65us/step - loss: 41.2802 - val_loss: 139.4420
Epoch 106/10000
1126/1126 [==============================] - 0s 66us/step - loss: 41.1423 - val_loss: 138.9081
Epoch 107/10000
1126/1126 [==============================] - 0s 68us/step - loss: 41.0069 - val_loss: 138.3929
Epoch 108/10000
1126/1126 [==============================] - 0s 67us/step - loss: 40.8728 - val_loss: 137.8710
Epoch 109/10000
1126/1126 [==============================] - 0s 69us/step - loss: 40.7409 - val_loss: 137.3632
Epoch 110/10000
1126/1126 [==============================] - 0s 64us/step - loss: 40.6113 - val_loss: 136.8666
Epoch 111/10000
1126/1126 [==============================] - 0s 63us/step - loss: 40.4852 - val_loss: 136.3731
Epoch 112/10000
1126/1126 [==============================] - 0s 65us/step - loss: 40.3614 - val_loss: 135.8813
Epoch 113/10000
1126/1126 [==============================] - 0s 67us/step - loss: 40.2403 - val_loss: 135.4087
Epoch 114/10000
1126/1126 [==============================] - 0s 67us/step - loss: 40.1209 - val_loss: 134.9418
Epoch 115/10000
1126/1126 [==============================] - 0s 65us/step - loss: 40.0028 - val_loss: 134.4816
Epoch 116/10000
1126/1126 [==============================] - 0s 79us/step - loss: 39.8867 - val_loss: 134.0211
Epoch 117/10000
1126/1126 [==============================] - 0s 65us/step - loss: 39.7725 - val_loss: 133.5923
Epoch 118/10000
1126/1126 [==============================] - 0s 69us/step - loss: 39.6599 - val_loss: 133.1552
Epoch 119/10000
1126/1126 [==============================] - 0s 67us/step - loss: 39.5500 - val_loss: 132.7351
Epoch 120/10000
1126/1126 [==============================] - 0s 65us/step - loss: 39.4414 - val_loss: 132.3214
Epoch 121/10000
1126/1126 [==============================] - 0s 70us/step - loss: 39.3352 - val_loss: 131.9174
Epoch 122/10000
1126/1126 [==============================] - 0s 67us/step - loss: 39.2305 - val_loss: 131.5165
Epoch 123/10000
```

```
1126/1126 [==============================] - 0s 65us/step - loss: 39.1277 - val_loss: 131.1276
Epoch 124/10000
1126/1126 [==============================] - 0s 64us/step - loss: 39.0267 - val_loss: 130.7510
Epoch 125/10000
1126/1126 [==============================] - 0s 66us/step - loss: 38.9275 - val_loss: 130.3716
Epoch 126/10000
1126/1126 [==============================] - 0s 68us/step - loss: 38.8287 - val_loss: 130.0041
Epoch 127/10000
1126/1126 [==============================] - 0s 69us/step - loss: 38.7317 - val_loss: 129.6444
Epoch 128/10000
1126/1126 [==============================] - 0s 66us/step - loss: 38.6355 - val_loss: 129.2898
Epoch 129/10000
1126/1126 [==============================] - 0s 67us/step - loss: 38.5403 - val_loss: 128.9347
Epoch 130/10000
1126/1126 [==============================] - 0s 63us/step - loss: 38.4465 - val_loss: 128.5932
Epoch 131/10000
1126/1126 [==============================] - 0s 67us/step - loss: 38.3534 - val_loss: 128.2533
Epoch 132/10000
1126/1126 [==============================] - 0s 66us/step - loss: 38.2618 - val_loss: 127.9296
Epoch 133/10000
1126/1126 [==============================] - 0s 66us/step - loss: 38.1718 - val_loss: 127.6115
Epoch 134/10000
1126/1126 [==============================] - 0s 69us/step - loss: 38.0827 - val_loss: 127.2932
Epoch 135/10000
1126/1126 [==============================] - 0s 70us/step - loss: 37.9948 - val_loss: 126.9863
Epoch 136/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.9078 - val_loss: 126.6821
Epoch 137/10000
1126/1126 [==============================] - 0s 63us/step - loss: 37.8222 - val_loss: 126.3928
Epoch 138/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.7377 - val_loss: 126.1026
Epoch 139/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.6544 - val_loss: 125.8260
Epoch 140/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.5725 - val_loss: 125.5495
Epoch 141/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.4917 - val_loss: 125.2797
Epoch 142/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.4121 - val_loss: 125.0145
Epoch 143/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.3344 - val_loss: 124.7616
Epoch 144/10000
1126/1126 [==============================] - 0s 67us/step - loss: 37.2577 - val_loss: 124.5154
Epoch 145/10000
1126/1126 [==============================] - 0s 68us/step - loss: 37.1822 - val_loss: 124.2771
Epoch 146/10000
1126/1126 [==============================] - 0s 63us/step - loss: 37.1076 - val_loss: 124.0427
Epoch 147/10000
```

```
1126/1126 [==============================] - 0s 66us/step - loss: 37.0344 - val_loss: 123.8090
Epoch 148/10000
1126/1126 [==============================] - 0s 65us/step - loss: 36.9619 - val_loss: 123.5844
Epoch 149/10000
1126/1126 [==============================] - 0s 65us/step - loss: 36.8899 - val_loss: 123.3617
Epoch 150/10000
1126/1126 [==============================] - 0s 66us/step - loss: 36.8189 - val_loss: 123.1460
Epoch 151/10000
1126/1126 [==============================] - 0s 68us/step - loss: 36.7483 - val_loss: 122.9370
Epoch 152/10000
1126/1126 [==============================] - 0s 67us/step - loss: 36.6790 - val_loss: 122.7284
Epoch 153/10000
1126/1126 [==============================] - 0s 72us/step - loss: 36.6106 - val_loss: 122.5249
Epoch 154/10000
1126/1126 [==============================] - 0s 63us/step - loss: 36.5425 - val_loss: 122.3227
Epoch 155/10000
1126/1126 [==============================] - 0s 66us/step - loss: 36.4757 - val_loss: 122.1174
Epoch 156/10000
1126/1126 [==============================] - 0s 66us/step - loss: 36.4093 - val_loss: 121.9274
Epoch 157/10000
1126/1126 [==============================] - 0s 68us/step - loss: 36.3438 - val_loss: 121.7386
Epoch 158/10000
1126/1126 [==============================] - 0s 66us/step - loss: 36.2796 - val_loss: 121.5557
Epoch 159/10000
1126/1126 [==============================] - 0s 65us/step - loss: 36.2156 - val_loss: 121.3741
Epoch 160/10000
1126/1126 [==============================] - 0s 65us/step - loss: 36.1526 - val_loss: 121.1974
Epoch 161/10000
1126/1126 [==============================] - 0s 65us/step - loss: 36.0898 - val_loss: 121.0200
Epoch 162/10000
1126/1126 [==============================] - 0s 65us/step - loss: 36.0279 - val_loss: 120.8617
Epoch 163/10000
1126/1126 [==============================] - 0s 67us/step - loss: 35.9663 - val_loss: 120.6948
Epoch 164/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.9052 - val_loss: 120.5319
Epoch 165/10000
1126/1126 [==============================] - 0s 66us/step - loss: 35.8441 - val_loss: 120.3779
Epoch 166/10000
1126/1126 [==============================] - 0s 66us/step - loss: 35.7837 - val_loss: 120.2233
Epoch 167/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.7235 - val_loss: 120.0711
Epoch 168/10000
1126/1126 [==============================] - 0s 65us/step - loss: 35.6646 - val_loss: 119.9206
Epoch 169/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.6061 - val_loss: 119.7724
Epoch 170/10000
1126/1126 [==============================] - 0s 67us/step - loss: 35.5475 - val_loss: 119.6245
Epoch 171/10000
```

```
1126/1126 [==============================] - 0s 66us/step - loss: 35.4898 - val_loss: 119.4903
Epoch 172/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.4324 - val_loss: 119.3552
Epoch 173/10000
1126/1126 [==============================] - 0s 65us/step - loss: 35.3751 - val_loss: 119.2173
Epoch 174/10000
1126/1126 [==============================] - 0s 68us/step - loss: 35.3185 - val_loss: 119.0828
Epoch 175/10000
1126/1126 [==============================] - 0s 67us/step - loss: 35.2623 - val_loss: 118.9504
Epoch 176/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.2067 - val_loss: 118.8195
Epoch 177/10000
1126/1126 [==============================] - 0s 63us/step - loss: 35.1516 - val_loss: 118.6970
Epoch 178/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.0971 - val_loss: 118.5745
Epoch 179/10000
1126/1126 [==============================] - 0s 67us/step - loss: 35.0427 - val_loss: 118.4594
Epoch 180/10000
1126/1126 [==============================] - 0s 63us/step - loss: 34.9884 - val_loss: 118.3433
Epoch 181/10000
1126/1126 [==============================] - 0s 67us/step - loss: 34.9349 - val_loss: 118.2307
Epoch 182/10000
1126/1126 [==============================] - 0s 64us/step - loss: 34.8809 - val_loss: 118.1244
Epoch 183/10000
1126/1126 [==============================] - 0s 65us/step - loss: 34.8269 - val_loss: 118.0214
Epoch 184/10000
1126/1126 [==============================] - 0s 70us/step - loss: 34.7725 - val_loss: 117.9163
Epoch 185/10000
1126/1126 [==============================] - 0s 64us/step - loss: 34.7188 - val_loss: 117.8198
Epoch 186/10000
1126/1126 [==============================] - 0s 67us/step - loss: 34.6644 - val_loss: 117.7262
Epoch 187/10000
1126/1126 [==============================] - 0s 69us/step - loss: 34.6108 - val_loss: 117.6365
Epoch 188/10000
1126/1126 [==============================] - 0s 72us/step - loss: 34.5575 - val_loss: 117.5465
Epoch 189/10000
1126/1126 [==============================] - 0s 65us/step - loss: 34.5042 - val_loss: 117.4609
Epoch 190/10000
1126/1126 [==============================] - 0s 66us/step - loss: 34.4511 - val_loss: 117.3758
Epoch 191/10000
1126/1126 [==============================] - 0s 66us/step - loss: 34.3979 - val_loss: 117.2935
Epoch 192/10000
1126/1126 [==============================] - 0s 65us/step - loss: 34.3448 - val_loss: 117.2123
Epoch 193/10000
1126/1126 [==============================] - 0s 66us/step - loss: 34.2919 - val_loss: 117.1349
Epoch 194/10000
1126/1126 [==============================] - 0s 65us/step - loss: 34.2391 - val_loss: 117.0566
Epoch 195/10000
```

```
1126/1126 [==============================] - 0s 74us/step - loss: 34.1863 - val_loss: 116.9913
Epoch 196/10000
1126/1126 [==============================] - 0s 69us/step - loss: 34.1346 - val_loss: 116.9243
Epoch 197/10000
1126/1126 [==============================] - 0s 73us/step - loss: 34.0831 - val_loss: 116.8623
Epoch 198/10000
1126/1126 [==============================] - 0s 67us/step - loss: 34.0319 - val_loss: 116.7949
Epoch 199/10000
1126/1126 [==============================] - 0s 66us/step - loss: 33.9806 - val_loss: 116.7341
Epoch 200/10000
1126/1126 [==============================] - 0s 64us/step - loss: 33.9295 - val_loss: 116.6741
Epoch 201/10000
1126/1126 [==============================] - 0s 66us/step - loss: 33.8783 - val_loss: 116.6195
Epoch 202/10000
1126/1126 [==============================] - 0s 67us/step - loss: 33.8275 - val_loss: 116.5637
Epoch 203/10000
1126/1126 [==============================] - 0s 65us/step - loss: 33.7769 - val_loss: 116.5065
Epoch 204/10000
1126/1126 [==============================] - 0s 64us/step - loss: 33.7261 - val_loss: 116.4560
Epoch 205/10000
1126/1126 [==============================] - 0s 68us/step - loss: 33.6754 - val_loss: 116.4063
Epoch 206/10000
1126/1126 [==============================] - 0s 74us/step - loss: 33.6246 - val_loss: 116.3582
Epoch 207/10000
1126/1126 [==============================] - 0s 67us/step - loss: 33.5738 - val_loss: 116.3131
Epoch 208/10000
1126/1126 [==============================] - 0s 66us/step - loss: 33.5232 - val_loss: 116.2681
Epoch 209/10000
1126/1126 [==============================] - 0s 68us/step - loss: 33.4730 - val_loss: 116.2254
Epoch 210/10000
1126/1126 [==============================] - 0s 69us/step - loss: 33.4226 - val_loss: 116.1899
Epoch 211/10000
1126/1126 [==============================] - 0s 71us/step - loss: 33.3725 - val_loss: 116.1549
Epoch 212/10000
1126/1126 [==============================] - 0s 64us/step - loss: 33.3224 - val_loss: 116.1218
Epoch 213/10000
1126/1126 [==============================] - 0s 66us/step - loss: 33.2722 - val_loss: 116.0899
Epoch 214/10000
1126/1126 [==============================] - 0s 66us/step - loss: 33.2219 - val_loss: 116.0593
Epoch 215/10000
1126/1126 [==============================] - 0s 64us/step - loss: 33.1718 - val_loss: 116.0283
Epoch 216/10000
1126/1126 [==============================] - 0s 68us/step - loss: 33.1215 - val_loss: 115.9987
Epoch 217/10000
1126/1126 [==============================] - 0s 70us/step - loss: 33.0711 - val_loss: 115.9687
Epoch 218/10000
1126/1126 [==============================] - 0s 65us/step - loss: 33.0208 - val_loss: 115.9401
Epoch 219/10000
```

```
1126/1126 [==============================] - 0s 66us/step - loss: 32.9703 - val_loss: 115.9156
Epoch 220/10000
1126/1126 [==============================] - 0s 66us/step - loss: 32.9198 - val_loss: 115.8915
Epoch 221/10000
1126/1126 [==============================] - 0s 67us/step - loss: 32.8694 - val_loss: 115.8709
Epoch 222/10000
1126/1126 [==============================] - 0s 64us/step - loss: 32.8191 - val_loss: 115.8497
Epoch 223/10000
1126/1126 [==============================] - 0s 69us/step - loss: 32.7685 - val_loss: 115.8275
Epoch 224/10000
1126/1126 [==============================] - 0s 72us/step - loss: 32.7183 - val_loss: 115.8092
Epoch 225/10000
1126/1126 [==============================] - 0s 66us/step - loss: 32.6680 - val_loss: 115.7891
Epoch 226/10000
1126/1126 [==============================] - 0s 64us/step - loss: 32.6179 - val_loss: 115.7751
Epoch 227/10000
1126/1126 [==============================] - 0s 75us/step - loss: 32.5672 - val_loss: 115.7580
Epoch 228/10000
1126/1126 [==============================] - 0s 63us/step - loss: 32.5169 - val_loss: 115.7453
Epoch 229/10000
1126/1126 [==============================] - 0s 65us/step - loss: 32.4664 - val_loss: 115.7362
Epoch 230/10000
1126/1126 [==============================] - 0s 65us/step - loss: 32.4158 - val_loss: 115.7251
Epoch 231/10000
1126/1126 [==============================] - 0s 64us/step - loss: 32.3652 - val_loss: 115.7149
Epoch 232/10000
1126/1126 [==============================] - 0s 67us/step - loss: 32.3149 - val_loss: 115.7063
Epoch 233/10000
1126/1126 [==============================] - 0s 65us/step - loss: 32.2638 - val_loss: 115.6969
Epoch 234/10000
1126/1126 [==============================] - 0s 67us/step - loss: 32.2132 - val_loss: 115.6906
Epoch 235/10000
1126/1126 [==============================] - 0s 66us/step - loss: 32.1624 - val_loss: 115.6847
Epoch 236/10000
1126/1126 [==============================] - 0s 65us/step - loss: 32.1116 - val_loss: 115.6779
Epoch 237/10000
1126/1126 [==============================] - 0s 64us/step - loss: 32.0603 - val_loss: 115.6740
Epoch 238/10000
1126/1126 [==============================] - 0s 79us/step - loss: 32.0095 - val_loss: 115.6648
Epoch 239/10000
1126/1126 [==============================] - 0s 78us/step - loss: 31.9590 - val_loss: 115.6585
Epoch 240/10000
1126/1126 [==============================] - 0s 72us/step - loss: 31.9084 - val_loss: 115.6501
Epoch 241/10000
1126/1126 [==============================] - 0s 76us/step - loss: 31.8577 - val_loss: 115.6442
Epoch 242/10000
1126/1126 [==============================] - 0s 66us/step - loss: 31.8073 - val_loss: 115.6401
Epoch 243/10000
```

```
1126/1126 [==============================] - 0s 81us/step - loss: 31.7567 - val_loss: 115.6369
Epoch 244/10000
1126/1126 [==============================] - 0s 76us/step - loss: 31.7068 - val_loss: 115.6346
Epoch 245/10000
1126/1126 [==============================] - 0s 65us/step - loss: 31.6565 - val_loss: 115.6303
Epoch 246/10000
1126/1126 [==============================] - 0s 65us/step - loss: 31.6066 - val_loss: 115.6265
Epoch 247/10000
1126/1126 [==============================] - 0s 66us/step - loss: 31.5570 - val_loss: 115.6232
Epoch 248/10000
1126/1126 [==============================] - 0s 65us/step - loss: 31.5070 - val_loss: 115.6220
Epoch 249/10000
1126/1126 [==============================] - 0s 64us/step - loss: 31.4573 - val_loss: 115.6229
Epoch 250/10000
1126/1126 [==============================] - 0s 67us/step - loss: 31.4074 - val_loss: 115.6232
Epoch 251/10000
1126/1126 [==============================] - 0s 67us/step - loss: 31.3576 - val_loss: 115.6229
Epoch 252/10000
1126/1126 [==============================] - 0s 65us/step - loss: 31.3080 - val_loss: 115.6247
Epoch 253/10000
1126/1126 [==============================] - 0s 69us/step - loss: 31.2582 - val_loss: 115.6245
Epoch 254/10000
1126/1126 [==============================] - 0s 63us/step - loss: 31.2085 - val_loss: 115.6245
Epoch 255/10000
1126/1126 [==============================] - 0s 66us/step - loss: 31.1588 - val_loss: 115.6220
Epoch 256/10000
1126/1126 [==============================] - 0s 64us/step - loss: 31.1097 - val_loss: 115.6221
Epoch 257/10000
1126/1126 [==============================] - 0s 66us/step - loss: 31.0603 - val_loss: 115.6230
Epoch 258/10000
1126/1126 [==============================] - 0s 66us/step - loss: 31.0111 - val_loss: 115.6246
Epoch 00258: early stopping


In [9]: y_pred = model.predict(X_test)
        plt.title('Coût et coût de validation')
        line1,=plt.plot(history.history['loss'], label="Loss", linestyle='-', color='r')
        line2,=plt.plot(history.history['val_loss'], label="Val loss", linestyle='-', color='b'
        first_legend = plt.legend(handles=[line1, line2], loc=1)

        plt.show()

        plt.title('y_pred en fonction de y_test')

        plt.plot(y_pred[:], y_test[:], '+')
        plt.ylabel('Test')
        plt.xlabel('Prédiction')
        plt.show()
```
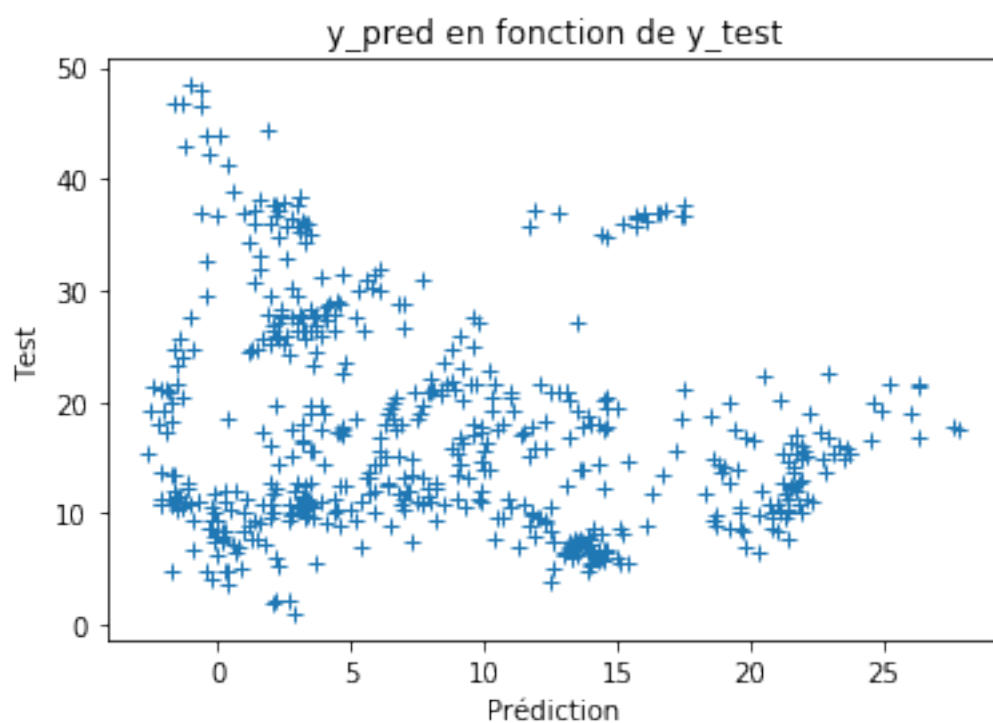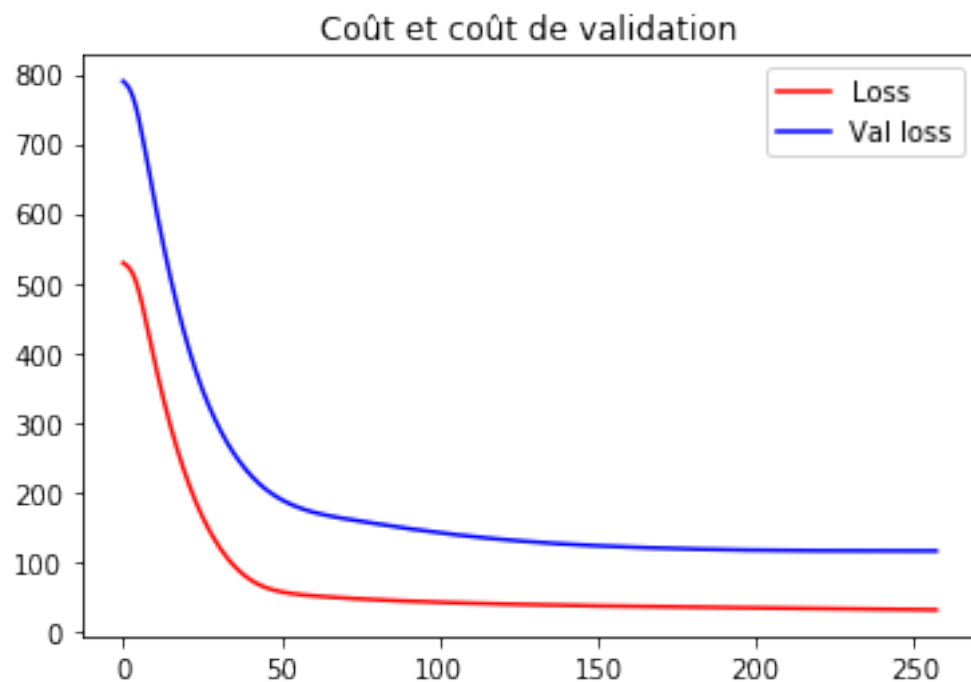
Coût et coût de validation

y_pred en fonction de y_test

```
In [10]: model = gru_model(32, X_train.shape[1:])
```

```
----------------------------------------------------------------
Layer (type)                 Output Shape              Param #
================================================================
gru_1 (GRU)                  (None, 32)                4224
----------------------------------------------------------------
dense_3 (Dense)              (None, 1)                 33
================================================================
Total params: 4,257
Trainable params: 4,257
Non-trainable params: 0

----------------------------------------------------------------
```

In [11]: early_stopping = EarlyStopping(monitor='val_loss', verbose=1, mode='auto', patience=10
         history = model.fit(X_train, y_train, batch_size=32, epochs=10000, validation_data=(X_

```
Train on 1126 samples, validate on 563 samples
Epoch 1/10000
1126/1126 [==============================] - 1s 755us/step - loss: 529.1473 - val_loss: 788.834
Epoch 2/10000
1126/1126 [==============================] - 0s 63us/step - loss: 525.4269 - val_loss: 784.6237
Epoch 3/10000
1126/1126 [==============================] - 0s 64us/step - loss: 520.6984 - val_loss: 778.6225
Epoch 4/10000
1126/1126 [==============================] - 0s 63us/step - loss: 513.5087 - val_loss: 769.3862
Epoch 5/10000
1126/1126 [==============================] - 0s 64us/step - loss: 502.4514 - val_loss: 755.4194
Epoch 6/10000
1126/1126 [==============================] - 0s 64us/step - loss: 486.5924 - val_loss: 736.1571
Epoch 7/10000
1126/1126 [==============================] - 0s 59us/step - loss: 466.1212 - val_loss: 712.2956
Epoch 8/10000
1126/1126 [==============================] - 0s 61us/step - loss: 442.1940 - val_loss: 685.2072
Epoch 9/10000
1126/1126 [==============================] - 0s 61us/step - loss: 416.2204 - val_loss: 656.1459
Epoch 10/10000
1126/1126 [==============================] - 0s 61us/step - loss: 389.4214 - val_loss: 626.0789
Epoch 11/10000
1126/1126 [==============================] - 0s 63us/step - loss: 362.6257 - val_loss: 595.7354
Epoch 12/10000
1126/1126 [==============================] - 0s 59us/step - loss: 336.3436 - val_loss: 565.6826
Epoch 13/10000
1126/1126 [==============================] - 0s 59us/step - loss: 310.9813 - val_loss: 536.3514
Epoch 14/10000
1126/1126 [==============================] - 0s 60us/step - loss: 286.7975 - val_loss: 508.0355
Epoch 15/10000
1126/1126 [==============================] - 0s 60us/step - loss: 263.9318 - val_loss: 480.9333
Epoch 16/10000
```

```
1126/1126 [==============================] - 0s 60us/step - loss: 242.4595 - val_loss: 455.1769
Epoch 17/10000
1126/1126 [==============================] - 0s 70us/step - loss: 222.4127 - val_loss: 430.7964
Epoch 18/10000
1126/1126 [==============================] - 0s 73us/step - loss: 203.7894 - val_loss: 407.8252
Epoch 19/10000
1126/1126 [==============================] - 0s 72us/step - loss: 186.5791 - val_loss: 386.2594
Epoch 20/10000
1126/1126 [==============================] - 0s 77us/step - loss: 170.7667 - val_loss: 366.0920
Epoch 21/10000
1126/1126 [==============================] - 0s 70us/step - loss: 156.3238 - val_loss: 347.3253
Epoch 22/10000
1126/1126 [==============================] - 0s 62us/step - loss: 143.2280 - val_loss: 329.9439
Epoch 23/10000
1126/1126 [==============================] - 0s 61us/step - loss: 131.4308 - val_loss: 313.9159
Epoch 24/10000
1126/1126 [==============================] - 0s 59us/step - loss: 120.8726 - val_loss: 299.2004
Epoch 25/10000
1126/1126 [==============================] - 0s 59us/step - loss: 111.4875 - val_loss: 285.7166
Epoch 26/10000
1126/1126 [==============================] - 0s 58us/step - loss: 103.1783 - val_loss: 273.3874
Epoch 27/10000
1126/1126 [==============================] - 0s 60us/step - loss: 95.8524 - val_loss: 262.1463
Epoch 28/10000
1126/1126 [==============================] - 0s 58us/step - loss: 89.4268 - val_loss: 251.9192
Epoch 29/10000
1126/1126 [==============================] - 0s 59us/step - loss: 83.8102 - val_loss: 242.6388
Epoch 30/10000
1126/1126 [==============================] - 0s 60us/step - loss: 78.9314 - val_loss: 234.2244
Epoch 31/10000
1126/1126 [==============================] - 0s 61us/step - loss: 74.7074 - val_loss: 226.6112
Epoch 32/10000
1126/1126 [==============================] - 0s 60us/step - loss: 71.0642 - val_loss: 219.7154
Epoch 33/10000
1126/1126 [==============================] - 0s 63us/step - loss: 67.9293 - val_loss: 213.4668
Epoch 34/10000
1126/1126 [==============================] - 0s 67us/step - loss: 65.2356 - val_loss: 207.8126
Epoch 35/10000
1126/1126 [==============================] - 0s 64us/step - loss: 62.9278 - val_loss: 202.6909
Epoch 36/10000
1126/1126 [==============================] - 0s 65us/step - loss: 60.9478 - val_loss: 198.0474
Epoch 37/10000
1126/1126 [==============================] - 0s 61us/step - loss: 59.2505 - val_loss: 193.8466
Epoch 38/10000
1126/1126 [==============================] - 0s 60us/step - loss: 57.7935 - val_loss: 190.0451
Epoch 39/10000
1126/1126 [==============================] - 0s 59us/step - loss: 56.5440 - val_loss: 186.6093
Epoch 40/10000
```

```
1126/1126 [==============================] - 0s 60us/step - loss: 55.4738 - val_loss: 183.5047
Epoch 41/10000
1126/1126 [==============================] - 0s 59us/step - loss: 54.5501 - val_loss: 180.6981
Epoch 42/10000
1126/1126 [==============================] - 0s 60us/step - loss: 53.7483 - val_loss: 178.1682
Epoch 43/10000
1126/1126 [==============================] - 0s 60us/step - loss: 53.0464 - val_loss: 175.8665
Epoch 44/10000
1126/1126 [==============================] - 0s 62us/step - loss: 52.4239 - val_loss: 173.7697
Epoch 45/10000
1126/1126 [==============================] - 0s 60us/step - loss: 51.8654 - val_loss: 171.8799
Epoch 46/10000
1126/1126 [==============================] - 0s 62us/step - loss: 51.3556 - val_loss: 170.1736
Epoch 47/10000
1126/1126 [==============================] - 0s 66us/step - loss: 50.8848 - val_loss: 168.6246
Epoch 48/10000
1126/1126 [==============================] - 0s 66us/step - loss: 50.4461 - val_loss: 167.1992
Epoch 49/10000
1126/1126 [==============================] - 0s 64us/step - loss: 50.0350 - val_loss: 165.8895
Epoch 50/10000
1126/1126 [==============================] - 0s 69us/step - loss: 49.6466 - val_loss: 164.6743
Epoch 51/10000
1126/1126 [==============================] - 0s 59us/step - loss: 49.2760 - val_loss: 163.5069
Epoch 52/10000
1126/1126 [==============================] - 0s 65us/step - loss: 48.9238 - val_loss: 162.4172
Epoch 53/10000
1126/1126 [==============================] - 0s 89us/step - loss: 48.5874 - val_loss: 161.3468
Epoch 54/10000
1126/1126 [==============================] - 0s 69us/step - loss: 48.2683 - val_loss: 160.2845
Epoch 55/10000
1126/1126 [==============================] - 0s 71us/step - loss: 47.9631 - val_loss: 159.2272
Epoch 56/10000
1126/1126 [==============================] - 0s 58us/step - loss: 47.6741 - val_loss: 158.2029
Epoch 57/10000
1126/1126 [==============================] - 0s 62us/step - loss: 47.3969 - val_loss: 157.1989
Epoch 58/10000
1126/1126 [==============================] - 0s 60us/step - loss: 47.1306 - val_loss: 156.2171
Epoch 59/10000
1126/1126 [==============================] - 0s 61us/step - loss: 46.8730 - val_loss: 155.2663
Epoch 60/10000
1126/1126 [==============================] - 0s 62us/step - loss: 46.6242 - val_loss: 154.3504
Epoch 61/10000
1126/1126 [==============================] - 0s 61us/step - loss: 46.3814 - val_loss: 153.4595
Epoch 62/10000
1126/1126 [==============================] - 0s 63us/step - loss: 46.1444 - val_loss: 152.6084
Epoch 63/10000
1126/1126 [==============================] - 0s 60us/step - loss: 45.9127 - val_loss: 151.7786
Epoch 64/10000
```

```
1126/1126 [==============================] - 0s 63us/step - loss: 45.6850 - val_loss: 150.9797
Epoch 65/10000
1126/1126 [==============================] - 0s 63us/step - loss: 45.4618 - val_loss: 150.2120
Epoch 66/10000
1126/1126 [==============================] - 0s 63us/step - loss: 45.2439 - val_loss: 149.4643
Epoch 67/10000
1126/1126 [==============================] - 0s 59us/step - loss: 45.0307 - val_loss: 148.7338
Epoch 68/10000
1126/1126 [==============================] - 0s 62us/step - loss: 44.8218 - val_loss: 148.0121
Epoch 69/10000
1126/1126 [==============================] - 0s 63us/step - loss: 44.6181 - val_loss: 147.3023
Epoch 70/10000
1126/1126 [==============================] - 0s 67us/step - loss: 44.4178 - val_loss: 146.6207
Epoch 71/10000
1126/1126 [==============================] - 0s 68us/step - loss: 44.2206 - val_loss: 145.9347
Epoch 72/10000
1126/1126 [==============================] - 0s 64us/step - loss: 44.0274 - val_loss: 145.2674
Epoch 73/10000
1126/1126 [==============================] - 0s 67us/step - loss: 43.8376 - val_loss: 144.6124
Epoch 74/10000
1126/1126 [==============================] - 0s 81us/step - loss: 43.6512 - val_loss: 143.9579
Epoch 75/10000
1126/1126 [==============================] - 0s 76us/step - loss: 43.4681 - val_loss: 143.3295
Epoch 76/10000
1126/1126 [==============================] - 0s 79us/step - loss: 43.2874 - val_loss: 142.7154
Epoch 77/10000
1126/1126 [==============================] - 0s 82us/step - loss: 43.1092 - val_loss: 142.1014
Epoch 78/10000
1126/1126 [==============================] - 0s 96us/step - loss: 42.9339 - val_loss: 141.4998
Epoch 79/10000
1126/1126 [==============================] - 0s 80us/step - loss: 42.7607 - val_loss: 140.9011
Epoch 80/10000
1126/1126 [==============================] - 0s 65us/step - loss: 42.5903 - val_loss: 140.2915
Epoch 81/10000
1126/1126 [==============================] - 0s 65us/step - loss: 42.4227 - val_loss: 139.6818
Epoch 82/10000
1126/1126 [==============================] - 0s 61us/step - loss: 42.2587 - val_loss: 139.0728
Epoch 83/10000
1126/1126 [==============================] - 0s 62us/step - loss: 42.0983 - val_loss: 138.4679
Epoch 84/10000
1126/1126 [==============================] - 0s 61us/step - loss: 41.9404 - val_loss: 137.8730
Epoch 85/10000
1126/1126 [==============================] - 0s 62us/step - loss: 41.7850 - val_loss: 137.2736
Epoch 86/10000
1126/1126 [==============================] - 0s 63us/step - loss: 41.6321 - val_loss: 136.6803
Epoch 87/10000
1126/1126 [==============================] - 0s 65us/step - loss: 41.4816 - val_loss: 136.0929
Epoch 88/10000
```

```
1126/1126 [==============================] - 0s 62us/step - loss: 41.3339 - val_loss: 135.5029
Epoch 89/10000
1126/1126 [==============================] - 0s 63us/step - loss: 41.1886 - val_loss: 134.9095
Epoch 90/10000
1126/1126 [==============================] - 0s 64us/step - loss: 41.0461 - val_loss: 134.3373
Epoch 91/10000
1126/1126 [==============================] - 0s 62us/step - loss: 40.9062 - val_loss: 133.7713
Epoch 92/10000
1126/1126 [==============================] - 0s 61us/step - loss: 40.7686 - val_loss: 133.2067
Epoch 93/10000
1126/1126 [==============================] - 0s 61us/step - loss: 40.6337 - val_loss: 132.6461
Epoch 94/10000
1126/1126 [==============================] - 0s 61us/step - loss: 40.5016 - val_loss: 132.0886
Epoch 95/10000
1126/1126 [==============================] - 0s 61us/step - loss: 40.3717 - val_loss: 131.5469
Epoch 96/10000
1126/1126 [==============================] - 0s 60us/step - loss: 40.2450 - val_loss: 131.0141
Epoch 97/10000
1126/1126 [==============================] - 0s 61us/step - loss: 40.1206 - val_loss: 130.4932
Epoch 98/10000
1126/1126 [==============================] - 0s 60us/step - loss: 39.9985 - val_loss: 129.9865
Epoch 99/10000
1126/1126 [==============================] - 0s 61us/step - loss: 39.8792 - val_loss: 129.4890
Epoch 100/10000
1126/1126 [==============================] - 0s 60us/step - loss: 39.7626 - val_loss: 129.0038
Epoch 101/10000
1126/1126 [==============================] - 0s 62us/step - loss: 39.6479 - val_loss: 128.5318
Epoch 102/10000
1126/1126 [==============================] - 0s 64us/step - loss: 39.5356 - val_loss: 128.0644
Epoch 103/10000
1126/1126 [==============================] - 0s 71us/step - loss: 39.4254 - val_loss: 127.6144
Epoch 104/10000
1126/1126 [==============================] - 0s 68us/step - loss: 39.3179 - val_loss: 127.1705
Epoch 105/10000
1126/1126 [==============================] - 0s 69us/step - loss: 39.2123 - val_loss: 126.7370
Epoch 106/10000
1126/1126 [==============================] - 0s 68us/step - loss: 39.1084 - val_loss: 126.3145
Epoch 107/10000
1126/1126 [==============================] - 0s 64us/step - loss: 39.0069 - val_loss: 125.9021
Epoch 108/10000
1126/1126 [==============================] - 0s 62us/step - loss: 38.9073 - val_loss: 125.5000
Epoch 109/10000
1126/1126 [==============================] - 0s 62us/step - loss: 38.8103 - val_loss: 125.1063
Epoch 110/10000
1126/1126 [==============================] - 0s 67us/step - loss: 38.7150 - val_loss: 124.7229
Epoch 111/10000
1126/1126 [==============================] - 0s 59us/step - loss: 38.6216 - val_loss: 124.3461
Epoch 112/10000
```

```
1126/1126 [==============================] - 0s 60us/step - loss: 38.5302 - val_loss: 123.9879
Epoch 113/10000
1126/1126 [==============================] - 0s 60us/step - loss: 38.4405 - val_loss: 123.6396
Epoch 114/10000
1126/1126 [==============================] - 0s 62us/step - loss: 38.3530 - val_loss: 123.3071
Epoch 115/10000
1126/1126 [==============================] - 0s 69us/step - loss: 38.2675 - val_loss: 122.9796
Epoch 116/10000
1126/1126 [==============================] - 0s 64us/step - loss: 38.1838 - val_loss: 122.6697
Epoch 117/10000
1126/1126 [==============================] - 0s 66us/step - loss: 38.1018 - val_loss: 122.3664
Epoch 118/10000
1126/1126 [==============================] - 0s 63us/step - loss: 38.0220 - val_loss: 122.0637
Epoch 119/10000
1126/1126 [==============================] - 0s 63us/step - loss: 37.9441 - val_loss: 121.7707
Epoch 120/10000
1126/1126 [==============================] - 0s 63us/step - loss: 37.8680 - val_loss: 121.4827
Epoch 121/10000
1126/1126 [==============================] - 0s 68us/step - loss: 37.7933 - val_loss: 121.2056
Epoch 122/10000
1126/1126 [==============================] - 0s 61us/step - loss: 37.7202 - val_loss: 120.9364
Epoch 123/10000
1126/1126 [==============================] - 0s 56us/step - loss: 37.6480 - val_loss: 120.6783
Epoch 124/10000
1126/1126 [==============================] - 0s 60us/step - loss: 37.5771 - val_loss: 120.4259
Epoch 125/10000
1126/1126 [==============================] - 0s 65us/step - loss: 37.5078 - val_loss: 120.1771
Epoch 126/10000
1126/1126 [==============================] - 0s 64us/step - loss: 37.4400 - val_loss: 119.9422
Epoch 127/10000
1126/1126 [==============================] - 0s 60us/step - loss: 37.3736 - val_loss: 119.7138
Epoch 128/10000
1126/1126 [==============================] - 0s 62us/step - loss: 37.3087 - val_loss: 119.4917
Epoch 129/10000
1126/1126 [==============================] - 0s 60us/step - loss: 37.2445 - val_loss: 119.2706
Epoch 130/10000
1126/1126 [==============================] - 0s 66us/step - loss: 37.1813 - val_loss: 119.0568
Epoch 131/10000
1126/1126 [==============================] - 0s 71us/step - loss: 37.1191 - val_loss: 118.8517
Epoch 132/10000
1126/1126 [==============================] - 0s 68us/step - loss: 37.0582 - val_loss: 118.6489
Epoch 133/10000
1126/1126 [==============================] - 0s 58us/step - loss: 36.9980 - val_loss: 118.4537
Epoch 134/10000
1126/1126 [==============================] - 0s 60us/step - loss: 36.9388 - val_loss: 118.2626
Epoch 135/10000
1126/1126 [==============================] - 0s 61us/step - loss: 36.8798 - val_loss: 118.0745
Epoch 136/10000
```

```
1126/1126 [==============================] - 0s 64us/step - loss: 36.8219 - val_loss: 117.8876
Epoch 137/10000
1126/1126 [==============================] - 0s 66us/step - loss: 36.7648 - val_loss: 117.7094
Epoch 138/10000
1126/1126 [==============================] - 0s 64us/step - loss: 36.7084 - val_loss: 117.5328
Epoch 139/10000
1126/1126 [==============================] - 0s 61us/step - loss: 36.6527 - val_loss: 117.3605
Epoch 140/10000
1126/1126 [==============================] - 0s 61us/step - loss: 36.5978 - val_loss: 117.1910
Epoch 141/10000
1126/1126 [==============================] - 0s 58us/step - loss: 36.5437 - val_loss: 117.0329
Epoch 142/10000
1126/1126 [==============================] - 0s 56us/step - loss: 36.4901 - val_loss: 116.8728
Epoch 143/10000
1126/1126 [==============================] - 0s 59us/step - loss: 36.4371 - val_loss: 116.7211
Epoch 144/10000
1126/1126 [==============================] - 0s 59us/step - loss: 36.3848 - val_loss: 116.5668
Epoch 145/10000
1126/1126 [==============================] - 0s 62us/step - loss: 36.3328 - val_loss: 116.4178
Epoch 146/10000
1126/1126 [==============================] - 0s 56us/step - loss: 36.2817 - val_loss: 116.2741
Epoch 147/10000
1126/1126 [==============================] - 0s 61us/step - loss: 36.2312 - val_loss: 116.1335
Epoch 148/10000
1126/1126 [==============================] - 0s 66us/step - loss: 36.1815 - val_loss: 115.9932
Epoch 149/10000
1126/1126 [==============================] - 0s 67us/step - loss: 36.1323 - val_loss: 115.8629
Epoch 150/10000
1126/1126 [==============================] - 0s 61us/step - loss: 36.0835 - val_loss: 115.7343
Epoch 151/10000
1126/1126 [==============================] - 0s 61us/step - loss: 36.0346 - val_loss: 115.6060
Epoch 152/10000
1126/1126 [==============================] - 0s 56us/step - loss: 35.9866 - val_loss: 115.4783
Epoch 153/10000
1126/1126 [==============================] - 0s 61us/step - loss: 35.9389 - val_loss: 115.3632
Epoch 154/10000
1126/1126 [==============================] - 0s 62us/step - loss: 35.8912 - val_loss: 115.2500
Epoch 155/10000
1126/1126 [==============================] - 0s 65us/step - loss: 35.8440 - val_loss: 115.1321
Epoch 156/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.7972 - val_loss: 115.0250
Epoch 157/10000
1126/1126 [==============================] - 0s 66us/step - loss: 35.7505 - val_loss: 114.9205
Epoch 158/10000
1126/1126 [==============================] - 0s 65us/step - loss: 35.7042 - val_loss: 114.8145
Epoch 159/10000
1126/1126 [==============================] - 0s 64us/step - loss: 35.6586 - val_loss: 114.7161
Epoch 160/10000
```

```
1126/1126 [==============================] - 0s 58us/step - loss: 35.6129 - val_loss: 114.6176
Epoch 161/10000
1126/1126 [==============================] - 0s 59us/step - loss: 35.5672 - val_loss: 114.5130
Epoch 162/10000
1126/1126 [==============================] - 0s 55us/step - loss: 35.5226 - val_loss: 114.4190
Epoch 163/10000
1126/1126 [==============================] - 0s 55us/step - loss: 35.4777 - val_loss: 114.3293
Epoch 164/10000
1126/1126 [==============================] - 0s 55us/step - loss: 35.4331 - val_loss: 114.2350
Epoch 165/10000
1126/1126 [==============================] - 0s 60us/step - loss: 35.3892 - val_loss: 114.1458
Epoch 166/10000
1126/1126 [==============================] - 0s 55us/step - loss: 35.3448 - val_loss: 114.0572
Epoch 167/10000
1126/1126 [==============================] - 0s 55us/step - loss: 35.3011 - val_loss: 113.9746
Epoch 168/10000
1126/1126 [==============================] - 0s 63us/step - loss: 35.2576 - val_loss: 113.8945
Epoch 169/10000
1126/1126 [==============================] - 0s 56us/step - loss: 35.2143 - val_loss: 113.8125
Epoch 170/10000
1126/1126 [==============================] - 0s 63us/step - loss: 35.1719 - val_loss: 113.7382
Epoch 171/10000
1126/1126 [==============================] - 0s 59us/step - loss: 35.1295 - val_loss: 113.6623
Epoch 172/10000
1126/1126 [==============================] - 0s 72us/step - loss: 35.0875 - val_loss: 113.5905
Epoch 173/10000
1126/1126 [==============================] - 0s 74us/step - loss: 35.0456 - val_loss: 113.5164
Epoch 174/10000
1126/1126 [==============================] - 0s 67us/step - loss: 35.0037 - val_loss: 113.4443
Epoch 175/10000
1126/1126 [==============================] - 0s 59us/step - loss: 34.9622 - val_loss: 113.3735
Epoch 176/10000
1126/1126 [==============================] - 0s 55us/step - loss: 34.9210 - val_loss: 113.3083
Epoch 177/10000
1126/1126 [==============================] - 0s 56us/step - loss: 34.8795 - val_loss: 113.2381
Epoch 178/10000
1126/1126 [==============================] - 0s 62us/step - loss: 34.8383 - val_loss: 113.1673
Epoch 179/10000
1126/1126 [==============================] - 0s 64us/step - loss: 34.7973 - val_loss: 113.1037
Epoch 180/10000
1126/1126 [==============================] - 0s 61us/step - loss: 34.7561 - val_loss: 113.0413
Epoch 181/10000
1126/1126 [==============================] - 0s 59us/step - loss: 34.7151 - val_loss: 112.9819
Epoch 182/10000
1126/1126 [==============================] - 0s 59us/step - loss: 34.6741 - val_loss: 112.9233
Epoch 183/10000
1126/1126 [==============================] - 0s 56us/step - loss: 34.6331 - val_loss: 112.8676
Epoch 184/10000
```

```
1126/1126 [==============================] - 0s 56us/step - loss: 34.5923 - val_loss: 112.8119
Epoch 185/10000
1126/1126 [==============================] - 0s 58us/step - loss: 34.5517 - val_loss: 112.7613
Epoch 186/10000
1126/1126 [==============================] - 0s 59us/step - loss: 34.5111 - val_loss: 112.7090
Epoch 187/10000
1126/1126 [==============================] - 0s 57us/step - loss: 34.4703 - val_loss: 112.6571
Epoch 188/10000
1126/1126 [==============================] - 0s 57us/step - loss: 34.4298 - val_loss: 112.6126
Epoch 189/10000
1126/1126 [==============================] - 0s 59us/step - loss: 34.3891 - val_loss: 112.5676
Epoch 190/10000
1126/1126 [==============================] - 0s 58us/step - loss: 34.3484 - val_loss: 112.5251
Epoch 191/10000
1126/1126 [==============================] - 0s 65us/step - loss: 34.3078 - val_loss: 112.4827
Epoch 192/10000
1126/1126 [==============================] - 0s 66us/step - loss: 34.2674 - val_loss: 112.4427
Epoch 193/10000
1126/1126 [==============================] - 0s 66us/step - loss: 34.2272 - val_loss: 112.4029
Epoch 194/10000
1126/1126 [==============================] - 0s 60us/step - loss: 34.1873 - val_loss: 112.3657
Epoch 195/10000
1126/1126 [==============================] - 0s 58us/step - loss: 34.1475 - val_loss: 112.3293
Epoch 196/10000
1126/1126 [==============================] - 0s 57us/step - loss: 34.1075 - val_loss: 112.2907
Epoch 197/10000
1126/1126 [==============================] - 0s 58us/step - loss: 34.0678 - val_loss: 112.2543
Epoch 198/10000
1126/1126 [==============================] - 0s 58us/step - loss: 34.0283 - val_loss: 112.2231
Epoch 199/10000
1126/1126 [==============================] - 0s 58us/step - loss: 33.9887 - val_loss: 112.1868
Epoch 200/10000
1126/1126 [==============================] - 0s 58us/step - loss: 33.9494 - val_loss: 112.1546
Epoch 201/10000
1126/1126 [==============================] - 0s 58us/step - loss: 33.9103 - val_loss: 112.1215
Epoch 202/10000
1126/1126 [==============================] - 0s 61us/step - loss: 33.8713 - val_loss: 112.0907
Epoch 203/10000
1126/1126 [==============================] - 0s 61us/step - loss: 33.8323 - val_loss: 112.0604
Epoch 204/10000
1126/1126 [==============================] - 0s 55us/step - loss: 33.7933 - val_loss: 112.0323
Epoch 205/10000
1126/1126 [==============================] - 0s 59us/step - loss: 33.7544 - val_loss: 112.0022
Epoch 206/10000
1126/1126 [==============================] - 0s 56us/step - loss: 33.7150 - val_loss: 111.9739
Epoch 207/10000
1126/1126 [==============================] - 0s 67us/step - loss: 33.6760 - val_loss: 111.9445
Epoch 208/10000
```

```
1126/1126 [==============================] - 0s 63us/step - loss: 33.6372 - val_loss: 111.9184
Epoch 209/10000
1126/1126 [==============================] - 0s 64us/step - loss: 33.5985 - val_loss: 111.8929
Epoch 210/10000
1126/1126 [==============================] - 0s 60us/step - loss: 33.5595 - val_loss: 111.8701
Epoch 211/10000
1126/1126 [==============================] - 0s 56us/step - loss: 33.5206 - val_loss: 111.8527
Epoch 212/10000
1126/1126 [==============================] - 0s 59us/step - loss: 33.4820 - val_loss: 111.8364
Epoch 213/10000
1126/1126 [==============================] - 0s 58us/step - loss: 33.4428 - val_loss: 111.8172
Epoch 214/10000
1126/1126 [==============================] - 0s 60us/step - loss: 33.4044 - val_loss: 111.8005
Epoch 215/10000
1126/1126 [==============================] - 0s 59us/step - loss: 33.3655 - val_loss: 111.7824
Epoch 216/10000
1126/1126 [==============================] - 0s 60us/step - loss: 33.3267 - val_loss: 111.7629
Epoch 217/10000
1126/1126 [==============================] - 0s 59us/step - loss: 33.2881 - val_loss: 111.7488
Epoch 218/10000
1126/1126 [==============================] - 0s 59us/step - loss: 33.2492 - val_loss: 111.7401
Epoch 219/10000
1126/1126 [==============================] - 0s 58us/step - loss: 33.2101 - val_loss: 111.7311
Epoch 220/10000
1126/1126 [==============================] - 0s 59us/step - loss: 33.1712 - val_loss: 111.7250
Epoch 221/10000
1126/1126 [==============================] - 0s 59us/step - loss: 33.1325 - val_loss: 111.7154
Epoch 222/10000
1126/1126 [==============================] - 0s 57us/step - loss: 33.0945 - val_loss: 111.7098
Epoch 223/10000
1126/1126 [==============================] - 0s 57us/step - loss: 33.0560 - val_loss: 111.7040
Epoch 224/10000
1126/1126 [==============================] - 0s 56us/step - loss: 33.0179 - val_loss: 111.6994
Epoch 225/10000
1126/1126 [==============================] - 0s 56us/step - loss: 32.9802 - val_loss: 111.6953
Epoch 226/10000
1126/1126 [==============================] - 0s 57us/step - loss: 32.9426 - val_loss: 111.6918
Epoch 227/10000
1126/1126 [==============================] - 0s 55us/step - loss: 32.9048 - val_loss: 111.6918
Epoch 228/10000
1126/1126 [==============================] - 0s 56us/step - loss: 32.8667 - val_loss: 111.6899
Epoch 229/10000
1126/1126 [==============================] - 0s 55us/step - loss: 32.8289 - val_loss: 111.6879
Epoch 230/10000
1126/1126 [==============================] - 0s 57us/step - loss: 32.7909 - val_loss: 111.6844
Epoch 231/10000
1126/1126 [==============================] - 0s 56us/step - loss: 32.7533 - val_loss: 111.6826
Epoch 232/10000
```

```
1126/1126 [==============================] - 0s 59us/step - loss: 32.7154 - val_loss: 111.6810
Epoch 233/10000
1126/1126 [==============================] - 0s 61us/step - loss: 32.6779 - val_loss: 111.6800
Epoch 234/10000
1126/1126 [==============================] - 0s 58us/step - loss: 32.6402 - val_loss: 111.6813
Epoch 235/10000
1126/1126 [==============================] - 0s 55us/step - loss: 32.6026 - val_loss: 111.6825
Epoch 236/10000
1126/1126 [==============================] - 0s 55us/step - loss: 32.5648 - val_loss: 111.6819
Epoch 237/10000
1126/1126 [==============================] - 0s 60us/step - loss: 32.5276 - val_loss: 111.6779
Epoch 238/10000
1126/1126 [==============================] - 0s 59us/step - loss: 32.4903 - val_loss: 111.6744
Epoch 239/10000
1126/1126 [==============================] - 0s 59us/step - loss: 32.4530 - val_loss: 111.6712
Epoch 240/10000
1126/1126 [==============================] - 0s 59us/step - loss: 32.4157 - val_loss: 111.6723
Epoch 241/10000
1126/1126 [==============================] - 0s 59us/step - loss: 32.3781 - val_loss: 111.6669
Epoch 242/10000
1126/1126 [==============================] - 0s 61us/step - loss: 32.3409 - val_loss: 111.6639
Epoch 243/10000
1126/1126 [==============================] - 0s 56us/step - loss: 32.3040 - val_loss: 111.6617
Epoch 244/10000
1126/1126 [==============================] - 0s 58us/step - loss: 32.2670 - val_loss: 111.6591
Epoch 245/10000
1126/1126 [==============================] - 0s 63us/step - loss: 32.2297 - val_loss: 111.6561
Epoch 246/10000
1126/1126 [==============================] - 0s 63us/step - loss: 32.1926 - val_loss: 111.6565
Epoch 247/10000
1126/1126 [==============================] - 0s 62us/step - loss: 32.1556 - val_loss: 111.6604
Epoch 248/10000
1126/1126 [==============================] - 0s 74us/step - loss: 32.1180 - val_loss: 111.6597
Epoch 249/10000
1126/1126 [==============================] - 0s 60us/step - loss: 32.0806 - val_loss: 111.6641
Epoch 250/10000
1126/1126 [==============================] - 0s 58us/step - loss: 32.0428 - val_loss: 111.6674
Epoch 251/10000
1126/1126 [==============================] - 0s 60us/step - loss: 32.0052 - val_loss: 111.6728
Epoch 252/10000
1126/1126 [==============================] - 0s 63us/step - loss: 31.9673 - val_loss: 111.6793
Epoch 253/10000
1126/1126 [==============================] - 0s 62us/step - loss: 31.9295 - val_loss: 111.6874
Epoch 254/10000
1126/1126 [==============================] - 0s 65us/step - loss: 31.8918 - val_loss: 111.6947
Epoch 255/10000
1126/1126 [==============================] - 0s 67us/step - loss: 31.8538 - val_loss: 111.7028
Epoch 00255: early stopping
```

```
In [12]: y_pred = model.predict(X_test)
         plt.title('Coût et coût de validation')
         line1,=plt.plot(history.history['loss'], label="Loss", linestyle='-', color='r')
         line2,=plt.plot(history.history['val_loss'], label="Val loss", linestyle='-', color='l
         first_legend = plt.legend(handles=[line1, line2], loc=1)

         plt.show()

         plt.title('y_pred en fonction de y_test')

         plt.plot(y_pred[:], y_test[:], '+')
         plt.ylabel('Test')
         plt.xlabel('Prédiction')
         plt.show()
```


Coût et coût de validation

y_pred en fonction de y_test