Import libraries

```
# Install necessary packages
!pip install pandas scikit-learn tensorflow
```

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```

For training validation and testing

```
import csv
import chardet
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.regularizers import l1
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn.metrics import mean_squared_error
import math

# Load the dataset
dataset = pd.read_csv('/content/CrossValidation_Dataset.csv', encoding='latin-1')

#Encoding
with open('CrossValidation_Dataset.csv', 'rb') as f:
    result = chardet.detect(f.read(100000))
```

```
encoding = result['encoding']
print(encoding)

dataset = pd.read_csv('/content/CrossValidation_Dataset.csv', encoding=encoding)

# Extract features and target variable
X = dataset[['WindSpeed(m/s)', 'WindDirection(°)', 'TheoreticalPowerCurve(KWh)']]
y = dataset['LVActivePower(kW)']

# Normalize features
scaler = MinMaxScaler()
X_normalized = scaler.fit_transform(X)

# Split the data into train, validate, and test sets
X_train, X_temp, y_train, y_temp = train_test_split(X_normalized, y, test_size=0.4, random_state=42)
X_val, X_test, y_val, y_test = train_test_split(X_temp, y_temp, test_size=0.5, random_state=42)

# Build the LSTM model
model = Sequential()
model.add(LSTM(50, activation='relu', input_shape=(X_train.shape[1], 1), kernel_regularizer=l1(0.01)))
model.add(Dense(1))

# Compile the model
model.compile(optimizer=Adam(learning_rate=0.01), loss='mse', metrics=['mae'])

# Reshape data for LSTM (add time dimension)
X_train = X_train.reshape((X_train.shape[0], X_train.shape[1], 1))
X_val = X_val.reshape((X_val.shape[0], X_val.shape[1], 1))
X_test = X_test.reshape((X_test.shape[0], X_test.shape[1], 1))

# Train the model
model.fit(X_train, y_train, epochs=50, batch_size=32, validation_data=(X_val, y_val))

# Evaluate the model on the test set
loss, mae = model.evaluate(X_test, y_test)
print(f'Test Mean Absolute Error: {mae}')

# Assuming 'y_test_last_20_pred' is a 2D array
# Inverse transform the normalized predictions to get actual ActivePower values
scaler = MinMaxScaler()
y = y.values.reshape(-1, 1)
scaler.fit(y)

# Get last 1440 rows from test set
last_1440 = X_test.shape[0] - 1440

X_test_last_1440 = X_test[last_1440:]
y_test_last_1440 = y_test[last_1440:]

# Make predictions
y_pred_last_1440 = model.predict(X_test_last_1440)

# Inverse transform predictions
y_pred_last_1440 = scaler.inverse_transform(y_pred_last_1440).flatten()

# Calculate RMSE
rmse = math.sqrt(mean_squared_error(y_test_last_1440, y_pred_last_1440))

# Create DataFrame
result_df = pd.DataFrame({
    'Actual': y_test_last_1440,
    'Predicted': y_pred_last_1440,
    'RMSE': rmse
})

print(result_df)

# Create rows to write
rows = [
    [actual, predicted, rmse]
    for actual, predicted in zip(y_test_last_1440, y_pred_last_1440)
]


# Open csv file for writing
with open('CrossValidation_predictions.csv', 'w') as f:
```

```
    # Create csv writer
    writer = csv.writer(f)

    # Write column headers
    writer.writerow(['Actual', 'Predicted', 'RMSE'])

    # Write each row
    writer.writerows(rows)

print('CSV saved successfully!')
```

```
54/54 [==============================] - 0s 5ms/step - loss: 444904.0938 - mae: 401.3160 - val_loss: 407500.968
Epoch 32/50
54/54 [==============================] - 0s 5ms/step - loss: 433881.5625 - mae: 390.1720 - val_loss: 400322.250
Epoch 33/50
54/54 [==============================] - 0s 5ms/step - loss: 432828.3438 - mae: 387.7444 - val_loss: 396529.000
Epoch 34/50
54/54 [==============================] - 0s 6ms/step - loss: 428102.9375 - mae: 382.6075 - val_loss: 394719.718
Epoch 35/50
54/54 [==============================] - 0s 5ms/step - loss: 419150.5625 - mae: 373.1447 - val_loss: 400622.468
Epoch 36/50
54/54 [==============================] - 0s 6ms/step - loss: 418782.5000 - mae: 374.2210 - val_loss: 392556.468
Epoch 37/50
54/54 [==============================] - 0s 5ms/step - loss: 422555.6562 - mae: 371.2031 - val_loss: 395839.250
Epoch 38/50
54/54 [==============================] - 0s 6ms/step - loss: 416763.9062 - mae: 361.4541 - val_loss: 374882.156
Epoch 39/50
54/54 [==============================] - 0s 5ms/step - loss: 405302.0625 - mae: 354.7910 - val_loss: 379157.625
Epoch 40/50
54/54 [==============================] - 0s 6ms/step - loss: 401382.1250 - mae: 343.3402 - val_loss: 377883.687
Epoch 41/50
54/54 [==============================] - 0s 5ms/step - loss: 401677.9688 - mae: 352.4096 - val_loss: 367801.187
Epoch 42/50
54/54 [==============================] - 0s 5ms/step - loss: 407943.5000 - mae: 348.7497 - val_loss: 363729.312
Epoch 43/50
54/54 [==============================] - 0s 5ms/step - loss: 394091.6875 - mae: 340.1716 - val_loss: 364208.625
Epoch 44/50
54/54 [==============================] - 0s 5ms/step - loss: 401975.2188 - mae: 339.0789 - val_loss: 362415.500
Epoch 45/50
54/54 [==============================] - 0s 6ms/step - loss: 392512.8438 - mae: 336.5830 - val_loss: 358386.375
Epoch 46/50
54/54 [==============================] - 0s 5ms/step - loss: 386775.7500 - mae: 321.6102 - val_loss: 357321.468
Epoch 47/50
54/54 [==============================] - 0s 5ms/step - loss: 390551.0000 - mae: 336.7225 - val_loss: 389150.218
Epoch 48/50
54/54 [==============================] - 0s 5ms/step - loss: 382125.2500 - mae: 316.7751 - val_loss: 360951.187
Epoch 49/50
54/54 [==============================] - 0s 5ms/step - loss: 386089.3125 - mae: 324.1678 - val_loss: 351155.937
Epoch 50/50
54/54 [==============================] - 0s 5ms/step - loss: 381765.6875 - mae: 321.5490 - val_loss: 357286.093
18/18 [==============================] - 0s 3ms/step - loss: 282846.2500 - mae: 258.6875
Test Mean Absolute Error: 258.6874694824219
18/18 [==============================] - 0s 3ms/step
           Actual     Predicted          RMSE
532    117.829873  1.600453e+05  6.139042e+06
2801  3463.218018  1.166583e+07  6.139042e+06
2016     0.000000  2.324617e+05  6.139042e+06
858   2523.486358  8.554189e+06  6.139042e+06
941   2709.325716  9.000079e+06  6.139042e+06
...           ...           ...           ...
307     78.451192  4.881173e+05  6.139042e+06
965   3370.074951  1.108653e+07  6.139042e+06
999    321.701987  1.271122e+06  6.139042e+06
1960     0.000000  4.979617e+05  6.139042e+06
240   2800.435658  8.937020e+06  6.139042e+06

[572 rows x 3 columns]
CSV saved successfully!
```

Future Prediction - 24 hrs

```
import numpy as np

# Train model only on training data
model.fit(X_train, y_train, epochs=50)

# No of features
no_features = X_train.shape[1]

# Create dummy 2D input
next_1440 = pd.DataFrame(np.zeros((1440, no_features)))

# Make predictions
y_pred_next_1440 = model.predict(next_1440)

# Inverse transform predictions
y_pred_next_1440 = scaler.inverse_transform(y_pred_next_1440)

# RMSE will be Nan as we don't have actual values
rmse = [np.nan]*len(y_pred_next_1440)

# Prepare rows for writing to CSV
rows = [
    [np.nan, pred, rmse_val]
    for pred, rmse_val in zip(y_pred_next_1440, rmse)
]

# Write predictions to CSV
with open('CrossValidation_future_predictions.csv', 'w') as f:
    writer = csv.writer(f)
    writer.writerow(['Predicted'])
    writer.writerows(rows)


print('Future predictions saved to CSV')
```

```
Epoch 23/50
54/54 [==============================] - 0s 4ms/step - loss: 364872.5938 - mae: 302.0420
Epoch 24/50
```

```
54/54 [==============================] - 0s 6ms/step - loss: 353723.6250 - mae: 287.9124
Epoch 47/50
54/54 [==============================] - 0s 6ms/step - loss: 352952.8750 - mae: 290.4261
Epoch 48/50
54/54 [==============================] - 0s 6ms/step - loss: 350378.5000 - mae: 282.6345
Epoch 49/50
54/54 [==============================] - 0s 6ms/step - loss: 356775.7812 - mae: 292.3760
Epoch 50/50
54/54 [==============================] - 0s 6ms/step - loss: 353992.6562 - mae: 283.1582
45/45 [==============================] - 0s 3ms/step
Future predictions saved to CSV
```

Please use following link to see output files and resources - https://github.com/MIHIR-RANJAN/Wind_Turbine_Power_Prediction_Problem_SE20UARI020_SE20UARI095_SE20UARI112.git