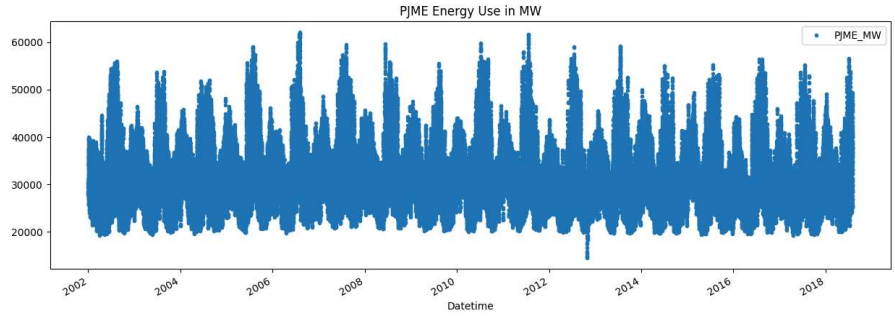
```
import pandas as pd
import numpy as np
import xgboost as xgb
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import TimeSeriesSplit


df = pd.read_csv('/content/PJME_hourly.csv')
df = df.set_index('Datetime')
df.index = pd.to_datetime(df.index)



df.head()
```

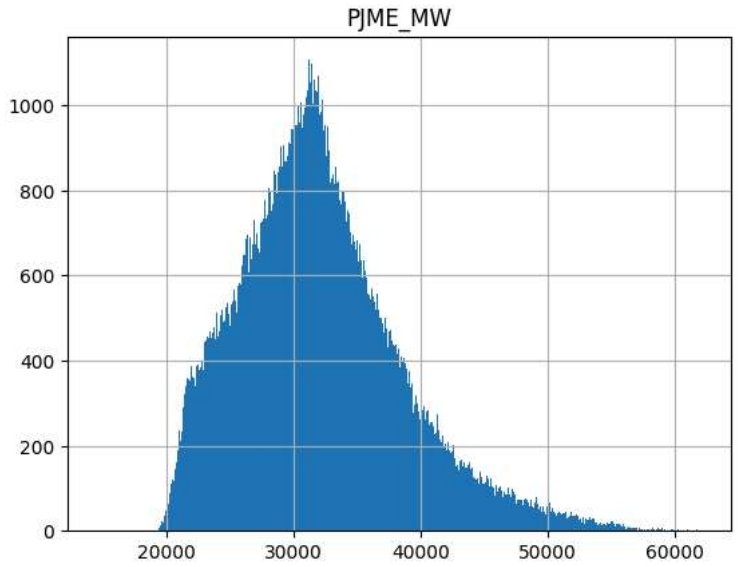
Datetime	PJME_MW
2002-12-31 01:00:00	26498.0
2002-12-31 02:00:00	25147.0
2002-12-31 03:00:00	24574.0
2002-12-31 04:00:00	24393.0
2002-12-31 05:00:00	24860.0

```
df.plot(style='.',
        figsize=(15, 5),
        title='PJME Energy Use in MW')
plt.show()
```



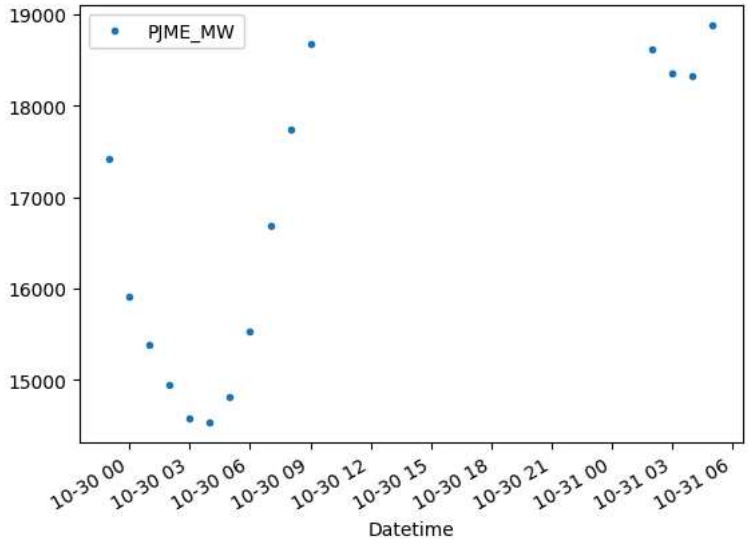

```
df.hist(bins=500)
```

```
array([[<Axes: title={'center': 'PJME_MW'}>]], dtype=object)
```




```
df.query('PJME_MW < 19000').plot(style='.')
```

```
<Axes: xlabel='Datetime'>
```



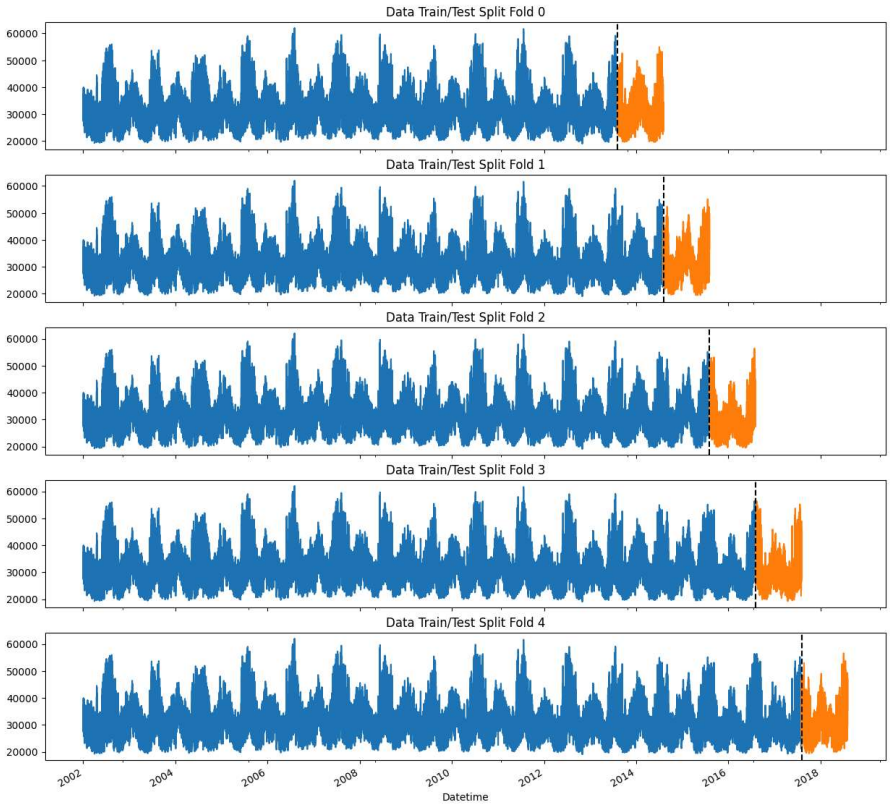

```
df = df.query('PJME_MW > 19000').copy()
```

```
df.min()
```

```
PJME_MW    19085.0
dtype: float64
```

```
N_SPLITS  = 5
TEST_SIZE = 24*365 # WE WANT TOP PREIDICT 1 YEAR AND OUR DATA IS HOURLY

tss =TimeSeriesSplit(n_splits=N_SPLITS , test_size=TEST_SIZE ,gap= 24)

df = df.sort_index()


for train_idx, val_idx in tss.split(df):
    break
```

```
fig, axs = plt.subplots(5, 1, figsize=(15, 15), sharex=True)

fold = 0
for train_idx, val_idx in tss.split(df):
    train = df.iloc[train_idx]
    test = df.iloc[val_idx]
    train['PJME_MW'].plot(ax=axs[fold],
                          label='Training Set',
                          title=f'Data Train/Test Split Fold {fold}')
    test['PJME_MW'].plot(ax=axs[fold],
                         label='Test Set')
    axs[fold].axvline(test.index.min(), color='black', ls='--')
    fold += 1
plt.show()
```



```
def create_features(df):
    """
    Create time series features based on time series index.
    """
    df = df.copy()
    df['hour'] = df.index.hour
    df['dayofweek'] = df.index.dayofweek
    df['quarter'] = df.index.quarter
    df['month'] = df.index.month
    df['year'] = df.index.year
    df['dayofyear'] = df.index.dayofyear
    df['dayofmonth'] = df.index.day
    df['weekofyear'] = df.index.isocalendar().week
    return df
df = create_features(df)


def add_lags(df):
    target_map = df['PJME_MW'].to_dict()
    df['lag1year'] = (df.index - pd.Timedelta('364 days')).map(target_map)
    df['lag2year'] = (df.index - pd.Timedelta('728 days')).map(target_map)
    df['lag3year'] = (df.index - pd.Timedelta('1092 days')).map(target_map)
    return df
df = add_lags(df)


df
```

Datetime	PJME_MW	hour	dayofweek	quarter	month	year	dayofyear	dayofmonth	weekofy
2002-01-01 01:00:00	30393.0	1	1	1	1	2002	1	1	
2002-01-01 02:00:00	29265.0	2	1	1	1	2002	1	1	
2002-01-01 03:00:00	28357.0	3	1	1	1	2002	1	1	
2002-01-01 04:00:00	27899.0	4	1	1	1	2002	1	1	
2002-01-01 05:00:00	28057.0	5	1	1	1	2002	1	1	
...	...	...	...	...	...	...	...	...	

```
df.isna().sum()
```

```
PJME_MW           0
hour              0
dayofweek         0
quarter           0
month             0
year              0
dayofyear         0
dayofmonth        0
weekofyear        0
lag1year       8758
lag2year      17500
lag3year      26240
dtype: int64
```

```
fold = 0
preds = []
scores = []
for train_idx, val_idx in tss.split(df):
    train = df.iloc[train_idx]
    test = df.iloc[val_idx]

    train = create_features(train)
    test = create_features(test)

    FEATURES = ['dayofyear', 'hour', 'dayofweek', 'quarter', 'month','year',
                'lag1year','lag2year','lag3year']
    TARGET = 'PJME_MW'

    X_train = train[FEATURES]
    y_train = train[TARGET]

    X_test = test[FEATURES]
    y_test = test[TARGET]

    reg = xgb.XGBRegressor(base_score=0.5, booster='gbtree',
                           n_estimators=1000,
                           early_stopping_rounds=50,
                           objective='reg:linear',
                           max_depth=3,
                           learning_rate=0.01)
    reg.fit(X_train, y_train,
            eval_set=[(X_train, y_train), (X_test, y_test)],
            verbose=100)

    y_pred = reg.predict(X_test)
    preds.append(y_pred)
    score = np.sqrt(mean_squared_error(y_test, y_pred))
    scores.append(score)
```

```
[0]     validation_0-rmse:32732.49608   validation_1-rmse:31956.60163
/usr/local/lib/python3.10/dist-packages/xgboost/core.py:160: UserWarning: [09:31:31] WARNING: /workspace/src/objective/regression_obj.c
  warnings.warn(smsg, UserWarning)
[100]   validation_0-rmse:12532.64369   validation_1-rmse:11906.14134
[200]   validation_0-rmse:5747.92495    validation_1-rmse:5359.26490
[300]   validation_0-rmse:3872.48134    validation_1-rmse:3900.86965
[400]   validation_0-rmse:3434.23853    validation_1-rmse:3762.33705
[441]   validation_0-rmse:3370.76149    validation_1-rmse:3764.48078
[0]     validation_0-rmse:32672.16678   validation_1-rmse:32138.89241
/usr/local/lib/python3.10/dist-packages/xgboost/core.py:160: UserWarning: [09:31:40] WARNING: /workspace/src/objective/regression_obj.c
  warnings.warn(smsg, UserWarning)
[100]   validation_0-rmse:12513.65574   validation_1-rmse:12224.93373
[200]   validation_0-rmse:5753.34937    validation_1-rmse:5662.07107
[300]   validation_0-rmse:3902.71304    validation_1-rmse:3933.73076
[400]   validation_0-rmse:3476.90515    validation_1-rmse:3590.55005
[500]   validation_0-rmse:3353.72424    validation_1-rmse:3516.39915
[600]   validation_0-rmse:3297.94766    validation_1-rmse:3481.94003
[700]   validation_0-rmse:3258.48267    validation_1-rmse:3461.37383
[800]   validation_0-rmse:3221.51553    validation_1-rmse:3436.49603
[900]   validation_0-rmse:3190.11480    validation_1-rmse:3428.88699
[999]   validation_0-rmse:3166.16314    validation_1-rmse:3420.31309
[0]     validation_0-rmse:32631.20370   validation_1-rmse:31073.29733
/usr/local/lib/python3.10/dist-packages/xgboost/core.py:160: UserWarning: [09:31:56] WARNING: /workspace/src/objective/regression_obj.c
  warnings.warn(smsg, UserWarning)
[100]   validation_0-rmse:12499.28425   validation_1-rmse:11136.70202
[200]   validation_0-rmse:5750.81453    validation_1-rmse:4813.22087
[300]   validation_0-rmse:3917.04200    validation_1-rmse:3553.46419
[400]   validation_0-rmse:3494.55924    validation_1-rmse:3495.32356
[411]   validation_0-rmse:3475.26636    validation_1-rmse:3503.65414
[0]     validation_0-rmse:32528.44438   validation_1-rmse:31475.39670
/usr/local/lib/python3.10/dist-packages/xgboost/core.py:160: UserWarning: [09:32:01] WARNING: /workspace/src/objective/regression_obj.c
  warnings.warn(smsg, UserWarning)
[100]   validation_0-rmse:12462.36581   validation_1-rmse:12020.28283
[200]   validation_0-rmse:5738.57925    validation_1-rmse:5796.45874
[300]   validation_0-rmse:3918.53218    validation_1-rmse:4388.39477
[400]   validation_0-rmse:3501.24270    validation_1-rmse:4173.36380
[500]   validation_0-rmse:3384.02490    validation_1-rmse:4119.56538
[600]   validation_0-rmse:3325.50024    validation_1-rmse:4105.01446
[700]   validation_0-rmse:3282.73755    validation_1-rmse:4091.23557
[800]   validation_0-rmse:3250.37610    validation_1-rmse:4083.12690
[900]   validation_0-rmse:3223.87814    validation_1-rmse:4081.46154
[999]   validation_0-rmse:3199.82843    validation_1-rmse:4052.57120
[0]     validation_0-rmse:32462.05557   validation_1-rmse:31463.90500
/usr/local/lib/python3.10/dist-packages/xgboost/core.py:160: UserWarning: [09:32:15] WARNING: /workspace/src/objective/regression_obj.c
  warnings.warn(smsg, UserWarning)
[100]   validation_0-rmse:12445.87740   validation_1-rmse:11963.42706
```

```
[200]   validation_0-rmse:5752.44568    validation_1-rmse:5611.92884
[300]   validation_0-rmse:3951.51709    validation_1-rmse:4156.41403
[400]   validation_0-rmse:3539.25569    validation_1-rmse:4006.58873
[439]   validation_0-rmse:3480.87364    validation_1-rmse:4011.68406
```

```
print(f'Score across folds {np.mean(scores):0.4f}')
print(f'Fold scores:{scores}')
```

```
Score across folds 3742.5833
Fold scores:[3760.8277187583353, 3420.313091887879, 3478.018038580526, 4052.5712055405547, 4001.186553933809]
```

```
df = create_features(df)

FEATURES = ['dayofyear', 'hour', 'dayofweek', 'quarter', 'month', 'year',
            'lag1year','lag2year','lag3year']
TARGET = 'PJME_MW'

X_all = df[FEATURES]
y_all = df[TARGET]

reg = xgb.XGBRegressor(base_score=0.5,
                       booster='gbtree',
                       n_estimators=500,
                       objective='reg:linear',
                       max_depth=3,
                       learning_rate=0.01)
reg.fit(X_all, y_all,
        eval_set=[(X_all, y_all)],
        verbose=100)
```

```
[0]     validation_0-rmse:32403.88991
/usr/local/lib/python3.10/dist-packages/xgboost/core.py:160: UserWarning: [09:33:49] WA
  warnings.warn(smsg, UserWarning)
[100]   validation_0-rmse:12426.83220
[200]   validation_0-rmse:5751.73275
[300]   validation_0-rmse:3971.53256
[400]   validation_0-rmse:3571.21833
[499]   validation_0-rmse:3456.76877
```

```
XGBRegressor(base_score=0.5, booster='gbtree', callbacks=None,
             colsample_bylevel=None, colsample_bynode=None,
             colsample_bytree=None, device=None, early_stopping_rounds=None,
             enable_categorical=False, eval_metric=None, feature_types=None,
             gamma=None, grow_policy=None, importance_type=None,
             interaction_constraints=None, learning_rate=0.01, max_bin=None,
             max_cat_threshold=None, max_cat_to_onehot=None,
             max_delta_step=None, max_depth=3, max_leaves=None,
             min_child_weight=None, missing=nan, monotone_constraints=None,
             multi_strategy=None, n_estimators=500, n_jobs=None,
             num_parallel_tree=None, objective='reg:linear', ...)
```

```
df.index.max()
```

```
Timestamp('2018-08-03 00:00:00')
```

```
future = pd.date_range(start='2018-08-03',end='2019-08-01',freq='1h')
future_df = pd.DataFrame(index=future)


future_df['isFuture']= True
df['isFuture']= False
df_and_future = pd.concat([df,future_df])
df_and_future = create_features(df_and_future)
df_and_future = add_lags(df_and_future)


df_and_future
```

	PJME_MW	hour	dayofweek	quarter	month	year	dayofyear	dayofmonth	weekofy
2002-01-01 01:00:00	30393.0	1	1	1	1	2002	1	1	
2002-01-01 02:00:00	29265.0	2	1	1	1	2002	1	1	
2002-01-01 03:00:00	28357.0	3	1	1	1	2002	1	1	
2002-01-01 04:00:00	27899.0	4	1	1	1	2002	1	1	

```
future_w_features = df_and_future.query('isFuture').copy()
```

```
future_w_features['pred'] = reg.predict(future_w_features[FEATURES])


future_w_features['pred'].plot(figsize=(10, 5),
                               ms=1,
                               lw=1,
                               title='Future Predictions')
plt.show()
```