```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import MinMaxScaler, StandardScaler
%matplotlib inline
```

```
import os, sys
from google.colab import drive

drive.mount('/content/drive')
nb_path = '/content/drive/MyDrive/Colab Notebooks/site-packages'
sys.path.insert(0, nb_path)  # or append(nb_path)
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/c
```

```
#!pip install --target=$'/content/drive/MyDrive/Colab Notebooks/site-packages' mxnet-cu101
```

```
#!pip install --target='/content/drive/MyDrive/Colab Notebooks/site-packages' gluonts
```

```
datapath = '/content/drive/MyDrive/Colab Notebooks/태양열 발전량 예측'
trainpath = datapath + '/train/train.csv'
testpath = datapath + '/test' # 여러개 csv 파일 존재함
samplepath = datapath + '/sample_submission.csv'

train_org = pd.read_csv(trainpath, index_col=0)
```

```
sample = pd.read_csv(samplepath)
```

timestamp 찍어서 인덱스로 넣기

```
from itertools import accumulate


def find_month(day):
    month_table = [31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31]
    month_table = list(accumulate(map(int, month_table)))
    # [31, 59, 90, 120, 151, 181, 212, 243, 273, 304, 334, 365]
    day = (day % 365) + 1
    if day <= 181: # 6까지
        idx = 0

        while idx < 5:
            if day > month_table[idx]:
                idx += 1

            else:
                break

        return idx+1

    else:
        idx = 6

        while idx < 11:
            if day > month_table[idx]:
                idx += 1

            else:
                break

        return idx+1


def set_days(df):
    month_table = [0, 31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31] # 보편적인 1년의 일 수 그냥
    month_table = list(accumulate(map(int, month_table))) # 누적하기
    copied = df.copy()
    copied['Day'] = (copied['Day'] % 365) + 1
    modifed = []

    for i, v in enumerate(month_table):
        if i > 0:
            temp = copied[copied['Month'] == i].copy()
            temp['Day'] = temp['Day'] - month_table[i-1]
            modifed.append(temp)

    return pd.concat(modifed)
```

```
df = train_org.reset_index()
df['Year'] = df['Day'] / 365 + 2016  # 그냥 Timestamp 찍기 위한 가정임.
df['Year'] = df['Year'].apply(lambda x: int(x))
df['Month'] = df['Day'].apply(find_month)
df = set_days(df)

def to_str(y, mo, d, h, m):
    mo = str(int(mo)).zfill(2)
    d = str(int(d)).zfill(2)
    h = str(int(h)).zfill(2)
    m = str(int(m)).zfill(2)

    temp = f'{int(y)}-{mo}-{d} {h}:{m}:00'
    return temp

df['Timestamp'] = df.apply(lambda row : to_str(row['Year'], row['Month'], row['Day'], row['Hour'
df['Timestamp'] = pd.to_datetime(df['Timestamp'])
df = df.sort_values('Timestamp')
```

```
df.to_csv("/content/drive/MyDrive/ColabNotebooks/태양열 발전량 예측/Timestamped.csv", index=Fals
```

MQ-RNN

방법:

1. 시계열 데이터로 접근하여 Timestamp와 Target 값만 가져와 학습시킴. Target 값 자체가 주기성과 계절성이 뚜렷하기 때문에 가능함.
2. MQ-RNN Encoder로 값을 넣기 전에 NN을 추가해 원본 데이터가 다양한 피처를 조합해서 값을 가지도록 한 후, 해당 NN의 결과값을 MQ-RNN 인코더에 넣는 방법.

```
import os, sys
from google.colab import drive

drive.mount('/content/drive')
nb_path = '/content/drive/MyDrive/Colab Notebooks/site-packages'
sys.path.insert(0, nb_path)  # or append(nb_path)
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/c
```

```
%matplotlib inline
import mxnet as mx
from mxnet import gluon
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import MinMaxScaler, StandardScaler
```

```
df = pd.read_csv("/content/drive/MyDrive/Colab Notebooks/태양열 발전량 예측/Timestamped.csv")
df['Timestamp'] = pd.to_datetime(df['Timestamp']) # load하면 또 다시 변환해줘야 함
df
```

	Day	Hour	Minute	DHI	DNI	WS	RH	T	TARGET	Year	Month	Timestamp
0	1	0	0	0	0	1.5	69.08	-12	0.0	2016	1	2016-01-01 00:00:00
												2016-01-01

```
df = df.set_index(df['Timestamp'])
train_end = pd.to_datetime('2018-12-22 23:30:00') # 데이터 커져서 커널이 자꾸 죽어서 축소시킴. 6
valid_start = pd.to_datetime('2018-12-23 00:00:00')
train = df.loc[:train_end, ['TARGET', 'DHI', 'DNI', 'RH', 'T']]
valid = df.loc[valid_start:, ['TARGET', 'DHI', 'DNI', 'RH', 'T']]
```

```
from gluonts.dataset.common import ListDataset

prediction_window = 96 # 고정적으로 이틀치를 예측하도록 함

train_ds = ListDataset( # 4일전까지를 학습하고
    [{"start": train.index[0],
      "target": train.TARGET.values[:-prediction_window],
      'feat_dynamic_real' : [train.DHI.values[:-prediction_window],
                          train.DNI.values[:-prediction_window],
                          train.RH.values[:-prediction_window],
                          train['T'].values[:-prediction_window]]
      }],
    freq = "30min"
)

valid_ds = ListDataset(
    [{
        "start": valid.index[0],
        "target": valid.TARGET.values[:-prediction_window],
        'feat_dynamic_real' : [valid.DHI.values[:-prediction_window],
                        valid.DNI.values[:-prediction_window],
                        valid.RH.values[:-prediction_window],
                        valid['T'].values[:-prediction_window]]

      }],
    freq = "30min"
)
```

```
'''from gluonts.dataset.field_names import FieldName
from gluonts.dataset.common import ListDataset

train_ds = ListDataset([{FieldName.TARGET: target,
                         FieldName.START: start,
                         FieldName.FEAT_DYNAMIC_REAL: [fdr]}
                        for (target, start, fdr) in zip(temp.TARGET[:-prediction_window].values,
                                                            start_time,
                                                            feat_dynamic_real[:-prediction_wind
                      freq='30min')'''
```

```
'from gluonts.dataset.field_names import FieldName₩nfrom gluonts.dataset.common import ListD
```

```
from gluonts.model.seq2seq import MQRNNEstimator
from gluonts.mx.trainer import Trainer

freq = "30min"
quantiles = [0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9]

estimator = MQRNNEstimator(prediction_length=prediction_window,
                           freq=freq,
                           quantiles=quantiles,
                           trainer=Trainer(epochs=10, batch_size=32, ctx = mx.context.gpu()))

predictor = estimator.train(training_data=train_ds
                            #, validation_data=valid
                            )
```

```
  0%|          | 0/50 [00:00<?, ?it/s]learning rate from ``lr_scheduler`` has been overwritte
100%|██████████| 50/50 [00:06<00:00,  7.58it/s, epoch=1/10, avg_epoch_loss=0.937]
100%|██████████| 50/50 [00:06<00:00,  7.77it/s, epoch=2/10, avg_epoch_loss=0.534]
100%|██████████| 50/50 [00:06<00:00,  7.77it/s, epoch=3/10, avg_epoch_loss=0.269]
100%|██████████| 50/50 [00:06<00:00,  7.74it/s, epoch=4/10, avg_epoch_loss=0.163]
100%|██████████| 50/50 [00:06<00:00,  7.79it/s, epoch=5/10, avg_epoch_loss=0.135]
100%|██████████| 50/50 [00:06<00:00,  7.76it/s, epoch=6/10, avg_epoch_loss=0.123]
100%|██████████| 50/50 [00:06<00:00,  7.80it/s, epoch=7/10, avg_epoch_loss=0.116]
100%|██████████| 50/50 [00:06<00:00,  7.81it/s, epoch=8/10, avg_epoch_loss=0.109]
100%|██████████| 50/50 [00:06<00:00,  7.82it/s, epoch=9/10, avg_epoch_loss=0.104]
100%|██████████| 50/50 [00:06<00:00,  7.82it/s, epoch=10/10, avg_epoch_loss=0.0985]
```

```
from gluonts.evaluation.backtest import make_evaluation_predictions

forecast_it, ts_it = make_evaluation_predictions(
    dataset=valid_ds,  # test dataset
    predictor=predictor,  # predictor
    num_samples=100,  # number of sample paths we want for evaluation
)
```

```
forecasts = list(forecast_it)
tss = list(ts_it)

forecast_entry = forecasts[0]
ts_entry = tss[0]
```

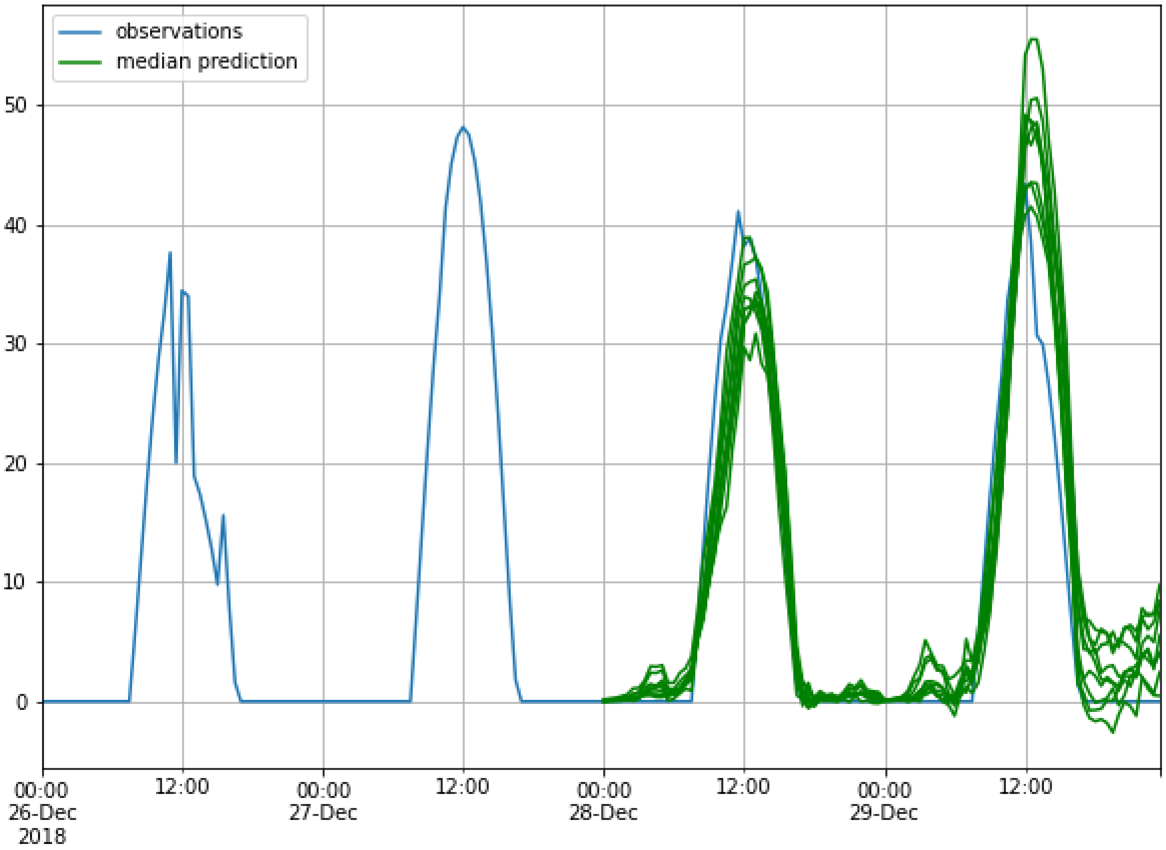
```
# print(f"Number of sample paths: {forecast_entry.num_samples}")
# print(f"Dimension of samples: {forecast_entry.samples.shape}")
print(f"Start date of the forecast window: {forecast_entry.start_date}")
print(f"Frequency of the time series: {forecast_entry.freq}")
```

```
Start date of the forecast window: 2018-12-28 00:00:00
Frequency of the time series: 30min
```

```
def plot_prob_forecasts(ts_entry, forecast_entry):
    plot_length = 48*4
    # prediction_intervals = (50.0, 90.0)
    legend = ["observations", "median prediction"] # + [f"{k}% prediction interval" for k in pre

    fig, ax = plt.subplots(1, 1, figsize=(10, 7))
    ts_entry[-plot_length:].plot(ax=ax)  # plot the time series
    # forecast_entry.plot(color='g', ax=ax)
    temp = pd.DataFrame(forecast_entry.forecast_array.transpose(), index=ts_entry.index[-forecas
    plt.grid(which="both")
    plt.legend(legend, loc="upper left")
    plt.show()
```

```
plot_prob_forecasts(ts_entry, forecast_entry) # epoch 5
```



```
prediction = next(predictor.predict(train))
```

prediction = next(predictor.predict(train)) # type(prediction) => QuantileForecast class

prediction.forecast_array => (num_quantiles, forecast values for predicition windows)

따라서 이번 예제에서 forecast_array는 (9, 96)의 shape을 가진다.

```
from gluonts.evaluation.backtest import make_evaluation_predictions

test_data = ListDataset(
    [{"start": temp.index[0], "target": temp.TARGET.values}],
    freq = "30min"
)
# test_data의 target 시간 이후부터 예측을 실행하는 것으로 보임. train과 test는 무슨 연관이 있는

```

```
forecast_it, ts_it = make_evaluation_predictions(
    dataset=test_data,  # test dataset
    predictor=predictor,  # predictor
    num_samples=100,  # number of sample paths we want for evaluation
)
```

```
forecasts = list(forecast_it)
tss = list(ts_it)

forecast_entry = forecasts[0]
ts_entry = tss[0]
```

```
# print(f"Number of sample paths: {forecast_entry.num_samples}")
# print(f"Dimension of samples: {forecast_entry.samples.shape}")
print(f"Start date of the forecast window: {forecast_entry.start_date}")
print(f"Frequency of the time series: {forecast_entry.freq}")
```

```
Start date of the forecast window: 2018-12-29 00:00:00
Frequency of the time series: 30min
```

```
new_ary = []

for ary in forecast_entry.forecast_array:
    ary = np.where(ary <0, 0, ary)
    new_ary.append(ary)

forecast_entry.forecast_array = np.array(new_ary)
```

```
pd.DataFrame(forecast_entry.forecast_array.transpose())
```

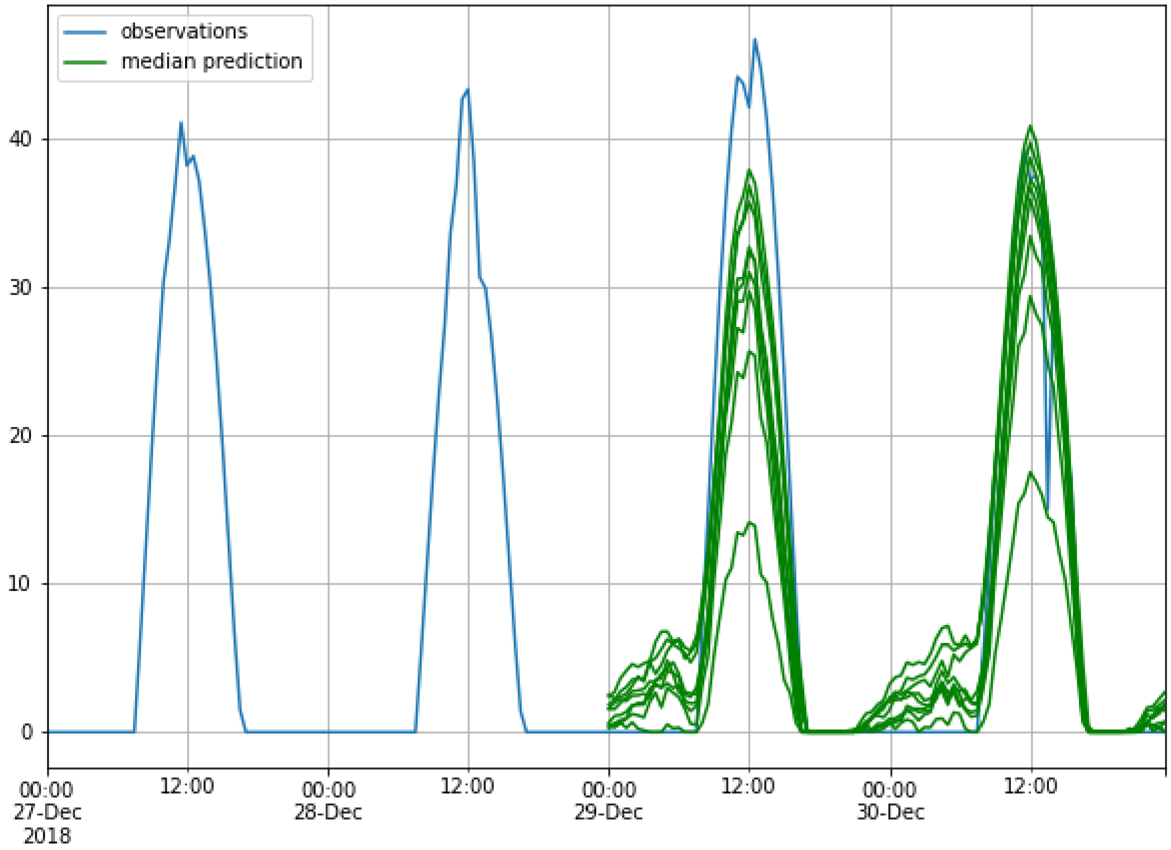
	0	1	2	3	4	5	6	7	
0	0.269632	0.457640	0.434057	0.647847	1.560288	1.620001	1.860057	2.392335	2.536
1	0.499269	0.591494	0.302545	1.093298	1.553852	1.986579	2.192621	2.720931	2.249
2	0.628407	0.822227	0.603191	1.158305	1.972452	2.226515	2.757081	3.644567	2.387
3	0.290450	0.918674	0.923385	1.368202	2.329176	2.099648	3.043955	4.142349	2.600
4	0.663518	1.219584	1.768284	1.822532	2.762099	2.462594	3.546255	4.595234	3.126
...	...	...	...	...	...	...	...	...	
91	0.119846	0.299270	0.414431	0.082710	0.002868	0.213356	0.492890	0.892344	0.495
92	0.592810	0.730253	0.566934	0.604504	0.602223	0.720347	1.168180	1.653026	1.432
93	0.464157	0.113364	0.084476	0.477775	1.180083	0.993950	0.966325	1.739074	1.494
94	0.281802	0.251896	0.370075	0.603392	1.617511	1.224970	1.443429	2.213345	1.792
95	0.638136	0.066466	0.072246	0.689490	1.443755	1.737517	1.872444	2.682036	2.142

96 rows × 9 columns

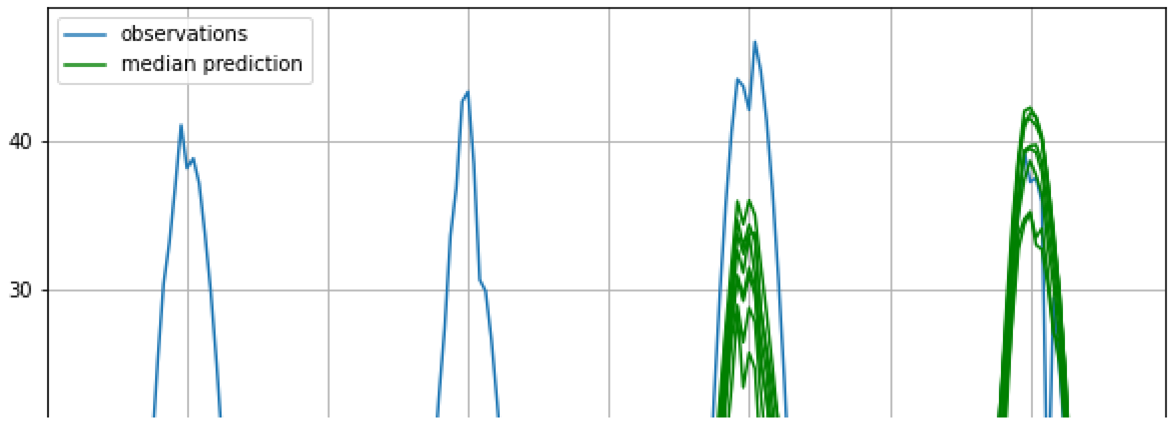
```
def plot_prob_forecasts(ts_entry, forecast_entry):
    plot_length = 48*4
    # prediction_intervals = (50.0, 90.0)
    legend = ["observations", "median prediction"] # + [f"{k}% prediction interval" for k in pre

    fig, ax = plt.subplots(1, 1, figsize=(10, 7))
    ts_entry[-plot_length:].plot(ax=ax)  # plot the time series
    # forecast_entry.plot(color='g', ax=ax)
    temp = pd.DataFrame(forecast_entry.forecast_array.transpose(), index=ts_entry.index[-forecas
    plt.grid(which="both")
    plt.legend(legend, loc="upper left")
    plt.show()
```

```
plot_prob_forecasts(ts_entry, forecast_entry) # epoch 5
```



```
plot_prob_forecasts(ts_entry, forecast_entry) # epoch 10
```



```
from gluonts.evaluation import Evaluator

evaluator = Evaluator(quantiles=quantiles)

agg_metrics, item_metrics = evaluator(ts_it, forecast_it)
```

```
def pinball_loss(y_true, quantile_forecast, quantiles):
    total = 0
    for quantile, pred in zip(quantiles, quantile_forecast):
        if y_true >= pred:
            total += (y_true - pred) * quantile

        else:
            total += (1-quantile) * (pred - y_true)

    return total / len(quantiles)
```