```
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```

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```
import tensorflow as tf
print(tf.__version__)
```

```
2.3.0
```

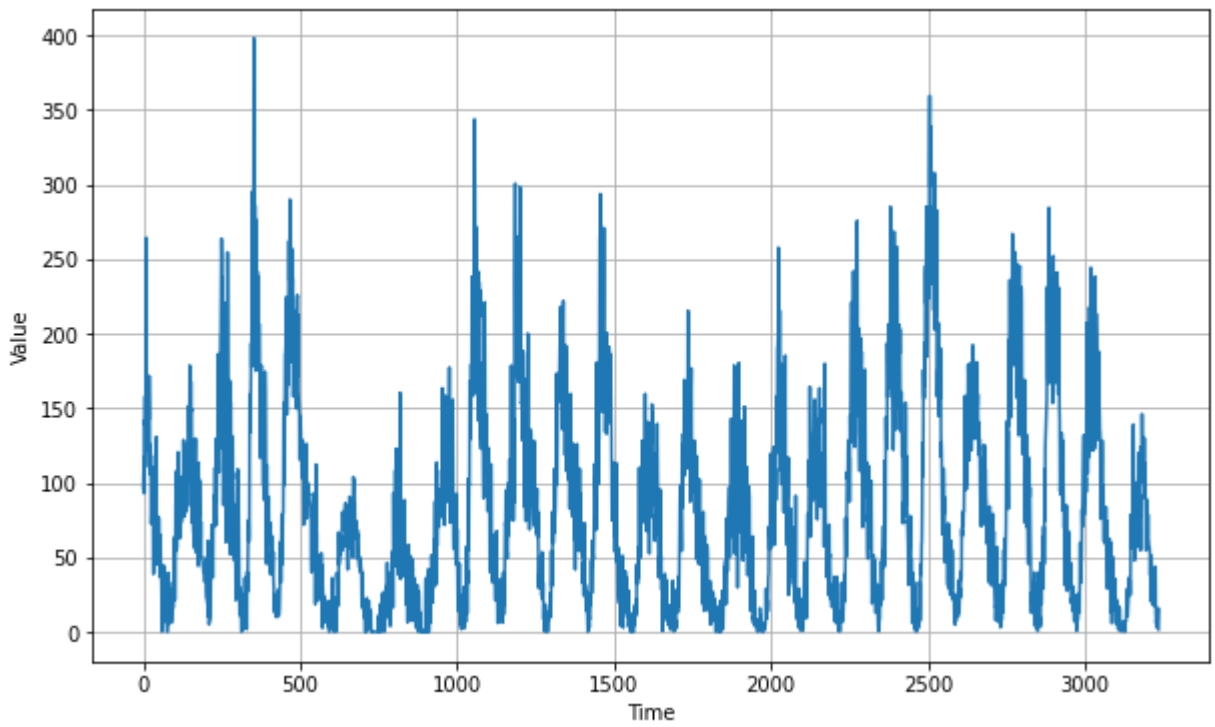
```
import numpy as np
import matplotlib.pyplot as plt
def plot_series(time, series, format="-", start=0, end=None):
    plt.plot(time[start:end], series[start:end], format)
    plt.xlabel("Time")
    plt.ylabel("Value")
    plt.grid(True)
```

```
!wget --no-check-certificate \
    https://storage.googleapis.com/laurencemoroney-blog.appspot.com/Sunspots.csv \
    -O /tmp/sunspots.csv
```

```
--2020-09-24 18:49:33--  https://storage.googleapis.com/laurencemoroney-blog.appspot.com
Resolving storage.googleapis.com (storage.googleapis.com)... 173.194.216.128, 173.194.21
Connecting to storage.googleapis.com (storage.googleapis.com)|173.194.216.128|:443... co
HTTP request sent, awaiting response... 200 OK
Length: 70827 (69K) [application/octet-stream]
Saving to: ‘/tmp/sunspots.csv’

/tmp/sunspots.csv   100%[===================>]  69.17K  --.-KB/s    in 0.001s

2020-09-24 18:49:34 (62.7 MB/s) - ‘/tmp/sunspots.csv’ saved [70827/70827]
```

```
import csv
time_step = []
sunspots = []

with open('/tmp/sunspots.csv') as csvfile:
  reader = csv.reader(csvfile, delimiter=',')
  next(reader)
  for row in reader:
```

```
    sunspots.append(float(row[2]))
    time_step.append(int(row[0]))

series = np.array(sunspots)
time = np.array(time_step)
plt.figure(figsize=(10, 6))
plot_series(time, series)
```

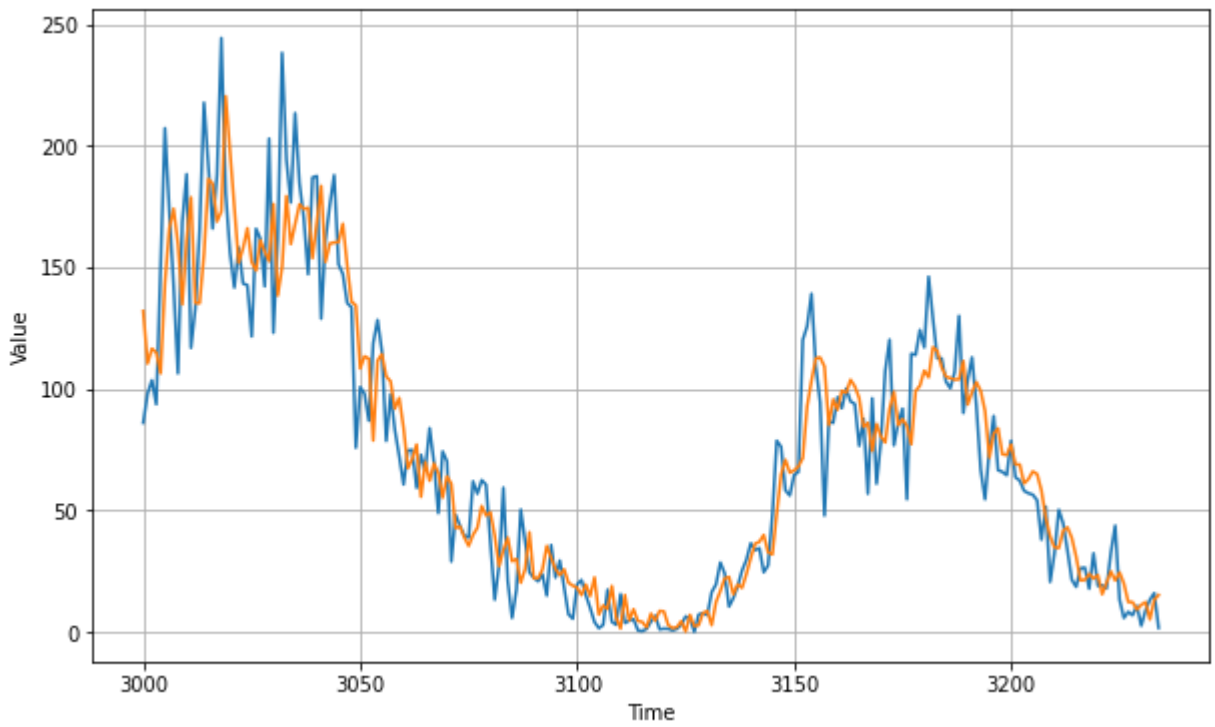



```
split_time = 3000
time_train = time[:split_time]
x_train = series[:split_time]
time_valid = time[split_time:]
x_valid = series[split_time:]

window_size = 60
batch_size = 32
shuffle_buffer_size = 1000



def windowed_dataset(series, window_size, batch_size, shuffle_buffer):
  dataset = tf.data.Dataset.from_tensor_slices(series)
  dataset = dataset.window(window_size + 1, shift=1, drop_remainder=True)
  dataset = dataset.flat_map(lambda window: window.batch(window_size + 1))
  dataset = dataset.shuffle(shuffle_buffer).map(lambda window: (window[:-1], window[-1]))
  dataset = dataset.batch(batch_size).prefetch(1)
  return dataset


#same thing, but with only dense layers (the other used LSTM's and lambdas as well)
dataset = windowed_dataset(x_train, window_size, batch_size, shuffle_buffer_size)
```

```
model = tf.keras.models.Sequential([
    tf.keras.layers.Dense(20, input_shape=[window_size], activation="relu"),
    tf.keras.layers.Dense(10, activation="relu"),
    tf.keras.layers.Dense(1)
])

model.compile(loss="mse", optimizer=tf.keras.optimizers.SGD(lr=1e-7, momentum=0.9))
model.fit(dataset,epochs=100,verbose=0)
```

```
<tensorflow.python.keras.callbacks.History at 0x7f20b1761160>
```

```
forecast=[]
for time in range(len(series) - window_size):
  forecast.append(model.predict(series[time:time + window_size][np.newaxis]))

forecast = forecast[split_time-window_size:]
results = np.array(forecast)[:, 0, 0]


plt.figure(figsize=(10, 6))

plot_series(time_valid, x_valid)
plot_series(time_valid, results)
```




```
#also bad
tf.keras.metrics.mean_absolute_error(x_valid, results).numpy()
```

```
14.996658
```