What is time series

A time series is a series of data points indexed (or listed or graphed) in time order. Most commonly, a time series is a sequence taken at successive equally spaced points in time. Thus it is a sequence of discrete-time data. Examples of time series are heights of ocean tides, counts of sunspots, and the daily closing value of the Dow Jones Industrial Average.
https://en.wikipedia.org/wiki/Time_series

Comman patterns in Time Series

Trend

It could be upward or downward trend

Seasonality

Patterns repeating at regular intervals

White Noise

Auto correleation TIme Series

No trend or Seasonality
Normally Time series with real data consists of all the four

Trend + Seasonality + Noise + Auto Correlation

UHG Stock price data

No trend or Seasonality

In some case we train only for certain range for data

https://medium.com/@SeoJaeDuk/trend-seasonality-moving-average-auto-regressive-model-my-journey-to-time-series-data-with-3e1faabde73a

In [2]:

```
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline

import tensorflow as tf
from tensorflow import keras
```

In [3]:

```
def plot(x,y):
   plt.figure(figsize=(10,6))
   plt.plot(x,y)
   plt.xlabel("Time")
   plt.ylabel("Series")
   plt.grid(True)
```

In [4]:

```
time = np.arange( 5 * 365 )
slope = 0.1
series = time * slope
```

In [6]:

```
time[0:50]
```

Out[6]:

```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
       17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33,
       34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49])
```

In [7]:

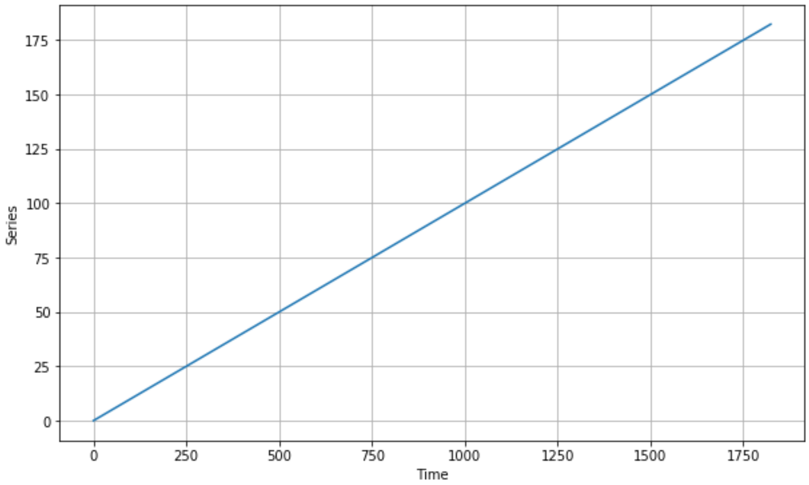
```
series[0:50]
```

Out[7]:

```
array([0. , 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1. , 1.1, 1.2,
       1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2. , 2.1, 2.2, 2.3, 2.4, 2.5,
       2.6, 2.7, 2.8, 2.9, 3. , 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8,
       3.9, 4. , 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9])
```

In [8]:

```
plot(time,series)
```



Seasonality

In [9]:

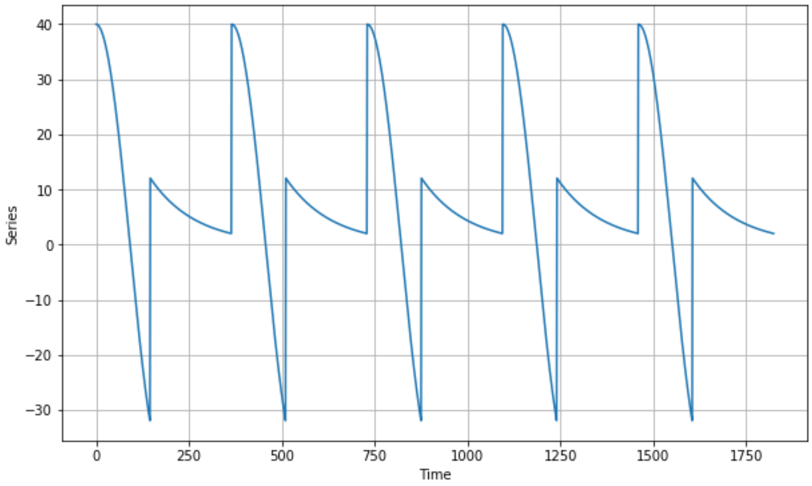
```
def seasonal_pattern(season_time):
  """Just an arbitrary pattern, you can change it if you wish"""
  return np.where(season_time < 0.4,
          np.cos(season_time * 2 * np.pi),
          1 / np.exp(3 * season_time))

def seasonality(time, period, amplitude=1, phase=0):
  """Repeats the same pattern at each period"""
  season_time = ((time + phase) % period) / period
  return amplitude * seasonal_pattern(season_time)
```

In [10]:

```
baseline = 10
amplitude = 40
```

```
series = seasonality(time, period=365, amplitude=amplitude)

plt.figure(figsize=(10, 6))
plot(time, series)
plt.show()
```

```
<Figure size 720x432 with 0 Axes>
```



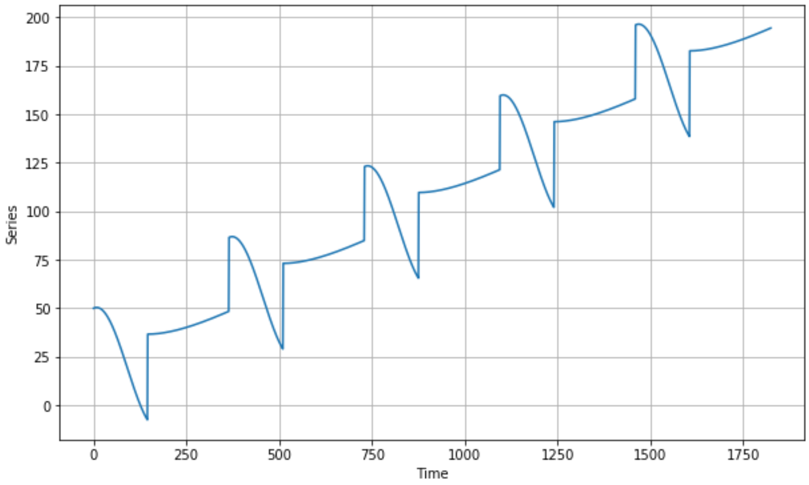
In [11]:

```
def trend (slope, time):
   return slope * time
```

In [12]:

```
# Add slope to seasonality

baseline = 10
amplitude = 40
slope = 0.1
series = seasonality(time, period=365, amplitude=amplitude) + baseline  + trend(slope , time)


plt.figure(figsize=(10, 6))
plot(time, series)
plt.show()
```

```
<Figure size 720x432 with 0 Axes>
```



Noise

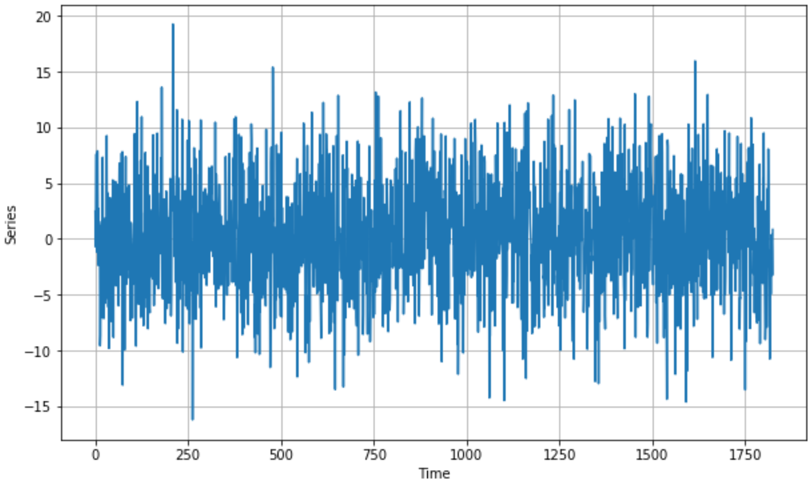
In [13]:

```
def white_noise(time, noise_level=1, seed=None):
    print (len(time))
    rnd = np.random.RandomState(seed)
    return rnd.randn(len(time)) * noise_level
```

In [14]:

```
noise_level = 5
noise = white_noise(time, noise_level, seed=42)

plt.figure(figsize=(10, 6))
plot(time, noise)
plt.show()
```

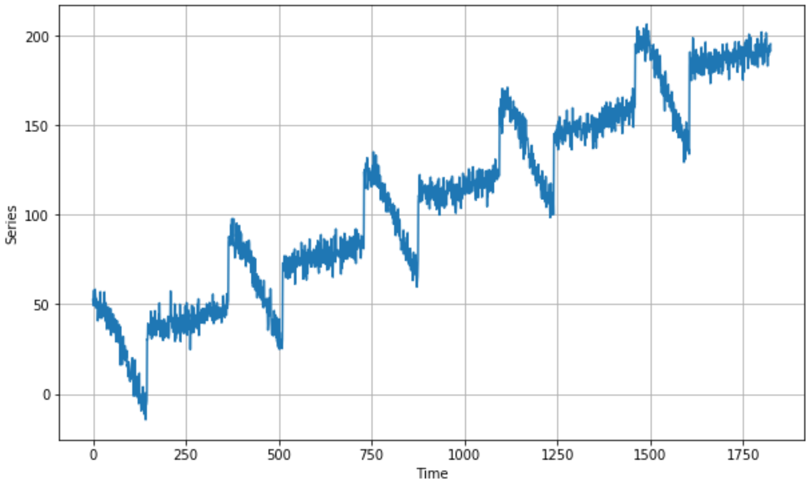
```
1825
<Figure size 720x432 with 0 Axes>
```



In [15]:

```
#time = np.arange(5*365 )
#slope = 0.1
#series = time * slope

series = seasonality(time, period=365, amplitude=amplitude) + baseline  + trend(slope , time) + noise

plt.figure(figsize=(10, 6))
plot(time, series)
plt.show()
```

```
<Figure size 720x432 with 0 Axes>
```



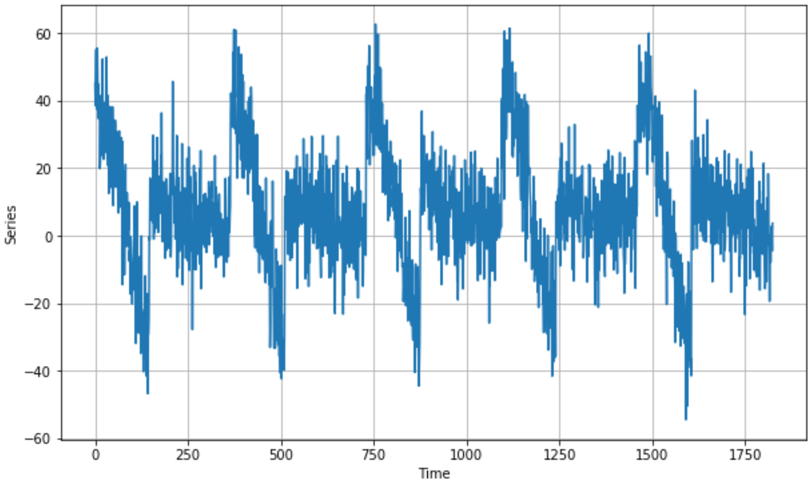
In [16]:

```
baseline = 10
amplitude = 40
#time = np.arange(365)
series = seasonality(time, period=365, amplitude=amplitude)
```

In [18]:

```
series += noise

plt.figure(figsize=(10, 6))
plot(time, series)
plt.show()
```

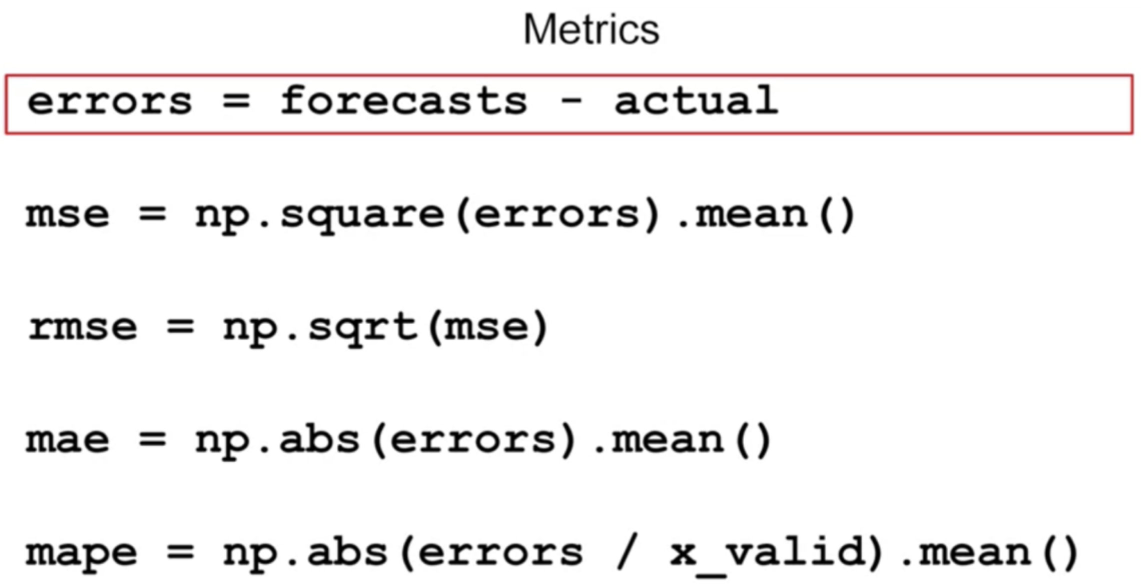
```
<Figure size 720x432 with 0 Axes>
```



In [ ]:

In [ ]:

Metrics for evaluating performance

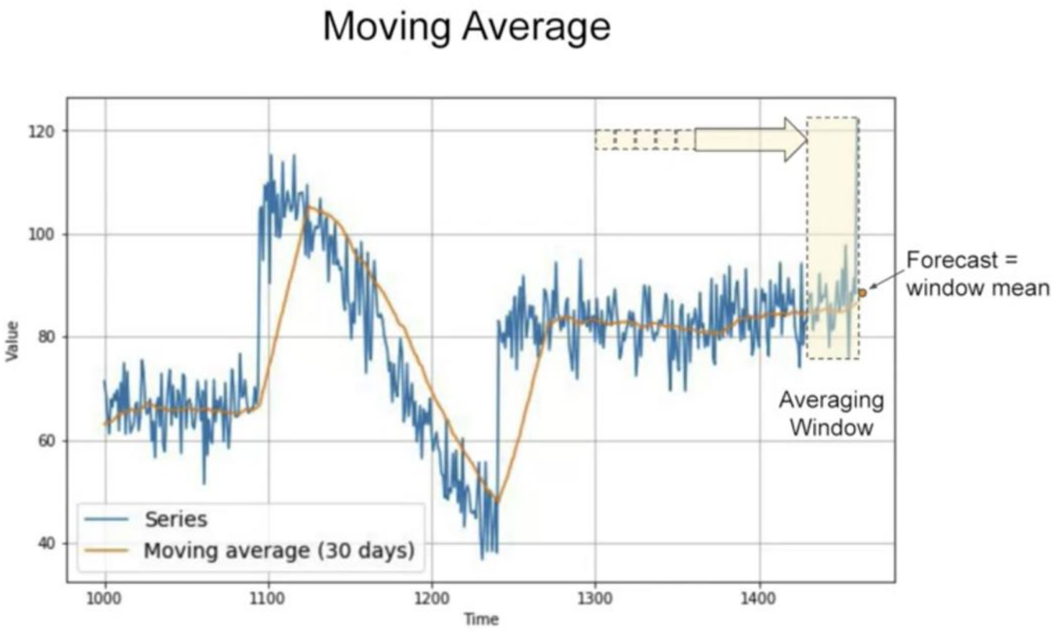


Metrics

```
errors = forecasts - actual

mse = np.square(errors).mean()

rmse = np.sqrt(mse)

mae = np.abs(errors).mean()

mape = np.abs(errors / x_valid).mean()
```

errors = forecasts - actuals
mse = np.square(errors).mean()
rmse = np.sqrt(mse)
mae = np.abs(errors).mean()
mape = np.abs(errors / x_valid).mean()

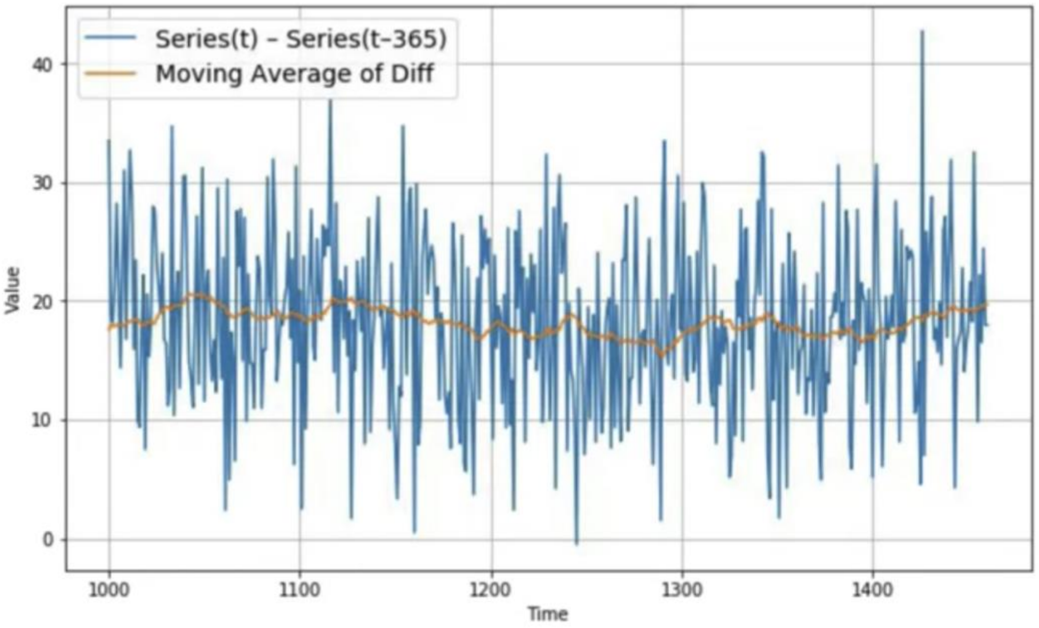
Moving Average



Difference

We remove the trend and the seasonailty from the time series

Moving Average on Differenced Time Series



```
In [ ]:
```