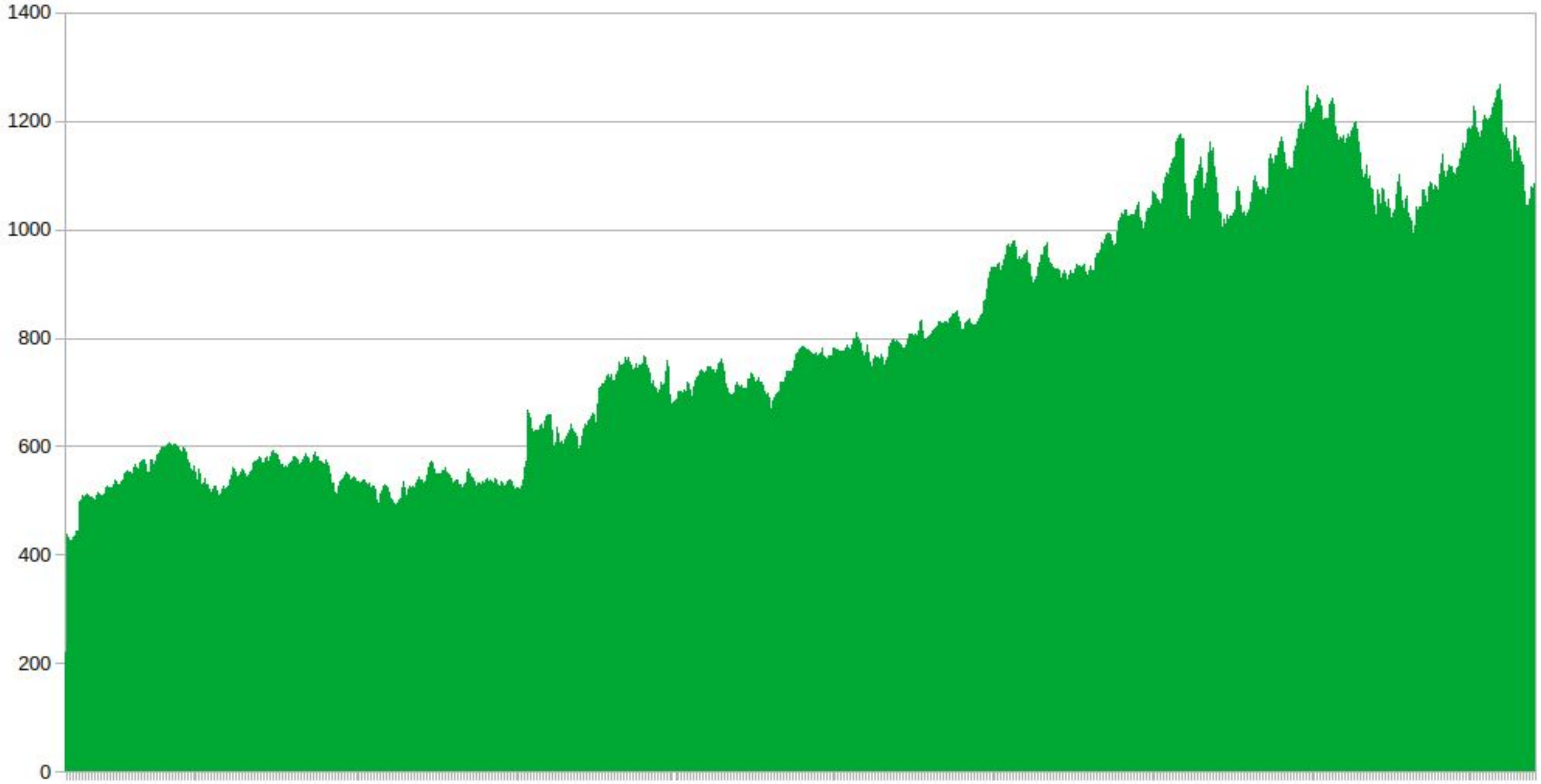
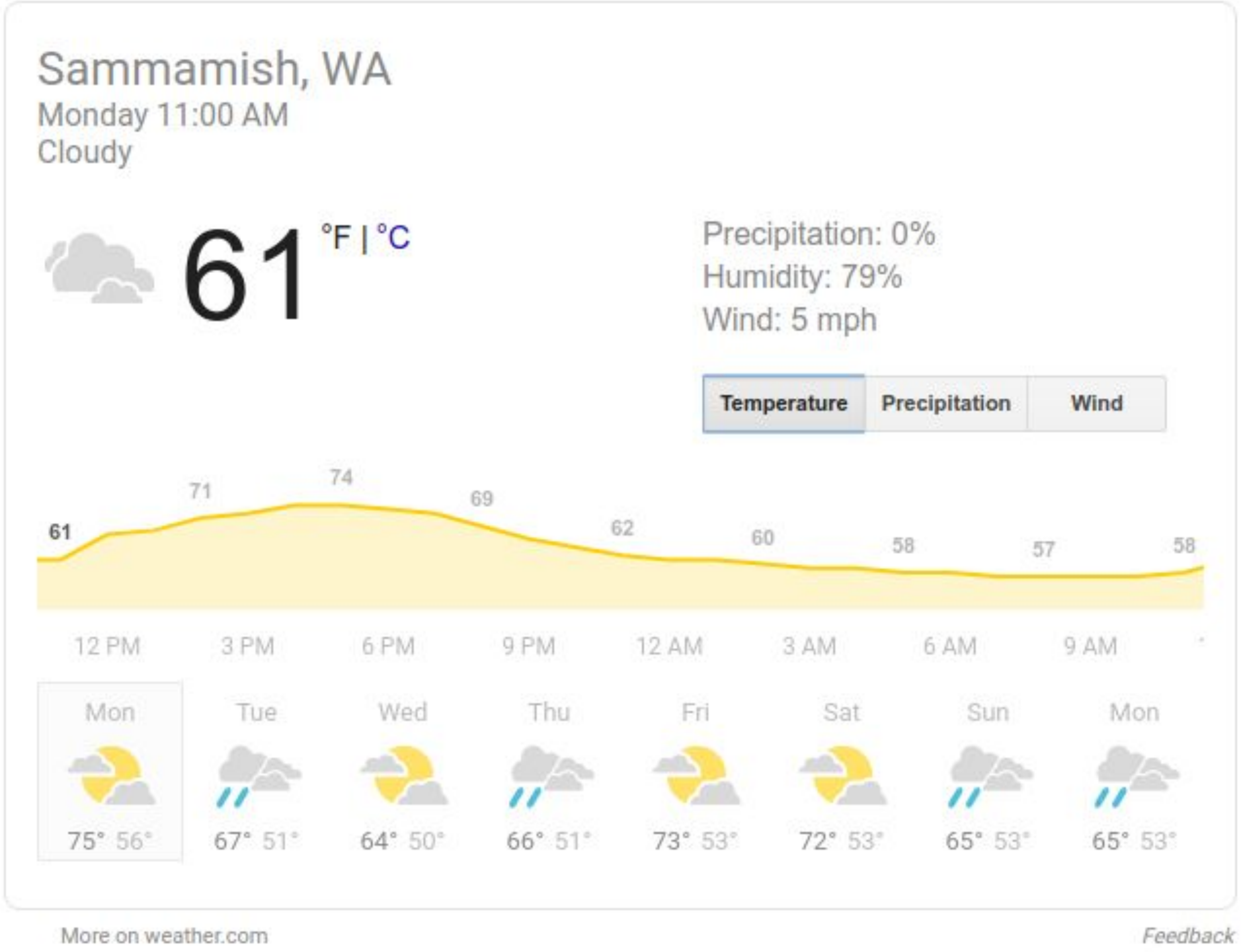


Chart Created by lmoroney@



Sammamish, WA
Monday 11:00 AM
Cloudy

61 °F | °C

Precipitation: 0%
Humidity: 79%
Wind: 5 mph

Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon
75° 56°	67° 51°	64° 50°	66° 51°	73° 53°	72° 53°	65° 53°	65° 53°

More on weather.com

Feedback

Chart From Google Search

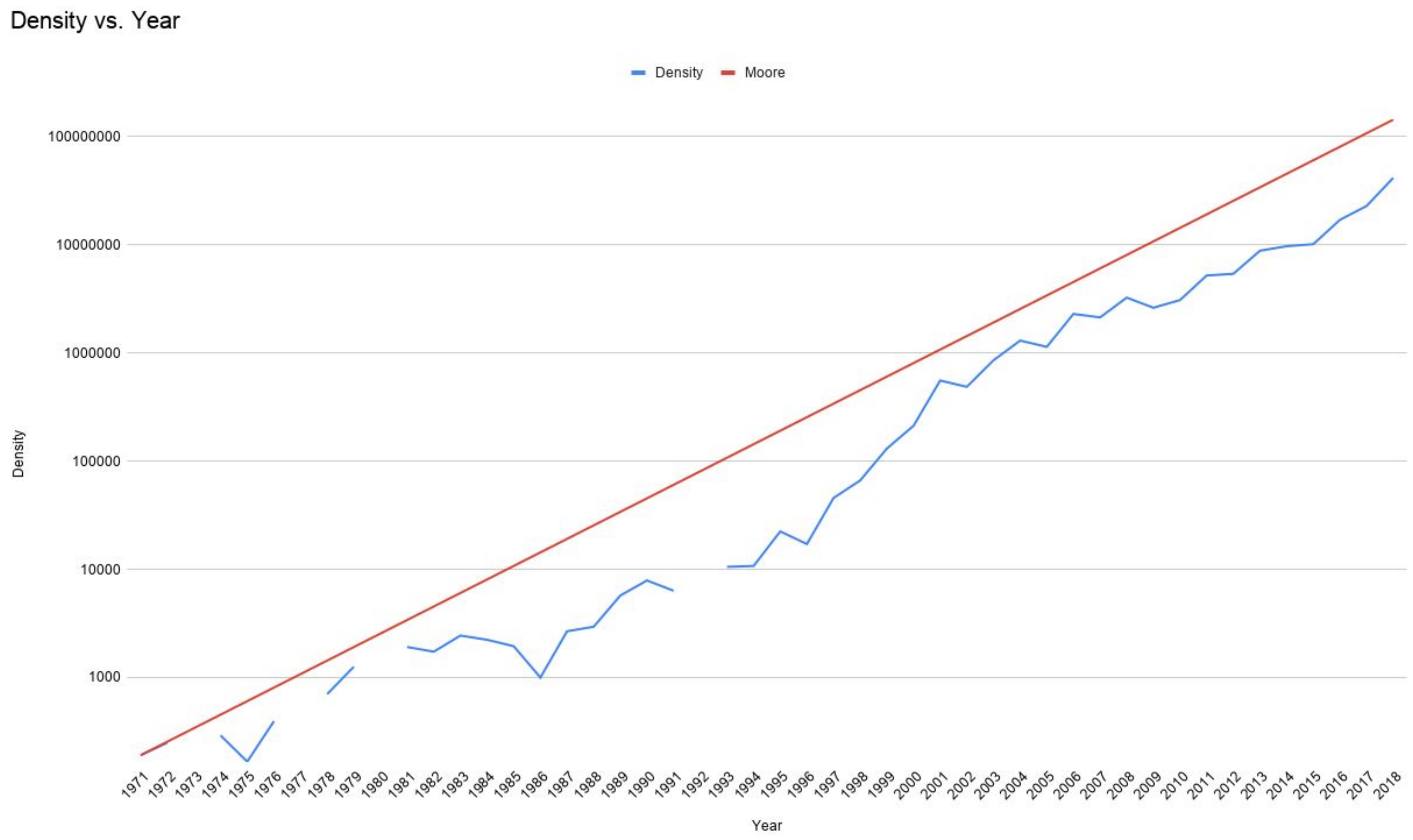
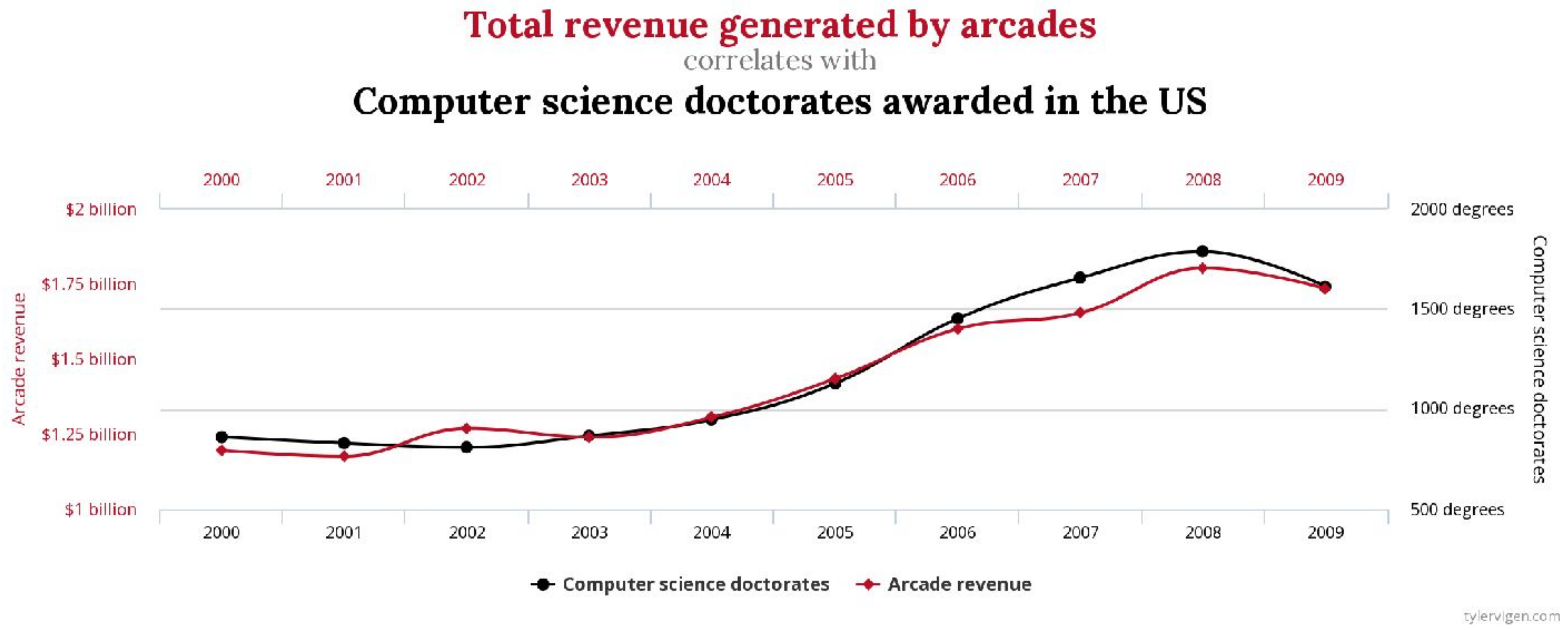
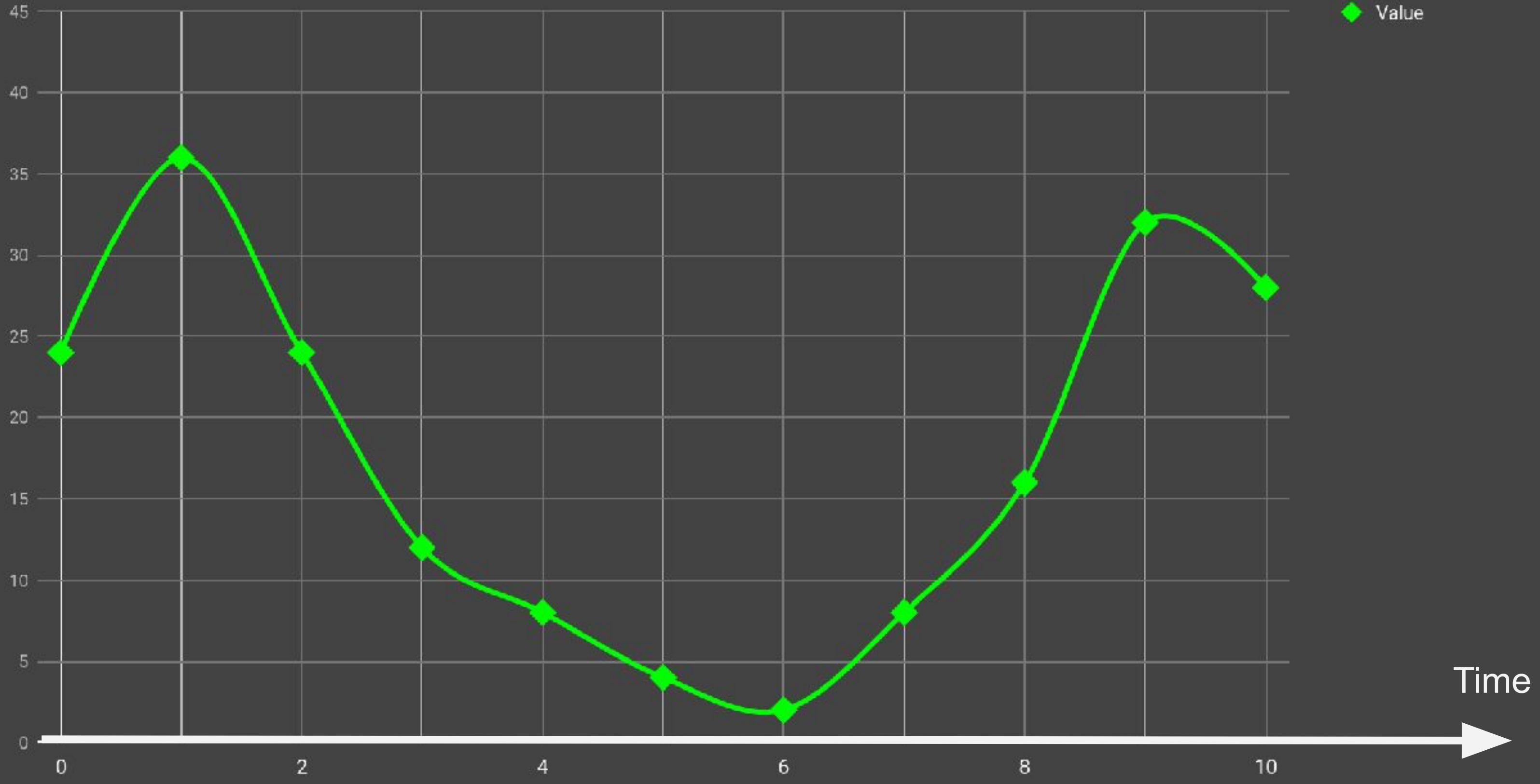


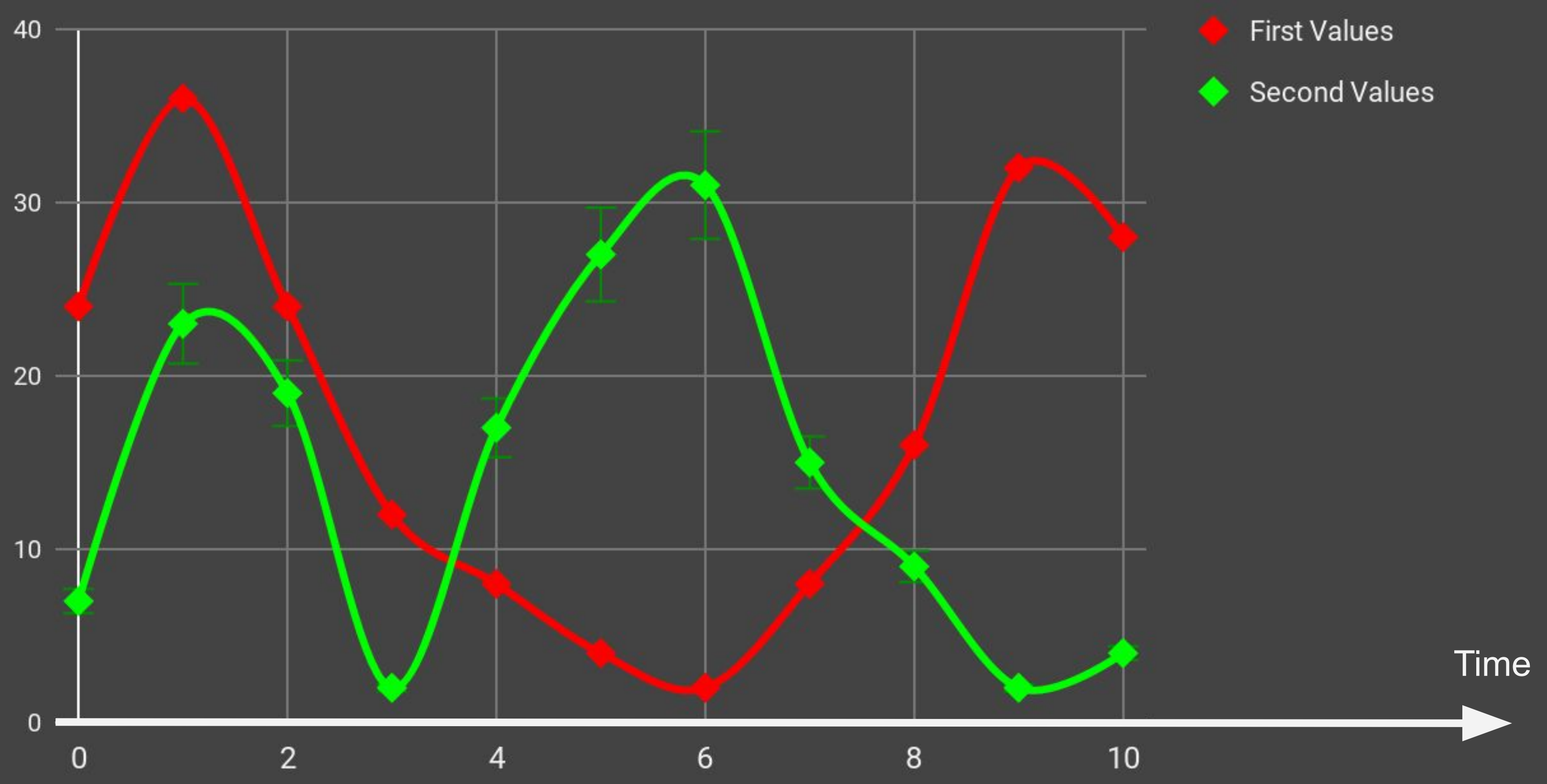
Chart Created by lmoroney@


Total revenue generated by arcades
correlates with
Computer science doctorates awarded in the US
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
$2 billion
$1.75 billion
$1.5 billion
$1.25 billion
$1 billion
Arcade revenue
2000 degrees
1500 degrees
1000 degrees
500 degrees
Computer science doctorates
Computer science doctorates
Arcade revenue
tylervigen.com

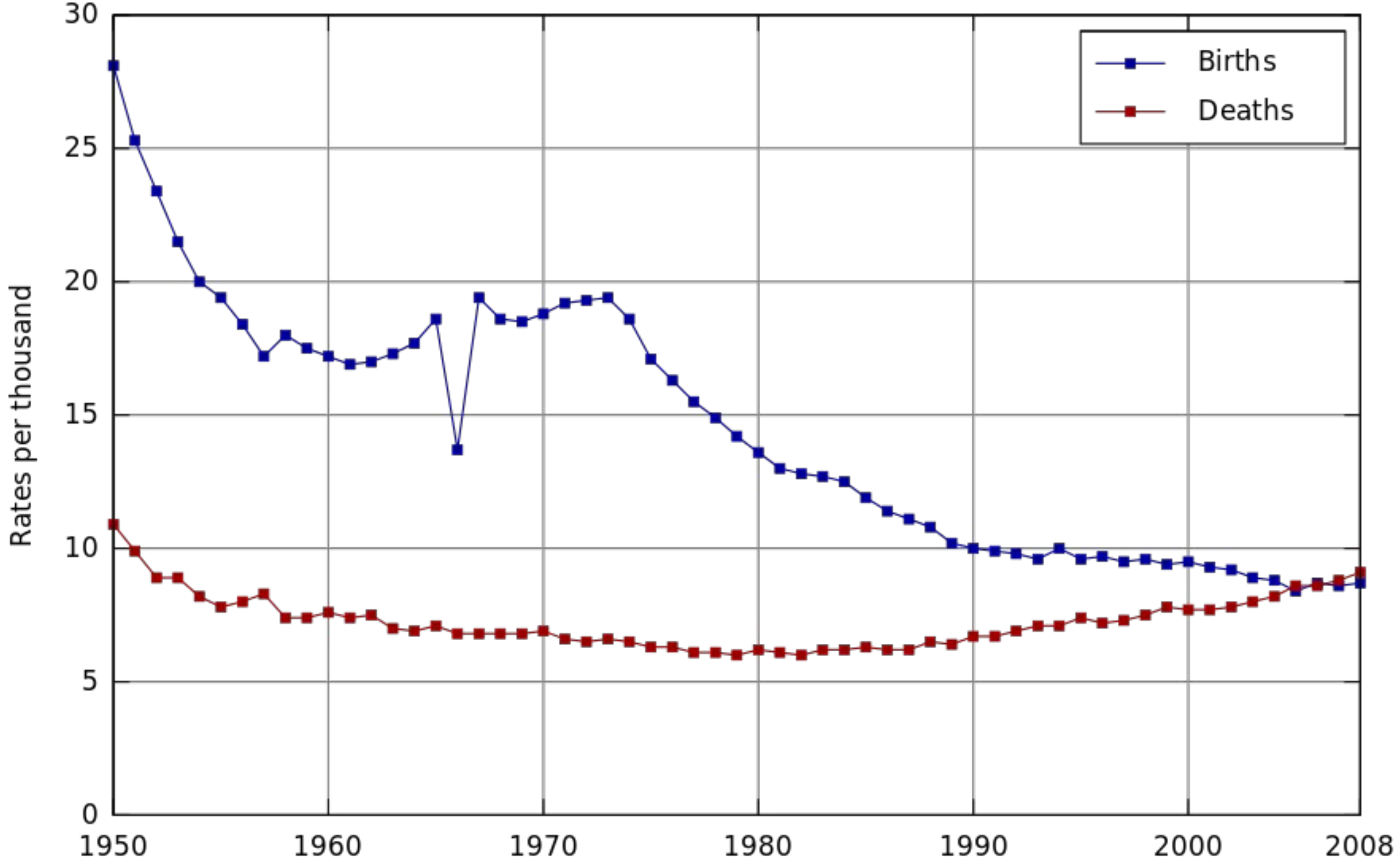
Univariate Time Series

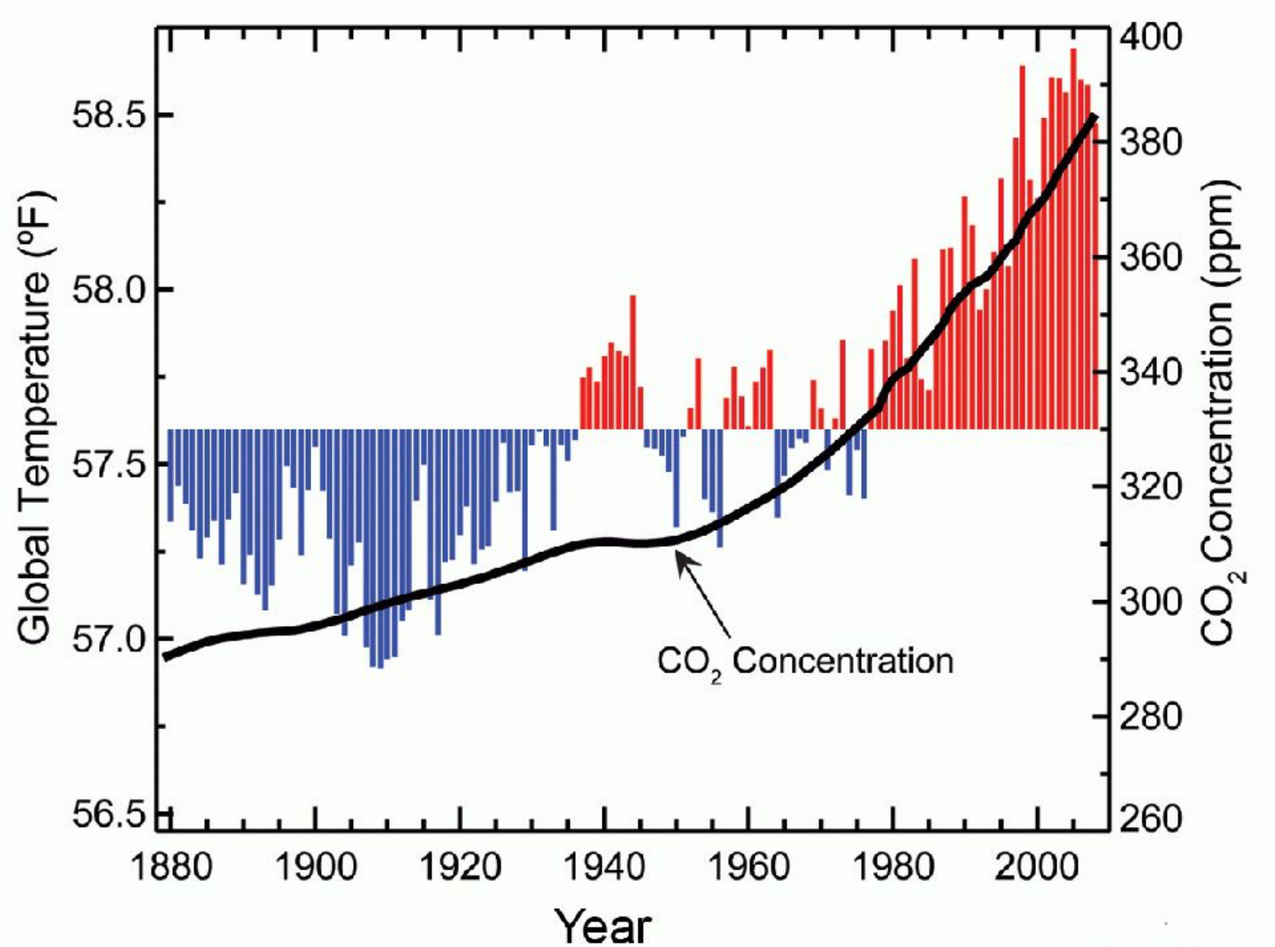


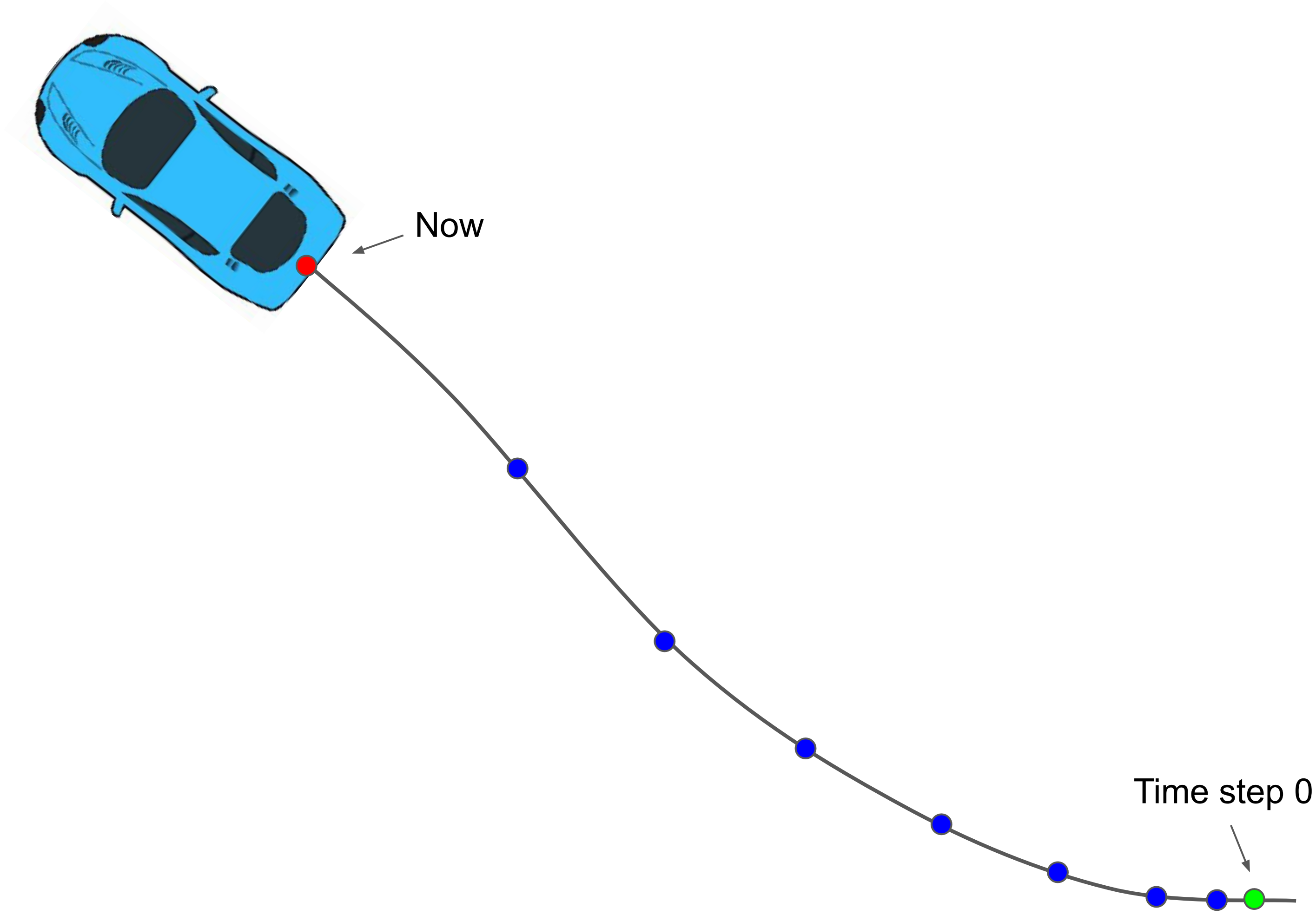
Multivariate Time Series

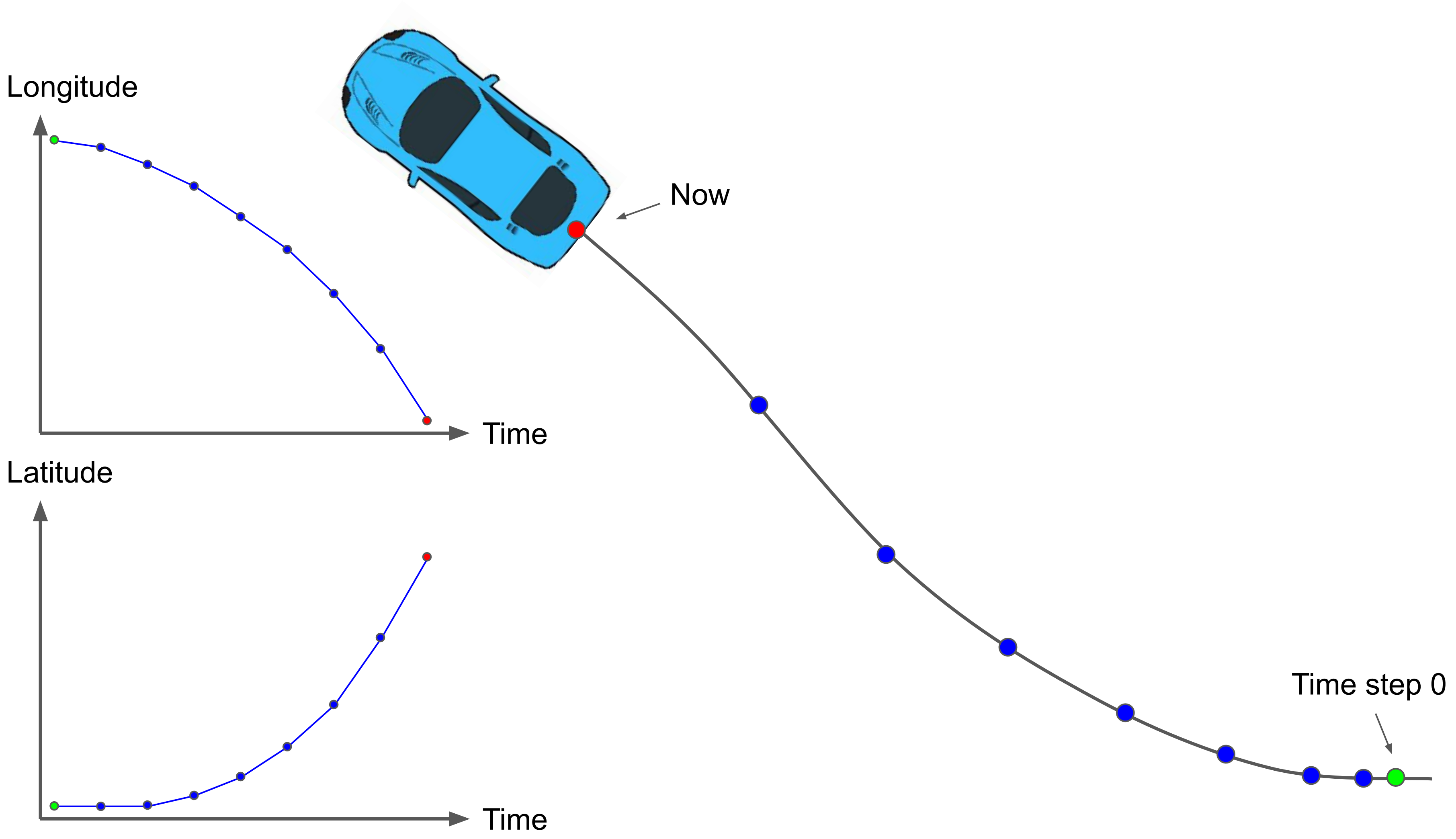


Birth and Death Rate in Japan

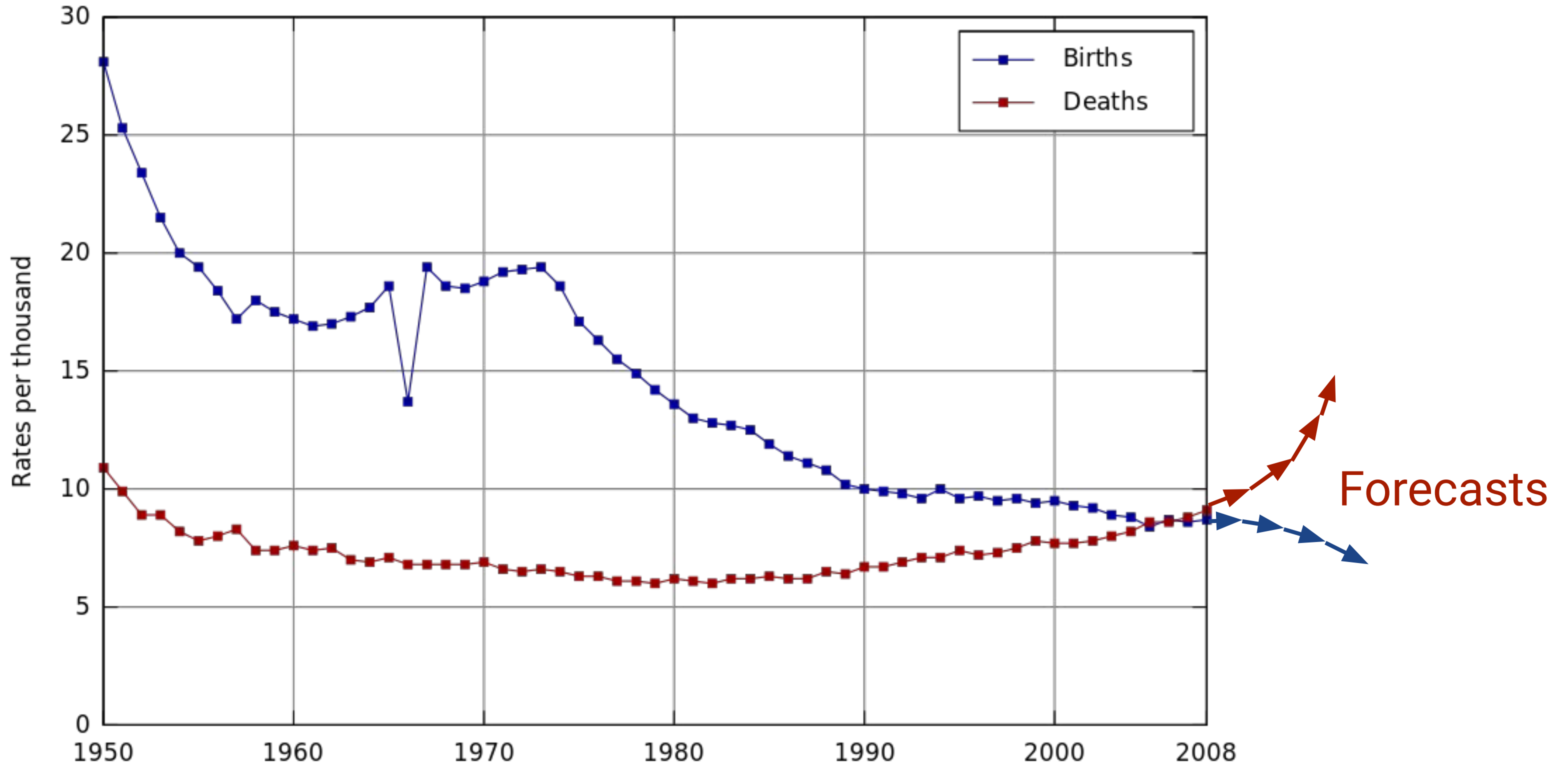



Global Temperature (°F)
58.5
58.0
57.5
57.0
56.5
400
380
360
340
320
300
280
260
CO_2 Concentration (ppm)
CO_2 Concentration
1880
1900
1920
1940
1960
1980
2000
Year


Now
Time step 0


Longitude
Time
Latitude
Time
Now
Time step 0

Birth and Death Rate in Japan



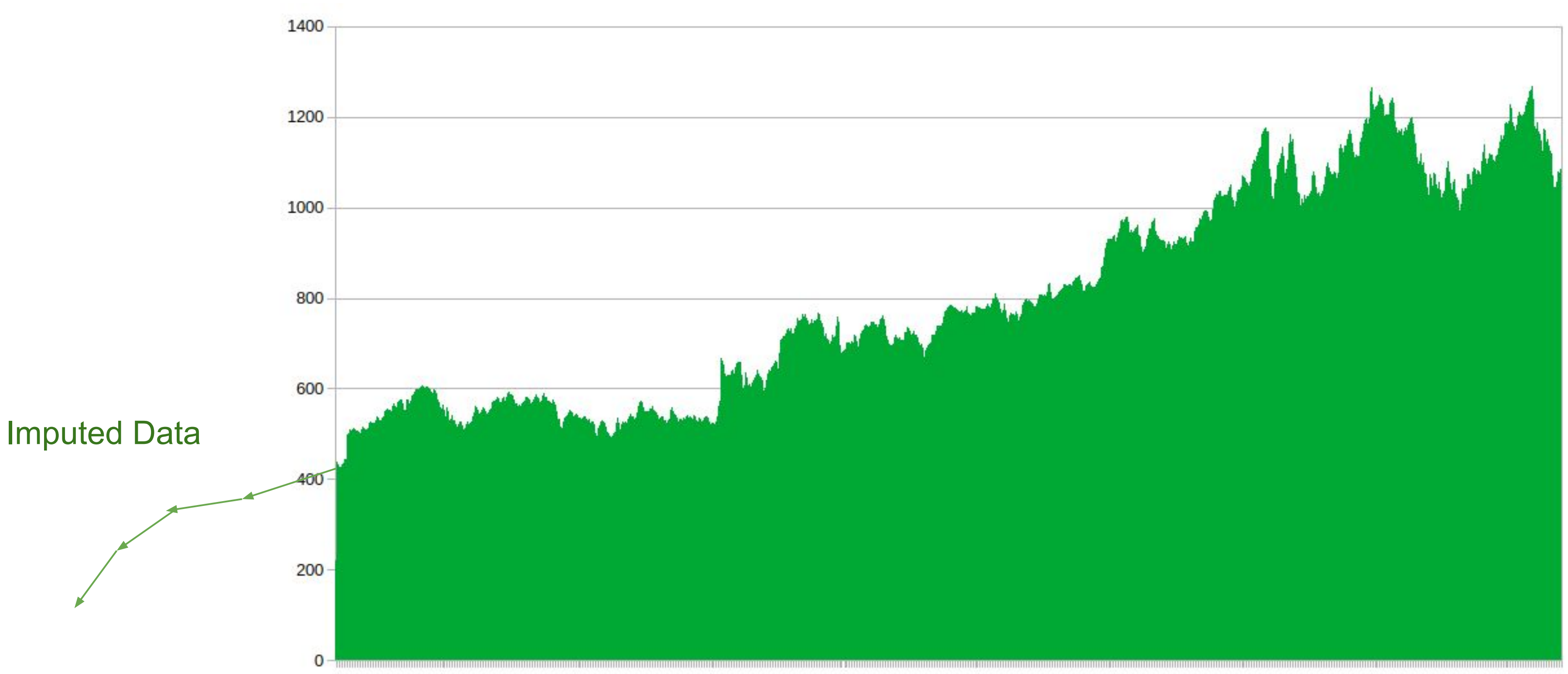


Chart Created by lmoroney@

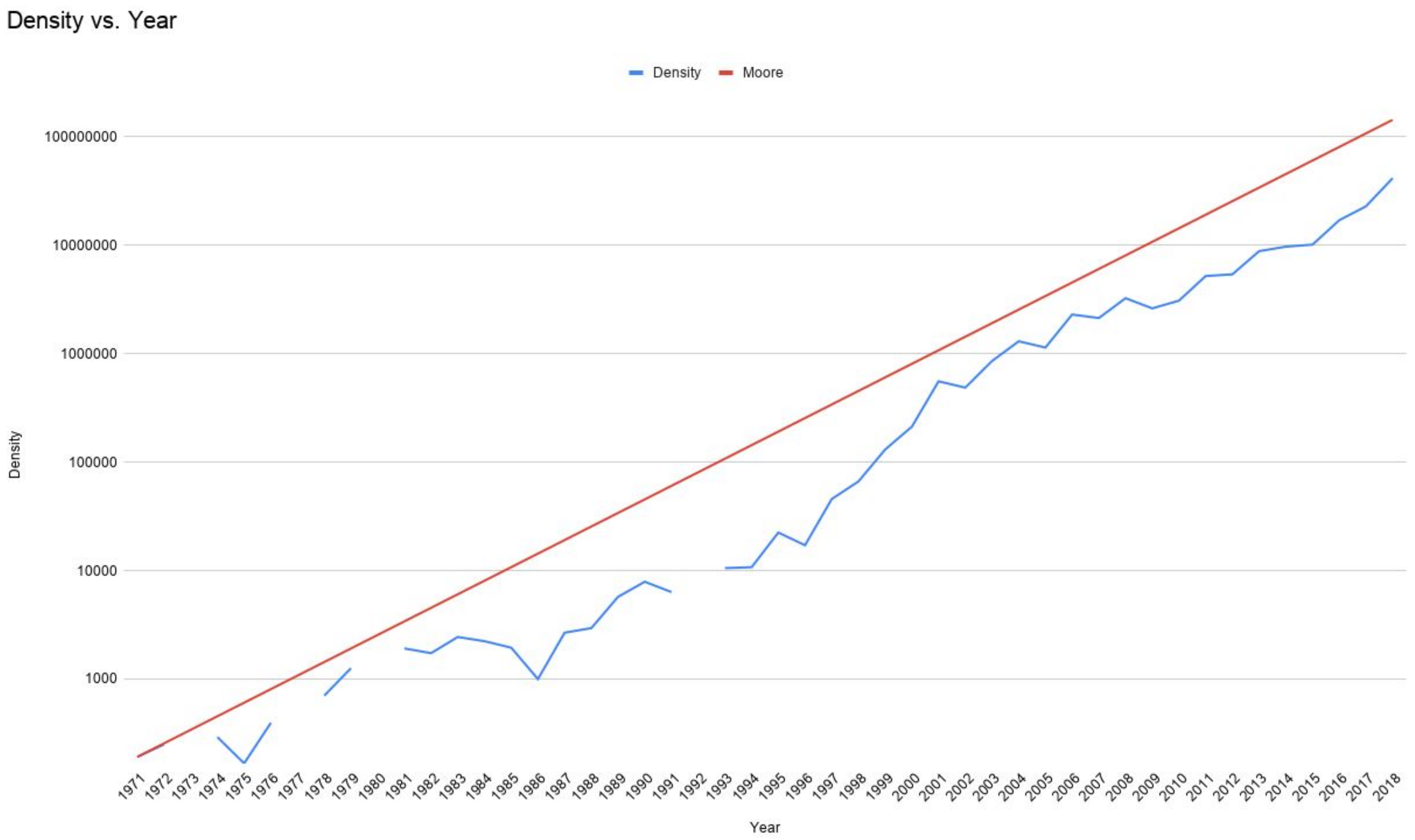


Chart Created by lmoroney@

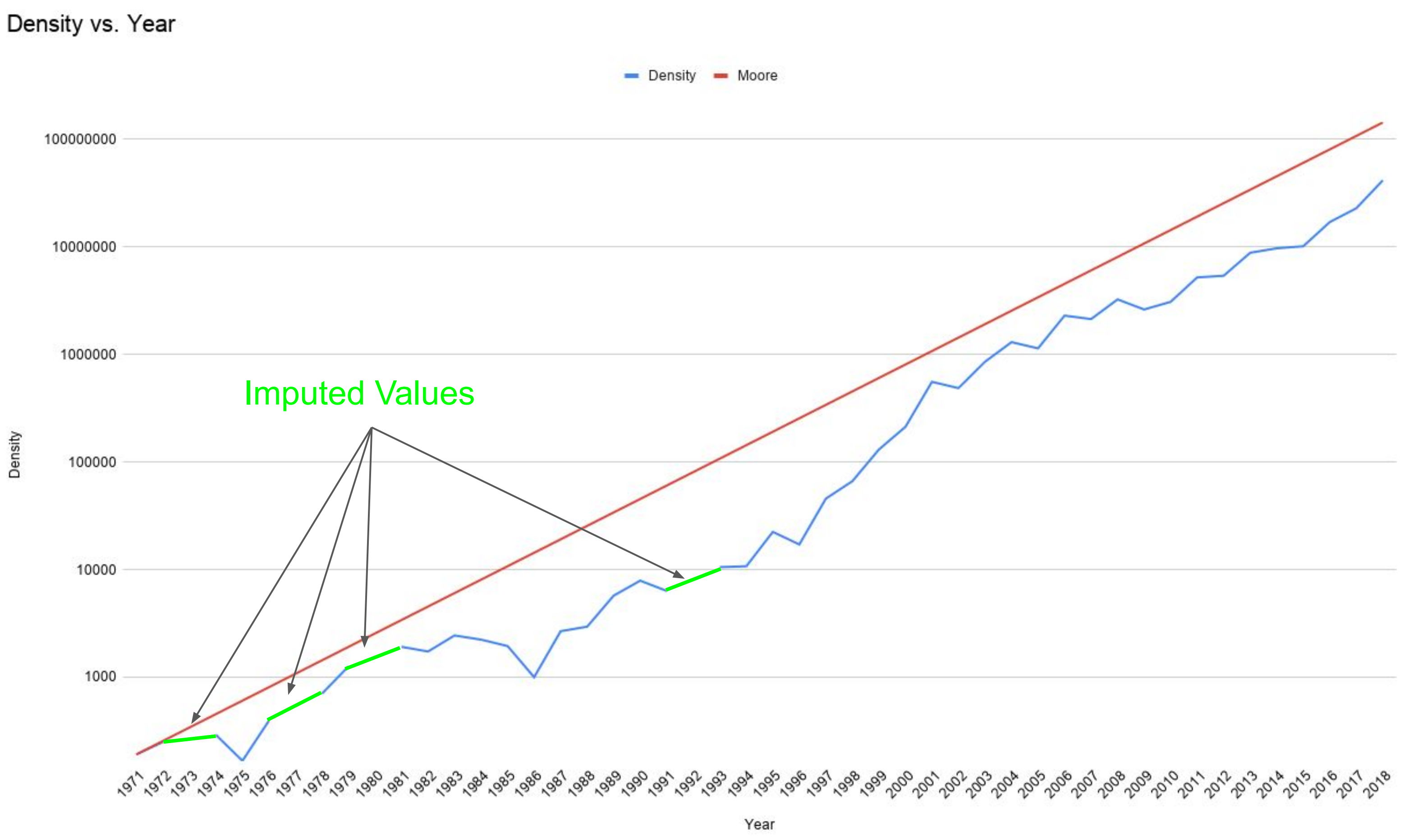
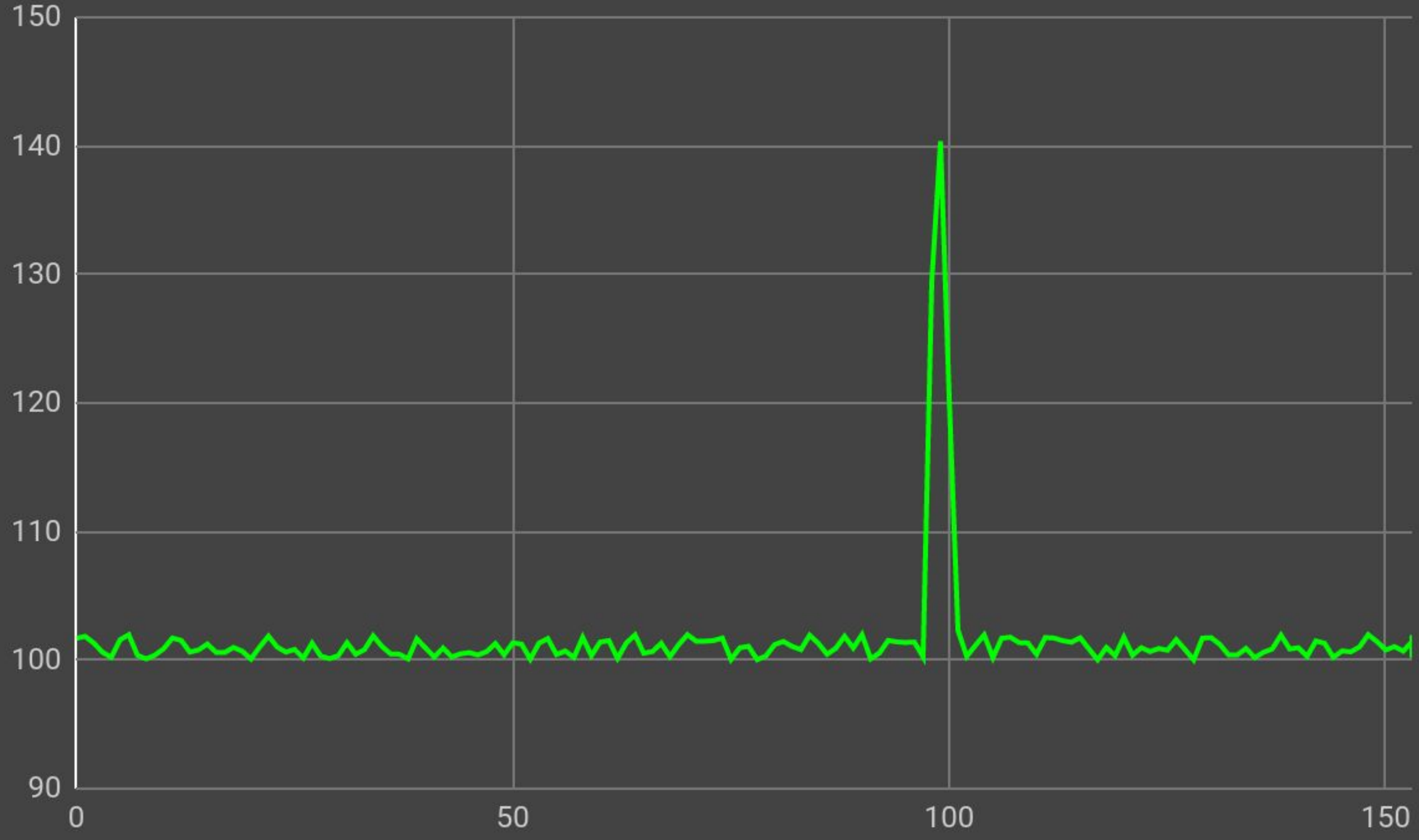
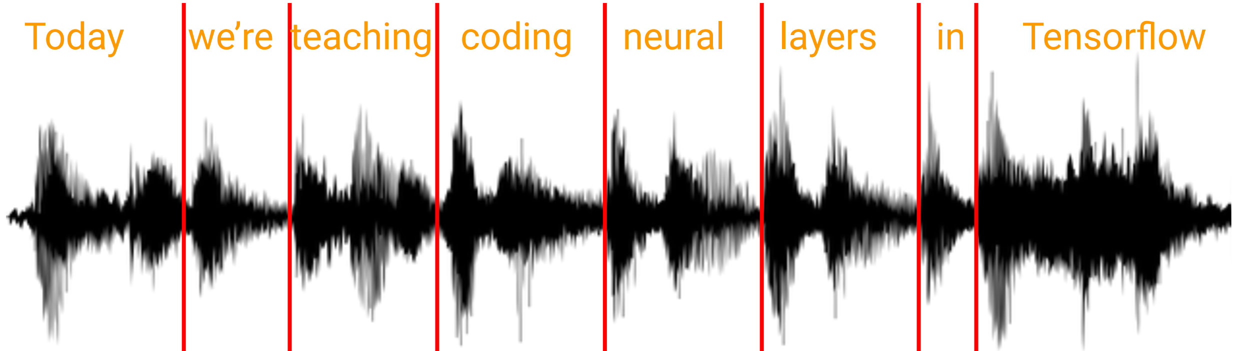


Chart Created by lmoroney@


150
140
130
120
110
100
90
0
50
100
150


Today
we're
teaching
coding
neural
layers
in
Tensorflow

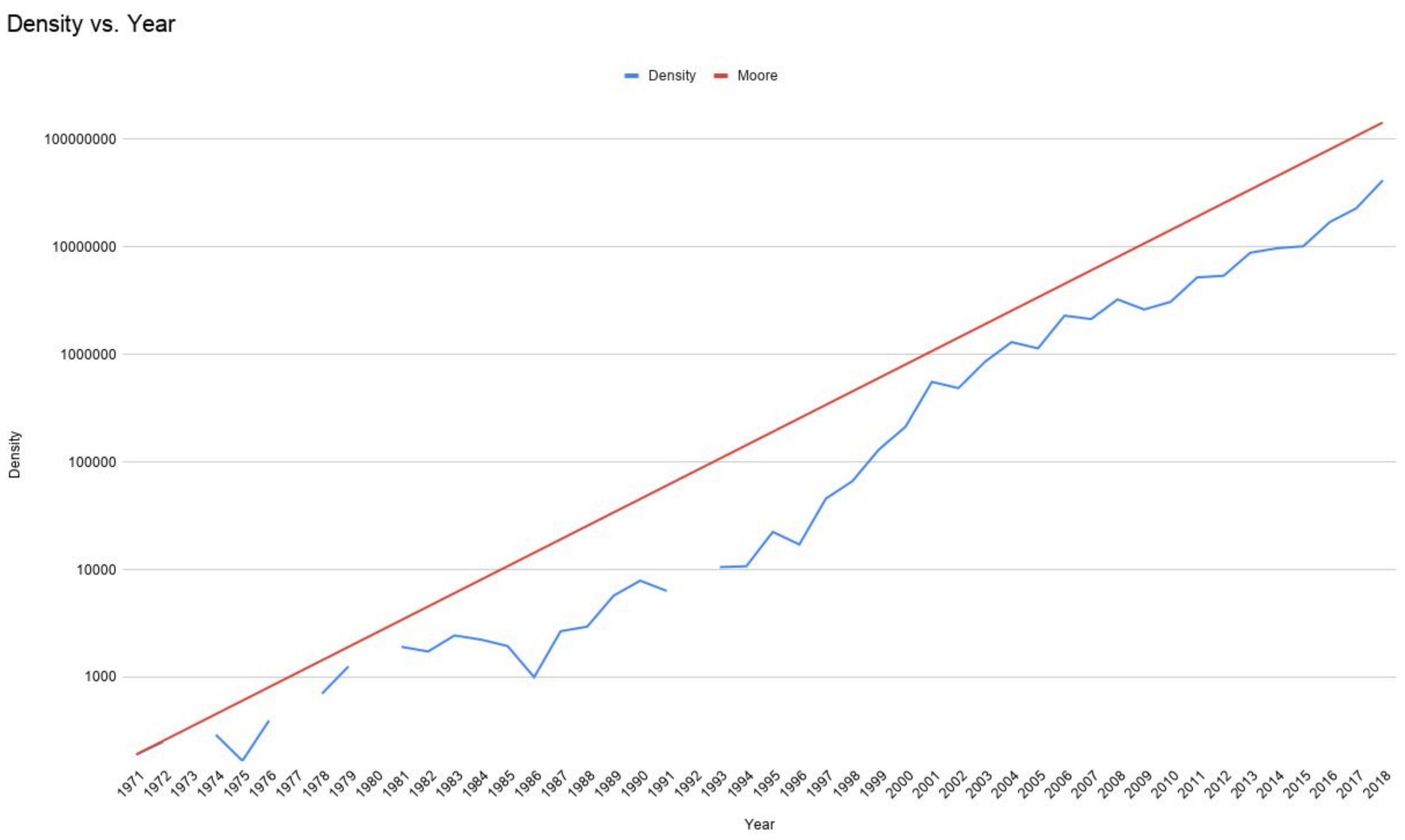
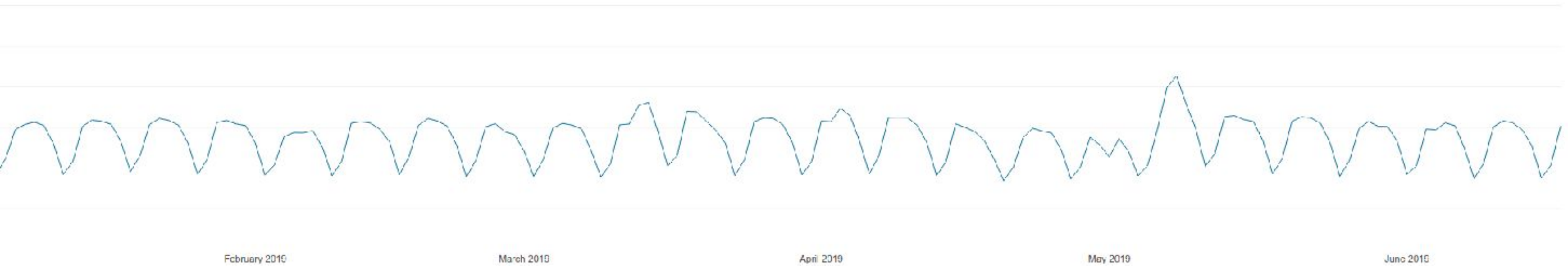
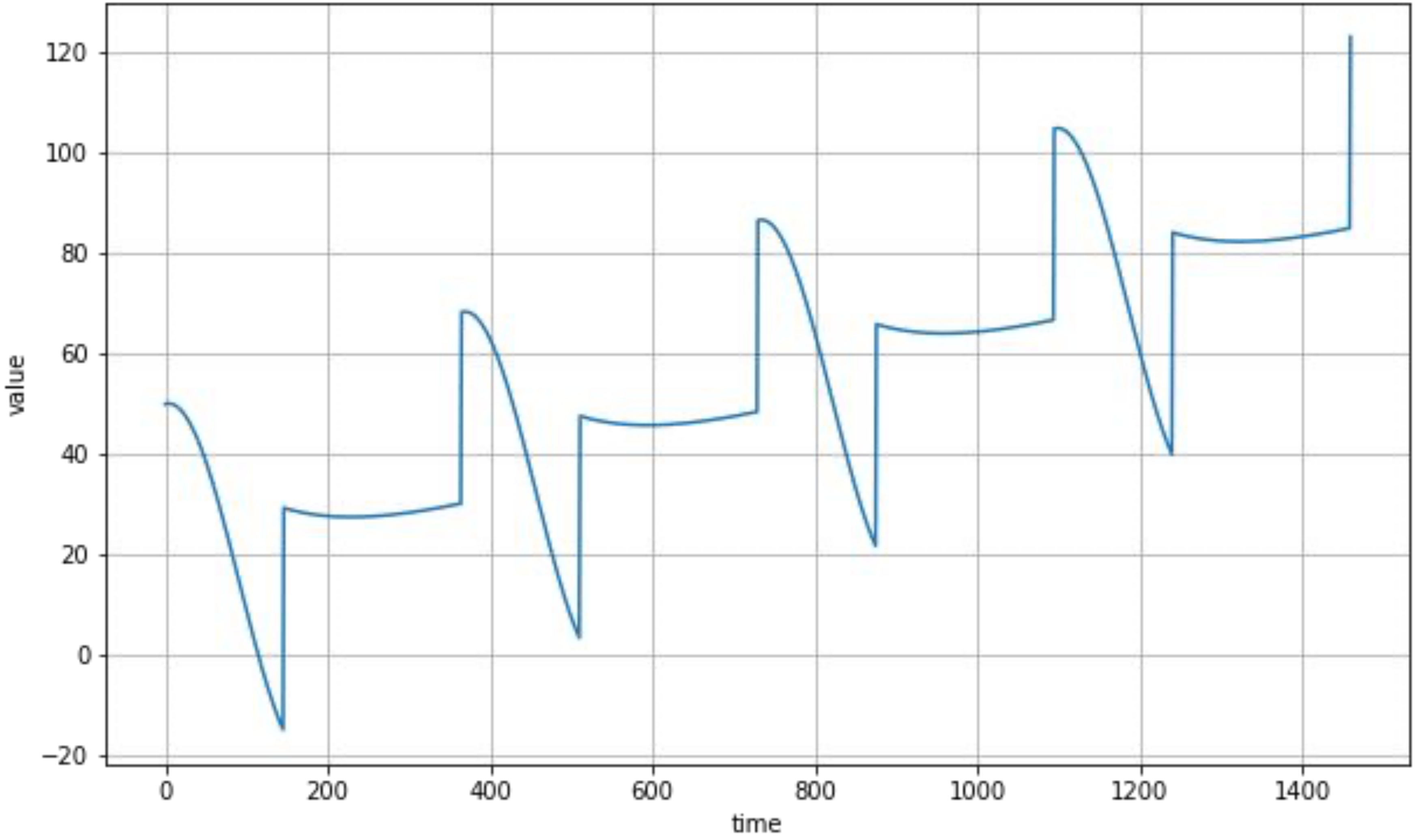
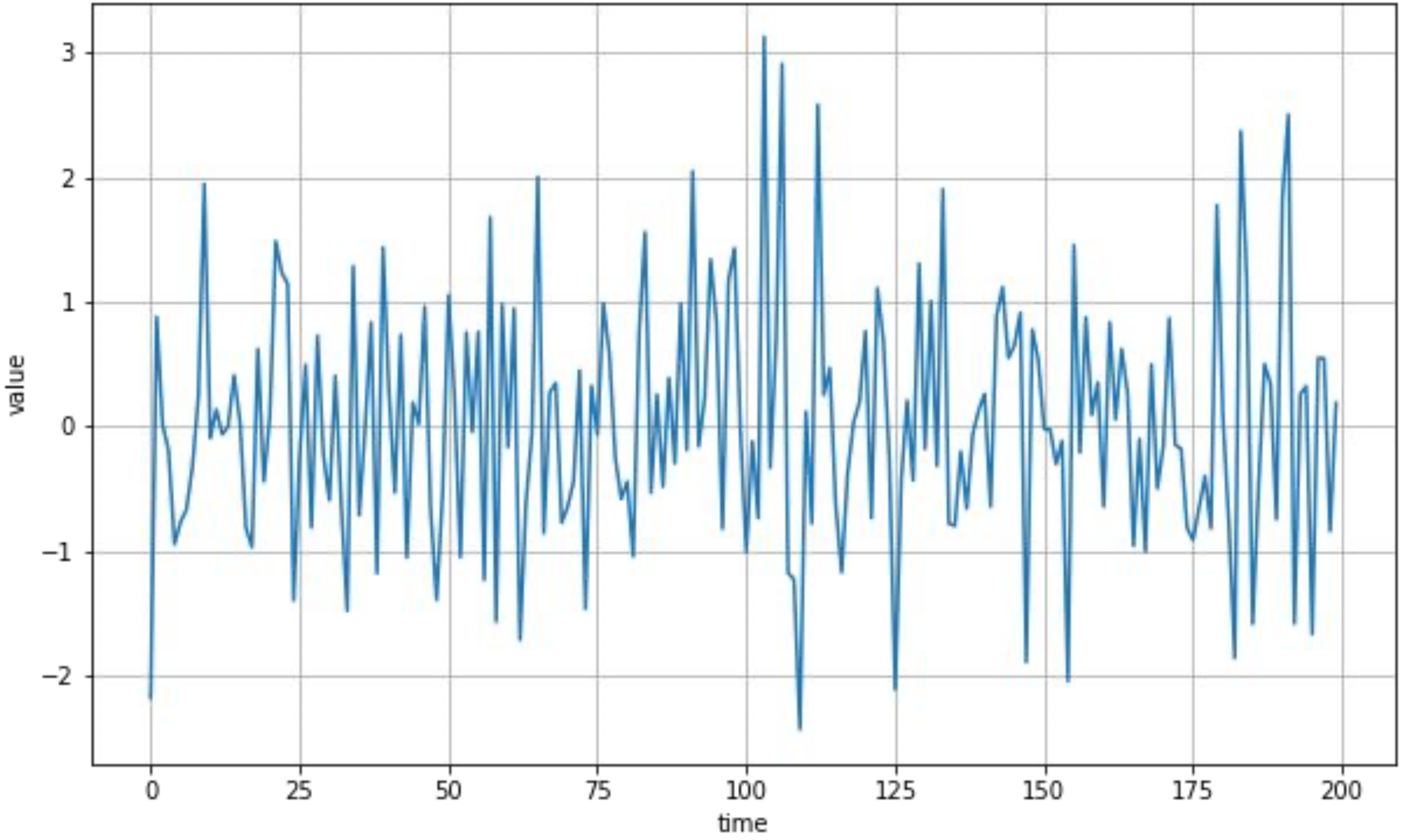


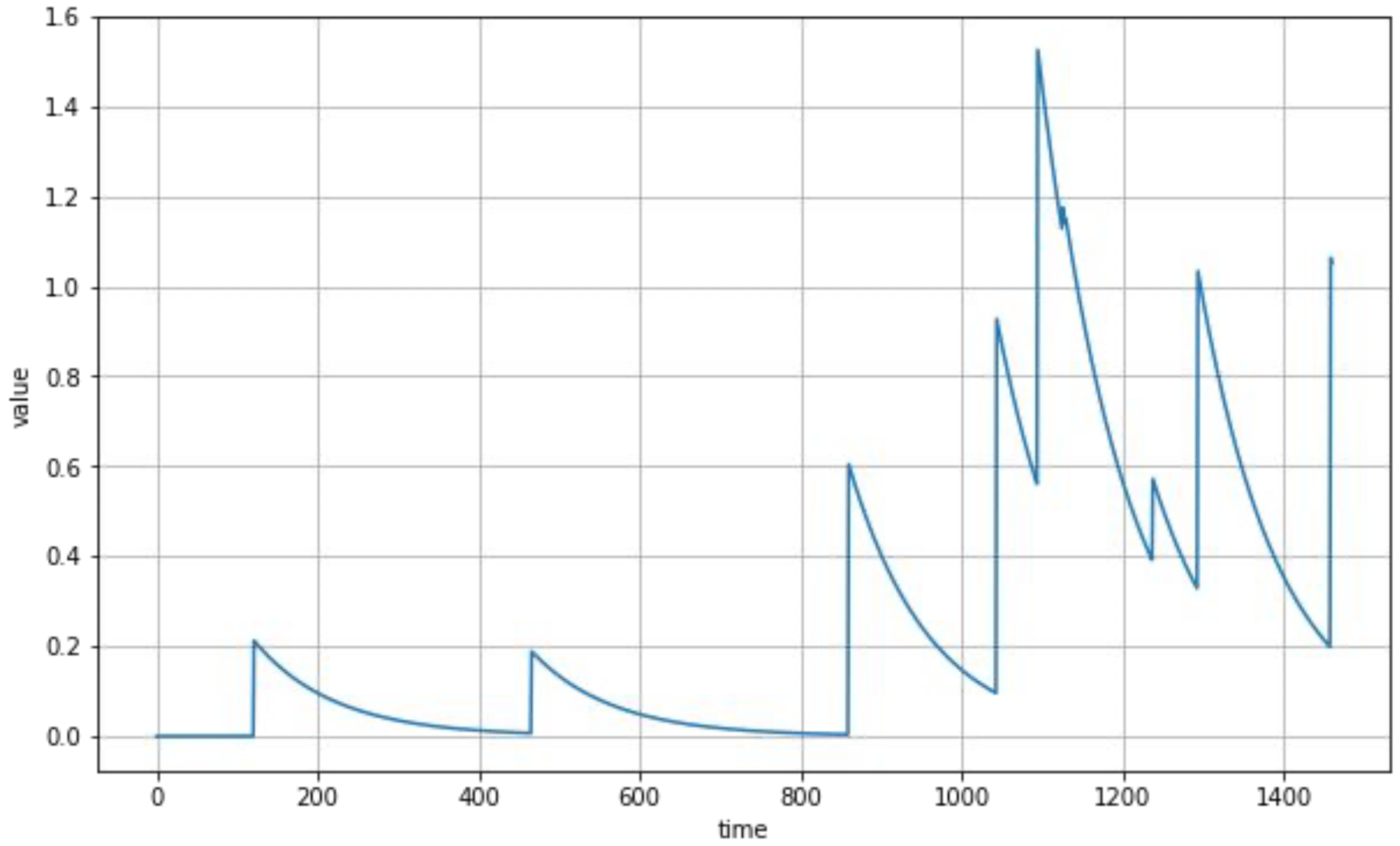
Chart Created by lmoroney@


February 2019
March 2019
April 2019
May 2019
June 2019

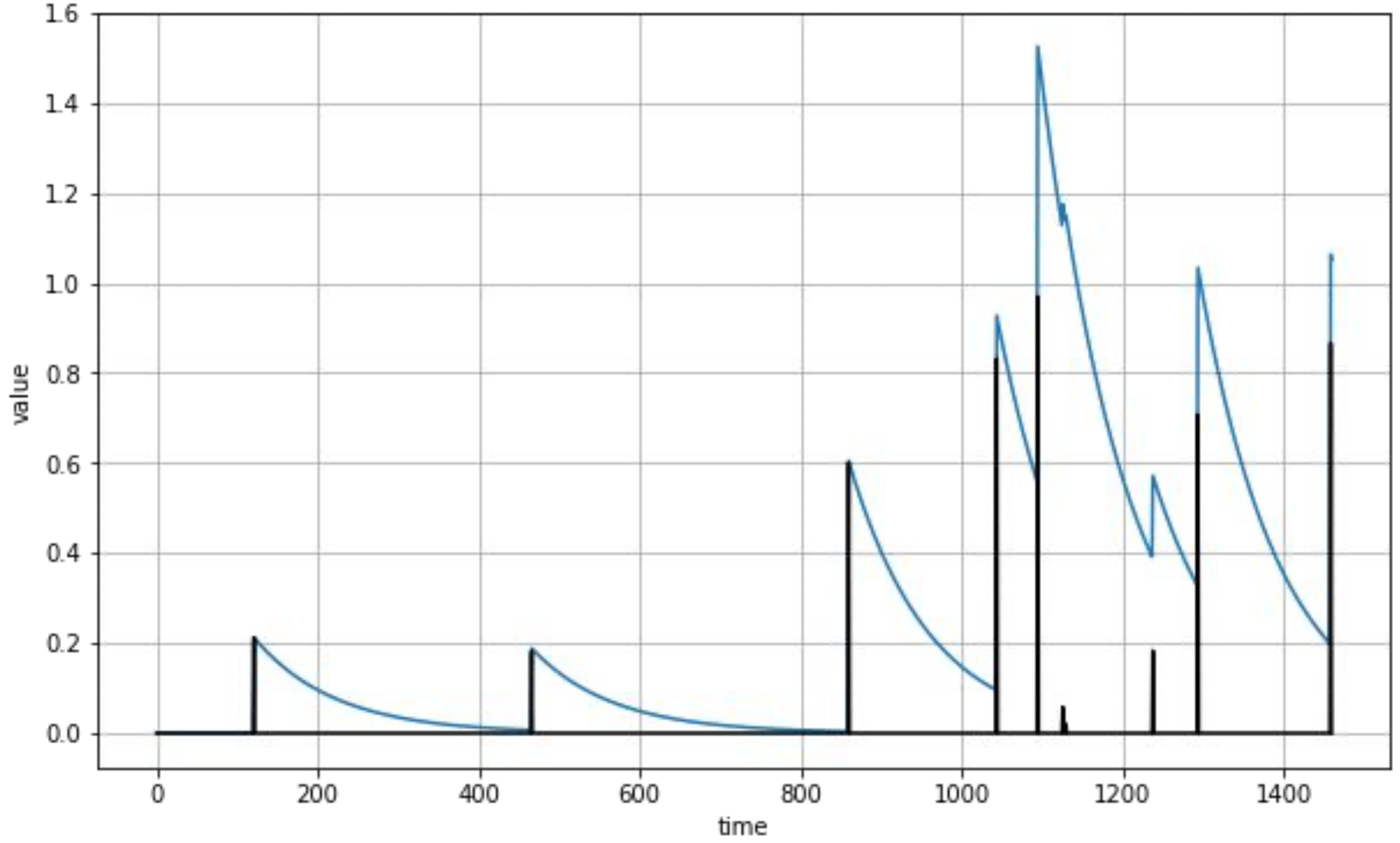

120
100
80
60
40
20
0
−20
value
0
200
400
600
800
1000
1200
1400
time


value
time
3
2
1
0
−1
−2
0
25
50
75
100
125
150
175
200

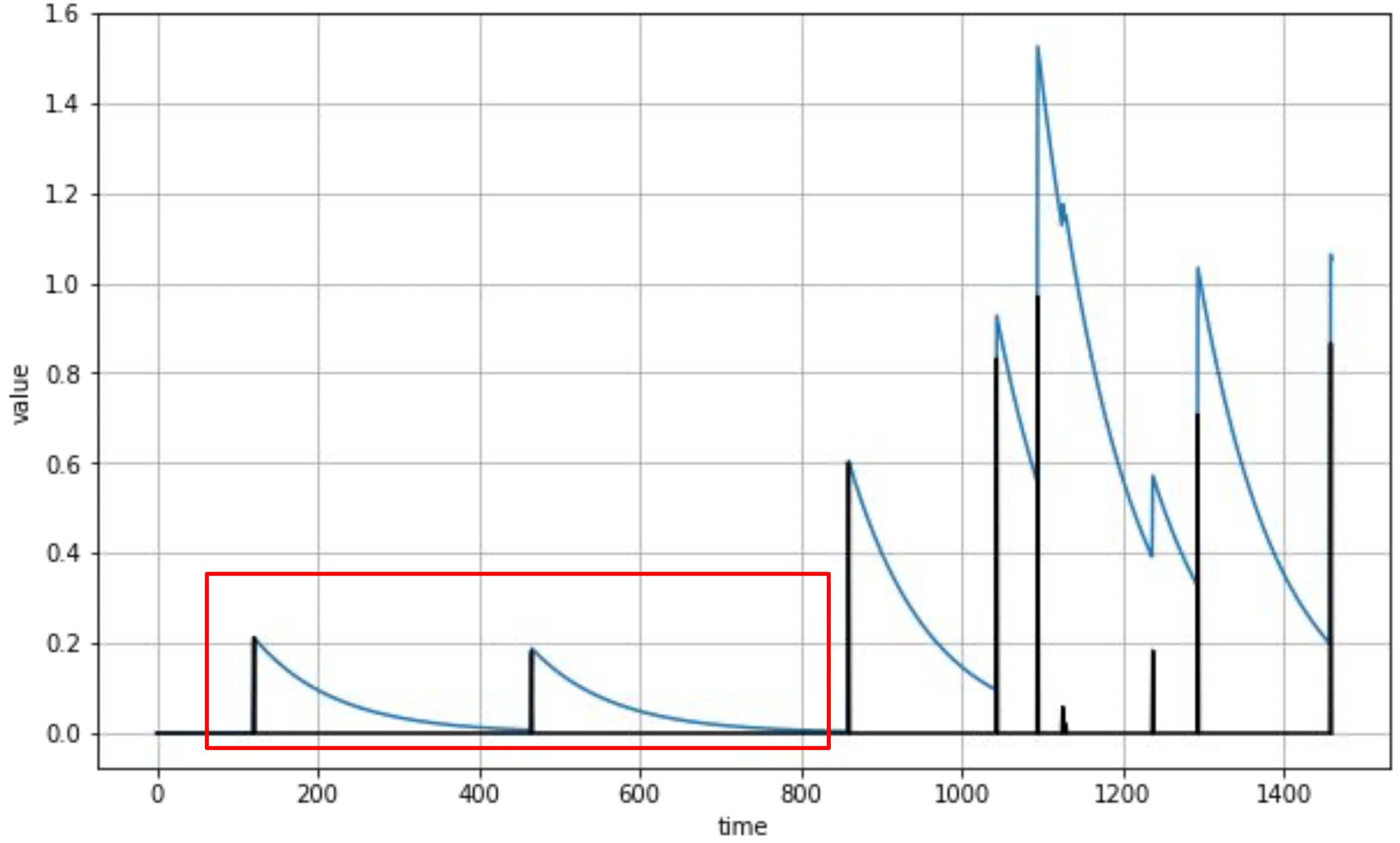
Autocorrelation



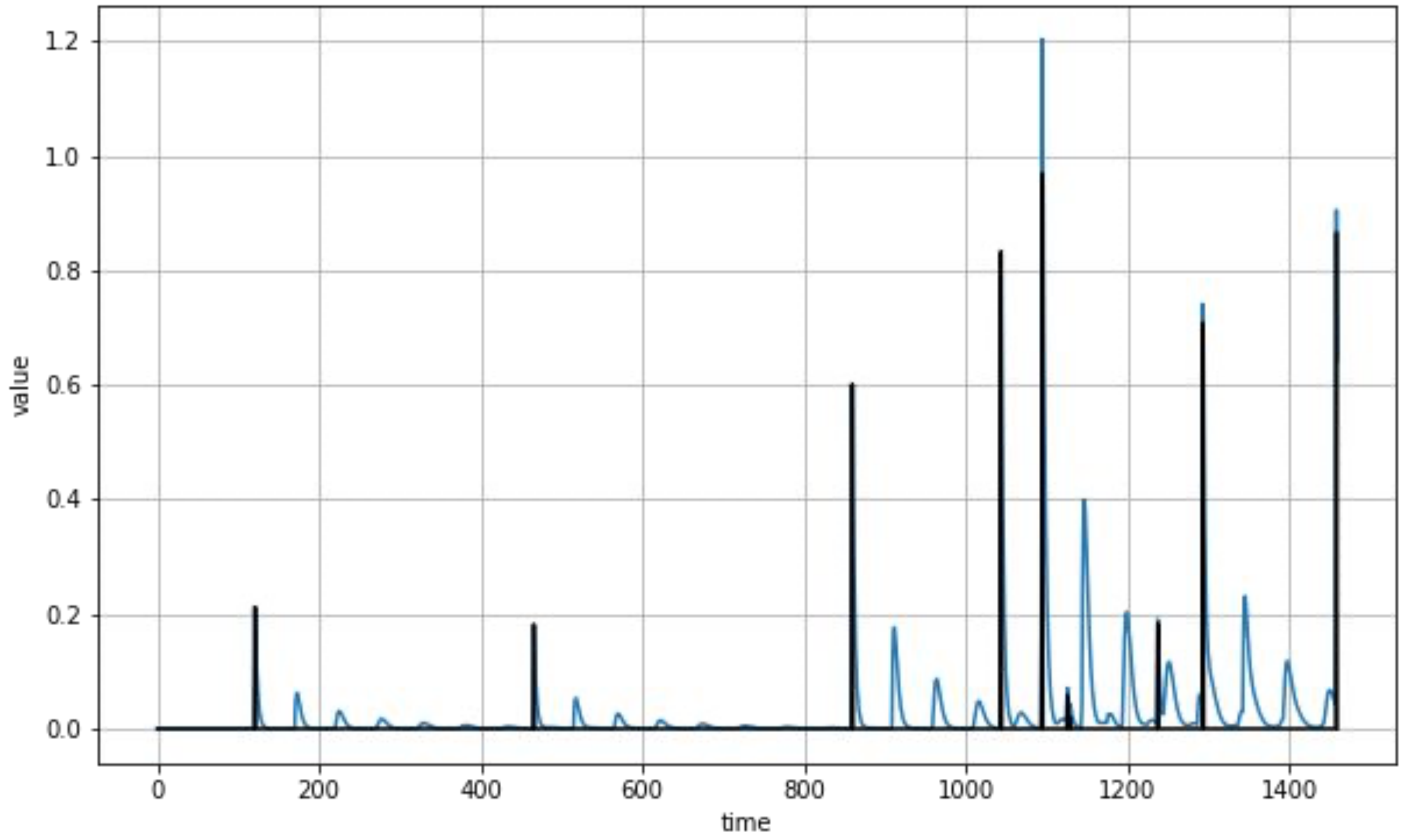
$v(t) = 0.99 \times v(t-1)$ + occasional spike



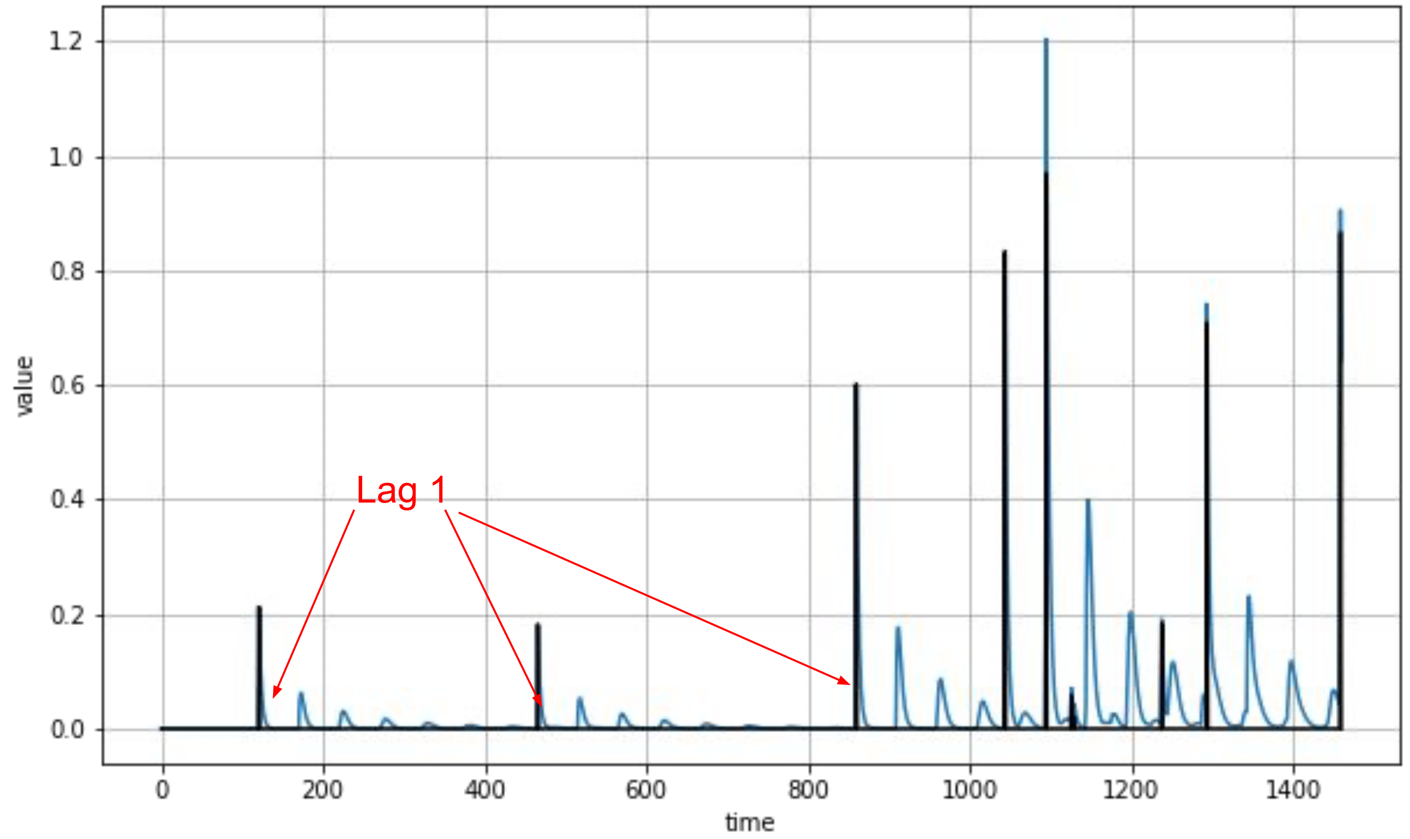
$v(t) = 0.99 \times v(t-1)$ + occasional spike



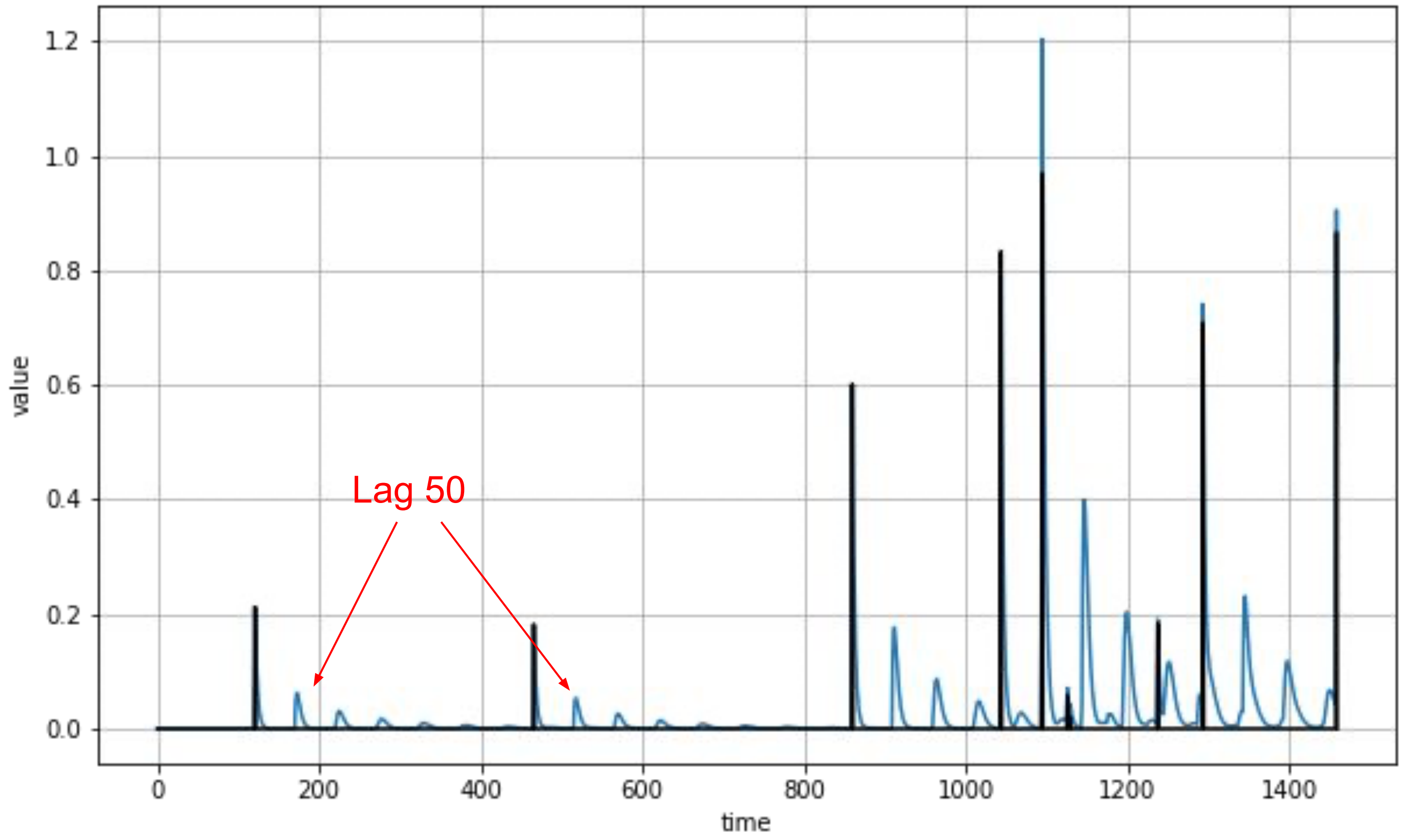
$v(t) = 0.7 \times v(t-1) + 0.2 \times v(t-50)$ + occasional spike



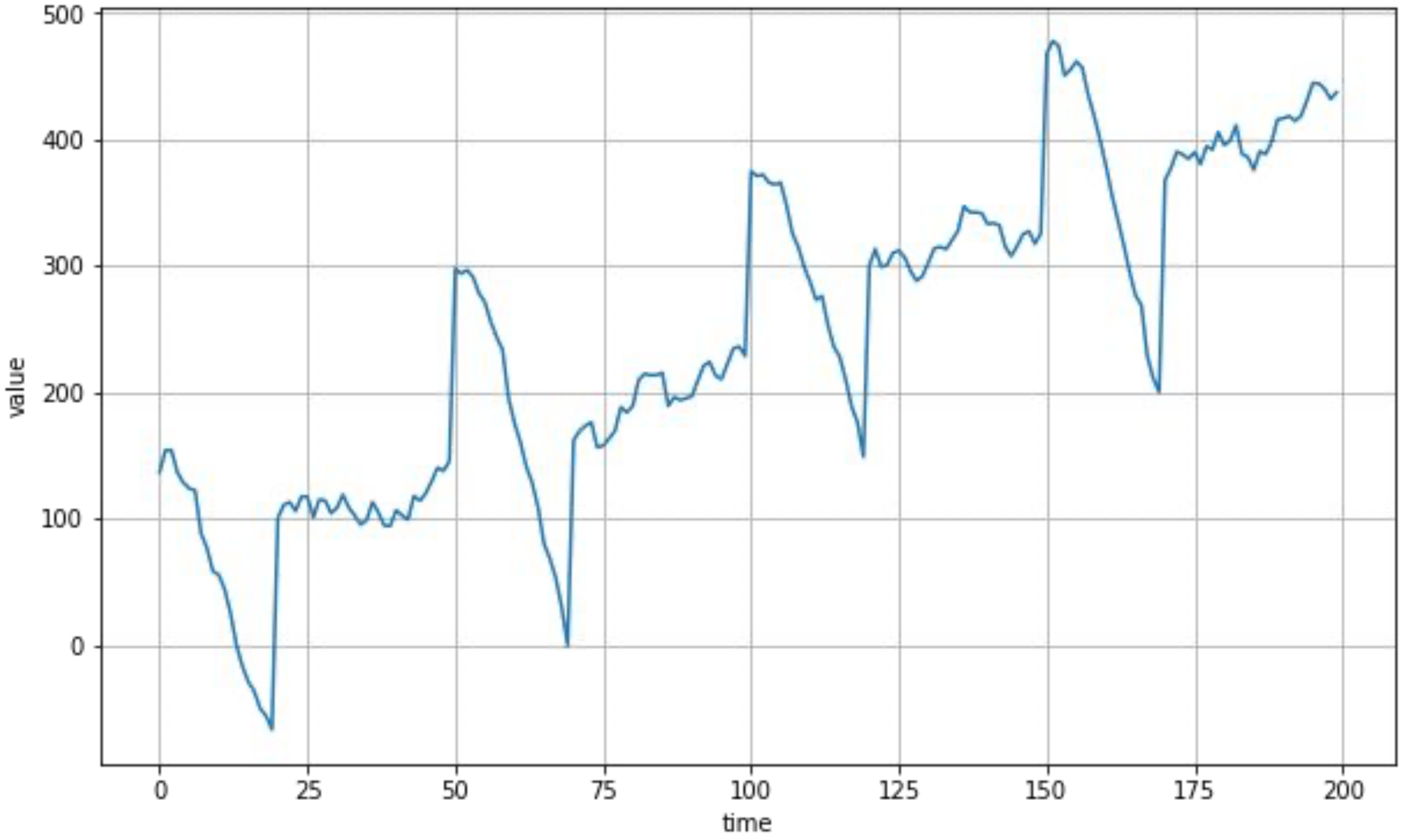
$v(t) = 0.7 \times v(t-1) + 0.2 \times v(t-50)$ + occasional spike



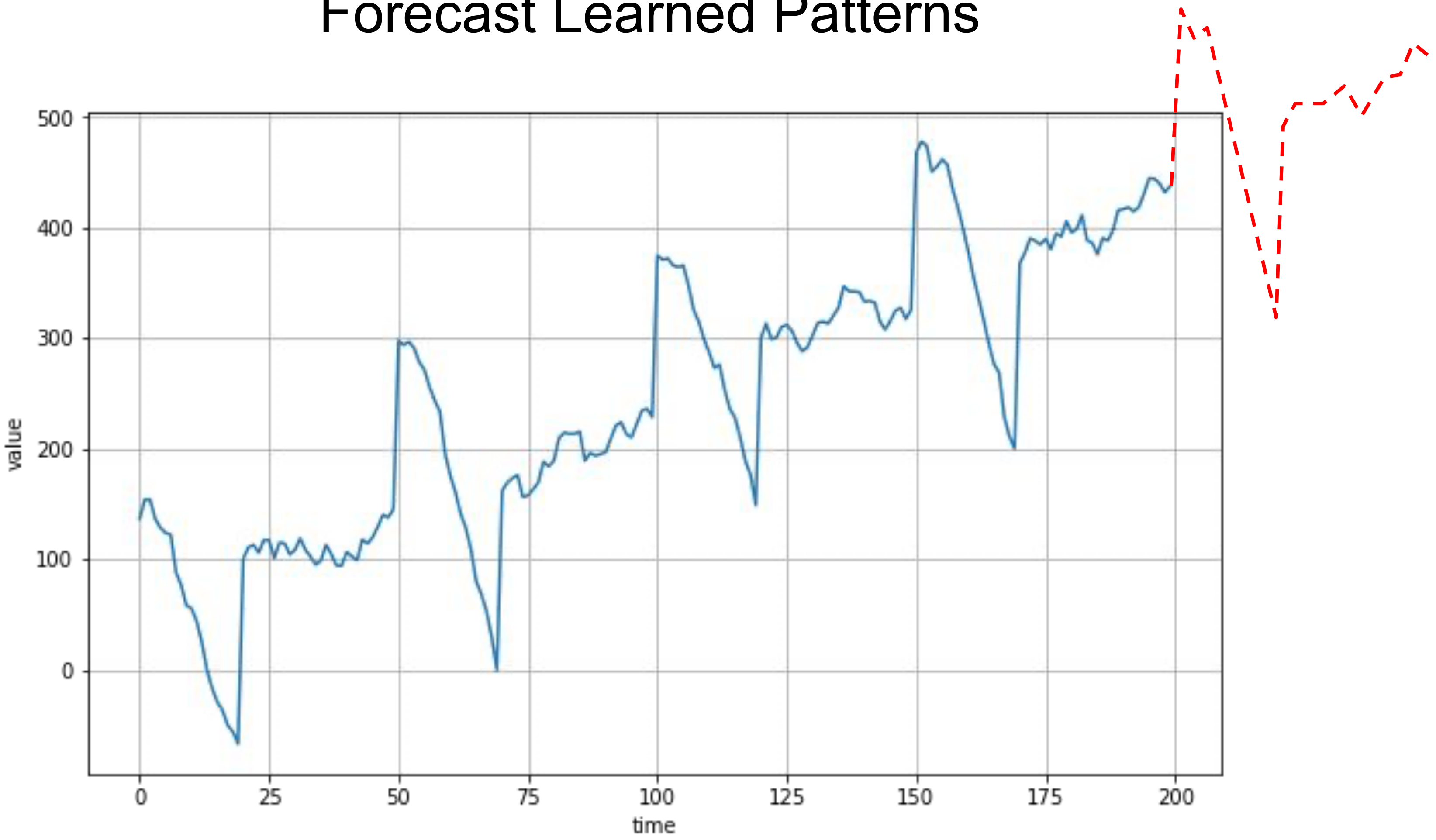
$v(t) = 0.7 \times v(t-1) + 0.2 \times v(t-50)$ + occasional spike



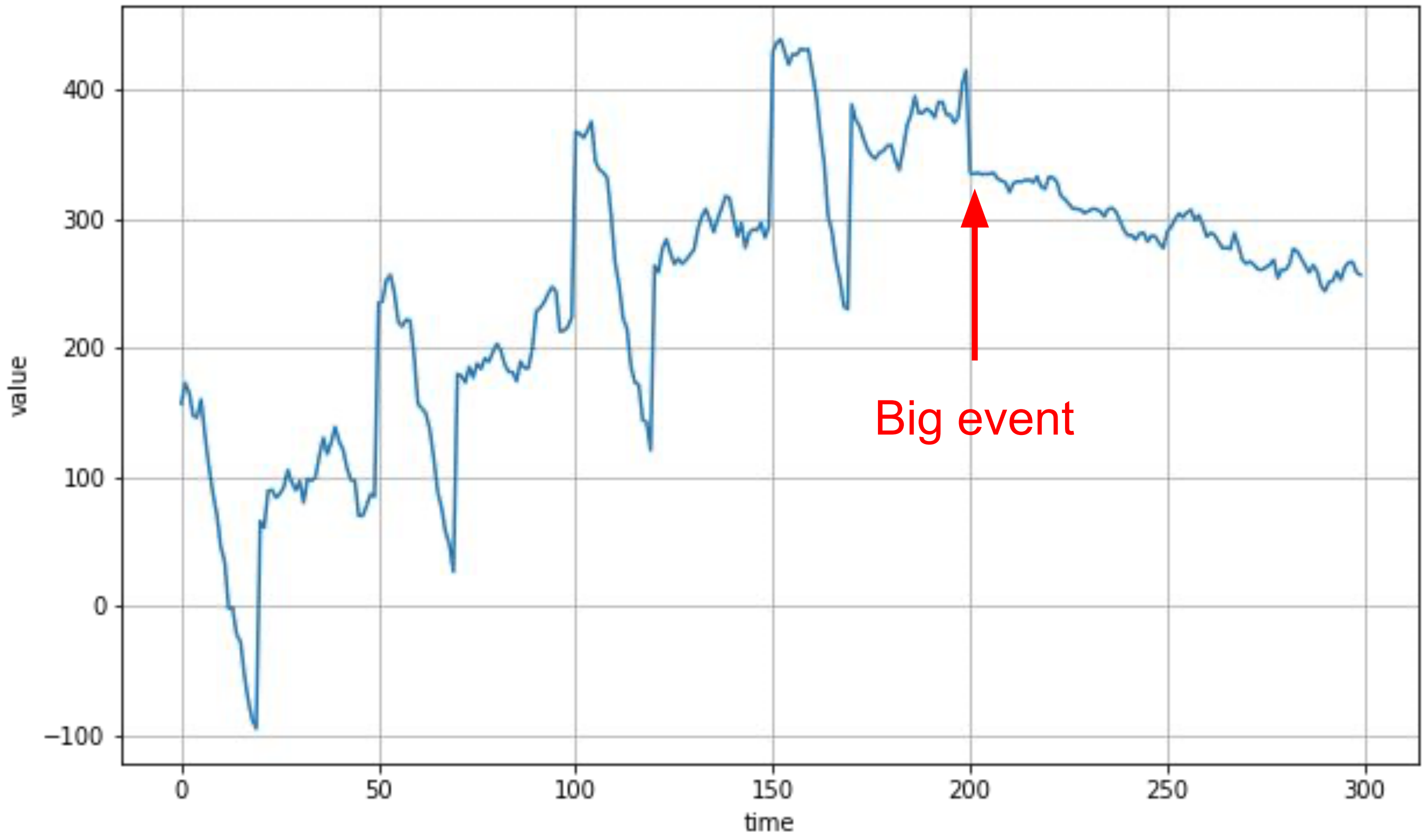
Trend + Seasonality + Autocorrelation + Noise



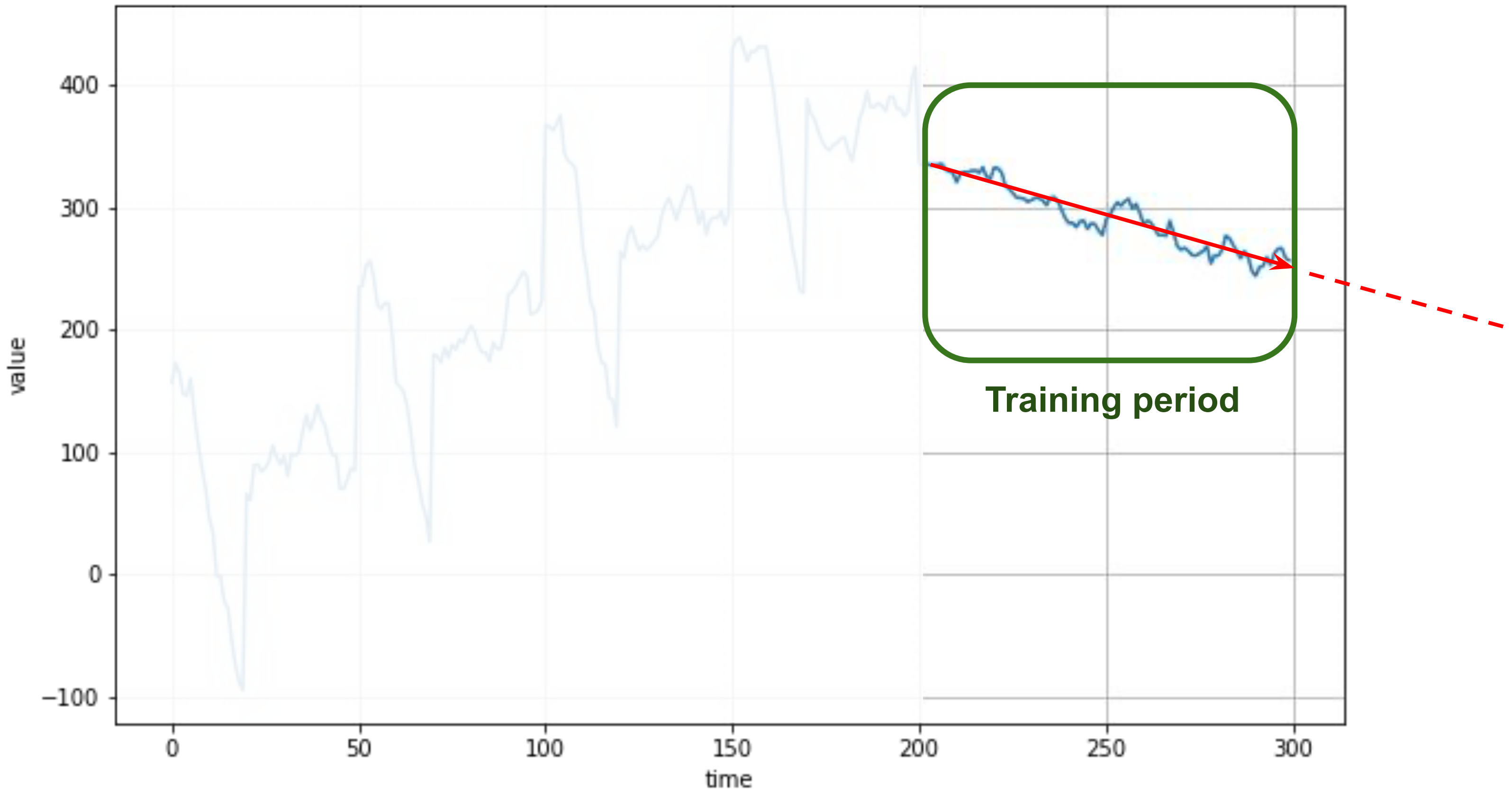
Forecast Learned Patterns



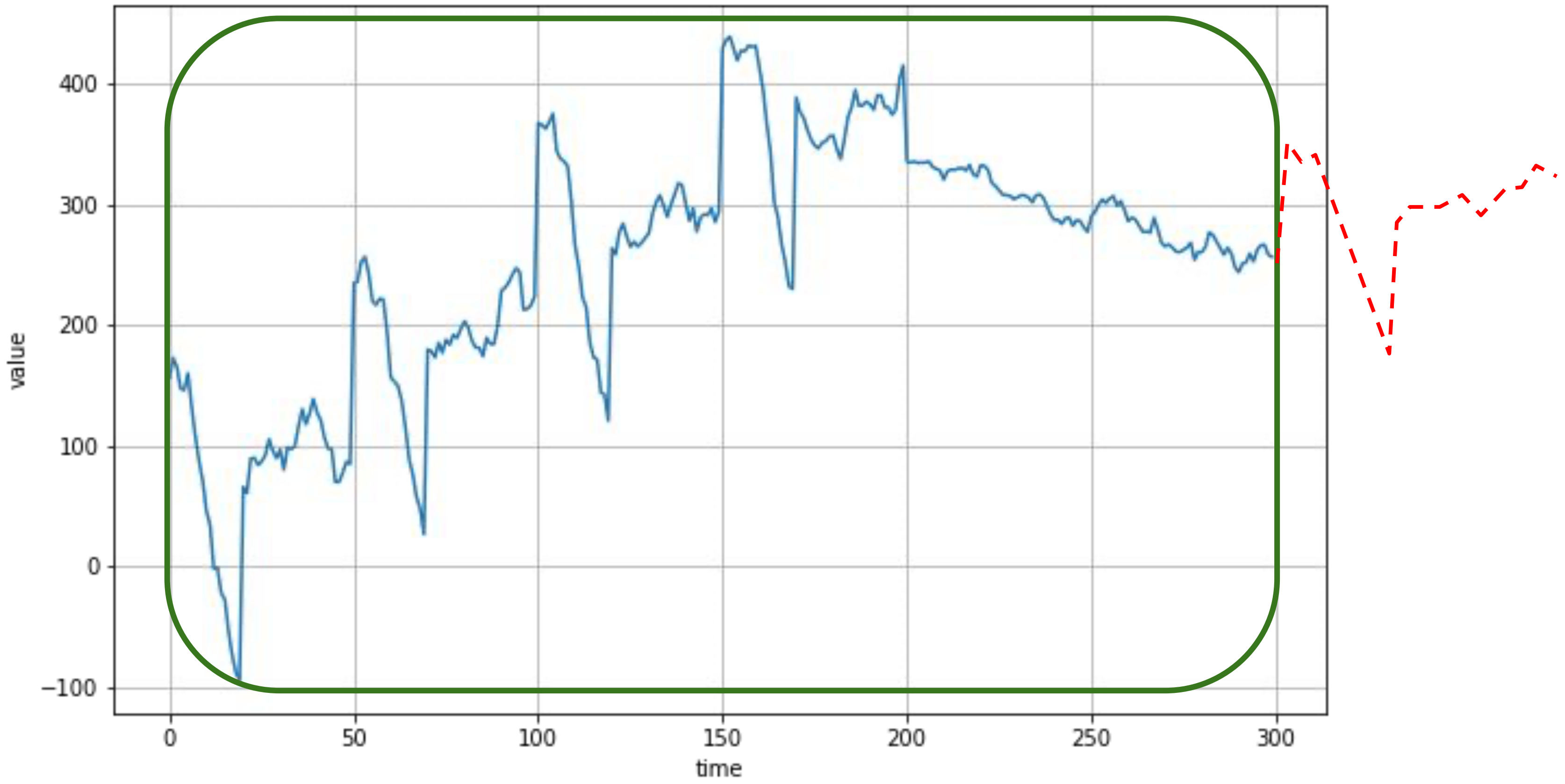
Non-Stationary Time Series



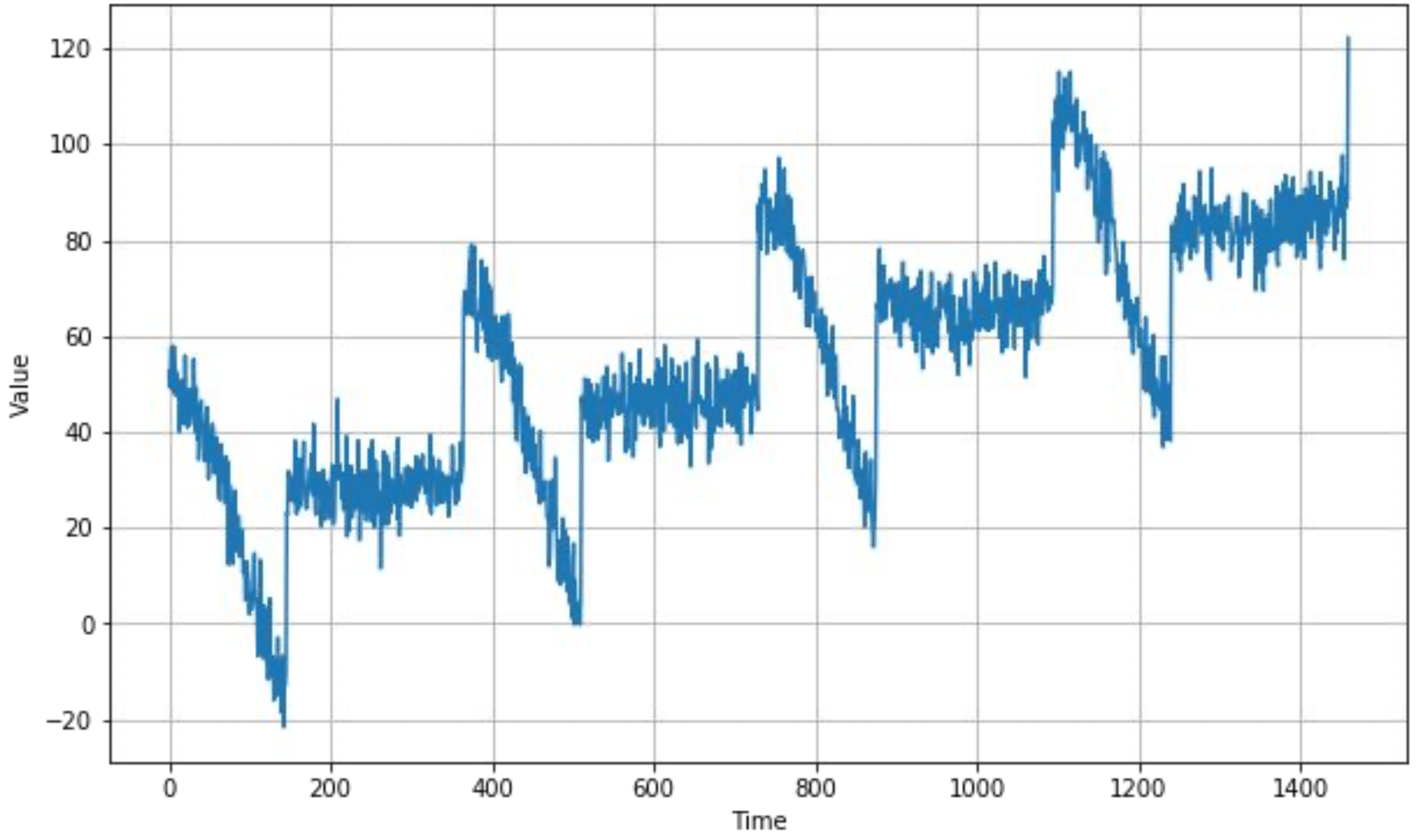
Non-Stationary Time Series



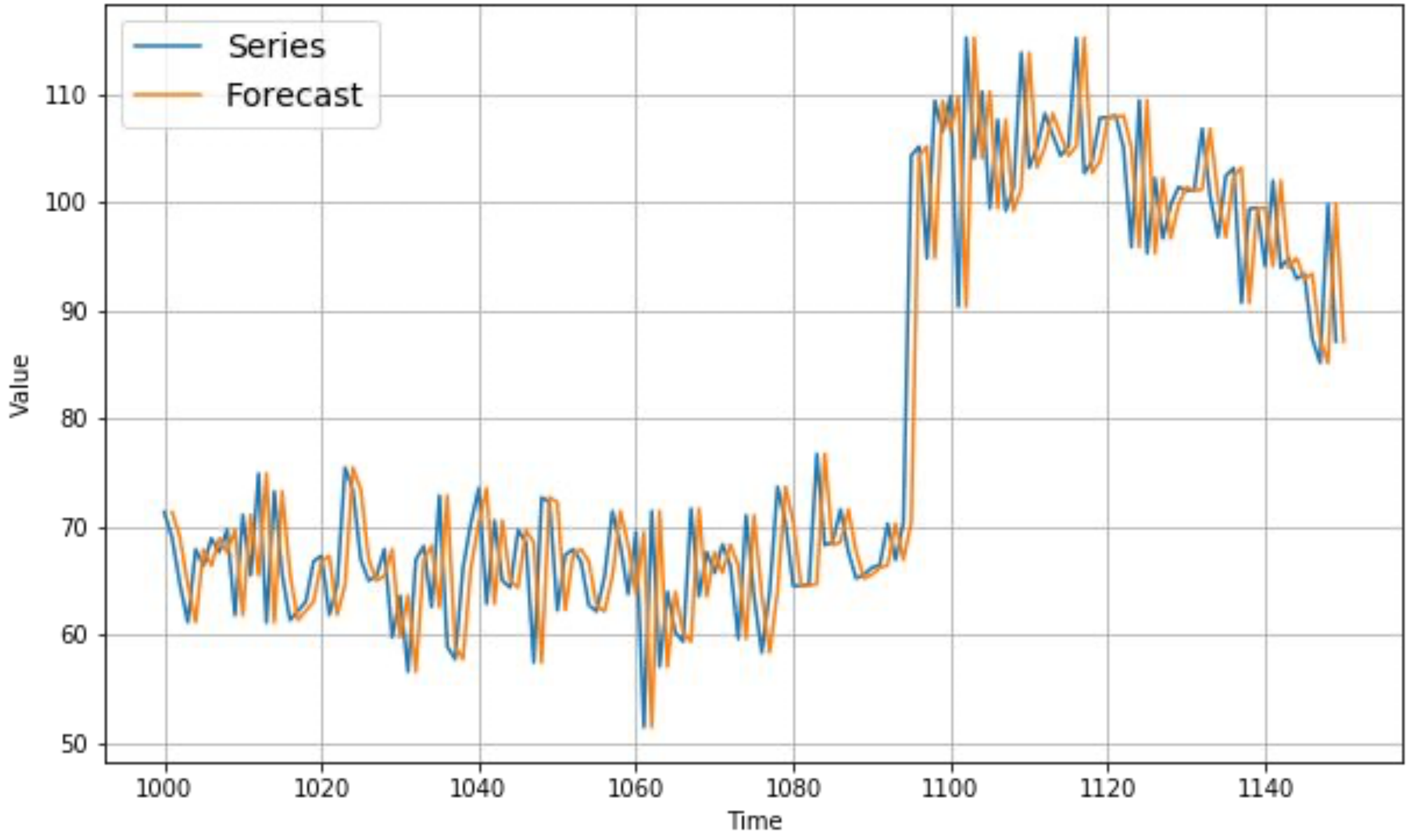
Non-Stationary Time Series



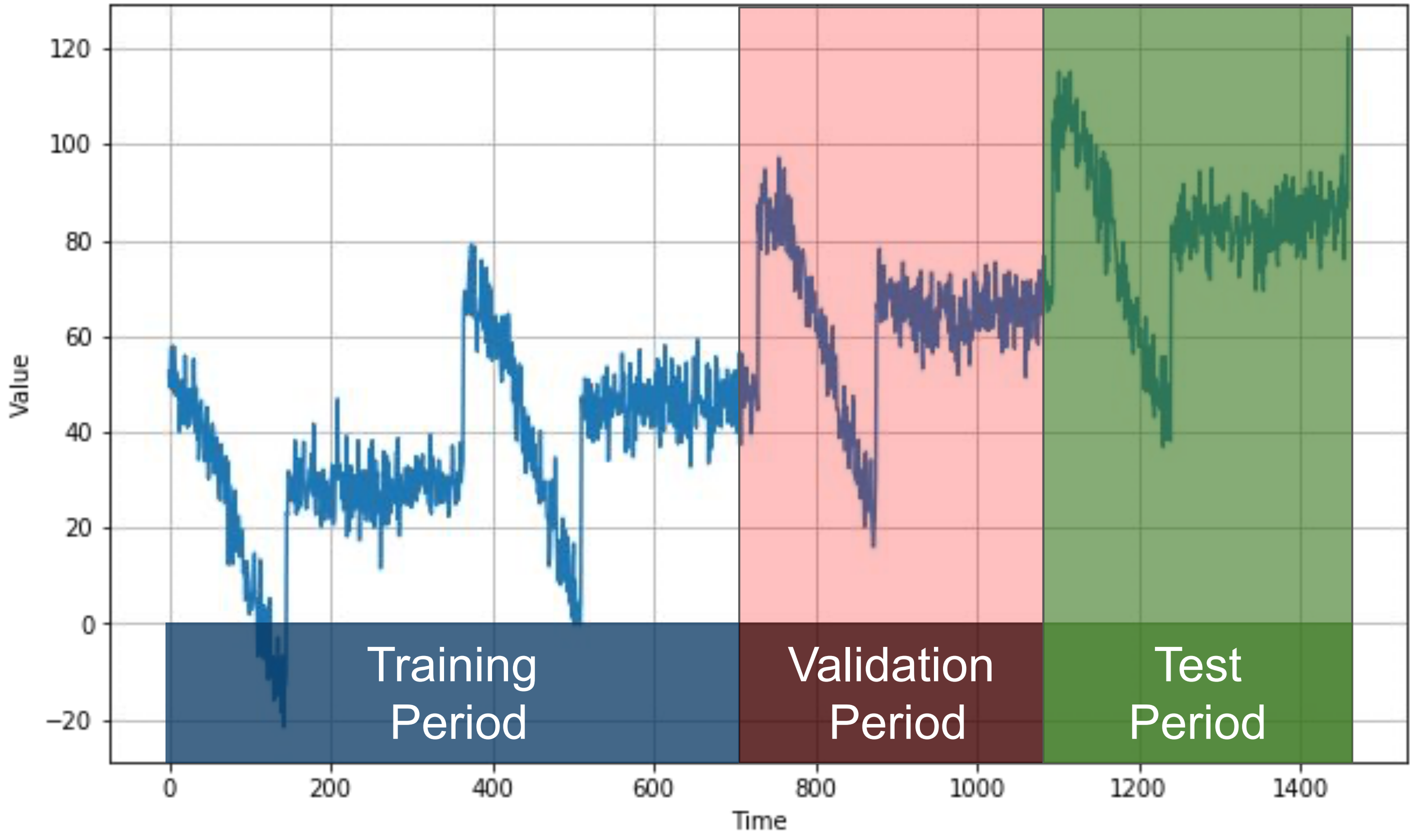
Trend + Seasonality + Noise



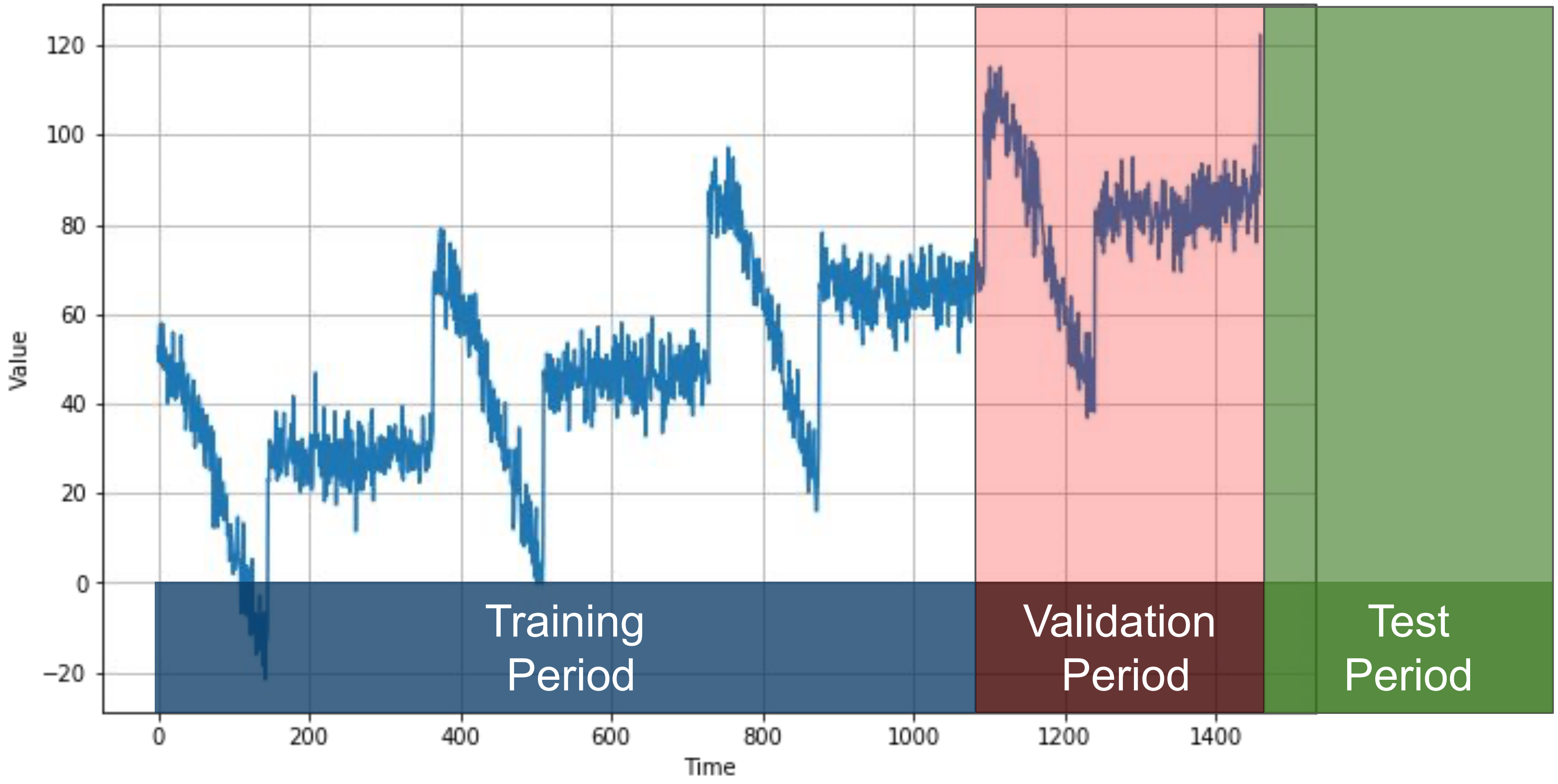
Naive Forecasting



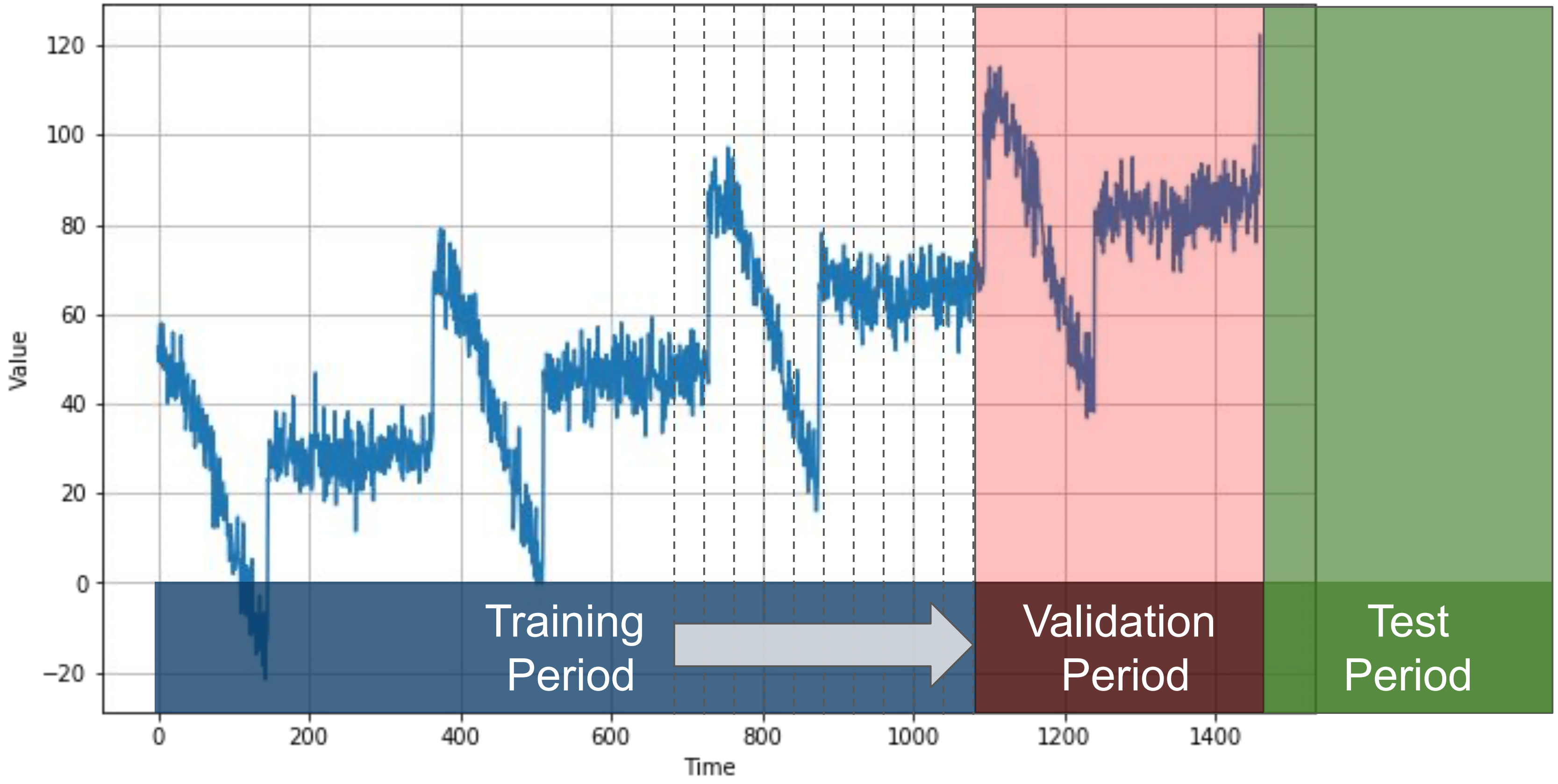
Fixed Partitioning



Fixed Partitioning



Roll-Forward Partitioning



```
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 - actual

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

rmse = np.sqrt(mse)

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

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

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

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

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

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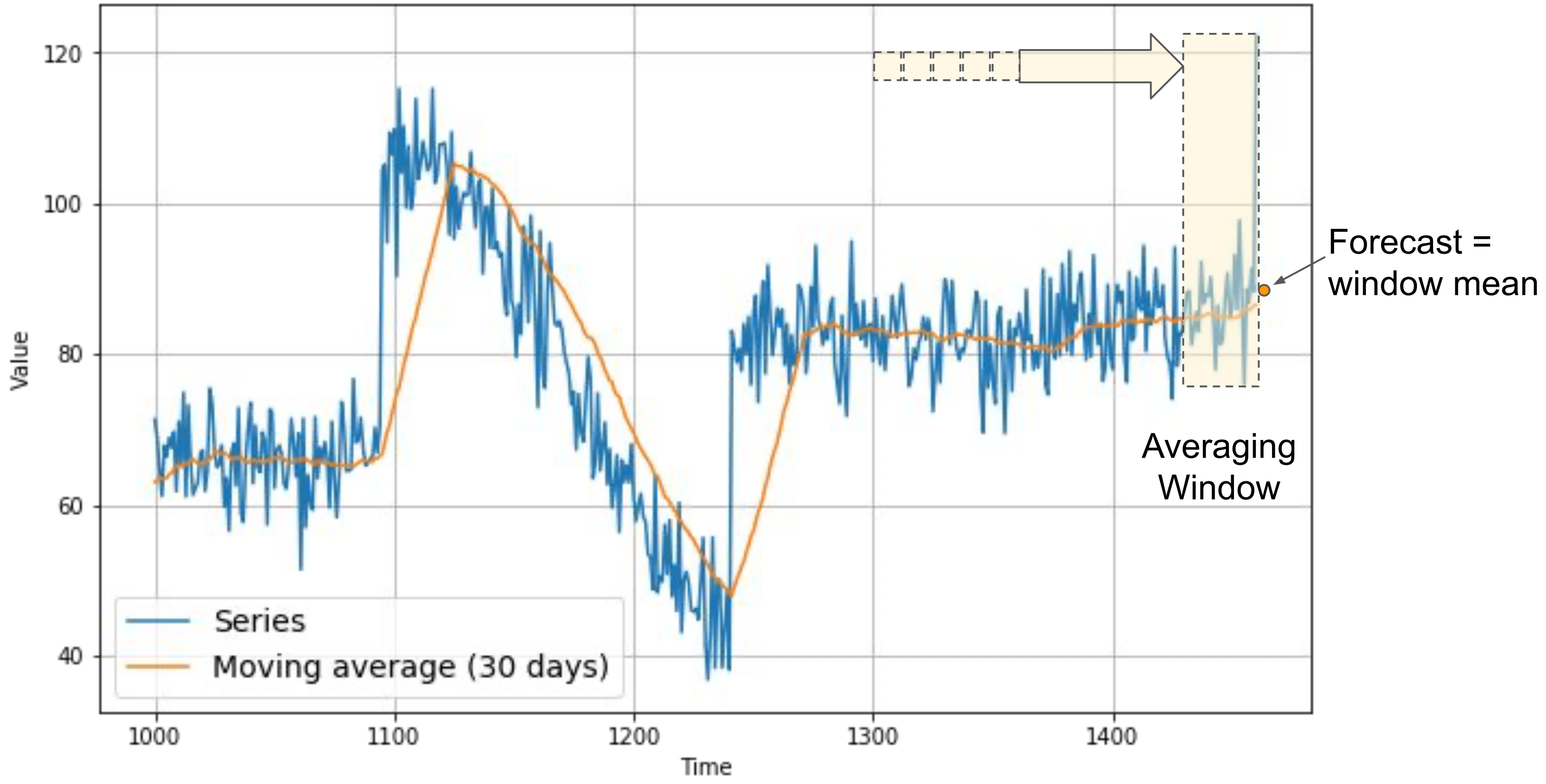
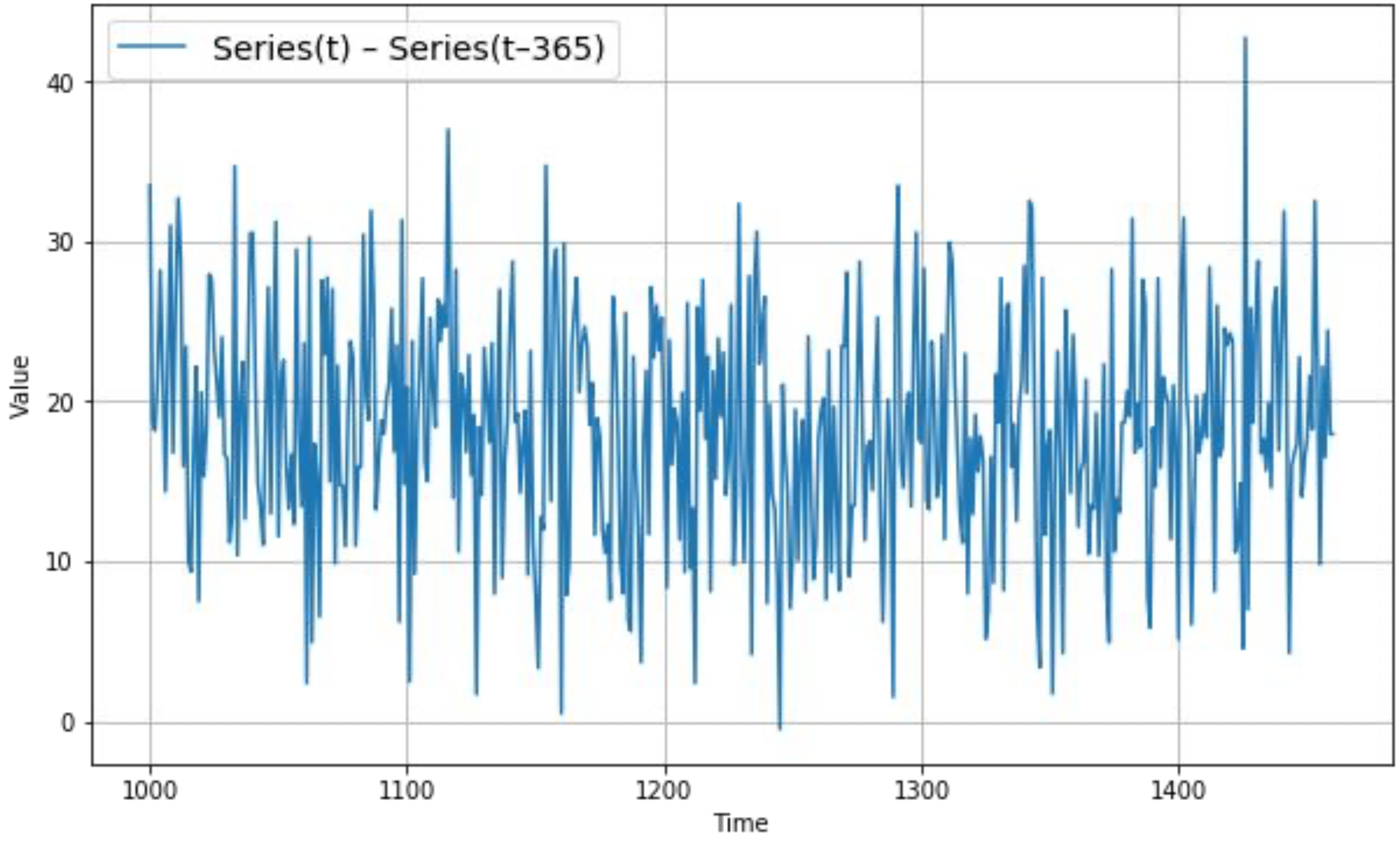
```
errors = forecasts - actual

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

rmse = np.sqrt(mse)

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

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

```
mae = tf.keras.metrics.mae(x_valid, naive_forecast).numpy()

5.937908515321673
```

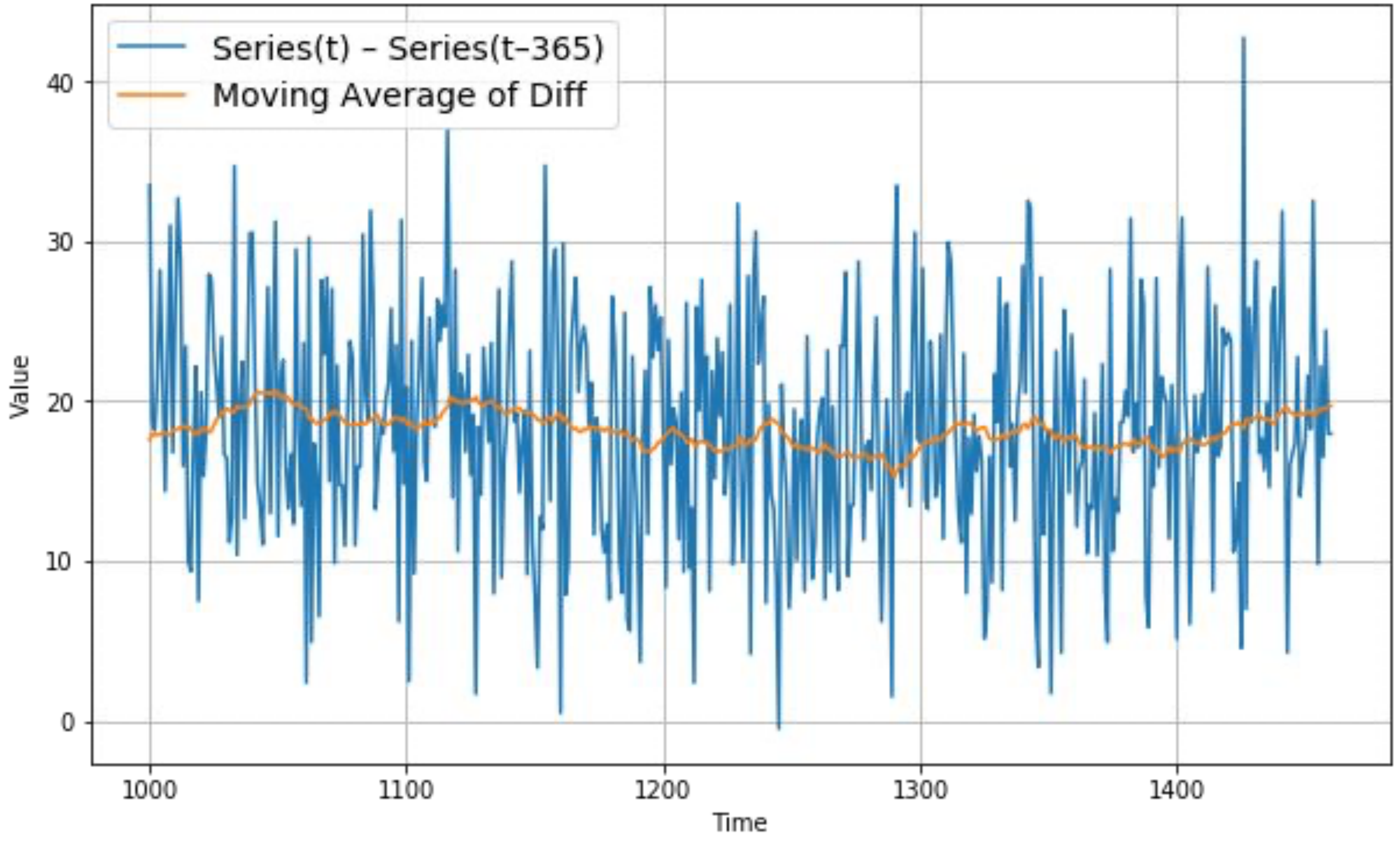
Moving Average



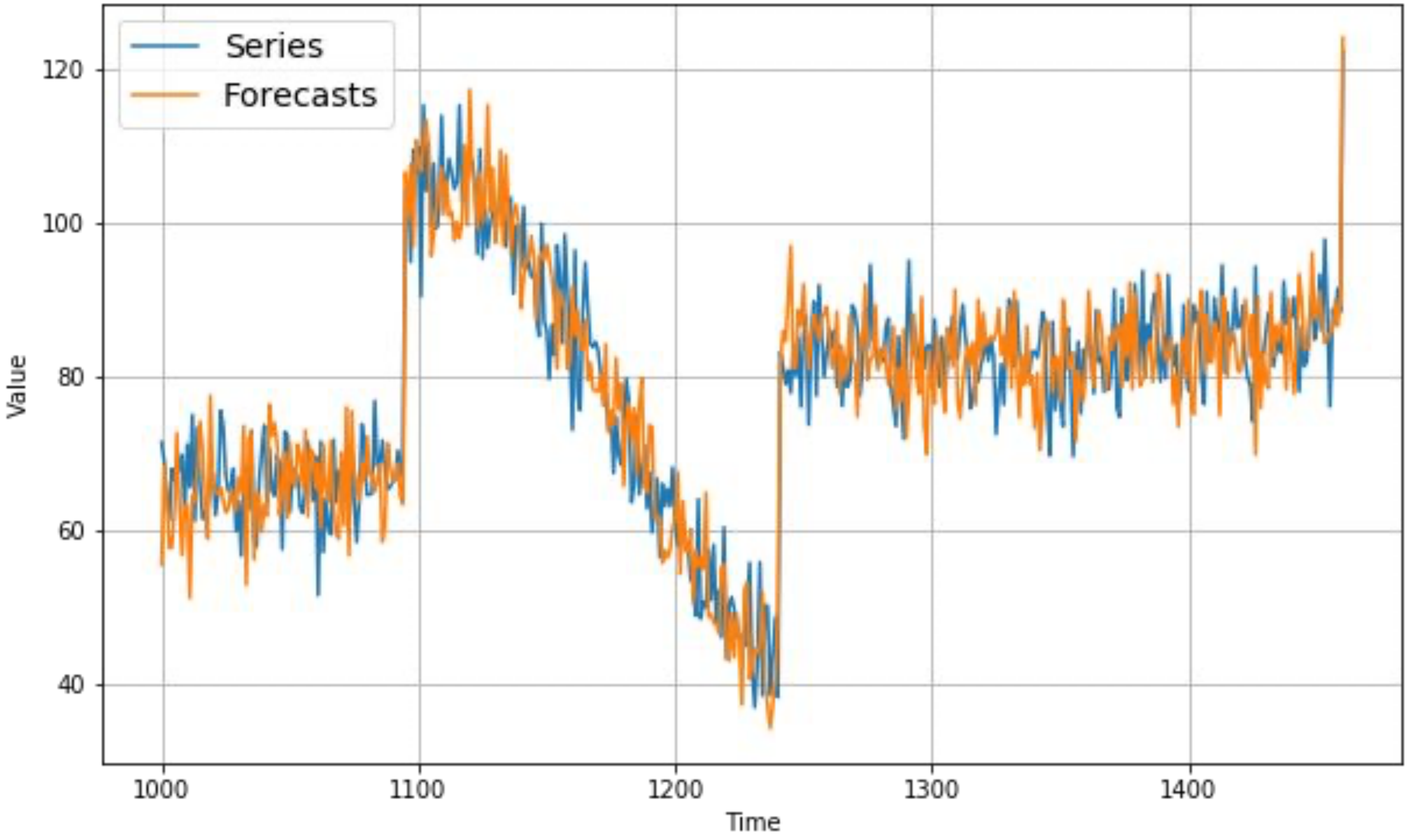
Differencing



Moving Average on Differenced Time Series

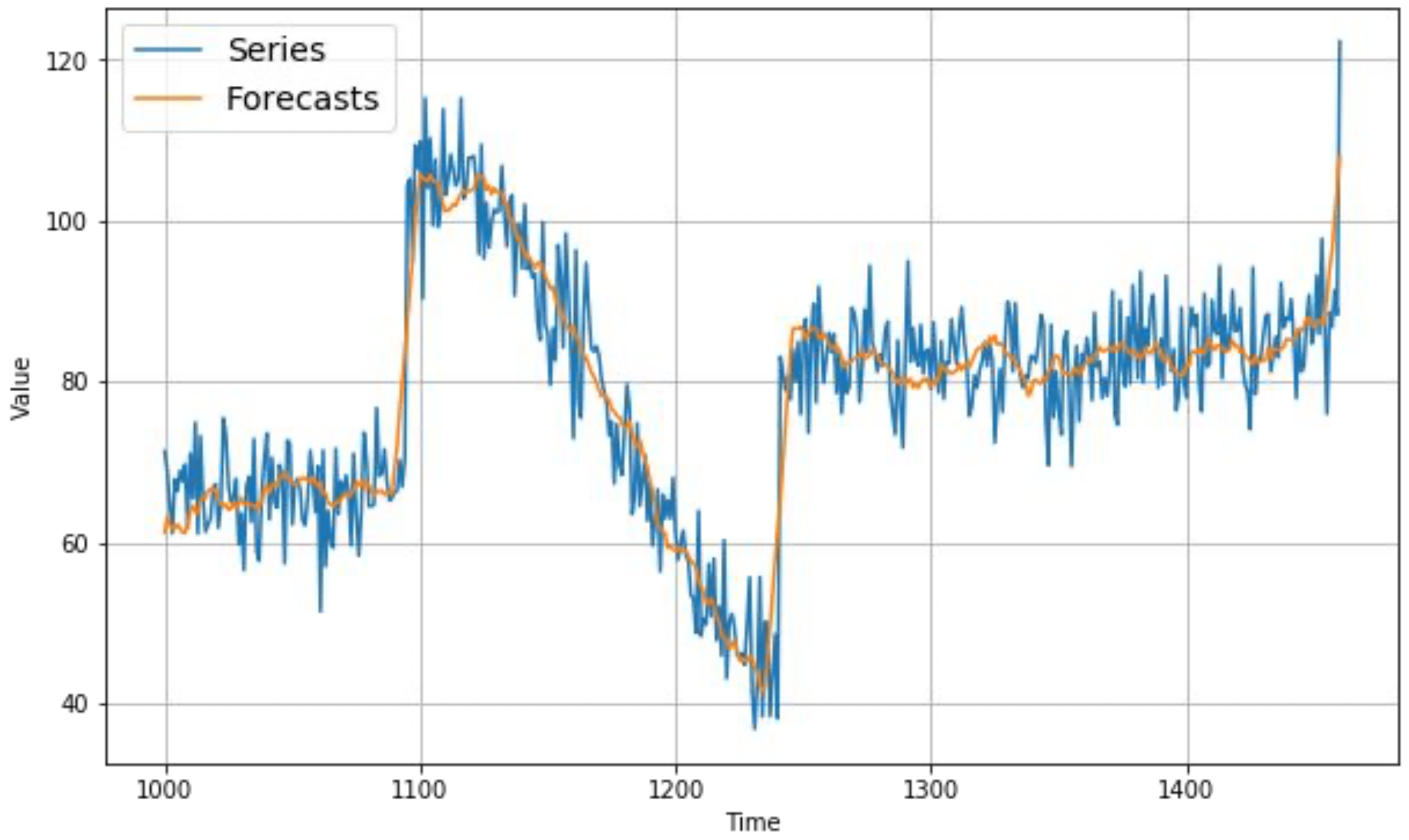


Restoring the Trend and Seasonality



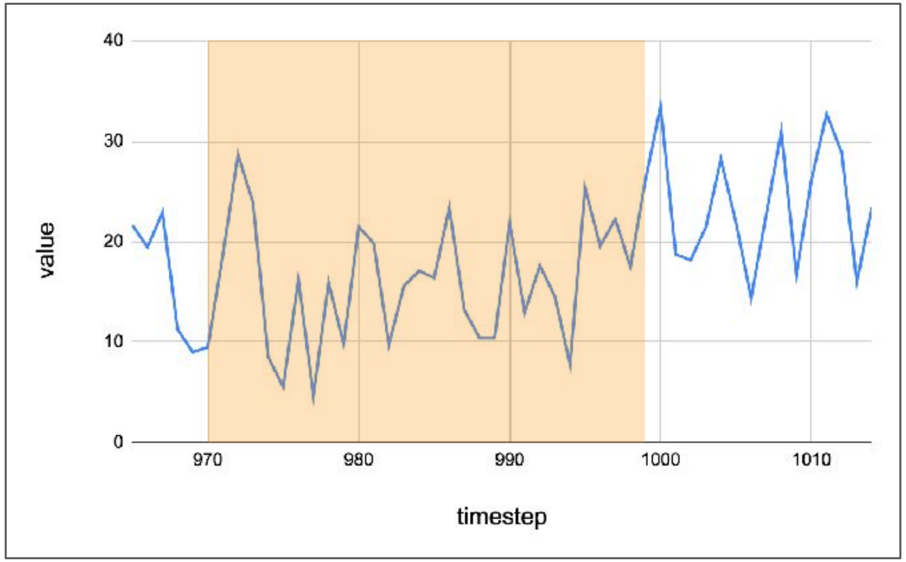
Forecasts = moving average of differenced series + series(t – 365)

Smoothing Both Past and Present Values

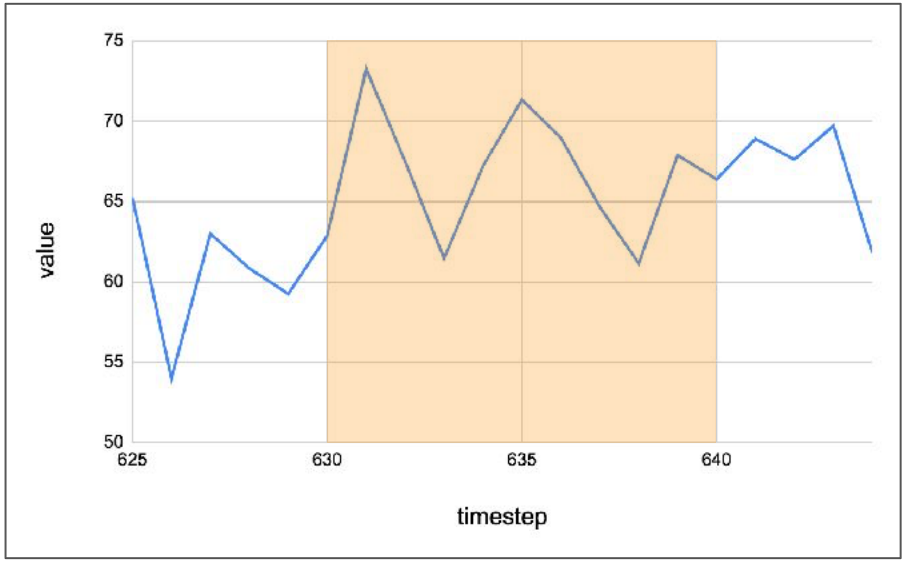


Forecasts = trailing moving average of differenced series + centered moving average of past series (t – 365)

Trailing Moving Average of Differenced Series
(zoomed at t_{1000}, window size = 30)



Centered Moving Average of Past Series (t - 365)
(zoomed at t_{635}, window size = 11)



$TMA_{t1000} = (v_{t970} + v_{t971} + v_{t972} + \dots v_{t999}) / 30$

$CMA_{t635} = (v_{t630} + v_{t631} + v_{t632} + \dots . v_{t640}) / 11$

$\longrightarrow$ forecast at $t_{1000} = TMA_{t1000} + CMA_{t635}$ $\longleftarrow$