



TIME SERIES ANALYSIS & FORECASTING

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SMOOTHING METHODS

MOVING AVERAGE (MA)

- Moving average comes in two flavors:

A– Equally weighted moving average(MA)

1. Trailing Moving Average:

calculated as the average of raw observations at, before and after time, t .

2. Centered Moving Average

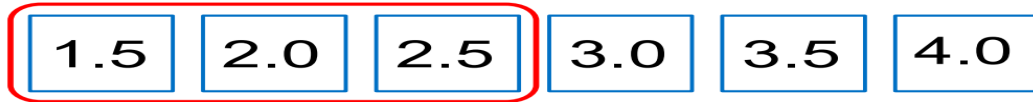
uses historical observations and is used on time series forecasting.

B– Weighted moving average (WMA)

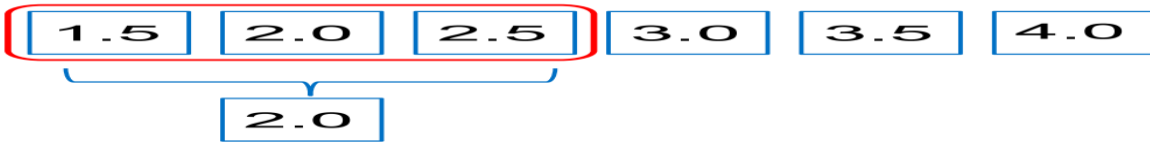
EQUALLY WEIGHTED MOVING AVERAGES

Centered moving average example

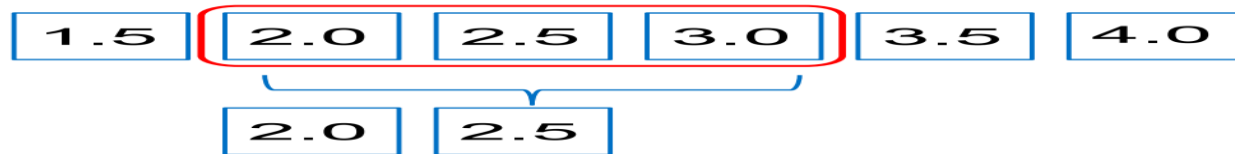
The first step in calculating moving average is to select a window size (we'll use 3).



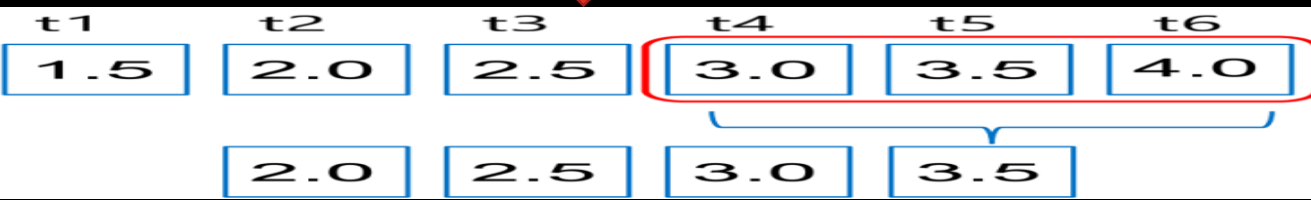
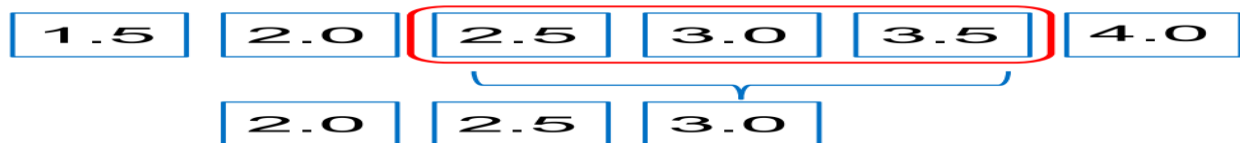
We slide the window over the first 3 values and calculate the mean within.



We slide the window over one place and calculate the new mean.

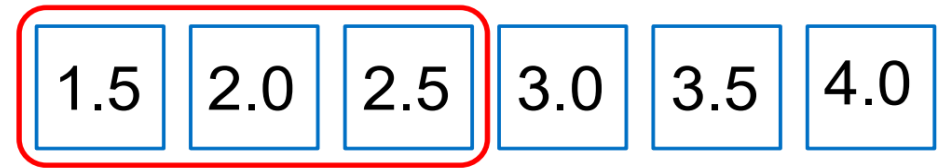


We continue this process until we reach the end.

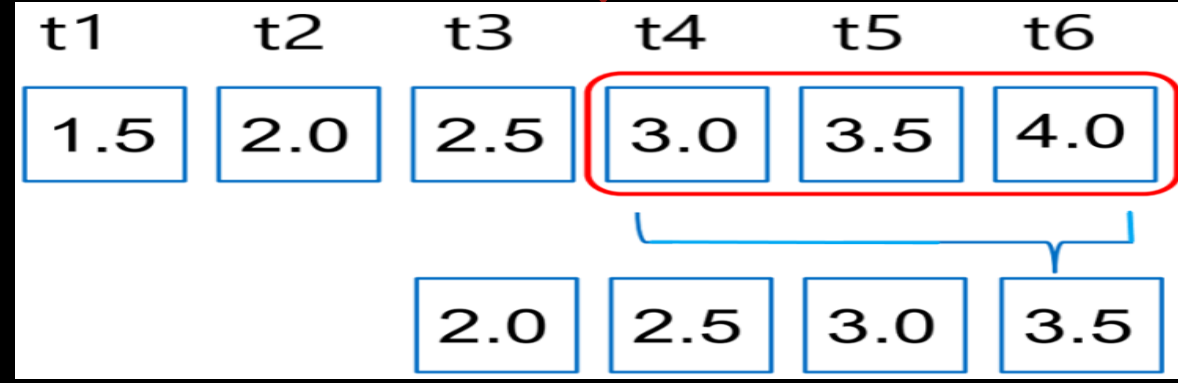
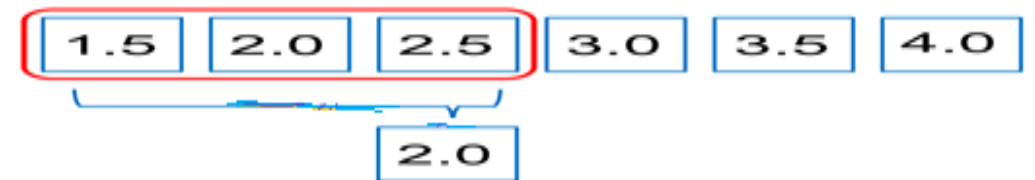


Trailing moving average example

The first step in calculating moving average is to select a window size (we'll use 3).

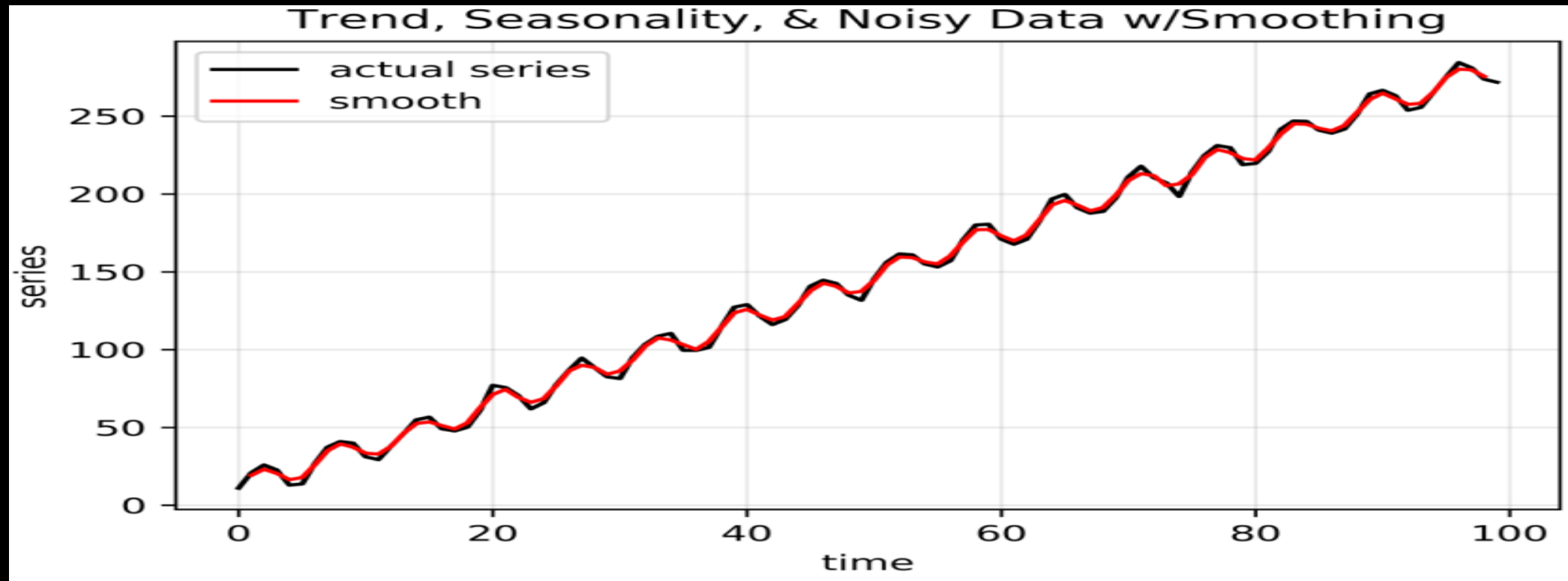


We slide the window over the first 3 values and calculate the mean within.



MOVING AVERAGE (MA)

We saw in all three cases that this simple moving average technique extracted the key pattern within the data.

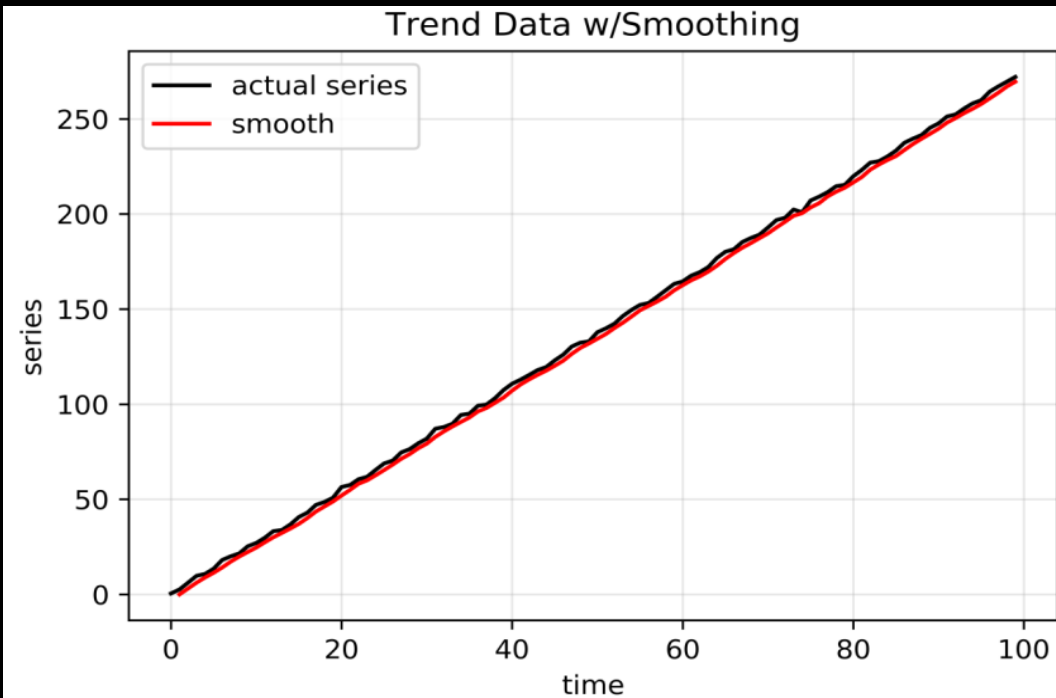


One with trend and seasonality

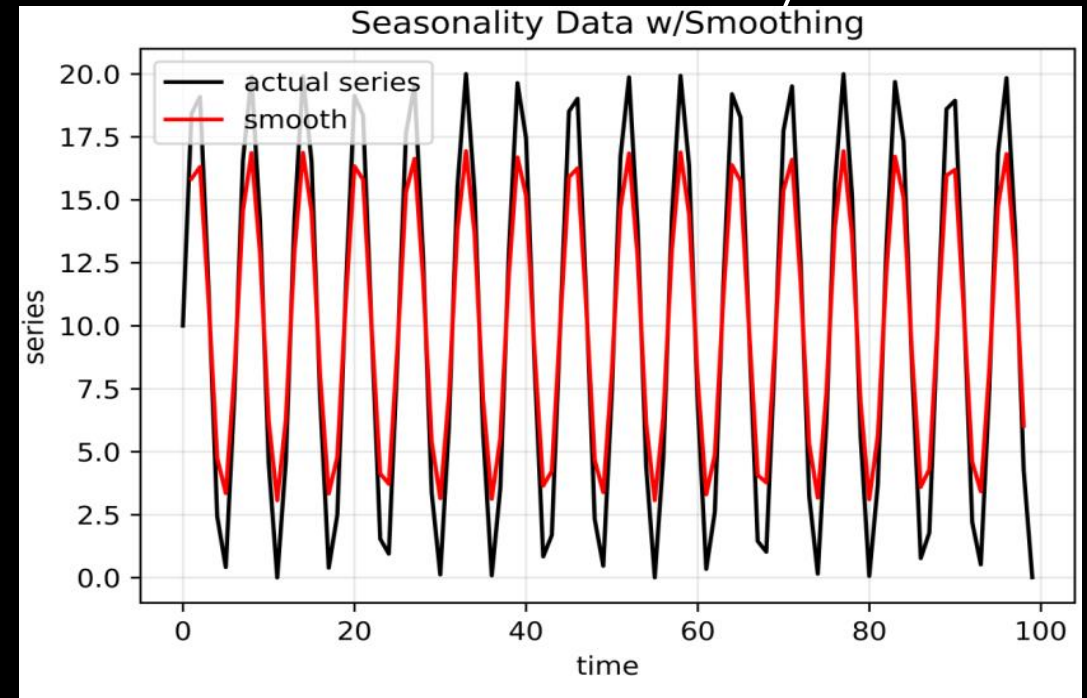
EQUALLY WEIGHTED MOVING AVERAGES

Let's apply this equally weighted moving average technique to three datasets:

- One with trend



- One with seasonality

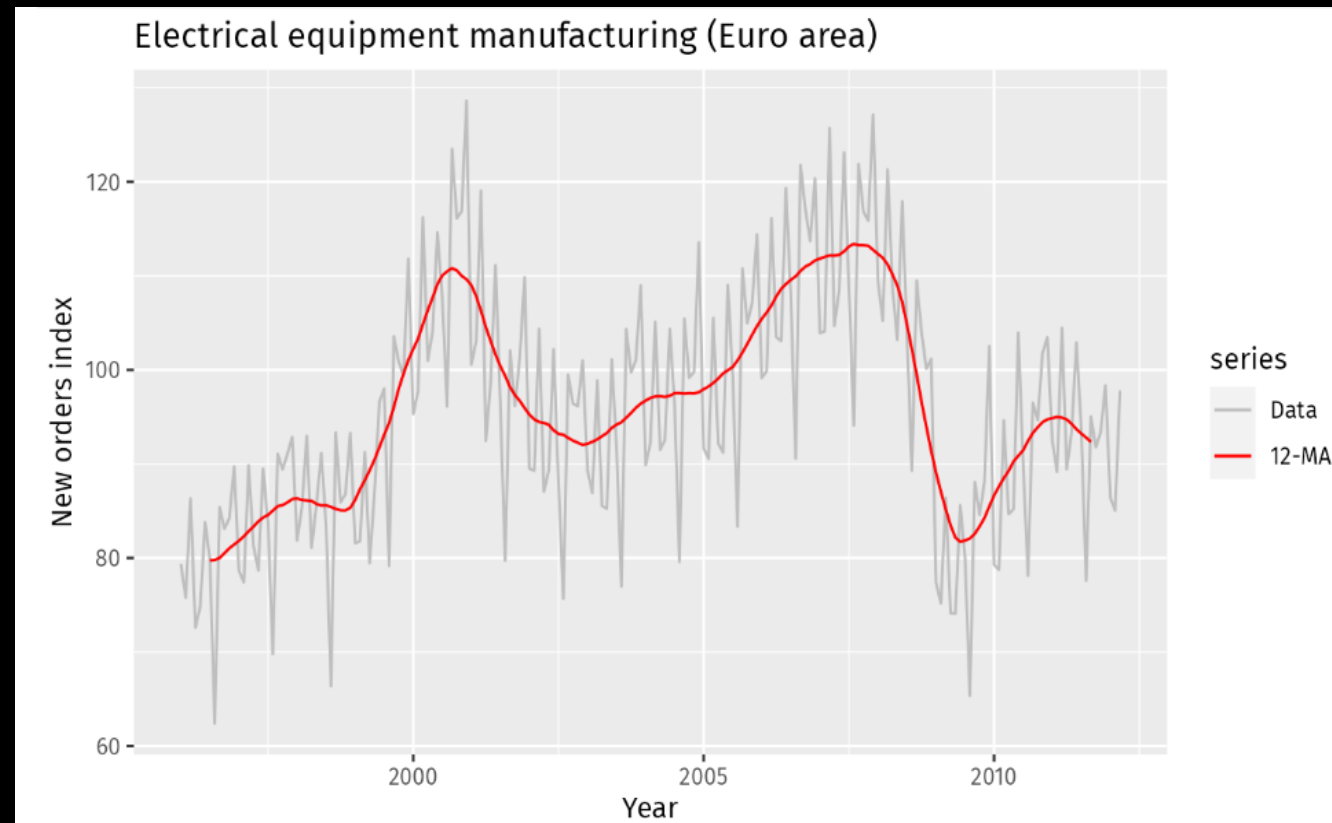


EQUALLY WEIGHTED MOVING AVERAGES

- Moving average represents the **trend-cycle** component.

-Any time series can be decomposed into 3 components: trend-cycle, seasonality and residuals. Since it is difficult to estimate trend and cycle components separately, we combine trend and cycle into one trend-cycle component.

[Source](#), [source2](#)



EQUALLY WEIGHTED MOVING AVERAGES

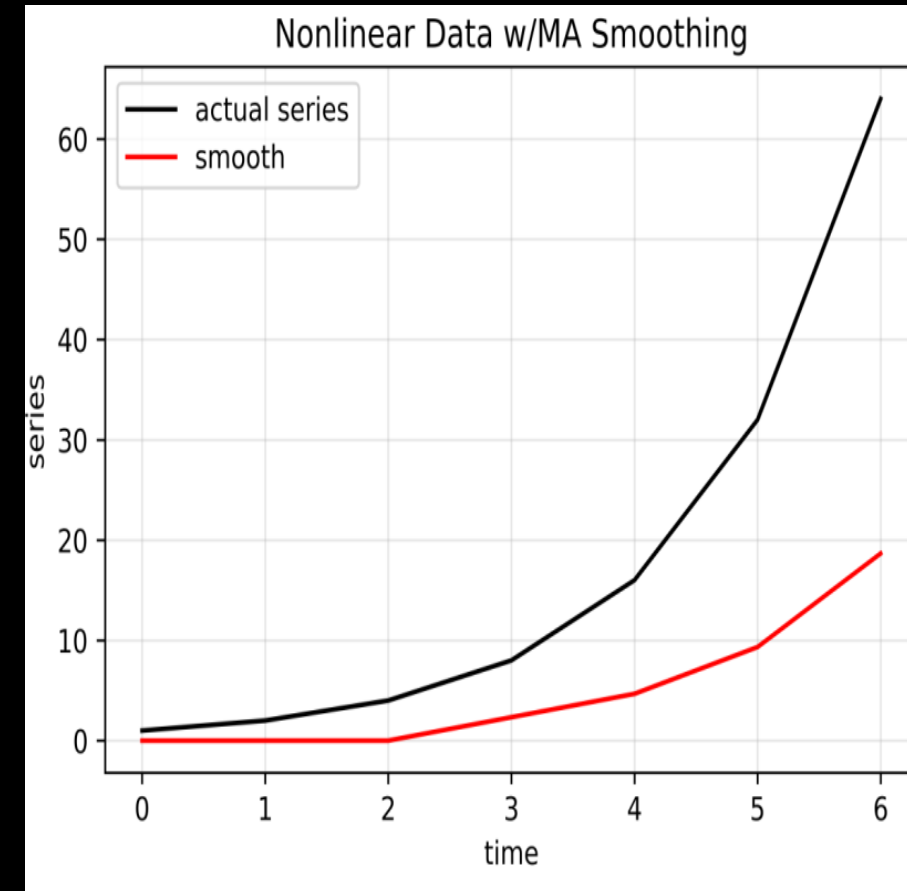
- **A few questions should come to mind:**

- How well does this method do from a forecasting perspective?
- Is equal weighting the best weighting scheme?

Equally Weighted Moving Average – Issues

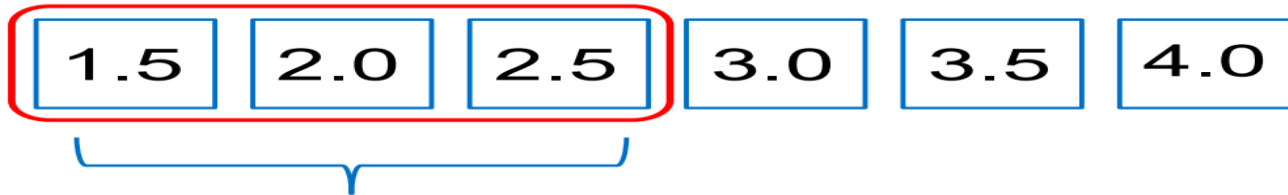
This technique clearly lags the trend. That becomes a bigger problem as the trend becomes more aggressive.

- Now is the time to explore another weighting scheme to see if we can do better.
- Next up is exponentially weighted moving average (sometimes known as single exponential smoothing).



WEIGHTED MOVING AVERAGE

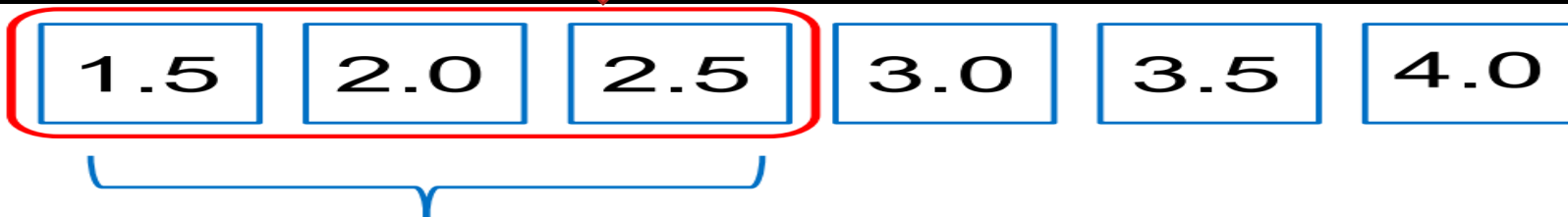
We slide the window over the first 3 values and calculate the mean but differently.



Instead of applying equal weights to all 3 observations, let's apply exponential weights.

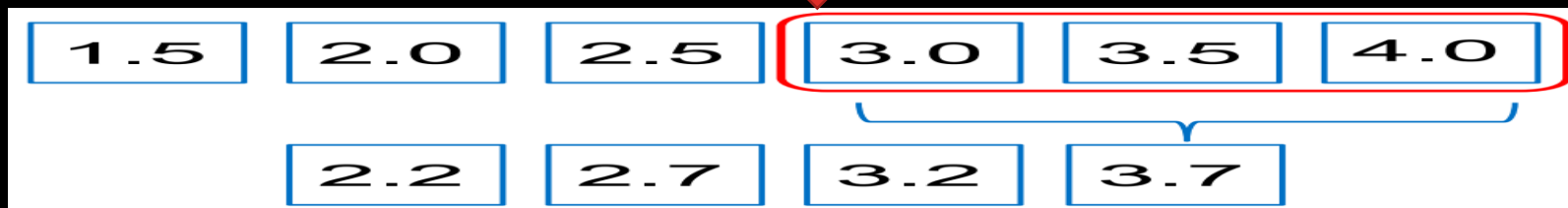
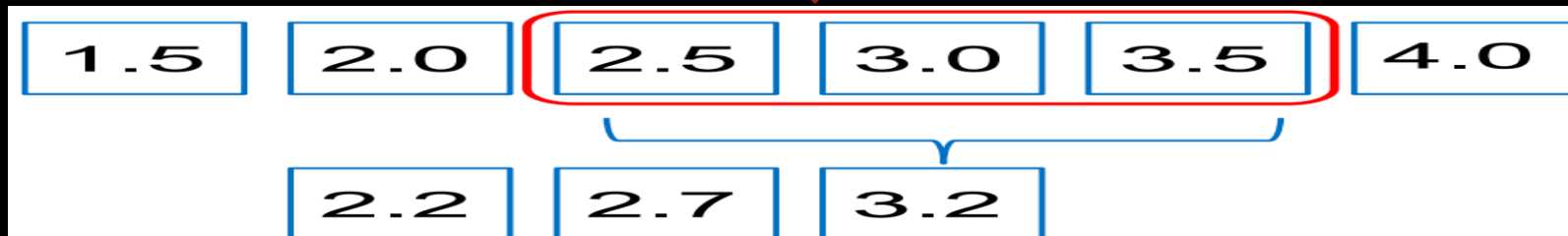
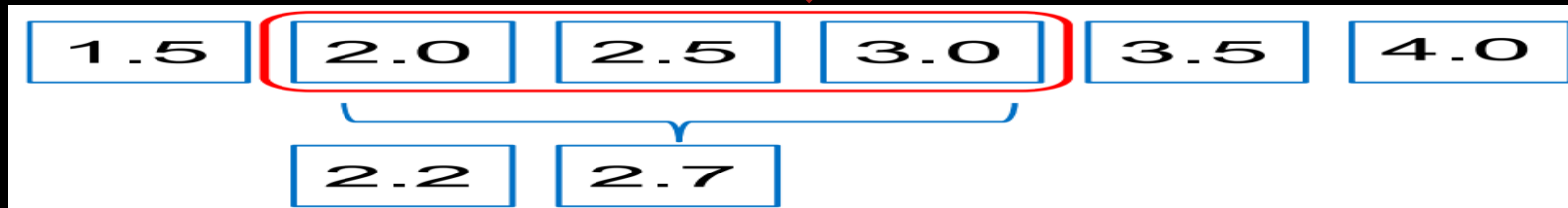
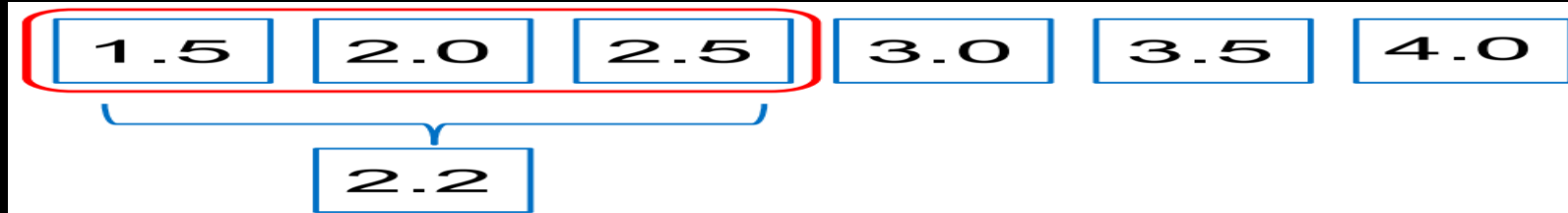
There are many ways to create exponential weights. To keep things simple, we'll leverage this simple formula:

$$w + w^2 + w^3 = 1$$
$$w = w_{t-1} \sim 0.543$$
$$w^2 = w_{t-2} \sim 0.294$$
$$w^3 = w_{t-3} \sim 0.160$$



$$(w_{t-3} \times 1.5) + (w_{t-2} \times 2.0) + (w_{t-1} \times 2.5) = 2.2$$

WEIGHTED MOVING AVERAGE

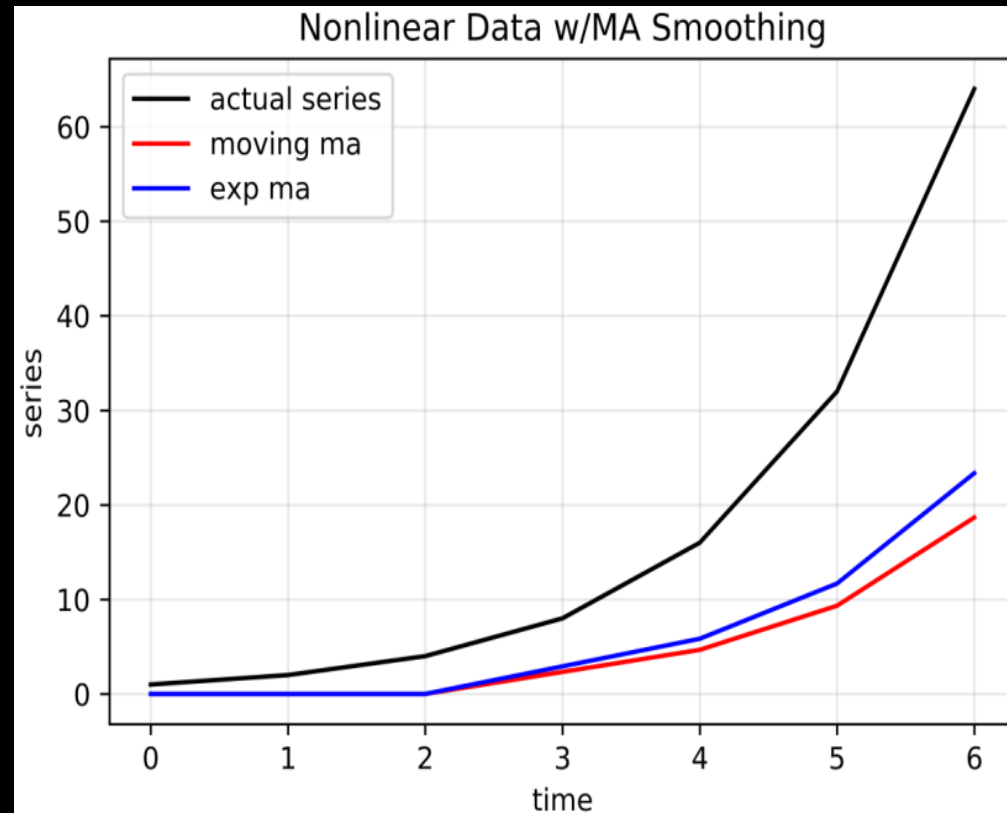


WEIGHTED MOVING AVERAGE

- Weighted moving average works by smoothing the series as a whole.

Now that you know how it works, a few questions should come to mind:

- Do you think this method will do a better job forecasting than equally weighted moving average?
- Is exponentially weighted smoothing sufficient for forecasting in general?



WEIGHTED MOVING AVERAGE – ISSUES

Comparing exponentially weighted moving average to equally weighted moving average:

- Exponential is more sensitive to local changes.
- However, it still lags significantly.
- Therefore, we need to explore more complex forecasting mechanisms that leverage smoothing.