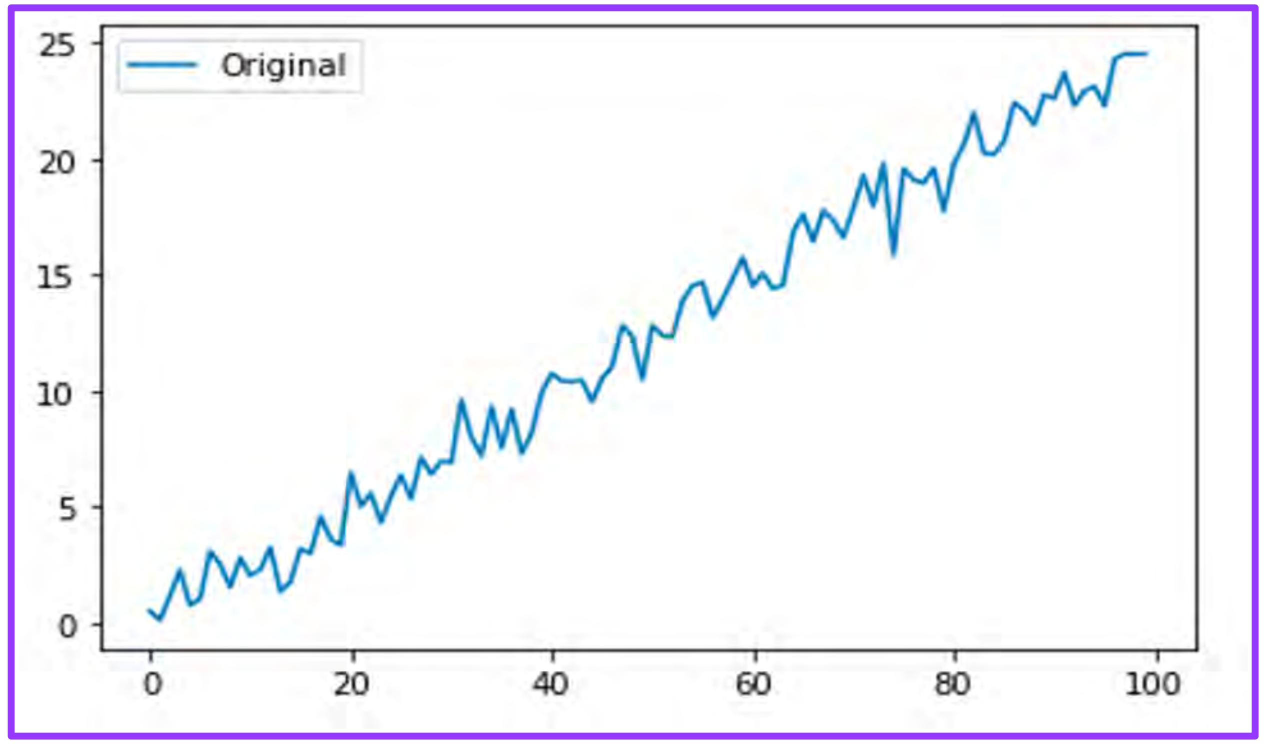
Smoothing

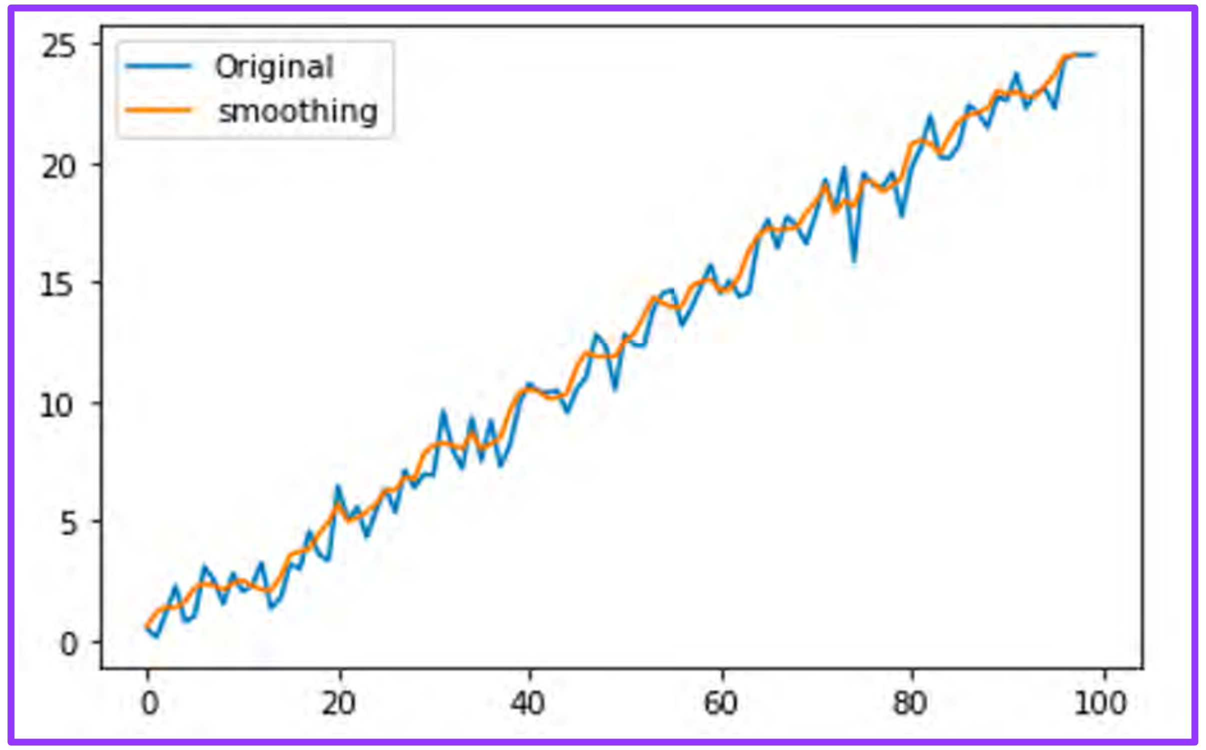
Intro

- time series transformation
- smoothing
  - moving average
  - exponential moving average
    - single
    - double
    - triple

SMOOTHING

- smoothing is a simple method for reducing noise in the data
- can also be used to provide simple forecasts





Moving average

$$s_t = \frac{x_t + x_{t-1} + \ldots + x_{t-n+1}}{n}$$

5.0	5.0	6.000000	9.000000	0.000	6.0000	5.000000	9.000000	4.00000	4.000000

$n = 3$

5.333333	6.666667	5.000	5.0000	3.666667	6.666667	6.00000	5.666667

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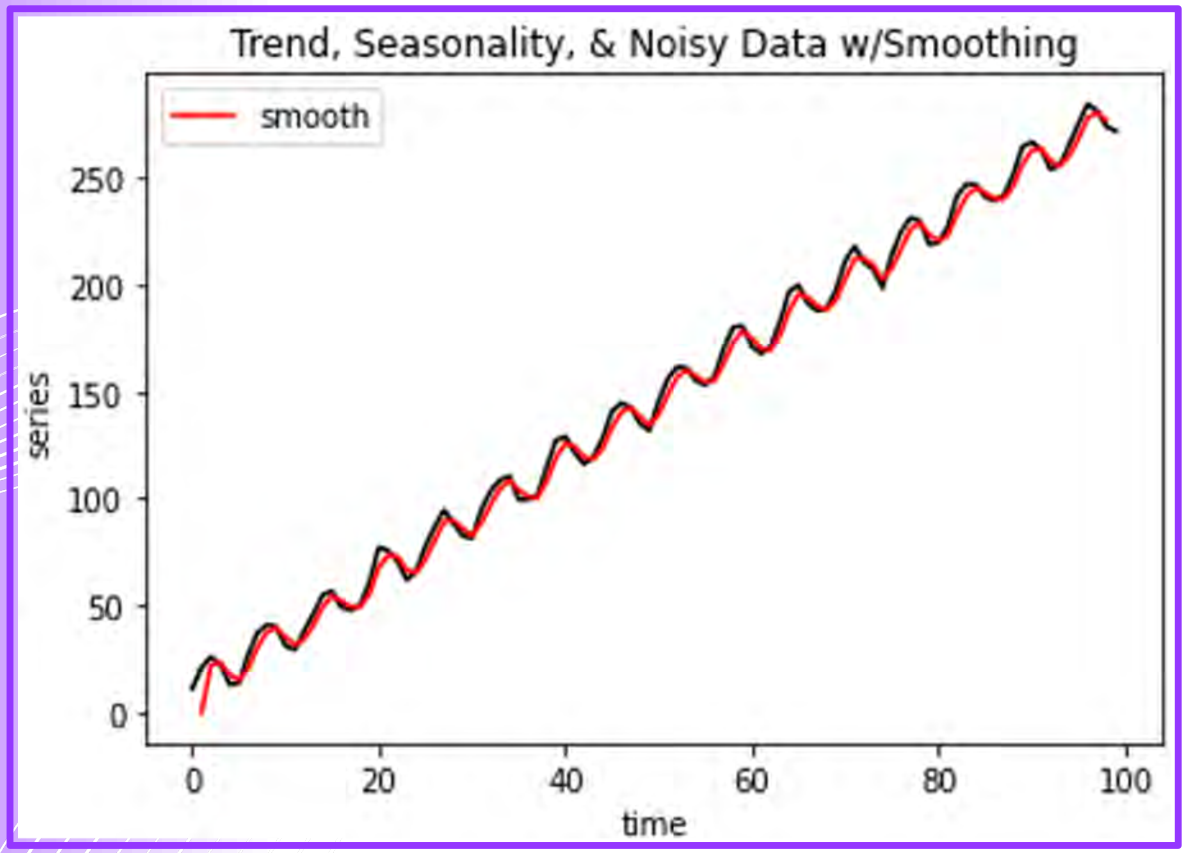
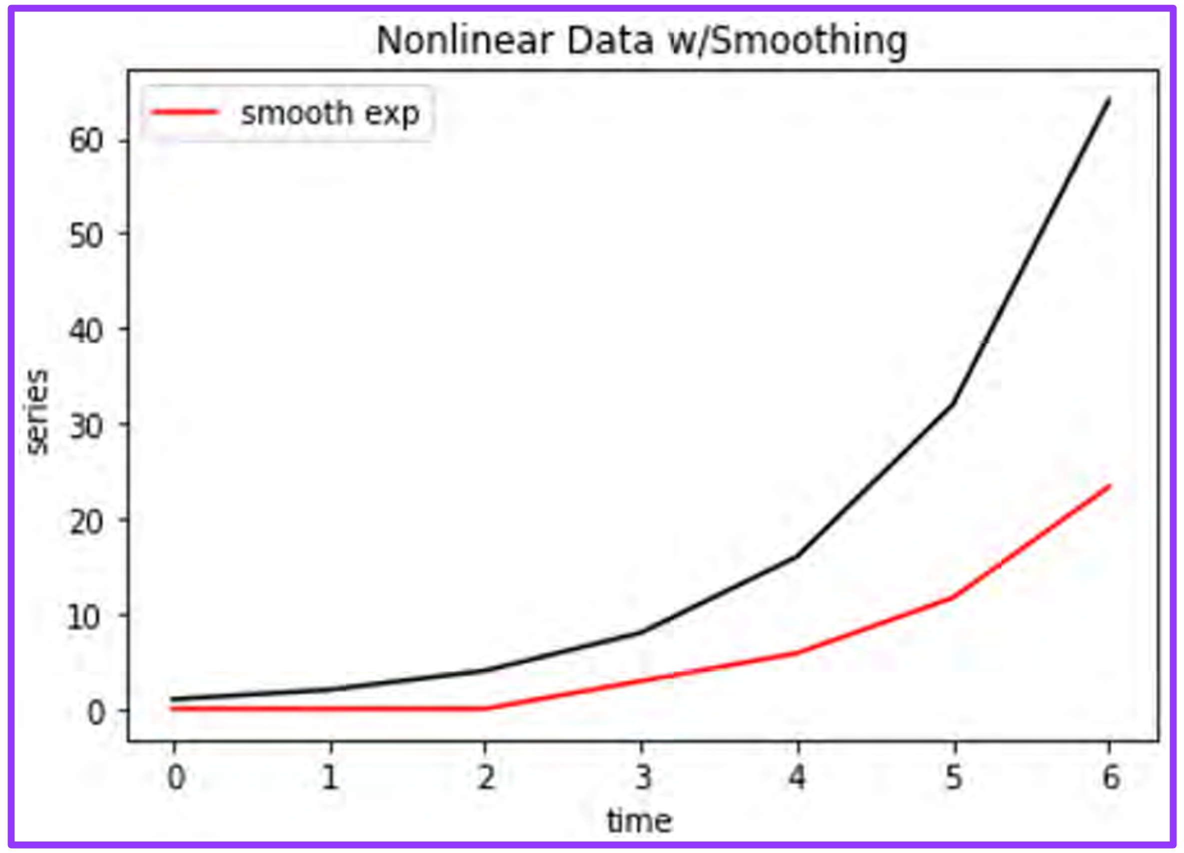
Moving average

- weights every data point equally
- cannot track exponential growth well





Exponential Moving average

$$s_0 = x_0$$
$$s_t = \alpha x_t + (1 - \alpha) s_{t-1}$$

$$\alpha = 0.1$$

X	5.0	6.0	9.0	0.0	6.0	5.0	9.0	4.0	4.0	
S	5.0	5.1	5.490000	4.941	5.0469	5.042210	5.437989	5.29419	5.164771	

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Single exponential moving average

$$s_0 = x_0$$

$$s_t = \alpha x_t + (1-\alpha)s_{t-1}$$

- to provide varying weights to recent values
- Expanded equation can be used for recursively forecasting future values

$$s_t = \alpha x_t + \alpha(1-\alpha)x_{t-1} + \alpha(1-\alpha)^2 x_{t-2} + \ldots + (1-\alpha)^t x_0$$

s_t = Smooth the value at time **t**

x_t = Actual value at time **t**

α = Parameter optimized to fit past data

Double exponential moving average

$$s_t = \alpha x_t + (1-\alpha)(s_{t-1} + b_{t-1})$$

Smooth the **value** of the series

$$b_t = \beta(s_t - s_{t-1}) + (1-\beta)b_{t-1}$$

Smooth the **trend** of the series

$$\hat{x}_{t+1} = s_t + b_t$$

Future prediction of the series = sum of value and trend

Triple exponential moving average

$$s_t = \alpha(x_t - c_{t-L}) + (1 - \alpha)(s_{t-1} + b_{t-1})$$

Smooth the **value** of the series

$$b_t = \beta(s_t - s_{t-1}) + (1 - \beta)b_{t-1}$$

Smooth the **Trend** of the series

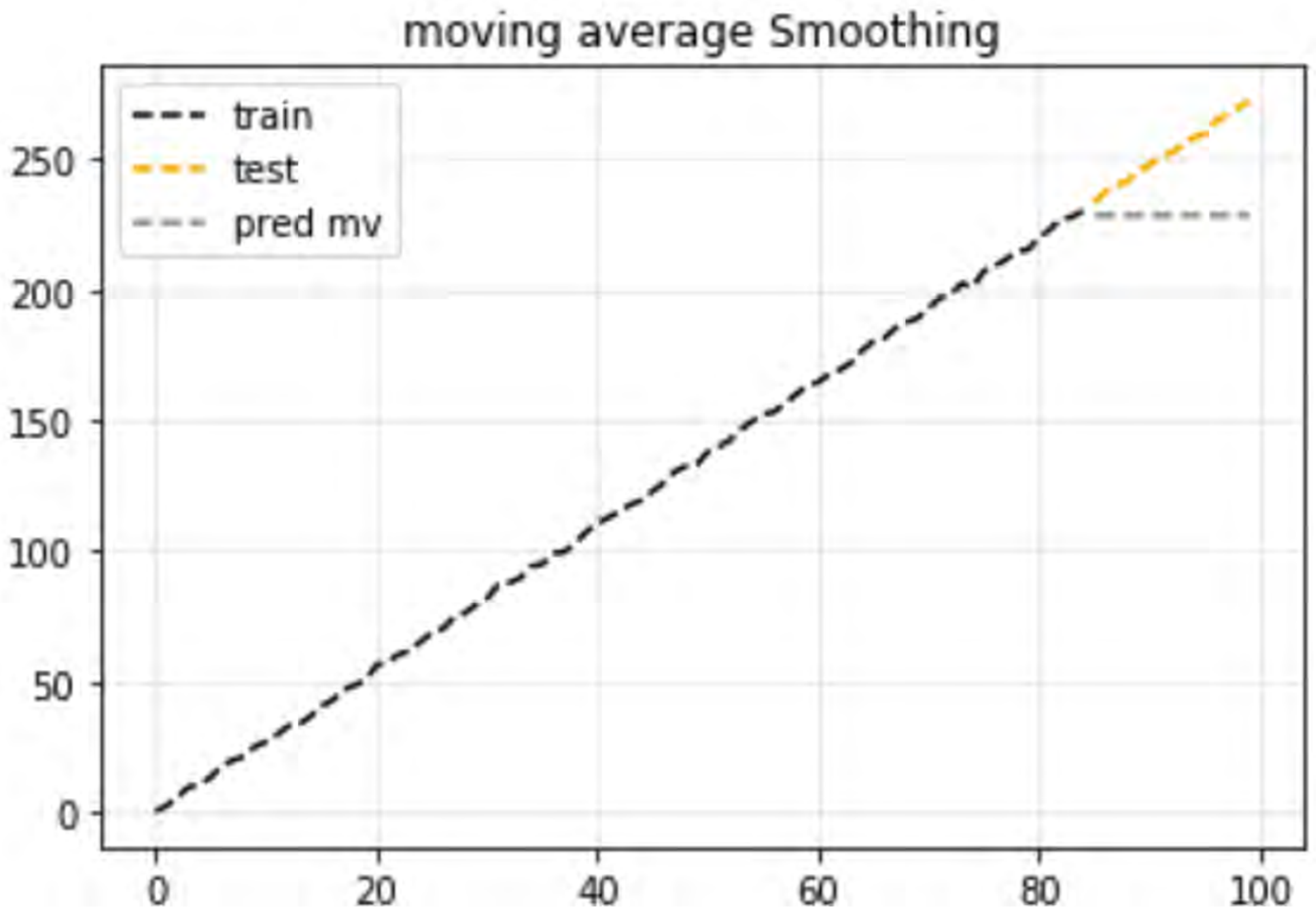
$$c_t = \gamma(x_t - s_{t-1} - b_{t-1}) + (1 - \gamma)c_{t-L}$$

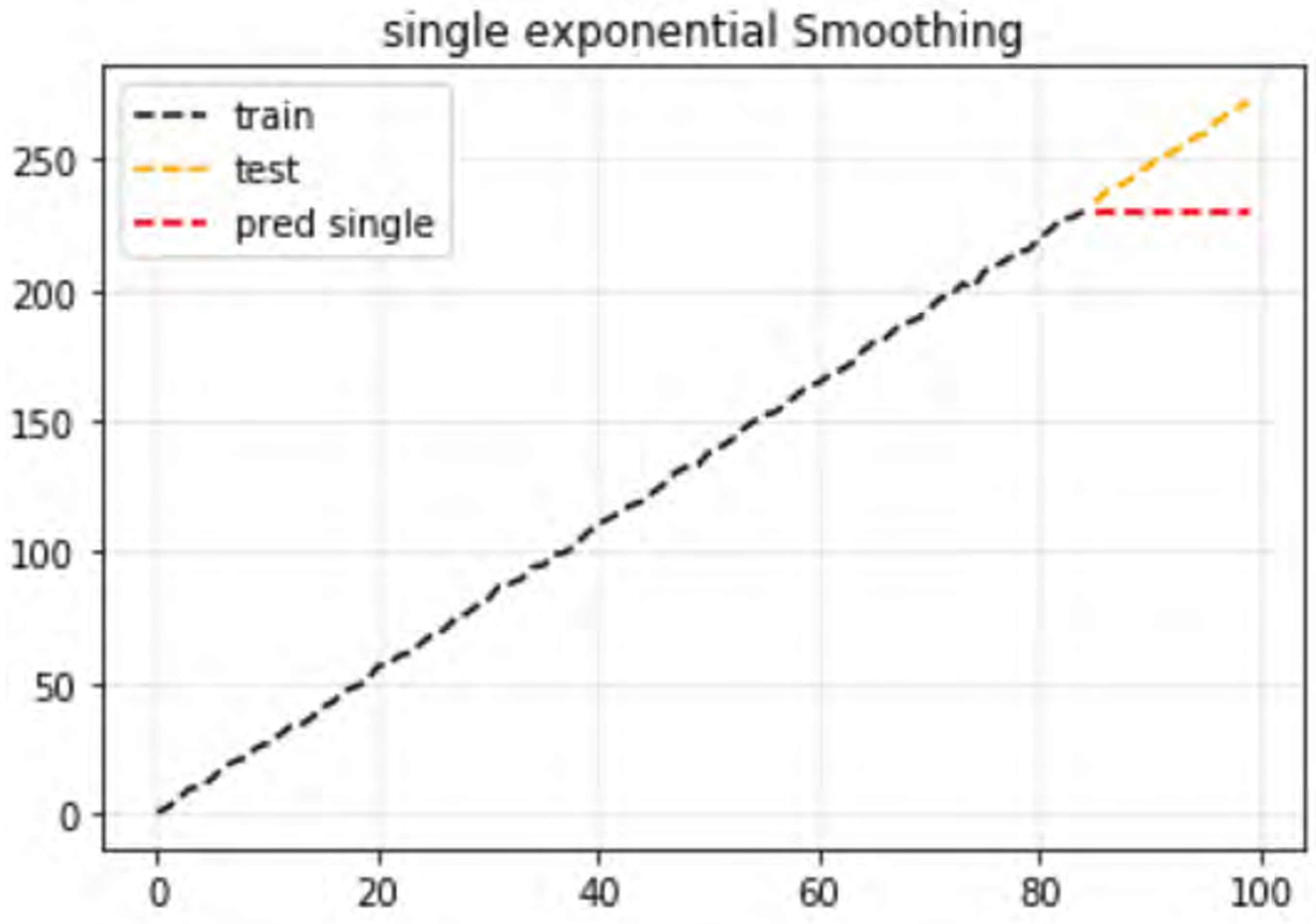
Smooth the **seasonality** of the series

$$\hat{x}_{t+m} = (s_t + mb_t)c_{t-L+(m-1) \mod L}$$

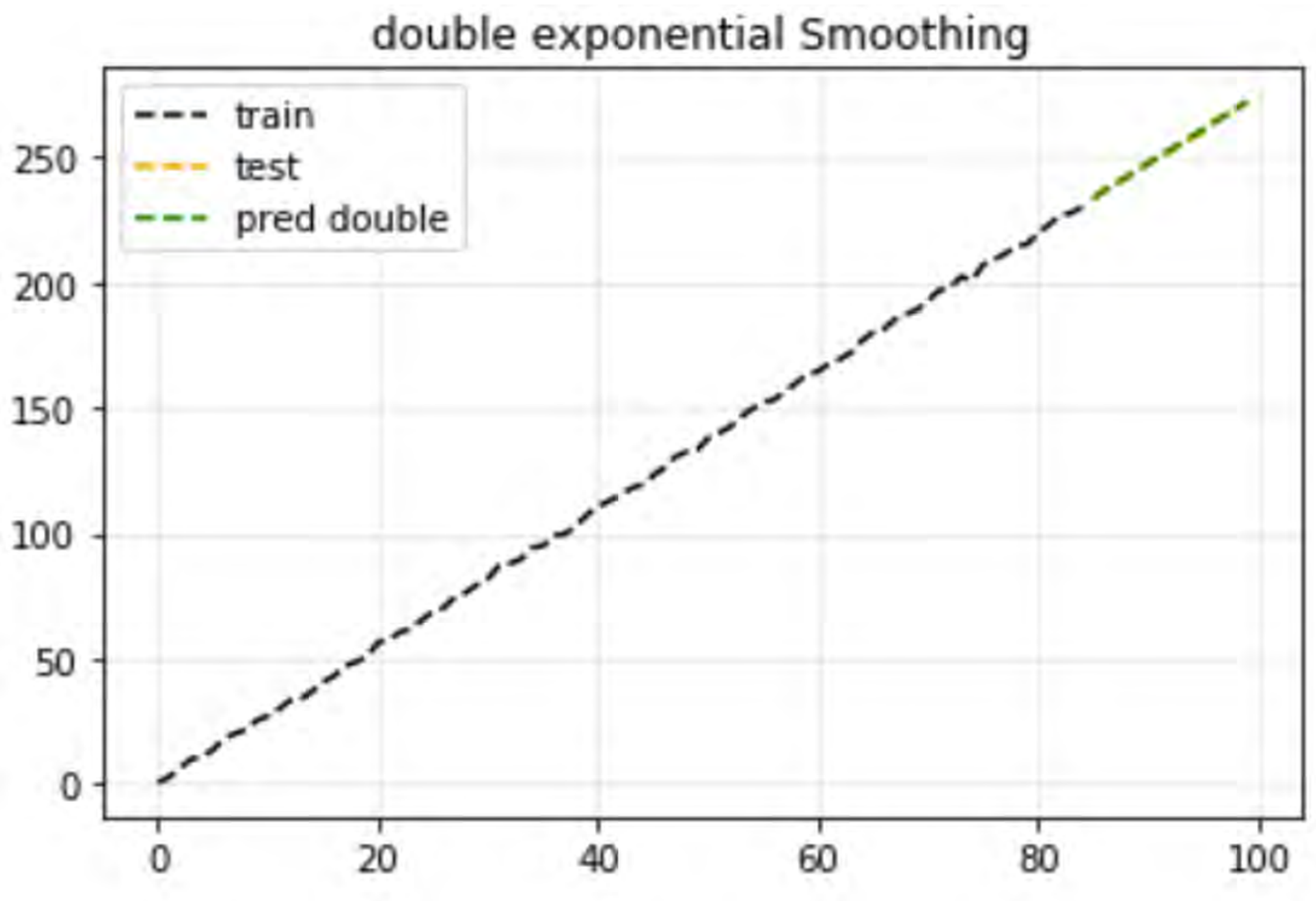
L = Length of time of the seasonality

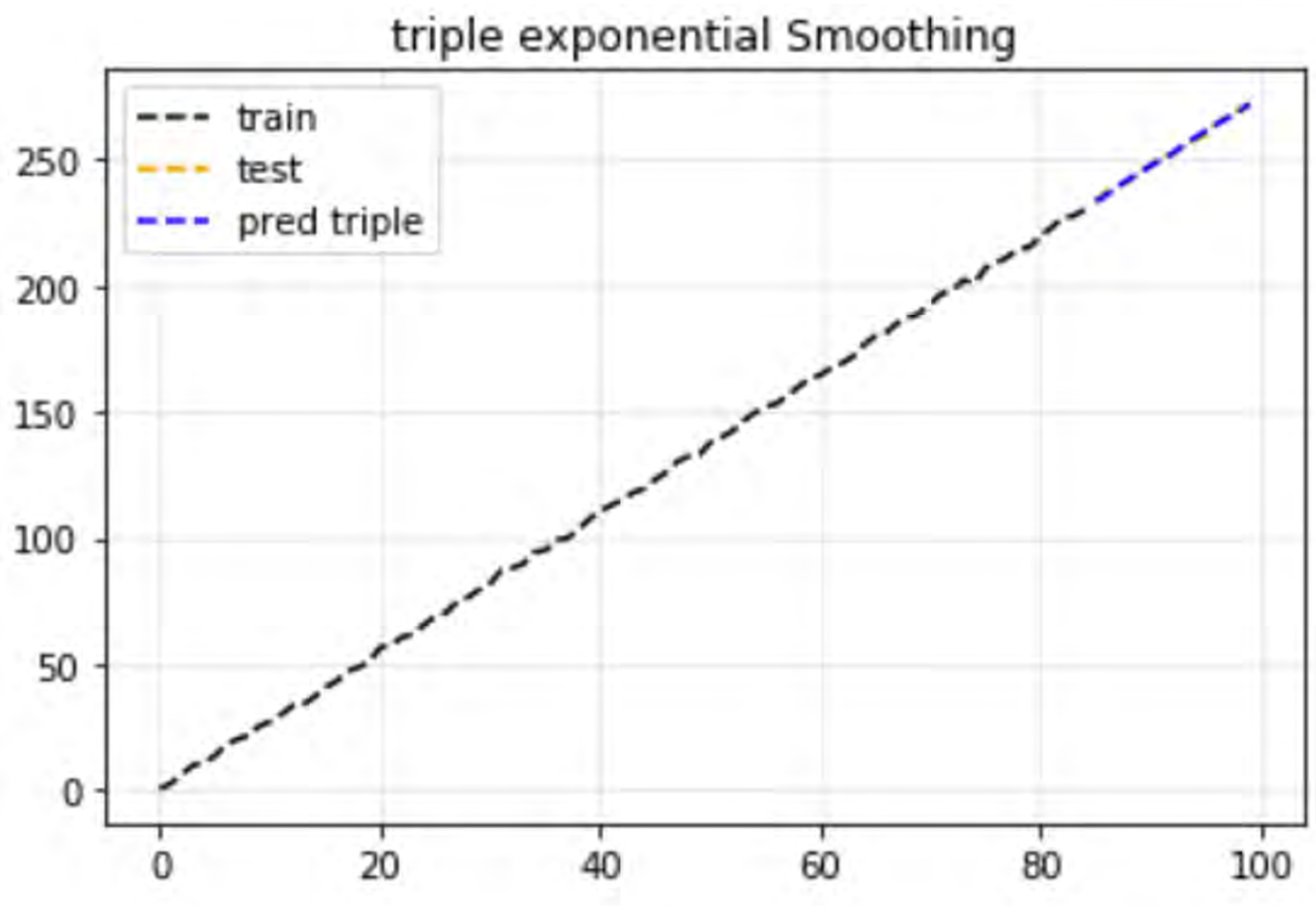
Prediction with smoothing (trend)



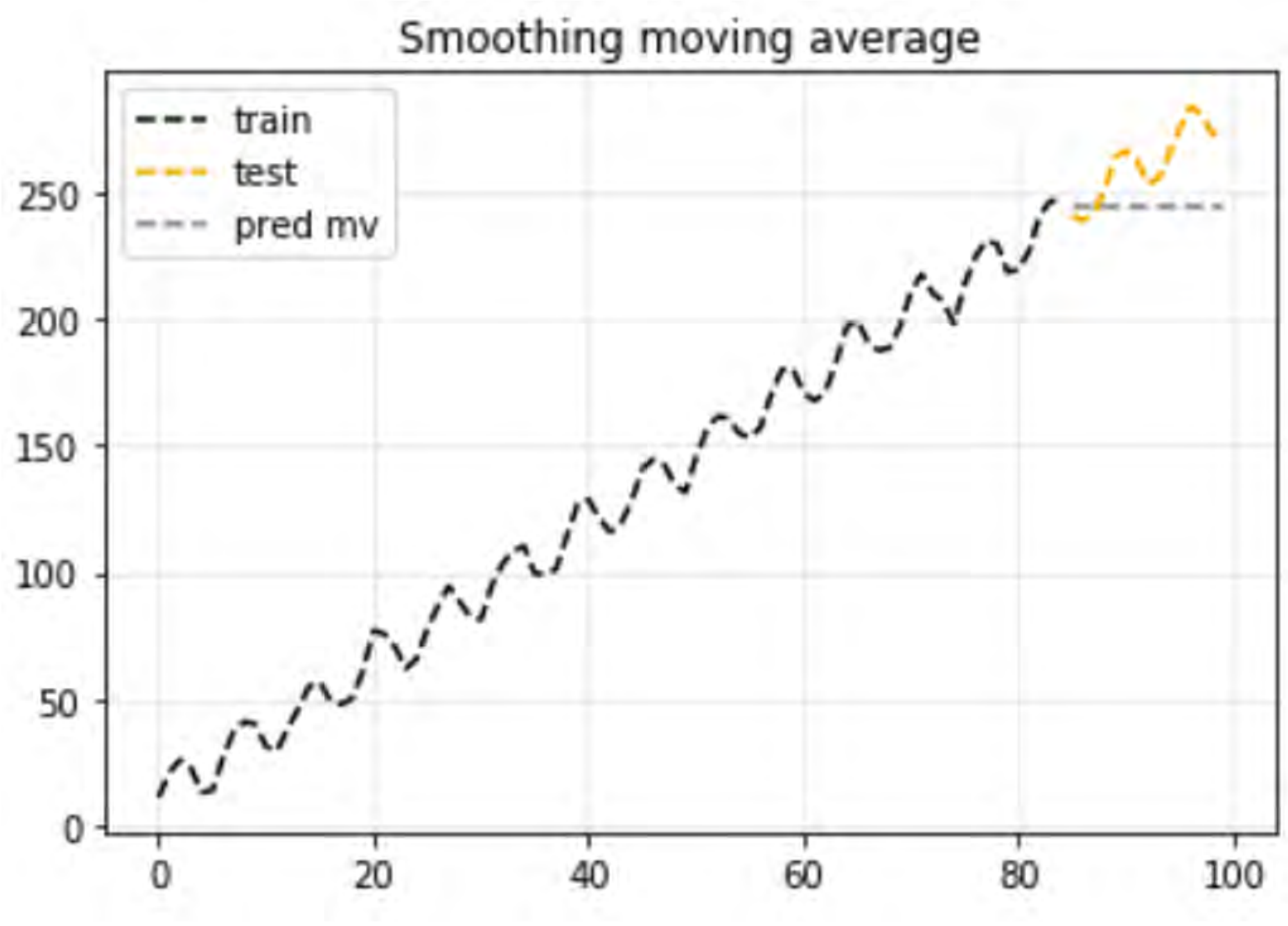


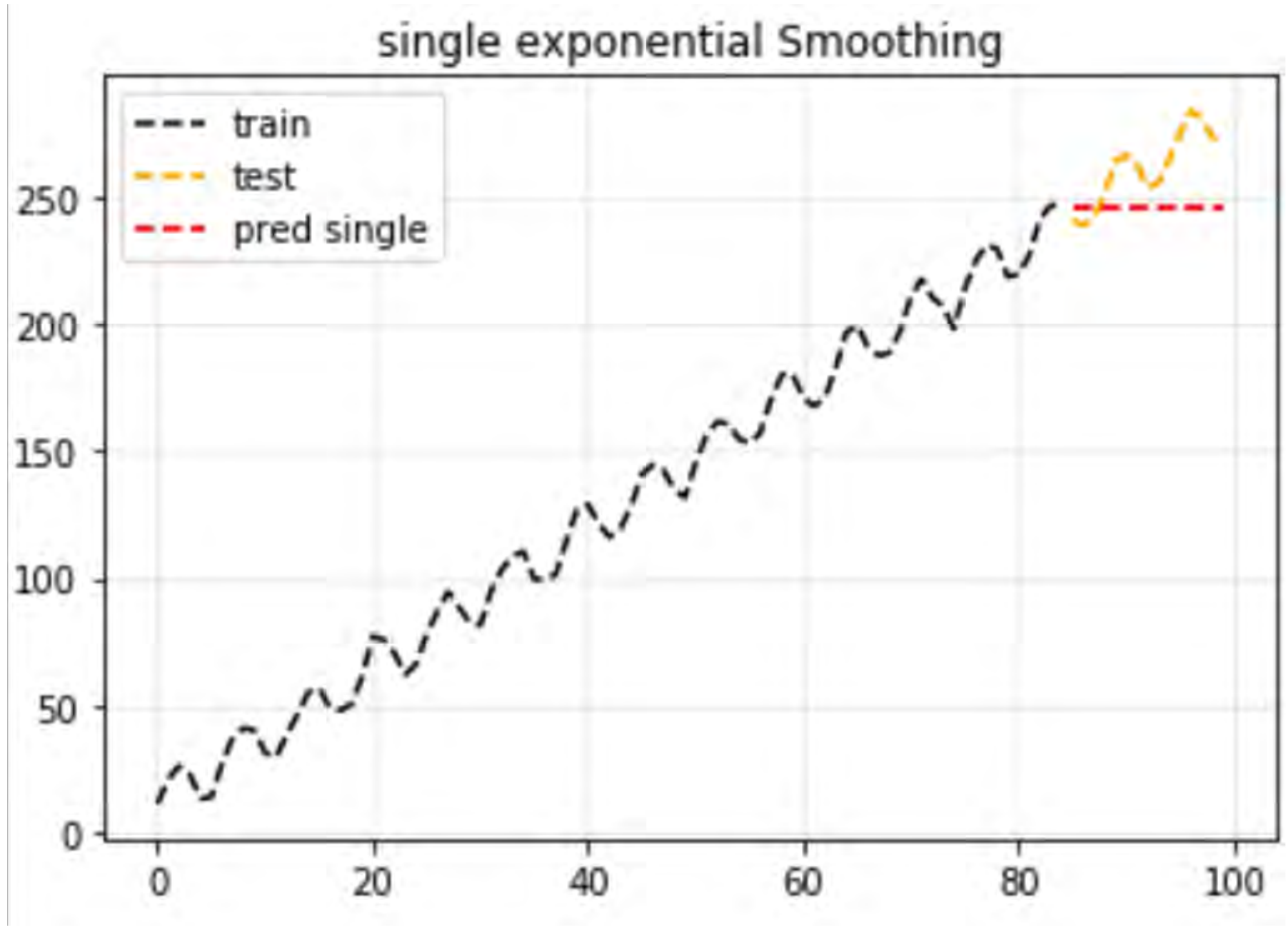
Prediction with smoothing (trend)



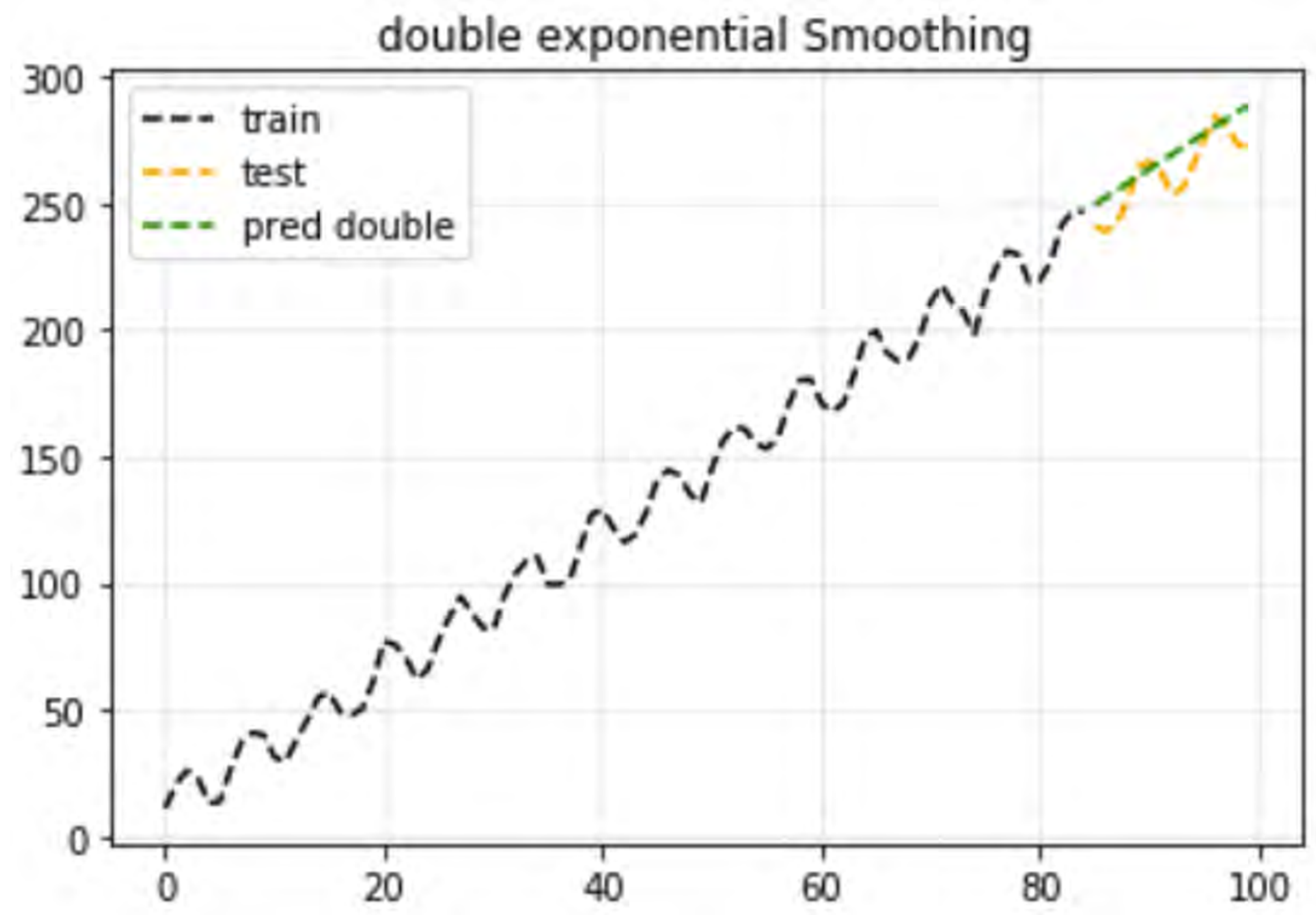


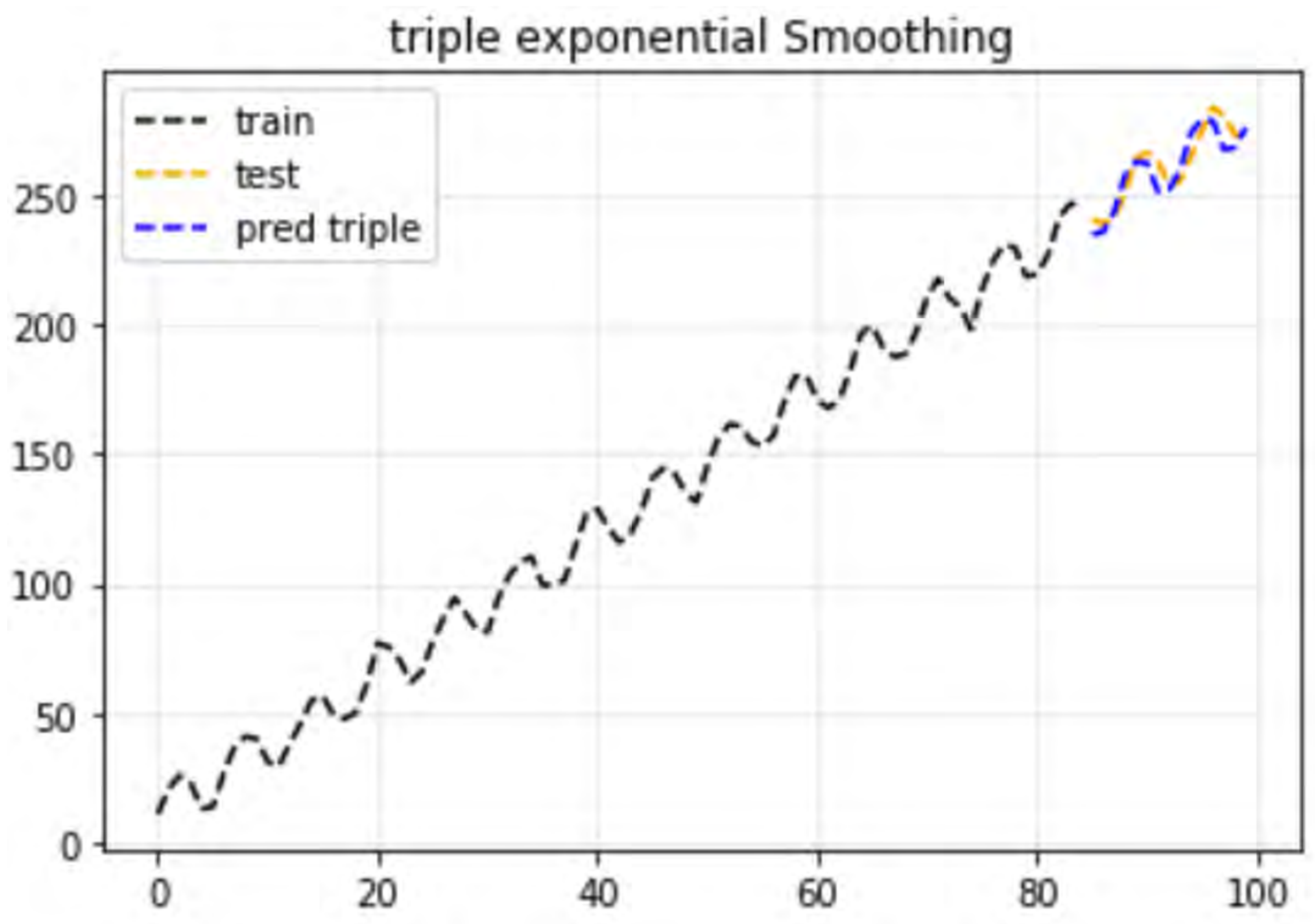
Prediction with smoothing (trend + seasonal)



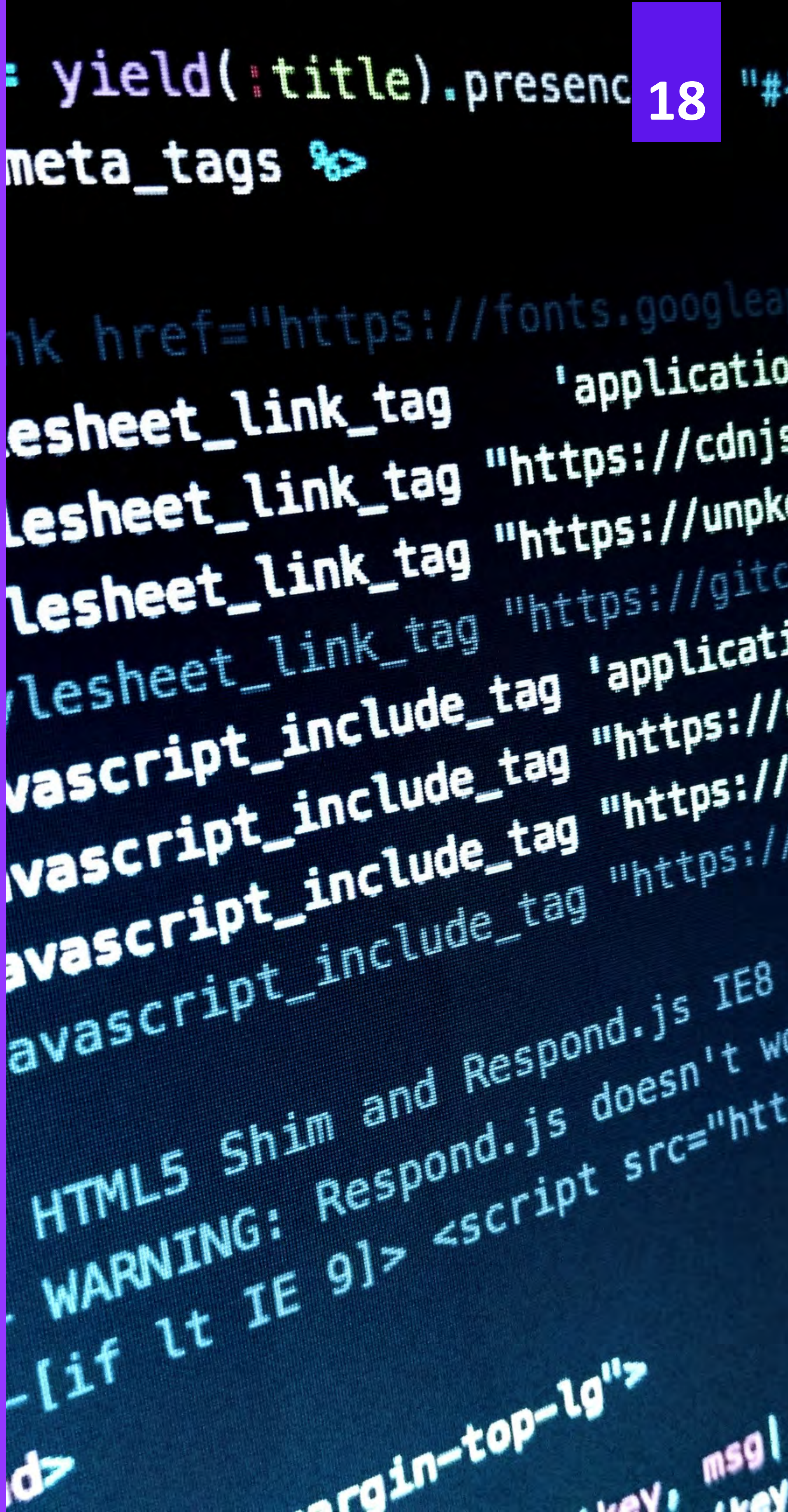


Prediction with smoothing (trend + seasonal)





Conclusion



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