Methods for Time Series Prediction

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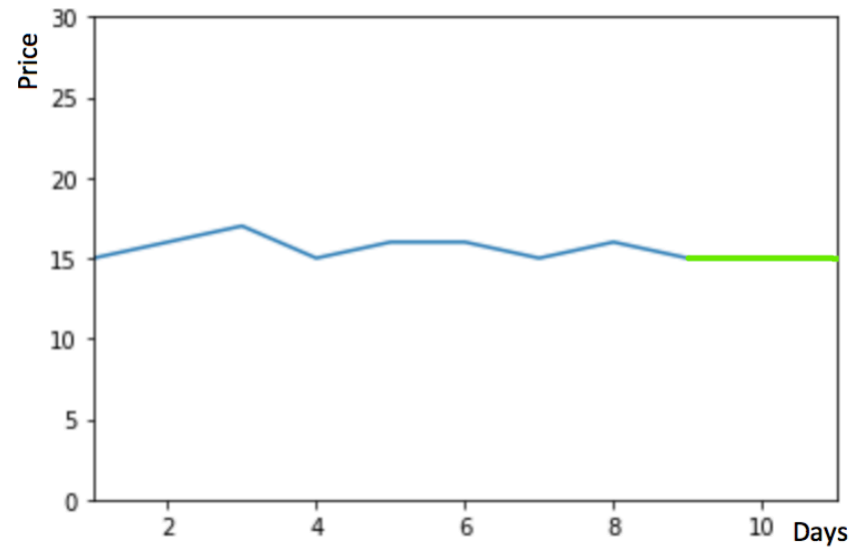# AGENDA

- Introduction
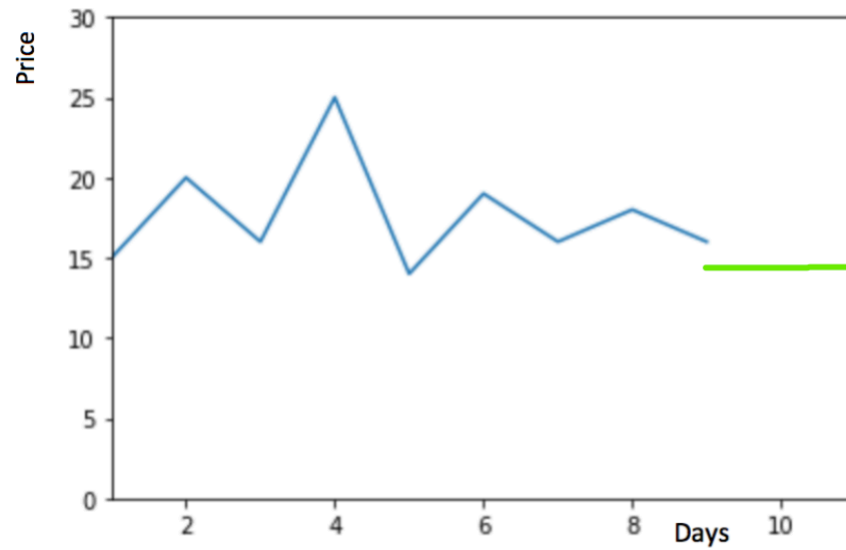- Traditional methods
- Machine learning methods

Naïve Approach

$$\hat{y}_{t+1} = y_t$$
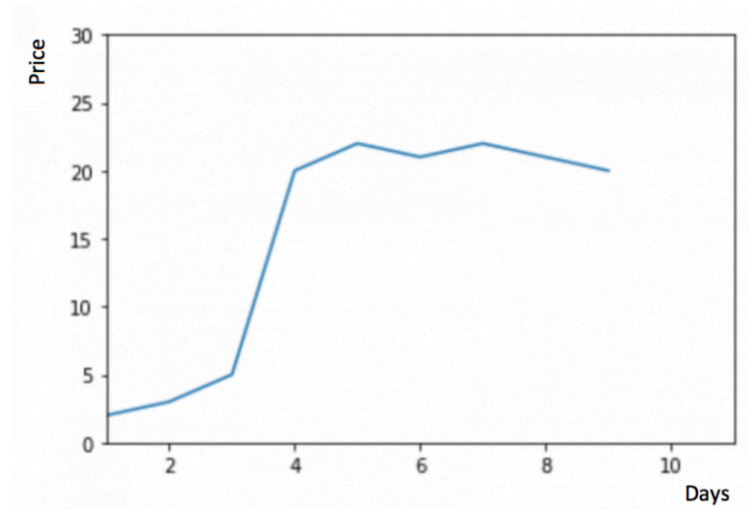
Simple Average

$$\hat{y}_{x+1} = \frac{1}{x}\sum_{i=1}^{x} y_i$$

Moving Average

$$\hat{y_i} = \frac{1}{p}(y_{i-1} + y_{i-2} + y_{i-3} \ldots\ldots + y_{i-p})$$

Simple Exponential Smoothing

$$\hat{y}_{T+1|T} = \alpha y_T + \alpha(1-\alpha)y_{T-1} + \alpha(1-\alpha)^2 y_{T-2} + \cdots$$

$$\hat{y}_{t+1|t} = \alpha * y_t + (1-\alpha) * \hat{y}_{t|t-1}$$

Autoregressive Integrated Moving Average

- ARIMA(p, d, q)

- p is the order of autogressive model, d is the degree of differencing, q is the order of moving average.

$$X_t - \alpha_1 X_{t-1} - \cdots - \alpha_{p'} X_{t-p'} = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q},$$

ARIMA(1,0,0)

▶ The first-order autogressive model

$$\hat{Y}_t = \mu + \phi_1 Y_{t-1}$$

ARIMA(1,1,0)

- Differenced first order autogressive model

$$\hat{Y}_t - Y_{t-1} = \mu + \phi_1(Y_{t-1} - Y_{t-2})$$

ARIMA(0,1,0)

- Random walk

$$\hat{Y}_t - Y_{t-1} = \mu$$

ARIMA(0,1,1)
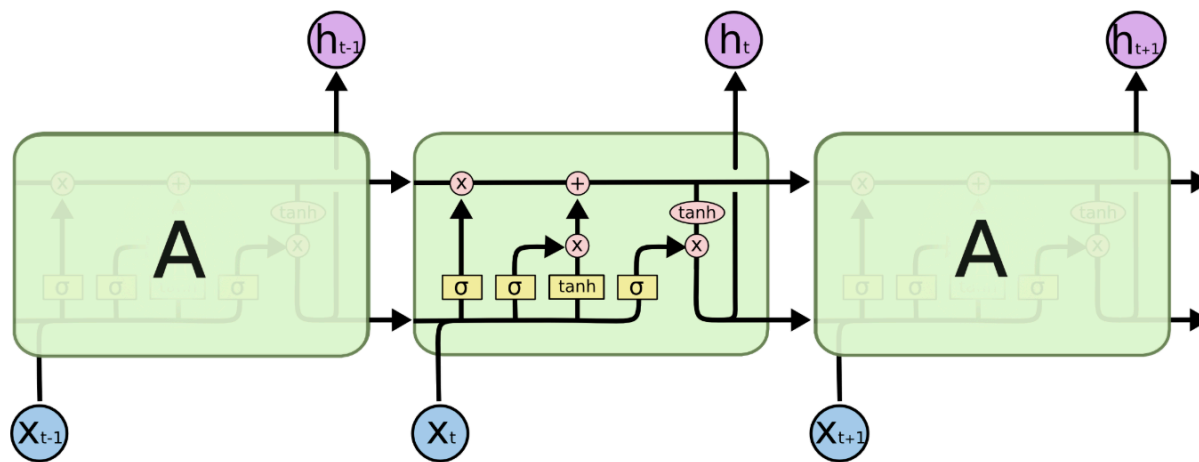
- Simple exponential smoothing

$$\hat{Y}_t = \hat{Y}_{t-1} + \alpha e_{t-1}$$

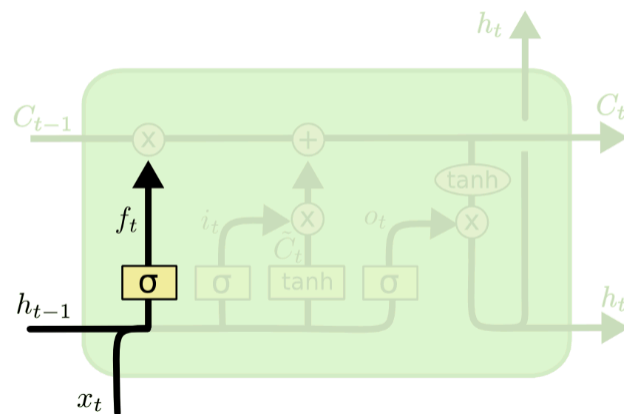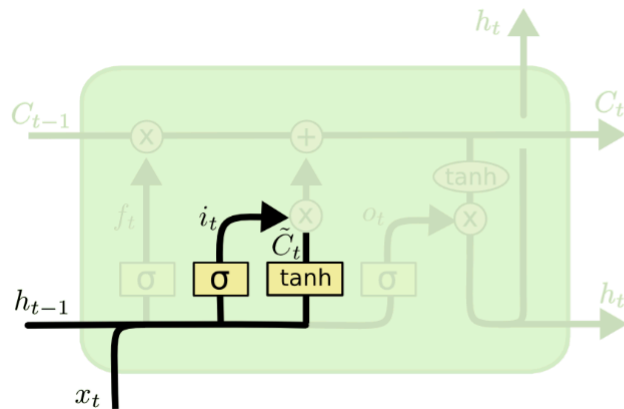# LSTM Network

▶ Long-short term memory network

LSTM Network

▶ Forget gate

$$f_t = \sigma\left(W_f \cdot [h_{t-1}, x_t] \; + \; b_f\right)$$

LSTM Network

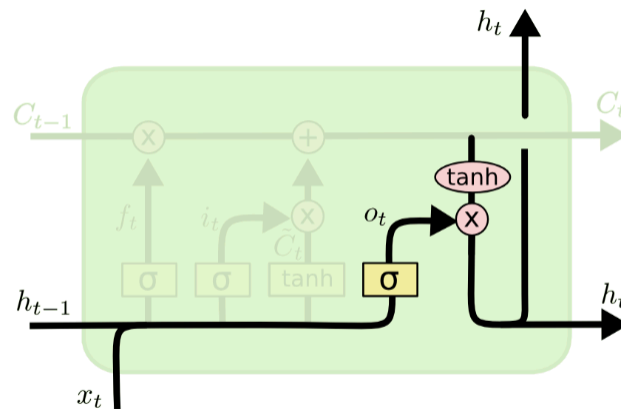▶ Input gate

$$i_t = \sigma\left(W_i \cdot [h_{t-1}, x_t] \;+\; b_i\right)$$

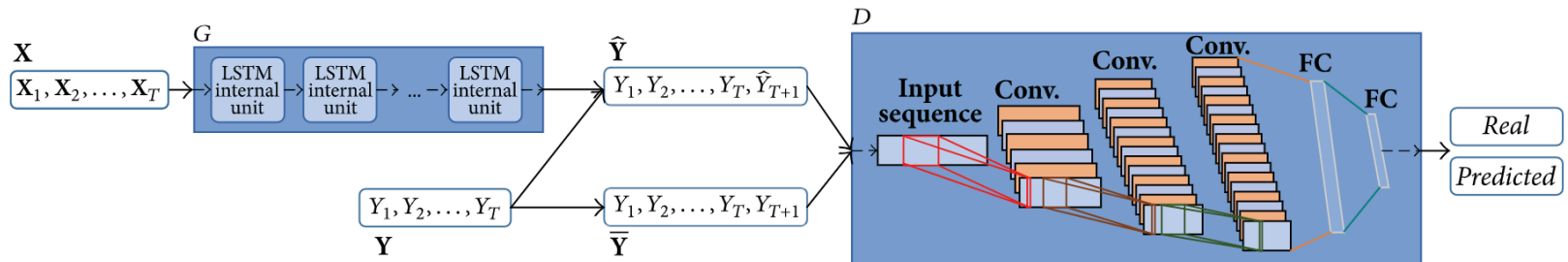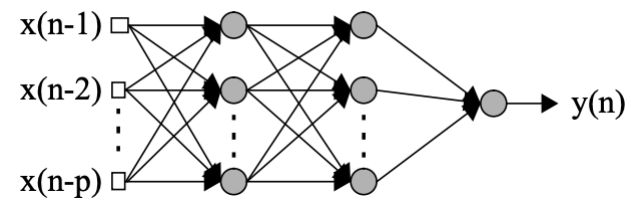$$\tilde{C}_t = \tanh(W_C \cdot [h_{t-1}, x_t] \;+\; b_C)$$

LSTM Network

▶ Output gate

$$o_t = \sigma \left(W_o \; [\, h_{t-1}, x_t \,] \; + \; b_o \right)$$

$$h_t = o_t * \tanh \left(C_t \right)$$

Other Network

- MLP
- GAN

Thanks!

- Quenstions?

References

- 7 methods to perform time series forcasting

- Autogressive integerated average moving, Wikipedia

- Time Series Prediction with Multilayer Perceptron, FIR and Elman Neural Networks

- Understanding LSTM Networks

- Stock Market Prediction on High-Frequency Data Using Generative Adversarial Nets