Exponential Smoothing

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Forecasting Exercise 4

Learning Objectives

- Simple Exponential Smoothing
- Forward Forecasting
- Generating Forecast errors

Exponential Smoothing

- Simple exponential smoothing is taking a weighted average of the all past values , so that the weights decreases exponentially into the past. More weight is given to most recent values. It should be used for forecasting series that have no trend and seasonality.

$$\hat{g}_{t+1} = \alpha x_t + \alpha(1-\alpha)\hat{x}_{t-1} + \alpha(1-\alpha)^2\hat{x}_{t-2} + ...$$

- $\hat{x}_{t-1,2,..n}$ is the smoothed value of the series
- x_t is actual value at time t
- $\hat{g}_{t+1}$ is the forecast values for x at time $t+1$
- α is the smoothing parameter or constant
- the initial $\hat{x}_0$ must be chosen ($\hat{x}_0 = g_0$).

The Smoothing Parameter

- $\alpha \in [0,1]$
- Different values of α gives different smoothness level.
- We choose α and $\hat{x}_0$ by minimizing the sum of squared error (SSE)

$$SSE = \sum_{t=1}^{T} (x_t - \hat{x}_{t|t-1})^2$$

Components

- Forecast equation: $\hat{x}_{t+h} = g_t$
- Smoothing/Updating equation: $g_t = \alpha x_t + (1 - \alpha) g_{t-1}$

Evaluating Forecast Accuracy

The accuracy of the forecast is how well the model performs on test data, i.e., data not used when fitting the model. We measure forecast errors in several ways:

- Mean Error (ME) $= \frac{1}{T}\sum_{t=1}^{T}(x_t - \hat{x}_t)$
- Mean Absolute Error (MAE) $= \frac{1}{T}\sum_{t=1}^{T}|(x_t - \hat{x}_t)|$
- Mean Percentage Error (MPE) $= \frac{1}{T}\sum_{t=1}^{T}\frac{(x_t - \hat{x}_t)}{x_t} \times 100$

Evaluating Forecast Accuracy

- Mean Absolute Percentage Error (MAPE) = $\frac{1}{T}\sum_{t=1}^{T}|\frac{(x_t - \hat{x}_t)}{x_t}| \times 100$
- Root Mean Square Error (RMSE) = $\sqrt{\frac{1}{T}\sum_{t=1}^{T}(x_t - \hat{x}_t)^2}$