An analysis using simulation to compare several moving average techniques for time series data.

A Preprint

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Abstract

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***K*eywords** blah · blee · bloo · these are optional and can be removed

1 Introduction:

1.1 Background of The Study

Data for time series is gathered from various points throughout time. As a result, the data set has a great deal of variety. So, a technique known as smoothing is employed to lessen these variations. Techniques for removing noise from a time series of data include smoothing techniques. It aids in determining the datset's trend. When data is compiled, any volatility or other types of noise can be removed or reduced. Data smoothing is the term for this. Data smoothing is based on the notion that it can recognize simpler changes to assist in the prediction of various trends and patterns. It serves as a tool for statisticians or traders who must examine a lot of data, which is frequently challenging.

1.2 Objective of The Study

Among all others smoothing methods moving average methods is the oldest and simplest smoothing methods. The main object of that study is comparing different types of moving average smoothing techniques such as simple moving average(SMA),exponentially-weighted moving average (EWMA), weighted moving average (WMA), double exponential moving average(DEMA),Hull moving average(HMA), Zero lag exponential moving average(ZLEMA) etc. Among them the syudy compares SMA, EWMA, WMA, DEMA,HMA and ZLEMA.

2 Literature review

Raudys, Lenčiauskas, and Malčius (2013) smoothed financial data using the moving average.

Ivanovski, Milenkovski, and Narasanov (2018) extrapolated the number of tourists using the moving average. The study aids in making wise decisions for the future.

Hameed (2015) compares every smoothing method currently in use to forecast future demand for private universities in Bangladesh. They contrast different kinds of currently used smoothing techniques and discover that Holt's method provides the optimum accuracy for their work.

For the purpose of early detection of infectious disease outbreaks, Yang et al. (2018) conducts simulation-based studies on the comparison of statistical and time series forecasting techniques. Here, various approaches are discussed in an effort to use simulation to produce the greatest results.

Sinaga and Irawati (2020) studied about medical disposable supply demand forecasting by moving average and exponential moving average method.

For predicting power load, Karim and Alwi (2013) employed exponential smoothing and moving average, and exponential moving average outperformed moving average.

Fong et al. (2020) tried to find an accurate early forecasting model from Small dataset of 2019-nCoV Novel Coronavirus outbreak.

3 Methodology

3.1 Simple moving average (SMA)

By averaging several different subsets of the entire data set, a simple moving average (SMA) statistical technique is utilized to examine data points. Because it is calculated by averaging a predetermined number of successive data points with equal weight for each, it is referred to as being "simple." The SMA is used to highlight long-term trends or patterns in the data and to smooth out short-term volatility in the data.The formula for SMA is given below,

$$T_t = \frac{\sum_{i=-m}^{m} Y_{t+i}}{k}$$

here k is the number of order and Y_i is the observation. m=$\frac{k-1}{2}$ is the half width of a moving average as the number of points. For example, a arithmetic moving average of 3 ordered at time t is $T_t = \frac{Y_{t-1}+Y_t+Y_{t+1}}{3}$.

Simple Moving Average (SMA) and Exponential Moving Average (EMA) both measure trend direction over time. SMA only determines an average, but EMA gives more weight to data that is more recent.

3.2 Exponentially moving average (EMA)

Simple Moving Average (SMA) and Exponential Moving Average (EMA) both measure trend direction over time. SMA only determines an average, but EMA gives more weight to data that is more recent.

$$EMA = C\breve{\ } P\frac{2}{(n+1)} + P$$

where C and P are current data point and an exponential moving average of the previous period (simple average used for the first period) respectively. THe formula is given below,

3.3 Weighted moving average

When calculating the weighted moving average, recent data points are given more weighting than historical data points. When added together, the weights' total value ought to be 100%, or 1. The weighting factor used to calculate the WMA is determined by the period selected for the indicator. For example, a 5 period WMA would be calculated as follows:

$$WMA = \frac{(5P_1 + 4P_2 + 3P_3 + 2P_4 + 1P_5)}{(5+4+3+2+1)}$$

Where, P_1= current price P_2 = price one bar ago and so on.

3.4 ZLEMA

John Ehlers and Ric Way created the Zero Lag Exponential Moving Average (ZLEMA) indicator. The goal is to get rid of the inherent lag that all averages and other trend following indicators have.

This is what the ZLEMA aims to accomplish by tracking recent prices more closely than historical prices, much like a standard EMA but with an even greater emphasis on recent prices. A moving average with less lag and good smoothing is the end product.

The benefits of using zero lag moving averages are as follows:

- A moving average exponential without lag that is more responsive to current price changes.
- The indicator is applicable across all instruments and timeframes.
- The indicator may be used as a signal or as a filter for signals.

Formula are given below ,

$$\alpha = \frac{2}{n+1}$$

$$Z_t = (1-\alpha)Z_t + \alpha(T_t - T_{t-\frac{n-1}{2}})$$

Where , n is the number of period. α represents the lag and Z_t represents the ZLEMA moving average at t time points.

3.5 DEMA

A level component and a trend component are used in double exponential smoothing at each period. Two weights, also known as smoothing parameters, are used in double exponential smoothing to update the components at each time.The formula is given below,

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + T_{t-1})$$

$$T_t = \gamma(L_t \breve{} L_{t\breve{}1}) + (1\breve{}\gamma)T_{t\breve{}1}$$

$$\hat{Y} = L_{t\breve{}1} + T_{t\breve{}1}$$

Here , L_t level at time t.
α weight for the level.
T_t trend at time t
γ weight for the trend
Y_t data value at time t
$\hat{Y}_t$ fitted value, or one-step-ahead forecast, at time t

4 Analysis

Table 1: Smoothing comparison table

Normal Distribution			Poisson Distribution			Weibull Distribution		
TYPE	MAE	MSE	TYPE	MAE	MSE	TYPE	MAE	MSE
SMA	2.813	12.440	SMA	1.770	4.978	SMA	0.319	0.164
EMA	1.624	4.142	EMA	1.028	1.660	EMA	0.184	0.055
DEMA	0.742	0.864	DEMA	0.469	0.346	DEMA	0.084	0.011
WMA	1.875	5.529	WMA	1.180	2.212	WMA	0.213	0.073
HMA	1.875	5.529	HMA	1.180	2.212	HMA	0.213	0.073
ZLEMA	1.873	5.506	ZLEMA	1.187	2.216	ZLEMA	0.213	0.073

Table 2: Smoothing comparison table

Gamma Distribution			T Distribution			Exponential Distribution		
TYPE	MAE	MSE	TYPE	MAE	MSE	TYPE	MAE	MSE
SMA	1.770	4.978	SMA	0.622	0.629	SMA	0.100	0.020
EMA	1.028	1.660	EMA	0.359	0.209	EMA	0.059	0.007
DEMA	0.469	0.346	DEMA	0.164	0.044	DEMA	0.027	0.001
WMA	1.180	2.212	WMA	0.415	0.279	WMA	0.066	0.009
HMA	1.180	2.212	HMA	0.415	0.279	HMA	0.066	0.009
ZLEMA	1.187	2.216	ZLEMA	0.414	0.279	ZLEMA	0.068	0.009

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