Detailed Notes on Time Series Analysis

# Models

## ETS

Exponential Smoothing State Space Model (ETS) is a forecasting method that models error, trend, and seasonality components explicitly. It is suitable for time series data with clear trend and seasonal patterns. ETS includes variations like additive and multiplicative models depending on the nature of the data.

Example: Forecasting monthly retail sales with seasonal peaks during holidays.

## Theta

The Theta model is a decomposition-based forecasting method that combines linear regression with exponential smoothing. It is known for its accuracy and simplicity, especially in competitions like the M3 forecasting competition.

Example: Predicting airline passenger numbers using the Theta model.

## AR model

Autoregressive (AR) models use the dependency between an observation and a number of lagged observations. For example, AR(1) uses the previous value to predict the current value. It is suitable for stationary time series.

Example: Modeling daily stock prices using AR(1) model.

## MA model

Moving Average (MA) models use past forecast errors in a regression-like model. MA(q) uses the past q errors to predict the current value. It is often used in combination with AR models.

Example: Forecasting temperature using MA(2) model based on past errors.

## ARIMA

Autoregressive Integrated Moving Average (ARIMA) combines AR and MA models with differencing to make the time series stationary. It is widely used for non-seasonal time series forecasting.

Example: Forecasting GDP growth after differencing to remove trends.

## SeasonalNaive

Seasonal Naive forecasting assumes that the value of a time series repeats itself every season. For example, the forecast for January this year would be the value observed in January last year.

Example: Forecasting electricity demand by repeating last year's seasonal values.

## WeightedEnsemble

Weighted Ensemble models combine forecasts from multiple models using weighted averages. This approach often improves accuracy by leveraging the strengths of different models.

Example: Combining ARIMA and ETS forecasts for improved accuracy.

## SARIMA Model

Seasonal ARIMA (SARIMA) extends ARIMA by including seasonal differencing and seasonal AR and MA terms. It is suitable for time series with both trend and seasonal components.

Example: Forecasting monthly retail sales with seasonal patterns using SARIMA.

# Metrics

## MAPE

Mean Absolute Percentage Error (MAPE) measures the accuracy of a forecasting method as a percentage. It is calculated as the average absolute percent error between forecasted and actual values. Lower MAPE indicates better accuracy.

Example: A MAPE of 5% means the forecasted values are on average 5% off from the actual values.

## SMAPE

Symmetric Mean Absolute Percentage Error (SMAPE) adjusts MAPE to be symmetric and bounded. It is useful when comparing forecast accuracy across different scales.

Example: SMAPE is useful when actual values are close to zero, avoiding large percentage errors.

## MAE

Mean Absolute Error (MAE) measures the average magnitude of errors in a set of forecasts, without considering their direction. It is easy to interpret and widely used.

Example: MAE of 10 means the average error between predicted and actual values is 10 units.

## RSquared

R-squared (Coefficient of Determination) indicates how well the model explains the variability of the data. A value closer to 1 means a better fit.

Example: R² of 0.85 indicates the model explains 85% of the variance in the data.