

Time Series Forecasting

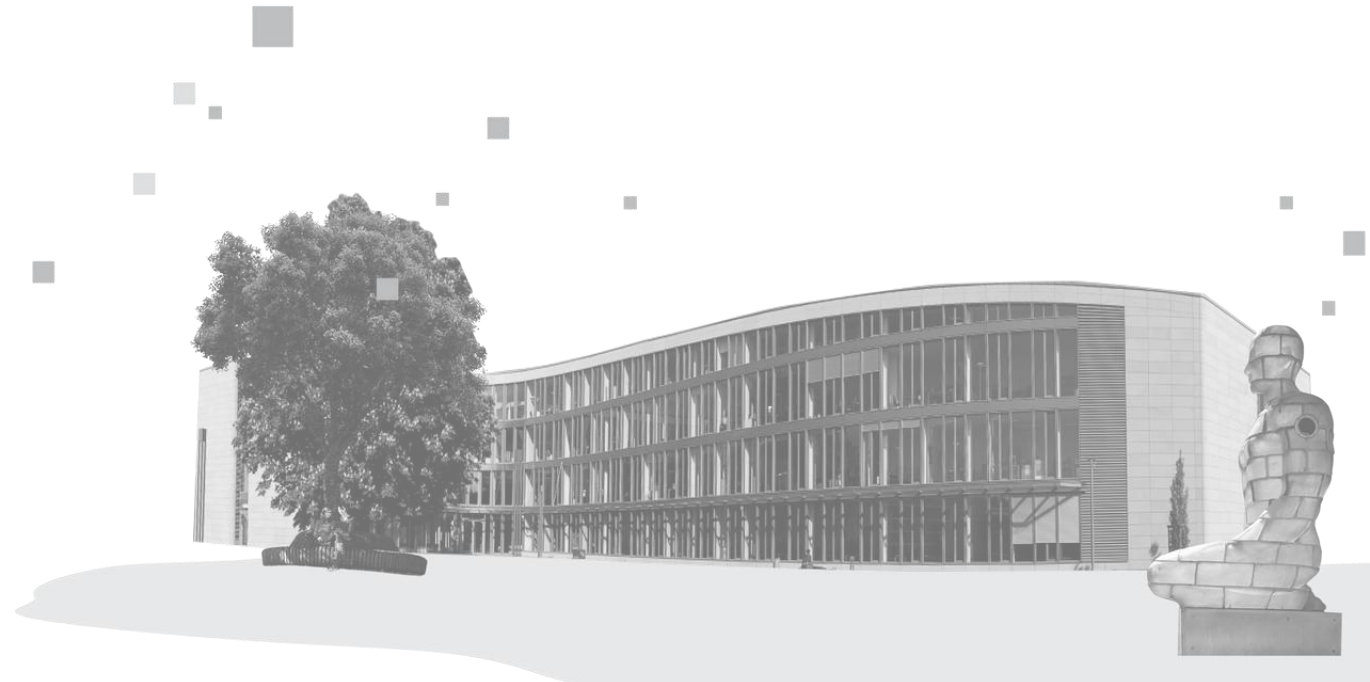
1.9 Statistical Methods III

Advanced forecasting models

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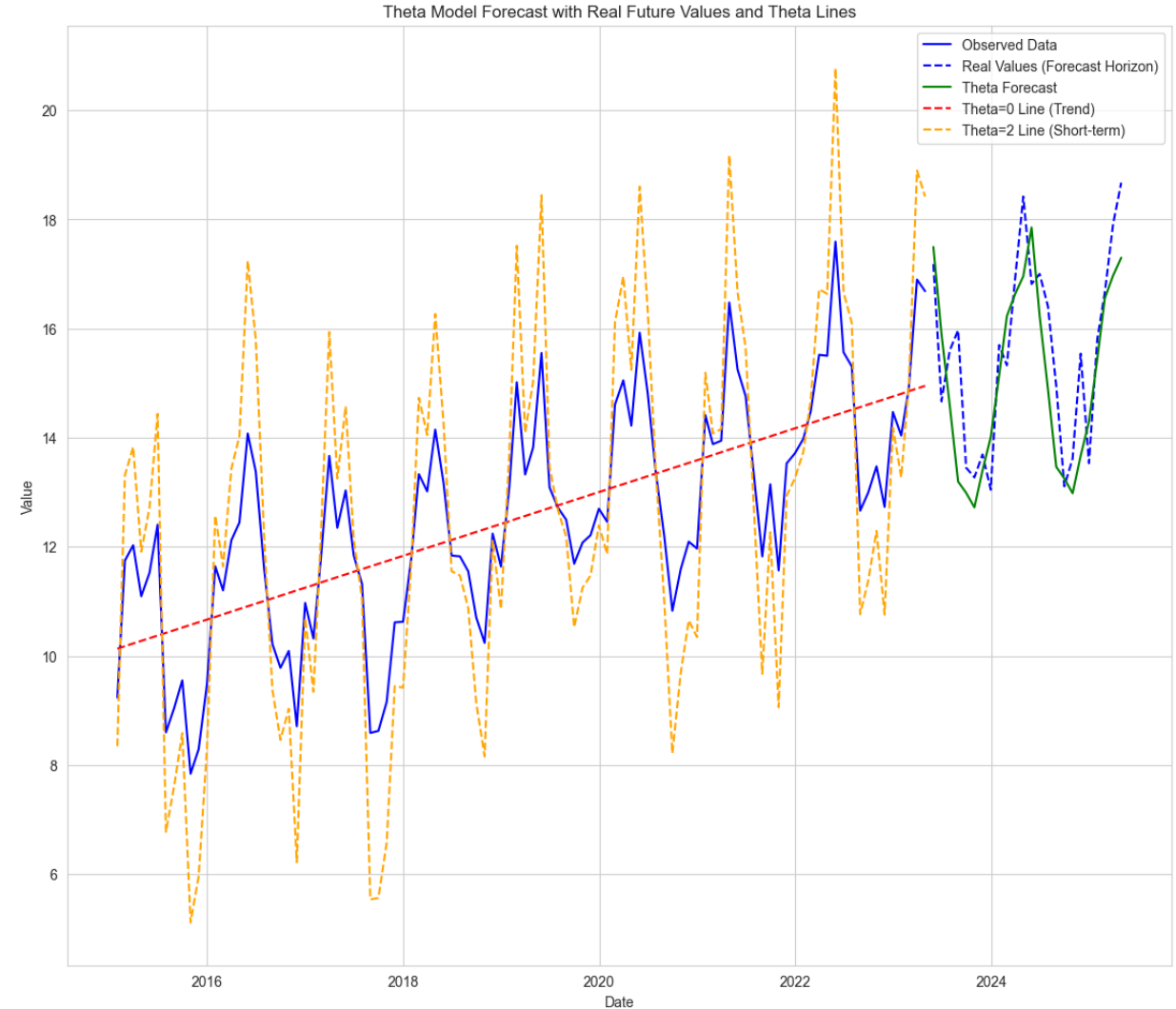
What we'll cover in this video



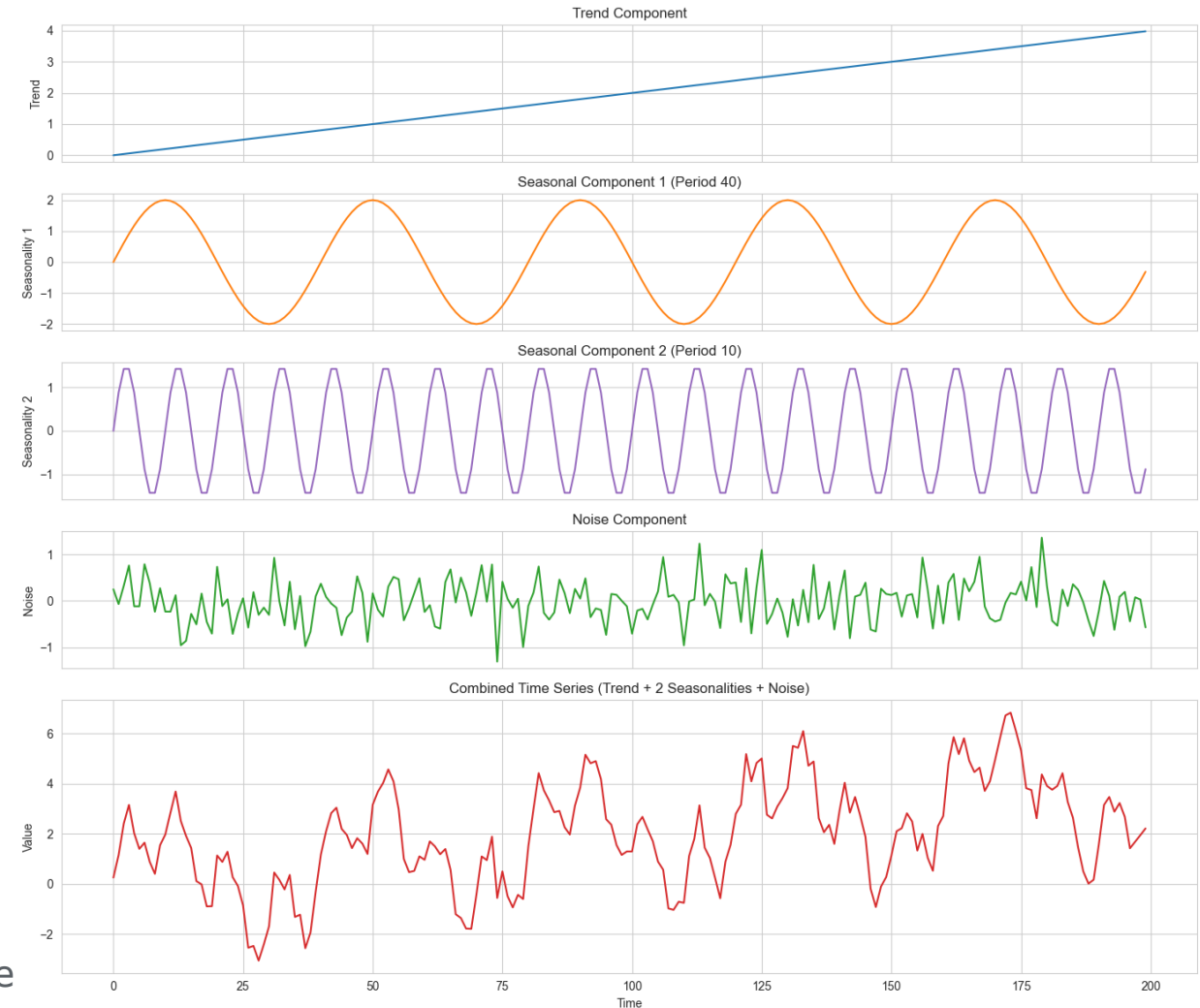
- Theta Method: How it works and when to use it
- TBATS and BATS: Handling complex and multiple seasonalities
- Dynamic Harmonic Regression: Fourier terms and ARIMA errors
- Prophet: Business-oriented forecasting with trend, seasonality, and holidays

Theta Method

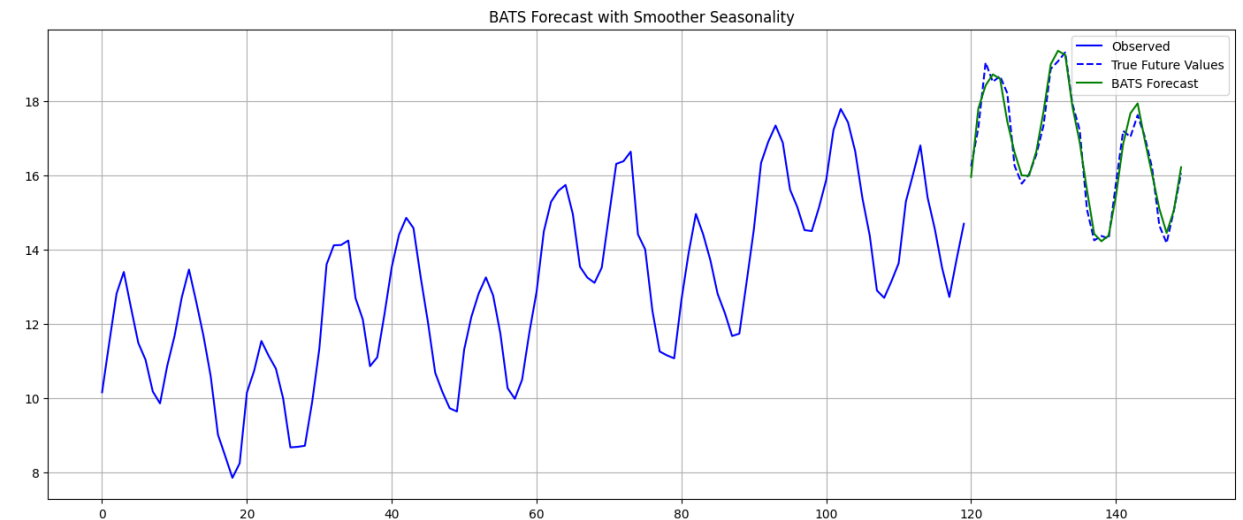
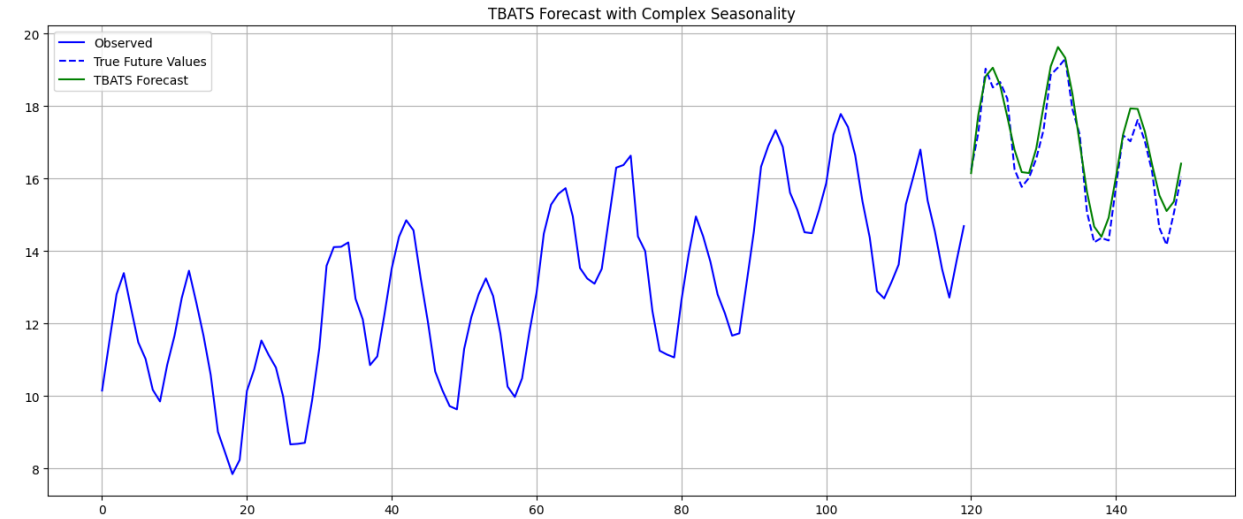
- Decomposes a time series into two or more “theta lines” by modifying the curvature (second differences)
- Known for its strong performance in the M3 forecasting competition
- Particularly robust for:
 - Trend-dominated series
 - Seasonal data when combined with seasonal adjustments
- Often implemented as part of Theta Forecast or AutoTheta packages in R and Python



- Designed for handling complex seasonal patterns, including:
 - Multiple seasonalities (like daily, weekly, yearly all at once)
 - Non-integer seasonality (for example, 365.25 days per year)
 - Long seasonal periods and complex interactions between trend and seasonality
- Automatically takes care of
 - Box-Cox transformations to stabilize variance
 - ARMA errors to model correlated noise
 - Damped trend components for smoother trend changes
- Works especially well with high-frequency, large-scale time series data

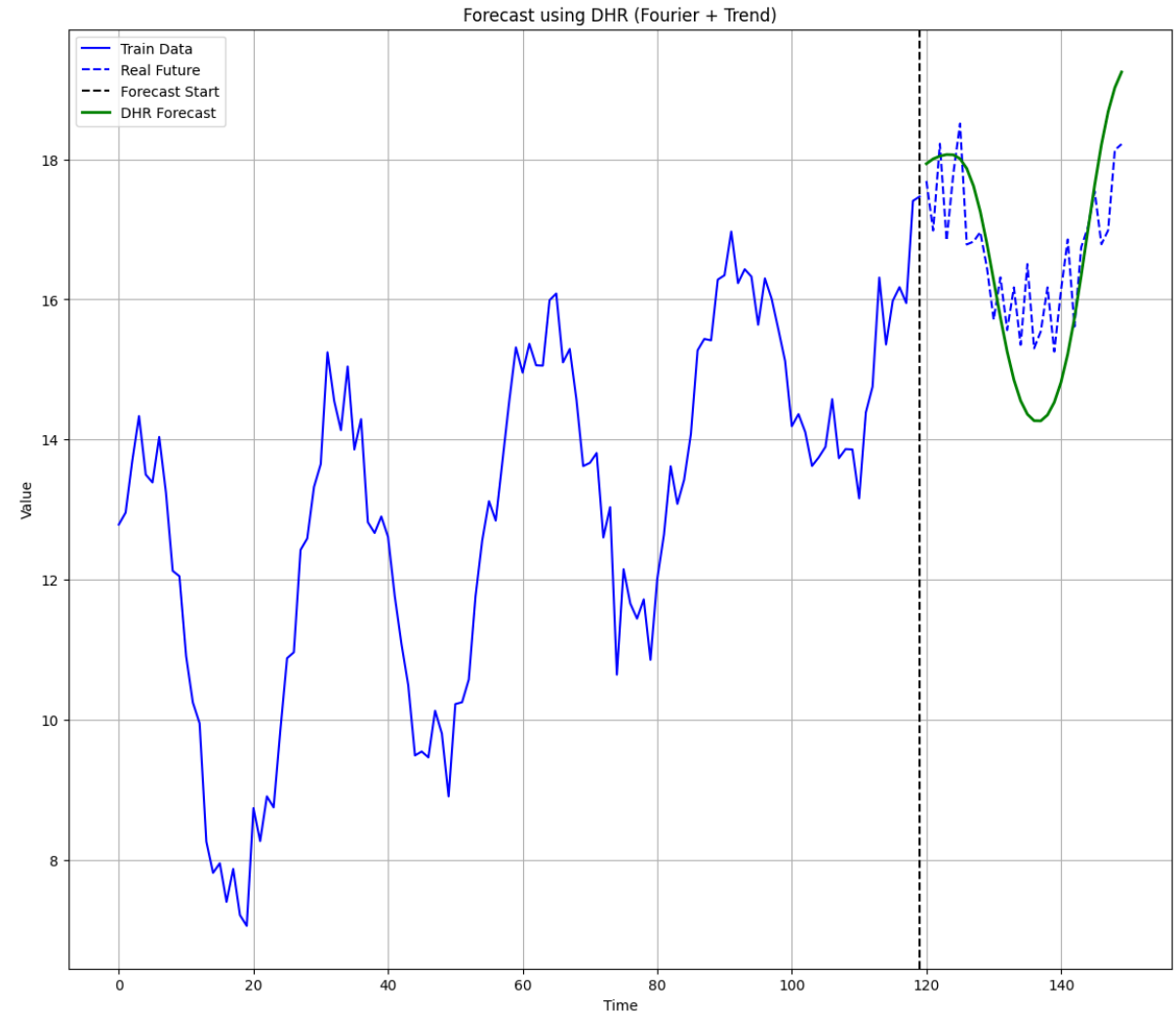


- Similar to TBATS but simpler and faster
- Does not include trigonometric seasonal terms
- Useful when seasonality is present but not overly complex
- Still models:
 - Box-Cox transformations
 - ARMA errors
 - Damped trends
- A good option when you want a balance between speed and flexibility



Dynamic Harmonic Regression (DHR)

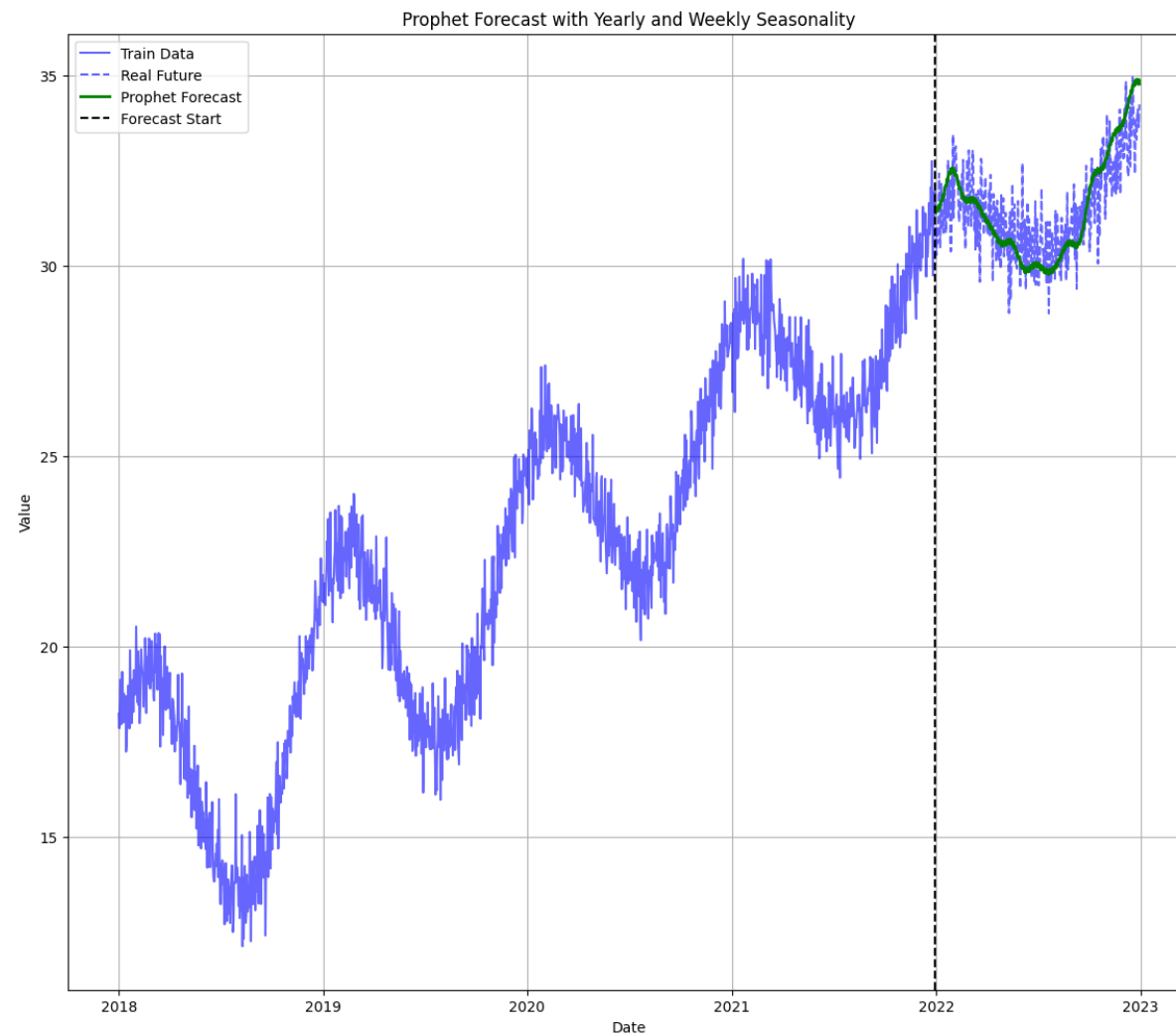
- Uses Fourier terms (sine and cosine functions) to model seasonality
- Combines with ARIMA errors to handle autocorrelation
- Especially good for:
 - Complex or multiple seasonalities
 - Non-integer seasonal cycles
- An alternative to STL + ARIMA for modeling seasonality
- Implemented in forecast (R) and partially in statsmodels (Python)



Prophet



- Open-source model
- Developed by Facebook (now Meta)
- Not purely statistical but close to a decomposable model with:
 - Trend
 - Seasonality
 - Holidays and special events
- Handles:
 - Multiple seasonalities
 - Missing data and irregular sampling
 - Outliers with automatic changepoint detection
- Great for business time series with clear patterns and external events



What we've learnt



- Theta method decomposes series by adjusting curvature — great for trend-focused data
- TBATS handles multiple, complex seasonalities and long seasonal periods with flexible components
- BATS is a simpler, faster alternative when seasonality isn't too complicated
- Dynamic Harmonic Regression models seasonality with Fourier terms combined with ARIMA errors
- Prophet breaks series into trend, seasonality, and holidays — perfect for business data with special events