

# Components of a time series

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Time series  
decomposition

# Contents



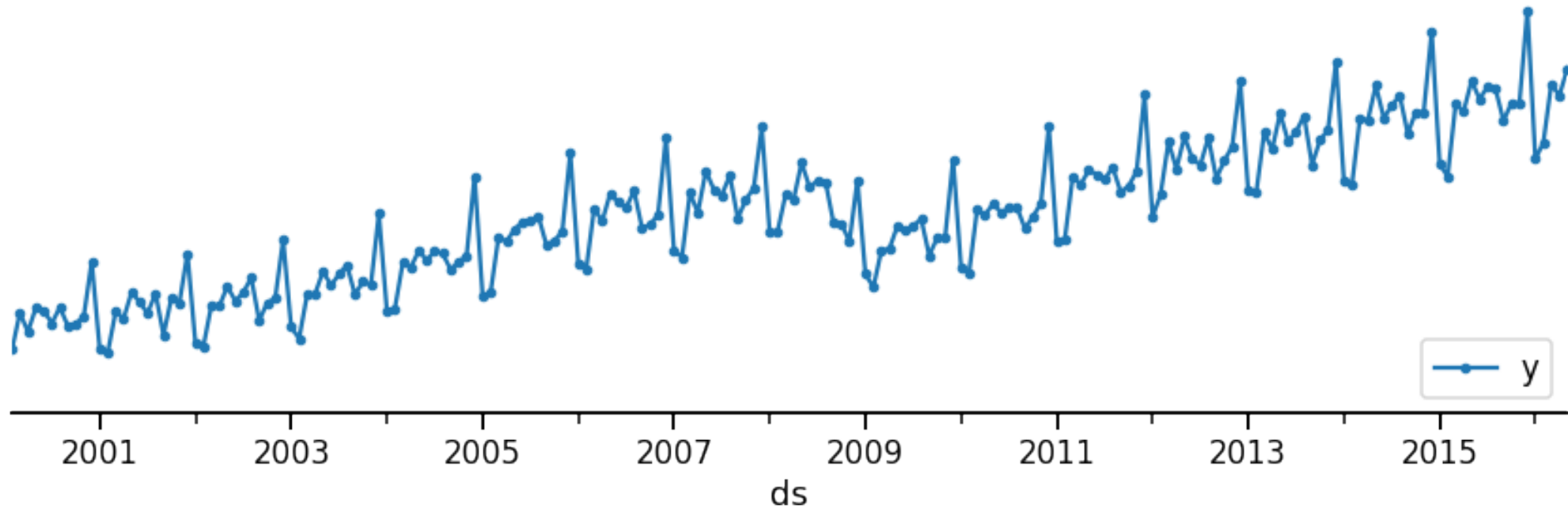
BREAKING TIME SERIES  
INTO COMPONENTS



WHY IS THIS USEFUL?

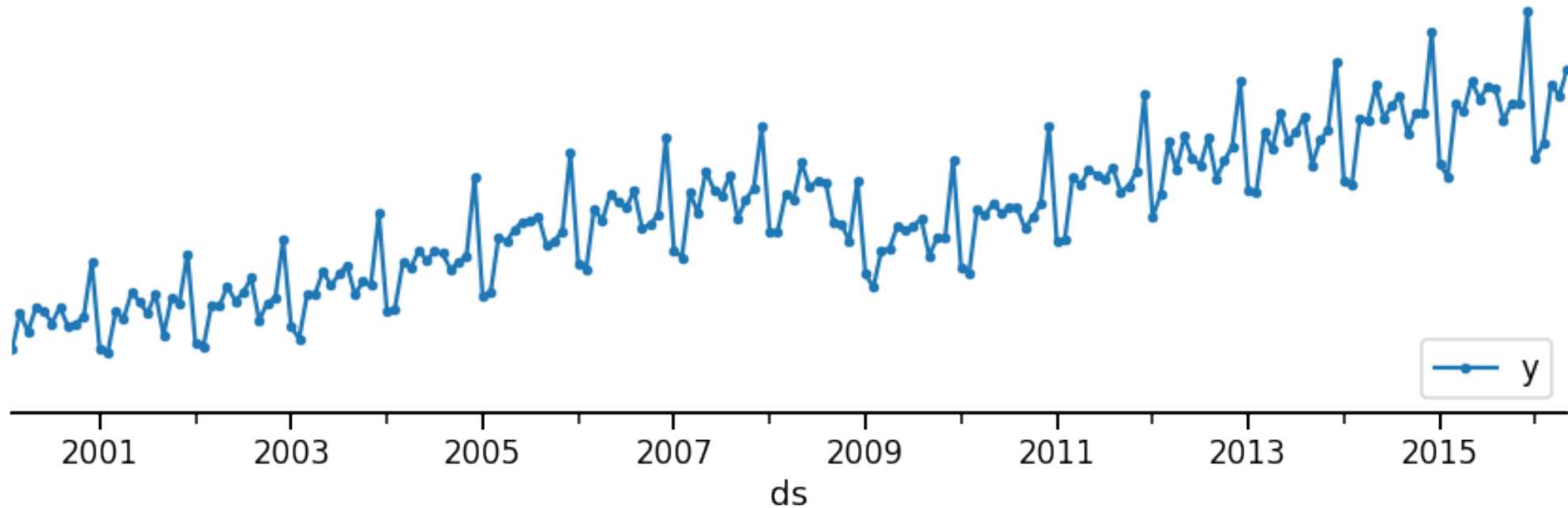
# Time series components

- Time series can sometimes be broken into individual components. Typically a trend, seasonal, and a residual component



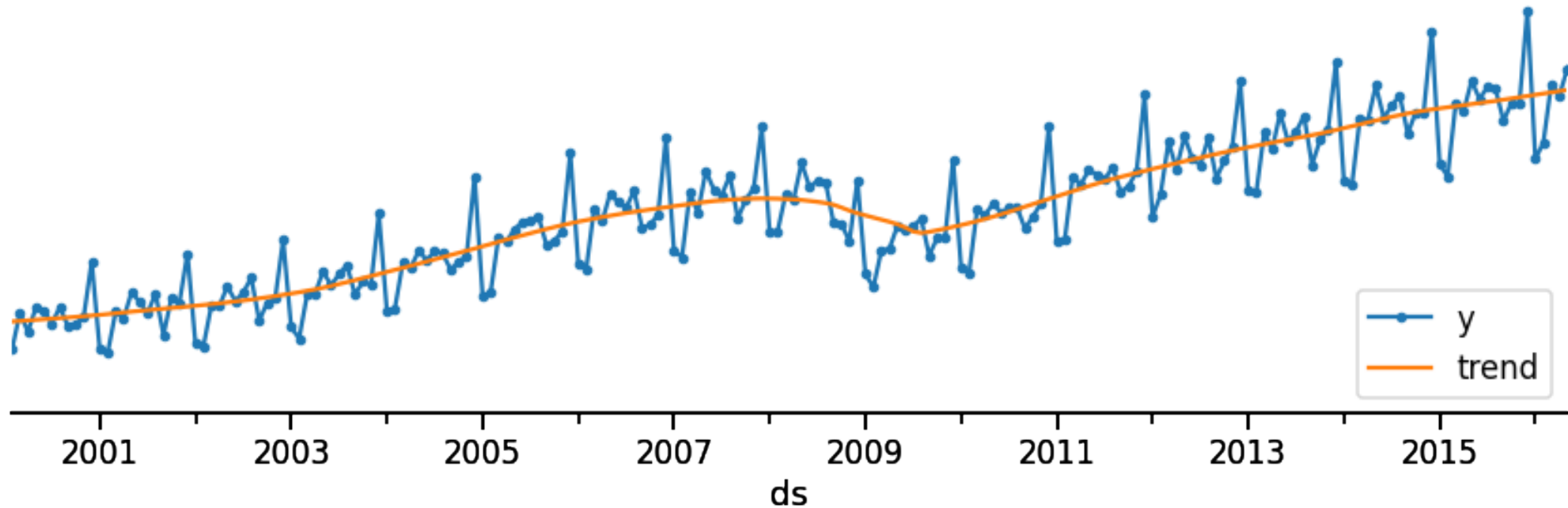
# Time series components: Trend

- Trend: A trend is a long-term increase or decrease of the baseline of the time series, not necessarily linear.



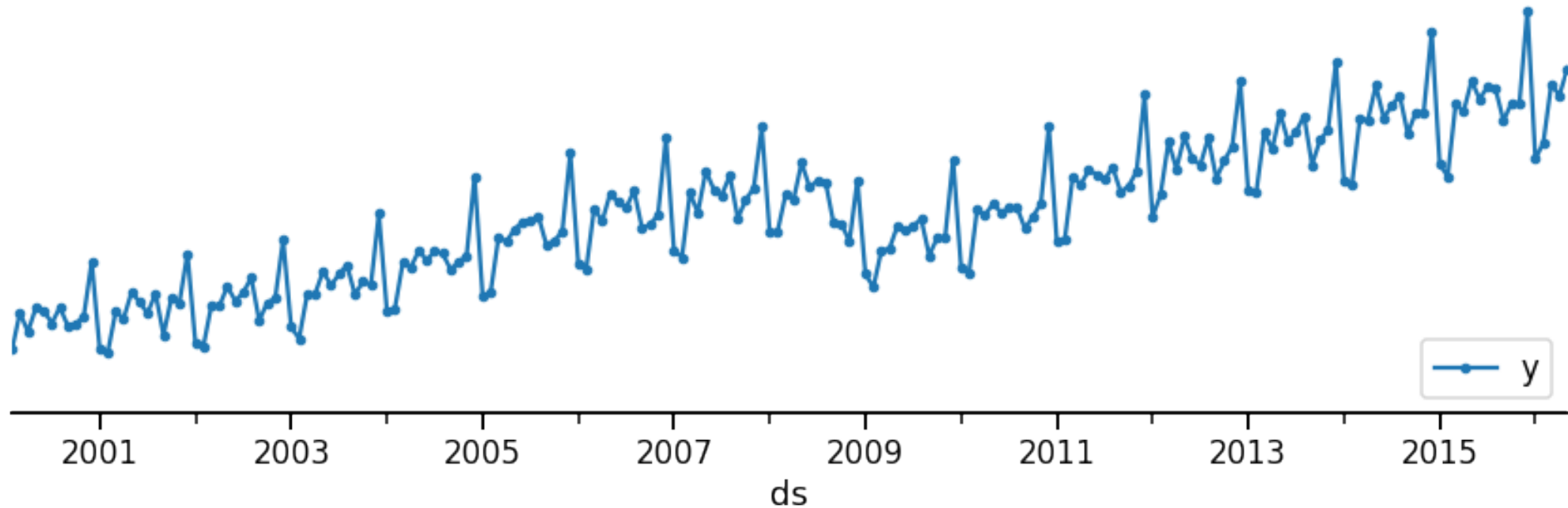
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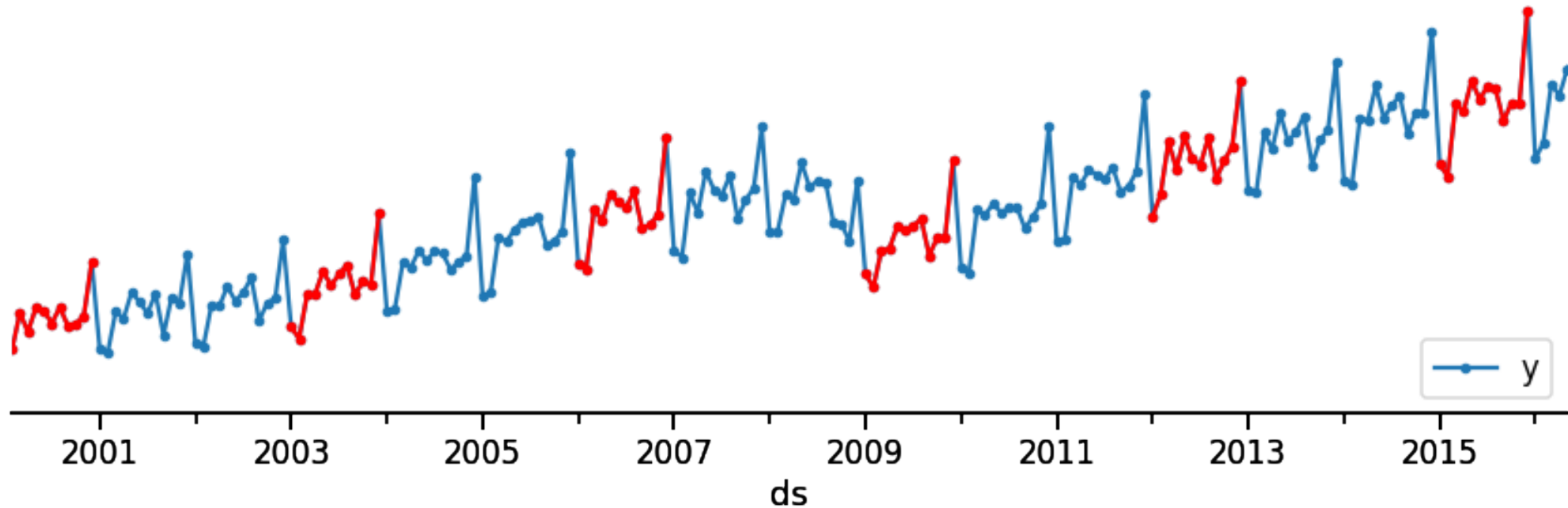
# Time series components: Seasonality

- Seasonality: A fixed periodic pattern in the time series. Patterns relate to seasonal factors such as time of the year or day of week.
- Examples: Black Friday, Christmas, School holidays, etc.

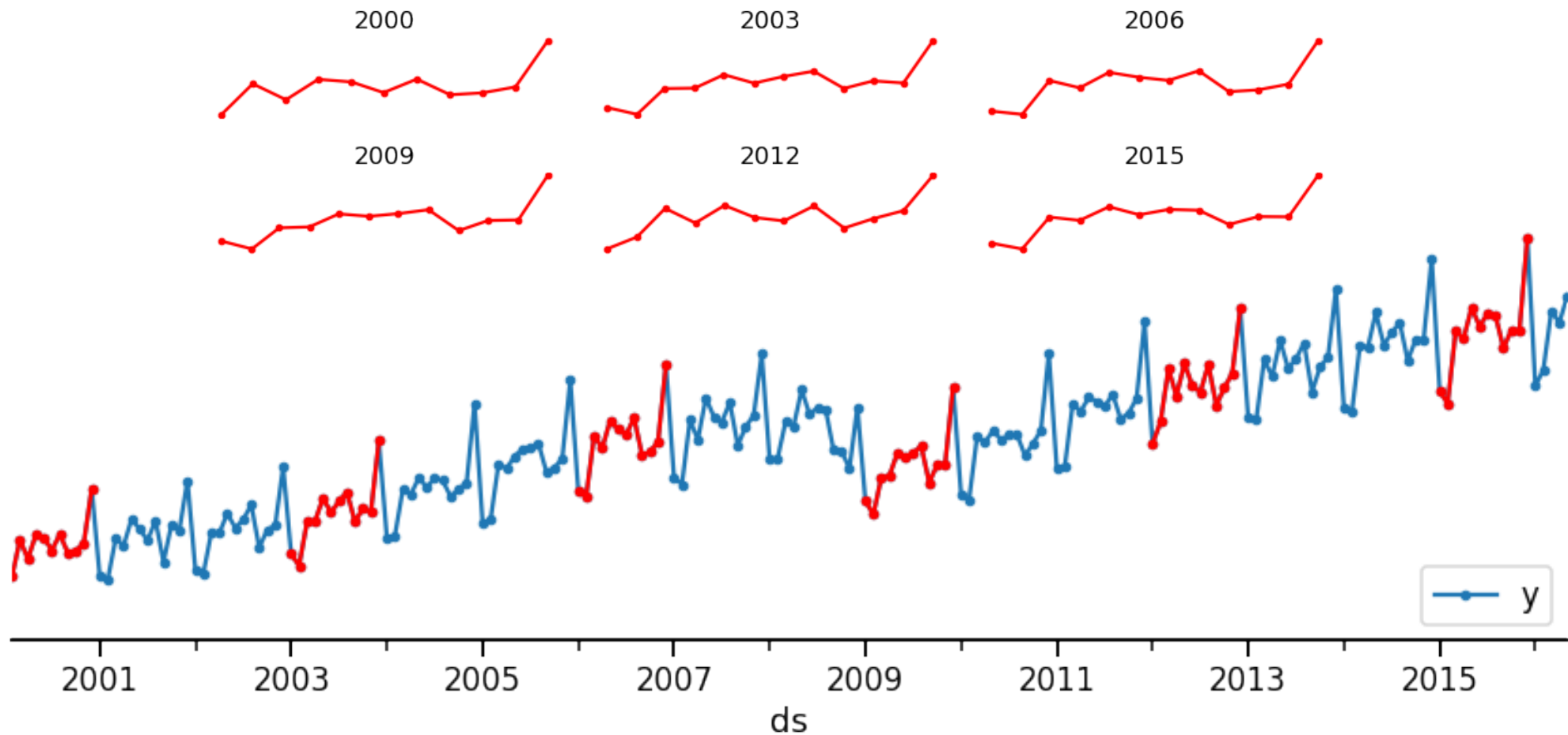


# Time series components: Seasonality

- Let us highlight some years here to illustrate yearly seasonality (i.e., a repeating pattern that occurs each year)



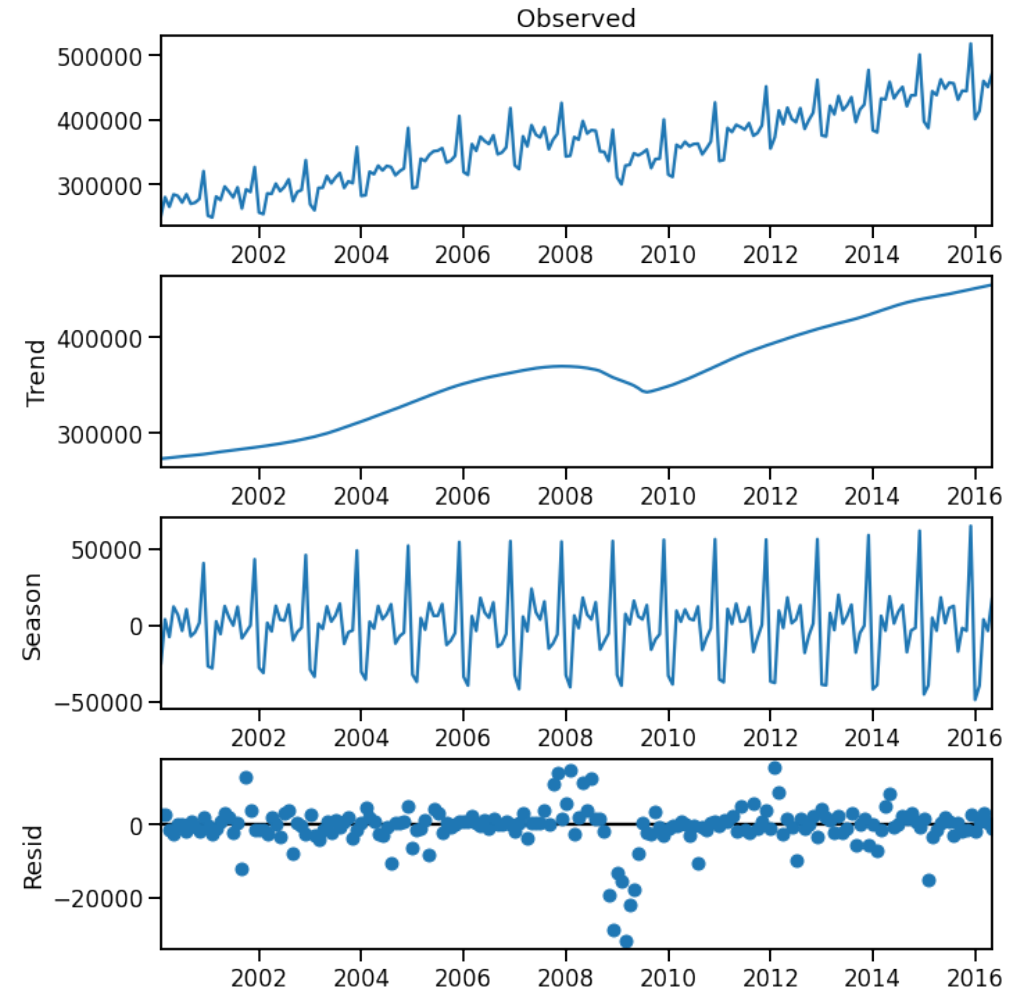
# Time series components: Seasonality





# Time series components: Residual

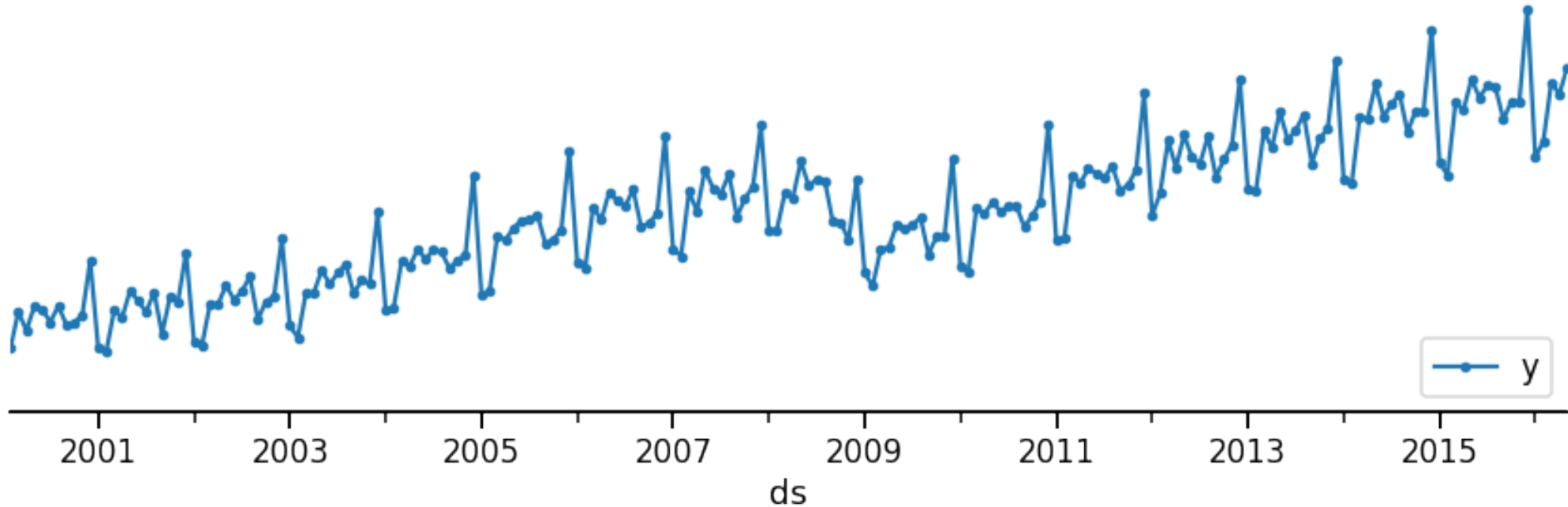
- The residual (aka. remainder, irregular) component is everything leftover after subtracting the other components



# Time series components: Bringing it back together

$$y(t) = \text{trend}(t) + \text{seasonal}(t) + \text{residual}(t)$$

$$y(t) = \text{trend}(t) \times \text{seasonal}(t) \times \text{residual}(t)$$



# Why is decomposition useful?



**Exploratory data analysis:** To answer questions such as “what was the impact of an ad campaign once we account for seasonality?”



**Pre-processing:** Useful for identifying outliers and can be used to impute outliers and missing data



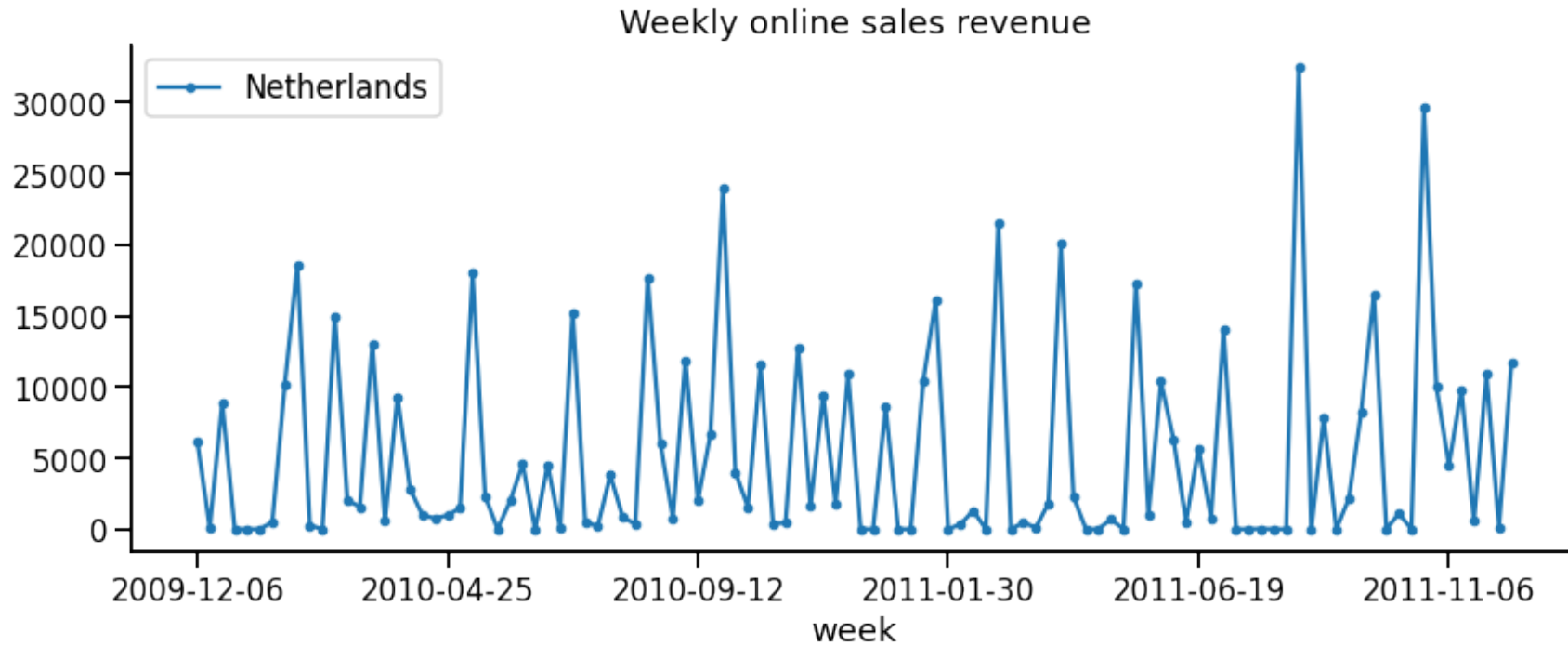
**Feature engineering:** Can derive features from the components to use as inputs in machine learning models



**Forecasting:** Forecast the components and aggregate to produce the final forecast

# Decomposition is not always possible

- Not all time series can be easily broken down into components



# Summary

Time series can be decomposed into components

Trend, seasonality, and a residual component is the most common

Decomposition is used in multiple ways including EDA, feature engineering, preprocessing, and forecasting

# Time series components: Seasonality

$$\text{seasonal}(t + T) = \text{seasonal}(t)$$

T is the period of the seasonality (e.g., 1 year)

