

# Handling Seasonal Datasets and Working with Seasonality

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# Seasonal Datasets



## Seasonality in time series datasets

### Capturing the seasonal pattern via data visualizations

- Season plot, month plot

### Extending the ARIMA model by seasonal parameters (SARIMA)

- Function `auto_arima()` from `pmdarima`

### Exploratory analysis with simple and STL decomposition



# Seasonality in Time Series

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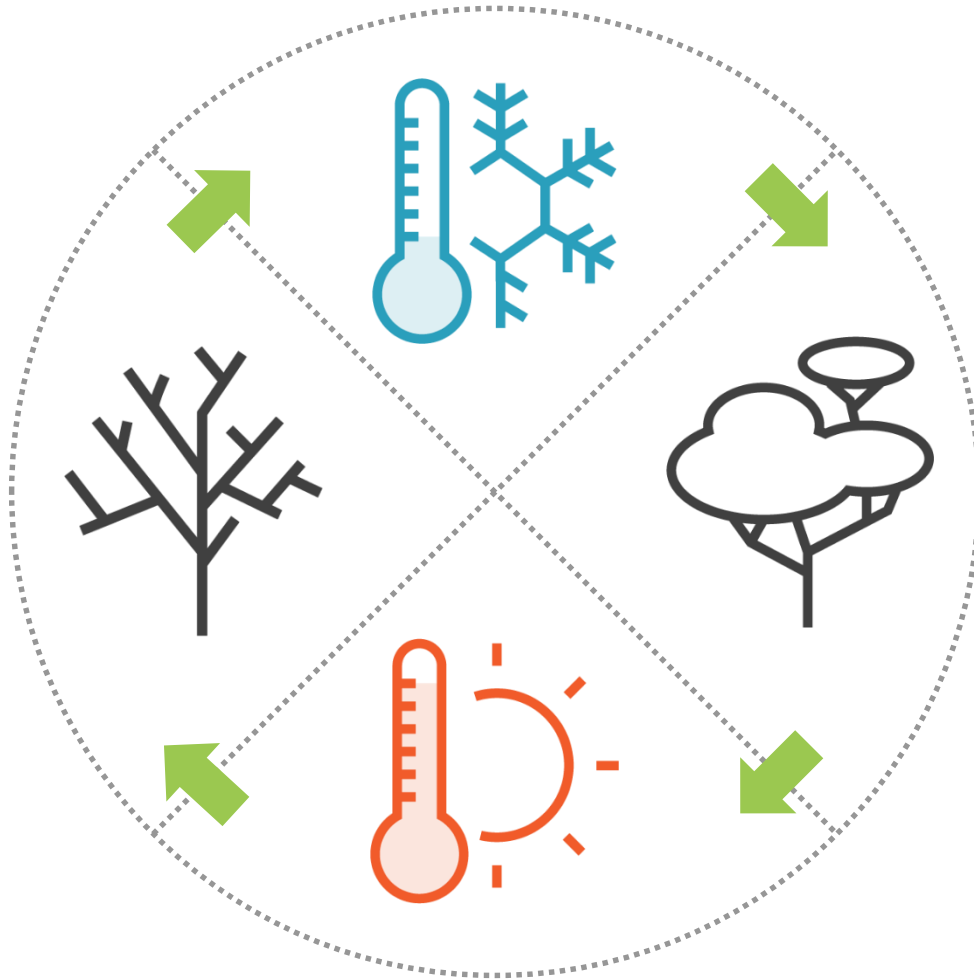


# Seasonality

A recurring pattern of seasonal cycles (year, month, week, day, hour). The pattern is enabled by a seasonal frequency, the number of periods that form one seasonal cycle.



# Temperature Patterns

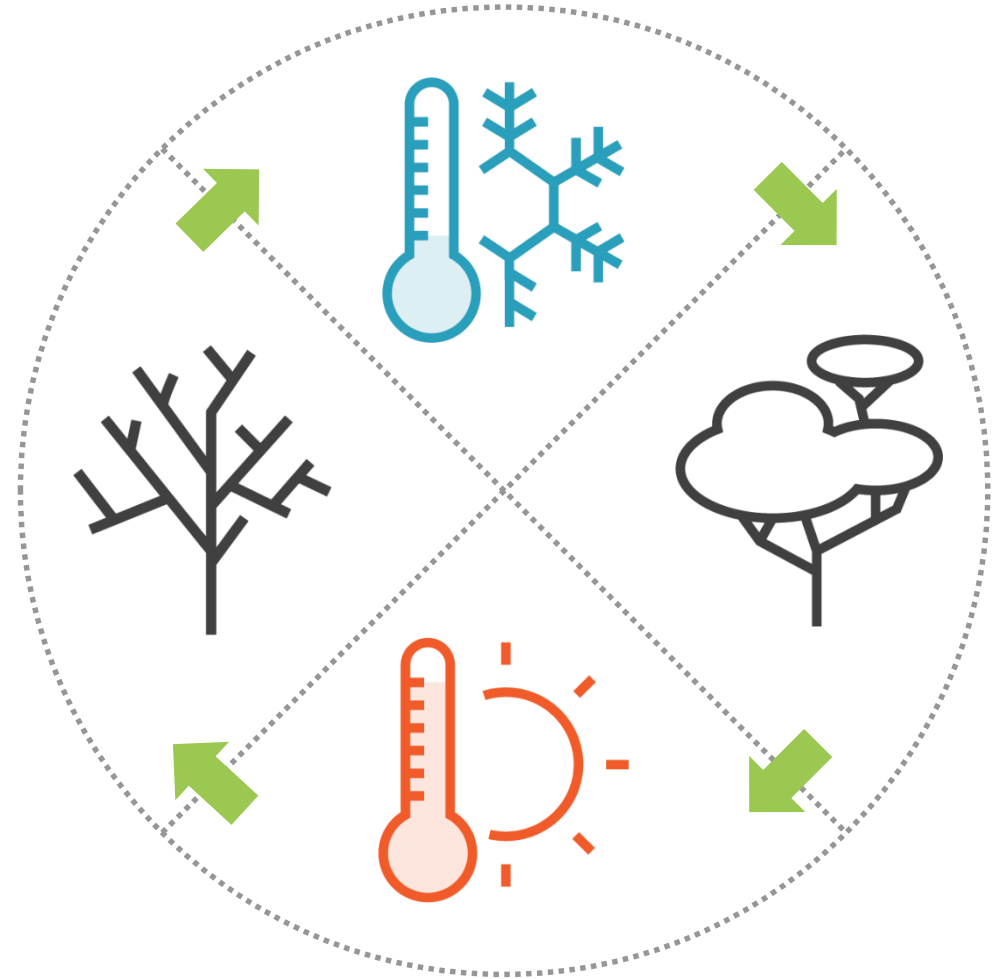


Yearly seasonal cycle

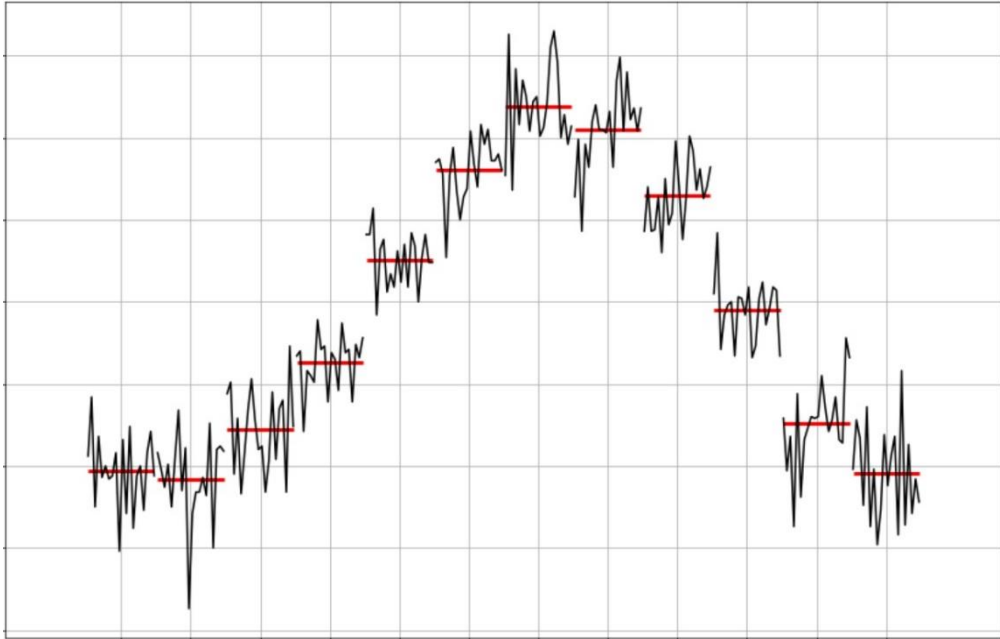
By month (12)

By week (approx. 52)

The seasonal cycle  
structures the data

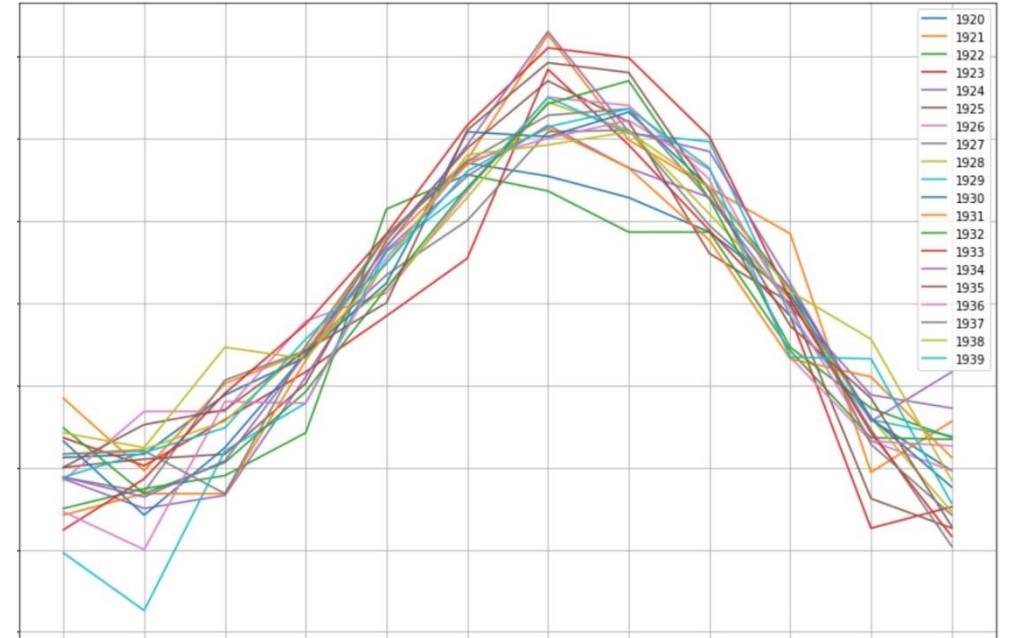


# Visualizing the Seasonal Pattern



**Month Plot**

Extracts patterns by plotting the seasons of a cycle in chronological order



**Season Plot**

Emphasizes the pattern by plotting the seasonal cycles over one another

# Seasonal ARIMA Model

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ARIMA( $p, d, q$ )( $P, D, Q$ )[ $m$ ]

ARIMA( $2, 1, 0$ )( $0, 0, 2$ )[ $12$ ]

## Parameters of a SARIMA Model

- General terms: Two autoregressive orders and one differencing step
- Seasonal terms: Two moving average terms
- Frequency of 12



# SARIMA Model Setup

**The parameter selection process gets more complex**

- Use ACF and PACF plots with a minimum of three seasonal cycles
- Example: Plot 36 lags if frequency is 12 (3x12)

**Automatic parameter selection tool**

- Function `auto_arima()` from `pmdarima`

**Dataset: `nottem.csv`**



# Simple Seasonal Decomposition

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# Modeling Univariate Seasonal Time Series

Seasonal ARIMA  
(SARIMA)

Holt-Winters  
exponential  
smoothing

Seasonal  
decomposition



# Seasonal Decomposition

**Divides the time series into its components:  
Trend, seasonality, residuals**

**Additive model: Summation of  
the components**

**Multiplicative model: Multiplication of  
the components**



# Simple Seasonal Decomposition

Constant seasonal  
component

NaN values

Slow to catch fast  
rises

Simplicity

A good starting  
point



# STL Decomposition

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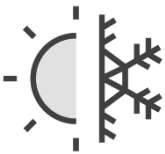
# Seasonal and Trend Decomposition Based on Loess



No missing observations



Robust towards outliers



Seasonality can be adjusted



Predictive analysis





# Pre-Defined Forecast Functions

**Naive: Last observation  
carried forward**

**Drift: Trend carried forward**

**Mean: Average of the series  
carried forward**

**Naive seasonal: LOCF with  
seasonal effect**



STL decomposition is a  
great benchmark against  
more advanced models.



# Seasonal Datasets



Seasonality is captured by the frequency

Generating month plots (statsmodels)  
and season plots (custom code)

Automatic ARIMA parameter selection  
with `auto_arima` (pmdarima)

Dividing the time series into its  
components (statsmodels, `stldecompose`)