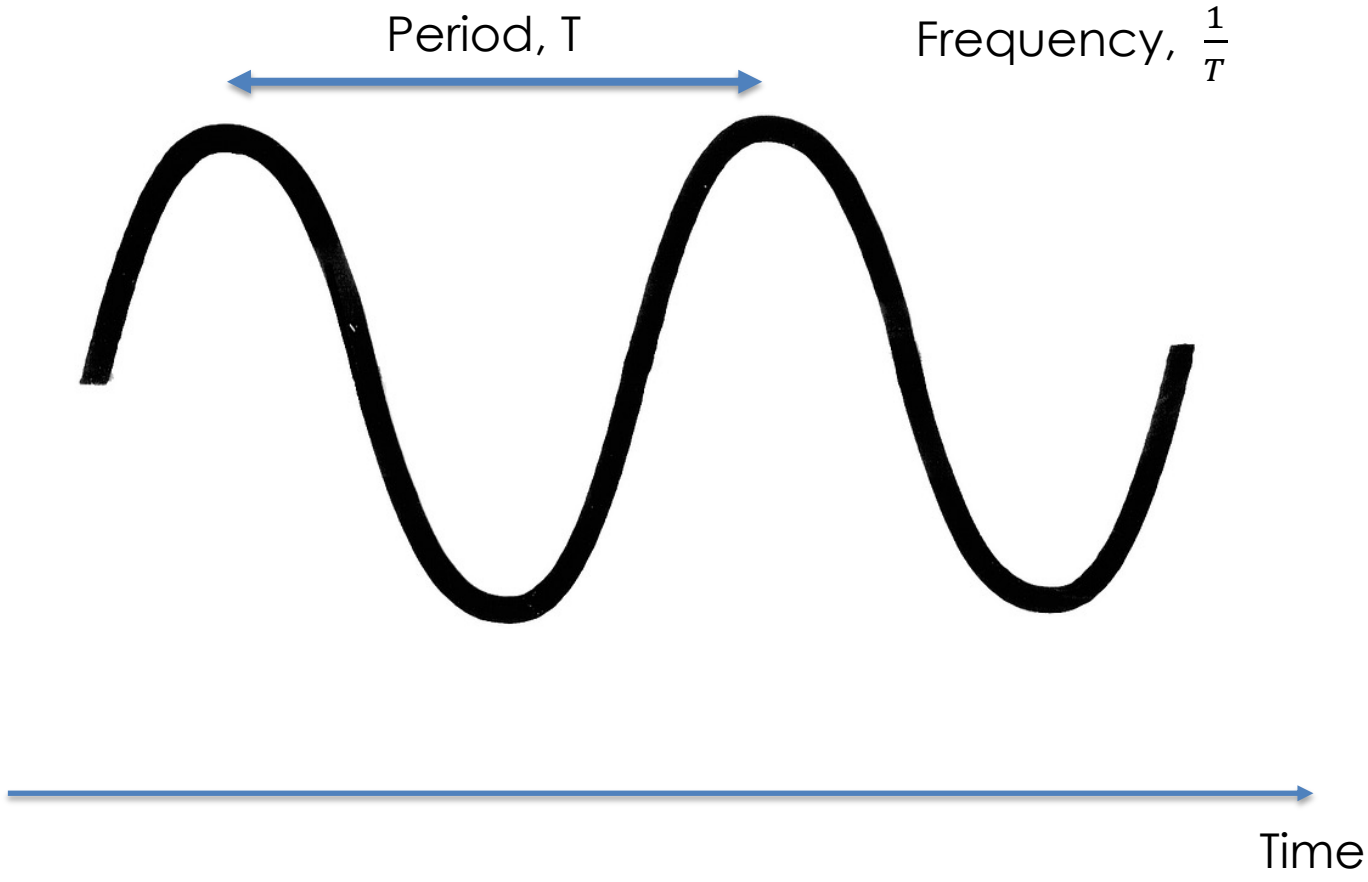
Seasonality & Cyclical patterns

Seasonality features

Terminology



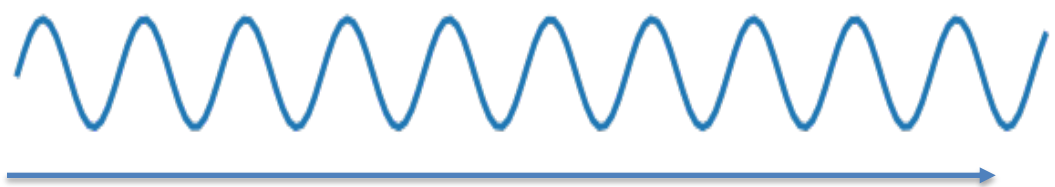
Period, T: The time taken for one repetition of a cycle.

Frequency , $\frac{1}{T}$: Number of occurrences of a repeating event over a unit of time.

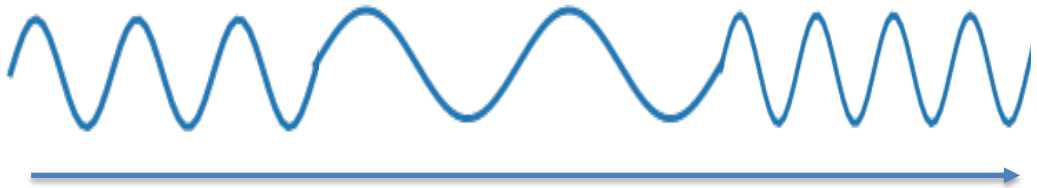
Example: For an **hourly time series**, the **daily period is 24 hours** and the **frequency is 1/24 per hour**.

What is seasonality?

A pattern or effect that repeats with **a fixed frequency** over time.



fixed frequency Time

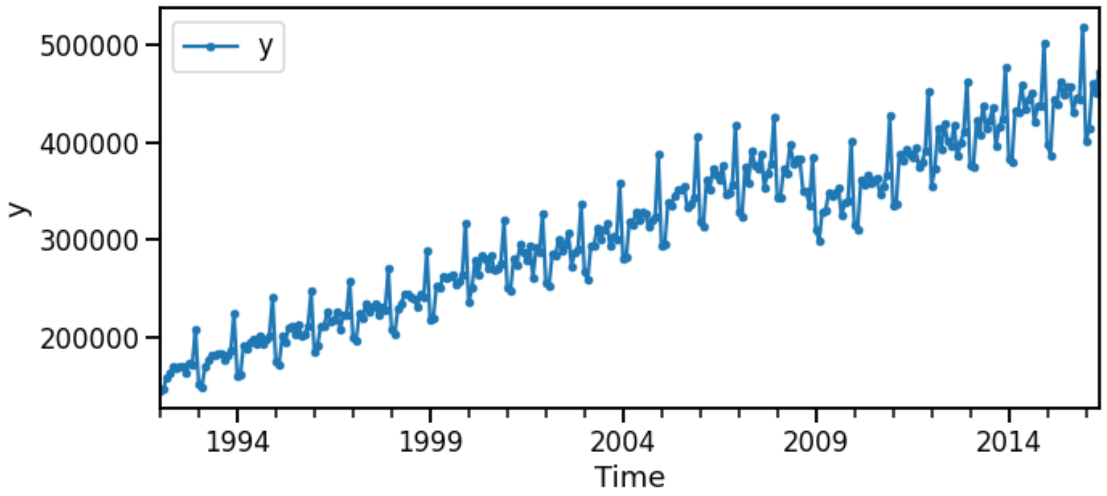


changing frequency Time

What is seasonality?

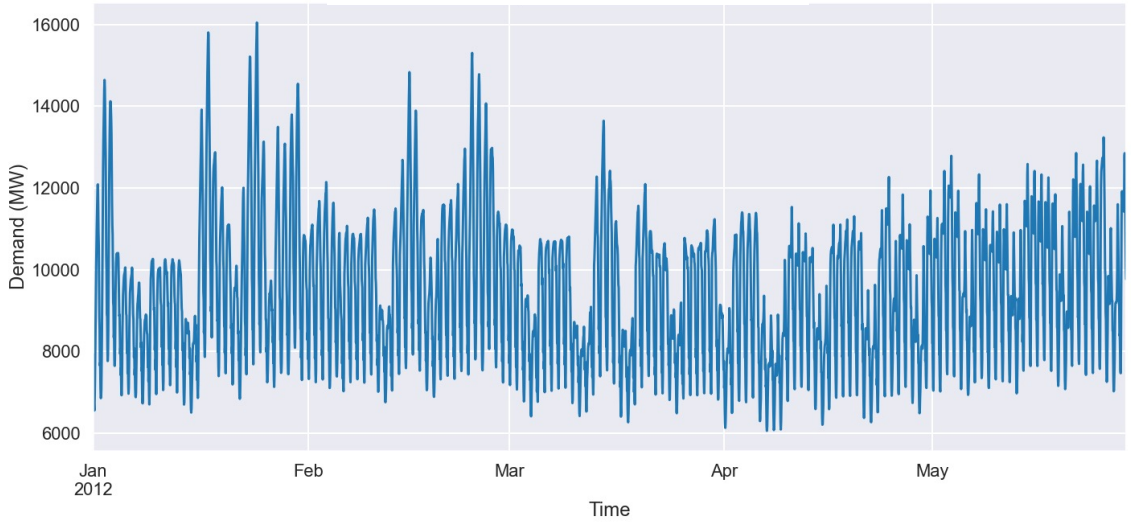
A pattern or effect that repeats with **a fixed frequency** over time.
Typically related to the calendar or time of day.

Retail sales



Yearly seasonality

Electricity demand

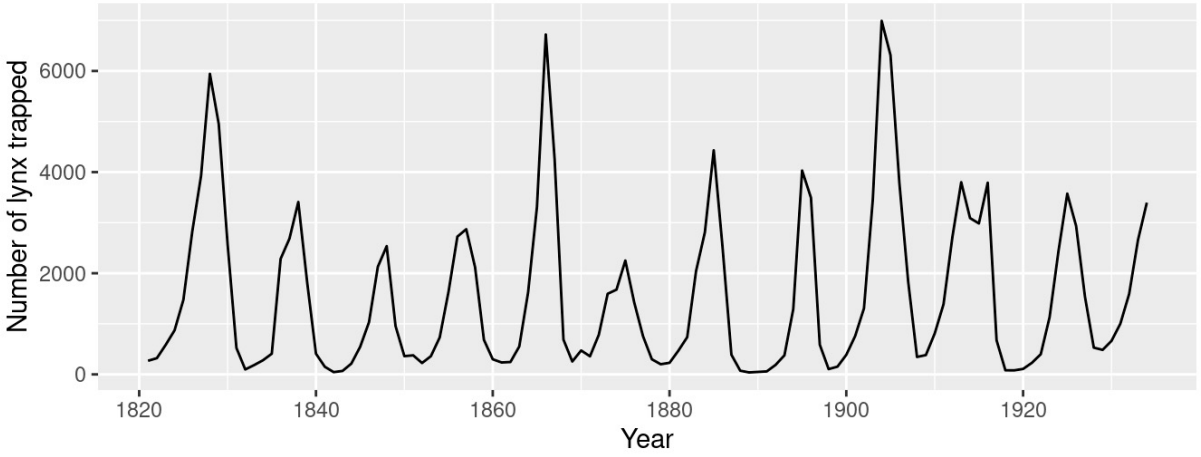


Daily, weekly, and yearly seasonality

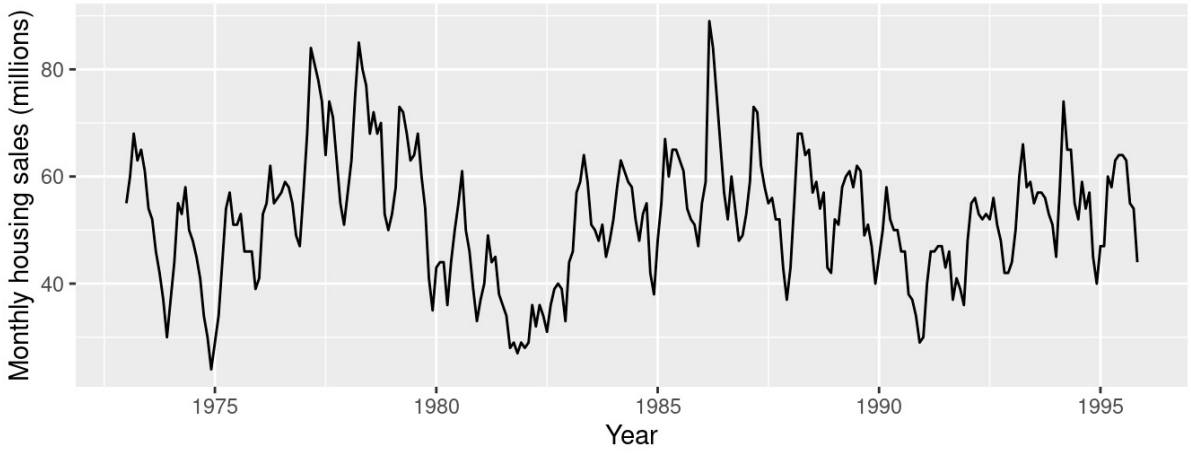
What are cyclical patterns?

A pattern that repeats **without a fixed frequency** over time.

Number of lynx



Monthly house sales in USA



Source: https://robjhyndman.com/hyndsight/cyclicts/

Features to capture seasonality and cyclical patterns

Seasonality

1. Lag features
2. Calendar features (aka datetime features)
3. Seasonal dummies (aka seasonal indicators)
4. Fourier features

Cyclical patterns

1. Lag features

Features to capture seasonality and cyclical patterns

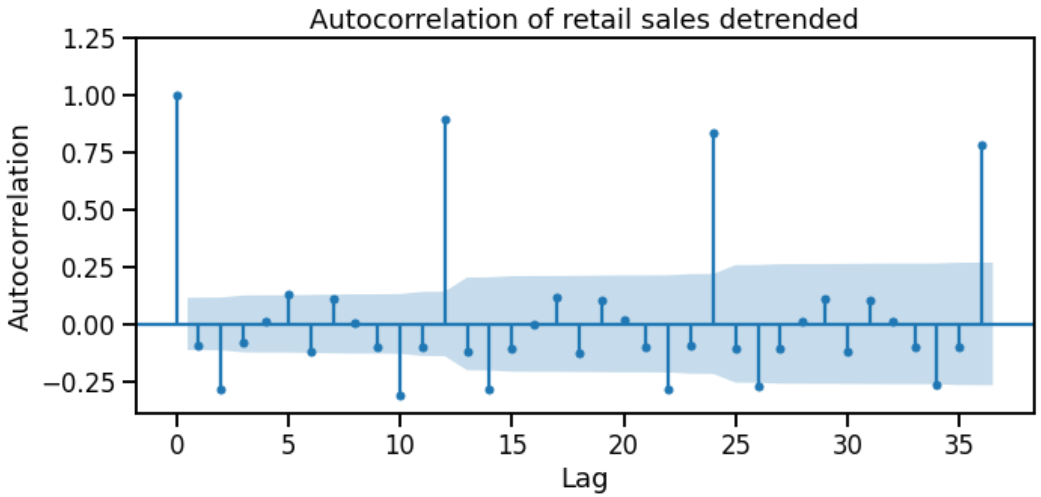
Seasonality

1. **Lag features**
2. Calendar features (aka datetime features)
3. Seasonal dummies (aka seasonal indicators)
4. Fourier features

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-12}$$

Cyclical patterns

1. **Lag features**



Features to capture seasonality and cyclical patterns

Seasonality

1. Lag features
2. **Calendar features (aka datetime features)**
3. Seasonal dummies (aka seasonal indicators)
4. Fourier features

Cyclical patterns

1. Lag features

Date	Sales	Month	Day of week
2020-02-12	23	2	2
2020-02-13	30	2	3
2020-02-14	35	2	4
2020-02-15	30	2	5
2020-02-16	?	2	6

Features to capture seasonality and cyclical patterns

Seasonality

1. Lag features
2. Calendar features (aka datetime features)
3. **Seasonal dummies (aka seasonal indicators)**
4. Fourier features

Cyclical patterns

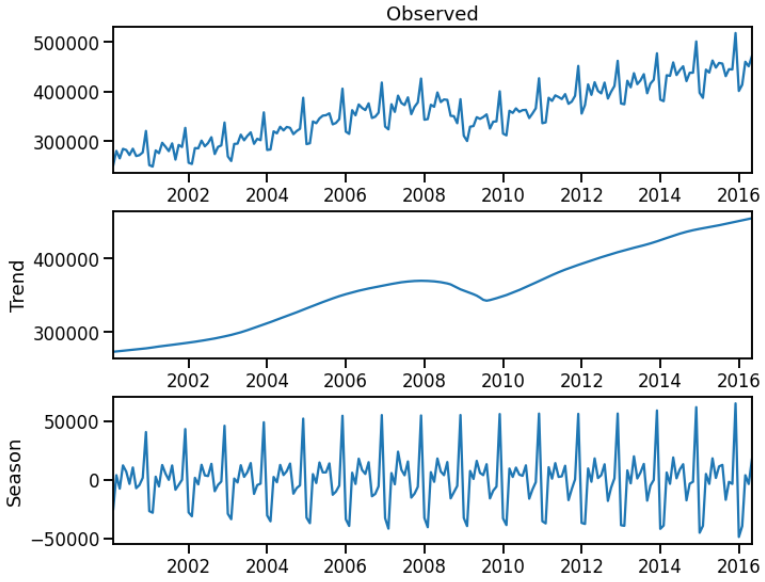
1. Lag features

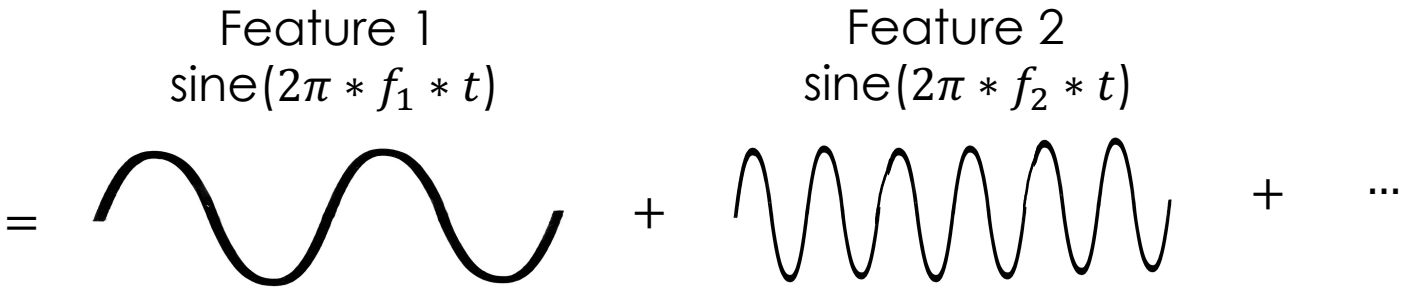
Date	Sales	Is_Jan	Is_Feb	Is_Mar	…
2020-02-12	23	0	1	0	
2020-02-13	30	0	1	0	
2020-02-14	35	0	1	0	
2020-02-15	30	0	1	0	
2020-02-16	?	0	1	0	

Features to capture seasonality and cyclical patterns

Seasonality

1. Lag features
2. Calendar features (aka datetime features)
3. Seasonal dummies (aka seasonal indicators)
4. **Fourier features**





Cyclical patterns

1. Lag features