Overview

Outliers

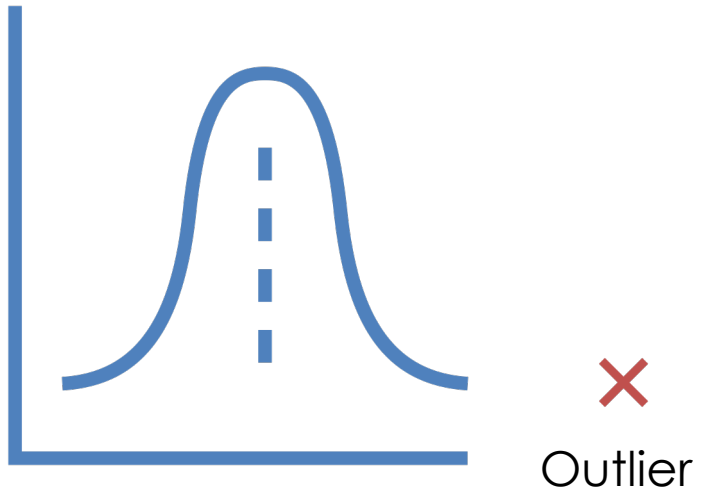
Contents

WHAT IS AN OUTLIER?

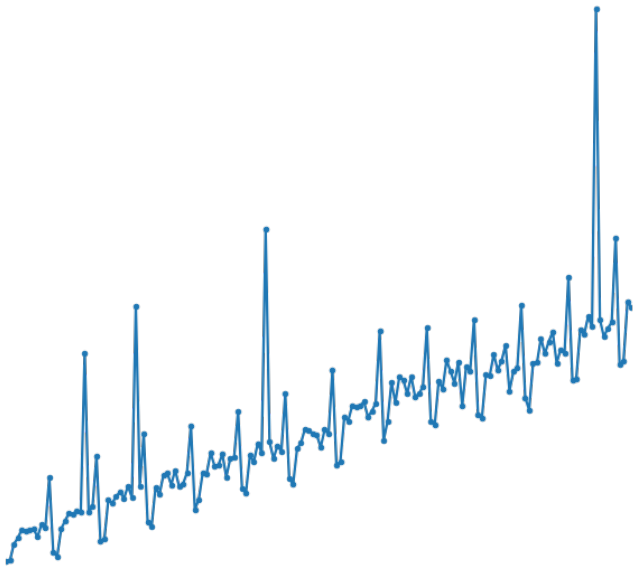
METHODS TO IDENTIFY OUTLIERS

What is an outlier?

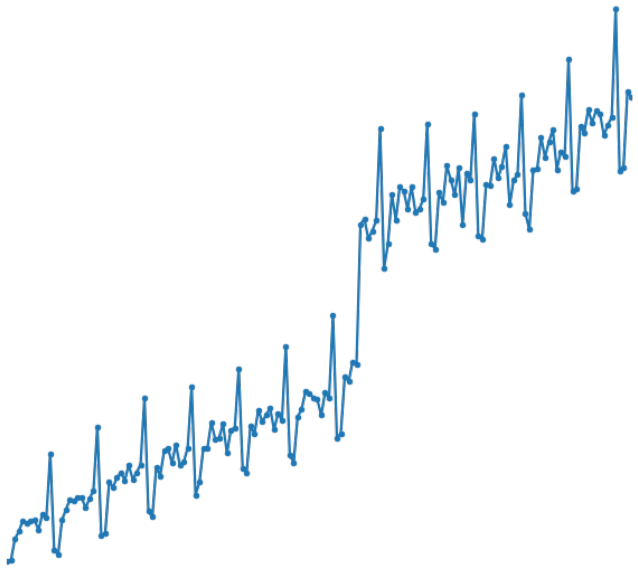
- Data that is very different from other observations
- Suspicion that data generating process is different for these points
- Cause of the outlier determines how we handle it



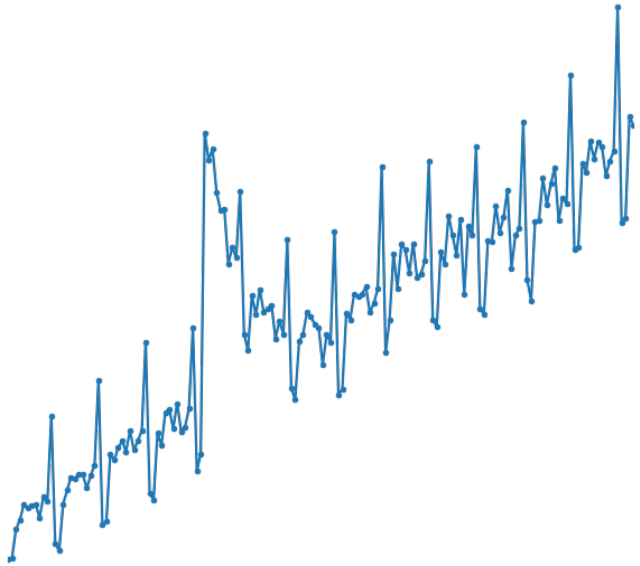
Outliers in time series data



Point outliers



Level shift outlier



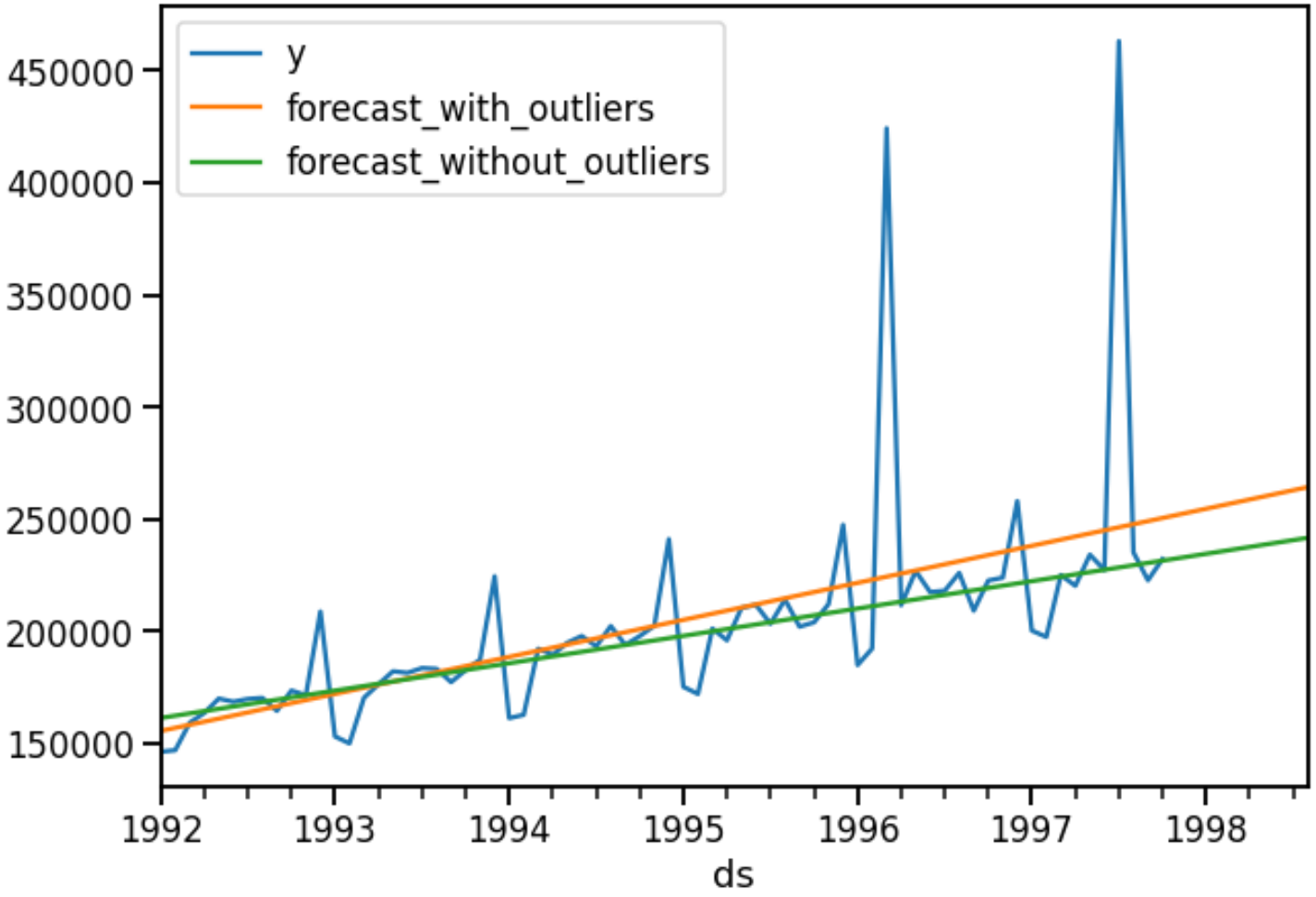
Transient shift outlier

Subsequence outlier *

* Blázquez-García, Ane, et al. "A review on outlier/anomaly detection in time series data." arXiv preprint arXiv:2002.04236 (2020)

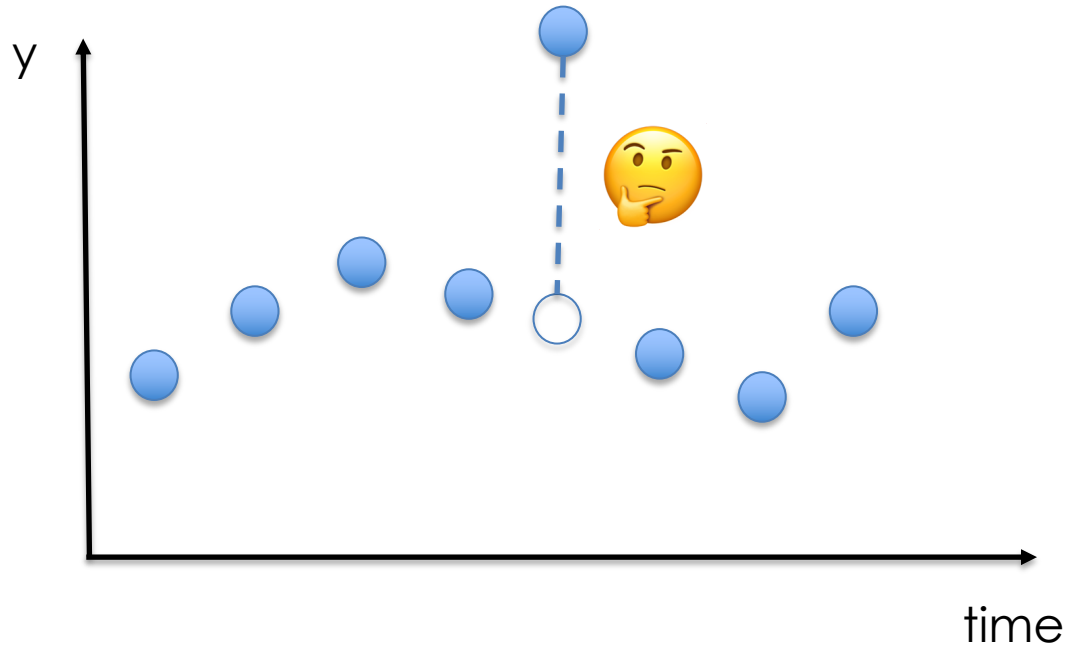
Why are outliers a problem?

Outliers can bias models which result in worse forecasts



Estimation methods

- Examine each actual: y_t
- Compute expected value: $\hat{y}_t$
- Is actual very different than expected?
- If yes, flag as an outlier
- Formally: $|y_t - \hat{y}_t| > \delta$, where δ is a threshold to select outliers



Estimation methods to identify outliers

1. Rolling mean
2. Rolling median
3. LOWESS residuals
4. STL residuals

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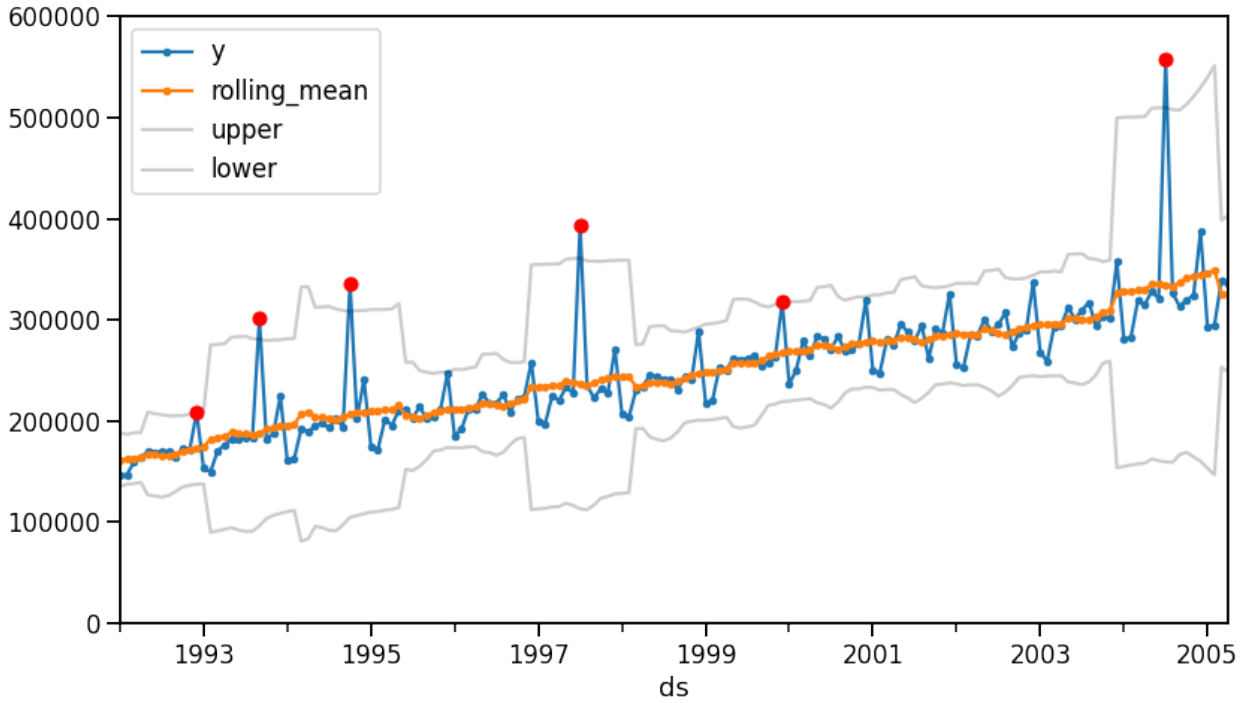

De-seasonalize the data first if seasonal!

Estimation methods to identify outliers

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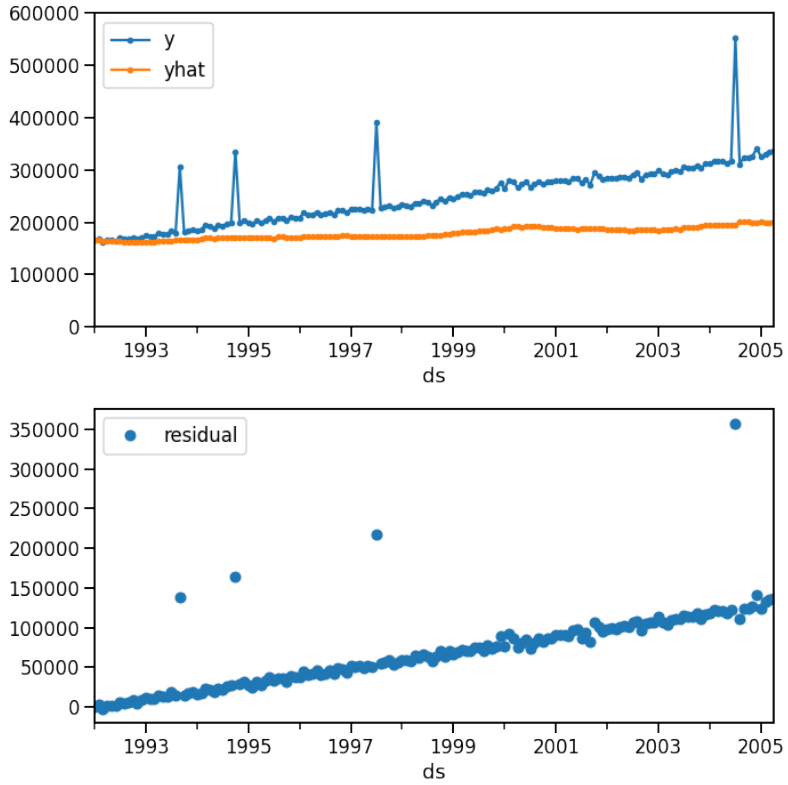
3. LOWESS residuals
4. STL residuals



Check for stationary residuals!

Estimation methods to identify outliers

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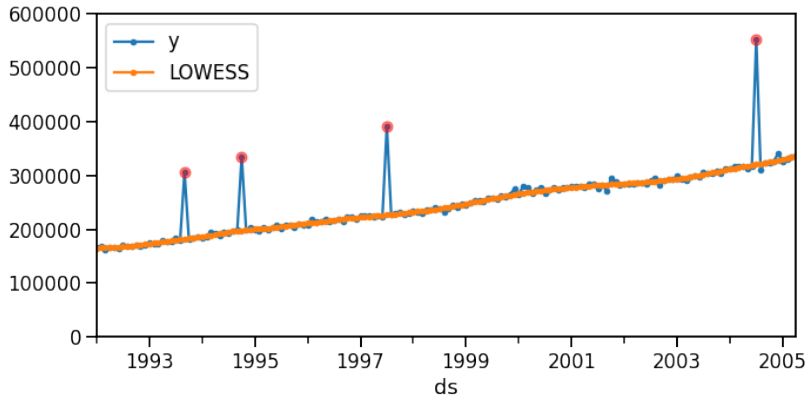

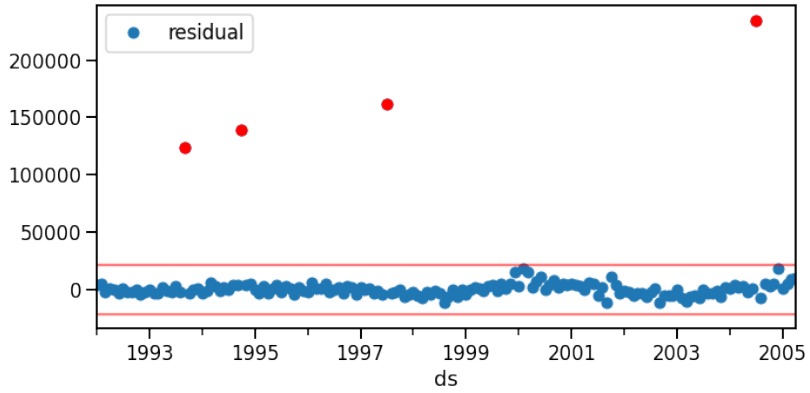

Check for stationary residuals!

Practical tips

- Strong seasonality: STL residuals
- Long term trends: LOWESS residuals
- Faster results: rolling mean or rolling median
- Adjust sensitivity depending on the use case:
  - Do you only care about extreme outliers?
  - What is the cost of a false positive? (e.g., manual review time but reduced business risk)
- Understand the nature of the outlier
  - Known cause which can occur in the future: Model the outlier as a feature
  - Random or uncontrollable: Treat as missing value and impute
- Sense check time series plots before and after imputation (even on a subsample)

Methods shown here are for time series: can be feature or target

Date	y	temperature	Foot fall
2015-01-03	18	23	0
2015-01-04	10000	26	20
2015-01-05	15	-3	2
2015-01-06	7	24	3

- Features which take discrete values and low volumes (i.e., count data) lack structure for STL and LOWESS.
- If the data is count like consider using rolling statistics methods or if the data looks stationary use extreme value analysis methods (e.g., IQR rule)