Log transform

Time series decomposition

Contents

LOG TRANSFORM

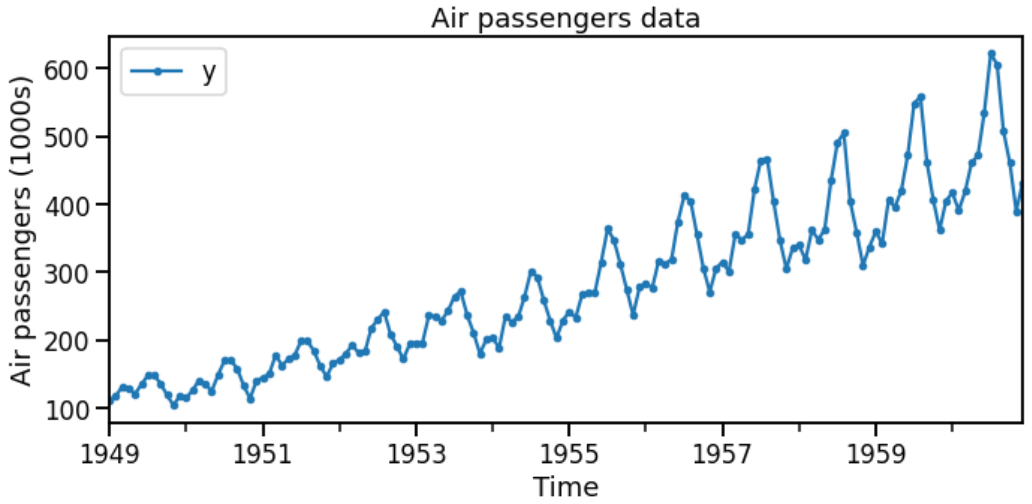
DISCUSS WHEN TO USE IT

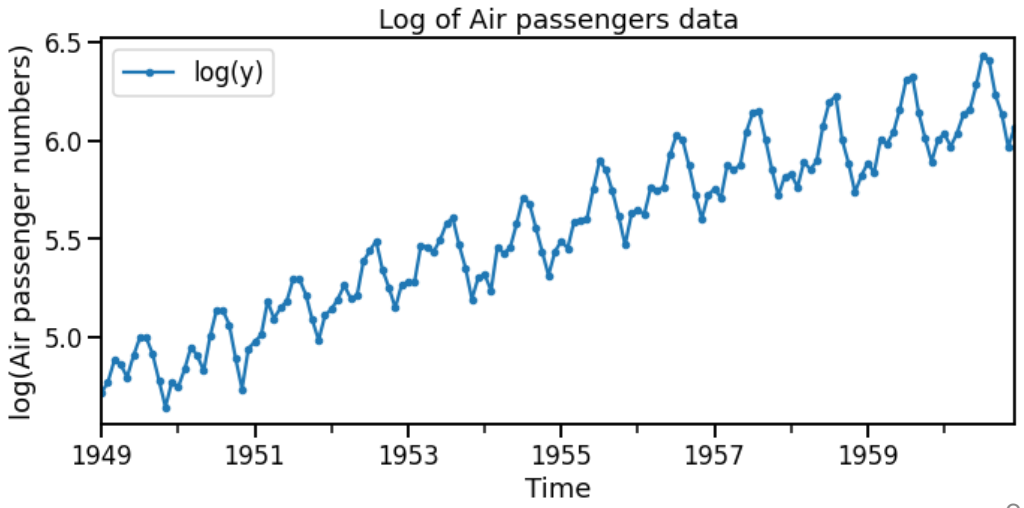
Log transform

- Some forecasting & decomposition methods perform better if the variance of the time series does not change with the level of the time series (e.g., ARIMA).
- The log transform can be used to stabilize the variance of a time series.
- The transform:

$$\tilde{y} = \log_b(y) \leftrightarrow y = b^{\tilde{y}}$$

- If the time series goes to zero or has negative values then $\log_b(y)$ is undefined. Can overcome this by adjusting the transform to: $\tilde{y} = \log_b(y + c) \leftrightarrow y = b^{\tilde{y}} - c$





Converting multiplicative to additive

- A multiplicative decomposition can be converted into an additive decomposition by taking the log of the target y(t).

- Take the log of y(t) for the multiplicative case:

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

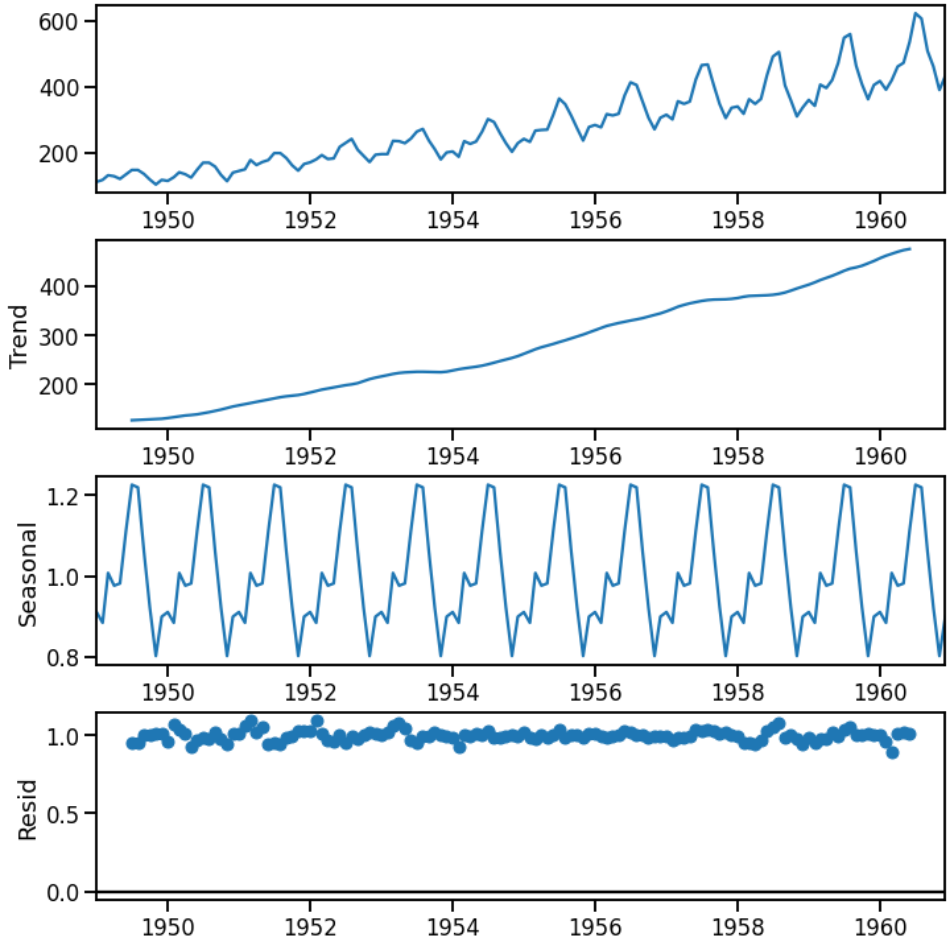
$$\log y(t) = \log (\text{trend}(t) \times \text{seasonal}(t) \times \text{residual}(t))$$

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

- If underlying time series is multiplicative then log of series is additive.

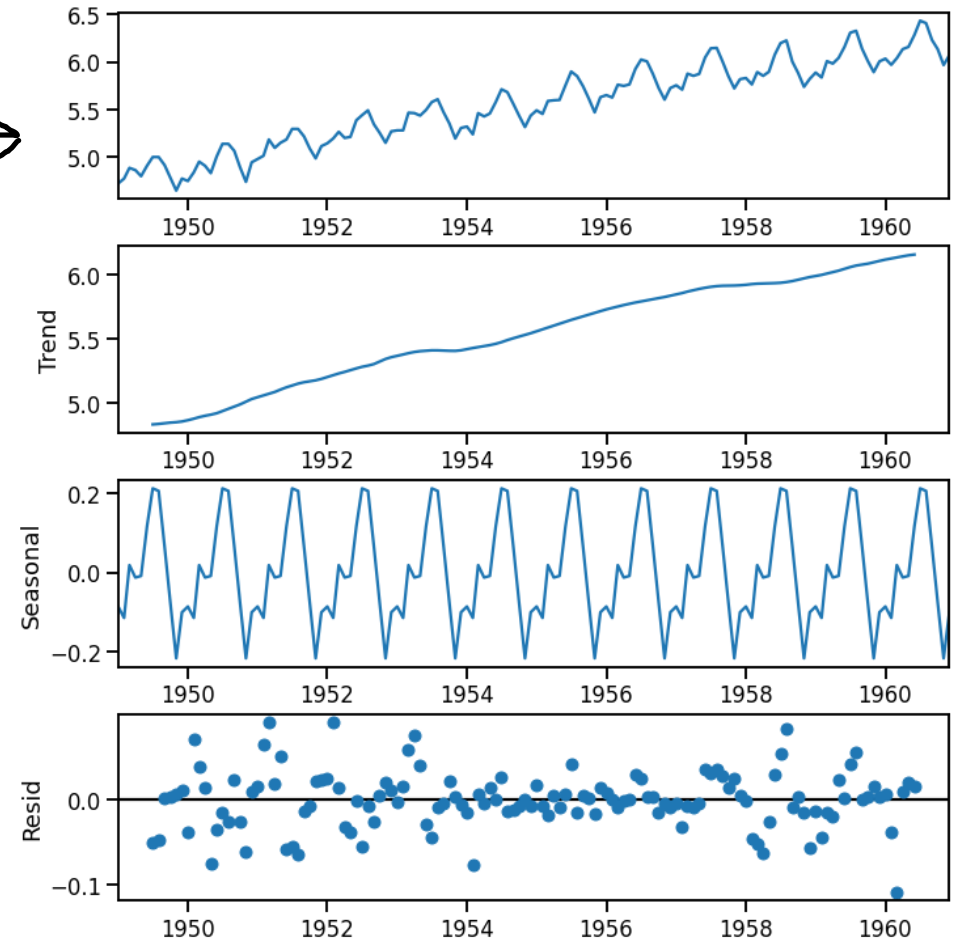
- Provides intuition as to why log transform can stabilize the variance.

Converting multiplicative to additive



Multiplicative

Log(y)



Additive

Converting multiplicative to additive

- This technique is useful because some time series decomposition methods (e.g., STL decomposition) and forecasting methods only handle the additive case.

- So we require log transforming the data first before using certain decomposition and forecasting methods.

Summary

The log transform can be used to stabilize the variance of a time series.

The log transform can convert a multiplicative time series to an additive one.