Making Series Stationary

What is Stationarity?

- A stationary series is one whose statistical properties like – mean, variance do not vary with time.

- Stationary Series will have
  - Constant mean
  - Constant variance
  - Constant Covariance

- A Series with trend and seasonality is not stationary

How to Make a Series Stationary?

- Differencing

Differencing

- Differencing
  - This is done to stabilize the mean by removing changes in the level
  - Differencing is performed by subtracting the previous observation from the present observation

$$[\ y(t) = x(t) - x(t-1)\ ]$$

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Differencing

- Differencing

	value
1	100
2	120
3	130
4	160
5	170
6	180

differencing

	value	D = 1
1	100	
2	120	20
3	130	10
4	160	30
5	170	10
6	180	10

Seasonal Differencing

- Seasonal Differencing

	value
1	100
2	20
3	150
4	55
5	220
6	98

Seasonal Differencing

- Seasonal Differencing
  - Preferred when the data has a seasonal pattern
  - Differencing is performed by subtracting the previous nth observation from the present observation
  - The value of n depends on the seasonal component

$$[\ y(t) = x(t) - x(t-n)\ ]$$

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Seasonal Differencing

- Seasonal Differencing

	value
1	100
2	20
3	150
4	55
5	220
6	98

Seasonal differencing

	value	D = 1
1	100	
2	20	
3	150	50
4	55	35
5	220	70
6	98	43

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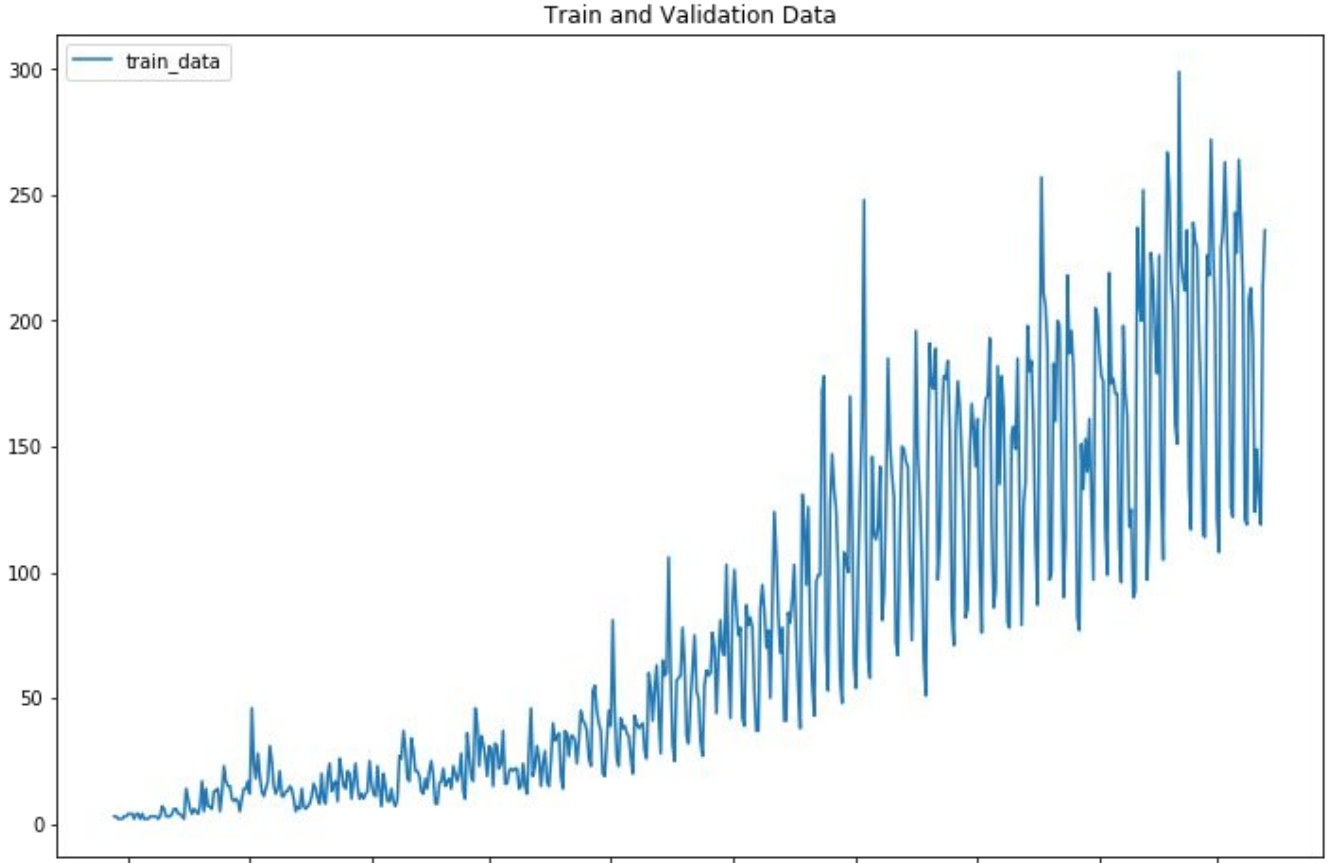
Differencing



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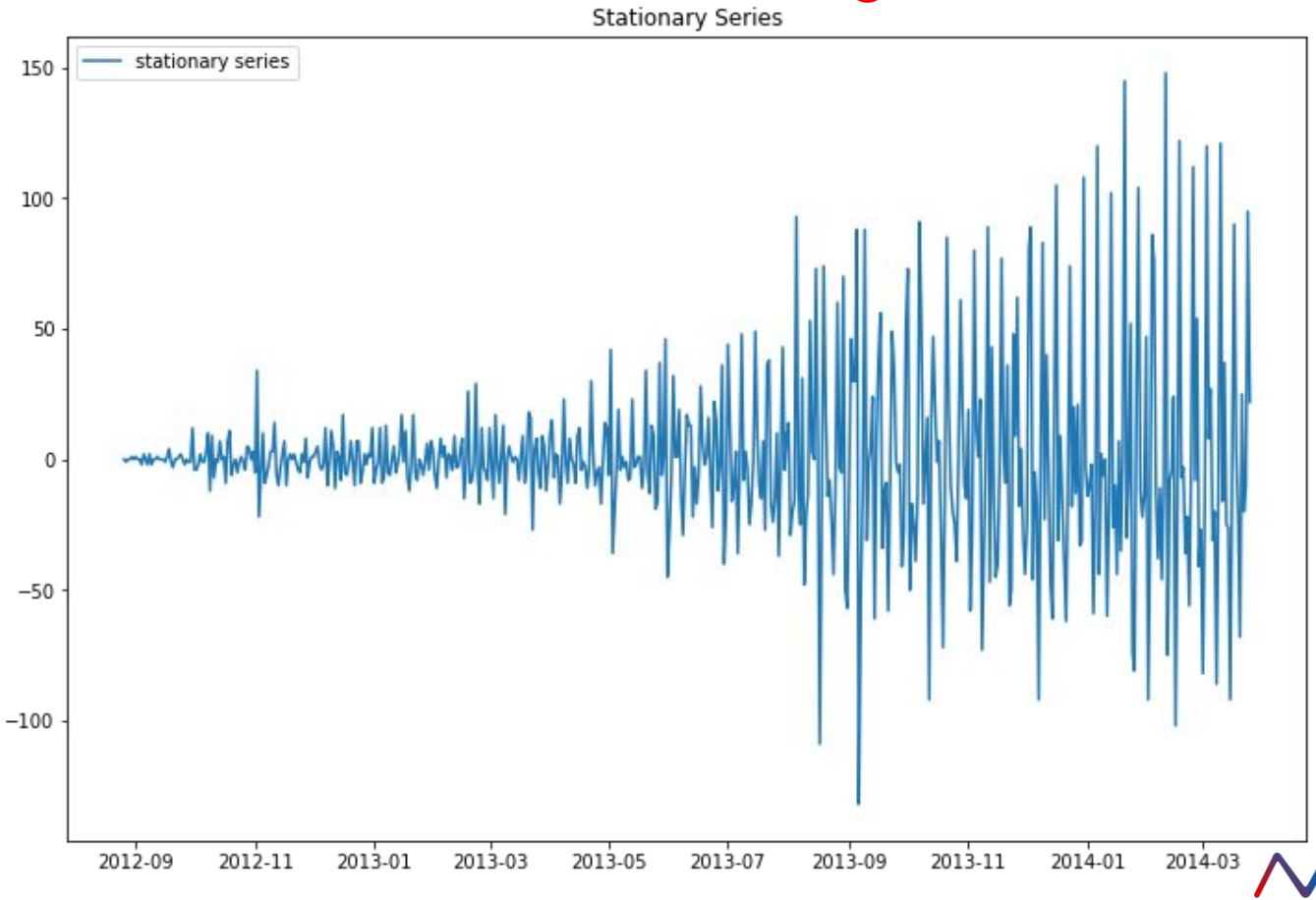
Differencing

- Differencing can stabilize the mean of the series.

Differencing



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Differencing

- Differencing can stabilize the mean of the series.
- Cannot deal with the high variance in our series.

In order to do that, we will have to look at some other techniques.

How to Make a Series Stationary?

- Differencing
- Seasonal Differencing
- Log transform
- Box cox transform

Log Transform

- Log Transform is used
  - To penalize the high values
  - Stabilize variance of time series

Box Cox Transform

- Log Transform is used
  - To penalize the high values
  - Stabilize variance of time series
- Box Cox Transforms
  - Stabilize variance of the time series
  - Takes lambda as input
  - Equivalent to log at λ = 0

$$y(\lambda) = \begin{cases} \frac{y^{\lambda}-1}{\lambda}, & \text{if } \lambda \neq 0; \\ \log y, & \text{if } \lambda = 0. \end{cases}$$

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Box Cox Transform

Below are some common values for lambda

- lambda = -1. is a reciprocal transform.
- lambda = -0.5 is a reciprocal square root transform.
- lambda = 0.0 is a log transform.
- lambda = 0.5 is a square root transform.
- lambda = 1.0 is no transform.

$$y(\lambda) = \begin{cases} \frac{y^{\lambda}-1}{\lambda}, & \text{if } \lambda \neq 0; \\ \log y, & \text{if } \lambda = 0. \end{cases}$$

Log transform is a special case of box - cox transform

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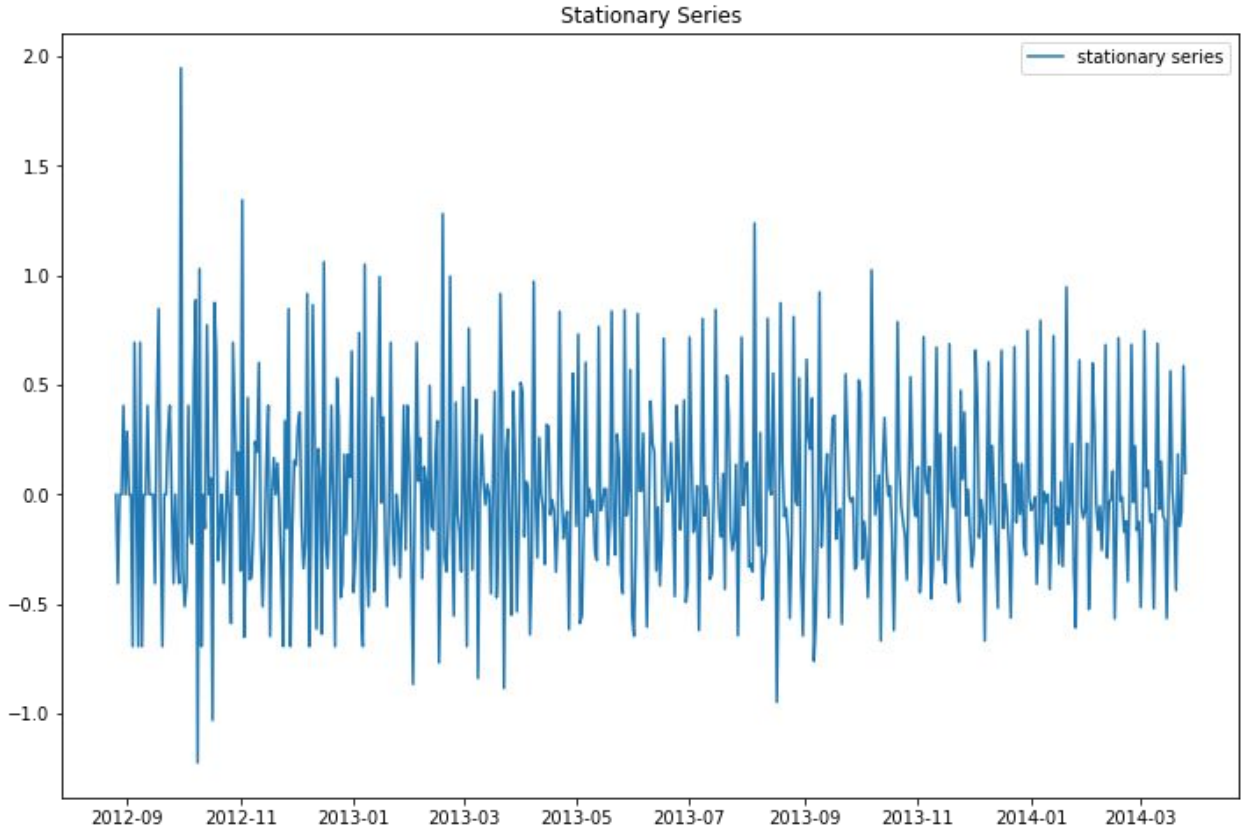
Log Transform



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Thank You

Notebook

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