Window functions in Tableau

TIME SERIES ANALYSIS IN TABLEAU

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What is a window?

- Windows refer to specific partitions you want to analyze
- Used specifically as an argument for window functions
- Window size is determined based off the start window and end window
- Provided no start or end window is supplied, the entire measures range of values is treated as one window

Let's select a **2 hour window** below.

Hour	Value
12 AM	100
1 AM	200
2 AM	300
3 AM	400
4 AM	500
5 AM	600
6 AM	700

The values from **12 AM – 1 AM** would make up your first window.

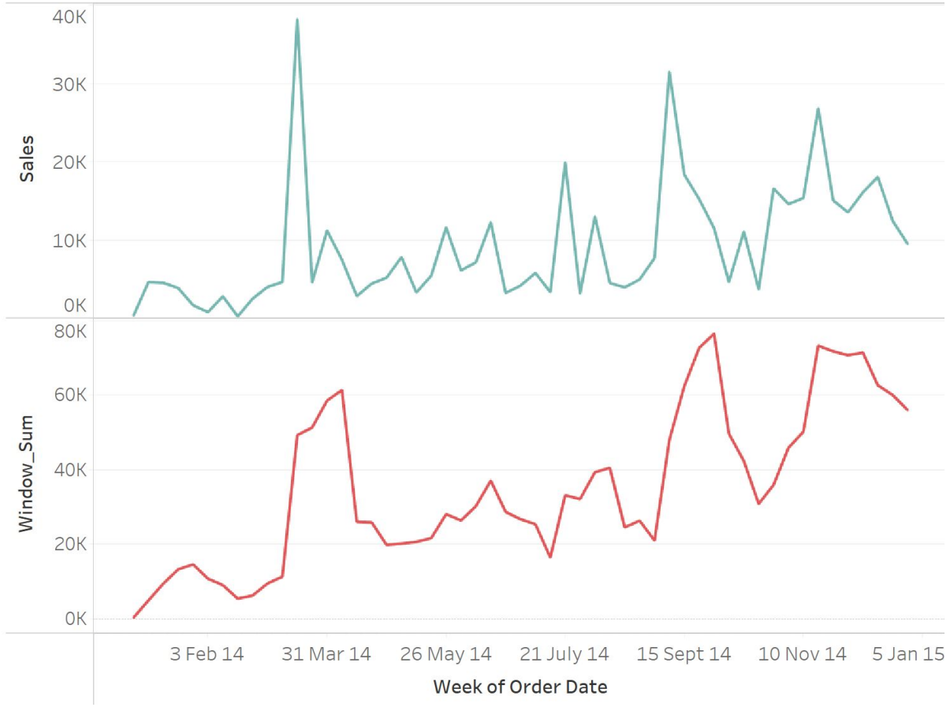
Hour	Value
12 AM	100
1 AM	200
2 AM	300
3 AM	400
4 AM	500
5 AM	600
6 AM	700

If we don't explicitly state the size of our windows, it would contain **all the values from 100 – 700.**

What is a window function?

Known as moving calculations that smooth data over specified time windows

- Examples include: window sums, moving averages and moving standard deviations
- Composed of a measure, start size, and end size



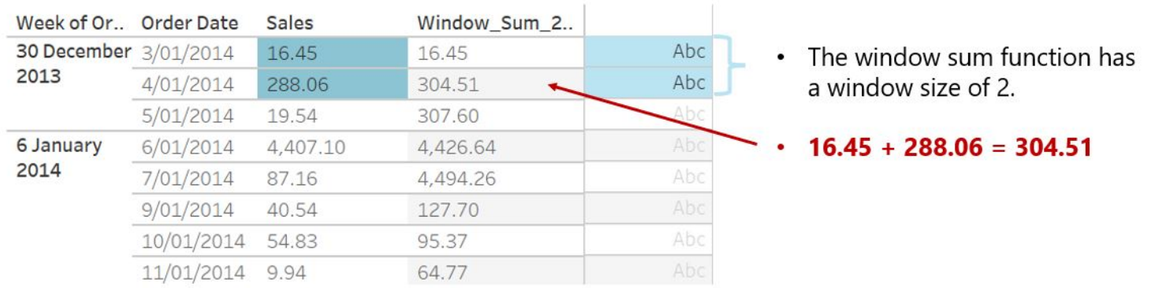
Window_Function(Measure, Window_Start, Window_End)

1 2 3

Measure – This is the respective measure you want to apply your Window Function against.
Window_Start – This is the **start** of your Window function, with **respect to your granularity**.
Window_End – This is the **end** of your Window function, with **respect to your granularity.**

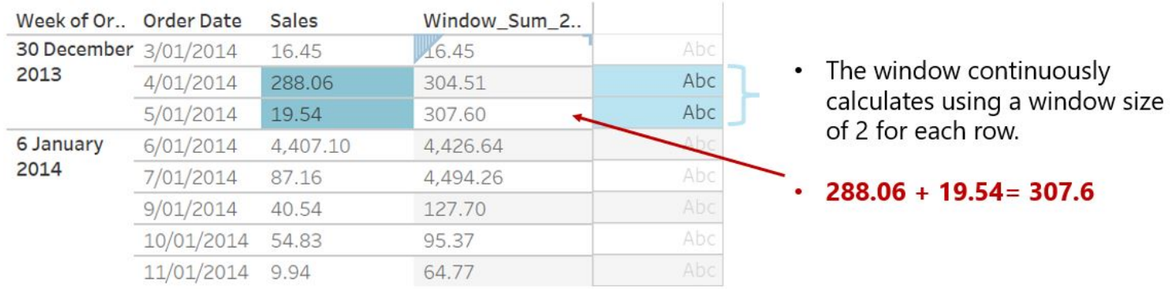
How does window sizing work?

- Sizing of your window refers to the number of data points to be included
- Once the window sizing is set, it applies this for each subsequent row wise calculation



Week of Or..	Order Date	Sales	Window_Sum_2..	
30 December 2013	3/01/2014	16.45	16.45	Abc
	4/01/2014	288.06	304.51	Abc
	5/01/2014	19.54	307.60	Abc
6 January 2014	6/01/2014	4,407.10	4,426.64	Abc
	7/01/2014	87.16	4,494.26	Abc
	9/01/2014	40.54	127.70	Abc
	10/01/2014	54.83	95.37	Abc
	11/01/2014	9.94	64.77	Abc

- The window sum function has a window size of 2.
- **16.45 + 288.06 = 304.51**



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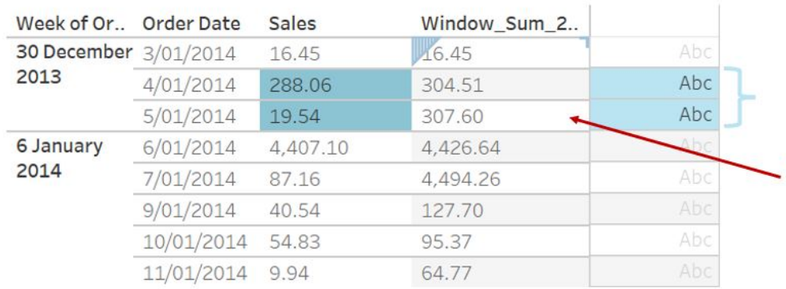
- The window continuously calculates using a window size of 2 for each row.
- **288.06 + 19.54= 307.6**

How does granularity impact window sizing?

- Granularity directly impacts the result of window aggregation function
- Aggregations are computed first, **before** window size



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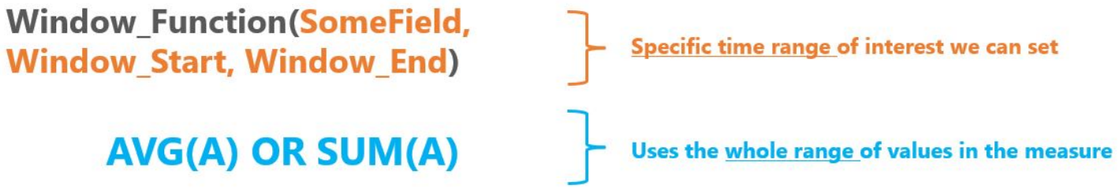
- Here we have a **daily** granularity.
- **Each window is composed of 2 days of sales.**

Week of Order Date	Sales	Window_Sum_2..	
30 December 2013	324.04	324.04	Abc
6 January 2014	4,599.57	4,923.62	Abc
13 January 2014	4,509.13	9,108.70	Abc
20 January 2014	3,842.39	8,351.52	Abc

- Here we have a **weekly** granularity.
- **Each window is composed of 2 weeks of sales.**
- **The window expression hasn't changed, but the granularity has.**

What's the purpose of a window function?

- Creates **aggregate** views of your data based on **specific** time windows
- Normal aggregation functions use the whole range of your data (i.e. no specification)

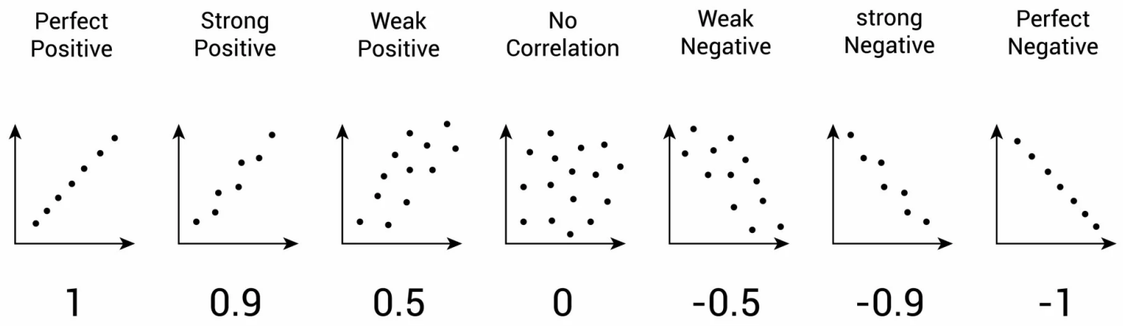


Example window functions:

- `WINDOW_SUM()`
- `WINDOW_AVG()`
- `WINDOW_STDEV()`
- `WINDOW_CORR()`
- `WINDOW_MEDIAN()`

What's correlation?

- Measures the extent to which two variables may be related
- **Correlation coefficient (r)** measures the **strength** and **direction** of the relationship
- Values range from -1 to 1
- A positive value means that as one variable increase, the other also increases
- Inversely, a negative direction means when one variable increases, the other decreases



How do window correlations work?

- Calculate the pearson correlation coefficient for the whole view between two aggregated variables
- In contrast to the `CORR()` function that requires non-aggregated variables

Category	Sales	Quantity	Correlation	Window_Corr
Furniture	741,999.795300001	8,028	0.437463606	-0.931733339
Office Supplies	719,047.032000002	22,906	0.159607503	-0.931733339
Technology	836,154.032999996	6,939	0.206949464	-0.931733339

- **WINDOW_CORR()** is finding the correlation using a window containing all the values in sales and quantity at an aggregated granularity.

Category	Sales	Quantity	Correlation	
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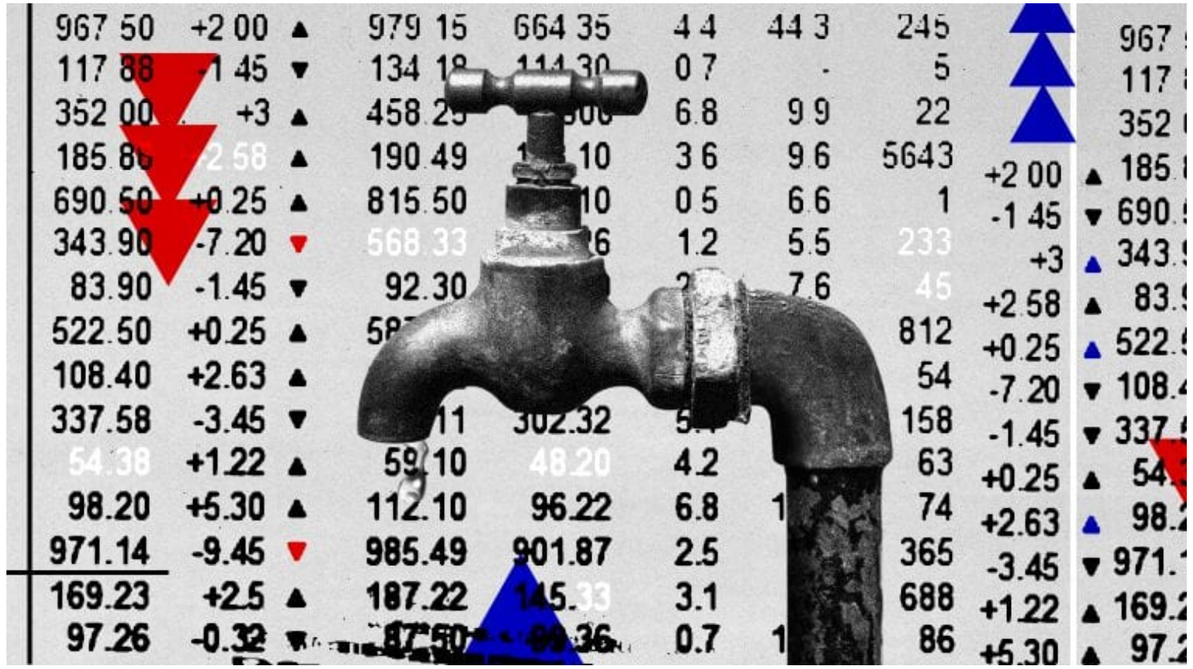
Technology	836,154.032999996	6,939	0.206949464	Abc

- **CORR()** is finding the correlation on a row-by-row basis, giving us a distinct value for each category.

Introducing the dataset

- Analyzing water trading activity and the seasonal transactions that occur
- Time series techniques to identify abnormal pricing patterns:
  - Moving averages
  - Window correlations



[1] https://theswaddle.com/water-is-now-a-traded-commodity-can-it-still-be-a-human-right-too/

Let's practice!

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Calculations with window functions

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Anomaly detection with window functions

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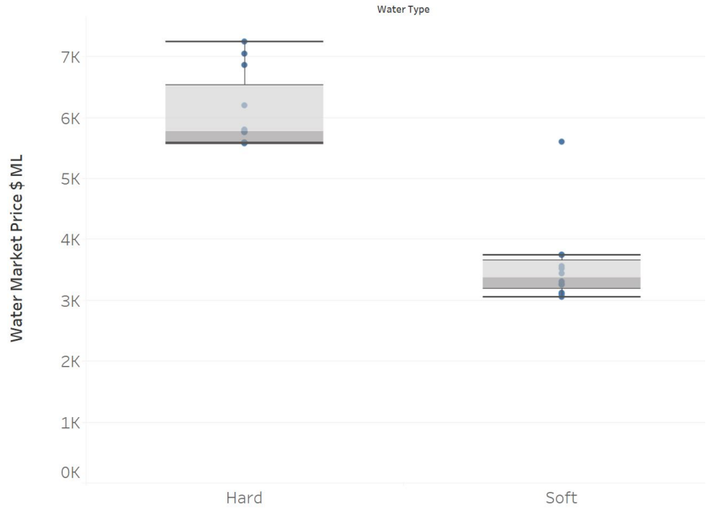
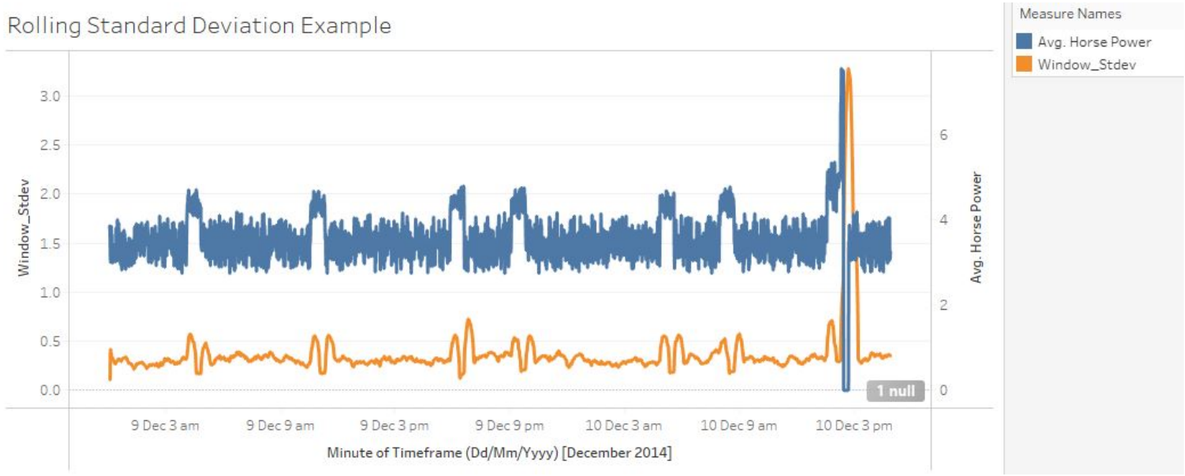
Standard deviation versus rolling standard deviation

- Standard deviation measures the degree of dispersion in a set of values
  - **High standard deviation** = high variance
  - **Low standard deviation** = low variance

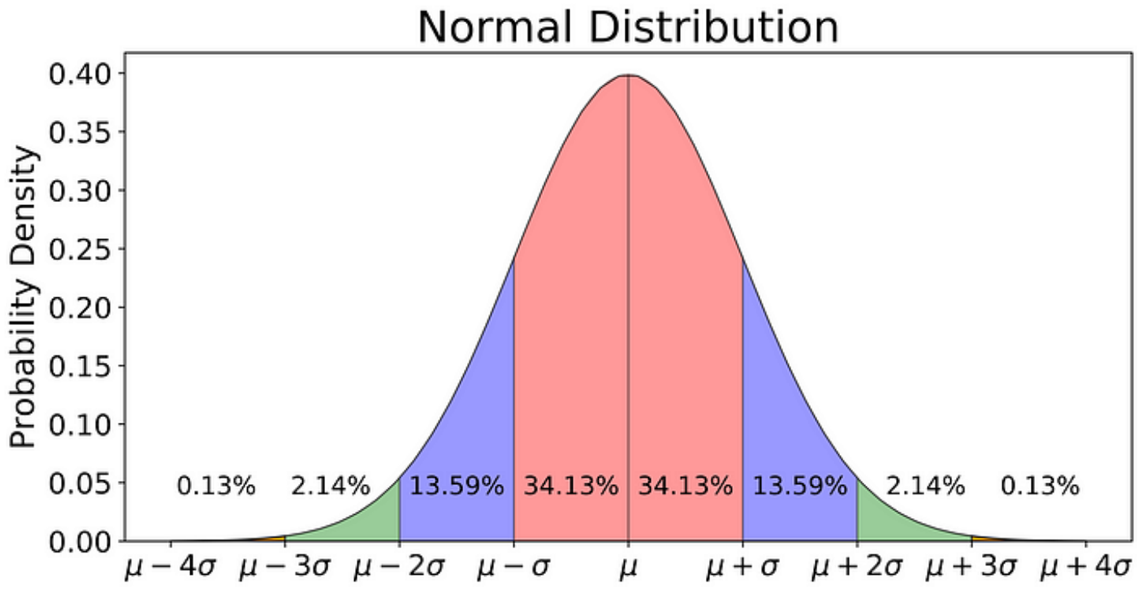


- Rolling standard deviation, calculated on a window subset, is useful to **identify variance inflation with respect to time**
- As the variance grows larger, this may signal an anomaly for analysis purposes



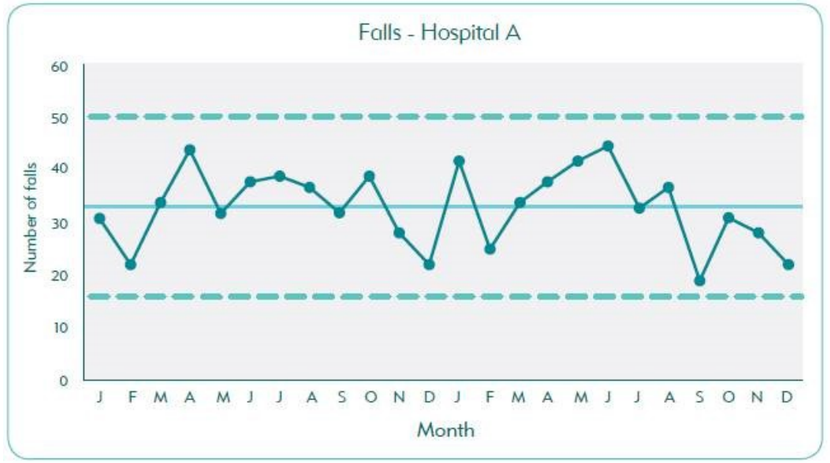
Standard deviation and anomaly detection

- Anomaly detection for time series data generally follows the 68, 95, 99 rule
- ~ 68% of all values = 1 standard deviation away from the mean
- 95% of all values = 2 standard deviation away from the mean
- ~ 99.7% of all values = 3 standard deviation away from the mean
- Any value > 3 standard deviations away from the mean is anomalous

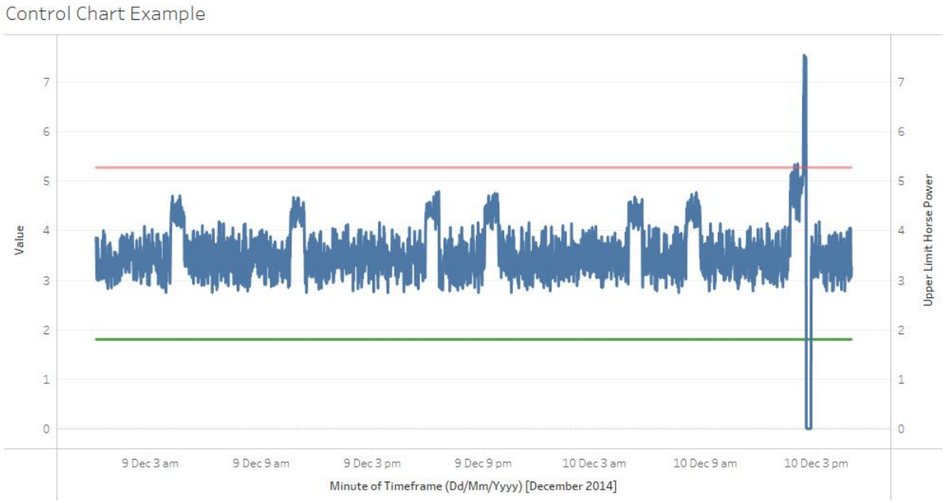


Upper and lower control limits

- Primarily utilized for univariate time series analysis as opposed to multivariate
- Control charts are an effective visual way of identifying the upper and lower bounds of what are *acceptable* values

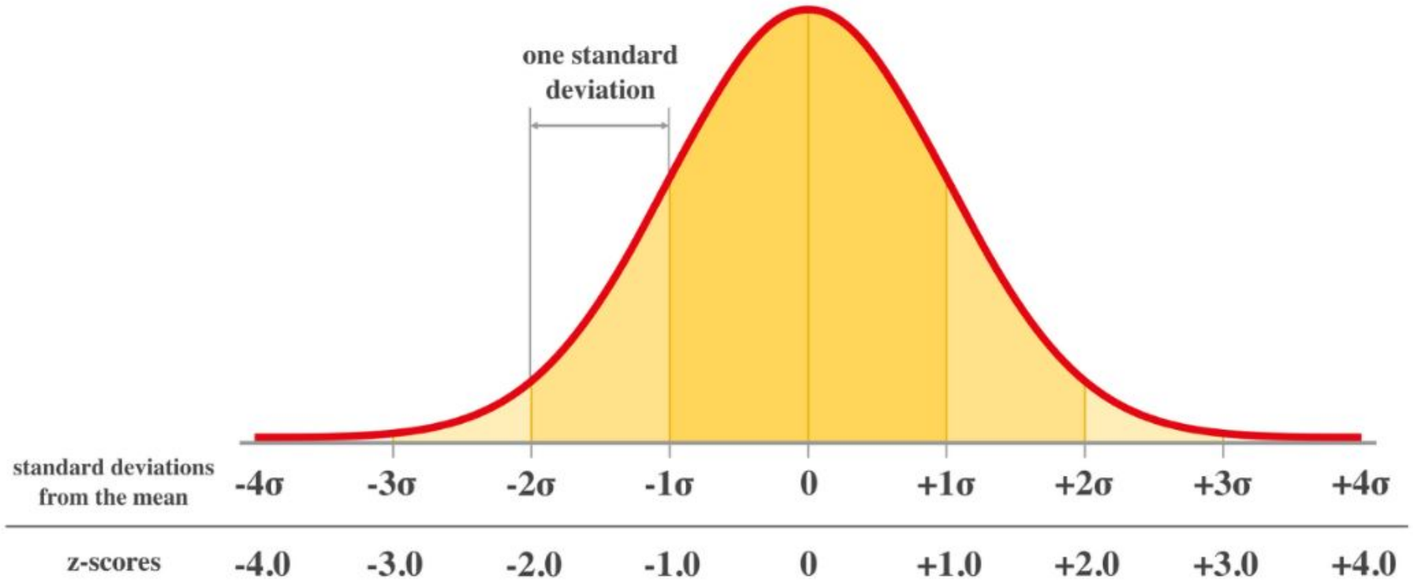


- Values that exceed the population mean +- 3 standard deviations are anomalous



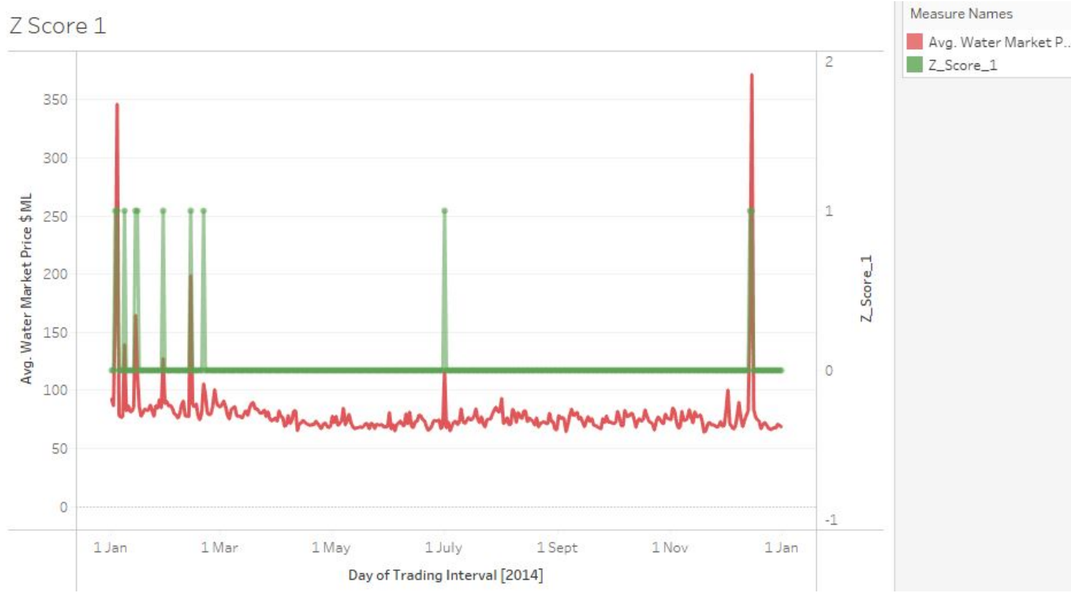
What are Z-scores?

- The Z-score is the number of standard deviations a data point lies above or below the mean
- A positive Z-score indicates the value is above the mean
- A negative Z-score indicates the value is below the mean
- Separate from standard deviation that measures distance between data points

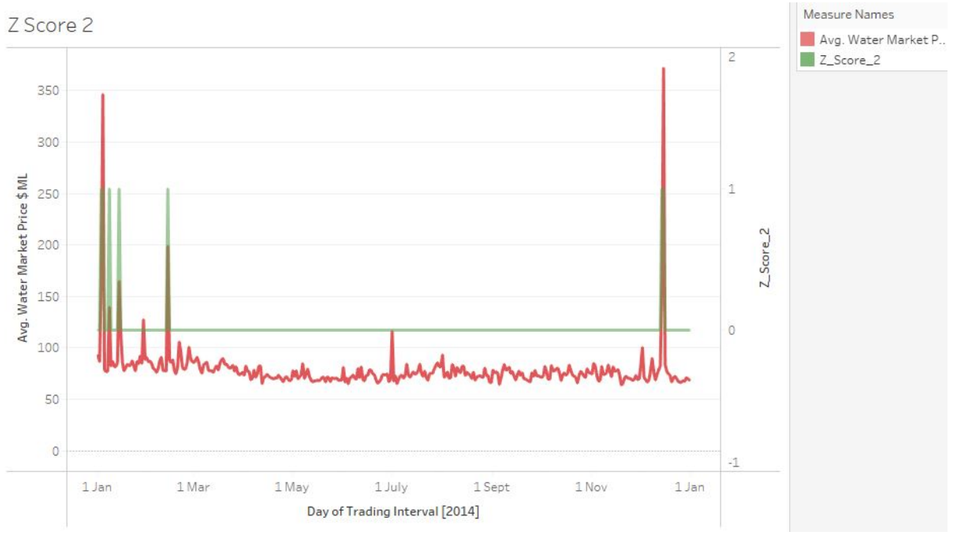


Z-scores and anomaly detection

- Z-scores +-3 are considered anomalous, but this is contextual



- Higher Z-scores mean less anomalies, but this depends on how sensitive your anomaly detection is



Let's practice!

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A deep dive into window calculations

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Let's practice!

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Congratulations!

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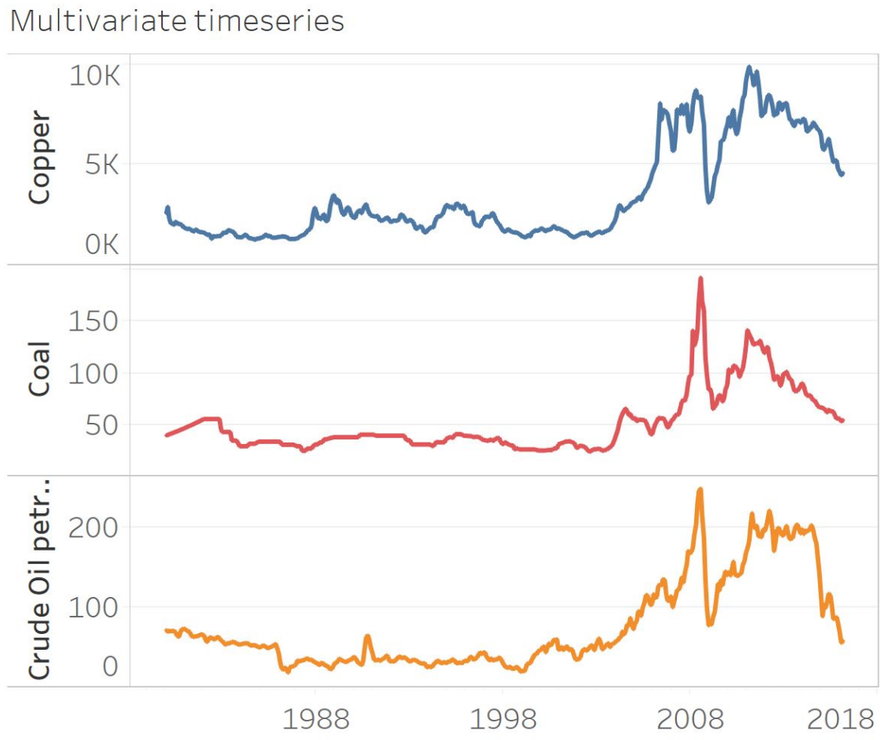
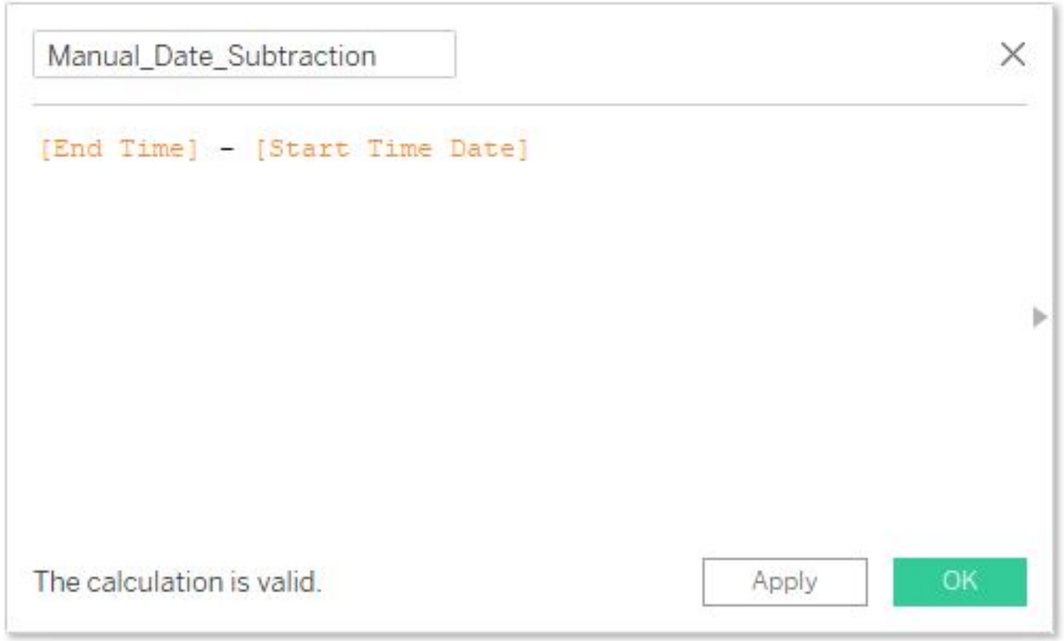
What you've learned: chapter one

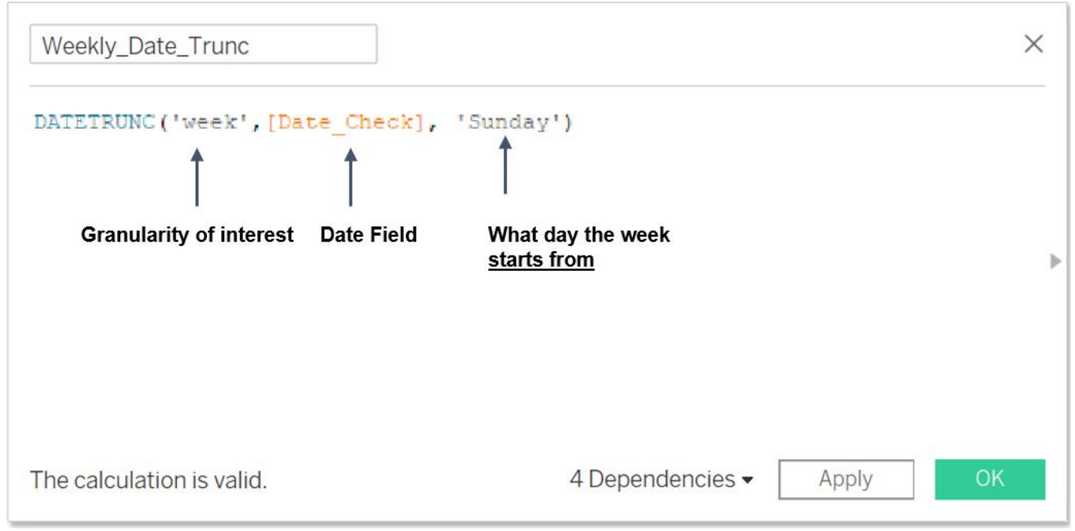
- What times series data is
- Continuous and discrete time series
- Univariate and multivariate analysis
- Data granularity
- Reforming and truncating date time stamps
- Calculated fields with dates



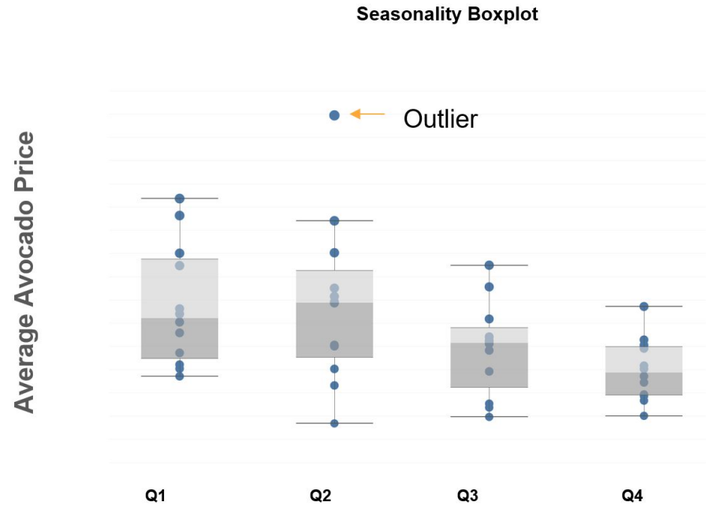


What you've learned: chapter two

- Date parsing
- Splitting up dates
- Date time stamp validation



- Seasonality
- Moving averages
- Box plots
- Percentiles



What you've learned: chapter three

- Windows
- Window sizes
- Window functions

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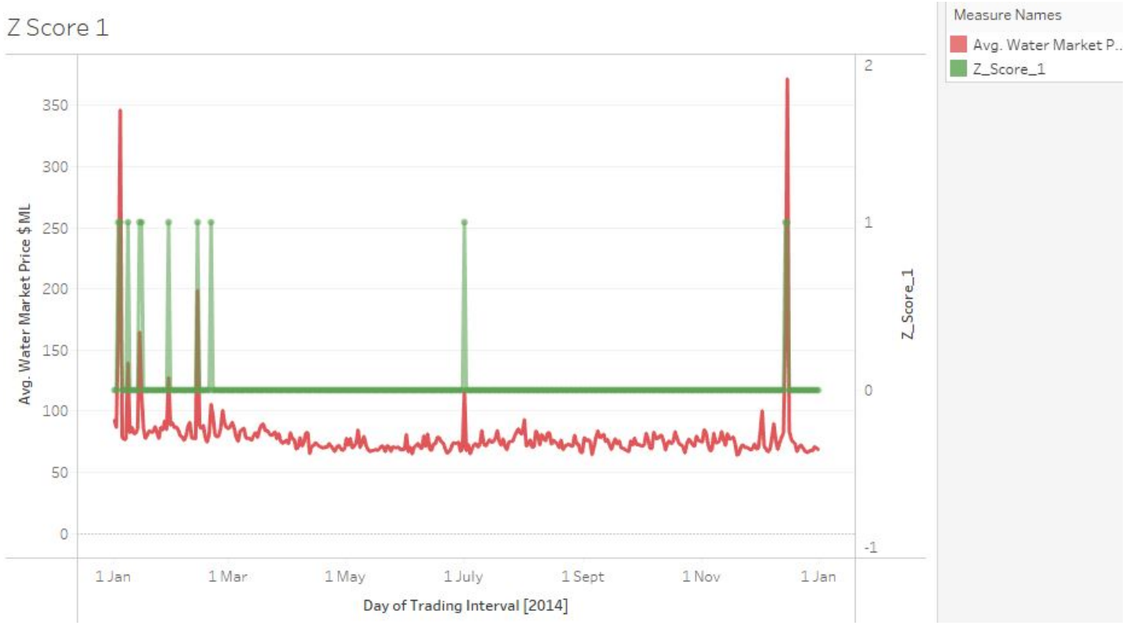
- Rolling standard deviations
- Upper and lower boundaries
- Z-scores and anomaly detection



Thank you!

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