



ADVANCED TABLEAU

FOR BUSINESS INTELLIGENCE



With Award-Winning Tableau Expert Dustin Cabral



Course Structure



This is a **project-based** course, for students looking for a practical, hands-on, and highly engaging approach to learning business intelligence with Tableau Desktop

Additional resources include:

- ★ **Downloadable Ebook** to serve as a helpful reference when you're offline or on the go
- ★ **Quizzes & Homework Exercises** to reinforce key concepts, with step-by-step solutions
- ★ **Bonus Projects** to test your abilities and apply the skills developed throughout the course

Course Outline

1

Table Relationships

Explore Tableau Relationships and data modelling tools inside the data source interface, sheets and visualizations

2

Dynamic Design

Create dynamic dashboard views leveraging multiple dimensions and measures, sheet selectors, container menus, background templates, set/parameter actions and more

3

Geospatial Mapping

Develop custom mapping solutions including buffer calculations, wms maps, map layers, hex maps, and geospatial fields

4

Advanced Calculations

Leverage complex calculations to deliver actionable insights for specific business use cases

5

Predictive Analytics

Use native and integrated predictive tools in Tableau including std deviations, forecasting, clustering, and R/Python integration

Introducing the Course Project

THE **SITUATION**

You've just been hired by **Maven Roasters**, a bespoke, small batch coffee roasting company. Your role? Use advanced analytics and visual design to take Maven's BI reports to the next level!

THE **BRIEF**

Maven Roasters needs a way to **track KPIs** (*sales, profit, units, returns*), **compare performance across markets**, **analyze category profitability**, and **identify high-value customers**.

All you've been given is a folder of excel files containing information about orders, returns, products, customers and territories.

THE **OBJECTIVE**

Use Tableau Desktop to:

- Create relationships between data sources
- Design dynamic dashboards & visuals
- Leverage geospatial mapping features
- Apply advanced calculations to key business use cases
- Integrate predictive analytics assets



Setting Expectations

1 This course is designed to cover **advanced topics** in Tableau Desktop

- We strongly recommend completing our *Up & Running with Tableau Desktop* course first
- This course dives deeper into advanced filtering, blending, set/parameter actions, mapping, predictive analytics and dynamic visual design, but not all Tableau Desktop features and integrations will be covered

2 What you see on your screen **may not always match mine**

- Tableau desktop updates on a *monthly* basis for minor releases and *quarterly/yearly* for major releases, so features and functionality may change over time

3 This course is primarily geared towards **data analysis and visualization**

- *Data preparation* is another key component of the analytics and business intelligence workflow, but we will cover this topic in depth in a separate course (*Tableau Prep*)

4 We will not cover **Tableau Server/Online** as part of this course

- This course will focus on *Tableau Desktop* specifically; online sharing and collaboration features will be covered in depth in a separate course (*Tableau Server*)

Relationships

Relationships

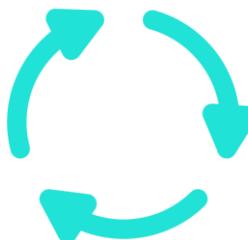
Relationships are part of Tableau's dynamic **Data Model** interface, which automatically assigns join conditions between related tables without materializing those tables into a single data source

Reduce Data Preparation



- *Reduce up front data prep by utilizing flexible relationship joins*
- *Relationships push the join to the viz-level, allowing for many more possible join scenarios to occur from the same source*

More Use Cases Per Source



- *Reduce the number of data sources pulled in to answer analytic questions*
- *Preserve all detailed records from a relationship source with multiple tables*

Trust Your Results

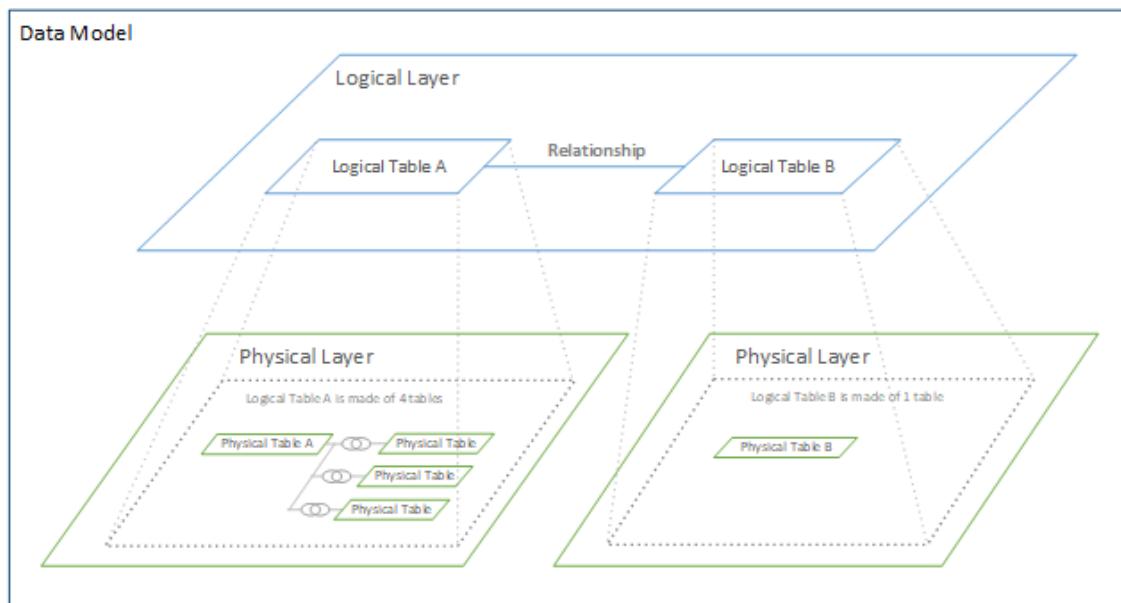


- *Retain measures that could be lost or distorted through joins and blends*
- *Relationships ensure measures will not duplicate or overstate due to join clauses*

Tableau Data Model

Tableau Desktop's **Data Model** is split into two distinct layers: **Logical & Physical**

- Both layers can be used *in conjunction* with each other
- Source data should be clearly understood prior to enabling either data model layer; however, the logical layer is generally more forgiving than the physical layer



Logical Layer represents the canvas for creating **relationships** between tables

Physical Layer represents the canvas for creating **unions & joins** between tables

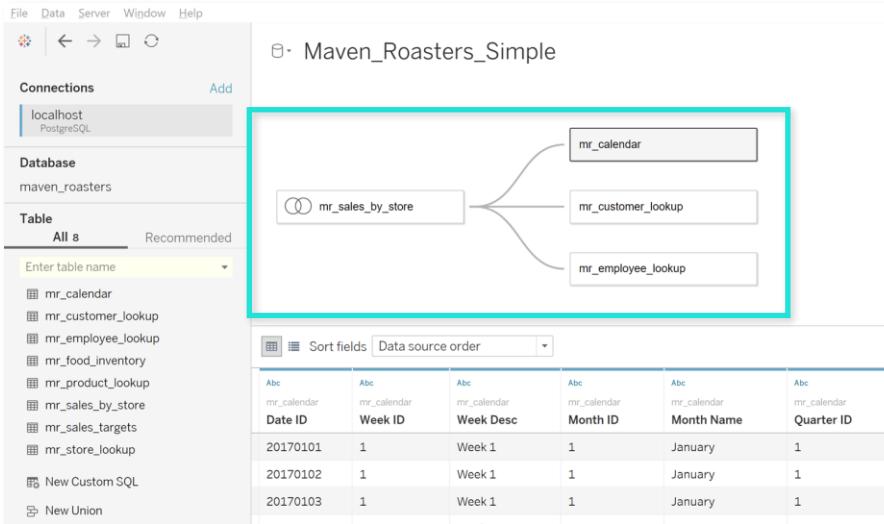
NOTE: The Physical layer is the same data model structure as the original data model prior to 2020.2.



The **Physical Layer** physically joins tables together, while the **Logical Layer** keeps tables separate, but defines relationships between them

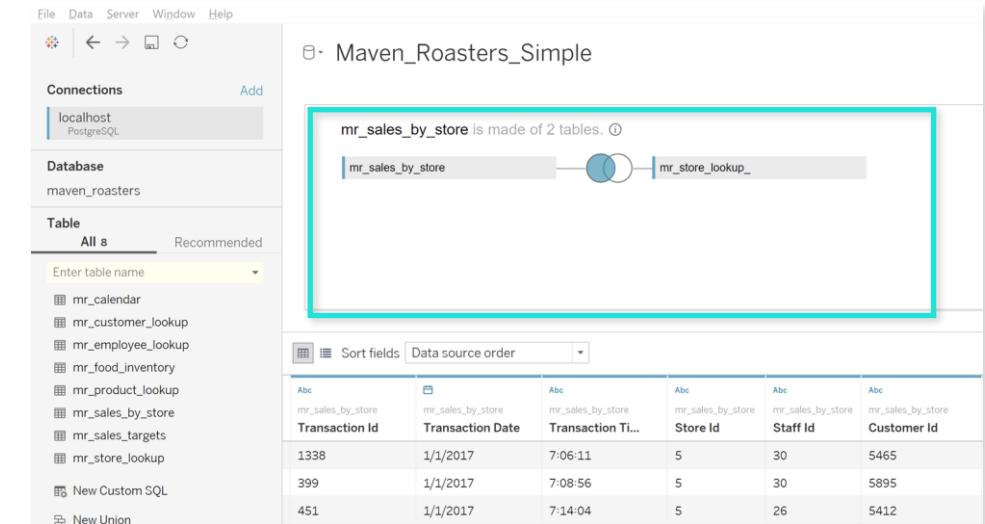
Logical and Physical Layers

Logical Layer



- Tables dragged here are called “**Logical**” tables
- Logical tables are **containers** for “Physical” tables
- Logical tables remain **distinct**, not merged in the data source
- “**Noodles**” connect Logical tables together via related fields

Physical Layer

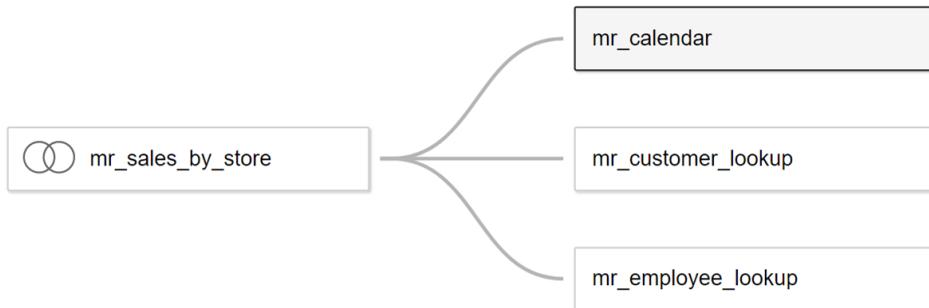


- Tables dragged here are called “**Physical**” tables
- Physical tables are **merged** into a single flat table that defines the logical table.
- **Joins / Unions** connect physical tables together via related fields

 **PRO TIP:** To access the data model view from pre-2020.2 (i.e. joins, unions, Venn Diagrams), simply double-click the table brought into the data canvas

Relationships vs. Joins

Relationships



- **Logical tables** are displayed using “noodles” to identify relationships between tables
- Require **matching fields** between logical tables
- Keeps **each table separate**, and only performs joins at viz-level when needed
- Avoids data duplication through **smart aggregation**

Joins

`mr_sales_by_store` is made of 2 tables. ⓘ



- **Physical tables** are displayed using Venn Diagrams to identify joins between tables.
- Require **join clause & join type** selection
- Joins data into **one physical table** with specified granularity defined
- Can support **row-level security** and **extract filters**

Requirements for Relationships



Dirty Data can make relationships more complex to use. Well-modelled data is preferred when using relationships.



Avoid upfront **data source filters** when using relationships. These limit automated Tableau join-culling.



Matching fields must share the **same data type**. Types cannot be changed in the data interface (*must be done at the database level*)



Tables with many **unmatched values** and models with **multiple fact tables** and with multiple dimension tables can make relationships less intuitive.



Geographic fields cannot be used to define relationships (*use the physical layer for these types of joins*)

Creating Relationships

Drag logical tables into the canvas:

The screenshot shows the Tableau Data Source Editor interface. On the left, the 'Connections' and 'Database' sections are visible, with 'localhost PostgreSQL' selected. In the center, a logical table named 'Maven_Roasters_Simple' is displayed. A logical table 'mr_sales_by_store' is highlighted with an orange border and has a blue circular icon with a double-headed arrow indicating it's a logical table. A hand cursor is shown dragging a line from this table to another logical table 'mr_employee_lookup', which is highlighted with a green border. Below the tables, a preview of the data is shown in a grid format.

mr_sales_by_store	mr_sales_by_store	mr_sales_by_store	mr_sales_by_store	mr_sales_by_store
Transaction Id	Transaction Date	Transaction Ti...	Store Id	Staff Id
1338	1/1/2017	7:06:11	5	30
399	1/1/2017	7:08:56	5	30
451	1/1/2017	7:14:04	5	26
1170	1/1/2017	7:20:24	5	12
248	1/1/2017	7:22:41	5	30

Define matching fields between logical tables:

The screenshot shows the 'Edit Relationship' dialog box. It displays two tables: 'mr_sales_by_store' and 'mr_employee_lookup'. Under 'mr_sales_by_store', the field 'Staff Id' is listed. Under 'mr_employee_lookup', the field 'Abc Staff Id (Mr Employee Lookup)' is listed. A green box highlights these two fields. Below the tables, there are sections for 'Performance Options' and 'Cardinality'. The 'Performance Options' section includes settings for cardinality and referential integrity, both of which are highlighted with green boxes. A 'Revert to Default' button is at the bottom.

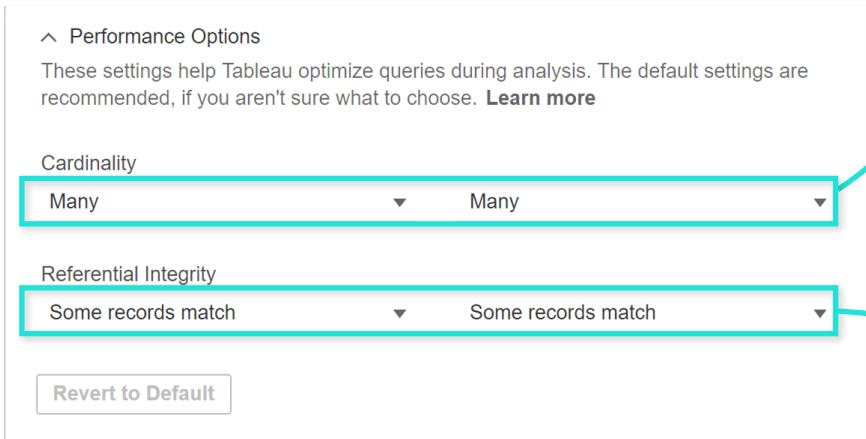
Set Performance Options
(only change if needed):



Relationships are **not supported** for data source connections including Cube Sources, Stored Procedures, Splunk, JSON, Salesforce (single source only), and SAP HANA (with OLAP chosen)

Optimizing Performance

Performance options are settings that define **cardinality** (uniqueness) and **referential integrity** (matching records) between two tables within a relationship



Cardinality

Determines if tableau aggregates before or after joining data during analysis

Many - if field values **aren't unique** or if you aren't sure. Aggregation will occur **before** Tableau joins.

One - if field values **are unique**. Aggregation will occur **after** Tableau joins.

NOTE: If "One" is chosen and records are NOT unique (including multiple null records), duplicate values will occur

Referential Integrity

Determines the type of join used to get dimension values for a measure during analysis

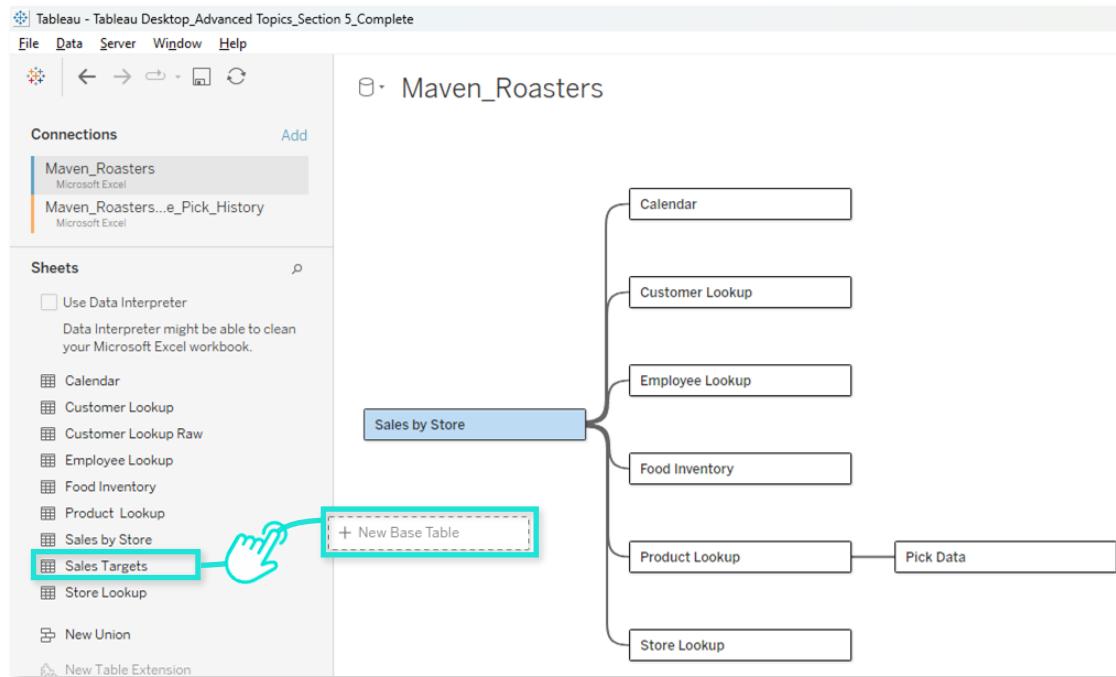
Some Records Match - if some values in the selected fields don't match or you aren't sure. Tableau uses **Outer Joins**, and all measures will show (even unmatched measures)

All Records Match - if all values in selected fields have a match in both tables. Joins are optimized with **Inner Joins**, but records can be removed/missing due to unmatched values.

NOTE: "All records match" treats records as if there are no null records in matching fields.

Multi-Fact Relationships

Multi-fact relationships allow you to join multiple fact tables using common dimensional keys



1 Add New Base Table

This option will appear when dragging out a table from your schema



2 Link Tables

Use the (+) symbol to click and drag the new base table over other tables



3 Define Matching Fields & Performance Options

Identify common fields to create table relationships

How do relationships differ from joins? [Learn more](#)

Sales Targets	Operator	Store Lookup
# Sales Outlet Id	=	# store id (Store Looku ▾)
+ Add more fields		

Interface Differences (2020.2)

DATA SOURCE INTERFACE

Pre-2020.2

Physical Layer (Joins & Unions)

The screenshot shows the Data Source Interface with a connection to 'localhost' and database 'maven_roasters'. A relationship is defined between 'mr_sales_by_store' and 'mr_product_lookup'. The resulting table view shows data from both tables joined together.

Product Id (Mr ...)	Product Group	Product Catego...	Product Type
32	Beverages	Coffee	Gourmet brewed c...
57	Beverages	Tea	Brewed Chai tea

2020.2+

Logical Layer (Relationships)

The screenshot shows the Data Source Interface with a connection to 'localhost' and database 'maven_roasters'. A relationship is defined between 'mr_sales_by_store' and three lookup tables: 'mr_calendar', 'mr_customer_lookup', and 'mr_employee_lookup'. The resulting table view shows data from 'mr_sales_by_store' and its associated lookups.

Transaction Id	Transaction Date	Store Id	Staff Id
1338	1/1/2017	7:06:11	5
399	1/1/2017	7:08:56	5
451	1/1/2017	7:14:04	26

Physical Layer (Joins & Unions)

Pre-2020.2

Shows all records in combined table resulting from join.

The screenshot shows the Data Grid interface with a connection to 'localhost' and database 'maven_roasters'. A relationship is defined between 'mr_sales_by_store' and 'mr_product_lookup'. The resulting table view shows all records from both tables joined together.

Product Id (Mr ...)	Product Group	Product Catego...	Product Type	Product Descri...	Unit Of Measure	Current Wholes...	Tax Exempt Yn	Promo Yn		
32	Beverages	Coffee	Gourmet brewed c...	Ethiopia Yg	16 oz	0.6	3	Y	N	
57	Beverages	Tea	Brewed Chai tea	Spicy Eye Opener...	Whoo you need yo...	24 oz	0.78	3.1	Y	N
59	Beverages	Drinking Chocolate	Hot chocolate	Dark chocolate Lg	Slightly bitter, bu...	16 oz	3.38	4.5	Y	N

2020.2+

Shows all records for the individual table selected in the relationship.

The screenshot shows the Data Grid interface with a connection to 'localhost' and database 'maven_roasters'. A relationship is defined between 'mr_sales_by_store' and three lookup tables: 'mr_calendar', 'mr_customer_lookup', and 'mr_employee_lookup'. The resulting table view shows data from 'mr_sales_by_store' and its associated lookups.

Transaction Id	Transaction Date	Store Id	Staff Id
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The screenshot shows the Data Grid interface with a connection to 'localhost' and database 'maven_roasters'. A relationship is defined between 'mr_sales_by_store' and three lookup tables: 'mr_calendar', 'mr_customer_lookup', and 'mr_employee_lookup'. The resulting table view shows data from 'mr_sales_by_store' and its associated lookups.

Date	Week ID	Week Desc	Month ID	Month Name
20170101	1	Week 1	1	January
20170102	1	Week 1	1	January
20170103	1	Week 1	1	January

Interface Differences (2020.2)

DATA PANE

Pre-2020.2

Single Dimension & Measure section

Data **Analytics**

Maven Roasters 2020.1...

Dimensions

- mr_product_lookup
- mr_sales_by_store
 - Customer Id
 - Instore Yn
 - Line Item Id
 - Order
 - Product Id
 - Promo Item Yn
 - Staff Id
 - Store Id
 - Transaction Date
 - Transaction Id
 - Transaction Time

Measures

- Quantity Sold
- Unit Price
- Number of Records
- Measure Values

2020.2+

Dimension & Measure section per table

Data **Analytics**

Maven Roasters 2020.2 and Above
mr_sales_by_store+ (maven_roasters)

Tables

- mr_calendar
- mr_customer_lookup
- mr_employee_lookup
- mr_sales_by_store
 - Customer Id
 - Instore Yn
 - Line Item Id
 - Manager (Mr Store Lookup1)
 - Neighborhood (Mr Store Lookup1)
 - Order
 - Product Id
 - Promo Item Yn
 - Staff Id
 - Store Address (Mr Store Lookup1)
 - Store City (Mr Store Lookup1)
 - Store Id
 - Store Id (Mr Store Lookup1)
 - Store Latitude (Mr Store Lookup1)
 - Store Longitude (Mr Store Lookup1)
 - Store Postal Code (Mr Store Lookup1)
 - Store Square Feet (Mr Store Lookup1)
 - Store State Province (Mr Store Lookup1)
 - Store Type (Mr Store Lookup1)
 - Transaction Date
 - Transaction Id
 - Transaction Time

Measures

- Quantity Sold
- Sales
- Unit Price
- mr_sales_by_store (Count)

VIEW DATA

Pre-2020.2

Single Combined Source View Data Preview

Columns SUM(Goal) SUM(Sales)

Rows Segment

Sheet 1

Consumer Corporate

View Data: Sheet 1

Category	City	Country	Customer ID	Customer Name	Order Date (DMY)	Order Date (MDY)
Furniture	Henderson	United States	CG-12520	Clare Gute	8/11/2017	11/8/2017
Furniture	Houston	United States	CG-12521	Mark Ladd	11/10/2016	12/20/2016
Office Supplies	Fort Lauderdale	United States	SO-20335	Sean Donnan	10/12/2016	4/9/2015
Office Supplies	Los Angeles	United States	BH-17170	Bronia Hoffman	9/6/2015	9/6/2015
Office Supplies	Los Angeles	United States	BH-17170	Bronia Hoffman	9/6/2015	9/6/2015
Office Supplies	Los Angeles	United States	BH-17170	Bronia Hoffman	9/6/2015	9/6/2015
Office Supplies	Los Angeles	United States	BH-17170	Bronia Hoffman	9/6/2015	9/6/2015
Office Supplies	Los Angeles	United States	BH-17170	Bronia Hoffman	9/6/2015	9/6/2015
Office Supplies	Los Angeles	United States	BH-17170	Bronia Hoffman	9/6/2015	9/6/2015
Office Supplies	Los Angeles	United States	BH-17170	Bronia Hoffman	9/6/2015	9/6/2015
Office Supplies	Concord	United States	AA-10480	Andrew Allen	15/4/2018	4/15/2018
Office Supplies	Madison	United States	PK-19075	Pete Kite	11/1/2015	11/1/2015
Office Supplies	West Jordan	United States	AG-10370	Alejandro Grove	13/5/2015	5/13/2015
Office Supplies	West Jordan	United States	YF-51947C	Torvalin Towell	7/10/2015	8/7/2015

Summary Full Data

2020.2+

Individual View Data Preview by Table

Columns SUM(Sales)

Rows Position Gender

Sheet 2

Position Gender

View Data: Maven Roasters 2020.2 and Above

Position	Gender	Sum
Coffee Wrangler	F	1
Coffee Wrangler	M	1
Coffee Wrangler	N	1

Columns SUM(Sales)

Rows Position Gender

Sheet 2

Position Gender

View Data: Maven Roasters 2020.2 and Above

Position	Gender	Sum
Coffee Wrangler	Null	1
Coffee Wrangler	F	1
Coffee Wrangler	M	1
Coffee Wrangler	N	1

OF RECORDS

Pre-2020.2

Number of Records = Source Record Count

Measures

- # Quantity Sold
- =# Sales
- # Unit Price
- =# Number of Records
- # Measure Values

2020.2+

TableName(Count) = Source Record Count

- Abc Transaction Id
- Abc Transaction Time
- # Quantity Sold
- =# Sales
- # Unit Price
- # mr_sales_by_store (Count)

The 8 R's of Relationships

The **8 R's of Relationships** help to describe the behavior caused by different relationship types

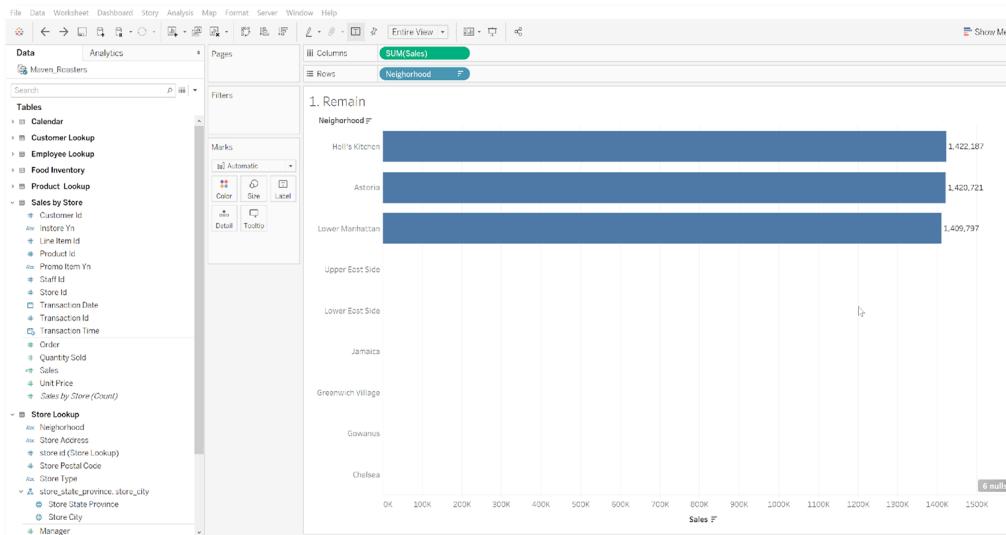
- We'll review each of these in the context of **contextual joins & smart aggregations** (more on that soon!)

Contextual Joins		Smart Aggregations	
Remain	<i>Full domains remain</i> for dimensions from a single table	Replicate	<i>Replicate</i> measures across lower levels of detail in the viz only
Relevant	<i>Relevant dimension domains</i> are shown across tables	Resolve	<i>Resolve</i> aggregations to the measure's native level of detail
Retain	All measure values are <i>retained</i>		
Recover	Unmatched dimensions can be <i>recovered</i> by using measures		
Represent	Unmatched measure values are <i>represented</i> as zero using ZN()		
Remove	Unmatched dimension/measure values can be <i>removed</i> with filters		

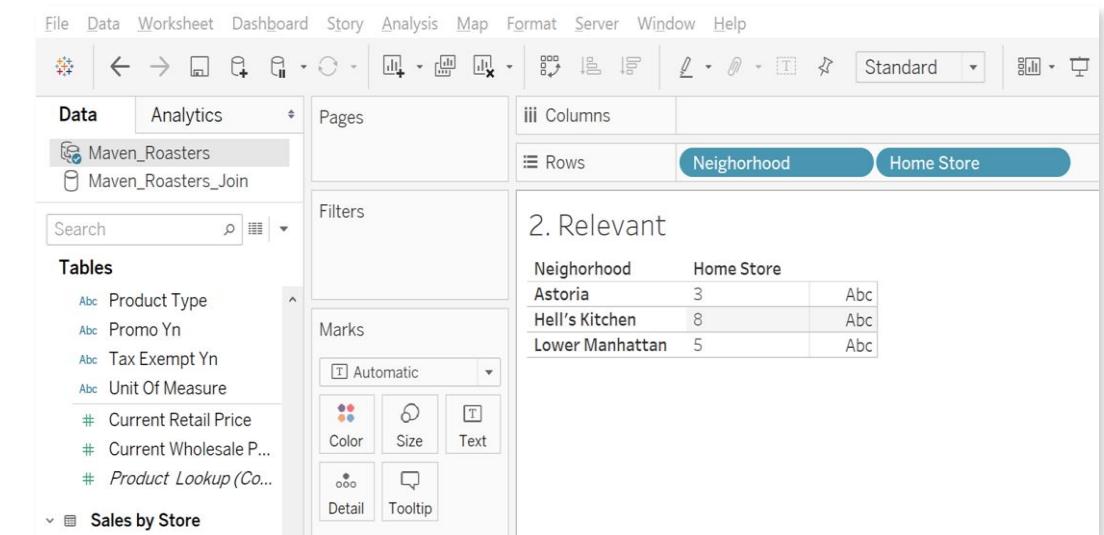
Contextual Joins

Contextual joins are created and applied at the viz-level, and dynamically change the join type based on the combination of dimensions and measures selected

Left Join ("Remain")



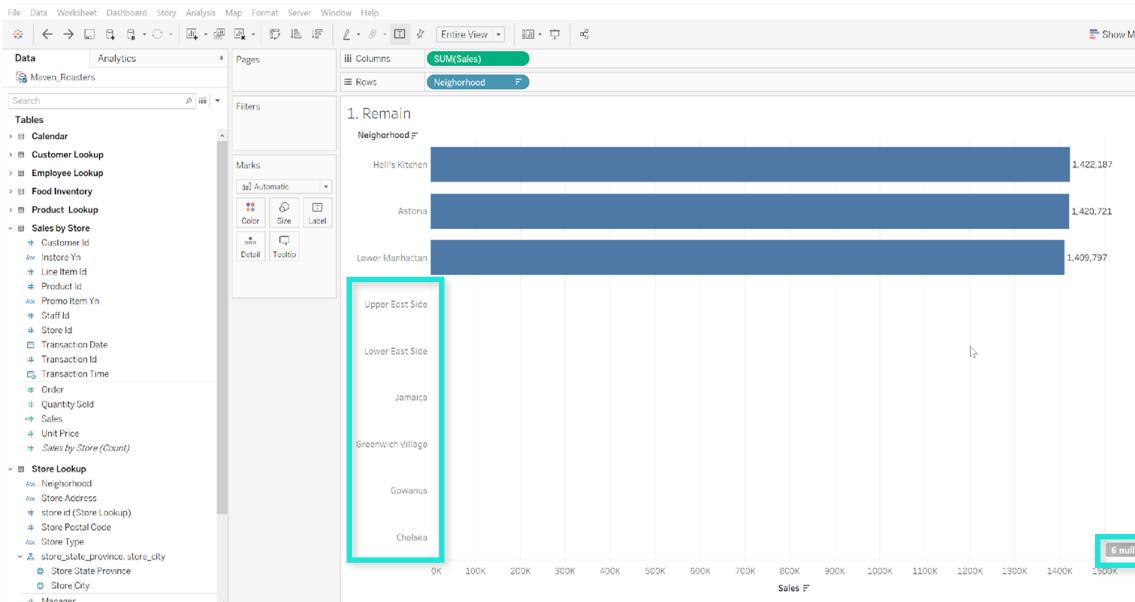
Inner Join ("Relevant")



Contextual Joins | Remain

Remain

If dimensions in the view are from a single table, Tableau will show **all dimension values** even if no matches exist in the measure tables (*think left join*)



Relationships leveraged in the view

Store ID = Store ID

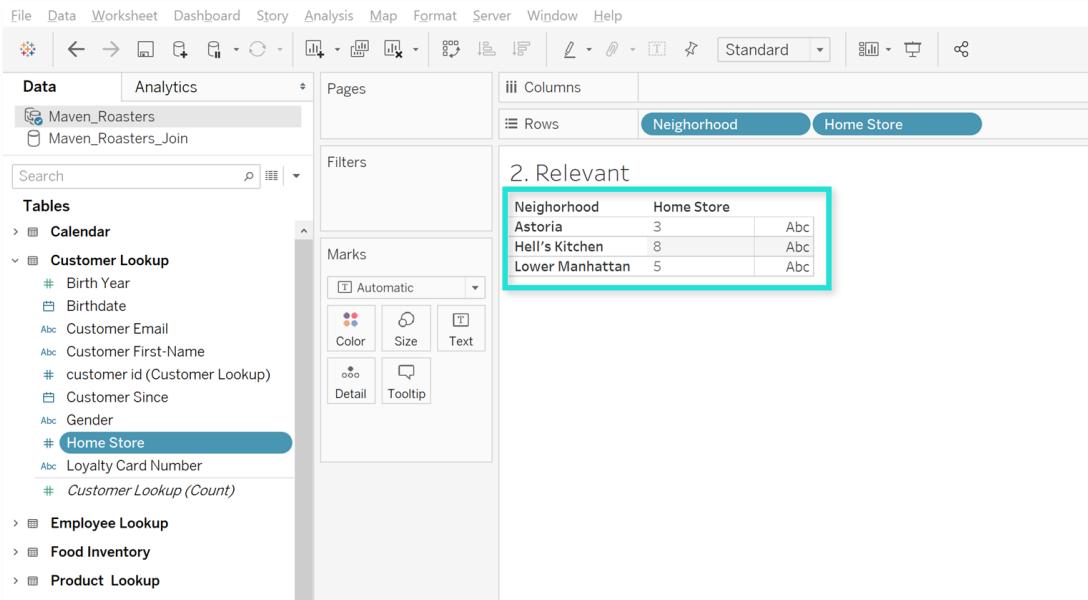
Sales by Store [Sales]

Store Lookup [Neighborhood]

Contextual Joins | Relevant

Relevant

Combining dimensions across tables displays only records where **matching fields** are found between the tables (*think inner join*)



Relationships leveraged in the view

Store ID = Store ID

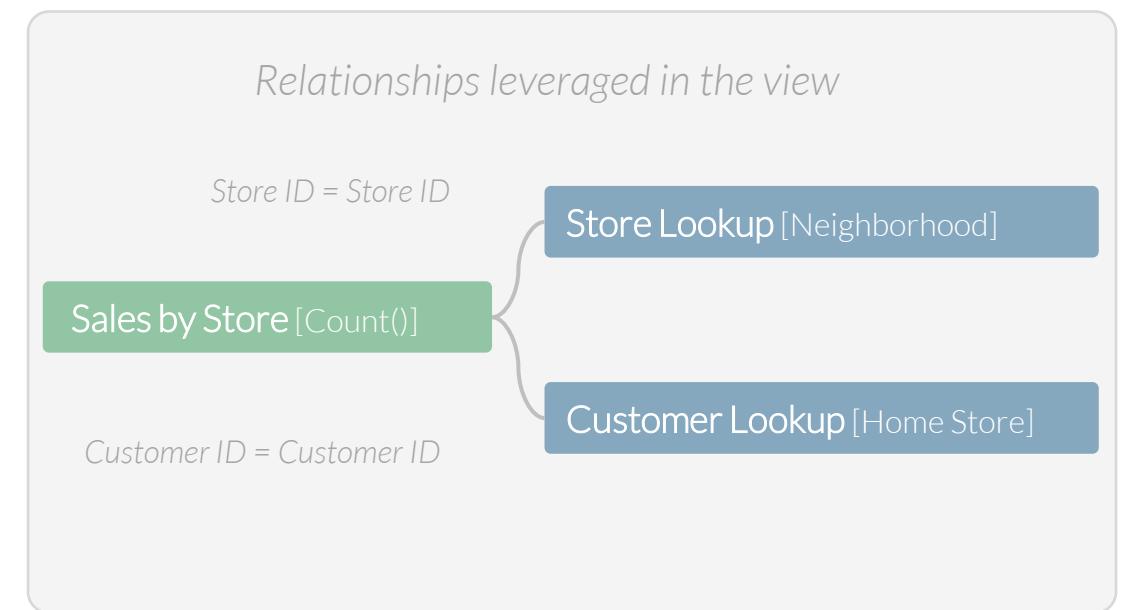
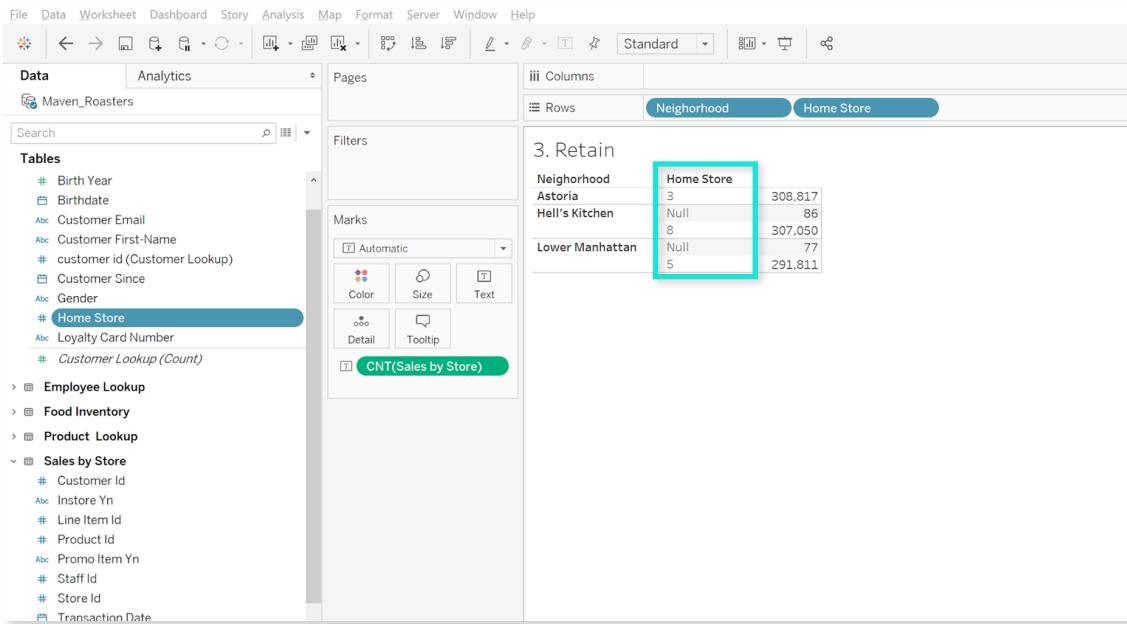
Store Lookup
[Neighborhood]

Customer Lookup
[Home Store]

Contextual Joins | Retain

Retain

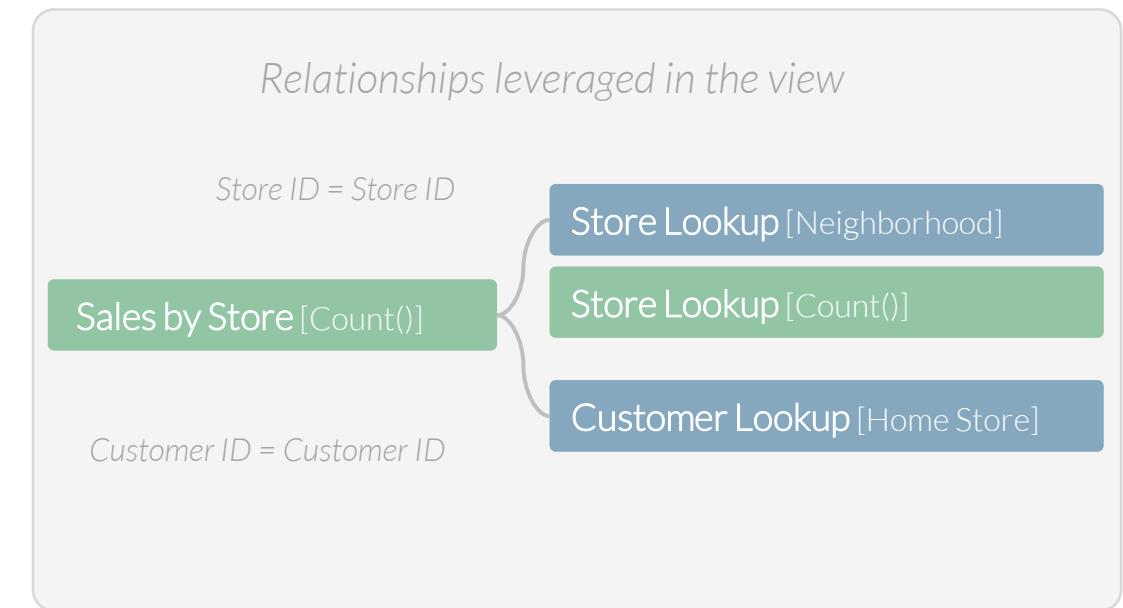
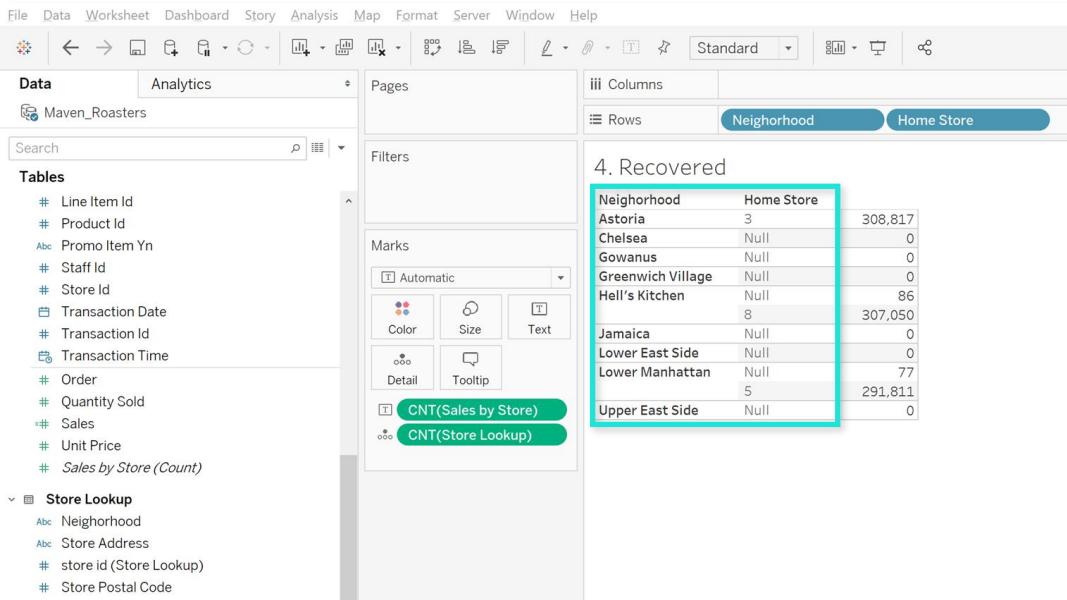
All records from measure tables are **ALWAYS** retained. Normally pulling dimensions from different tables creates an inner join, but adding a measure field will show ALL measure values from that table (*think left join*)



Contextual Joins | Recovered

Recovered

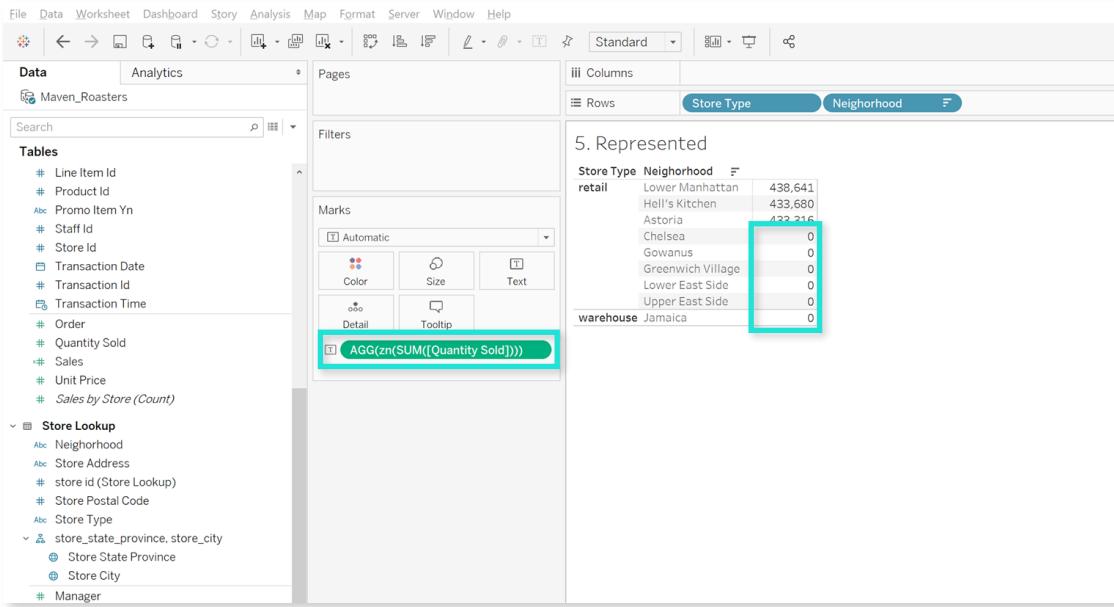
Recover unmatched dimensions by bringing in the respective “Count” field. In the below case, bringing in CNT(Store Lookup) allows us to view Neighborhoods without Home Stores.



Contextual Joins | Represented

Represented

Unmatched measure fields (excluding the default source Count fields) will **display as null** by default, but can be displayed as zero using the **ZN()** function



Relationships leveraged in the view

Store ID = Store ID

Sales by Store
[Quantity Sold]

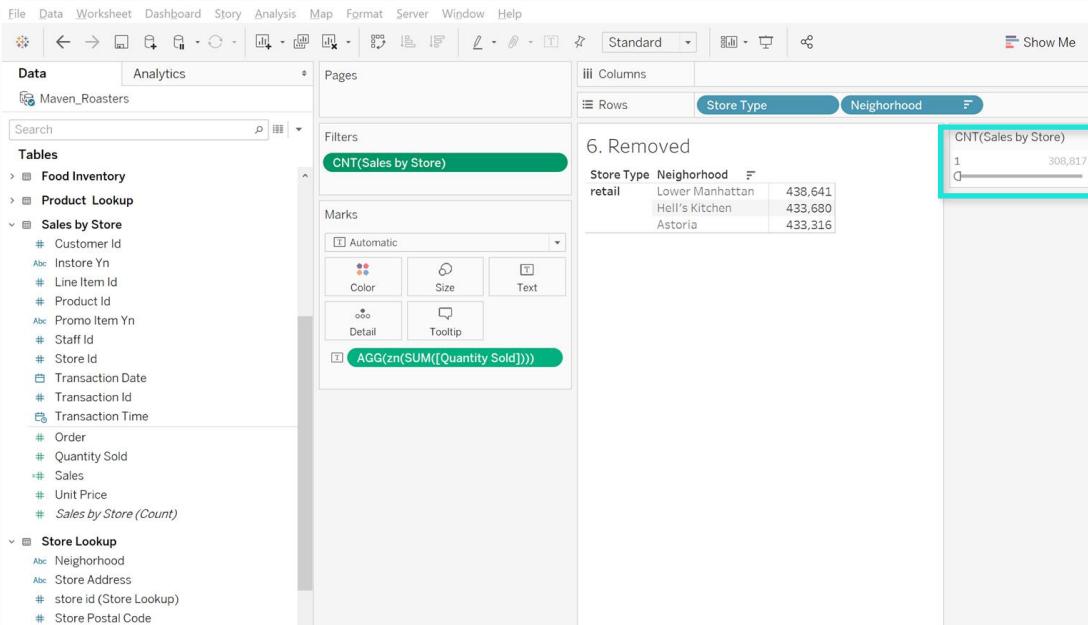
Store Lookup [Store Type]

Store Lookup [Neighborhood]

Contextual Joins | Removed

Removed

Use the “Count” field from the table you want to remove nulls from and choose **> 1** to remove nulls without removing ALL nulls (such as Neighborhoods without a home store)



Relationships leveraged in the view

Store ID = Store ID

Sales by Store
[Quantity Sold]

Store Lookup [Store Type]

Sales by Store [Count()]

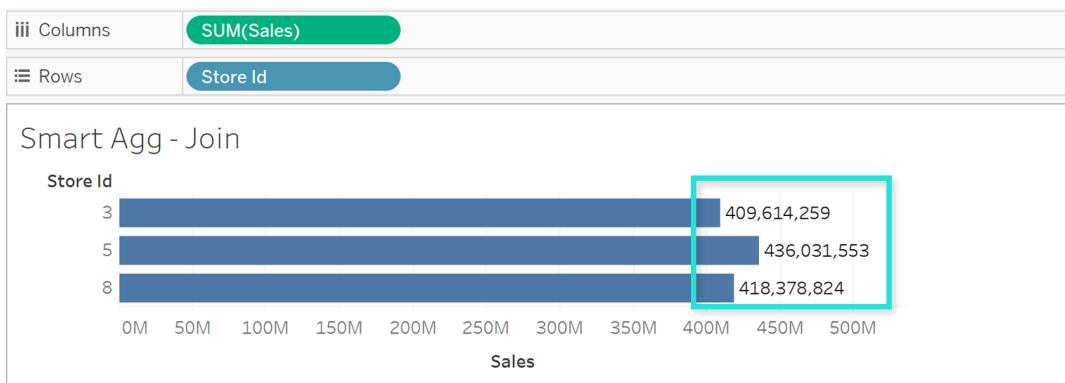
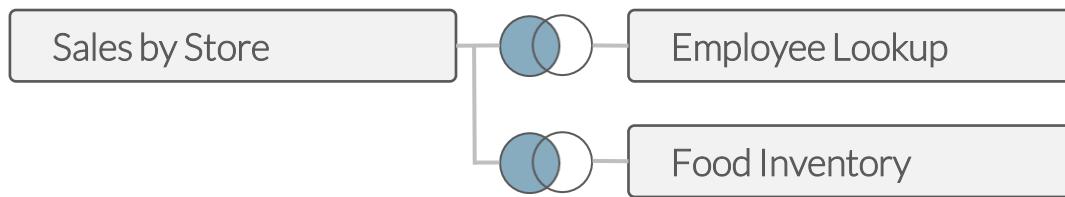
Store Lookup [Neighborhood]

Smart Aggregation

Smart aggregation allows measures to aggregate at the level of detail of their pre-join source

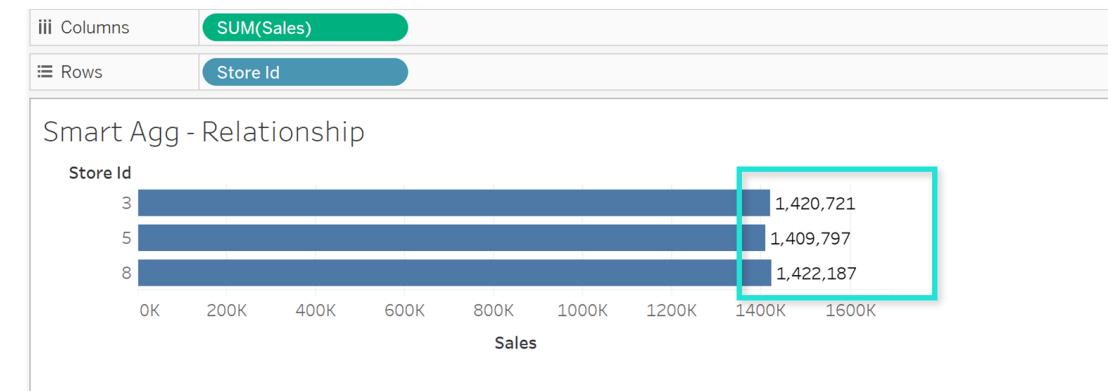
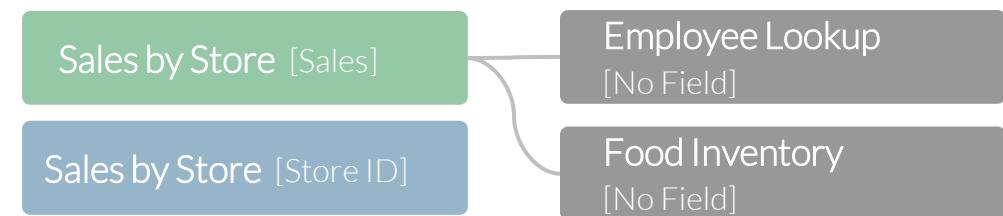
Physical Layer Joins:

Left Outer Join on Customer ID and Product ID



Relationships :

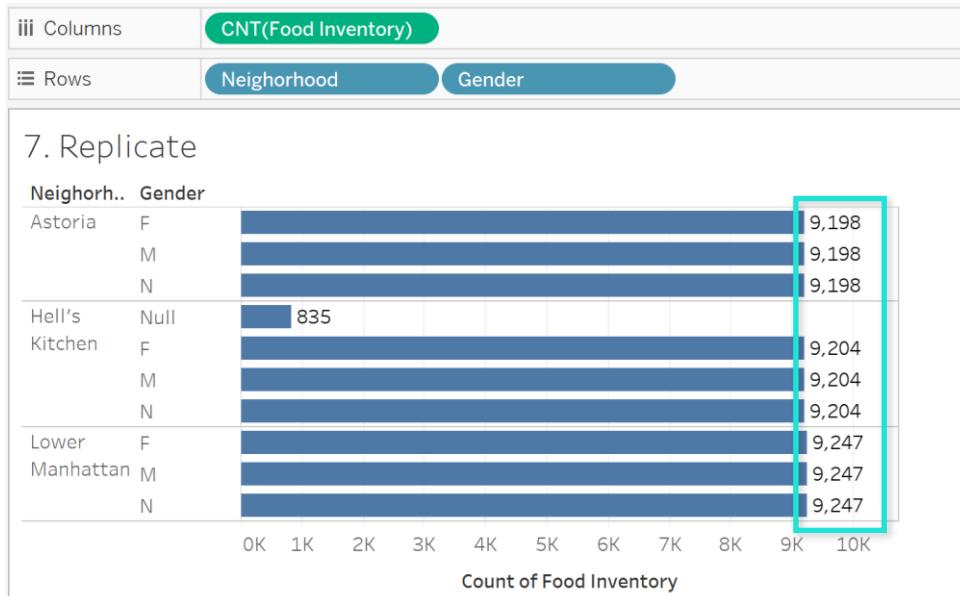
Matching fields on Customer ID and Product ID



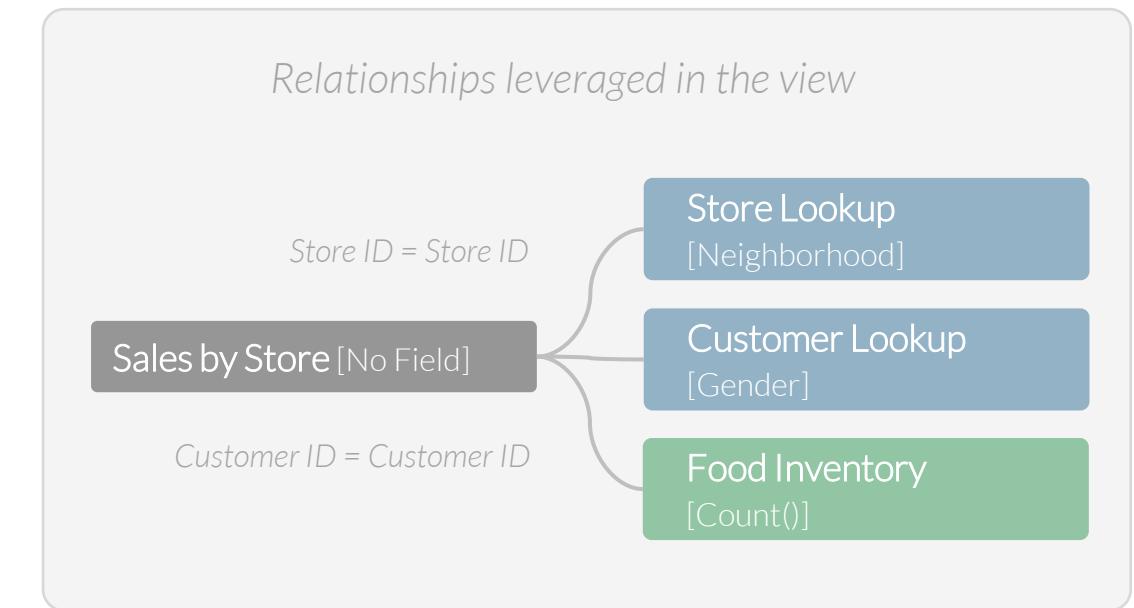
Smart Aggregation | Replicate

Replicate

Replicate measures across lower levels of detail in the **viz only**



Relationships leveraged in the view

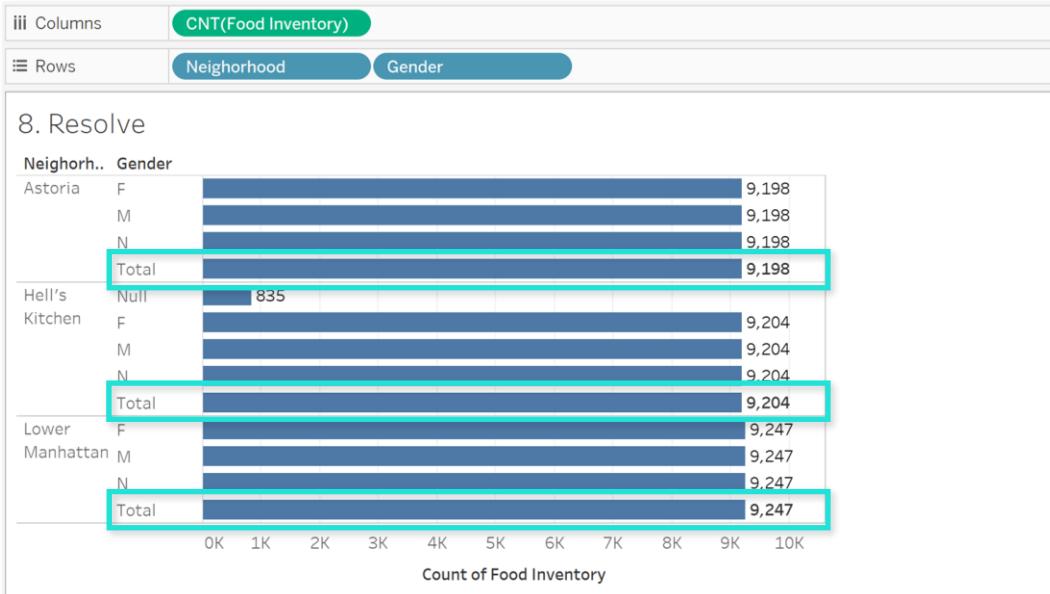


With a join, the many-to-many relationship between the Store Lookup and Customer Lookup tables would multiply Food Inventory values to incorrect proportions. Relationships replicate across measures in the view.

Smart Aggregation | Resolve

Resolve

Resolve aggregations to the measure's **native level of detail**



Relationships leveraged in the view

Store ID = Store ID

Sales by Store [No Field]

Customer ID = Customer ID

Store Lookup
[Neighborhood]

Customer Lookup
[Gender]

Food Inventory
[Count()]

Subtotals resolve to the measure's native aggregation (Food Inventory table) and do not aggregate replicated values across dimensions.

HOMEWORK: Relationships

THE **SITUATION**

The manager at your favorite bookstore, **Coffee & Books**, has enlisted your help to bring their data together. You'll need to use table relationships to create a data model for the team to use to support their business.

THE **BRIEF**

The team needs you to **create a dynamic data model** for their team to accurately analyze **sales, profits, and product mix**. The key will be to create a data source that is extremely flexible, but also provides peace of mind that the values in the reports are correct!

THE **OBJECTIVE**

Use Tableau Desktop to:

- Connect & transform raw data
- Relate source tables via matching fields
- Provide starter example analysis sheets for the team



Dynamic Design

Dynamic Design

Dynamic Design covers areas of dashboard creation that fall beyond basic sheet construction and interaction used in standard dashboards

- To make your dashboard design stand out, focus on **visual appeal, flexibility, and interactivity**

Visual Appeal



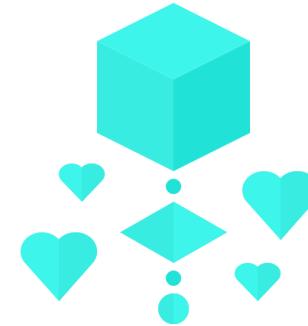
- *Elevate the visual appeal of your dashboard using external design tools and dynamic visual techniques*

Flexibility



- *Swap visuals, measures and dimensions to facilitate flexible analysis and keep users engaged*

Interactivity



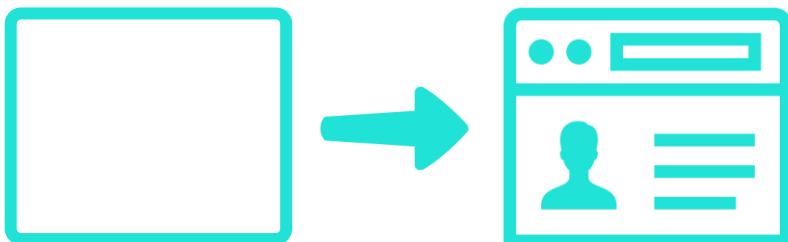
- *Leverage set & parameter actions to enable deeper analysis and app-like interaction with your visualizations*

Visual Appeal

Visual Appeal creates an engaging platform for users to explore and interact with your dashboard

- While analytics should be the backbone of your work, visual appeal can drive **user adoption** as well as **comprehension** of your vision

Background Templates:



Background templates provide **visual frameworks** for developers to build dashboards. Templates are both **creative** and **practical** tools for design.

Note: Templates do not refer to "Chart Templates", but rather visual guides to overall dashboard design

Information Indicators:



Information indicators come in many forms including **KPI shapes**, **Info Icons**, **Instructions/Commentary**

These devices communicate complementary data to better inform consumers of dashboards

Background Templates

Background Templates provide visual structure for developers to build stunning dashboards

- Templates can **speed up development** time and increase **visual appeal** of your analytic tools

PowerPoint

Create background in PPT, save as image file

NOTE: 1" in PPT = 100 Pixels in Tableau

Tableau Sheets

Sheets are created and floated on the dashboard pane



Combined Dashboard

Template image floated behind tableau sheets, Sheets are floated inside containers.

PRO TIP: Create background templates for each device (desktop, phone, tablet) and bring into your default view for dynamic template usage.

KPI Shapes

KPI Shapes provide visual indicators that convey complementary information to numeric values

- KPI shapes can be created via **shapes**, **images** or **Unicode characters** (depending on the use case)



This screenshot shows the Wikipedia page for "Geometric Shapes". It includes a table titled "U+25A0-U+25CF" with columns for Symbol, Name, HTML Hex, Description, and Last Recd. The table lists several symbols: BLACK SQUARE (U+25A0), BLACK PARALLELOGRAM (U+25A1), and BLACK LEFT POINTING TRIANGLE (U+25C4).

1 Unicode Characters

Copy Unicode character shapes from free online web-pages

https://en.wikipedia.org/wiki/Geometric_Shapes

Sales YOY Arrow

```
IF [Sales YOY Diff]>0 THEN "▲"  
ELSEIF [Sales YOY Diff]=0 THEN "●"  
ELSE "▼"  
END
```

2 Calculated Fields

Create conditional calculated fields with Unicode characters embedded in text.

Edit Label

Century Gothic 48

<SUM(Sales TY
YTD)>

<AGG(Sales YOY Arrow)><AGG(Sales YOY Diff %)>

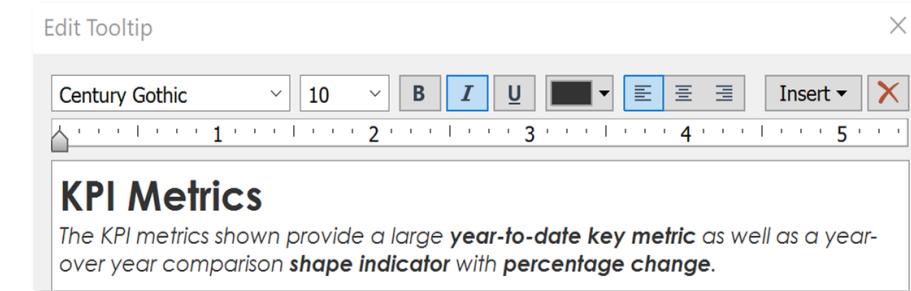
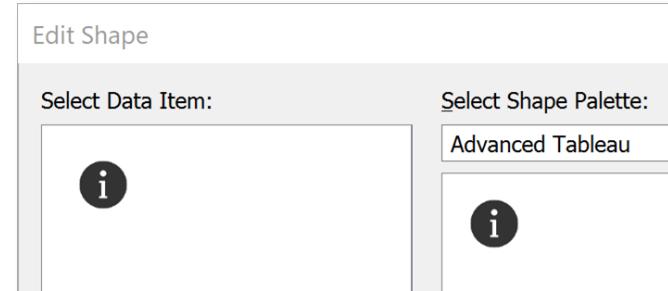
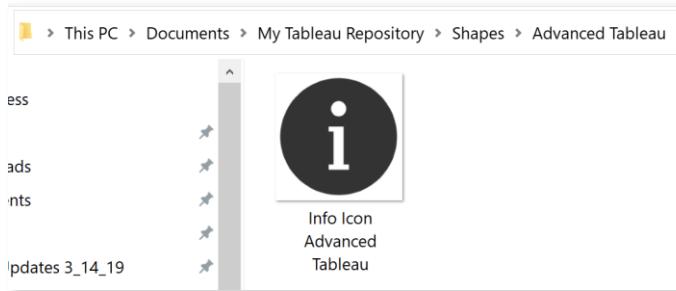
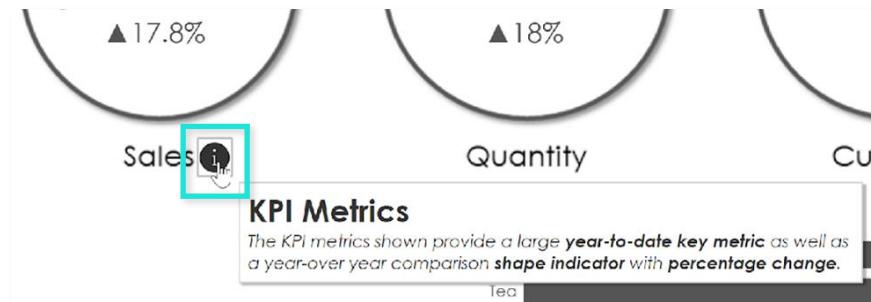
3 Text Labels

Layer measures, calculated fields and other text values as dynamic sheet labels

Info Icons

Info Icons can be used to provide detailed complimentary information within a dashboard

- Info icons are typically created using a combination of **custom shapes** and **tooltips**



1 My Tableau Repository

Download free icons and place in your shapes folder (My Tableau Repository > Shapes)

<https://icons8.com/icons>

2 Edit Shape Menu

In your sheet, open the shape menu and choose your custom icon.

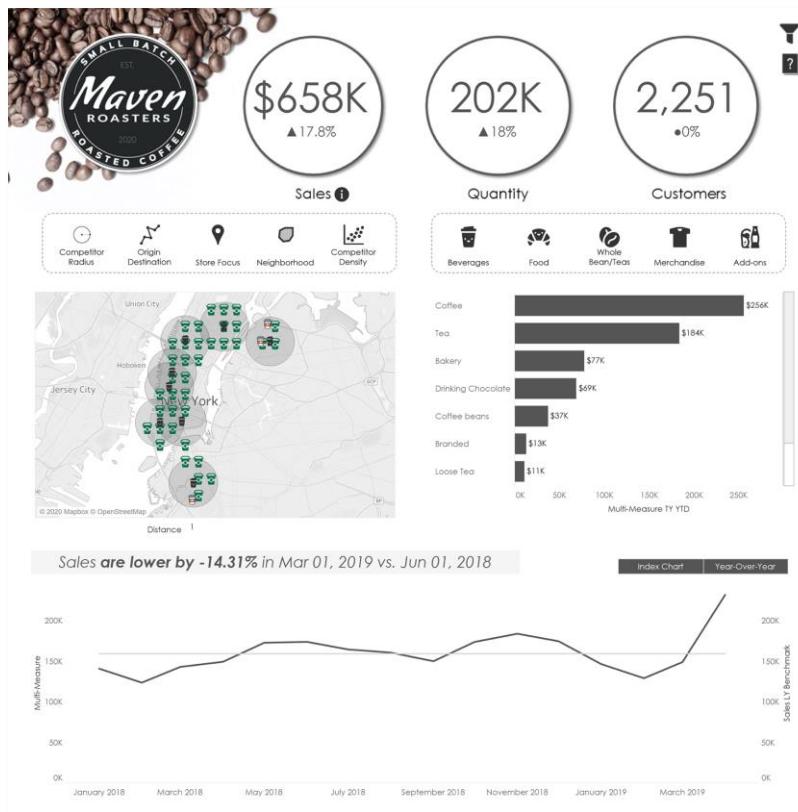
3 Tooltips

Type details into your tooltip to provide additional information for your users.

Instructions & Commentary

Instructions & Commentary provide end-users with helpful reference points to better utilize and understand your dashboard

Normal Dashboard View:



Instruction & Commentary Overlay:



1

Container Button

Use containers with buttons to enable toggling of an instruction panel.

2

Custom Image

Create an overlay image (in PPT) that is semi-transparent and embedded in a container.

Flexibility

Flexibility provides developers the ability to create layered analytics within a dashboard, both in the visualizations themselves and supporting filtering and complimentary content

- Two fundamental concepts in flexibility are **field swapping** and **containers**

Field Swapping:

Dimension/Measure 1



Dimension/Measure 2

Field swapping allows users to dynamically change the fields being displayed **INSIDE** a visualization

Containers:

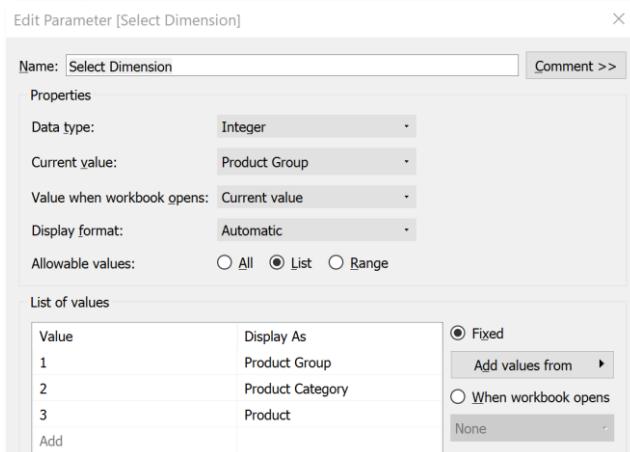


Containers allow users to swap out **entire visuals** or reveal additional **filters** or **information**

Multi-Dimensions

Multi-Dimensions enable users to dynamically swap out dimensions used in Tableau visualizations, and can be created in 3 steps:

1 Parameter



Create a **parameter** to allow users to select desired dimension to display

NOTE: Use integer for faster performance and a text display label

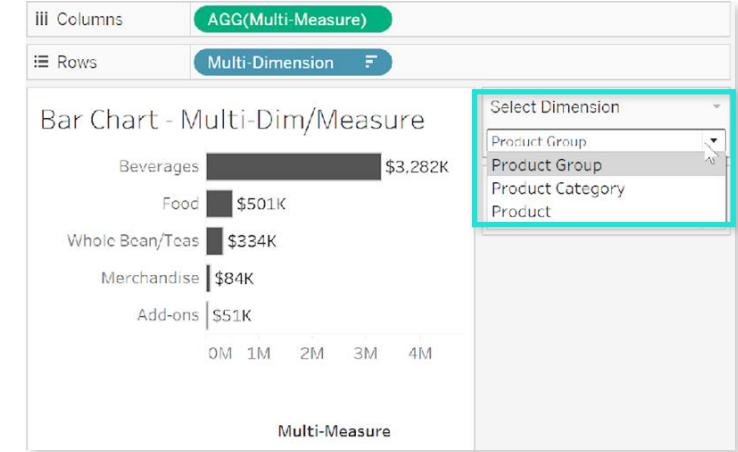
2 Calculated Field

```
CASE [Select Dimension]
WHEN 1 THEN [Product Group]
WHEN 2 THEN [Product Category]
WHEN 3 THEN [Product]
END
```

Create a **calculated field** using a case statement driven by the previously created parameter

NOTE: While IF statements can also be used, CASE statements are best for this use case

3 Visualization

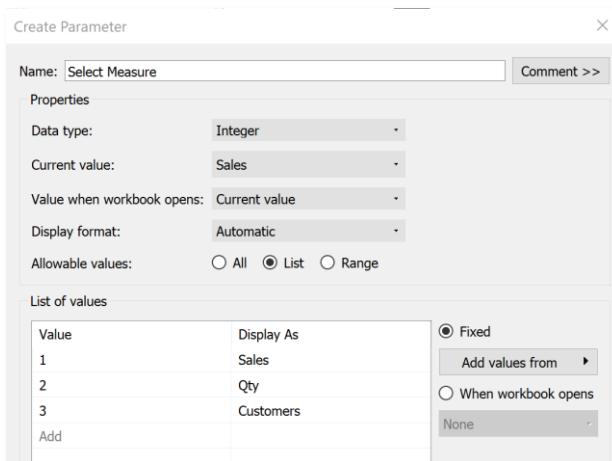


Create a **visualization** using the dimension calculated field and selector

Multi-Measures

Multi-Measures enable users to dynamically swap out measures used in Tableau visualizations, and can be created in 3 steps:

1 Parameter



Create a **parameter** to allow users to select desired measure to display

NOTE: Use integer for faster performance and a text display label

2 Calculated Field

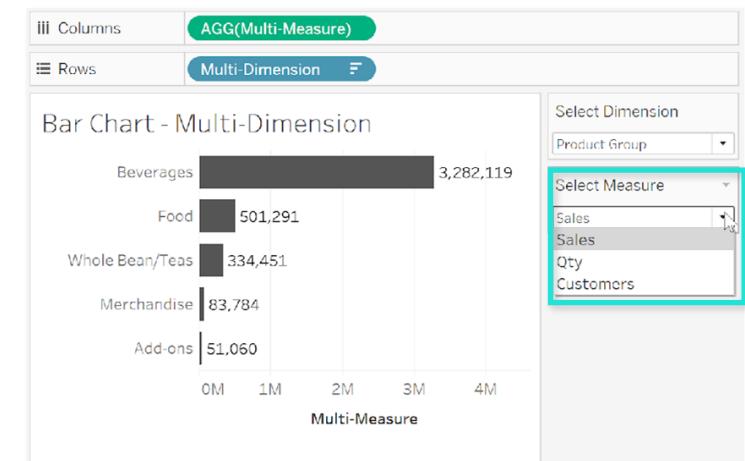
Multi-Measure

CASE [Select Measure]
WHEN 1 THEN SUM([Sales])
WHEN 2 THEN SUM([Quantity Sold])
WHEN 3 THEN COUNTD([Customer Id])
END

Create a **calculated field** using a case statement driven by the previously created parameter

NOTE: Aggregation must be applied at this level if differs by measure

3 Visualization



Create a **visualization** using the multi-measure calculated field and selector

PRO TIP: Dynamic Formatting

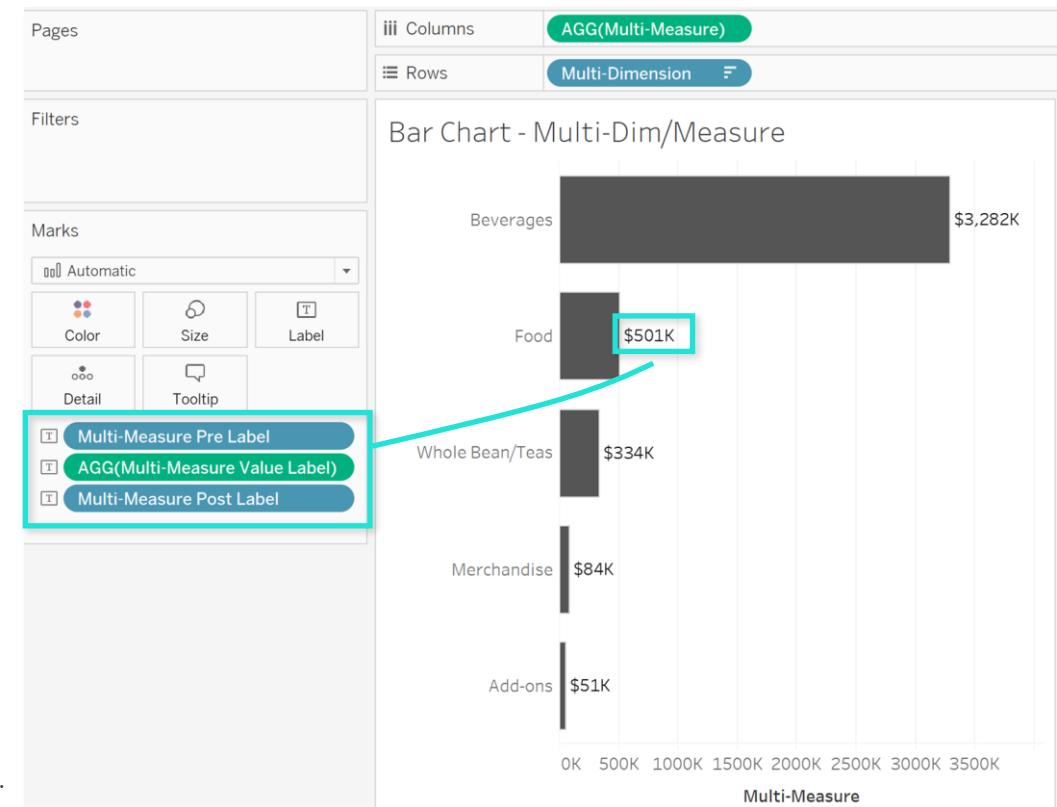
Multi-Measures add complexity due to mixed formatting (i.e. swapping between **Sales** and **Profit %**)

- Additional multi-select labels and aggregation calculations can be used to customize formats

Pre & Post Labels:

Multi-Measure Pre Label	Multi-Measure Post Label
CASE [Select Measure] WHEN 1 THEN "\$" WHEN 2 THEN "" WHEN 3 THEN "" END	CASE [Select Measure] WHEN 1 THEN "K" WHEN 2 THEN "K" WHEN 3 THEN "" END

Leverage the **multi-measure parameter** in two calculated fields, one for **before** (such as a \$) the value and one for **after** (% , K, M, etc.).



Dynamic Aggregation:

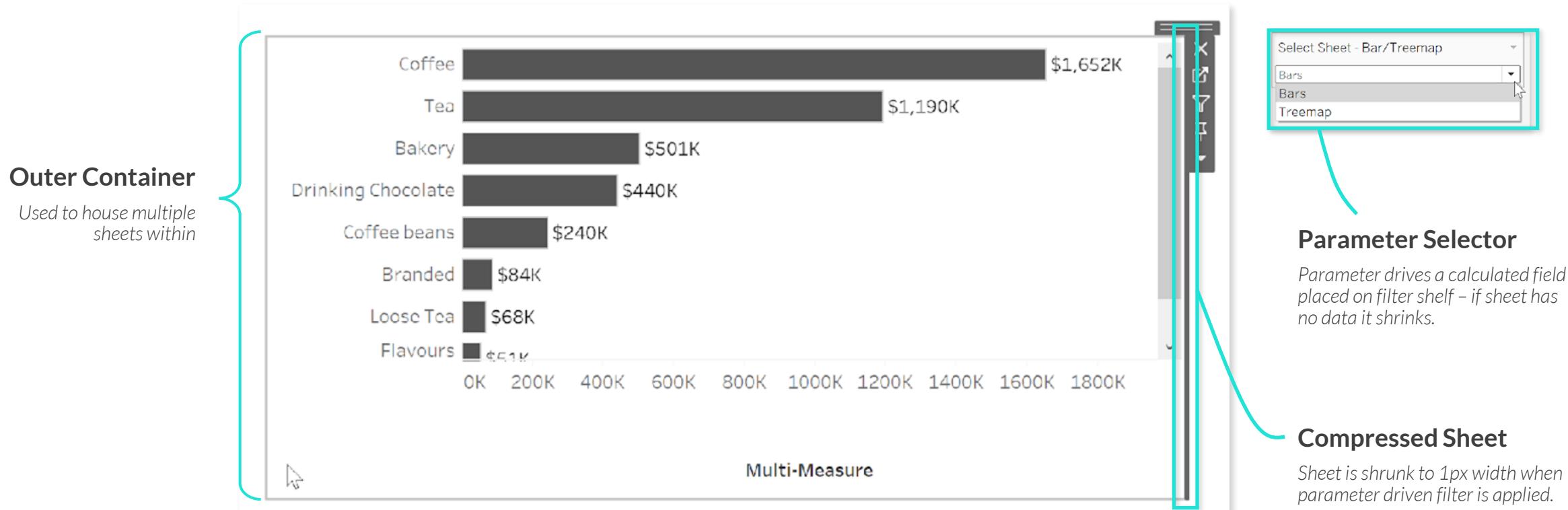
Multi-Measure Value Label	Maven_Roasters
CASE [Select Measure] WHEN 1 THEN SUM([Sales])/1000 WHEN 2 THEN SUM([Quantity Sold])/1000 WHEN 3 THEN COUNTD([Customer Id]) END	

Leverage the **multi-measure parameter** in a calculated field used for measure label display. This will allow for different levels of format aggregation per measure.

Sheet Selectors

Sheet selectors allow developers to change visuals within the **same physical space** in a dashboard

- These are especially useful to maintain user engagement and keep dashboard space **clean** and **focused**

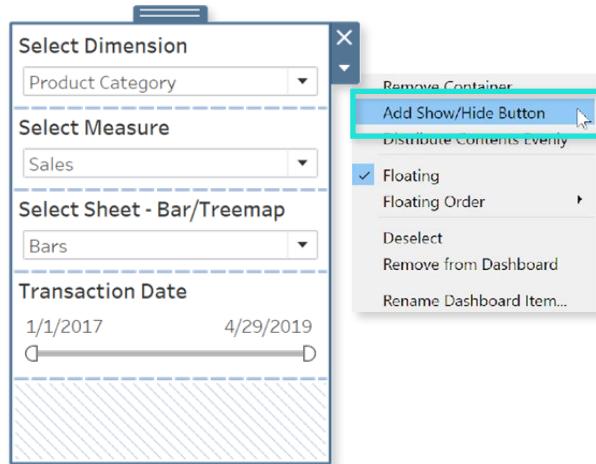


Filter Menus

Filter Menus enable users to show/hide filters on a dashboard

- Using filter menus helps conserve dashboard space, enhance usability and create app-like experiences

1 Show Button



Select container and choose “Add Show/Hide Button”

NOTE: Content (sheets, images, text, etc.) needs to be added to a container for this option to show

2 Customize Settings

A screenshot of the 'Edit Button' configuration dialog. It includes sections for 'Dashboard Item to Show/Hide' (set to 'Vertical'), 'Button Style' (set to 'Image Button'), 'Button Appearance' (with tabs for 'Item Shown' and 'Item Hidden'), 'Image' (with a 'Choose' button), 'Border' (set to 'None'), 'Background' (set to 'None'), 'Tooltip' (with a text input field), and 'Apply' and 'OK' buttons at the bottom. A large teal bracket on the right side of the slide points to this dialog.

Dashboard Items to Show/Hide

Select the container (by name) to show/hide in the dashboard

Button Style

Text or Image are options. Text will display flat text, while image will all for custom icons

Button Appearance

Text/Images need to be chosen for “shown” and “hidden” states

Image

Allows you to choose custom images/icons (default options are menu stack and X)

Border/Background

Add a border color or background color to the button

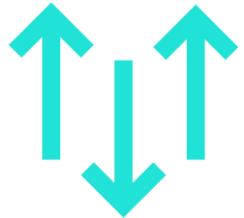
Tooltip

Flat text displayed when hovering over the button

Interactivity

Interactivity grants users the ability to dynamically change visualizations, their analytic components and physical structure simply by *selecting a visualization*

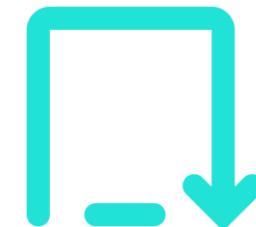
- **Parameter & Set Actions** enable next-level dashboard interaction for many types of use cases:



Multi-Measure



Index Chart



Year-Over-Year



Sheet Selector



Relative Dimensional Analysis



Proportional Brushing



Asymmetric Drilldown



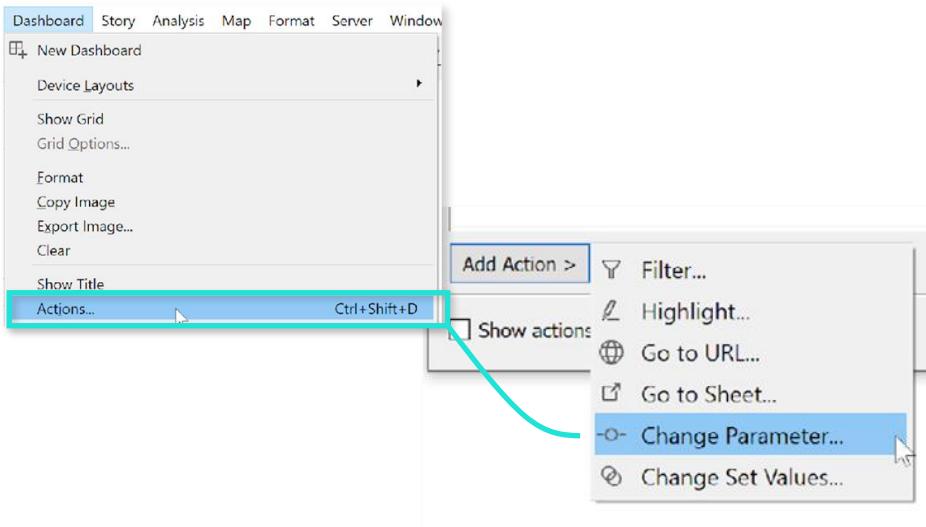
Color Scaling

Parameter Actions

Parameter Actions allow end-users to apply parameter values by selecting a visualization

- These actions drive the flow of analysis in an intuitive manner without drop-down box functionality

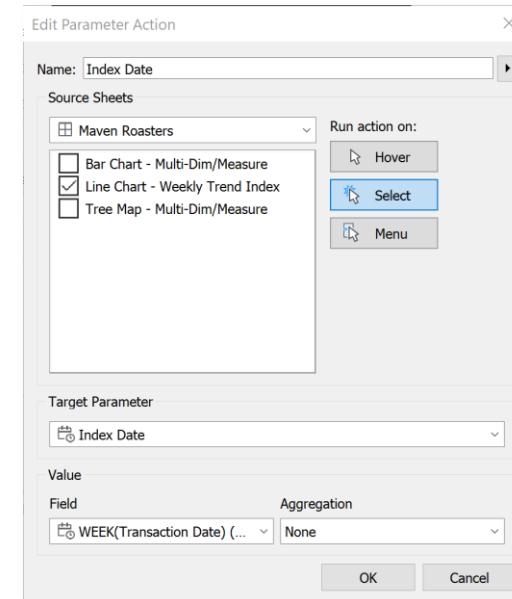
1 Create Parameter Action



Create a parameter action from the **dashboard > actions** menu
(shown as “**Change Parameter**” in the action menu)

NOTE: Parameter actions **cannot** be created from a sheet directly as filter actions can be

2 Customize Settings



Name

Choose parameter action name

Source Sheets

Select sheets to where action will be generated from

Run action on

Choose to action on Hover, Select, or Menu

Target Parameter

Select parameter to be impacted by the action

Value

Select field from source sheet to push to parameter

Aggregation

Select an aggregation type for field (if applicable)

Parameter Actions | Multi-Measure

Multi-Measures allow users to dynamically select metrics in a dashboard

- Enabling parameter actions as the driver (rather than a drop-down) creates an intuitive/immersive experience for end-users



- 1
- 2
- 3

Calculated Field

Match the field value to the value of the multi-metric parameter (i.e. 1 = Sales)

Source Sheet

Place calculated field on source sheet. Value will be pushed to parameter via action

Parameter Action

Action will pull calc field from source sheet and push to parameter

Parameter Actions | Index Chart

Index Charts allow for dynamic relative time comparison along an axis

- With use of parameter actions, once a date is selected all other points change relative to that date

Multi-Metric Table Calculation

Metric calc uses difference from table calc, while referencing the selected "index" date

Multi-Metric

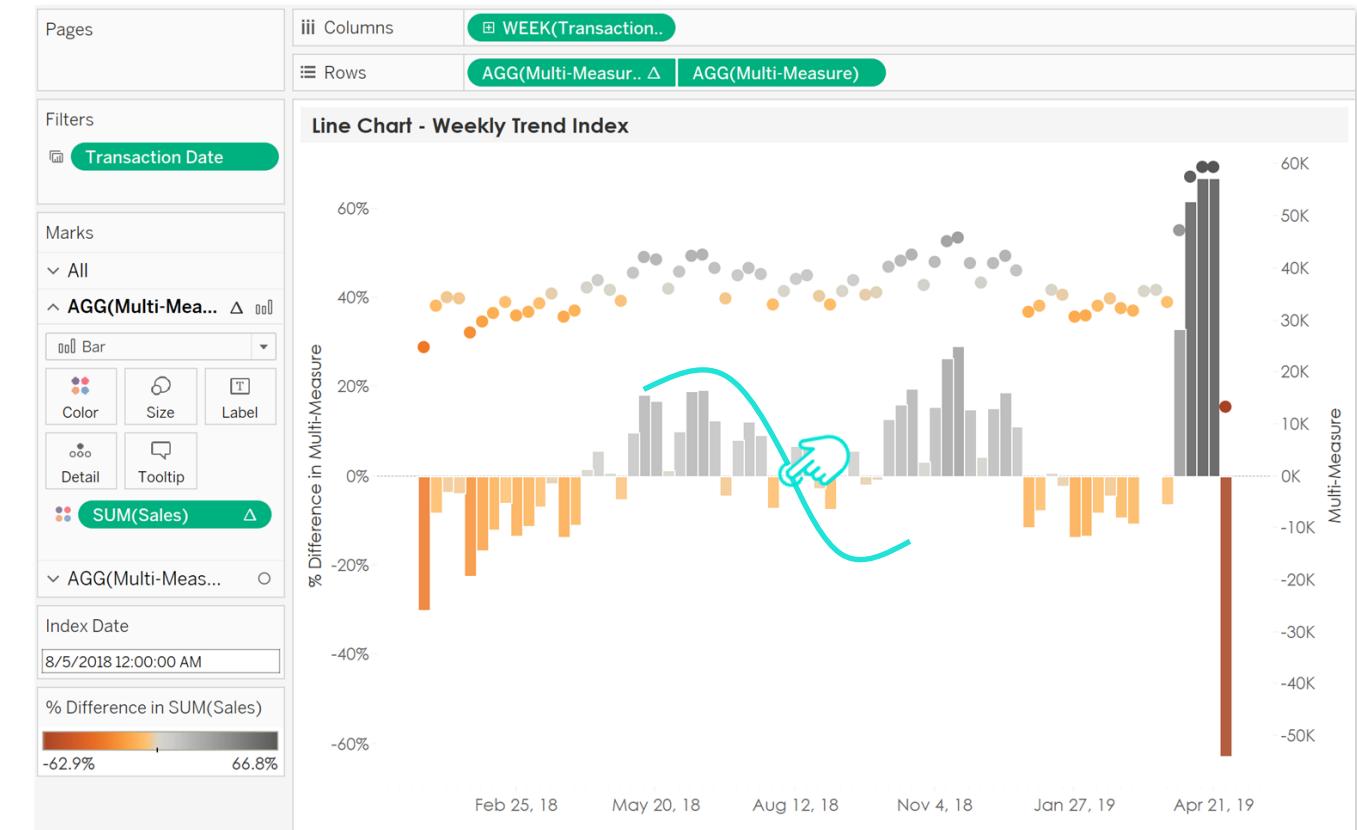
Normal multi-metric is dual axis to show true value against difference from

Index Date

Selected date that is pushed by a parameter action into a parameter

Color Legend

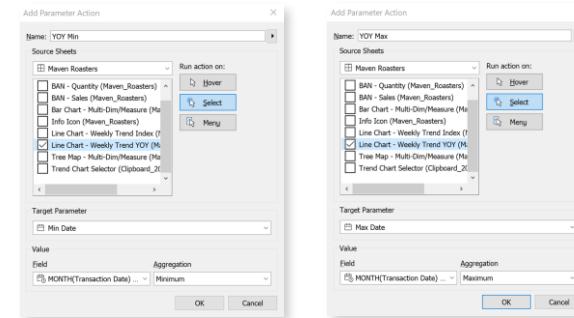
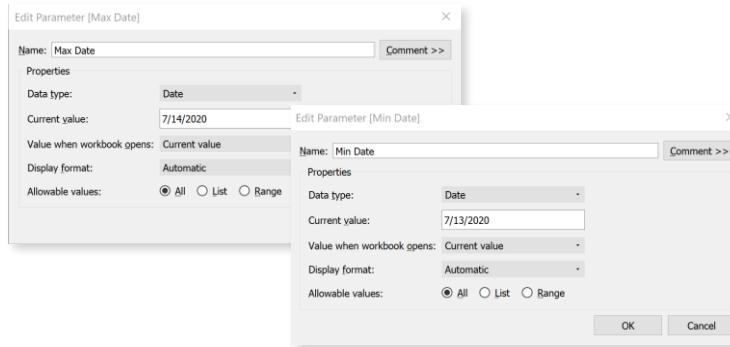
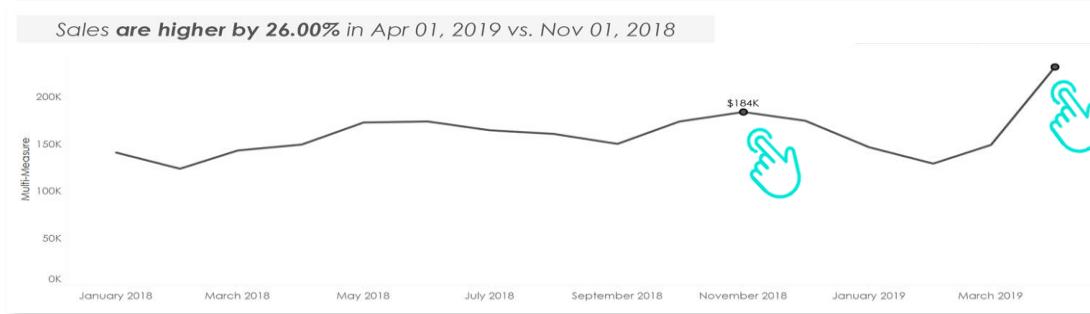
Sales metric is applied to color to maintain primary metric coloration



Parameter Actions | Year-Over-Year

Year-Over-Year charts allow for trend views with dynamic date-vs-date value comparisons

- Parameter actions make this dynamically selectable from the view by selecting two points in time



1 Date Parameters

Create both a min and max date parameter. These will be populated by the comparison dates chosen in the chart

2 Parameter Actions

Create both a min and max parameter action with matching aggregation types (max date = max aggregation, etc.)

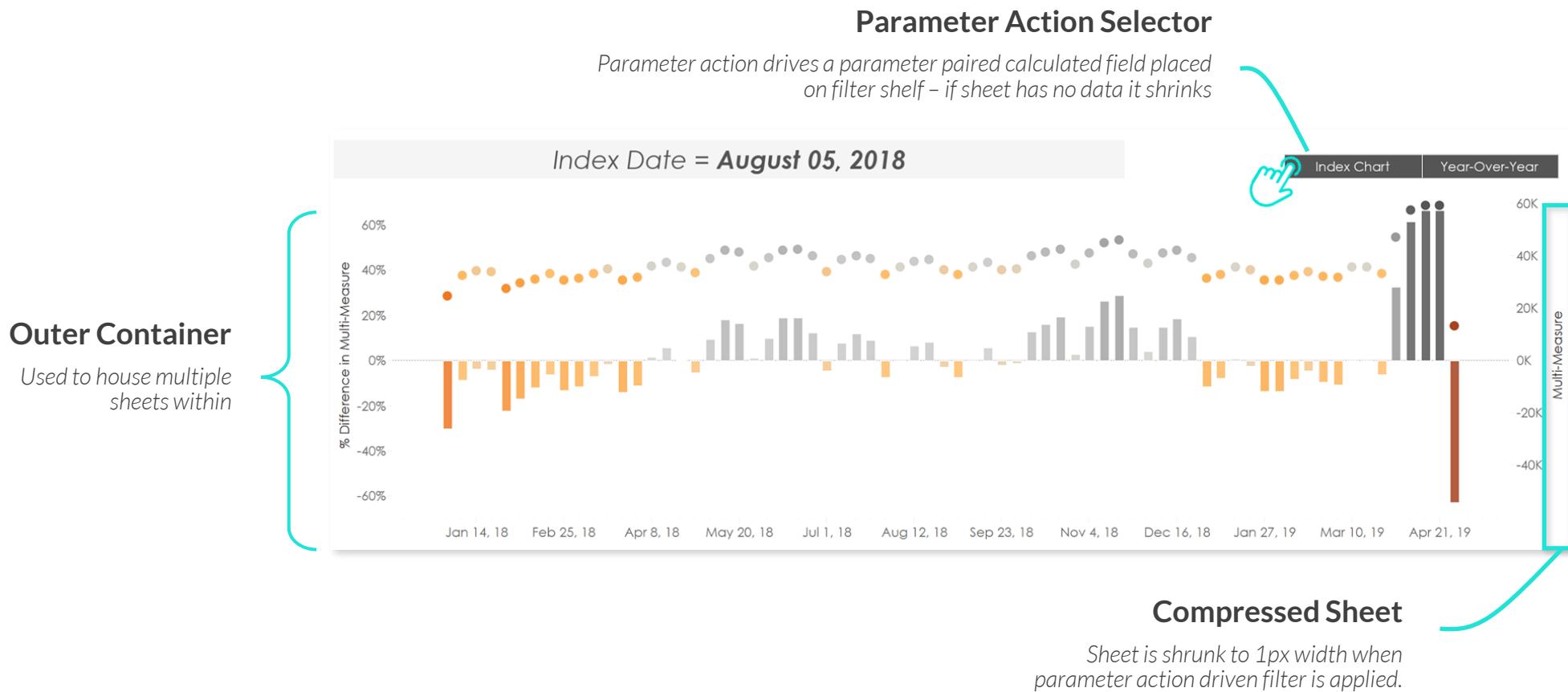
3 Calculations

Calculations will accept the values for dates pushed into the max and min parameters and display the difference in value (or percentage change)

Parameter Actions | Sheet Selector

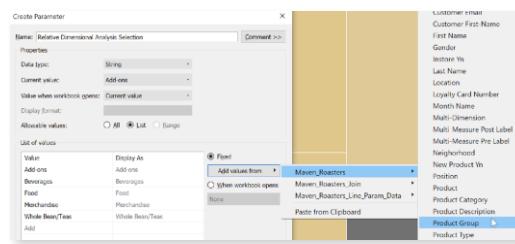
Sheet selectors allow developers to change visuals within the **same physical space** in a dashboard

- Using parameter actions can make sheet selectors easier to use and more aesthetically pleasing



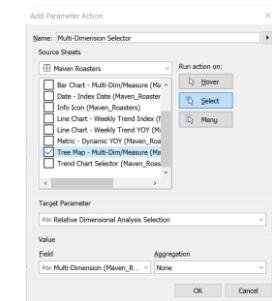
Parameter Actions | Relative Dimensional Analysis

Relative Dimensional Analysis gives users the ability to compare a single dimension in context to (relative to) all other dimensional values within the selected field



1 Dimension Parameter

Create a parameter to accept dimensions from dimensional parameter action



2 Parameter Action

Create parameter action to push selected dimension to dimension parameter, linked to a calculated field

```
Selected Dimension YOY Diff [Maven_Roasters]

max({ FIXED : max(
  IF [Multi-Dimension] = [Relative Dimensional Analysis Selection]
  THEN { FIXED [Multi-Dimension]: [Multi-Measure YOY Diff %]}
  else null
end) })
```

[Multi-Measure YOY Diff %]

3 Calculation

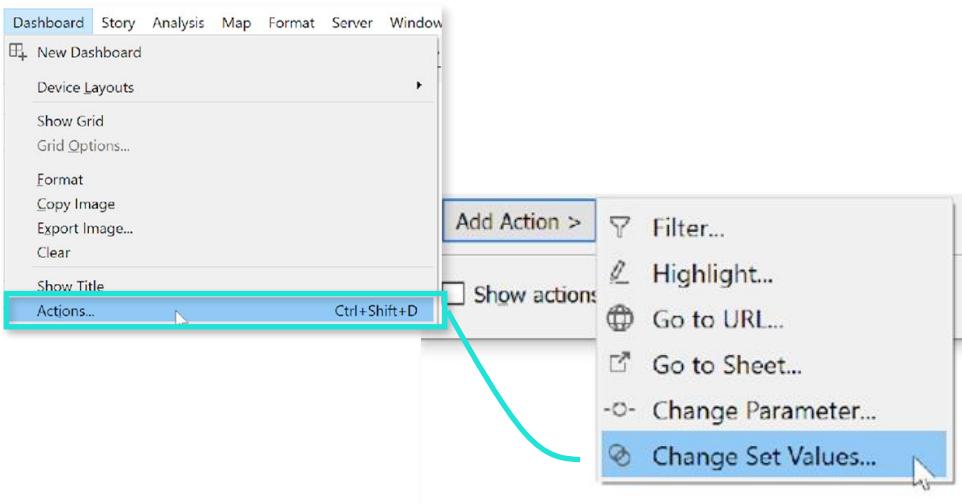
Calculation will accept the dimensional values from dimension parameters and compare value to every other dimensional value in the viz (shown via color scale)

Set Actions

Set Actions allow end-users to change set values by simply selecting a visualization

- Dynamic set adjustments allow for on-the-fly analysis and data exploration

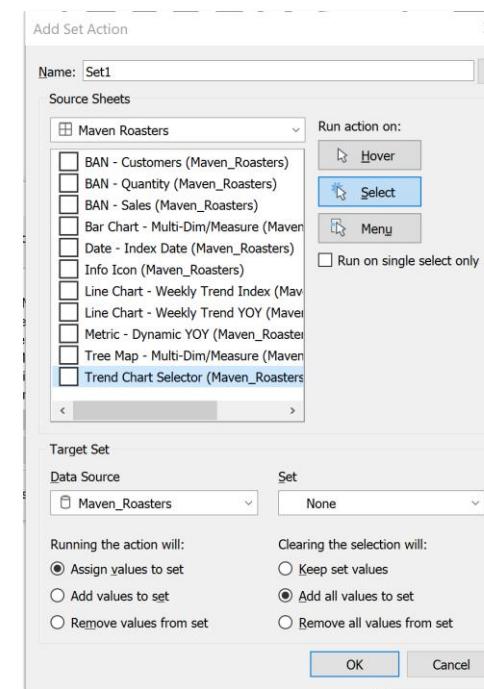
1 Create Set Action



Create a set action from the **dashboard > actions** menu (shown as "Change Set Values")

NOTE: Set actions **cannot** be created from a sheet directly like filter actions

2 Customize Settings



Name

Choose set action name

Source Sheets

Select sheets to where action will be generated from

Run action on

Choose to action on Hover, Select, or Menu

Target Set | Data Source / Set

Select data source/set to be impacted by the action

Running the action will:

Choose what the action does – assign, add, or remove values from a set

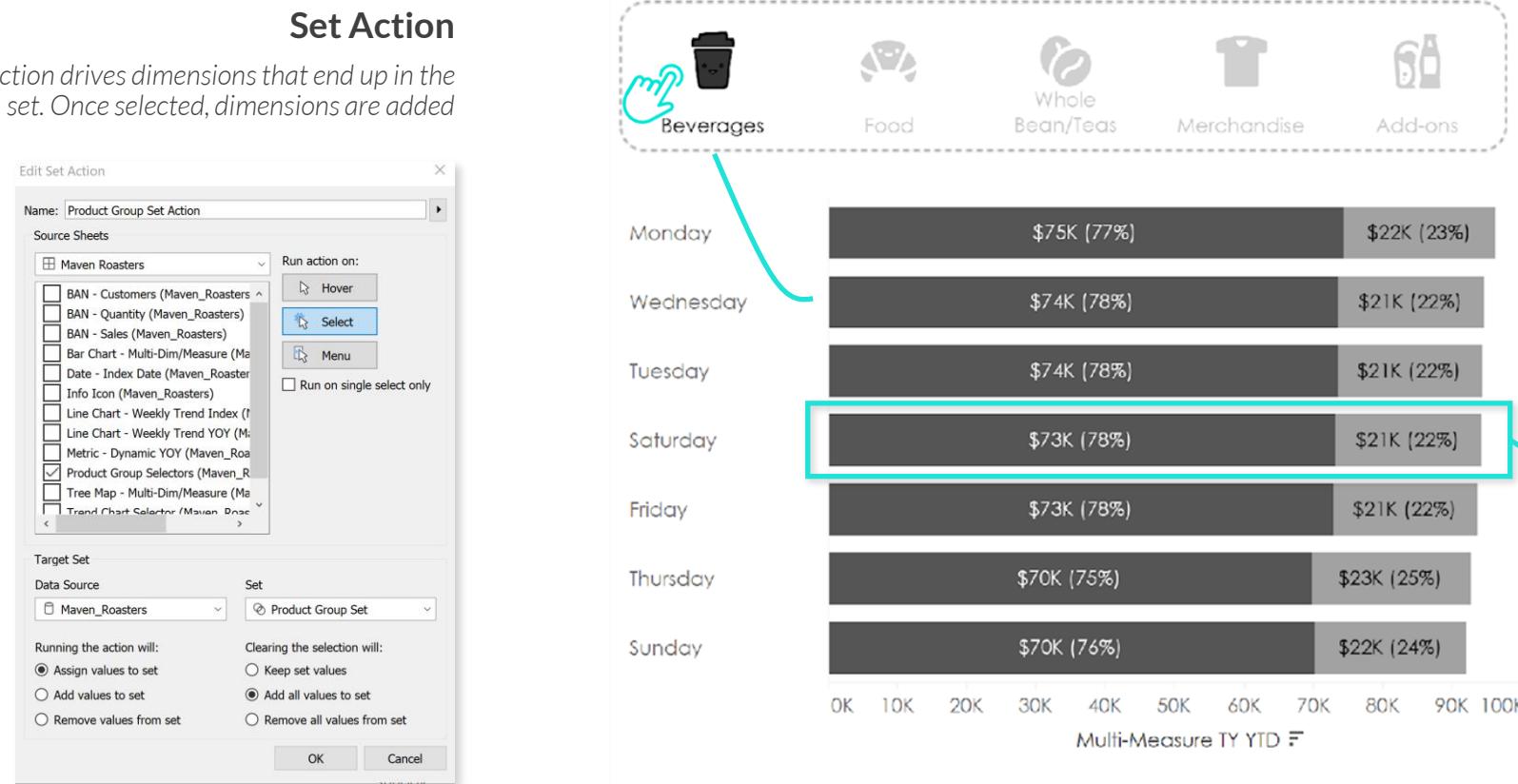
Clearing the selection will:

Choose what clearing the selection does – keeps, adds, or removes values from the set

Set Actions | Proportional Brushing

Proportional Brushing updates sets using set actions by selecting dimension(s) across a visualization on the color mark

- This shows users what portion of the overall value is represented by the selected dimension



Custom Icons

Shapes applied to dimensions create the icons for user selection

Set Applied to Color Mark

Set will inherit set action dimension and apply to the color mark. In/out colors will differentiate set status

Set Actions | Asymmetric Drilldown

Asymmetric Drilldown provides hierarchy drilldown for a selected dimension, while leaving other dimensions compressed

The screenshot illustrates the configuration of an asymmetric drilldown. On the left, two dialog boxes are shown: 'Edit Set [Asymmetric Set]' and 'Edit Set Action'. The 'Edit Set [Asymmetric Set]' box shows a 'Name' field with 'Asymmetric Set' and a 'Source Sheets' dropdown set to 'Maven Roasters Detail'. The 'Edit Set Action' box shows a 'Name' field with 'Drill-Down Set', a 'Run action on' dropdown with 'Select' checked, and a 'Target Set' section where 'Data Source' is 'Maven_Roasters' and 'Set' is 'Asymmetric Set'. A cyan arrow points from the 'Food' item in the main grid to the 'Edit Set Action' dialog.

Detail Drill-Down

Product Group	*Click for Product Detail*		Sales TY YTD
Beverages			\$507,947
Food			\$6,801
Whole Bean/Teas			\$6,287
Merchandise			\$11,034
Add-ons			\$6,168
Grand Total			\$6,385

Set & Set Action

Set is created from the higher-level hierarchy dimension, which is subsequently pushed by the set action when selected

Calculation

```
*Click for Product Detail*
IF [Asymmetric Set]
THEN [Product]
ELSE "" END
```

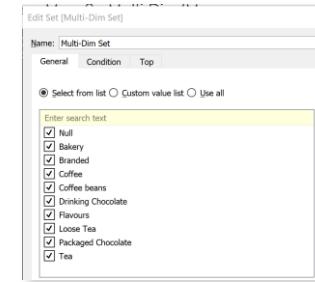
When engaged, the sub-dimension appears

Set Actions | Color Scaling

Color Scaling enables cross-dimensional comparison of subsets of data which are normally obscured by outliers within the data (i.e. very large/small values which impact scale)



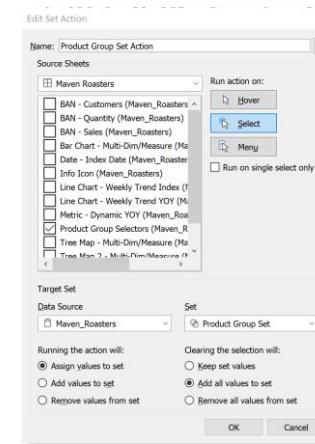
1



2



3



Create Set

Create base set which will accept values from set action

Calculated Field

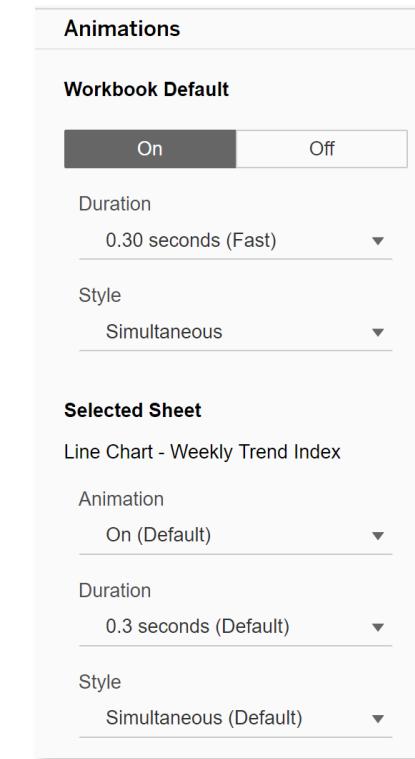
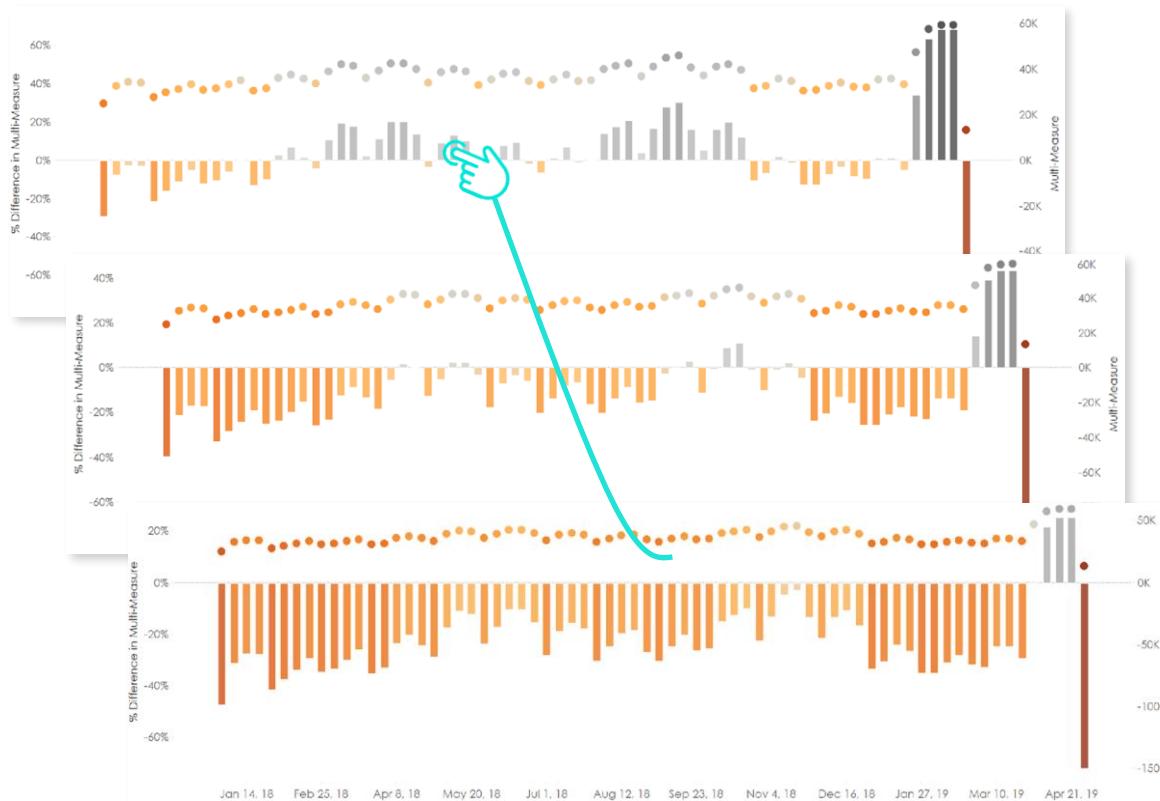
Calculated field will show metric only when set dimensions are enabled

Set Action

Set action will push selected dimensions to calculated field (which is applied to color)

PRO TIP: Viz Animations

Viz Animations provide a dynamic transition setting for visualizations using filters, filter actions, calculations and more



Workbook Default

By default animations are turned off (but can be turned on at a workbook level)

Duration

Duration can be set from fast (0.3s) to slow (2.0s) or even a custom value

Style

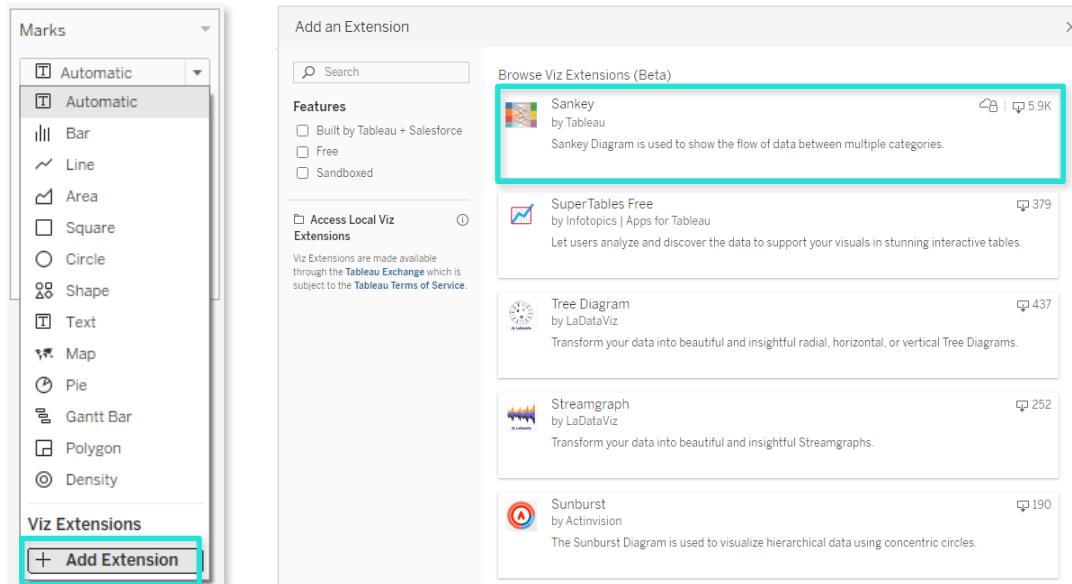
Style can be simultaneous (at the same time) or sequential (in order)

Selected Sheet

Animations can be customized at a sheet level for sheets selected

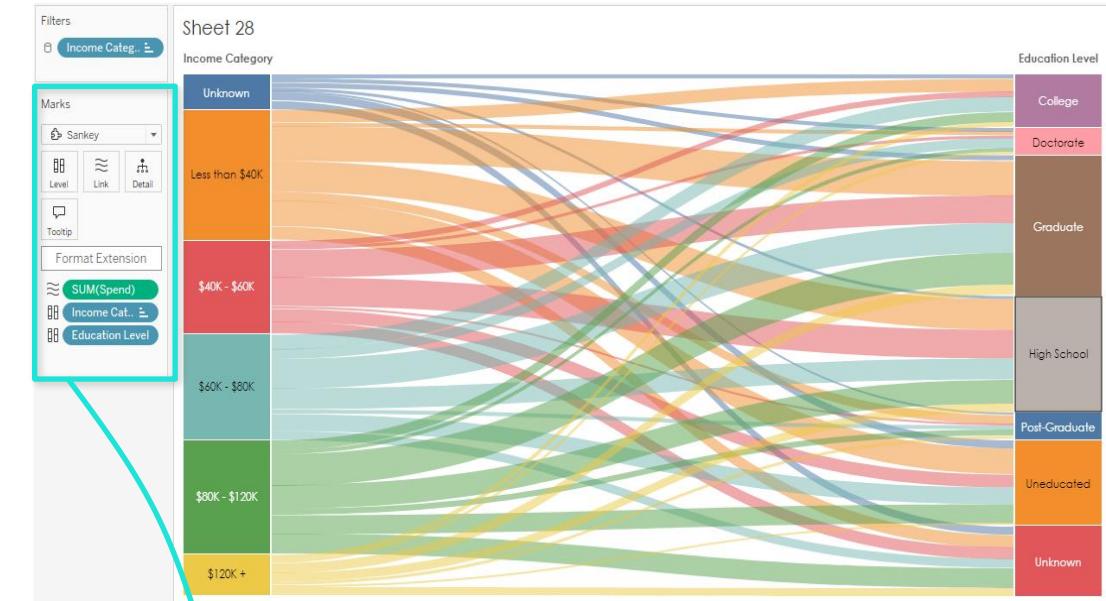
PRO TIP: Viz Extensions

Viz Extensions are 3rd party add-ins used for creating **novel visualizations** not native to Tableau



Add Extension

Select the Marks Card and choose **+ Add Extension** to see a library of free or paid extensions



Configure Extension

Configure your extension using the Marks Card or specialized formatting properties



Be cautious when using Viz Extensions with sensitive or proprietary data. Viz Extensions leverage aggregate-level data to create visualizations and may pass data securely to **third-party developers**. Ask your company's **security/IT team** for approval before using Viz Extensions with real data!

HOMEWORK: Dynamic Design

THE **SITUATION**

To better navigate the analytics career market, you've decided to utilize your data visualization skills to create a **custom analytics career dashboard**.

THE **BRIEF**

Your goal is to develop a robust dashboard that allows you to quickly **swap fields** and **visuals**, apply custom-focused **dimensional comparisons**, and enable fast **filtering** and **interaction**.

Everything will need to be both *functional* and *beautiful* – this dashboard will serve as both an analytics tool as well as a personal portfolio piece!

THE **OBJECTIVE**

Use Tableau Desktop to:

- Import custom templates
- Develop KPI indicators and App-like Filtering
- Enable dynamic field/visualization swapping
- Leverage Set/Parameter actions for custom business insights



Geospatial Mapping

Geospatial Mapping

Geospatial mapping includes any geographical visualization or calculation leveraged by Tableau

- We'll cover geospatial mapping in the context of **Data & Workspace**, **Use-Cases** and **Customization**

Data & Workspace



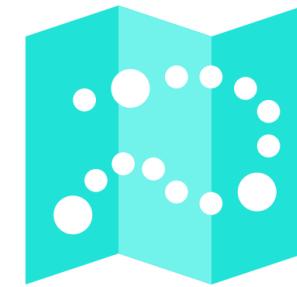
- Ingesting geospatial data and exploring the geospatial tools in Tableau Desktop

Use Cases



- Exploring various business scenarios and use cases for geospatial mapping

Customization



- Customizing maps and expanding on simple visuals using internal and external tools

Geospatial Data

Geospatial data comes in two primary forms: **geographic fields** and **spatial data files**

The screenshot shows the Tableau Data Source pane. On the left, there's a sidebar with 'Parameters' and 'Data Source'. The main area shows a field named 'Store Postal Code' with its properties. A dropdown menu is open under 'Geographic Role' with the following options: None, Airport, Area Code (U.S.), CBSA/MSA (U.S.), City, Congressional District (U.S.), Country/Region, County, NUTS Europe, State/Province, and ZIP Code/Postcode. The 'ZIP Code/Postcode' option is highlighted with a blue border.

Geographic Fields

Can be assigned to fields in any source so long as field types and roles are assigned correctly

Location fields are recognized by Tableau automatically (Country, State, City, Zip Code, etc.)

The screenshot shows the 'Connect' dialog in Tableau. It has sections for 'Search for Data' (Tableau Server) and 'To a File' (Microsoft Excel, Text file, JSON file, Microsoft Access, PDF file, Spatial file). The 'Spatial file' option is highlighted with a blue border and a cursor is pointing at it.

Spatial Data Files

Spatial data files are special file types that contain geospatial data using geometry fields (examples include Shape, GeoJSON, etc.)



PRO TIP: Latitude and Longitude fields are automatically generated with standard location fields!

The Mapping Workspace

The **mapping workspace** provides an array of customization and feature enablement tools for geospatial visualizations in Tableau

View Toolbar

Enables map search, panning, zoom, and multiple mark selection

Data Pane Fields

Geographic fields show in the data pane with a globe icon

The screenshot shows the Tableau interface with a map visualization of New York City. The View Toolbar at the top includes icons for search, pan, and zoom. The Data Pane on the left lists geographic fields like Neighborhood, Store # Text, and Store Address. The Marks Card displays a radius map with green coffee shop icons and gray buffer zones. The Map Options card shows settings for pan and zoom, map search, view toolbar, and map scale. The Map Menu is open, showing options like Background Maps, Background Images, and Geocoding.

Adjust map type from the mark drop-down or drag geographic fields to detail to impact the grain of the map

Map Menu

Provides additional map capability including background images and map layers

The Map Layers dialog box is open, showing the Background section with 'Style' set to 'Light' and 'Washout' at 0%. The Map Layers section contains a large list of checked options under 'Base' and 'Land Cover'. The Data Layer section shows 'Layer: No Data Layer'.

Map Layers

Control the coloration, level of geographic detail and integrated data layers

Map Options

Control options available to end-users on the map related to exploration, scale, and units

Geospatial Use Cases

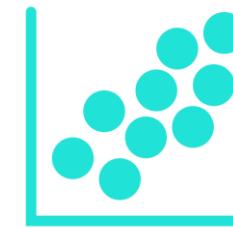
There are several common **use cases** that analysts can use to explore and visualize geospatial data in Tableau, including **heat maps**, **density maps**, **point distribution charts**, and more:



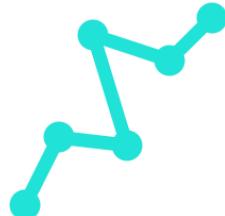
Point Distribution Maps



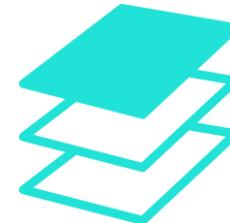
Heatmaps



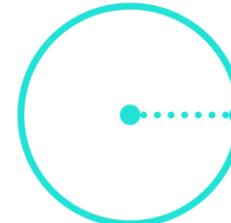
Density Maps



Flow Maps



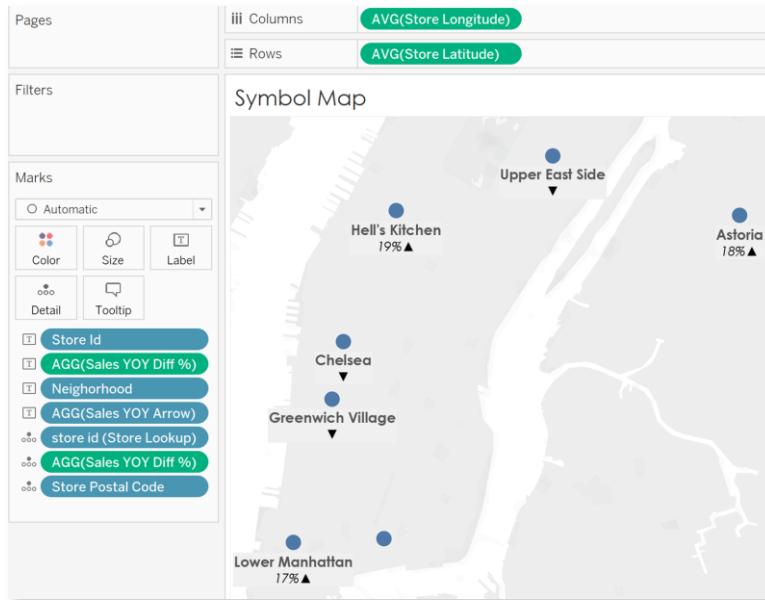
Layered Maps



Radius Maps

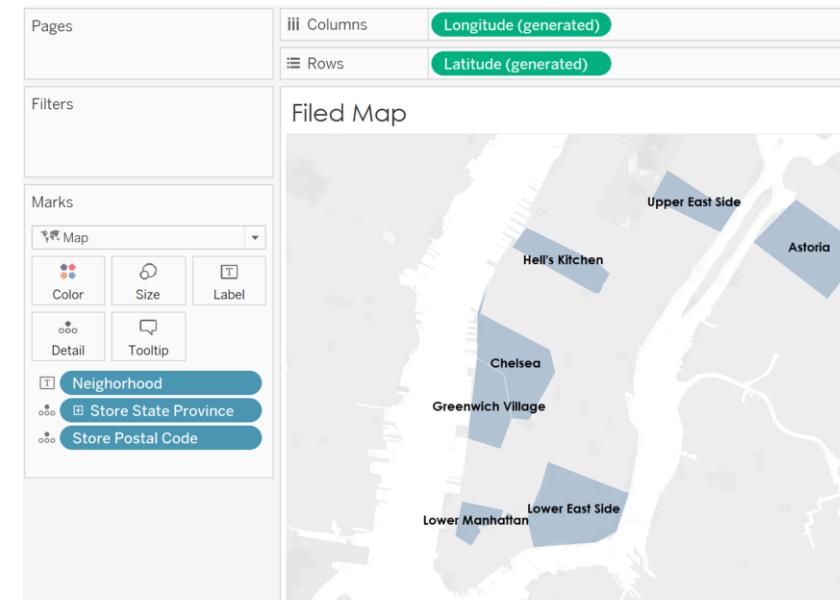
Standard Maps

There are two types of **standard maps** available in Tableau: **proportional symbol** & **filled maps**



Proportional Symbol Map

Symbol maps place **symbols** at lat/lon coordinates based on geographic fields used in the view (i.e. Country/State/City/Zip)



Filled Map

Filled maps leverage **polygons** to produce shaded area maps. Most standard geographic and geometric fields can be used to produce filled maps (except city)



Point Distribution Maps



Heatmaps



Density Maps

Spatial Functions

Spatial functions can be used for advanced analysis or to combine spatial and non-spatial data

MAKEPOINT

Converts data from latitude and longitude columns into spatial objects

=**MAKEPOINT** ([Latitude], [Longitude])

MAKELINE

Generates a line mark between two points

=**MAKELINE** ([Geometry 1], [Geometry 2])

DISTANCE

Returns distance measurement between two points in a specified unit (m, km, mi, ft)

=**DISTANCE** ([Geometry 1], [Geometry 2], "mi")

BUFFER

Returns a circular shape with a radius determined by defined distance and units

=**BUFFER** (**MAKEPOINT** ([Latitude], [Longitude]), 10, "mi")



Flow Maps



Layered Maps



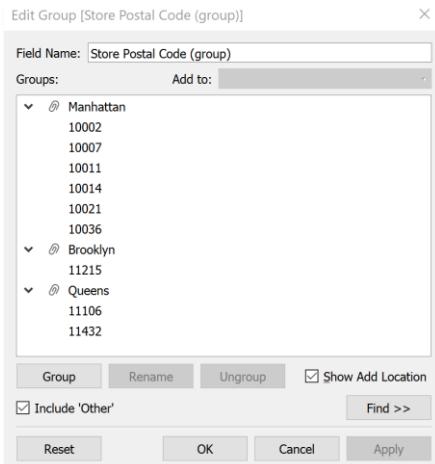
Radius Maps

Custom Territories

Custom territories allow users to dynamically select or consolidate geographic areas using traditional Tableau grouping functionality

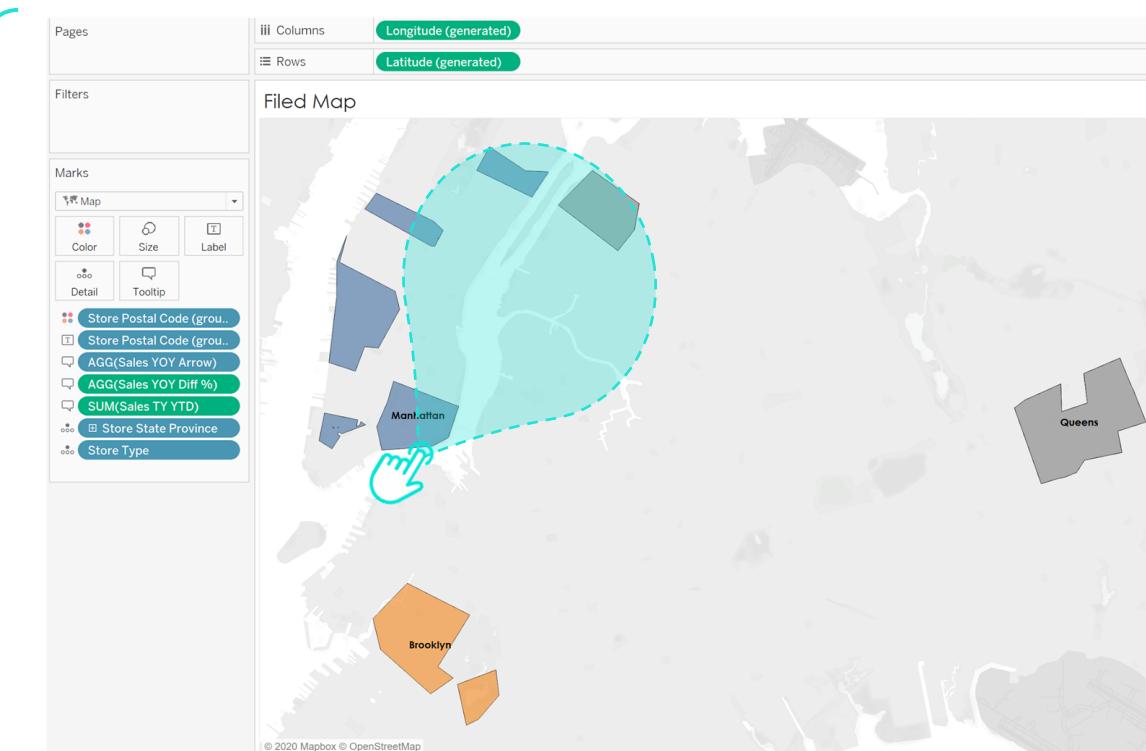
Geographic Group

Groups are created using geographic fields (i.e. State/Zip)



Custom Territory Visualization

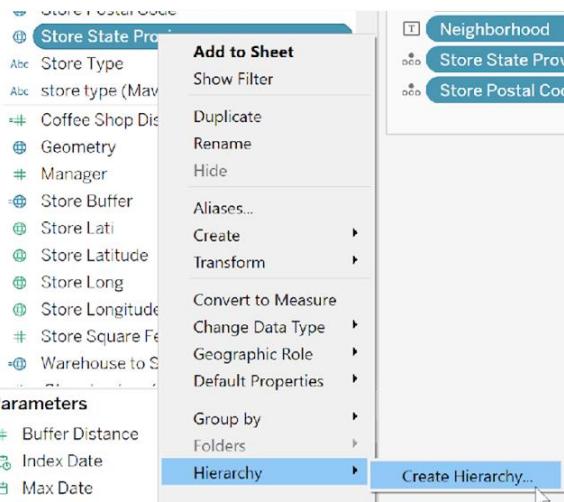
Remove other geographic fields except the new Geo Group (polygons will form around the defined areas)



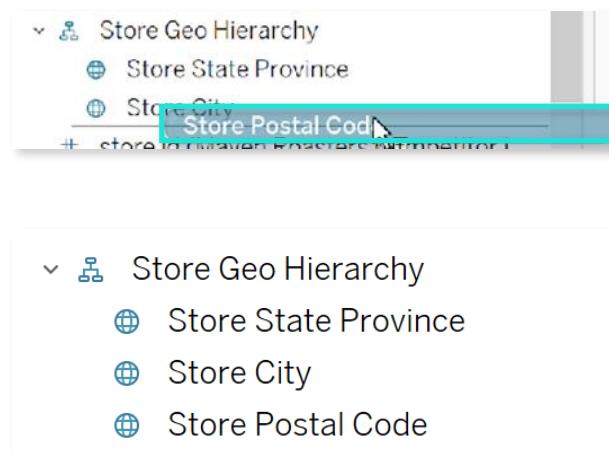
Map Hierarchies

Mapping hierarchies allow users to drill into custom geographic levels of detail within a map

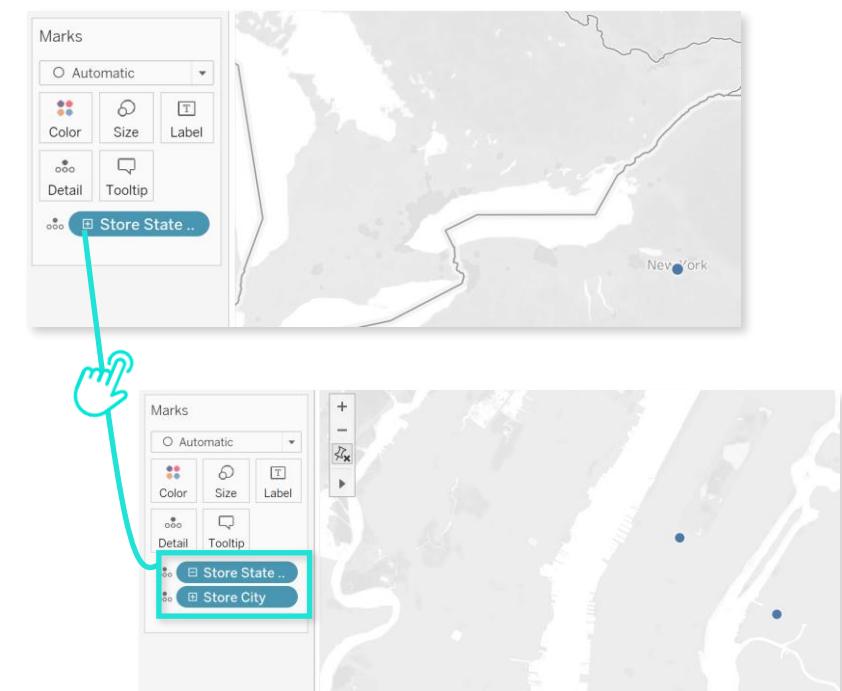
1 Create Hierarchy



2 Add Geographic Fields



3 Activate Hierarchy



Geospatial Customization

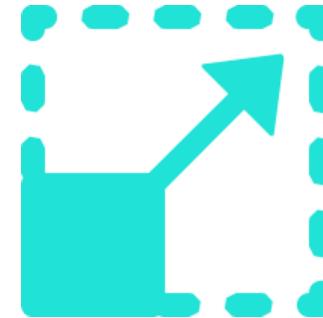
Geospatial customization provides additional mapping options and tool extensibility including custom formatting, 3rd party maps, and custom background images

Custom Formatting



- Advanced formatting tools and 3rd party maps enable a deep level of customization within Tableau Desktop

Background Images



- Custom backgrounds allow you to customize visuals or create non-traditional maps (i.e. office spaces or factory floor plans)

Map Layers

Map layers can be customized to format map colors, boundaries, labels and built-in data layers

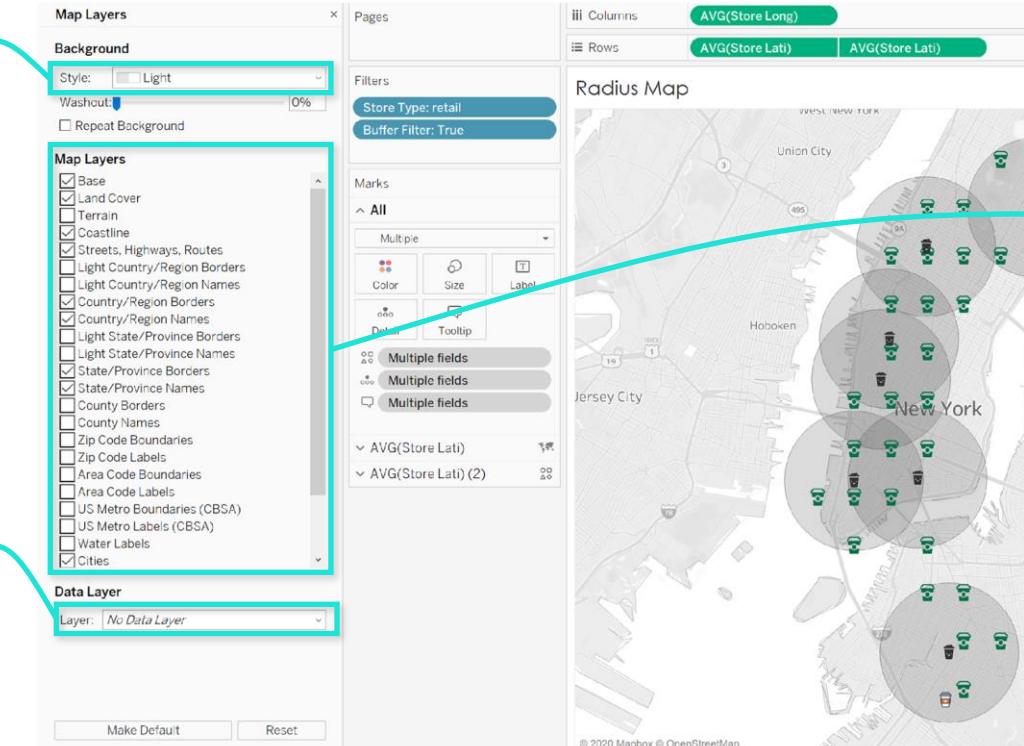
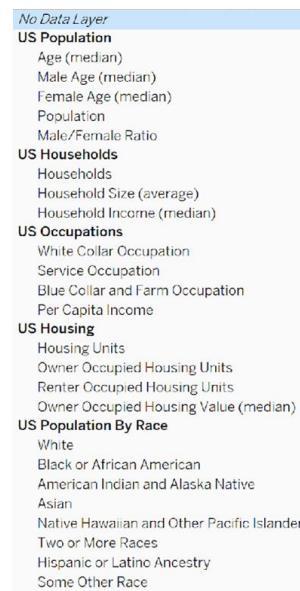
Background

Default mapbox/openstreet map styles built into Tableau

NOTE: Offline maps are available in the main Map menu as well

Data Layer

Additional US layers can be displayed behind the data set's metrics and dimensions



The Map Layers dialog box displays the following settings:

- Background:** Style: Light, Washout: 0%, Repeat Background: Unchecked.
- Data Layer:** Layer: No Data Layer.
- Map Layers:** A large list of map features:
 - Base
 - Land Cover
 - Terrain
 - Coastline
 - Streets, Highways, Routes
 - Light Country/Region Borders
 - Light Country/Region Names
 - Country/Region Borders
 - Country/Region Names
 - Light State/Province Borders
 - Light State/Province Names
 - State/Province Borders
 - County Borders
 - County Names
 - Zip Code Boundaries
 - Zip Code Labels
 - Area Code Boundaries
 - Area Code Labels
 - US Metro Boundaries (CBSA)
 - US Metro Labels (CBSA)
 - Water Labels
 - Cities

Map Layers

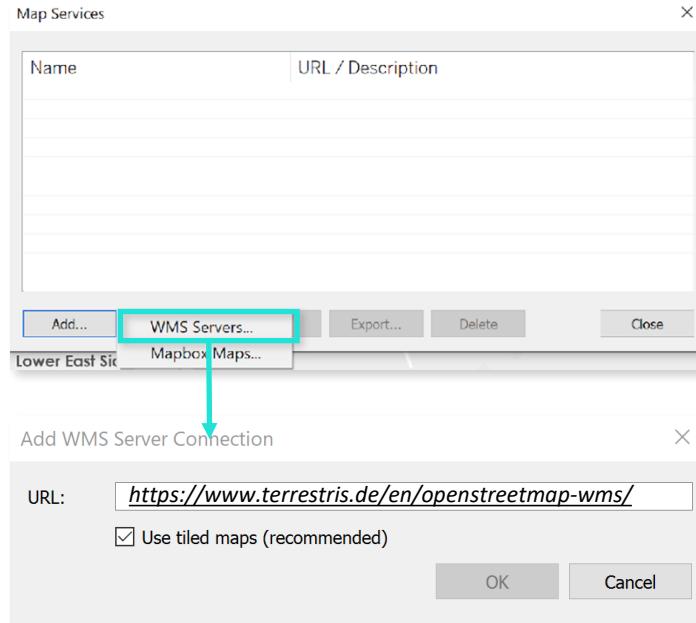
Dimensional layers that can be revealed/hidden by the developer (i.e. land cover, coastline, zip-code boundaries)

NOTE: Some layers will not be visible until users zoom into a map

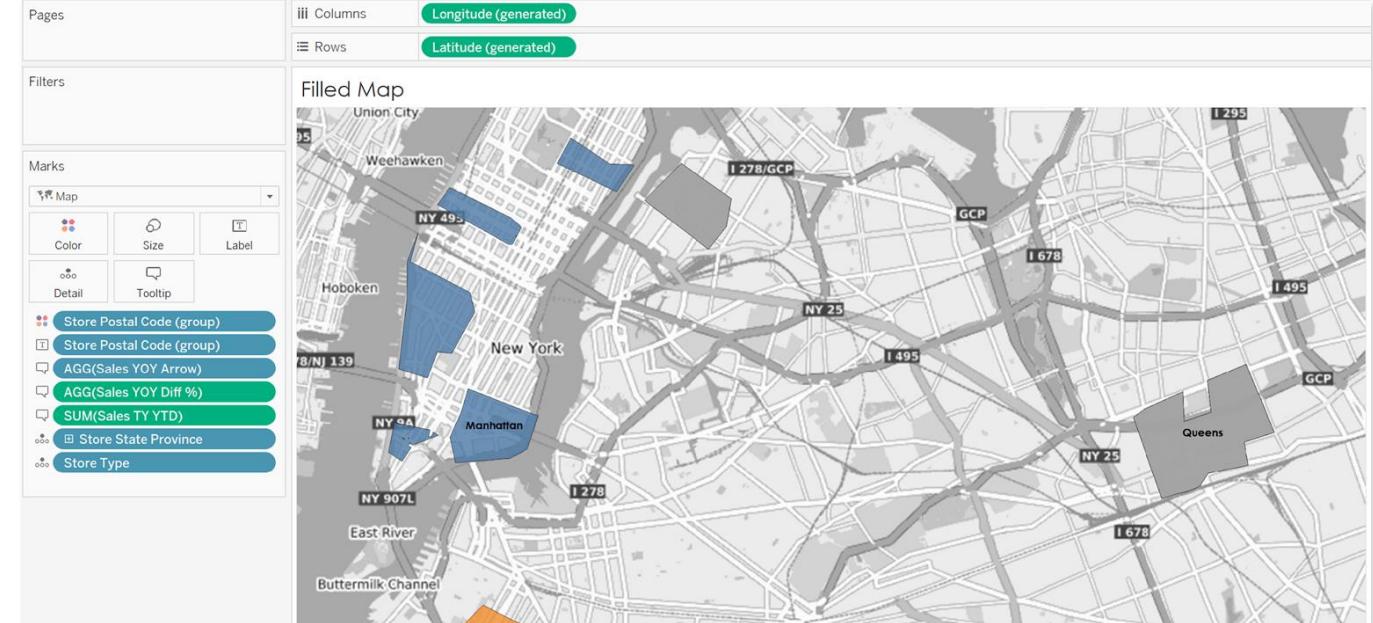
Background Maps | WMS

Background maps from WMS (“Web Map Services”) allow developers to embed hosted custom map backgrounds inside Tableau

1 Add WMS Server



2 Layer data & visuals

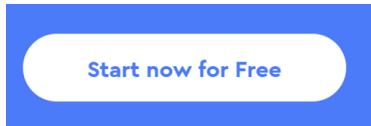


PRO TIP: You can save WMS connections as **.tms** files to allow others to easily connect to WMS map connections

Background Maps | Mapbox

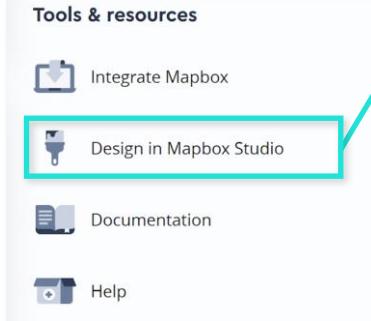
Mapbox is a 3rd party tool offering extensive map customization options with a free user account

1 Create Account



Create your Mapbox account

Using our world-class design and development tools for apps, navigation, AR, and data visualization. Already have an account? [Log in.](#)



2 Customize Map

The screenshot shows the Mapbox Studio interface. On the left, there's a sidebar with 'Components' and 'Layers' tabs. Under 'Components', several label categories are listed: Place labels, place-labels; Transit, transit-labels; Point of interest labels, poi-labels; and Natural features, natural-labels. Under 'Layers', there are more categories like country-label, state-label, settlement-major-label, settlement-minor-label, settlement-subdivision-label, airport-label, pol-label, water-point-label, water-line-label, natural-point-label, natural-line-label, and waterway-label. A central map view shows a coastal town with labels applied. At the top right, there are 'Share & develop' buttons for 'Draft' and 'Production'. Below the map, there's a note about the production URL being cached for performance. In the bottom right, there's a 'Developer resources' section for Tableau, with an integration URL provided: <https://api.mapbox.com/styles/v1/maven-analytics/monochrome-copy>. There's also a 'Download' section with a link to 'Monochrome.zip'.

3 Add Mapbox WMS

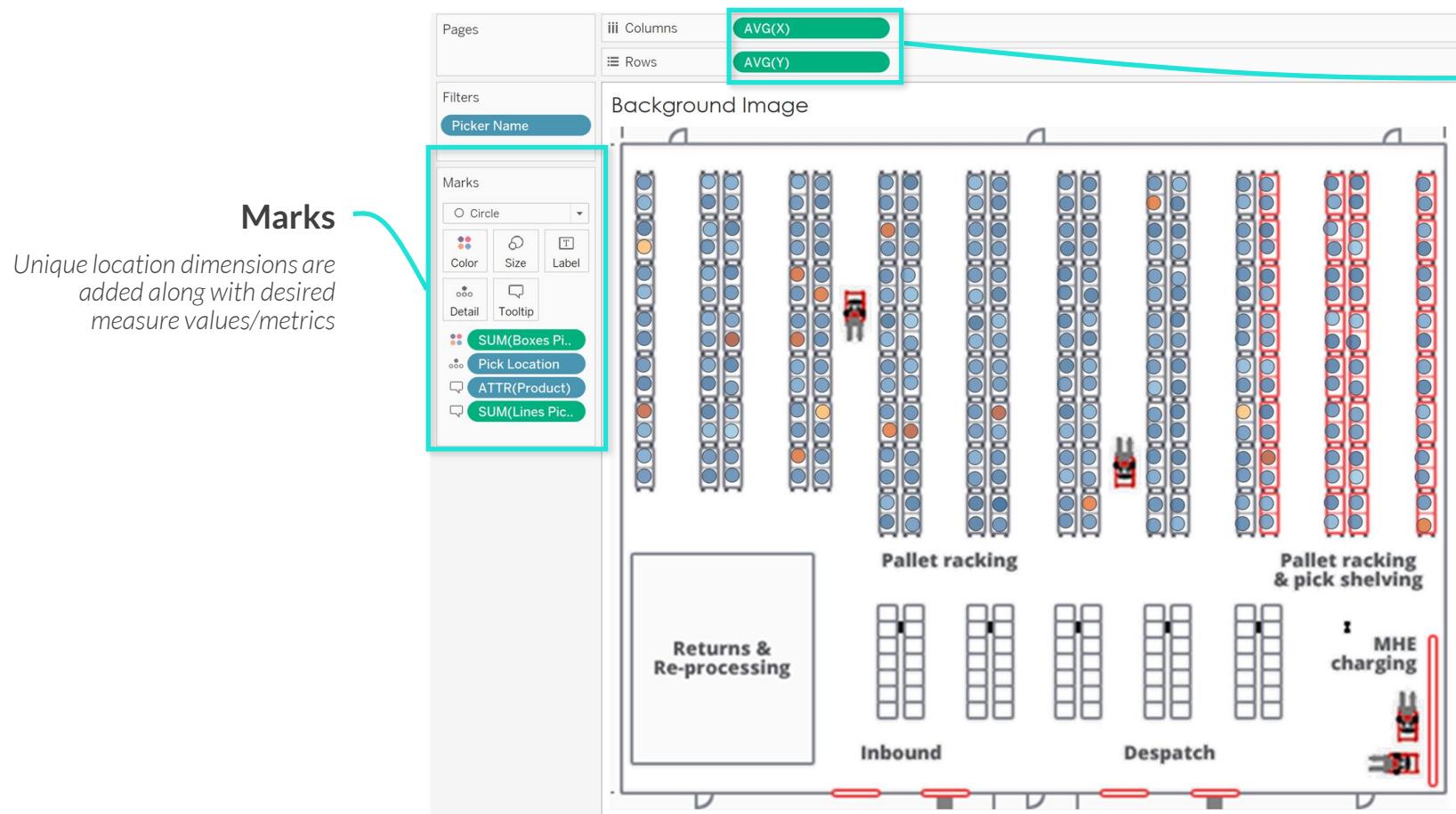
The screenshot shows the 'Map Services' dialog box in Tableau. It has fields for 'Name', 'URL / Description', and 'Add...'. Below these, there's a 'WMS Sources' tab where a 'Mapbox Maps...' button is highlighted with a teal box. To the right, there's a preview map of New York City with various data points. At the bottom, there are 'OK' and 'Cancel' buttons. The dialog also includes fields for 'Style name', 'API access token', 'Username', and 'Style ID'.



Mapbox's free account allows for **50,000 views / 200,000 tile requests per month**. This is important to consider before integrating with production / client work!

Background Images

Background images are custom visual layers behind your coordinate-based data points



Coordinates

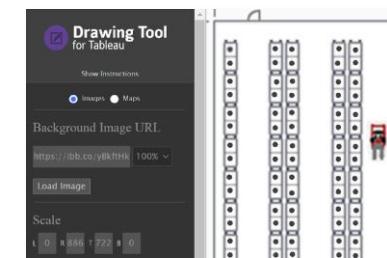
X/Y coordinates can be plotted on top of a custom background image (using native Tableau annotations or 3rd party tools)

Native Tableau Annotation:



3rd Party Coordinate Generation:

(Interworks Drawing Tool)



Common Mapping Issues

Common mapping issues can occur when data contains unknown or ambiguous spatial points

The screenshot shows a Tableau interface with a map of the United States. A tooltip at the bottom right says "Unknown". A context menu is open over this point, listing three options:

- Edit Locations...**: Correct the unknown locations.
- Filter data**: Exclude the special values from the view and calculations.
- Show data at default position**: Show the special values at a default position on the axis. For example, Null values are shown at 0.

Curved arrows point from each of these menu items to corresponding sections below:

- Edit Locations...** points to the "Edit Locations" dialog box.
- Filter data** points to the "Filters" section.
- Show data at default position** points to the "Show data at default position" section.

Edit Locations dialog box:

Geographic roles	Country/Region: United States	State/Province: None
City:	Store City	⚠️ 2 issues
Match values to locations		
Your Data		Matching Location
Brooklyn	Ambiguous	New York
Jamaica	Ambiguous	Long Island City
Long Island City		New York
New York		New York

Filters:

- Latitude (generated)
- Longitude (generated)

Show data at default position:

Null coordinates will default to "Null Island", a generic point on Tableau maps that will include missing data (**NOT RECOMMENDED**)



PRO TIP: Zip codes are often the source of nulls. Be sure to code zips as **strings** and/or **pad zeros** for zips less than 5 characters!

Edit Locations

Use edit locations to either add spatial fields to help Tableau identify locations (i.e. adding state to a city map when duplicate cities exist) or define lat/long points

Filter Data

Filter out the lat/long points in question (useful for true errors or false records, but be careful not to exclude valid records!)

Show data at default position

Null coordinates will default to "Null Island", a generic point on Tableau maps that will include missing data (**NOT RECOMMENDED**)

HOMEWORK: Geospatial Mapping

THE **SITUATION**

As part of your analytics side-hustle, you've been hired as an analytics consultant by **FEMA** (Federal Emergency Management Agency) as part of the National Dam Safety Program (NDSP).

THE **BRIEF**

For this project, you will be utilizing the National Inventory of Dams database to provide a **public-facing informational campaign tool** to the NDSP.

You've been asked to conduct a **geospatial analysis** to identify high risk dams within communities targeted for potential rehabilitation grants.

THE **OBJECTIVE**

Use Tableau Desktop to:

- Create spatial joins between data sources
- Leverage distance-based radius filtering & mapping visuals
- Customize mapping visuals using geospatial formatting
- Create custom geo-hierarchies



FEMA

Advanced Calculations

Advanced Calculations

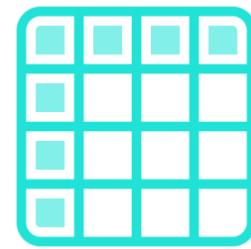
Advanced calculations go beyond basic Tableau functions to help solve specific, complex use cases

Regular Expressions



- Regular expressions (RegEx) leverage **text-based search pattern algorithms** to find/replace string values

Table Calculations



- Table calcs allow you to create custom calculations that exist within the **scope of a specific visual**

LOD Expressions



- Level of detail (LOD) expressions allow users to dynamically **control the grain** of your analysis

Regular Expressions

Regular expressions (**RegEx**) use special characters to define search patterns and find/replace text

`REGEXP_EXTRACT([Customer Email], '(\w+(@adipiscing)+\.[a-z]{2,4})')`

RegEx Function

Tableau regular expression function used to call a specific action:

REGEXP_REPLACE
REGEXP_MATCH
REGEXP_EXTRACT
REGEXP_EXTRACT_NTH

Target Field

Tableau field or parameter that is the subject of the regular expression

Metacharacters

Denoted by a character preceded by a backslash, these determine the matching logic:

. Match any character
\d Match any digit
\w Match a word
\s Match a whitespace
\t Match a tab
\n Match a new line

Capture Group

Denoted by parentheses, these are used to capture exact word/text matches:

(abc)
(Douglas)
(Apple)

Character Class

Denoted by square brackets, these can be used in place of character literals (exact word matches):

[abc] any of a, b, or c
[^abc] not a, b, or c
[a-g] character between a and g
[1-3] number between 1 and 3

Quantifiers

Defines the acceptable number of previous characters, metacharacters, groups or sets:

* match preceding 0 or more times
+ match preceding 1 or more times
{n} match preceding n times
{n,} match preceding n or more times
{n,m} match preceding between n and m
? Match preceding 0 or 1 times



PRO TIP: Tools like regexr.com or [ICU Project Userguide](#) are great resources to help you master regular expression syntax!

Regular Expressions Functions

Regular expressions in Tableau leverage four pre-defined functions, which represent the most common RegEx use cases: **Replace**, **Match**, **Extract** and **Extract_Nth**

REGEXP_REPLACE

Returns a copy of the given string where the regular expression pattern is replaced by the replacement string

=**REGEXP_REPLACE** ('abc 123', '\s', '-') = 'abc-123'

REGEXP_MATCH

Returns true if a substring of the specified string matches the regular expression pattern

=**REGEXP_MATCH** ('-([1234].[The.Market])-','\[\s*(\w*\.\.)(\w*\s*\]\)') = true

REGEXP_EXTRACT

Returns only the portion of the string that matches the regular expression pattern

=**REGEXP_EXTRACT** ('abc 123', '[a-z]+\s+(\d+)') = '123'

REGEXP_EXTRACT_NTH

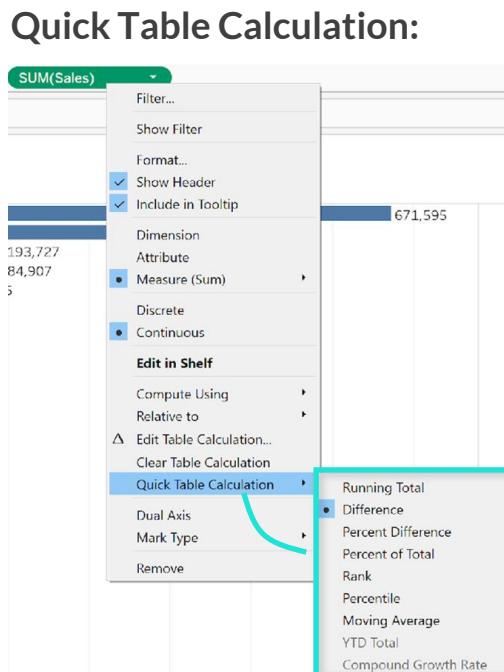
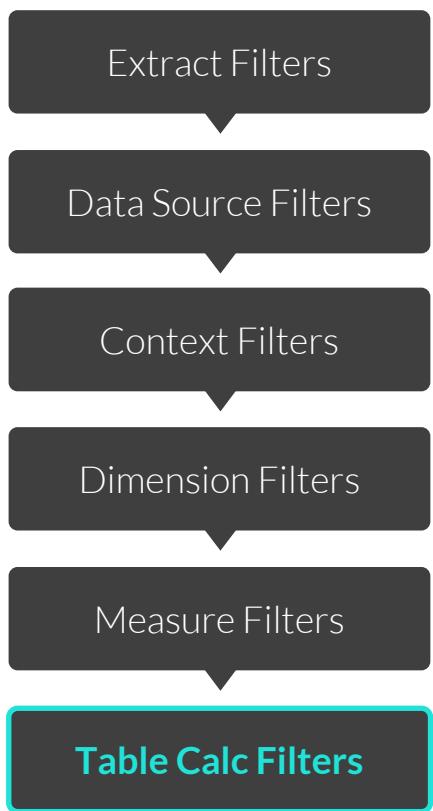
Returns the portion of the string that matches the regular expression pattern. The substring is matched to the nth capturing group, where n is the given index.

= **REGEXP_EXTRACT_NTH** ('abc 123', '([a-z]+\s+(\d+)', 2) = '123'

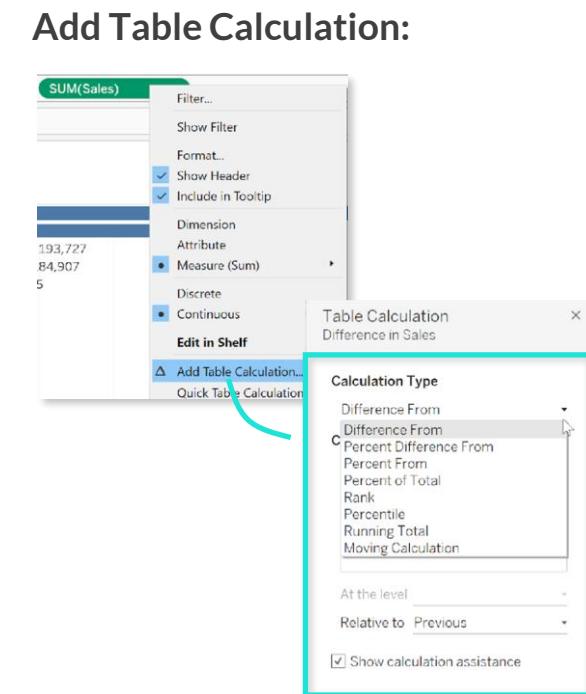
REVIEW: Table Calculations

Table calculations are sheet-based computations that only evaluate within a given visualization

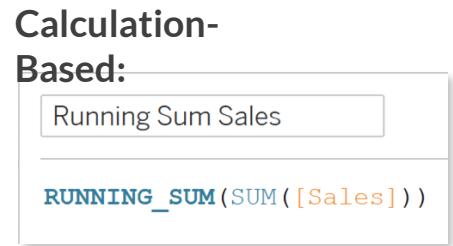
- Table calcs affect how values are computed within a visual, but *do not* change the underlying data
- Table calcs can be created from the **Quick Table Calculation** or **Add Table Calculation** menus, or as a formula



Quick access to common table calculation options, based on fields in the view



Includes more options than Quick Table Calculations



Created in the calculation pane and then pulled into the view

REVIEW: Addressing & Partitioning

When adding table calculations, you must use all dimensions in the level of detail for either **partitioning** (scoping) or for **addressing** (direction)

Table Calculation
% of Total Sales

Calculation Type
Percent of Total

Compute total across all pages

Compute Using

- Table (across)
- Table (down)
- Table
- Cell
- Specific Dimensions**

Year of Order Date (MDY)

State

At the level

Sort order Specific Dimensions

Show calculation assistance

Addressing Fields

Define the *direction* in which a calculation is evaluated (i.e down, across, across then down)

Partitioning Fields

Define the *level or group* at which table calcs are evaluated (i.e cells, tables, panes)

Pane / Partition

Pages

Filters

Marks

- Automatic
- Color
- Size
- Text
- Detail
- Tooltip

SUM(Sales) △

Across then down

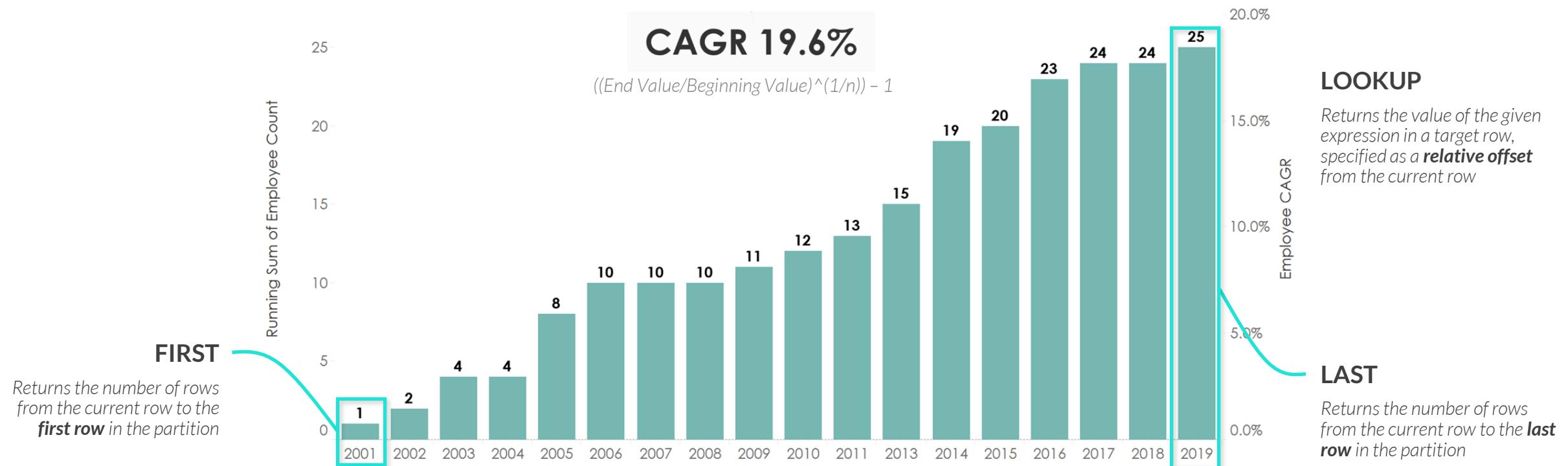
		Order Date			
		2011	2012	2013	2014
Quarter of Order	Month of Order ..	January	\$4,228	\$368	\$26,161
		February	\$35,093	\$7,100	\$10,657
Q2	March	\$35,407	-\$17,224	\$12,719	\$2,723
	April		\$5,900	\$5,053	\$864
	May		-\$16,464	\$6,483	\$26,559
					-\$11,040



PRO TIP: Re-order the addressing fields to change the direction of the calculation

Position-Based Table Calculation Functions

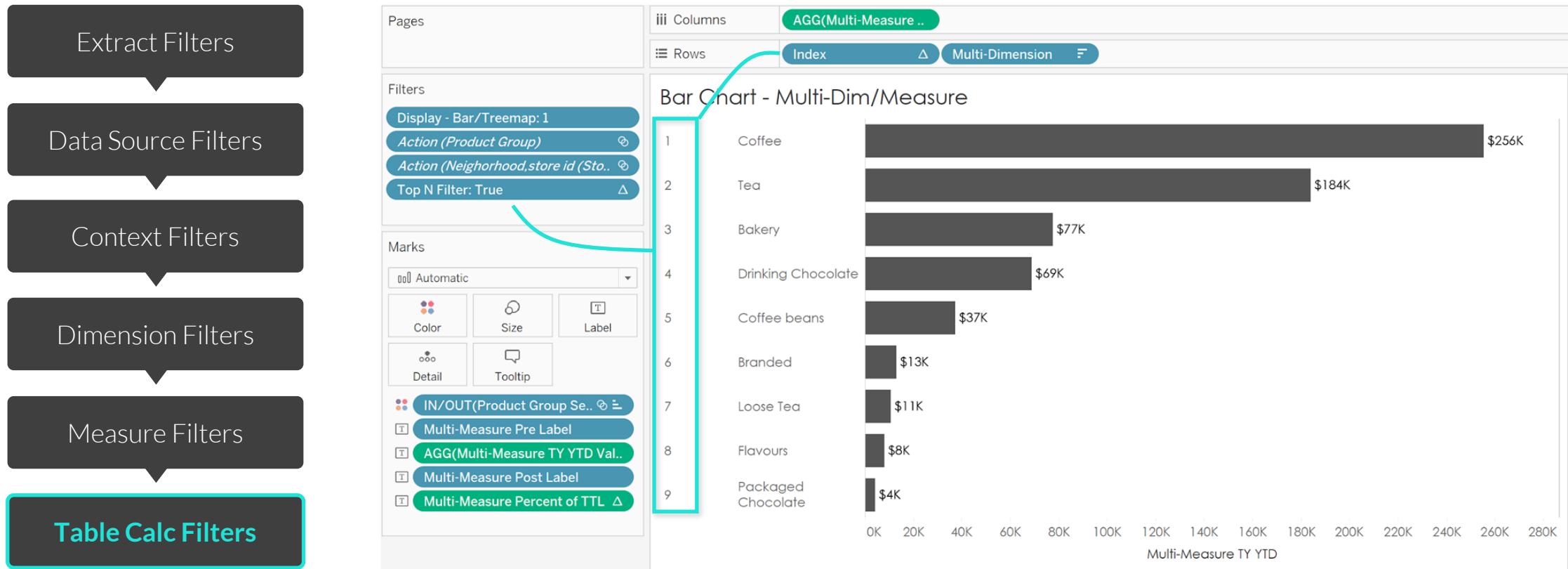
Position-based table calcs are valuable tools for advanced analytics, such as calculating metrics like Employee CAGR (continuous average growth rate)



PRO TIP: Index Top Filter

Index is a versatile table calculation which returns the index for the current row in the partition

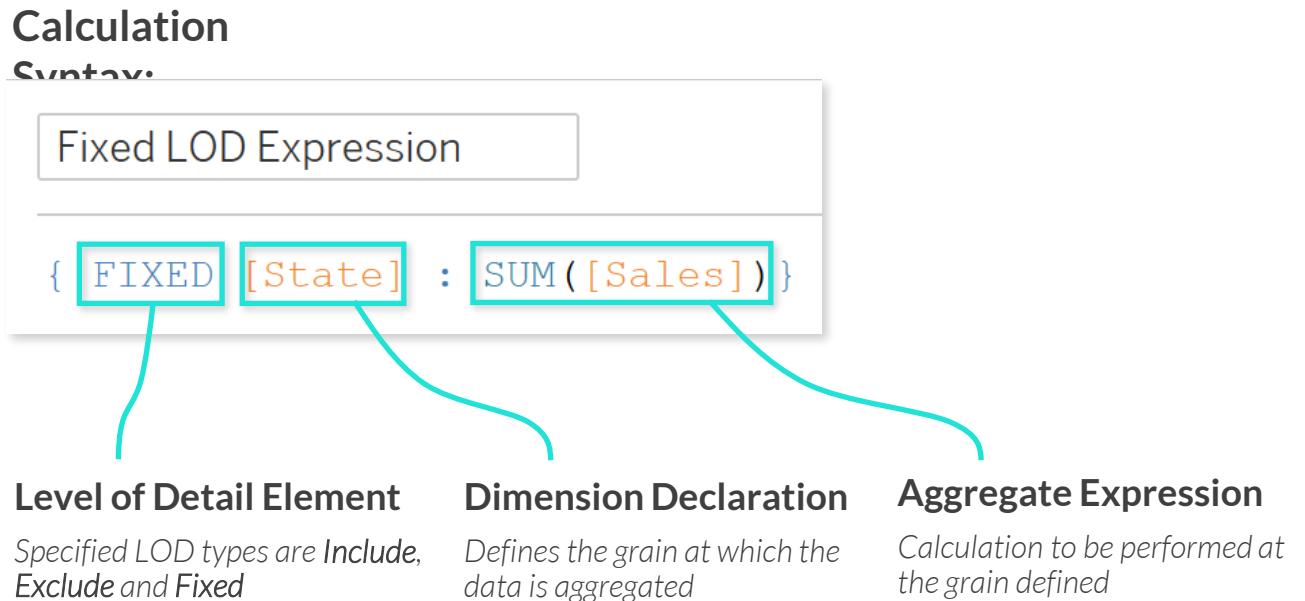
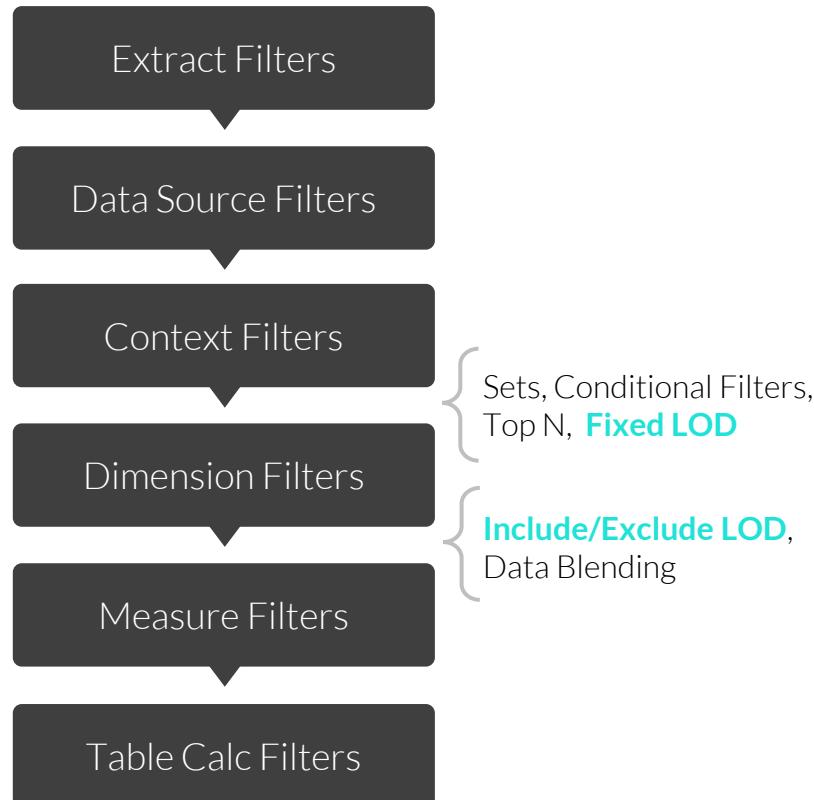
- One of the most common ways to leverage index is in place of a **TOP** function



REVIEW: Level of Detail Expressions

LOD expressions allow users to control the *granularity* at which a calculation is computed

- Unless LOD expressions are used, calculations will always compute at the level of detail shown in the view



Choosing an LOD Type

LOD expressions come in three flavors to define the granularity at which the calculation will be performed: **Fixed**, **Exclude**, and **Include**

Exclude LOD

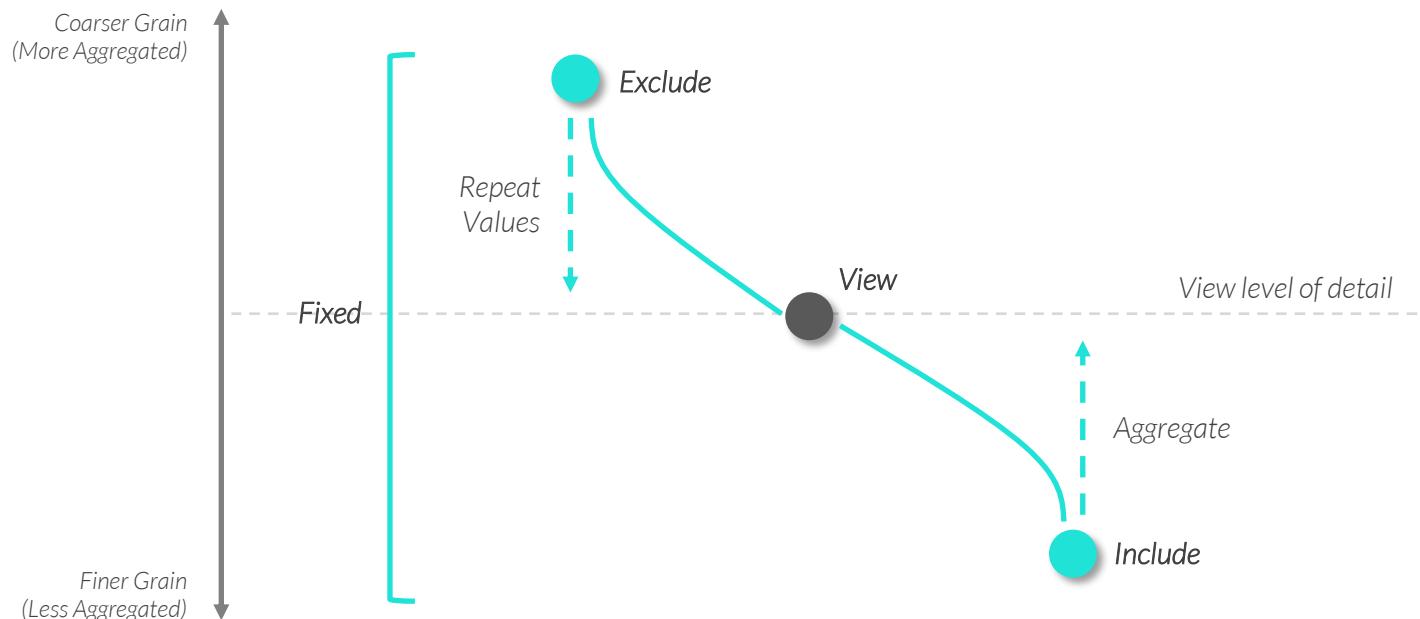
Calculated at a *coarser grain* (higher) than the view. These calculations *are impacted* by filters/dimensions in the view.

Include LOD

Calculated at a *finer grain* (lower) than the view. These calculations *are impacted* by filters/dimensions in the view.

Fixed LOD

Calculated at a *finer or coarser grain* than the view. These calculations *are NOT impacted* by filters/dimensions in the view unless specifically called out or *in context!*



PRO TIP: Use **table-scoped** LOD calculations by adding curly brackets around a field `{min([Order Date])}`, instead of a fixed LOD `{FIXED:min([Order Date])}`

LOD Use Case | Benchmarking & Time Flags

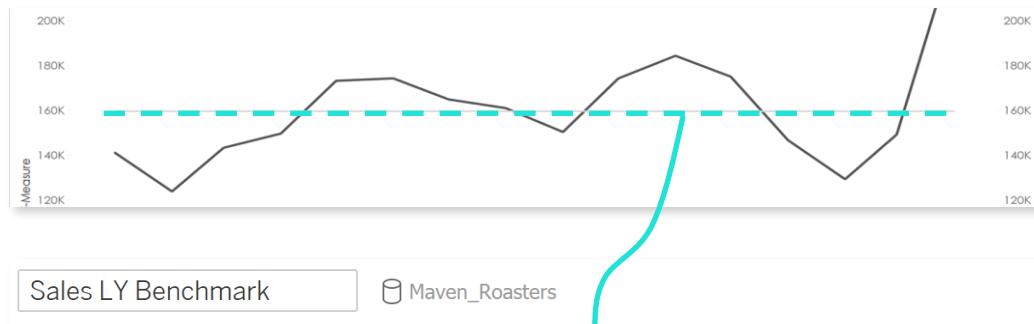
Benchmarking using LOD expressions allows users to isolate certain dimensions or measures for comparative analyses

- Along with benchmarking, **time flags** can allow for dynamic benchmarked dates to be applied to measures

Benchmarking

Use nested IF/LOD expressions to create benchmarks against a specific time periods or dimensions

Prior Year Benchmark:



```
IF [Select Measure] = 1 THEN  
SUM({  
    FIXED :  
    SUM(IF [Year ID] = 2018 THEN [Sales] else 0 end)} / 12  
else null  
end
```

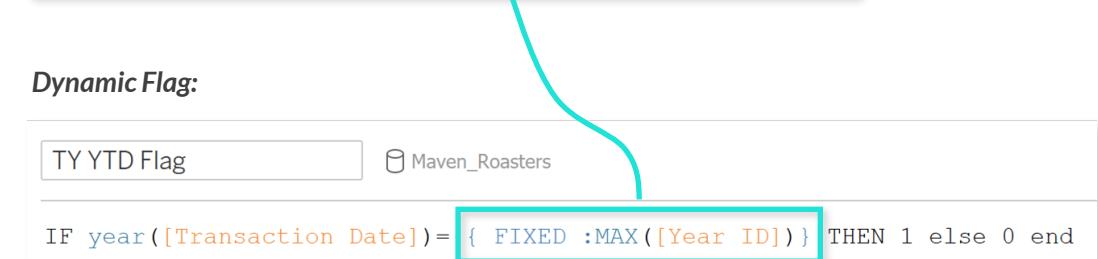
Time Flags

Create static time flags using IF expressions, or use LOD calculations to allow them to dynamically update as the data evolves

Static Flag:



Dynamic Flag:

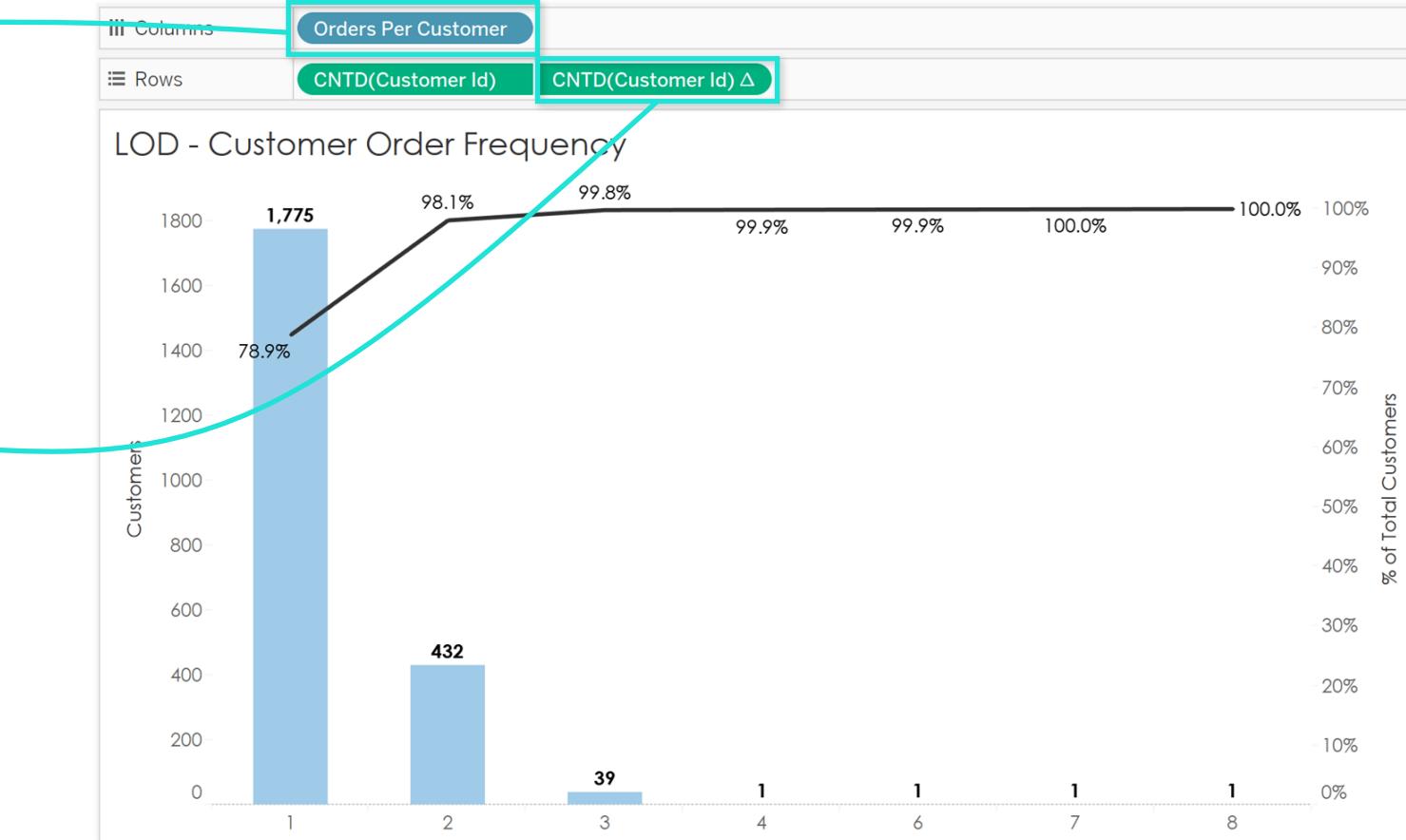


LOD Use Case | Customer Order Frequency

Customer order frequency leverages LODs to segment customers into buckets for further analysis or targeting (i.e. marketing, site optimization, promotions, etc.)

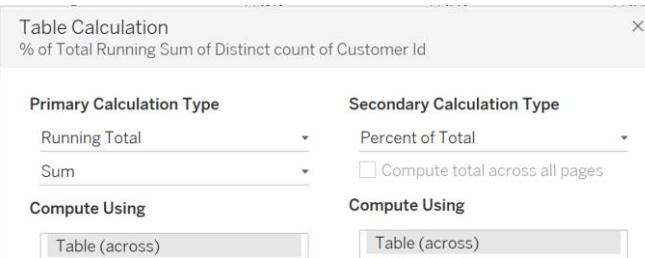
FIXED LOD

By fixing on [Customer Id] we can segment order frequency into buckets to be analyzed as bars



Nested Table Calculation

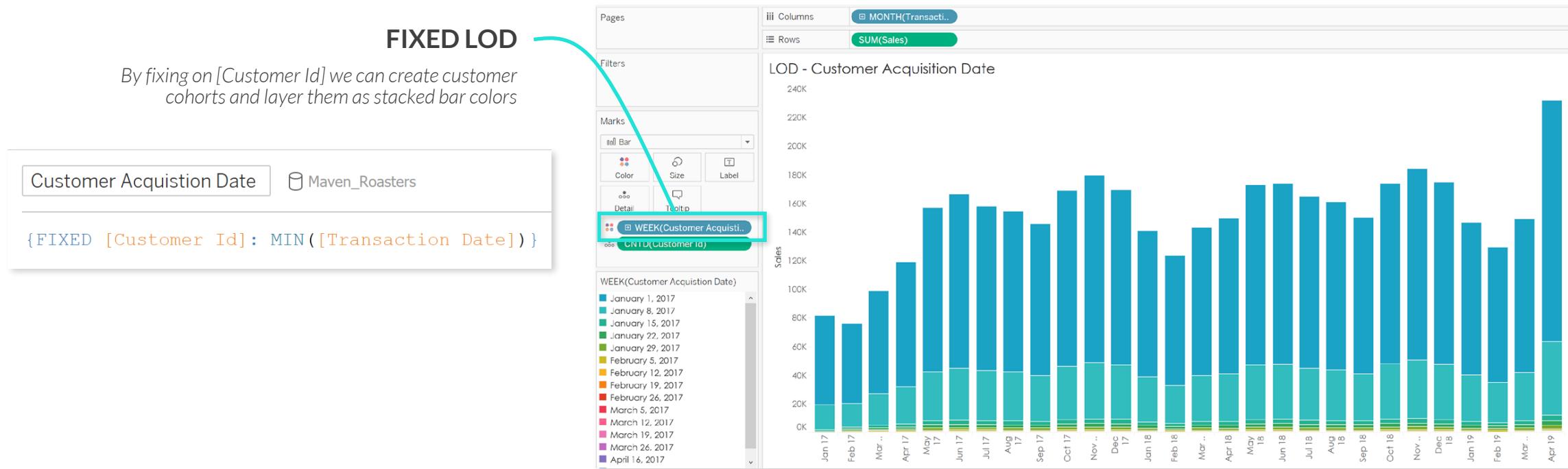
A pareto-style nested table calc applies a **running total** and **percent of total** to add depth to the magnitude of the [Orders Per Customer] metric



LOD Use Case | Cohort Analysis

Cohort analysis uses LODs to segment customers based on tenure

- Cohorts can be used to analyze key metrics like **customer lifetime value (LTV)**, retention and **churn**



LOD Use Case | New Customer Acquisition

New customer acquisition allows analysts to track net new customers, over time or segmented by various dimensions (i.e. markets, traffic sources, etc.)

Nested Fixed LOD

By fixing on the customer acquisition date, we isolate the initial order date and filter on new customers only

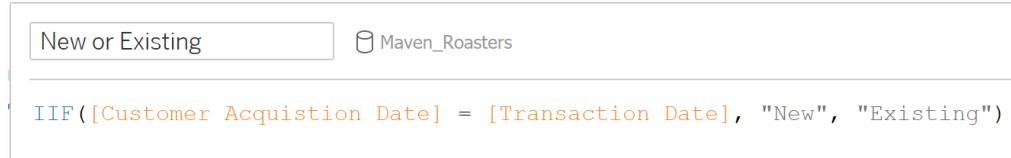
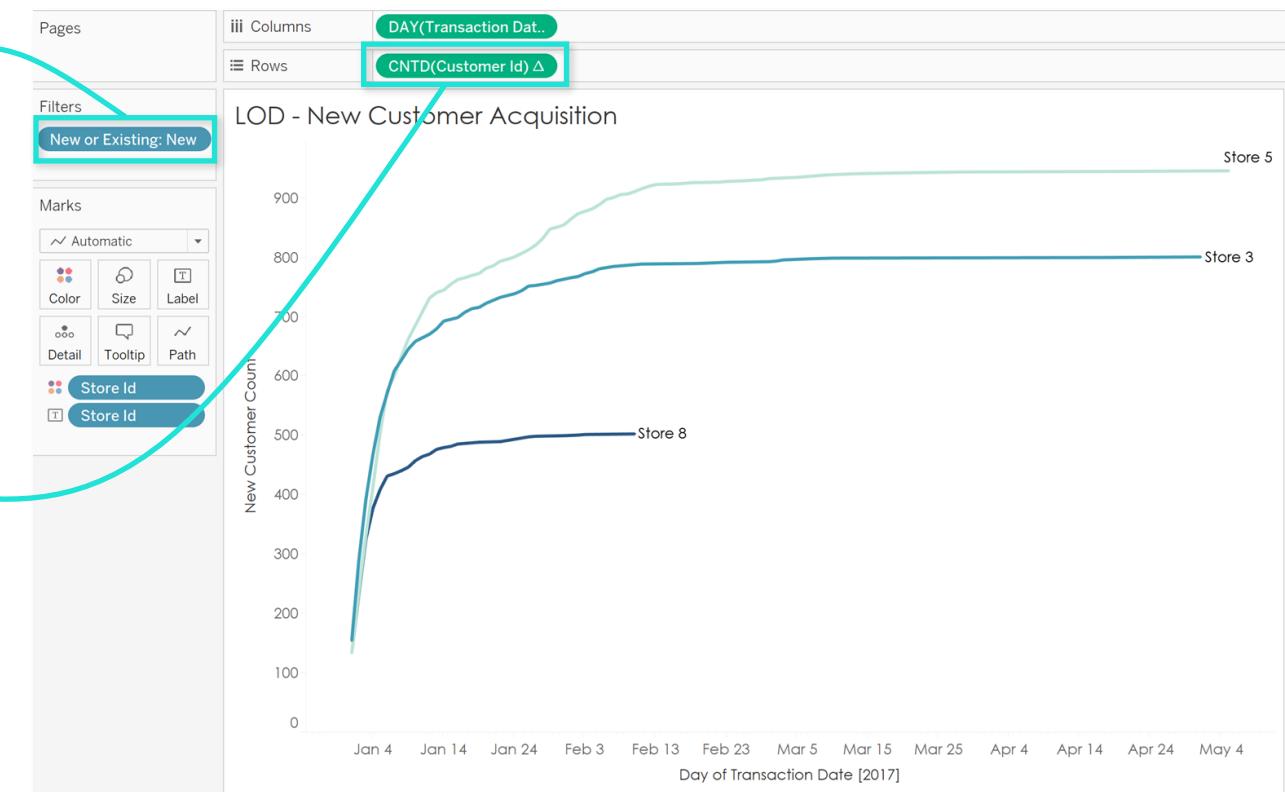


Table Calculation

Customer count is placed on rows and layered with a **running total** to show cumulative trending



HOMEWORK: Advanced Calculations

THE **SITUATION**

The **Boston Police Department (BPD)** commissioner is looking to analyze employee earnings in his department. Concerns about pay increases and comparisons to the Boston Fire Department have recently raised public interest in this topic.

THE **BRIEF**

You've been asked to analyze a **multi-year employee earnings dataset** provided by the city of Boston. Since this is public data, the BPD wants to ensure that reports are **100% accurate** and **crystal clear** in order to promote transparency within the department and to the general public.

THE **OBJECTIVE**

Use Tableau Desktop to:

- Create regular expressions to find / match text
- Leverage table calculations to create a CAGR analysis
- Use LODs to create cohort, benchmarking, and time flag tools



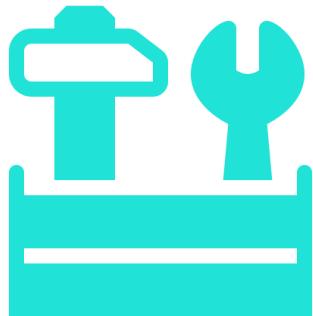
Predictive Analytics

Predictive Analytics

Predictive analytics is about determining the likelihood of future outcomes based on historical data

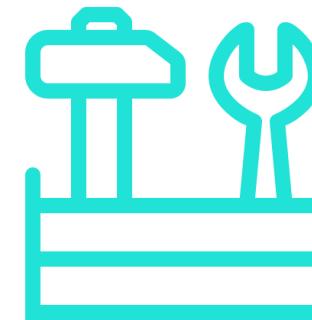
- Tableau Desktop provides both **internal** and **external** tools to enable predictive analytics

Internal Tools



- Tableau includes several **out-of-the box** predictive analytics tools, including:
 - Regression (trend lines)
 - Forecasting
 - Control charts
 - Cluster analysis

External Tools



- Tableau also integrates with **third-party** programming languages and tools, including:
 - Python
 - R
 - Matlab
 - etc.

Regression Models

Regression models in Tableau are represented in the form of **trend lines**

- Regression models are statistical models used to estimate trends/relationships between variables.



Linear



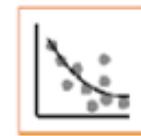
Logarithmic



Exponential



Polynomial



Power

Linear

Simplest regression model that estimates the relationship between two variables (increasing or decreasing). Use when data resembles linear pattern.

Example: If one loaf of bread costs \$2, 4 loaves will cost \$8

Logarithmic

Curved lines of best fit that increase quickly and then level off gradually. Avoid logarithmic trends when values are negative as they will be excluded.

Example: Efficiency of warehouse workers over time (eventually maxes out)

Exponential

Curved lines of best fit most suitable when rate of change between variables rises at increasingly higher rates. Avoid exponential trends for negative values (will be filtered out).

Example: Computing power of microchips over time (power doubles every two years – Moore's Law)

Polynomial

Curved lines of best fit most suitable when variables have a fluctuating relationship (data will appear to have a "bounce" in it).

Example: Revenue over time for a new product launch

Power

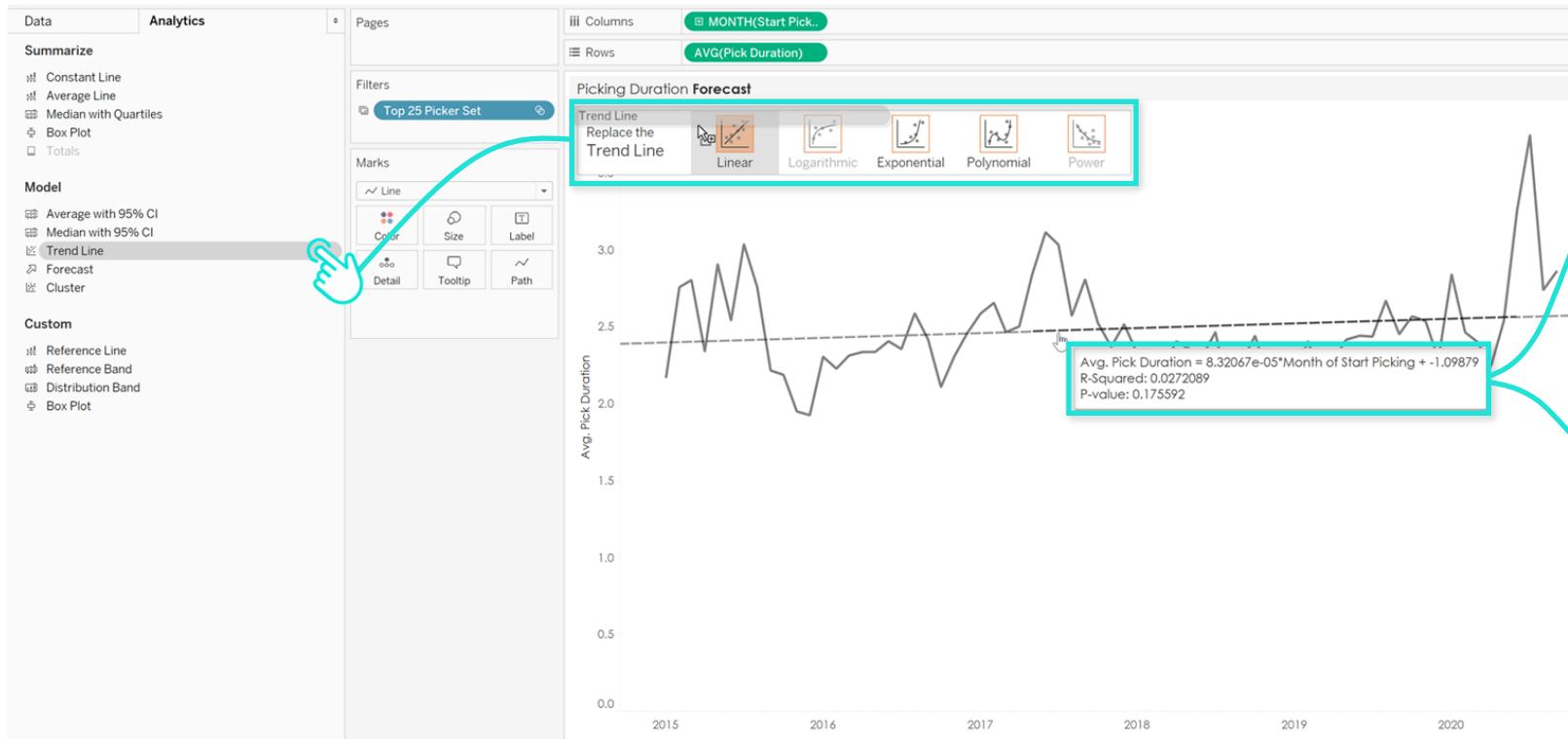
Curved lines of best fit most suitable when dependent variable increases at pre-determined rate. Avoid power trends for negative values (will be filtered out).

Example: The trajectory of a skipped stone over time

Trend Lines

Trend lines reveal the prevailing direction or “line of best fit” for a series of data points

- Trend lines can be especially useful when your data is “noisy”, or when a trend isn’t immediately clear
- **NOTE:** Trend lines require **two continuous variables** (if using time, needs to be continuous)



Is my trendline ACCURATE?

R-Squared

R-Squared explains how the variance of one variable explains the variance of another, ranging from **0-1** (closer to 1 = more accurate)

Example: If R-Squared = **0.50**, then only half of the observed variation can be explained by the model's inputs

P-Value

P-Value is the probability of obtaining results as extreme as the observed results, ranging from **0-1** (closer to 0 = more accurate)

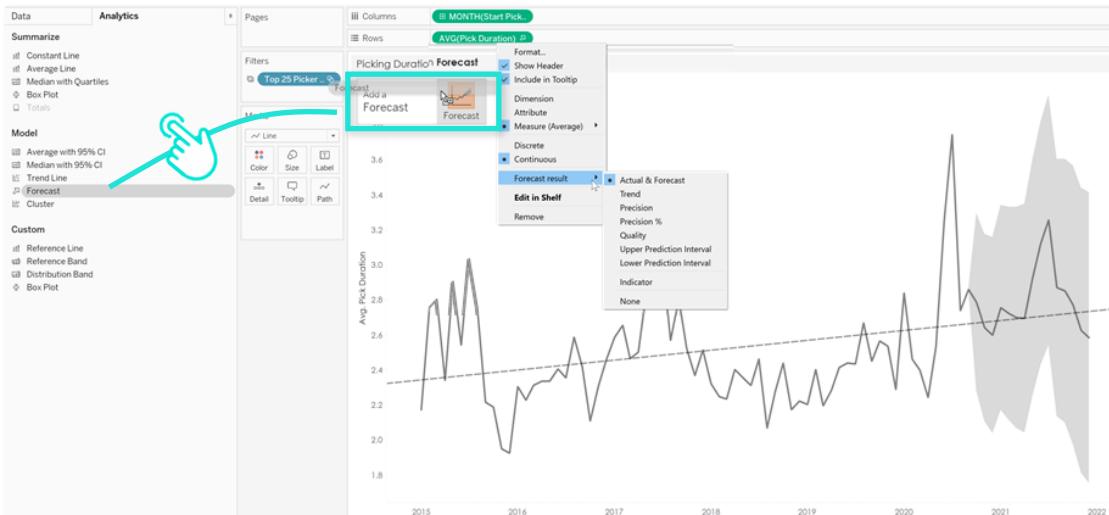
A P-Value of **<0.05** is a common standard for model accuracy and means that your trend-line is strong predictor for future data points

Forecasting

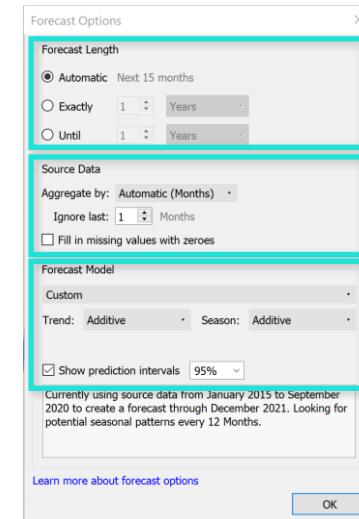
Forecast algorithms evaluate patterns in historical data to project potential *future* data points

- Tableau provides several drag-and-drop forecast tools in the **analytics pane**

Adding a Forecast:



Customization:



Forecast Length

Choose how long forecasts will extend; **Exactly** and **Until** will provide fixed dates, and **Automatic** will determine a length via forecast results

Source Data

Aggregate by gives you date granularity options down to the second. You can also ignore a defined number of data points and fill missing values with zero

Forecast Model

- Automatic** (default)
- Automatic without Seasonality** – Removes Seasonality
- Custom** – Adjustable trend and seasonality options:
 - Additive** – Contributions of the model are summed
 - Multiplicative** – Some contributions are multiplied



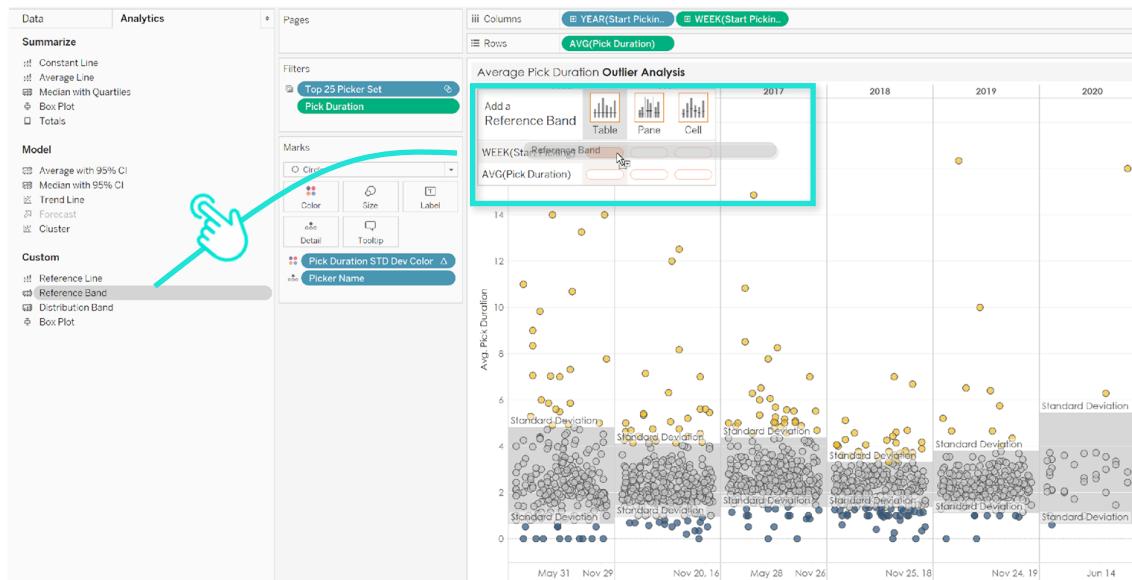
Exact dates are *not supported* in Tableau for forecasting. Use truncated dates like **Feb 2017** or continuous dateparts (**Year**, **Year + Quarter**, etc.). At least 5 datapoints are required for a forecast, at least 2 seasons for seasonality, and at least 24 months for a 12-month seasonal cycle.

Control Charts

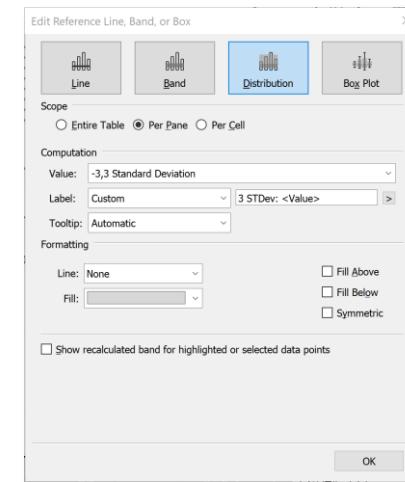
Control charts are a statistical tool designed to monitor manufacturing or business processes to ensure they are in a state of control (within limits)

- Control charts can be generated in Tableau using **reference bands**

Adding a Reference Band:



Customization:



Scope

Entire Table, Per Pane, or Per Cell

Value

Percentage, Percentile, Quantile, or Std. Dev

Label

None, Computation, Value, or Custom

Tooltip

Automatic, Custom, or None

Formatting

Line, Fill Color, Fill Above/Below, and Symmetry

Show Recalculated Band

Recalculate based on the user's selection

Clustering

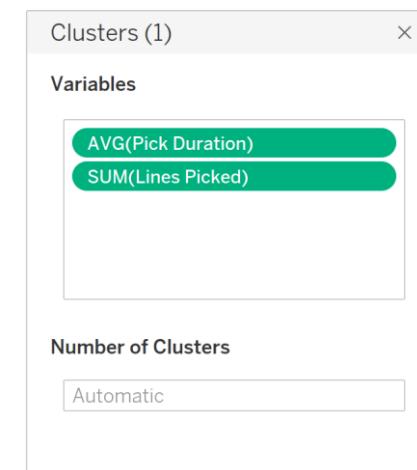
Clustering is a method of partitioning observations (marks) into clusters around the nearest mean (centroid)

- Observations within clusters are more similar to each other than to those in other clusters

Adding a Cluster:



Customization:



Variables

The fields Tableau uses to compute clusters (add/remove variables to adjust clusters)

NOTE: In the *Describe Clusters* dialog box, variable value grouping can be reviewed before modifying the cluster variables

Number of Clusters

The number of clusters will be determined automatically (using the *Calinski-Harabasz* criterion) unless explicitly defined by the user

NOTE: If a categorical value (dimension) has more than 25 unique values it will be disregarded in the cluster calculation



PRO TIP: Drag the cluster pill from the **marks card** to the **data pane** to create a cluster group that can be used in other sheets. Just refit the data and you're good to go!

R & Python Integration

R and **Python** are popular programming languages for performing complex statistical analysis

- R and Python functions and models can be used in Tableau via **calculated fields**

1 Install Platform:



<https://cloud.r-project.org/index.html>



<https://www.python.org/downloads/>

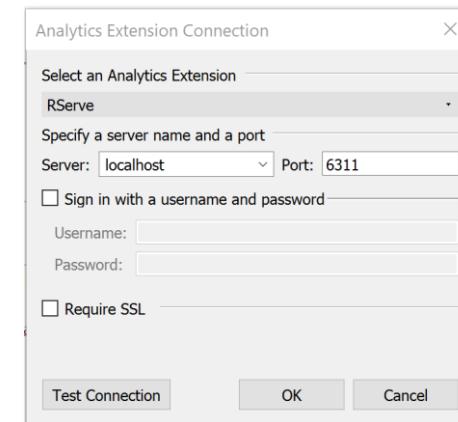
2 Install Server:

```
install.packages("Rserve")
library(Rserve)
Rserve()
```



<https://github.com/tableau/TabPy>

3 Connect to Service:



4 Add Calculated Fields:

SCRIPT_BOOL

SCRIPT_INT

SCRIPT_REAL

SCRIPT_STR



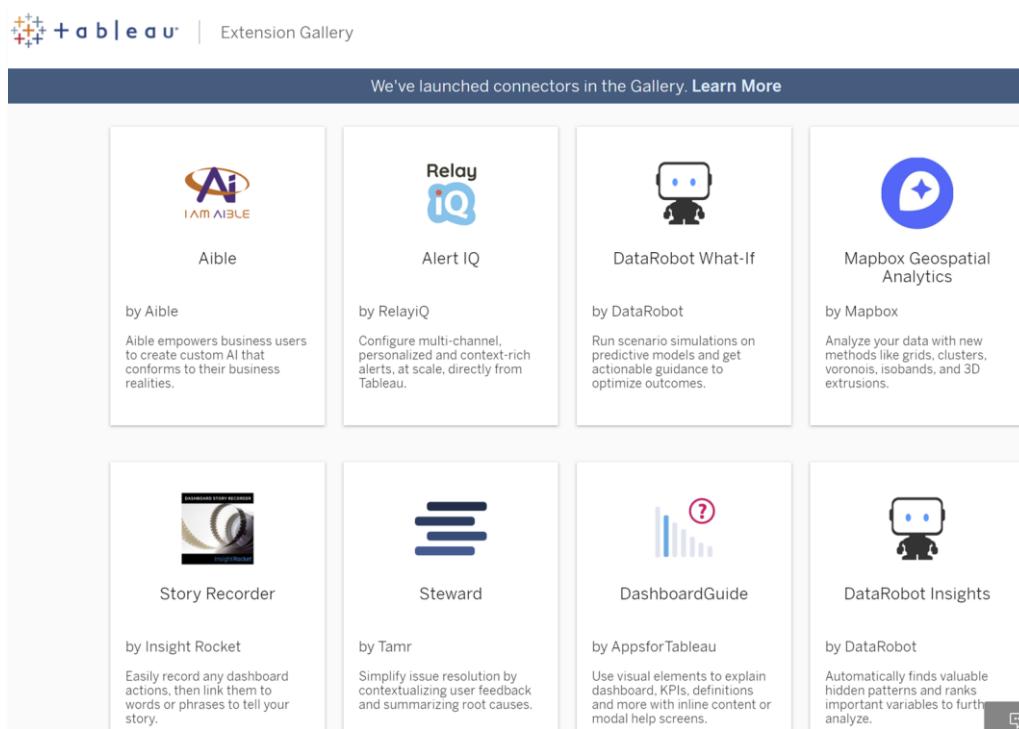
Remember that R/Python are **complex languages** which require a base-level proficiency to be utilized inside Tableau. Tableau leverages calculated fields to run R/Python Scripts, but users should know the languages first to effectively utilize R/Python inside Tableau.

Dashboard Extensions

Dashboard extensions are web applications created by Tableau partners, designed to help users customize and enhance standard dashboards

1

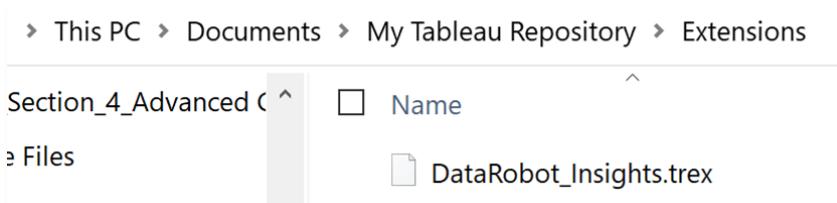
Download Extension from Gallery:



<https://extensiongallery.tableau.com/extensions?>

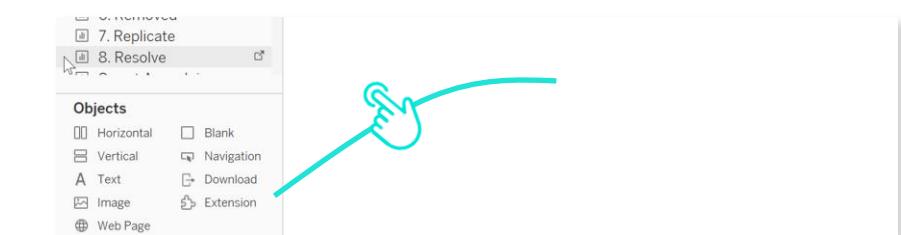
2

Add Extension to My Tableau Repository:



3

Add to Dashboard & Configure:



Most Tableau Extensions DON'T work with Tableau Public, and many require some level of external data sharing or cost for using their services!

HOMEWORK: Predictive Analytics

THE **SITUATION**

The **World Health Organization** has been generating significant press for a recent study on **global life expectancy**, and has asked you to help conduct some statistical modeling and predictive analysis to better understand the data

THE **BRIEF**

For this project you'll need to apply predictive analytics tools in Tableau to **explore trends, build forecasts**, and **conduct a cluster analysis** using the WHO life expectancy dataset.

Your job is to find key nuggets of information to help guide the team as they target regions to investigate in their future research.

THE **OBJECTIVE**

Use Tableau Desktop to:

- Create trends to identify patterns in the data
- Leverage forecasts to project future data points
- Apply clustering to segment WHO data

