HKUST
VISLAB

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HCI Initiative

COMP 4462
Data Visualization Tutorial

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Visualization process

Prepare data

- Get data
  - Download, crawl, collect
- Load data
  - Load data into visualization software
- Transform, join and aggregate
  - Make data to the form that ready to be drawn
- Filter
  - Clean up data and remove irrelevant information

Draw data (visualize)

- Visual encoding design
  - It's what you learn from the lectures
  - Marks and channels
  - Position, color, size, shape, etc.
- Interactions
  - Pan and zoom, select and filter
  - Click, drag and drop, scroll, and keyboard input, etc.

Get data

- Download data prepared by the others
  - Kaggle Dataset
  - World Bank
  - And many more
- Crawl from the web
  - Write you own program to crawl
  - From API
  - Extract from HTML or JSON
  - Python: Scrapy, Beautiful Soup
  - Nodejs: Cheerio
- Collect by yourself
  - Most costly
  - Takes time and efforts
  - But sometimes you have to when there is no existing dataset

Load data

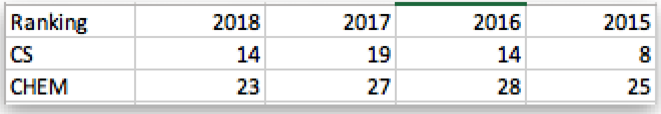
- Most common
    - csv, tsv: comma separated value, tab separated value
    - xlsx: Excel
    - HTTP request: Ajax, JSON, XML
- Databases
    - SQL: Oracle, MySQL, PostgreSQL, MS SQL, etc.
        - Structured, normalized
    - NoSQL: MongoDB
        - Document based
- PDF
    - Tableau supports import from PDF.
    - Import PDF to Excel: reference1, reference2.
- Other source
    - Google Cloud Public Datasets
        - Only available through Google Cloud
        - Too big to be downloaded

Clean data

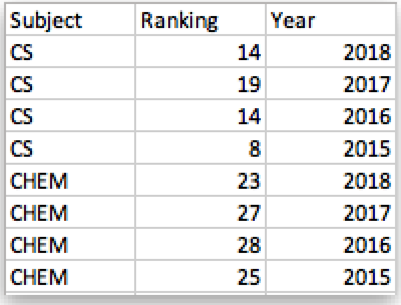
- Data is always dirty
    - Missing values
    - Typo
    - Overloaded fields (mixing continuous numbers with text)
    - Mismatch primary keys / external keys
    - Duplicated entries
    - Missing data for several days
        - Equipment failure / bugs in crawler programs / website is down
    - Non-sense error in data, e.g. integer overflow, or just not making any sense
    - Emoji / language / accent decoration
    - Identical typeface but different in unicode
- Depends on severity, it can be very nasty to deal with
- Data normalization
    - Google Text Normalization Challenge

Transform, join and aggregate

- Manipulate data to the form for visualization
  - Wide form
  - Long form
  - Derive attributes: percentage changes, year-to-year changes
- Join
  - Linking up multiple table or data sources
  - Inner join, left join, right join, outer join
  - Commonly join on ID
    - Sometimes on date
    - Sometimes on multiple attributes
- Aggregate
  - Statistical: counting, sum, average, median, etc.
  - Grouping: binning, frequency, time slicing
  - Moving average, running sum



Ranking	2018	2017	2016	2015
CS	14	19	14	8
CHEM	23	27	28	25



Subject	Ranking	Year
CS	14	2018
CS	19	2017
CS	14	2016
CS	8	2015
CHEM	23	2018
CHEM	27	2017
CHEM	28	2016
CHEM	25	2015

Filter

- Reduce the number of items to show
- Focus only on relevant data, clean up irrelevant data
    - Base on user interest
    - Or users' level of authority
        - Not everyone can access all the data
    - Time relevancy
        - Outdated data are no longer relevant to real-time analysis
    - Geographic relevance
        - You don't care about restaurants outside Hong Kong (unless you're going to travel)
- Hard to show all with a limited screen size
    - Especially on mobile device
    - Reduce cluttering, more "clickable" on screen to show item details
- Zoom in to a specific small subset of data
    - Then you can show more detail of each item
    - Google Maps, zoom in to show more detailed terrain

Tableau

Visualization with Tableau and data processing pipeline

- Install Tableau beforehand
  - Tableau student (Full version, preferred): https://www.tableau.com/academic/students
  - Or Tableau Public: https://public.tableau.com

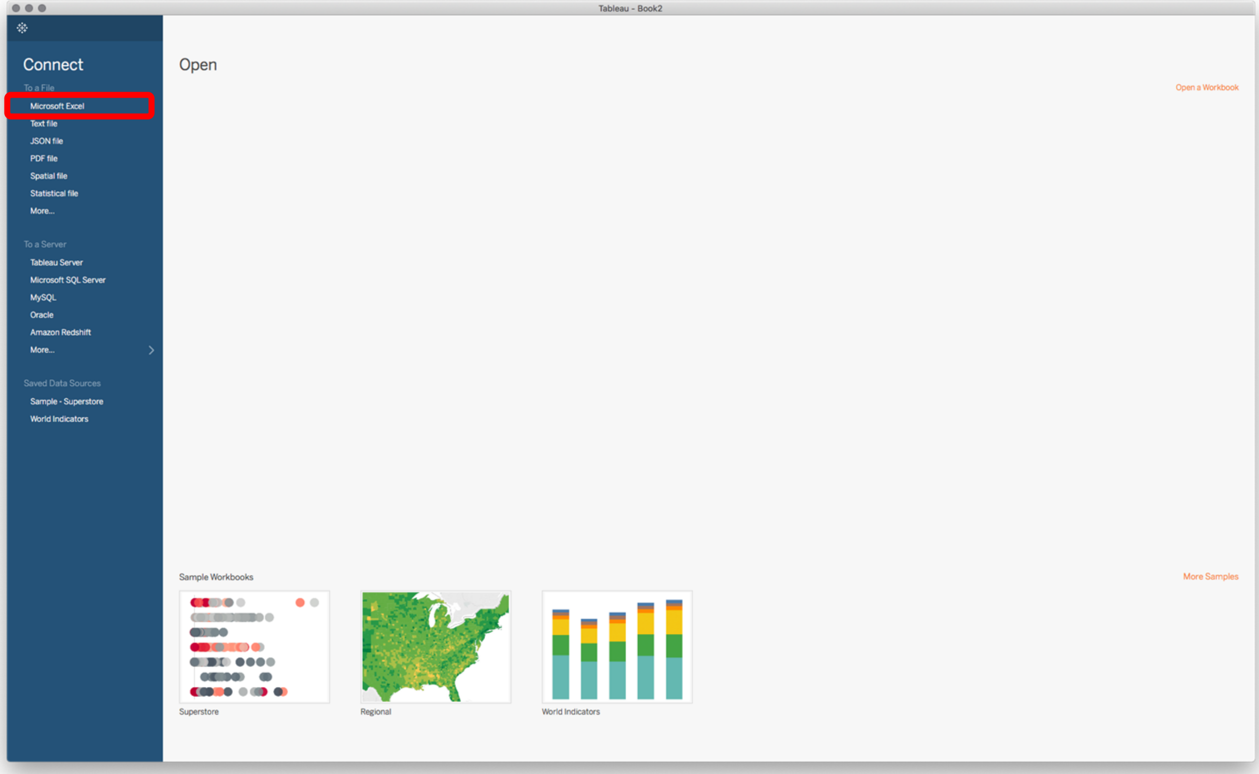
Tableau

- Tableau Public
  - Free
  - All saved works are public
    - Publicly viewable, downloadable
  - Must connect to the internet in order to save
  - Less data connectors
- Tableau Desktop
  - Free for students, need verification
  - Can save locally, use without connecting to the internet
  - More data connectors
- Tableau Prep
  - Prepare data for visualization
- Tableau Server
  - Standalone, dedicated server
  - Enterprise level, expensive

Load Data

Take the dataset (global_superstore_2016.xlsx) from GitHub as an example.

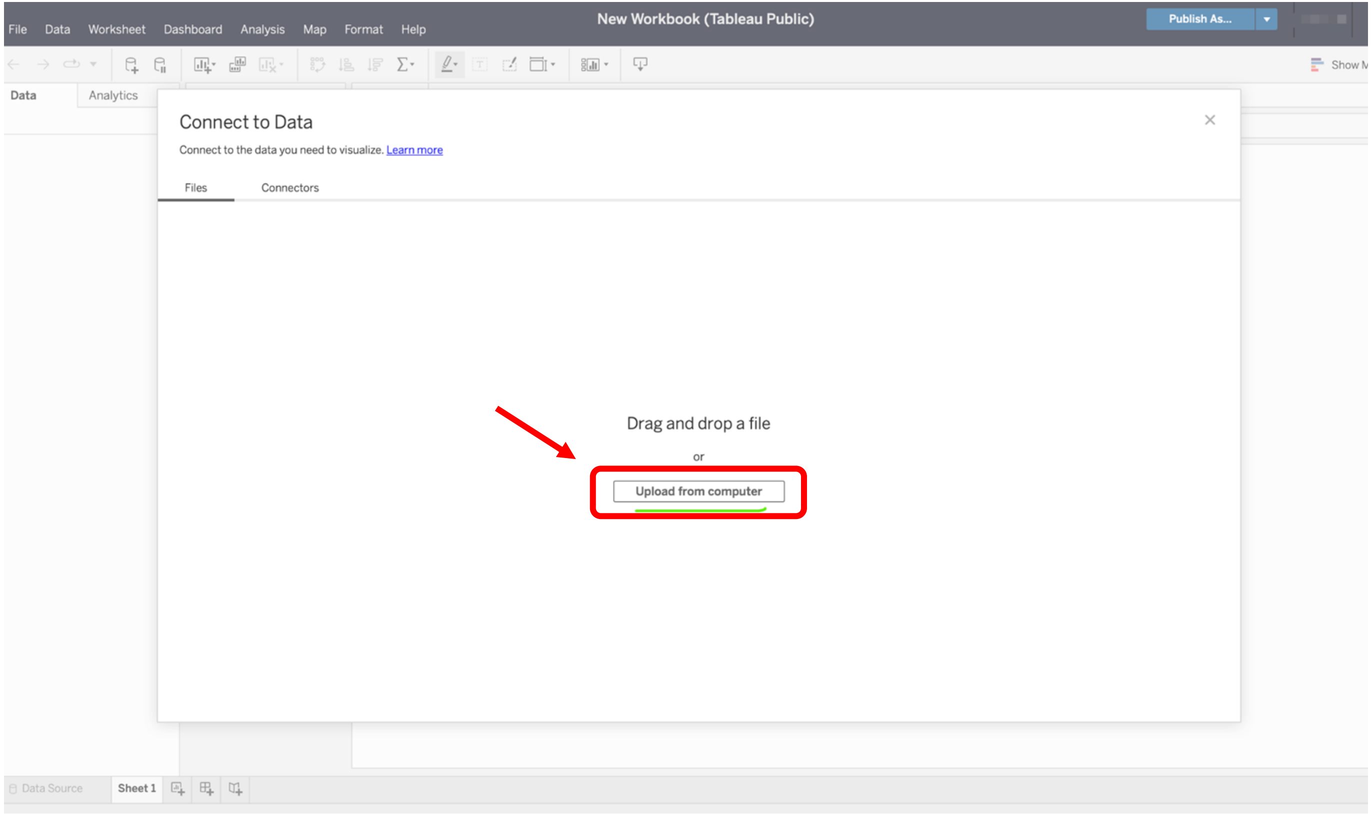
For Desktop



Load Data

Take the dataset (global_superstore_2016.xlsx) from GitHub as an example.

For Web Authoring



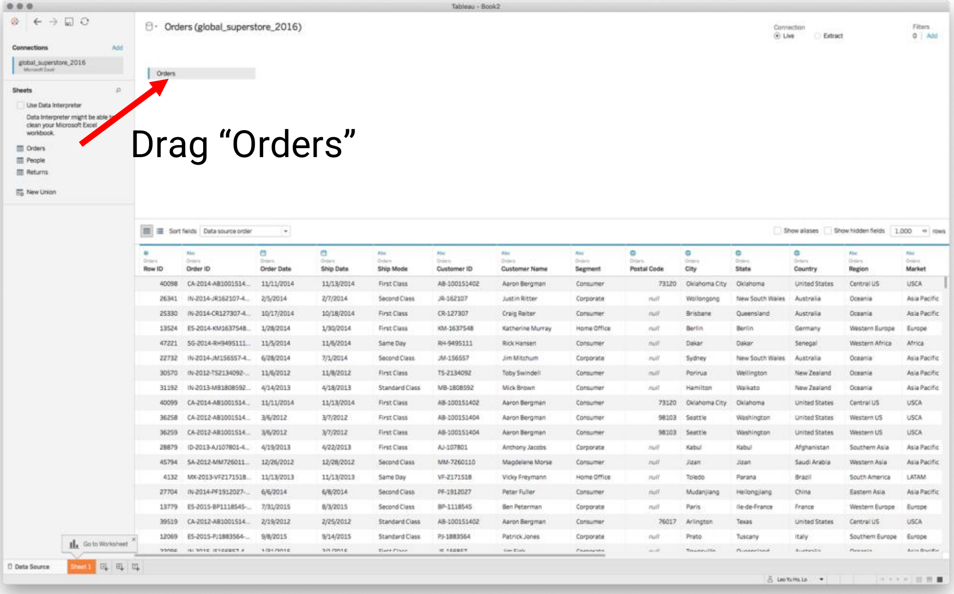
Connect to Data

Connect to the data you need to visualize. Learn more

Drag and drop a file

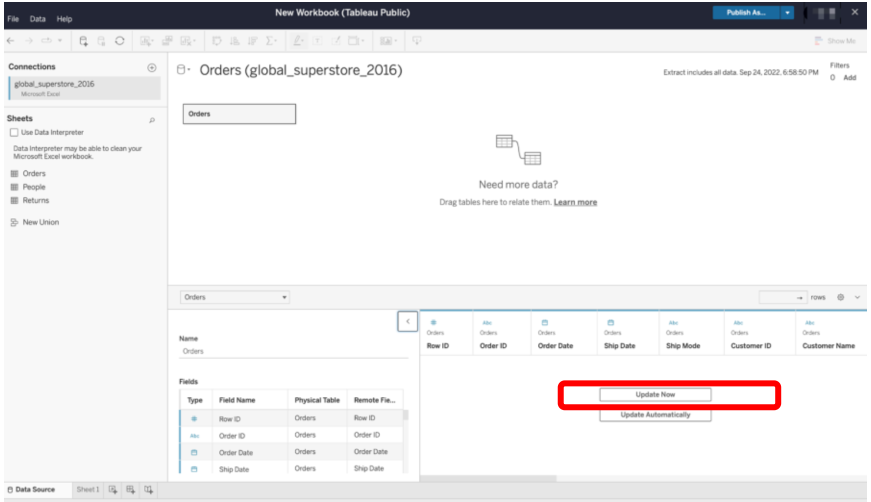
or

Load Data



Drag "Orders"

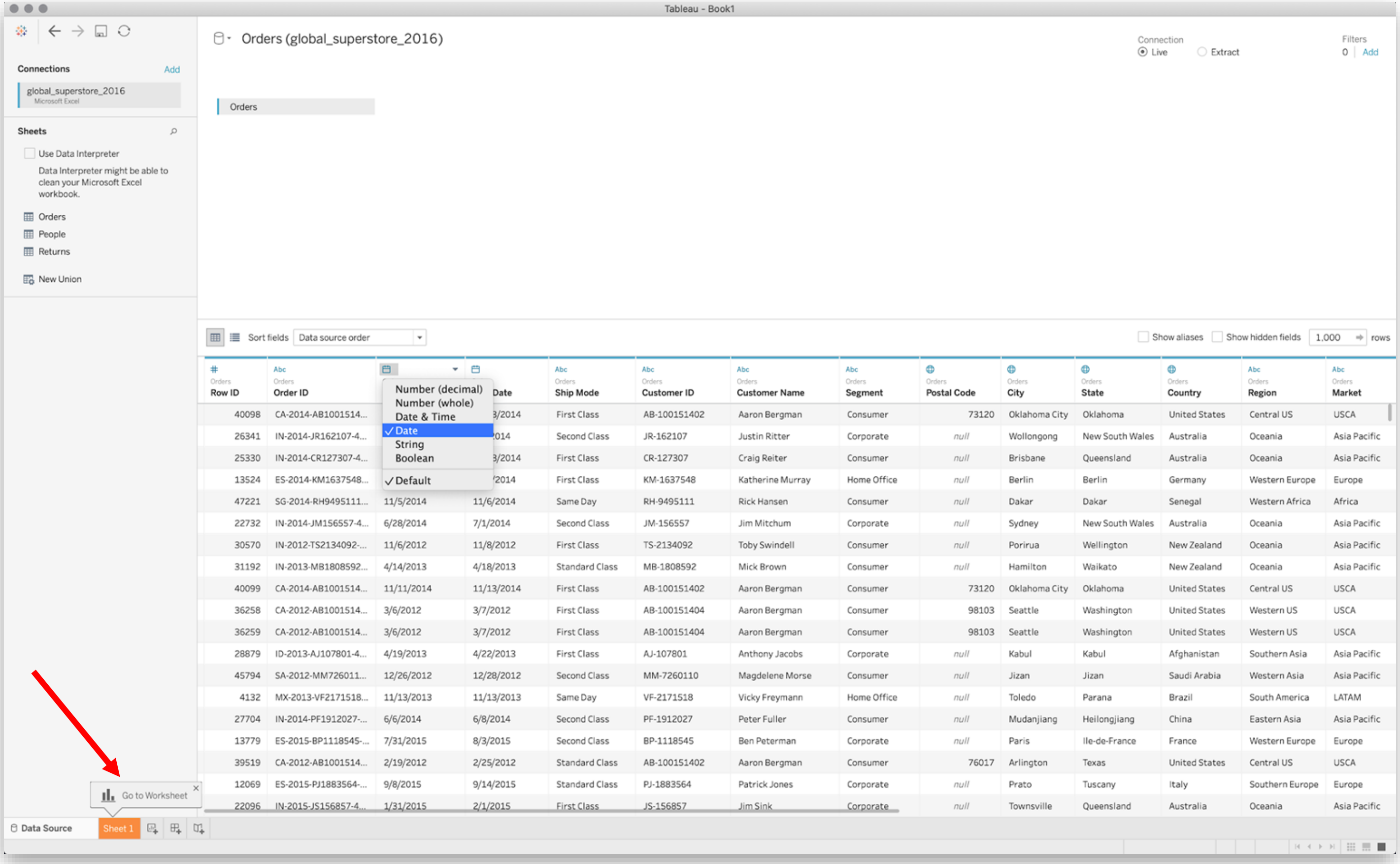
Row ID	Order ID	Order Date	Ship Date	Ship Mode	Customer ID	Customer Name	Segment	Postal Code	City	State	Country	Region	Market
40098	CA-2014-AB1001514...	11/11/2014	11/13/2014	First Class	AB-100151402	Aaron Bergman	Consumer	73120	Oklahoma City	Oklahoma	United States	Central US	USCA
26341	IN-2014-JR162107-4...	2/5/2014	2/7/2014	Second Class	JR-162107	Justin Ritter	Corporate	null	Wollongong	New South Wales	Australia	Oceania	Asia Pacific
25330	IN-2014-CR127307-4...	10/17/2014	10/18/2014	First Class	CR-127307	Craig Reiter	Consumer	null	Brisbane	Queensland	Australia	Oceania	Asia Pacific
13524	ES-2014-KM1637548...	1/28/2014	1/30/2014	First Class	KM-1637548	Katherine Murray	Home Office	null	Berlin	Berlin	Germany	Western Europe	Europe
47221	SG-2014-RH9495111...	11/5/2014	11/6/2014	Same Day	RH-9495111	Rick Hansen	Consumer	null	Dakar	Dakar	Senegal	Western Africa	Africa
22732	IN-2014-JM156557-4...	6/28/2014	7/1/2014	Second Class	JM-156557	Jim Mitchum	Corporate	null	Sydney	New South Wales	Australia	Oceania	Asia Pacific
30570	IN-2012-TS2134092-...	11/6/2012	11/8/2012	First Class	TS-2134092	Toby Swindell	Consumer	null	Porirua	Wellington	New Zealand	Oceania	Asia Pacific
31192	IN-2013-MB1808592...	4/14/2013	4/18/2013	Standard Class	MB-1808592	Mick Brown	Consumer	null	Hamilton	Waikato	New Zealand	Oceania	Asia Pacific
40099	CA-2014-AB1001514...	11/11/2014	11/13/2014	First Class	AB-100151402	Aaron Bergman	Consumer	73120	Oklahoma City	Oklahoma	United States	Central US	USCA
36258	CA-2012-AB1001514...	3/6/2012	3/7/2012	First Class	AB-100151404	Aaron Bergman	Consumer	98103	Seattle	Washington	United States	Western US	USCA
36259	CA-2012-AB1001514...	3/6/2012	3/7/2012	First Class	AB-100151404	Aaron Bergman	Consumer	98103	Seattle	Washington	United States	Western US	USCA
28879	ID-2013-AJ107801-4...	4/19/2013	4/22/2013	First Class	AJ-107801	Anthony Jacobs	Corporate	null	Kabul	Kabul	Afghanistan	Southern Asia	Asia Pacific
45794	SA-2012-MM726011...	12/26/2012	12/28/2012	Second Class	MM-7260110	Magdelene Morse	Consumer	null	Jizan	Jizan	Saudi Arabia	Western Asia	Asia Pacific
4132	MX-2013-VF2171518...	11/13/2013	11/13/2013	Same Day	VF-2171518	Vicky Freymann	Home Office	null	Toledo	Parana	Brazil	South America	LATAM
27704	IN-2014-PF1912027-...	6/6/2014	6/8/2014	Second Class	PF-1912027	Peter Fuller	Consumer	null	Mudanjiang	Heilongjiang	China	Eastern Asia	Asia Pacific
13779	ES-2015-BP1118545-...	7/31/2015	8/3/2015	Second Class	BP-1118545	Ben Peterman	Corporate	null	Paris	Ile-de-France	France	Western Europe	Europe
39519	CA-2012-AB1001514...	2/19/2012	2/25/2012	Standard Class	AB-100151402	Aaron Bergman	Consumer	76017	Arlington	Texas	United States	Central US	USCA
12069	ES-2015-PJ1883564-...	9/8/2015	9/14/2015	Standard Class	PJ-1883564	Patrick Jones	Corporate	null	Prato	Tuscany	Italy	Southern Europe	Europe
[illegible]	[illegible]	[illegible]	[illegible]	First Class	[illegible]	Jim Sink	Corporate	null	Townsville	Queensland	Australia	Oceania	Asia Pacific



Type	Field Name	Physical Table	Remote Fie...
#	Row ID	Orders	Row ID
Abc	Order ID	Orders	Order ID
▭	Order Date	Orders	Order Date
▭	Ship Date	Orders	Ship Date

If you page is like this, click **update now** to reach the status shown on the left.

Change to Sheet 1



□ Use Data Interpreter

Data Interpreter might be able to clean your Microsoft Excel workbook.

Connection: ● Live ○ Extract

Filters: 0 | Add

Sort fields: Data source order

□ Show aliases □ Show hidden fields 1,000 rows

Row ID	Order ID		Date	Ship Mode	Customer ID	Customer Name	Segment	Postal Code	City	State	Country	Region	Market
40098	CA-2014-AB1001514...		3/2014	First Class	AB-100151402	Aaron Bergman	Consumer	73120	Oklahoma City	Oklahoma	United States	Central US	USCA
26341	IN-2014-JR162107-4...		014	Second Class	JR-162107	Justin Ritter	Corporate	null	Wollongong	New South Wales	Australia	Oceania	Asia Pacific
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4132	MX-2013-VF2171518...	11/13/2013	11/13/2013	Same Day	VF-2171518	Vicky Freymann	Home Office	null	Toledo	Parana	Brazil	South America	LATAM
27704	IN-2014-PF1912027-...	6/6/2014	6/8/2014	Second Class	PF-1912027	Peter Fuller	Consumer	null	Mudanjiang	Heilongjiang	China	Eastern Asia	Asia Pacific
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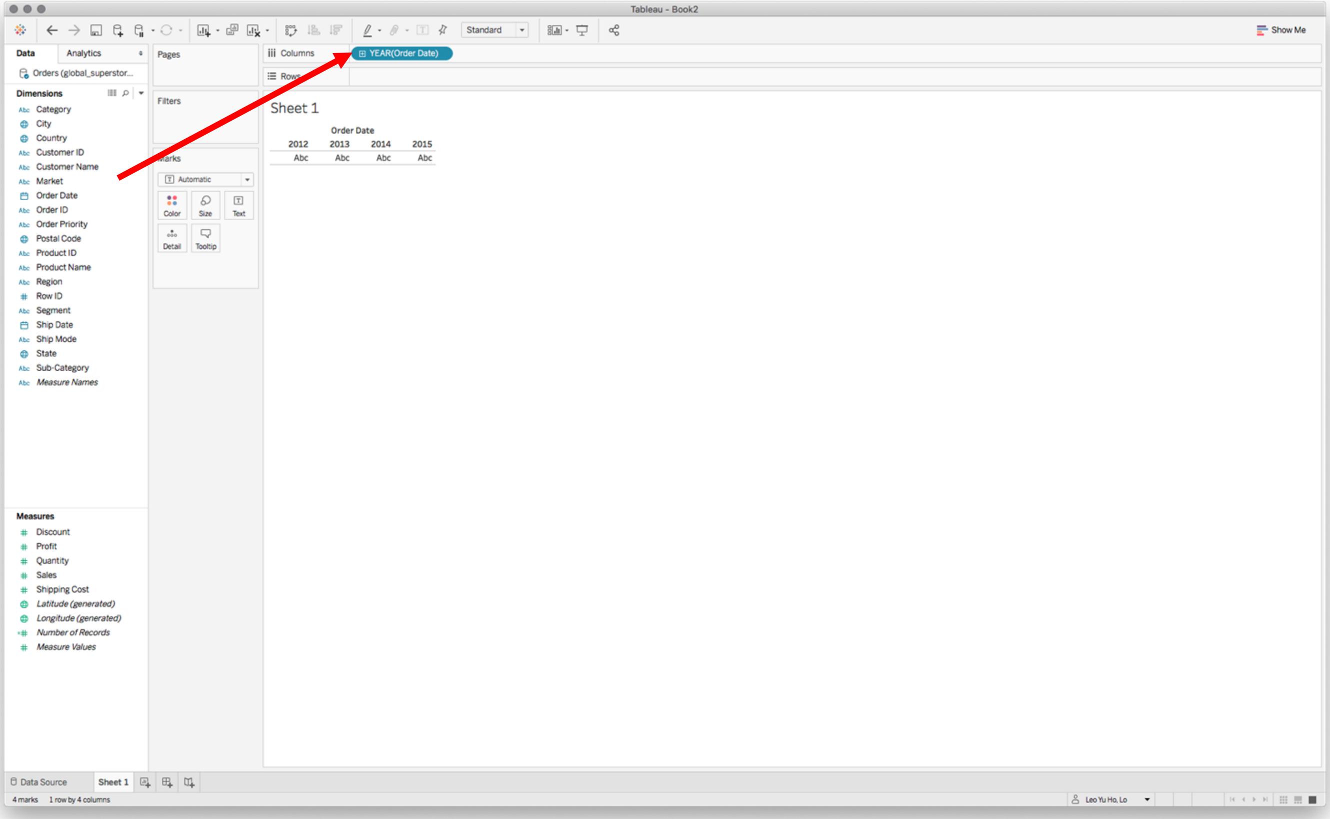
39519	CA-2012-AB1001514...	2/19/2012	2/25/2012	Standard Class	AB-100151402	Aaron Bergman	Consumer	76017	Arlington	Texas	United States	Central US	USCA
12069	ES-2015-PJ1883564-...	9/8/2015	9/14/2015	Standard Class	PJ-1883564	Patrick Jones	Corporate	null	Prato	Tuscany	Italy	Southern Europe	Europe
22096	IN-2015-JS156857-4...	1/31/2015	2/1/2015	First Class	JS-156857	Jim Sink	Corporate	null	Townsville	Queensland	Australia	Oceania	Asia Pacific

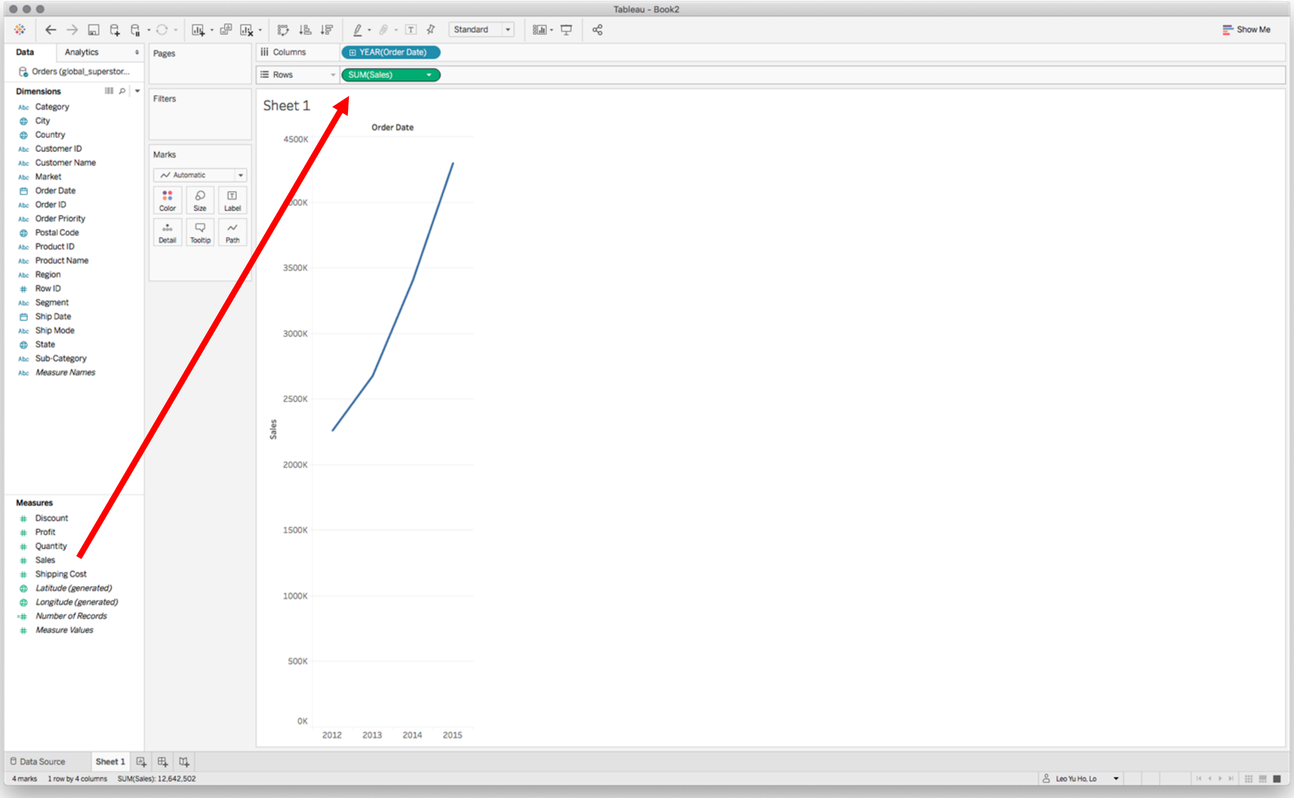
Basic Plotting: Select Row and Column



Sheet 1

Order Date			
2012	2013	2014	2015
Abc	Abc	Abc	Abc

Basic Plotting: Select Row and Column

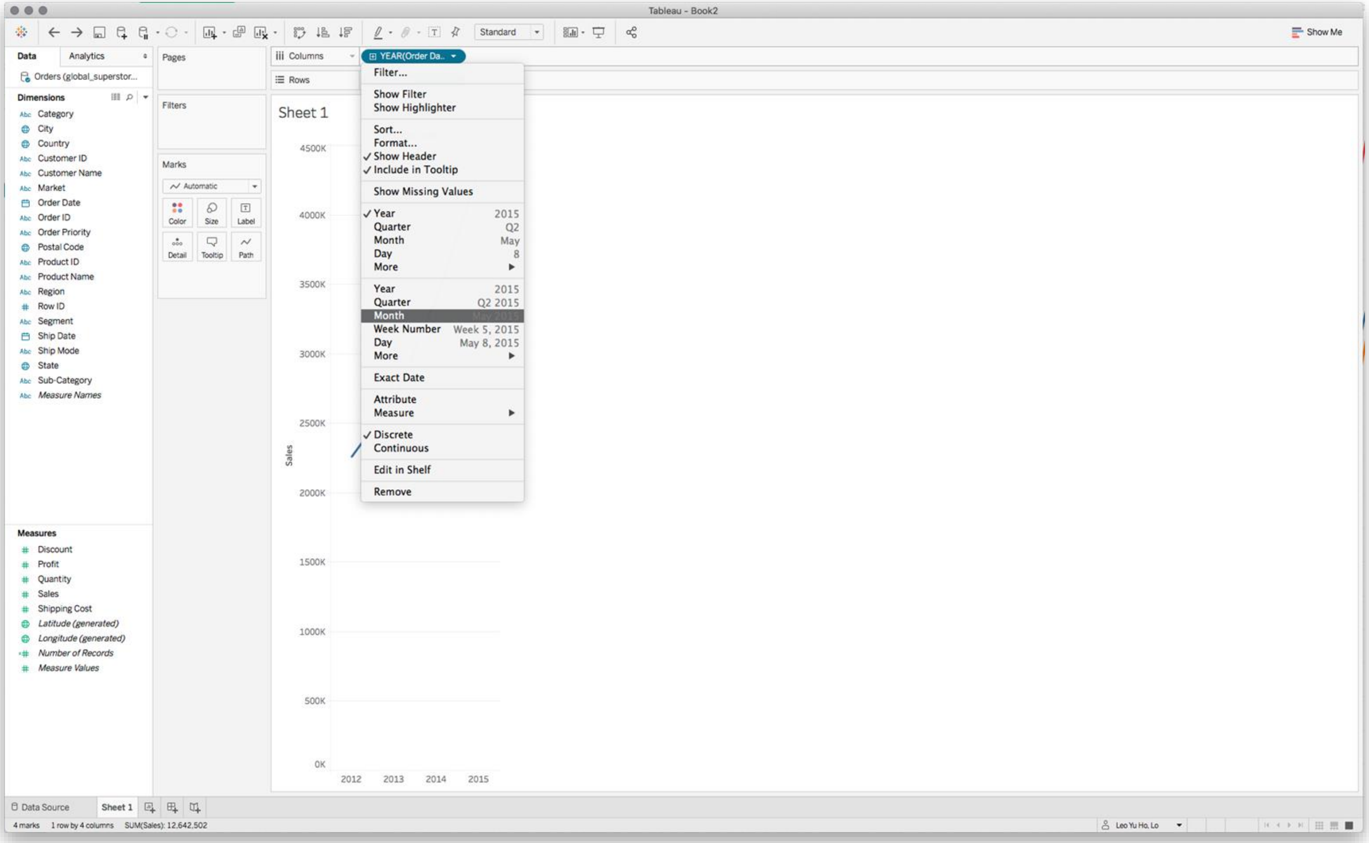


Columns: YEAR(Order Date)

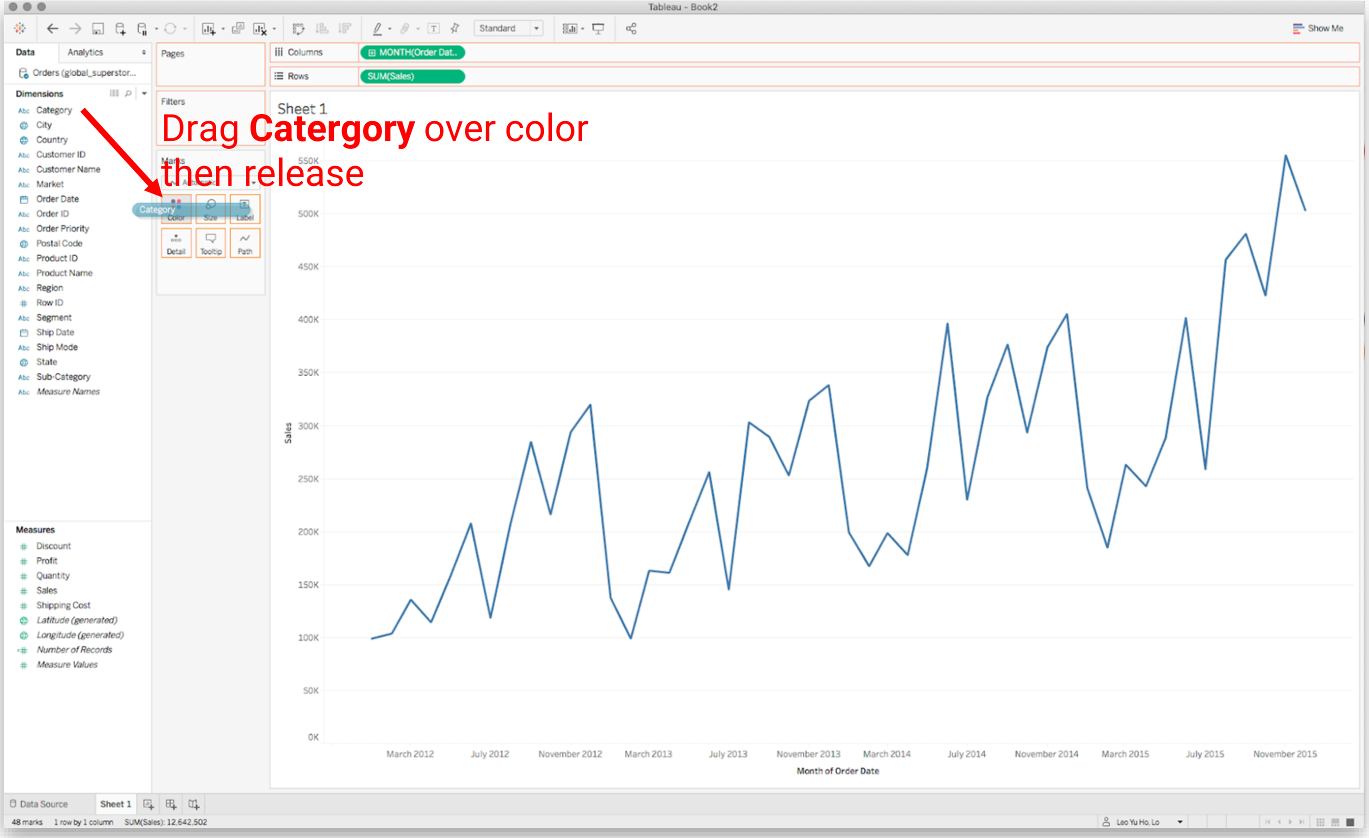
Rows: SUM(Sales)

4 marks 1 row by 4 columns SUM(Sales): 12,642,502

Basic Plotting: Adjust Date

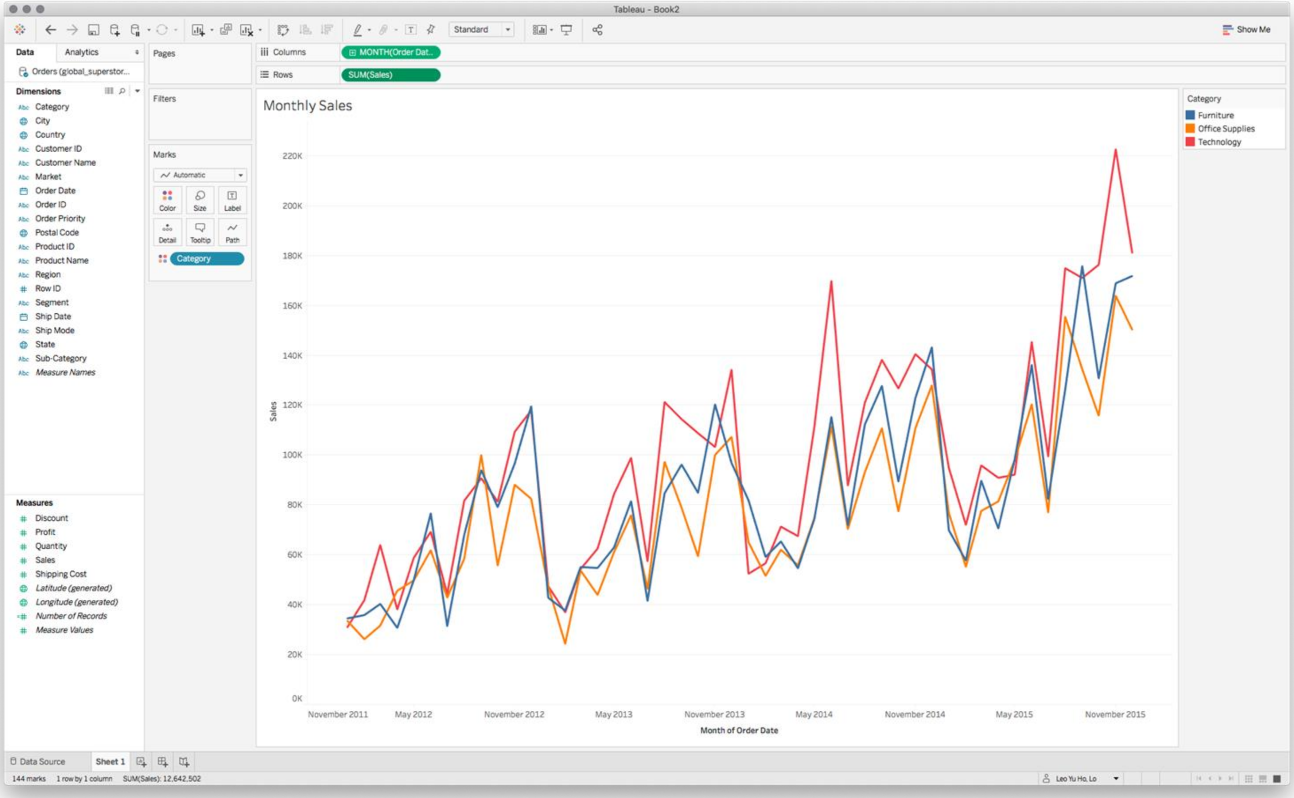


Basic Plotting: Marks with Color



Drag **Catergory** over color
then release

Basic Plotting: Ta-Da



Columns: MONTH(Order Dat..

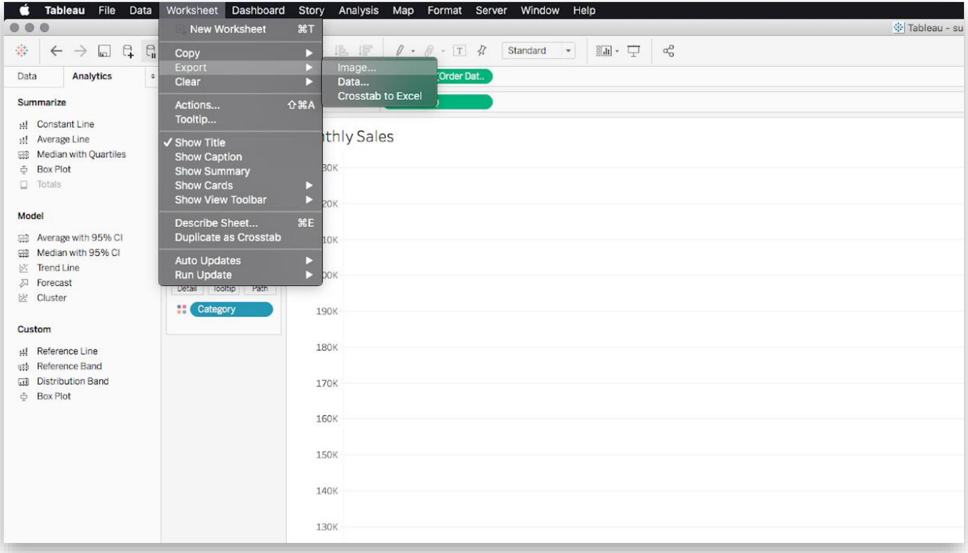
Rows: SUM(Sales)

Marks: Automatic

Category

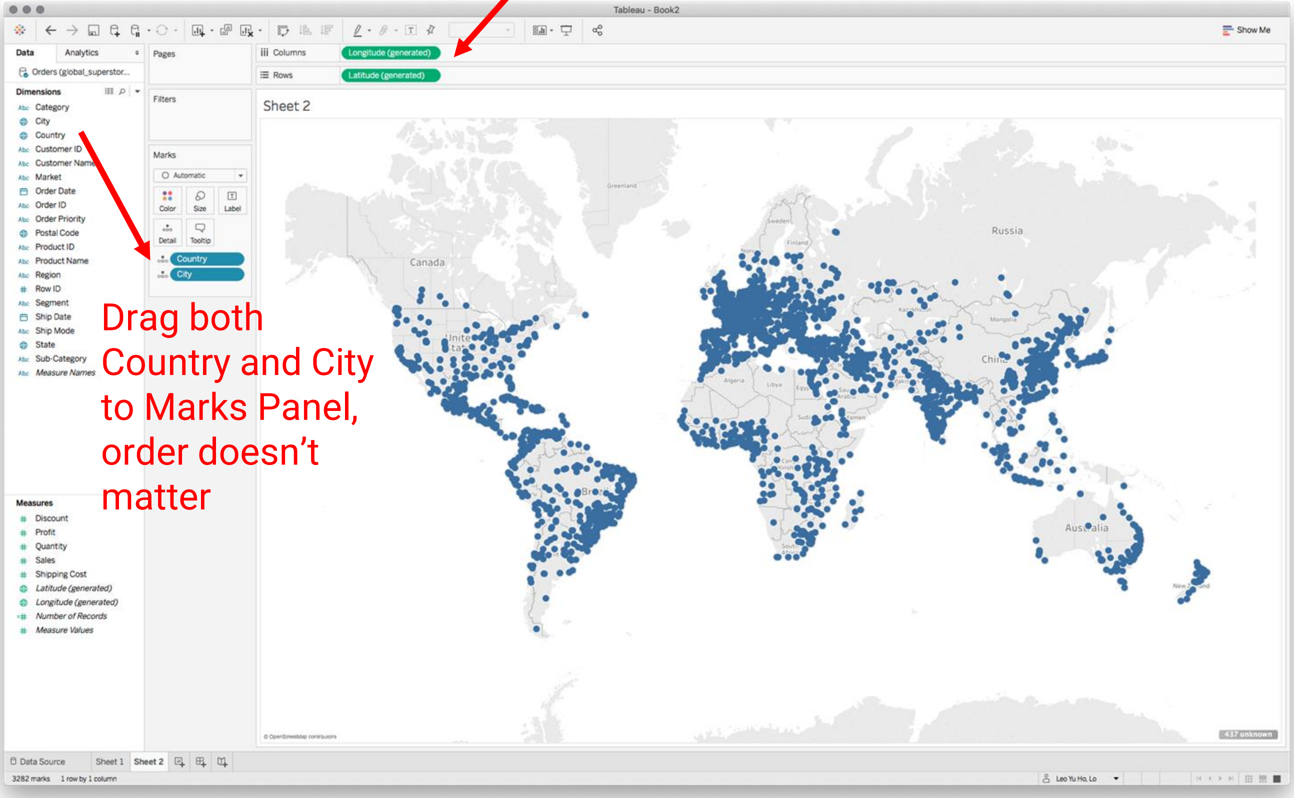
144 marks 1 row by 1 column SUM(Sales): 12,642,502

Export Image (Not available in Tableau Public)



Plotting with Map

Create a new sheet first.



Drag Longitude to Columns, and Latitude to Rows

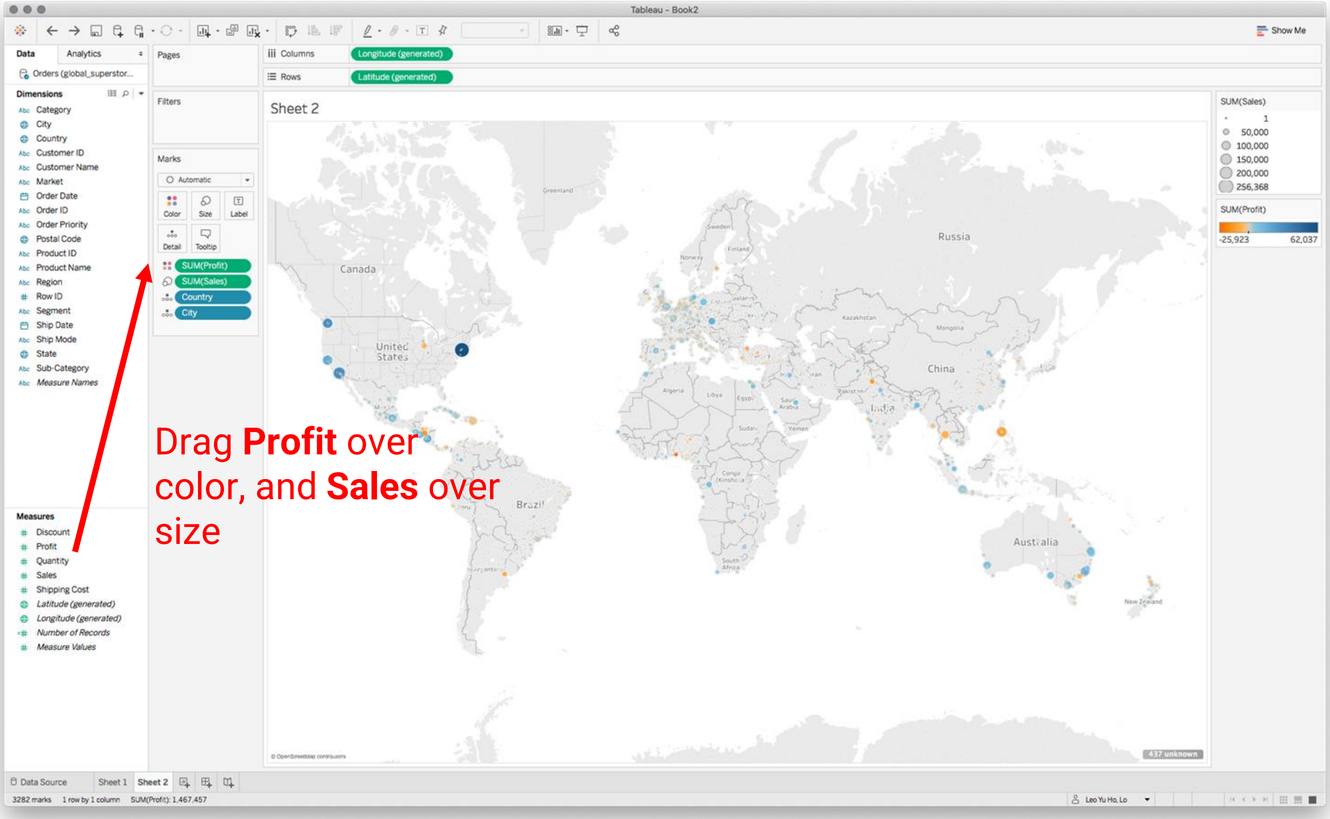
Drag both Country and City to Marks Panel, order doesn't matter

Columns: Longitude (generated)

Rows: Latitude (generated)

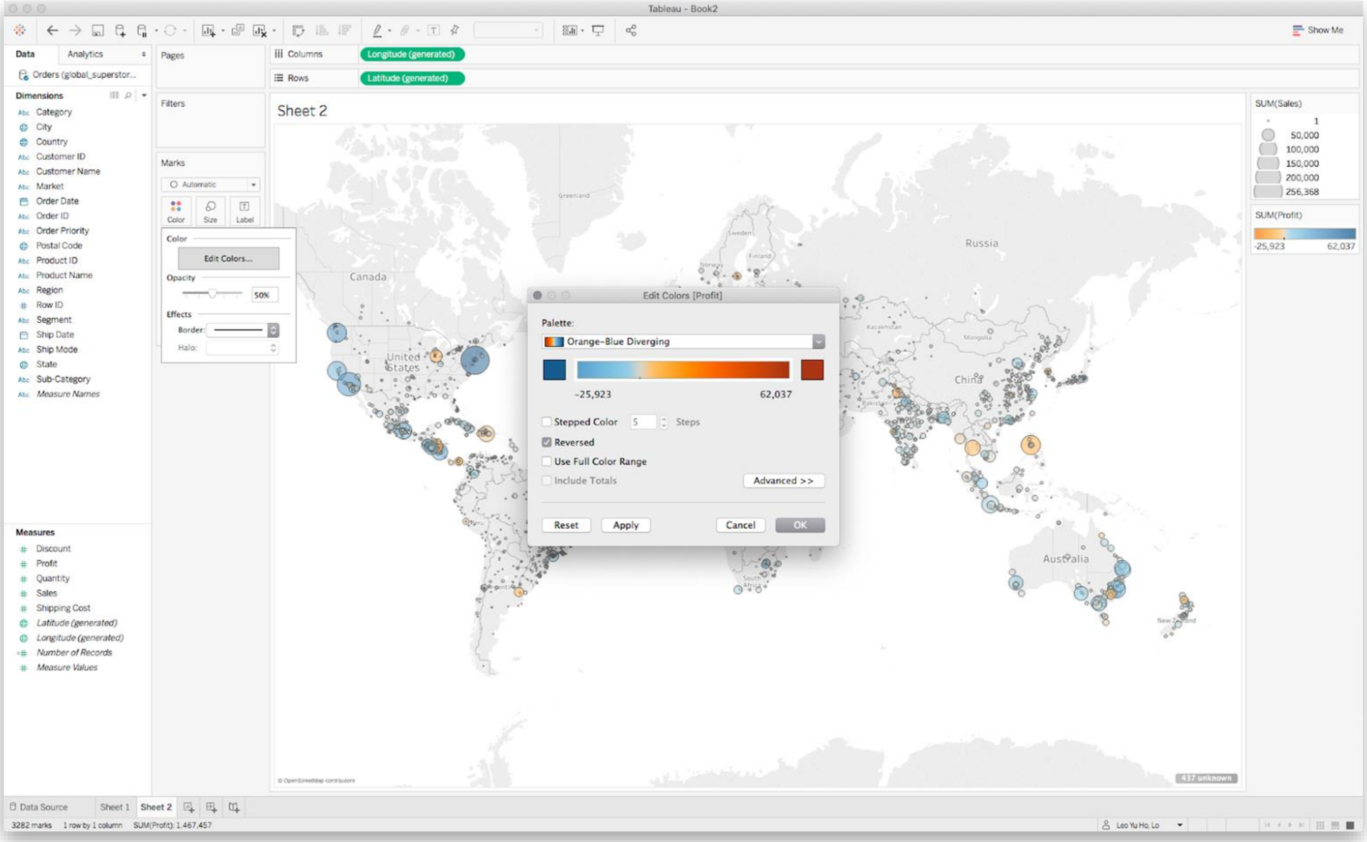
Marks: Automatic; Country; City

Plotting with Map: Encode with Size and Color



Drag **Profit** over color, and **Sales** over size

Adjust Color and Size



Edit Colors [Profit]

Palette: Orange-Blue Diverging

-25,923 62,037

☐ Stepped Color 5 Steps

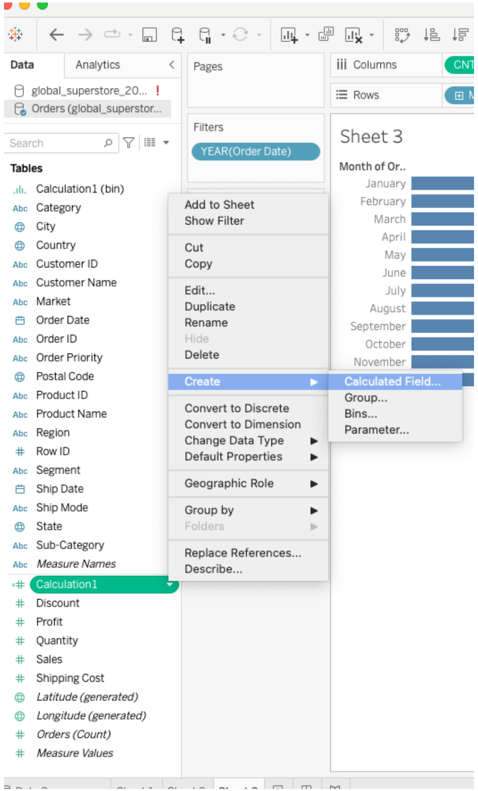
☑ Reversed

☐ Use Full Color Range

☐ Include Totals

Calculated Field

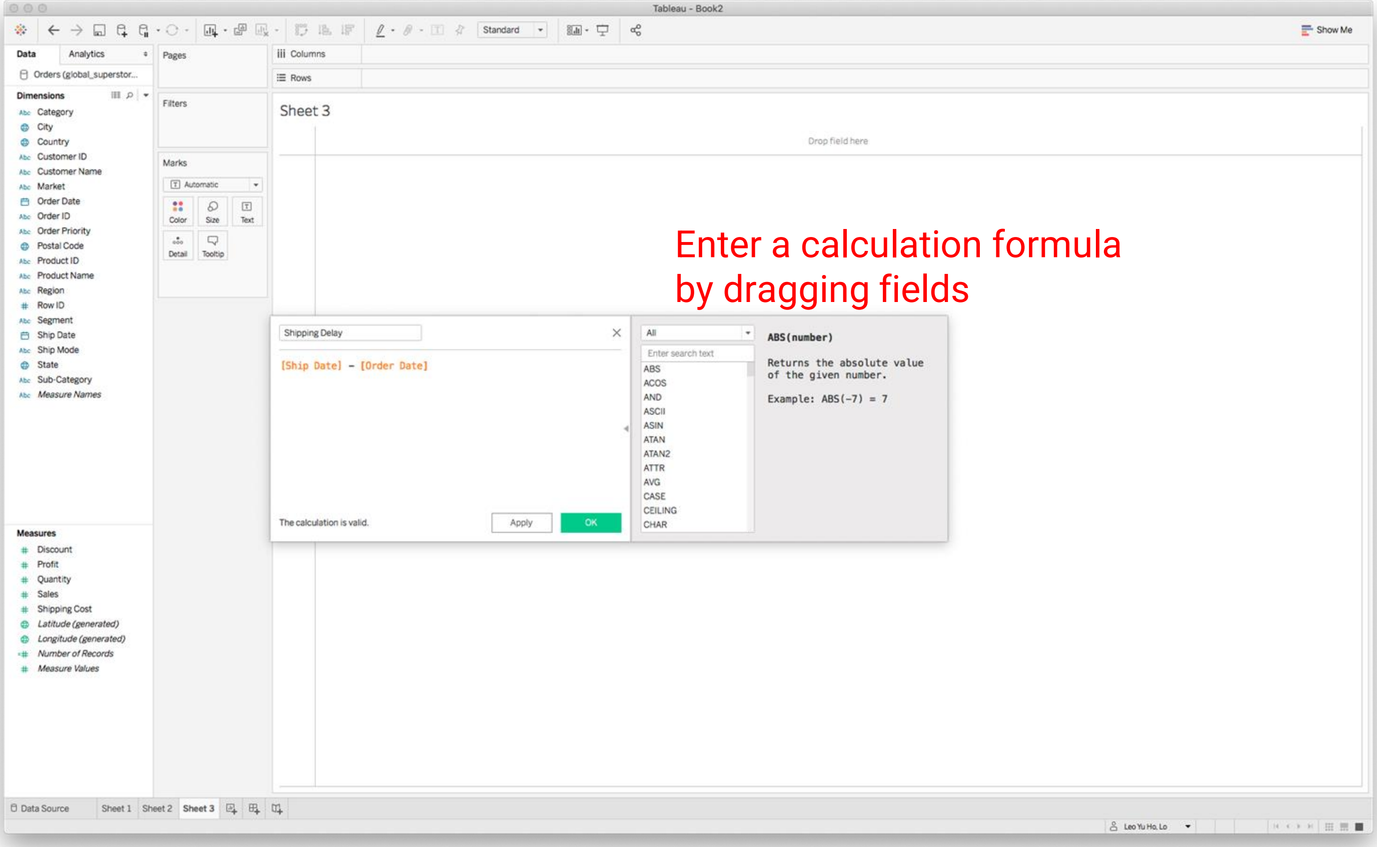
Create another new sheet.



For Tableau desktop, click “Create Calculated Field” by right clicking on “Dimensions” or “Measures”

For Tableau public, click “Create--Calculated Field” by right clicking on “Dimensions” or “Measures”

Calculated Field



Shipping Delay

```
[Ship Date] - [Order Date]
```

The calculation is valid.

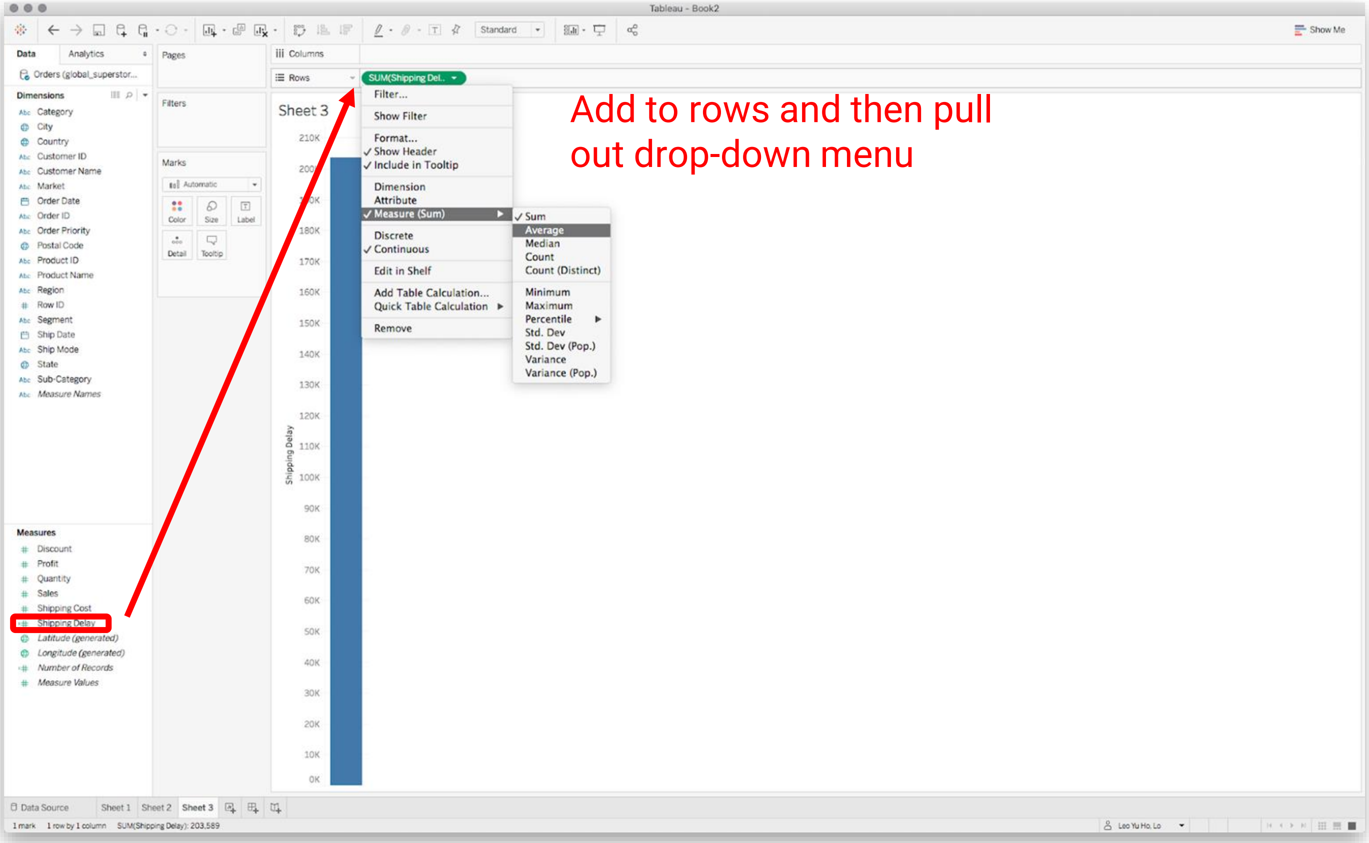
```
ABS(number)

Returns the absolute value
of the given number.

Example: ABS(-7) = 7
```

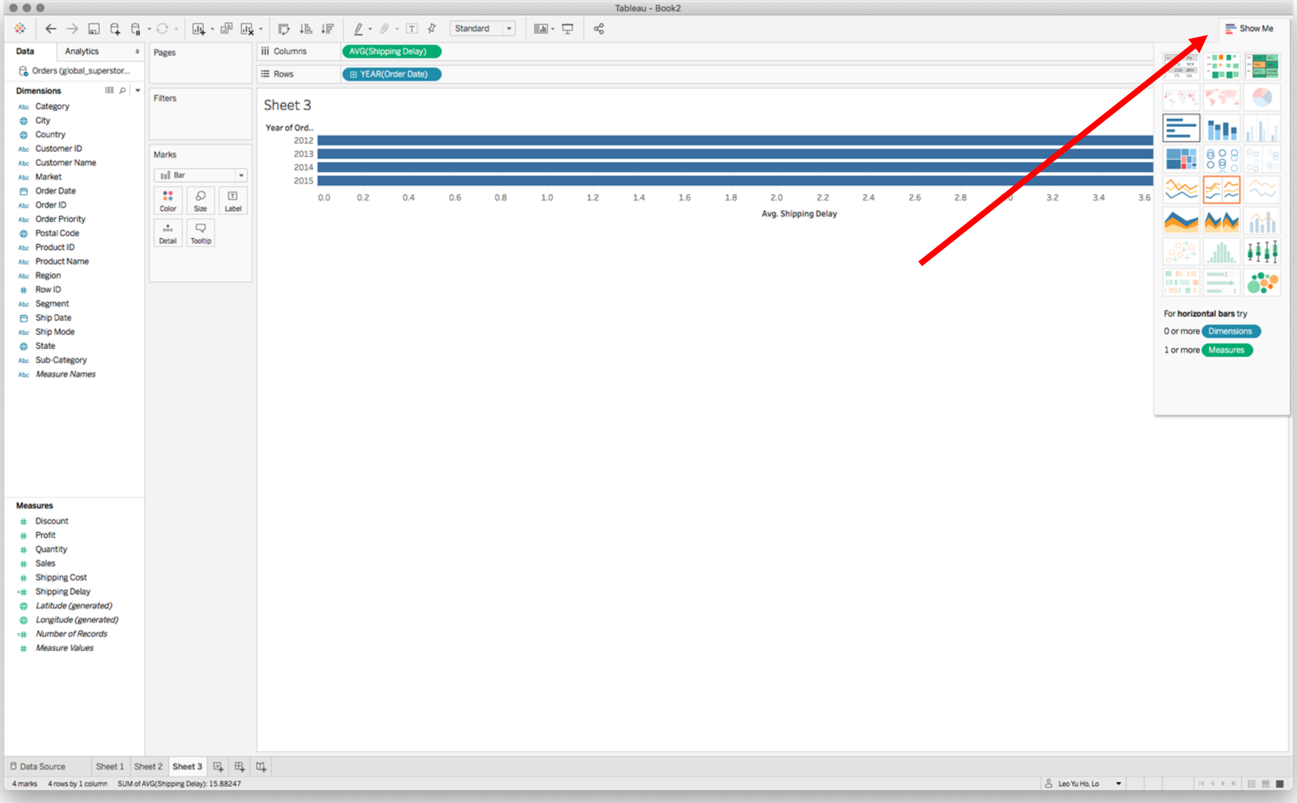
Enter a calculation formula by dragging fields

Aggregate



Add to rows and then pull out drop-down menu

Plotting is easy using “Show Me”



Columns: AVG(Shipping Delay)

Rows: YEAR(Order Date)

Marks: Bar

For **horizontal bars** try

0 or more Dimensions

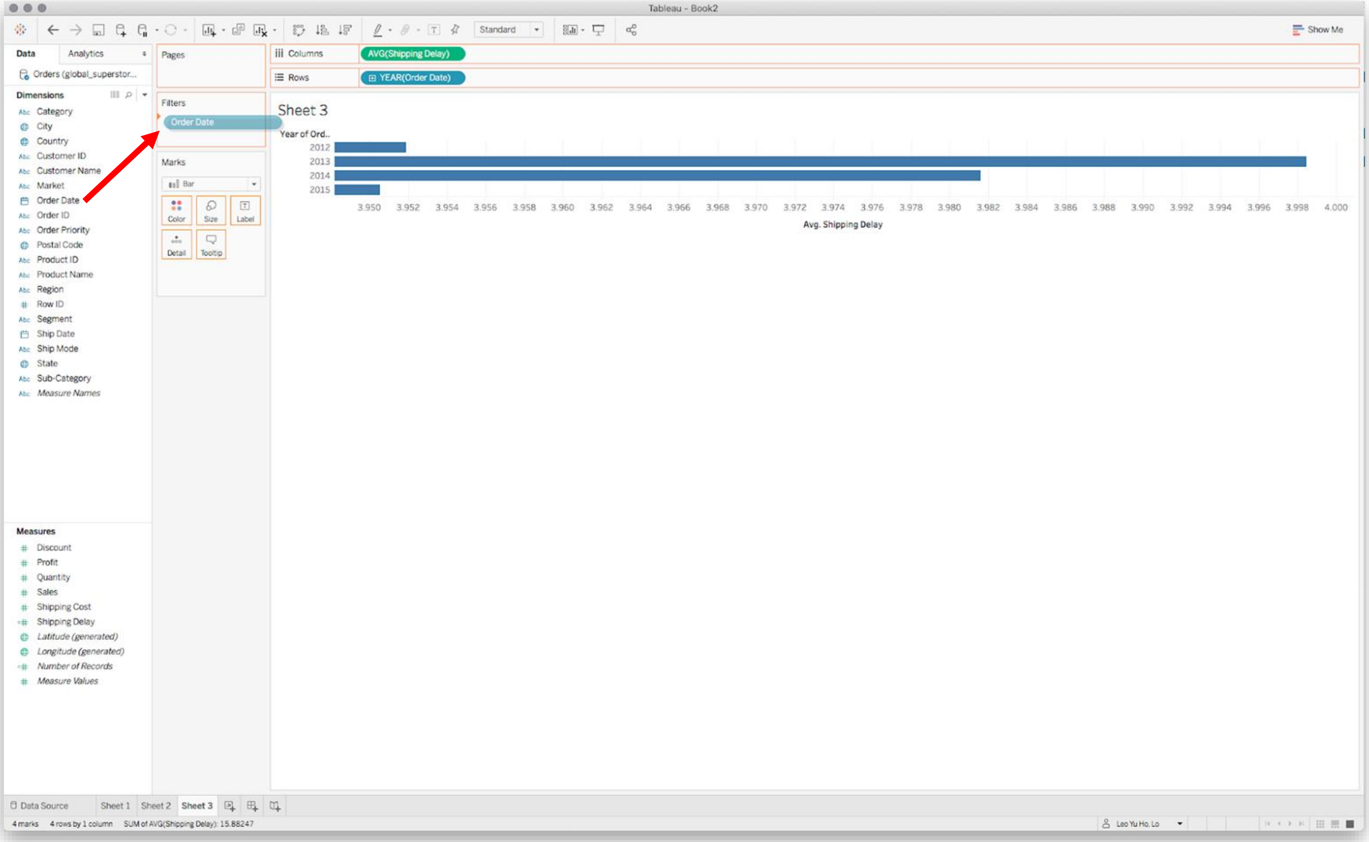
1 or more Measures

4 marks 4 rows by 1 column SUM of AVG(Shipping Delay): 15.88247

Gray-out means not suitable for the current selected data types.

Try different combinations for different plots!

Filter



Columns: AVG(Shipping Delay)

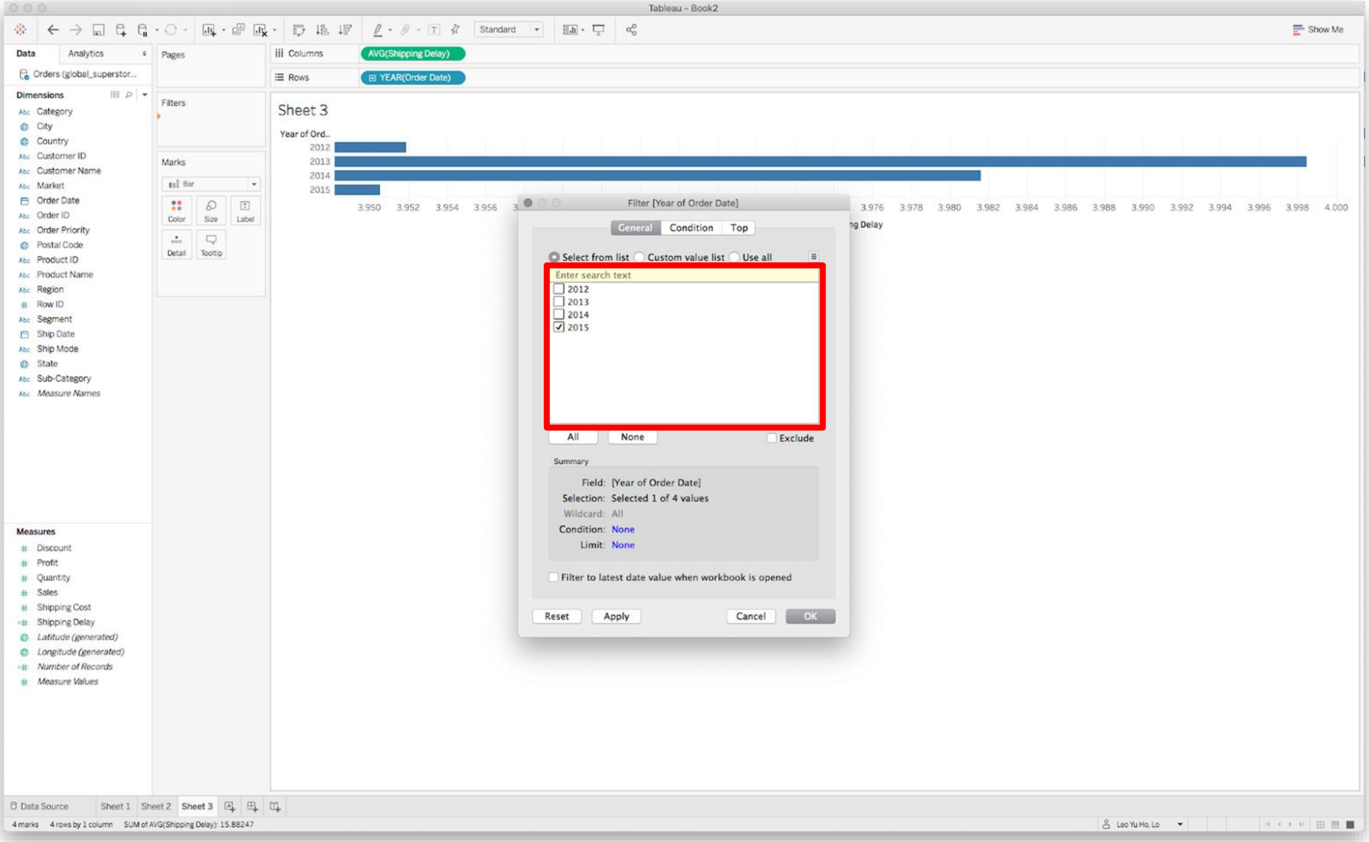
Rows: YEAR(Order Date)

Filters: Order Date

Marks: Bar

4 marks   4 rows by 1 column   SUM of AVG(Shipping Delay): 15.88247

Filter



Filter [Year of Order Date]

General | Condition | Top

● Select from list ○ Custom value list ○ Use all

Enter search text

☐ 2012
☐ 2013
☐ 2014
☑ 2015

All | None | ☐ Exclude

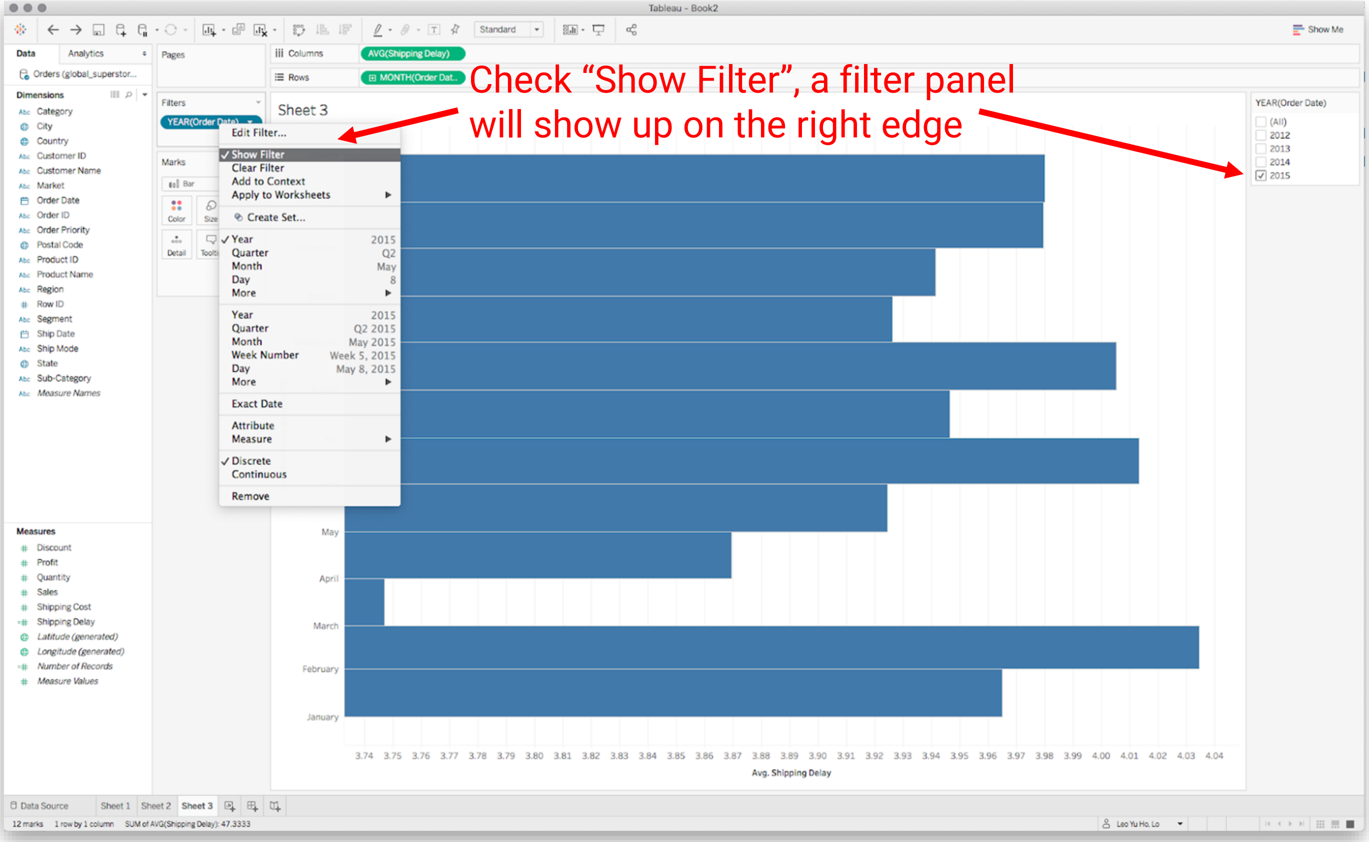
Summary

Field: [Year of Order Date]
Selection: Selected 1 of 4 values
Wildcard: All
Condition: None
Limit: None

☐ Filter to latest date value when workbook is opened

Reset | Apply | Cancel | OK

Interactive filtering



Check “Show Filter”, a filter panel will show up on the right edge

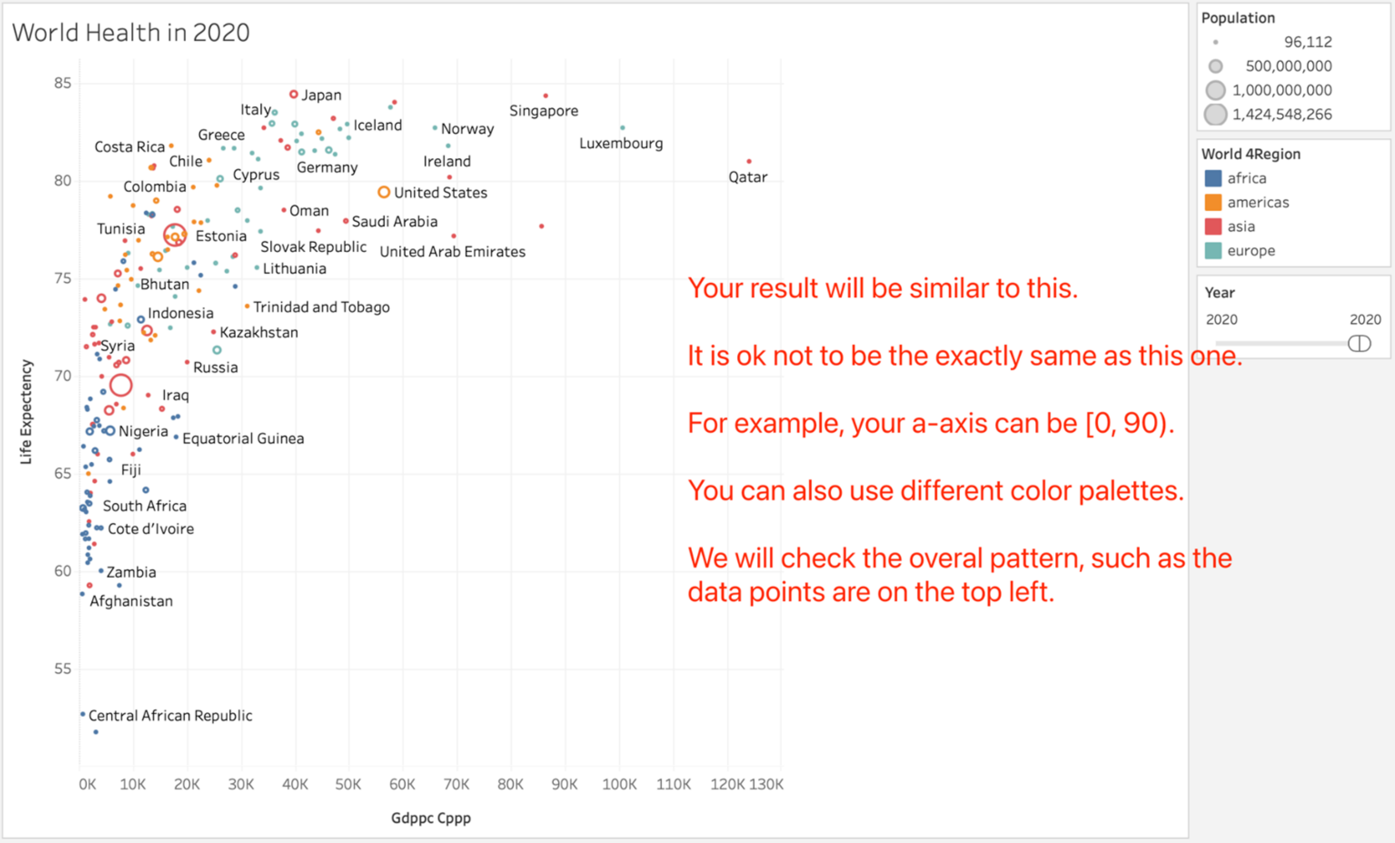
Lab exercise

- Tasks
  - Download dataset (world_data.csv) from GitHub
  - Import data from **Text** file
  - Watch the video Hans Rosling: 200 years in 4 minutes - BBC News
  - Recreate the bubble chart in the video with data of **2020** （An example is shown in the next page）
    - Column: Gdppc Cppp
    - Row: Life Expectancy
    - Size: Population
    - Color: World 4Region
    - Label: Country
    - Remember to set a filter to get Year 2020 data
  - Take a screenshot and upload to Canvas in .png format
    - Mac: cmd+shift+4
    - Windows: Snipping Tool

Lab exercise

- Optional
  - Try using “Show me” to create different charts
  - Plotting data on map, adjust color and size
  - Create “Calculated Field”, e.g. total GDP
  - Add an interactive filter

Lab exercise



Your result will be similar to this.

It is ok not to be the exactly same as this one.

For example, your a-axis can be [0, 90).

You can also use different color palettes.

We will check the overal pattern, such as the data points are on the top left.

An example of submitted image.

More topics on Tableau

- Coursera course
  - https://www.coursera.org/learn/analytics-tableau
- Tableau training videos
  - https://www.tableau.com/learn/training
- Tableau Viz Gallery
  - https://www.tableau.com/solutions/gallery
- Other notable features of Tableau
  - Dashboard, Storyboard
  - Parameters
  - Grouping
  - Table join
  - Features in “Analytics” tab, e.g. Trend Line, Cluster
  - Quick table calculation (e.g. running sum)
  - Tableau Prep
  - Import data from pdf

Next Tutorial

Data scientist toolbox: Python, Jupyter Notebook and Pandas

- Prepare your Google account beforehand
  - For using Google Colab
  - Jupyter notebook environment
  - Free!
  - No setup
- Alternatively, you can use Jupyter notebook on your computer, but that is cumbersome
- Learn more about Pandas