Clinical Business Intelligence & Data Visualization

15 October 2018

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Disclosures and Disclaimers

The author has no relevant financial or nonfinancial relationships to disclose. During the development, analysis, and preparation of this presentation, the author was an employee of the U.S. Veterans Health Administration, Department of Veterans Affairs.

The views and opinions expressed in this presentation are those of the author and do not necessarily reflect the official policy or position of any agency of the U.S. government.

Objectives

Understand how relational database management systems work

Understand how predictive analytics are used in clinical decision making

Integrate Server Query Language (SQL) coding to develop an interactive dashboard using Tableau

Be adventurous!

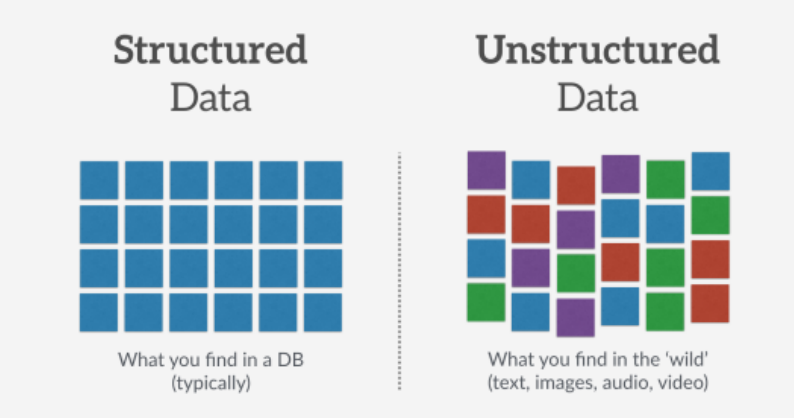
Background

Decision Support Systems (DSS) began approximately 40 years ago

DSS is an interactive process whereby data informs us to pursue certain actions
Computers, broadband internet, and large databases became practical

Complexity demanded a formal method to organize and standardize data

Data can be structured or unstructured



Source: **A Brief History of Decision Support Systems**
http://dssresources.com/history/dsshistory.html

Relational Database Management Systems

Data is the new oil. It's valuable, but if unrefined it cannot really be used.
-- Clive Humby

Databases are collections of interrelated data organized according to a schema to serve one or more applications. A database is […] a collection of tables whose organization is based on the relational model. There may be one or more databases available in each system on the host from each product.

Relational Database Management System (RDBMS) A collection of integrated services which support database management and together support and control the creation, use and maintenance of relational databases.

https://tools.ietf.org/html/rfc1697

Relational Database Management Systems

These are unique identifiers for each of the tables

Patient Table

PatientID	LastName	FirstName	MiddleName	Address	DOB
234632	Smith	John	Howard	1234 Pacific St, Seattle, WA 98195	1/1/1955
687568	Turner	Justin		100 College Drive, Hillcrest, CA 90022	2/1/1934
436356	Jackson	Michael		1005 N. Tennesee Ave, San Francisco, CA 90056	3/1/1967

Laboratory Table

LabID	PatientID	LastName	FirstName	MiddleName	LabTest	Date
3547347	234632	Smith	John	Howard	Chem 7	2/4/2017
6568674	234632	Smith	John	Howard	LFT	5/7/2017
1234121	687568	Turner	Justin		Chem 7	6/9/2015
2638765	687568	Turner	Justin		Chem 7	7/21/2016
4234525	687568	Turner	Justin		Lipid Panel	5/22/2017
3509876	436356	Jackson	Michael		Chem 7	12/1/2017
6708765	436356	Jackson	Michael		Chem 7	1/13/2018
6788432	436356	Jackson	Michael		Chem 7	2/5/2018
6807853	436356	Jackson	Michael		Culture	2/5/2018
1244151	436356	Jackson	Michael		LFT	2/5/2018

Diagnosis Table

DiagnosisID	PatientID	Description	Date
247965	234632	AA-867	2/2/2016
230780	234632	AA-867	2/2/2016
768547	234632	AA-324	3/24/2016
345676	234632	AA-452	5/23/2018
785476	687568	AA-634	9/12/2017
4654374	687568	AB-573	10/13/2017

Relational Database Management Systems

These are not unique identifiers for each of the tables

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PatientID	LastName	FirstName	MiddleName	Address	DOB
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6708765	436356	Jackson	Michael		Chem 7	1/13/2018
6788432	436356	Jackson	Michael		Chem 7	2/5/2018
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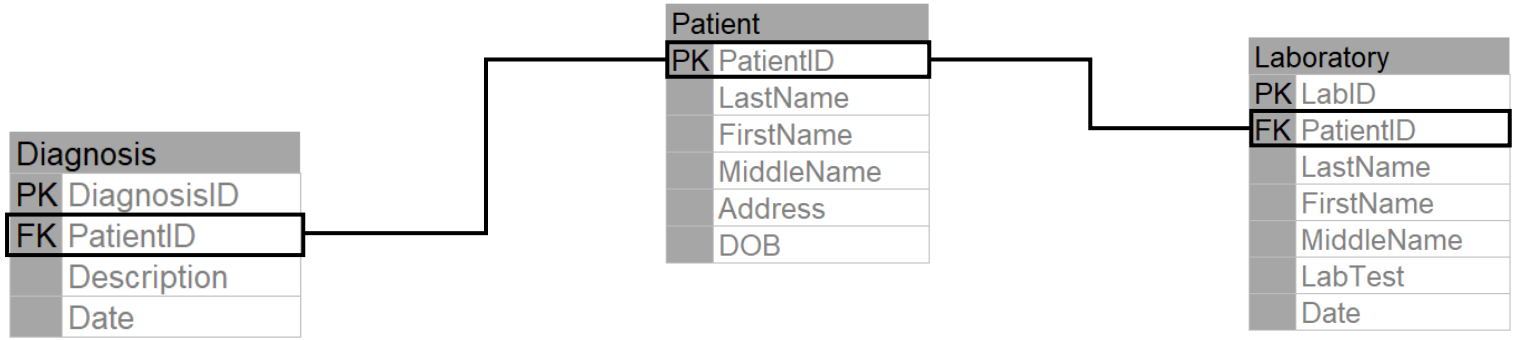
345676	234632	AA-452	5/23/2018
785476	687568	AA-634	9/12/2017
4654374	687568	AB-573	10/13/2017

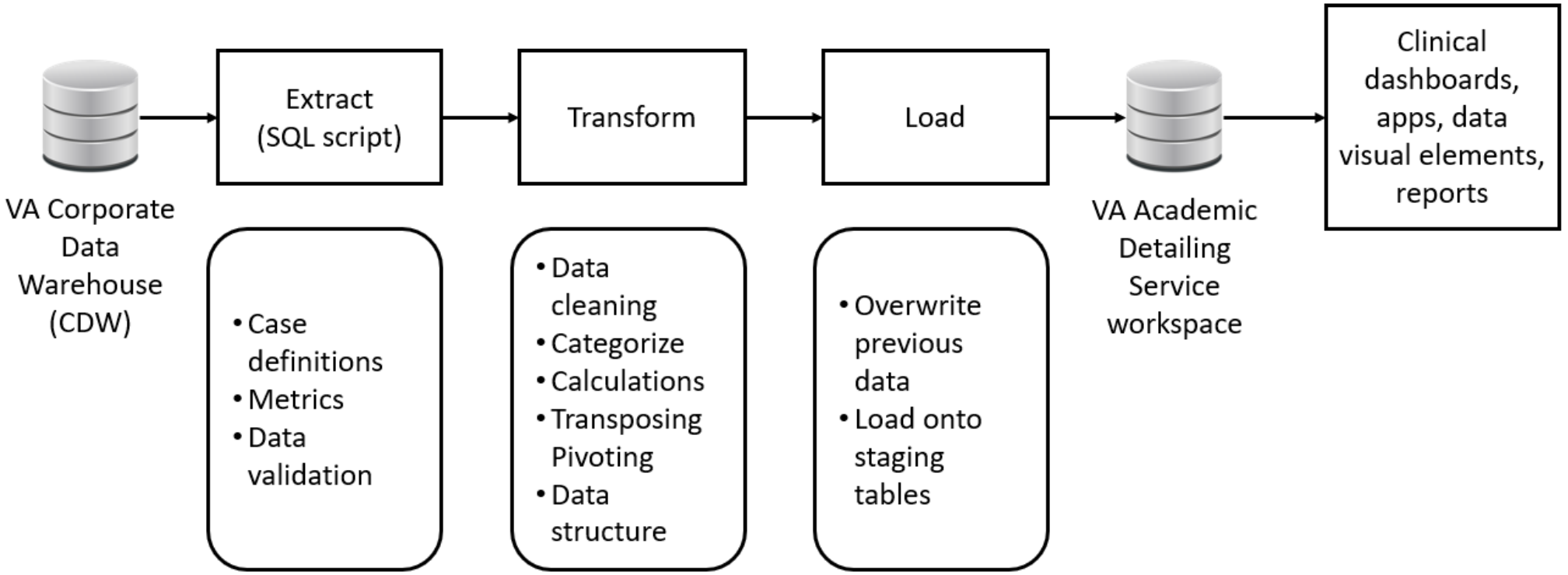
Relational Database Management Systems

Primary keys are unique identifiers that represent a single row in a table

Foreign keys are identifiers that link with a unique primary key

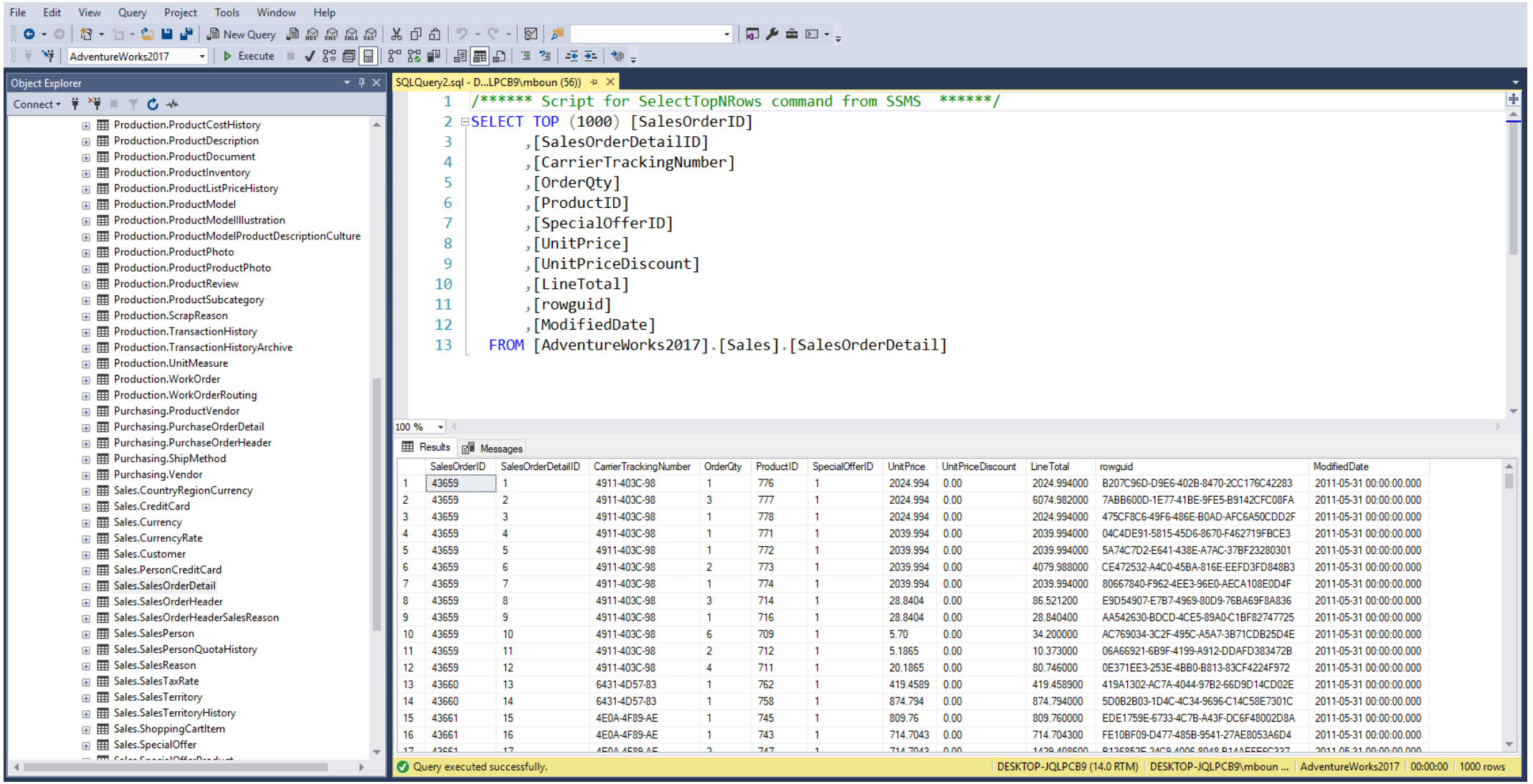


VA Academic Detailing Service



[VA Academic Detailing Service Public Site]

SQL Server Management Studio (SSMS)



[Tutorial link]

Writing SQL queries

```
SELECT *
FROM [Database].[Schema].[Table]
;

SELECT DISTINCT ColumnID
      , Column1
      , Column2
FROM [Database].[Schema].[Table]
;
```

Writing SQL queries

```
SELECT *
FROM [Database].[Schema].[Table]
;

SELECT DISTINCT ColumnID
      , Column1
      , Column2
FROM [Database].[Schema].[Table]
;
```

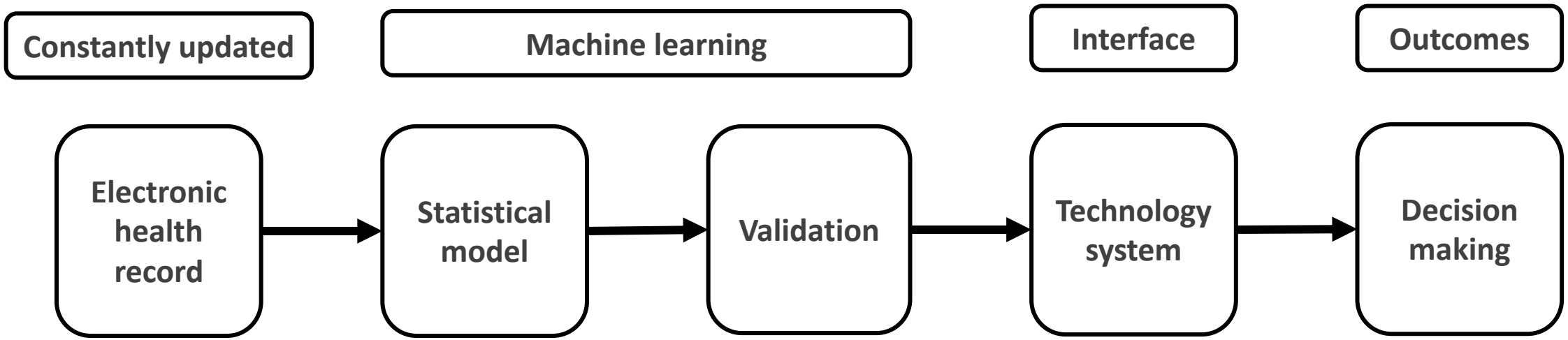
The optimizer reads from the `SELECT` statement to the terminator (`;`)

Checks for gross errors

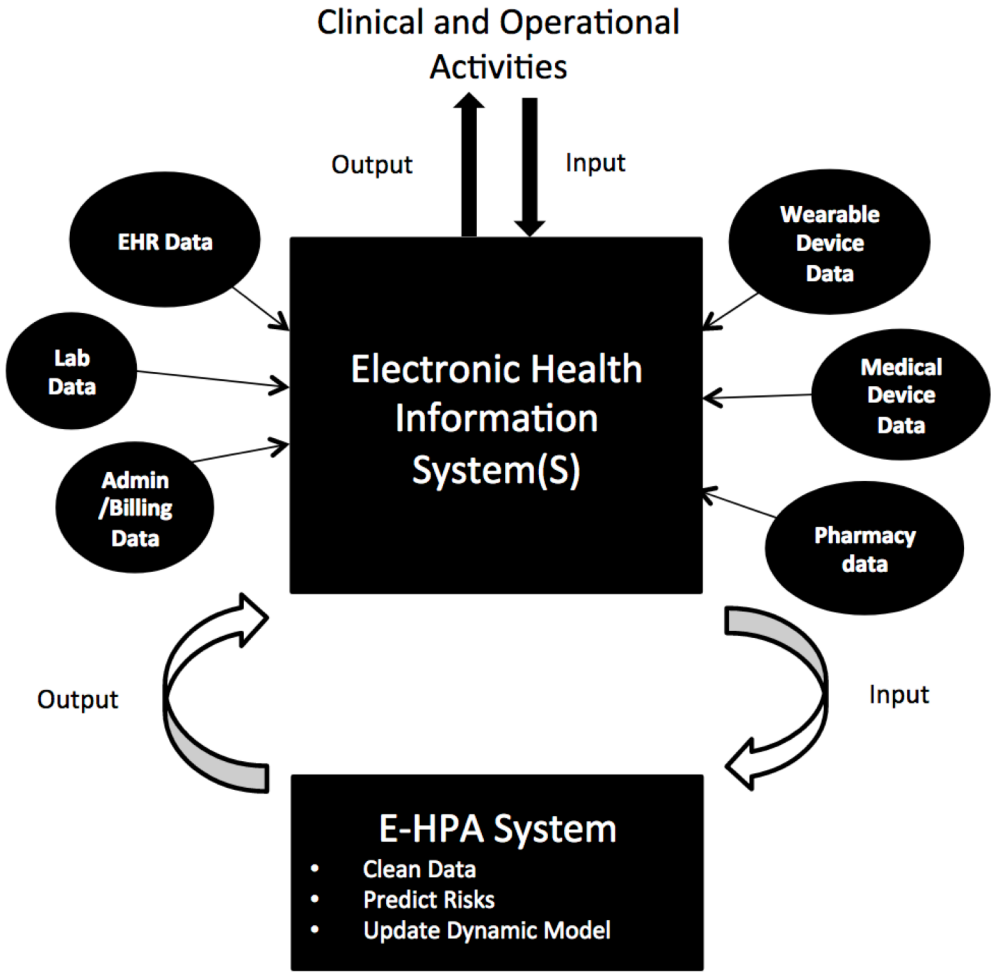
Finding none, it starts on the `FROM` statement and looks for the `[Database].[Schema].[Table]` and binds as `[Database].[Schema].[Table]`

The optimizers looks at `SELECT` and brings back all the columns that are in the comma separated list

Predictive analytics



Electronic Healthcare Predictive analytics (e-HPA) is the use of technologies or software systems that can autonomously employ—and sometimes reengineer, modify, or update—clinical risk prediction models for real-time, point-of-care decision making.
-- Health Affairs (2014)



Challenges:

Implementation
Stakeholder engagement
Local champions
Patient privacy
Interoperability
Training
Support
Funding
Sustainability

Figure 1. Electronic Healthcare Predictive Analytics (e-HPA) could theoretically utilize electronic data from any source, to clean and analyze, run and/or update predictive models , and output risk estimates back into the health information system to trigger or monitor specific clinical and/or operational activity.

Health Affairs (2014)

Predictive analytics: Clinical application

Veterans Affairs ...

Predictive analytics pointing VA to veterans at risk of suicide

By Nicole Ogrysko
@nogryskoWFED
April 20, 2018 5:35 pm

4 min read

80 Shares

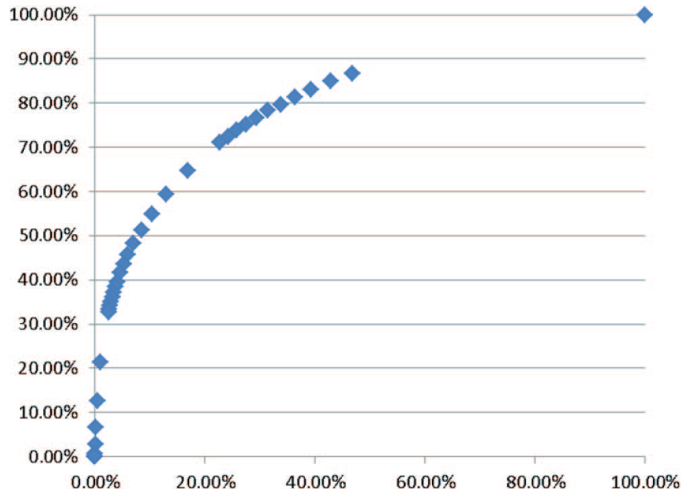
[Link]

Predictive analytics

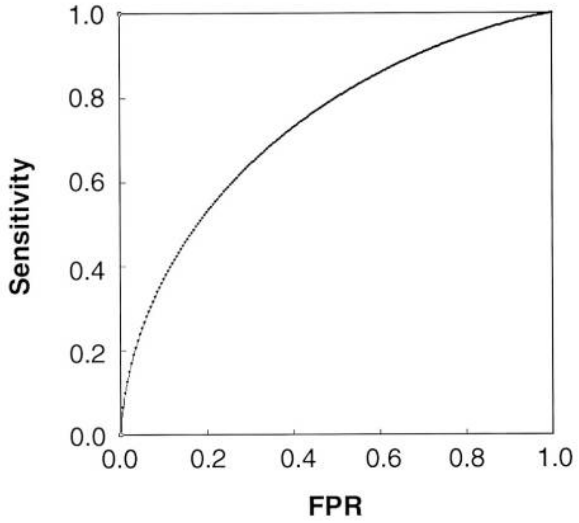
Psychological Services
2017, Vol. 14, No. 1, 34–49

In the public domain
http://dx.doi.org/10.1037/ser0000099

Development and Applications of the Veterans Health Administration's Stratification Tool for Opioid Risk Mitigation (STORM) to Improve Opioid Safety and Prevent Overdose and Suicide



Oliva (2017)



Park (2004)

Receiver operator characteristics (ROC) curve

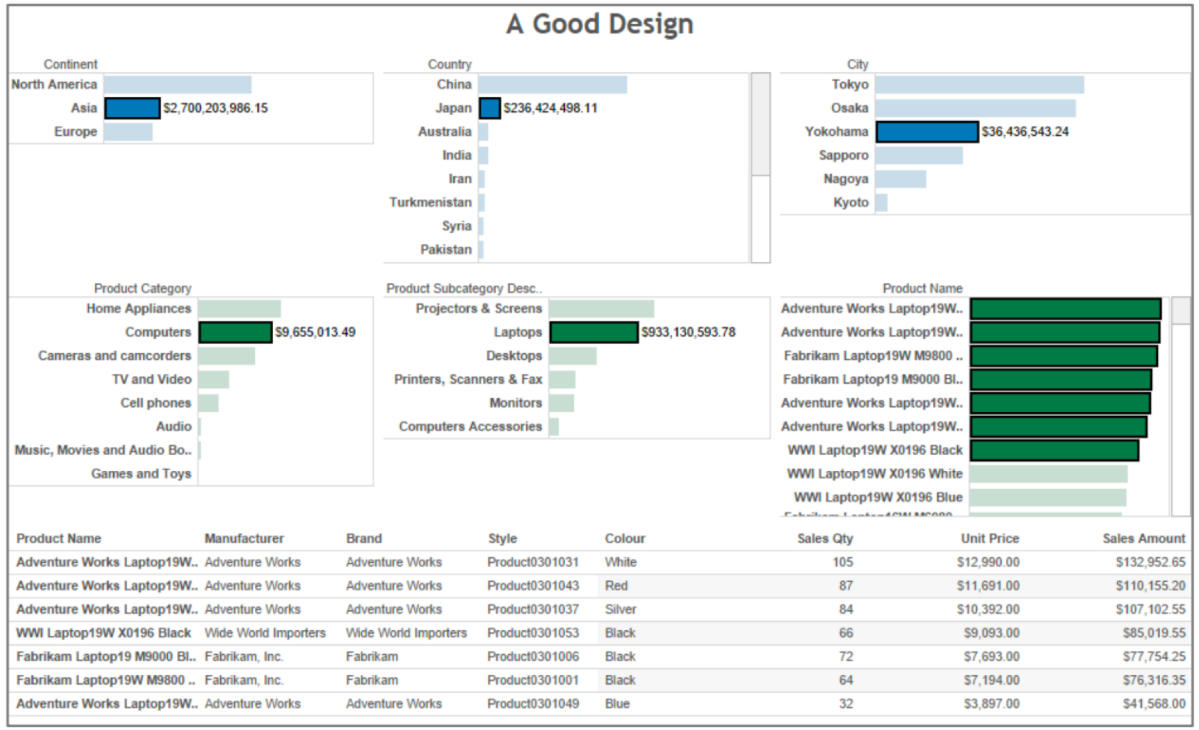
Dashboard Development using

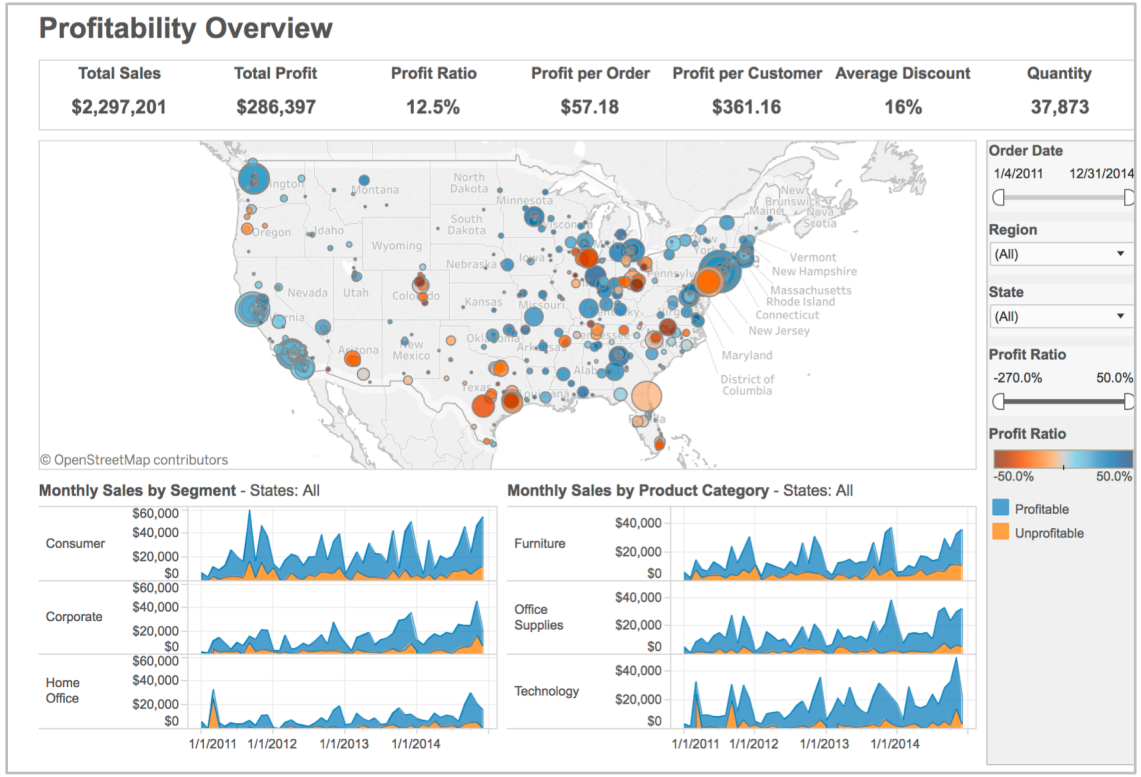
+ a b | e a u®

15 October 2018

Tableau

Business intelligence software to visualize data





NOT a statistical package

Dashboards

A **dashboard** is a platform that integrates multiple datasets, data structures, and sources into a single interface that is easily visualized and understood [1, 2]

Dashboards provide **real-time surveillance** of the health system's progress giving key personnel the ability to take corrective action

Dashboards emerged as a **visualization tool** that integrate balanced scorecards with electronic health data

Decision-makers would use these dashboard visualizations to access and analyze **key performance indicators (KPIs)**, which were intuitive and meaningful

Since their initial development, dashboards have found application as a **clinical decision support tool**

In-class exercise – Building a dashboard

Part 1: We want to perform a custom SQL query to answer the following questions from a hypothetical database:

- How many units were sold by item type?
- How many units were sold across time by item type?
- What was the average cost by item type?
- How much did each company purchase?

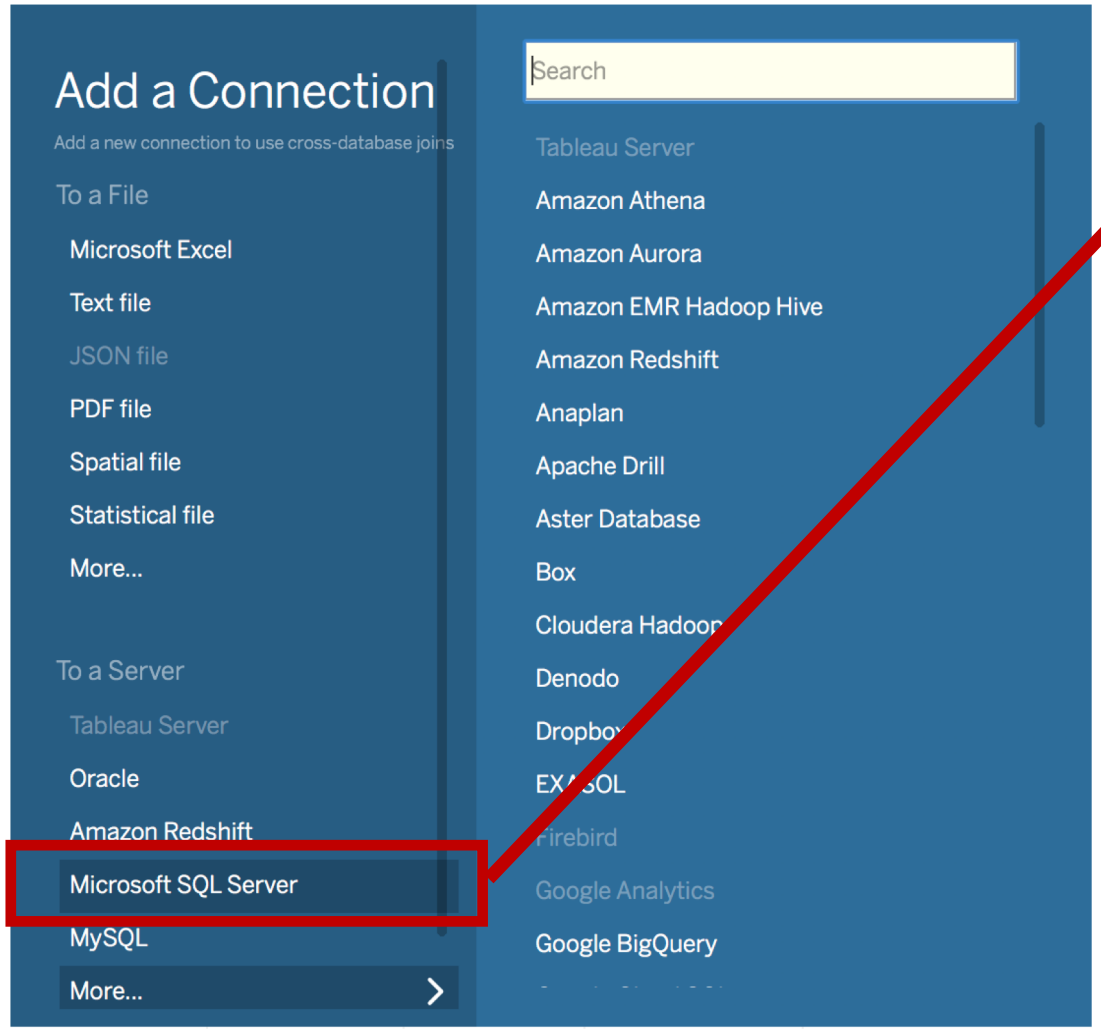
Part 2: Build a dashboard to visualize these answers

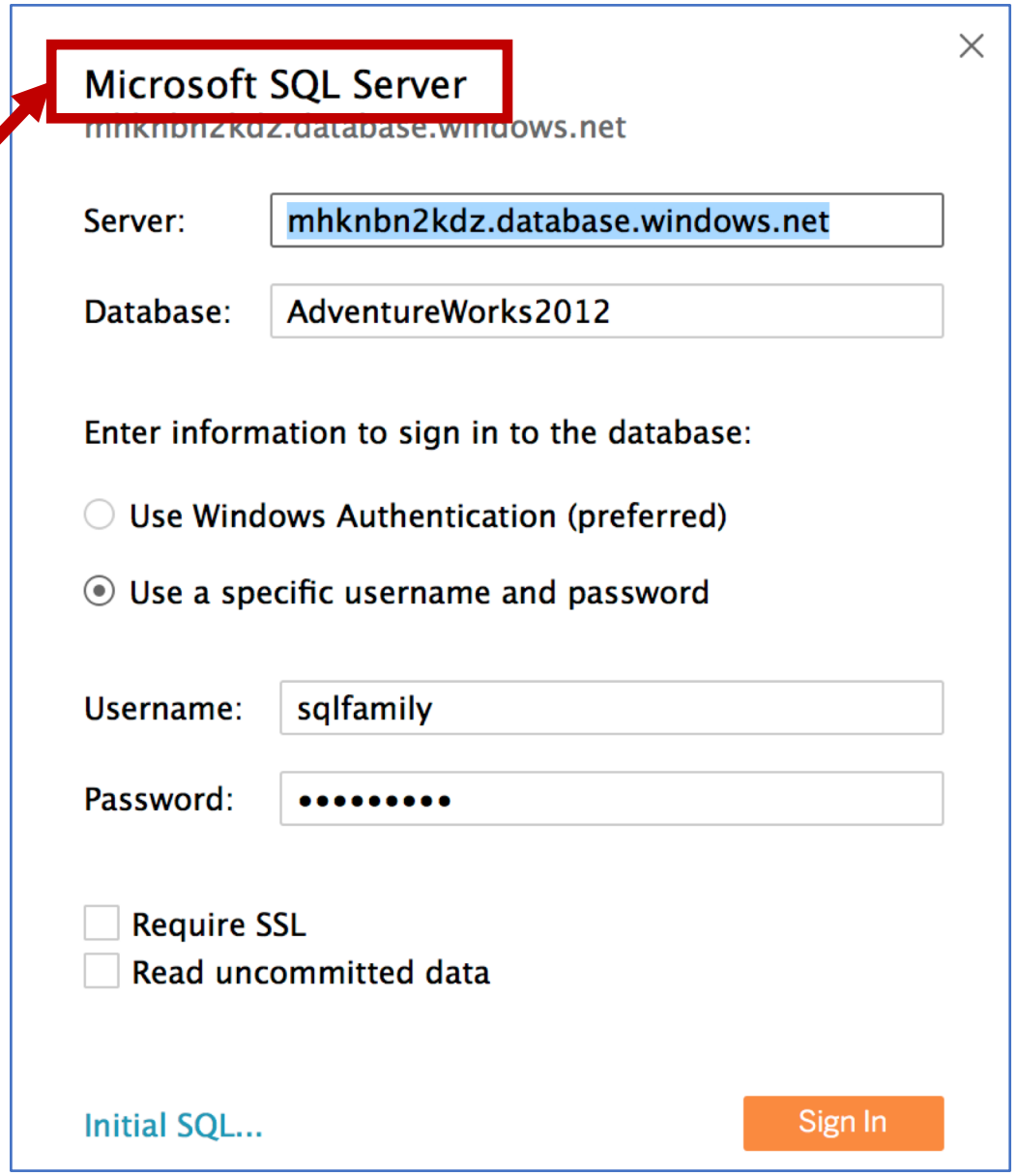
Connect to a SQL server database

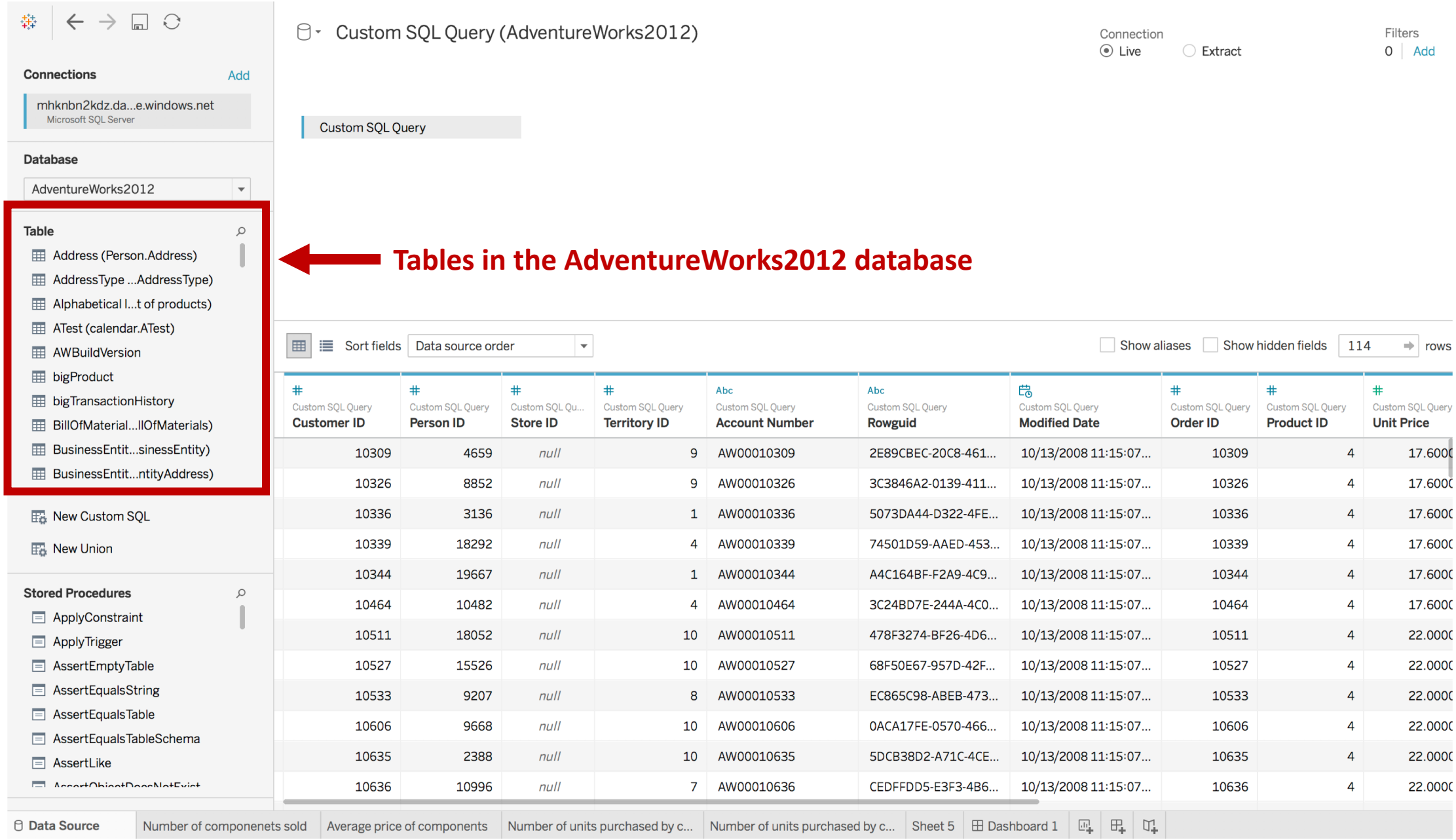
http://www.sqlservercentral.com/articles/Adventureworks/99281/

AdventureWorks2012 on Azure - Hosted by Red Gate Software
and provided to the community for practice

Server:	`mhknbn2kdz.database.windows.net`
Database:	`AdventureWorks2012`
User:	`sqlfamily`
Password:	`sqlf@m1ly`


Add a Connection
Add a new connection to use cross-database joins
To a File
Microsoft Excel
Text file
JSON file
PDF file
Spatial file
Statistical file
More...
To a Server
Tableau Server
Oracle
Amazon Redshift
Microsoft SQL Server
MySQL
More...
Search
Tableau Server
Amazon Athena
Amazon Aurora
Amazon EMR Hadoop Hive
Amazon Redshift
Anaplan
Apache Drill
Aster Database
Box
Cloudera Hadoop
Denodo
Dropbox
EXASOL
Firebird
Google Analytics
Google BigQuery


Microsoft SQL Server
mhknbn2kdz.database.windows.net
Server:
mhknbn2kdz.database.windows.net
Database:
AdventureWorks2012
Enter information to sign in to the database:
Use Windows Authentication (preferred)
Use a specific username and password
Username:
sqlfamily
Password:
Require SSL
Read uncommitted data
Initial SQL...
Sign In


Custom SQL Query (AdventureWorks2012)
Connection
Live
Extract
Filters
0 | Add
Connections
Add
mhknbn2kdz.da...e.windows.net
Microsoft SQL Server
Database
AdventureWorks2012
Custom SQL Query
Table
Address (Person.Address)
AddressType ...AddressType)
Alphabetical l...t of products)
ATest (calendar.ATest)
AWBuildVersion
bigProduct
bigTransactionHistory
BillOfMaterial...llOfMaterials)
BusinessEntit...sinessEntity)
BusinessEntit...ntityAddress)
Tables in the AdventureWorks2012 database
New Custom SQL
New Union
Stored Procedures
ApplyConstraint
ApplyTrigger
AssertEmptyTable
AssertEqualsString
AssertEqualsTable
AssertEqualsTableSchema
AssertLike
Sort fields
Data source order
Show aliases
Show hidden fields
114
rows
Custom SQL Query
Customer ID
Person ID
Store ID
Territory ID
Account Number
Rowguid
Modified Date
Order ID
Product ID
Unit Price
10309 4659 null 9 AW00010309 2E89CBEC-20C8-461... 10/13/2008 11:15:07... 10309 4 17.6000
10326 8852 null 9 AW00010326 3C3846A2-0139-411... 10/13/2008 11:15:07... 10326 4 17.6000
10336 3136 null 1 AW00010336 5073DA44-D322-4FE... 10/13/2008 11:15:07... 10336 4 17.6000
10339 18292 null 4 AW00010339 74501D59-AAED-453... 10/13/2008 11:15:07... 10339 4 17.6000
10344 19667 null 1 AW00010344 A4C164BF-F2A9-4C9... 10/13/2008 11:15:07... 10344 4 17.6000
10464 10482 null 4 AW00010464 3C24BD7E-244A-4C0... 10/13/2008 11:15:07... 10464 4 17.6000
10511 18052 null 10 AW00010511 478F3274-BF26-4D6... 10/13/2008 11:15:07... 10511 4 22.0000
10527 15526 null 10 AW00010527 68F50E67-957D-42F... 10/13/2008 11:15:07... 10527 4 22.0000
10533 9207 null 8 AW00010533 EC865C98-ABEB-473... 10/13/2008 11:15:07... 10533 4 22.0000
10606 9668 null 10 AW00010606 0ACA17FE-0570-466... 10/13/2008 11:15:07... 10606 4 22.0000
10635 2388 null 10 AW00010635 5DCB38D2-A71C-4CE... 10/13/2008 11:15:07... 10635 4 22.0000
10636 10996 null 7 AW00010636 CEDFFDD5-E3F3-4B6... 10/13/2008 11:15:07... 10636 4 22.0000
Data Source
Number of componenets sold
Average price of components
Number of units purchased by c...
Number of units purchased by c...
Sheet 5
Dashboard 1

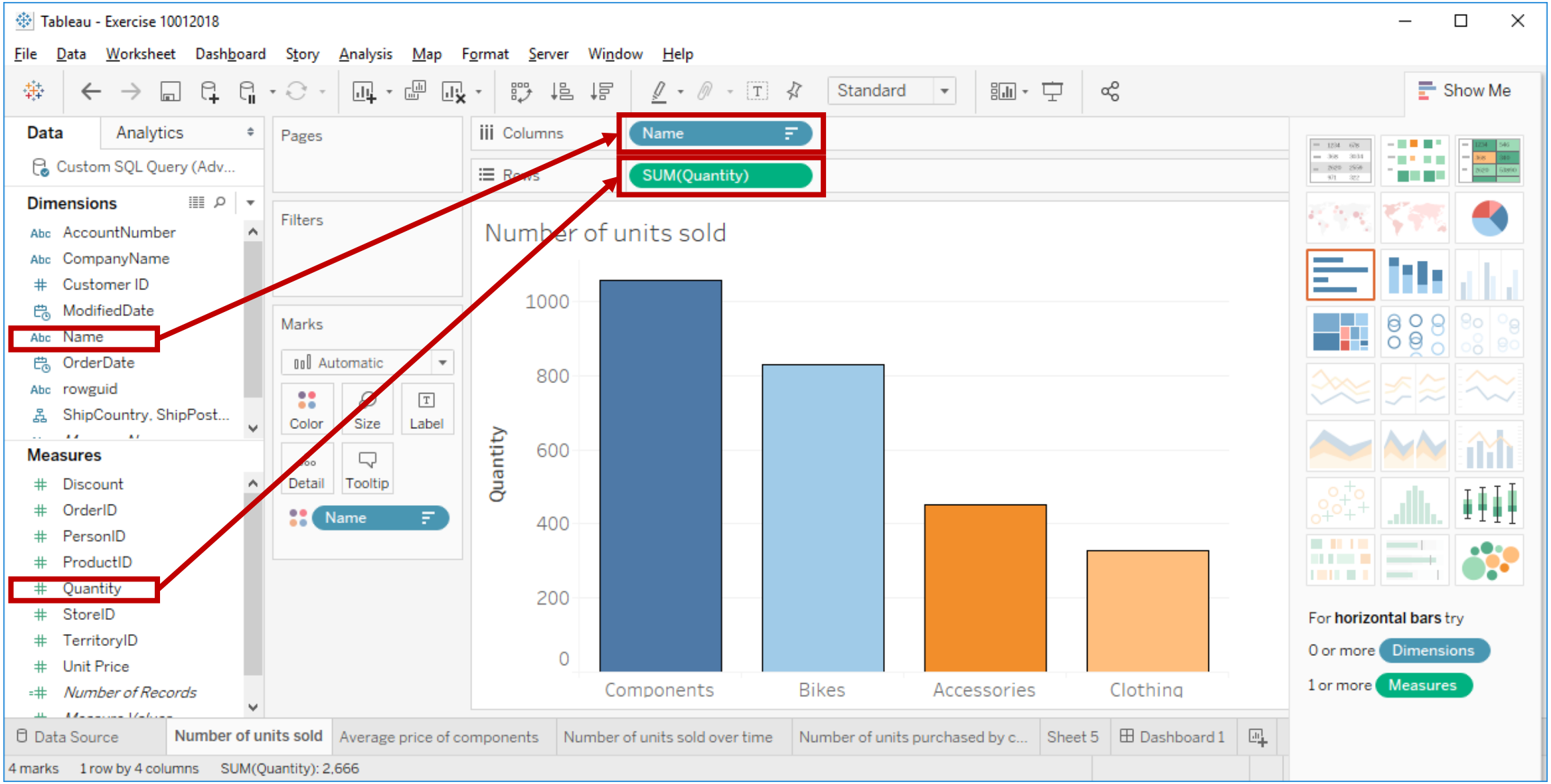


Tableau - Exercise 10012018
File Data Worksheet Dashboard Story Analysis Map Format Server Window Help
Standard
Show Me
Data
Analytics
Custom SQL Query (Adv...
Dimensions
Abc AccountNumber
Abc CompanyName
Customer ID
ModifiedDate
Abc Name
OrderDate
Abc rowguid
ShipCountry, ShipPost...
Measures
Discount
OrderID
PersonID
ProductID
Quantity
StoreID
TerritoryID
Unit Price
Number of Records
Pages
Filters
Marks
Automatic
Color
Size
Label
Detail
Tooltip
Name
Columns
Name
Rows
SUM(Quantity)
Number of units sold
Quantity
1000
800
600
400
200
0
Components
Bikes
Accessories
Clothing
For horizontal bars try
0 or more Dimensions
1 or more Measures
Data Source
Number of units sold
Average price of components
Number of units sold over time
Number of units purchased by c...
Sheet 5
Dashboard 1
4 marks
1 row by 4 columns
SUM(Quantity): 2,666

File Data Worksheet Dashboard Story Map Format Server Window Help

Dashboard Layout

Device Preview

Size

Generic Desktop (1366 x 76...

Sheets

- Number of units sold
- Average price of co...
- Number of units sol...
- Number of units pur...
- Country-1998
- Country-1997
- Country-1996
- Country-total

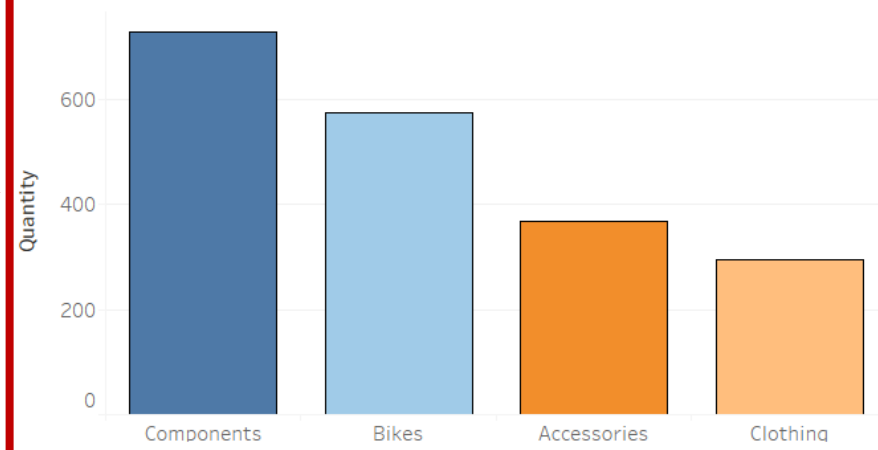
Objects

Horizontal Web Page
Vertical Blank
Text Extension
Image

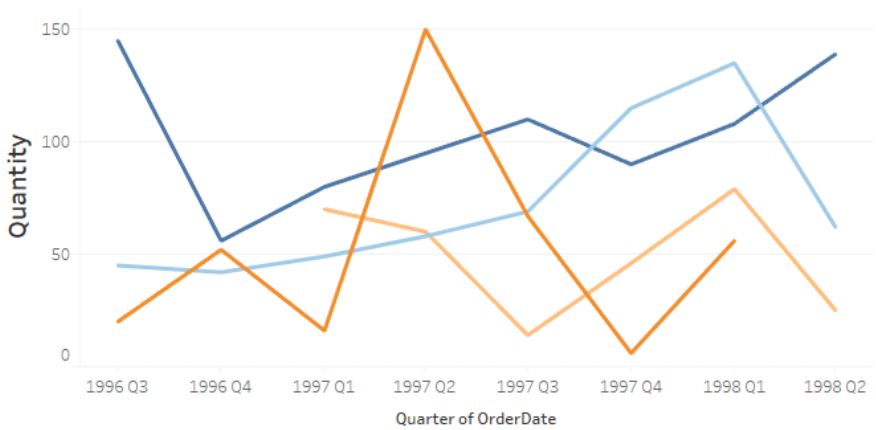
Tiled Floating

Show dashboard title

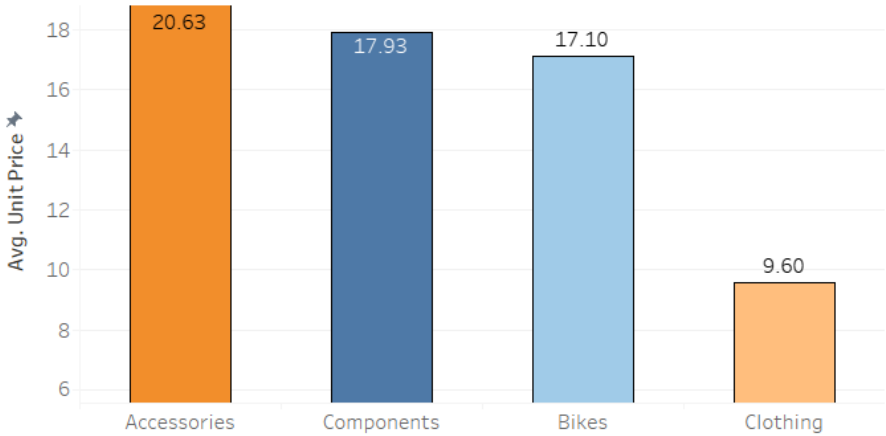
Number of units sold



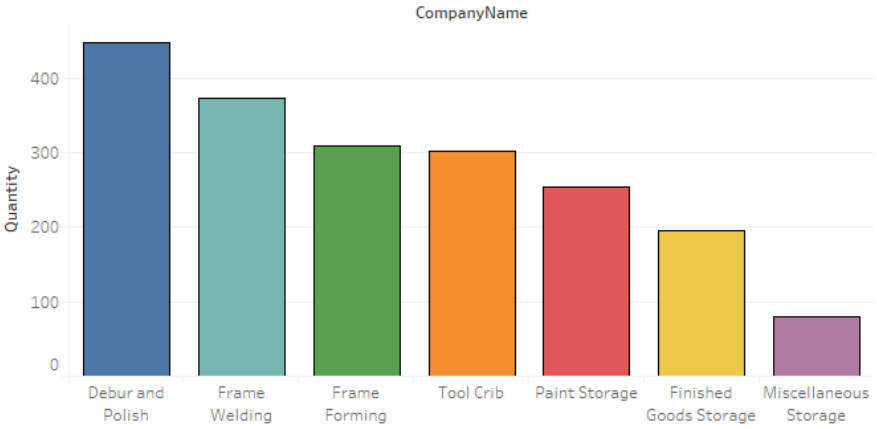
Number of units sold over time



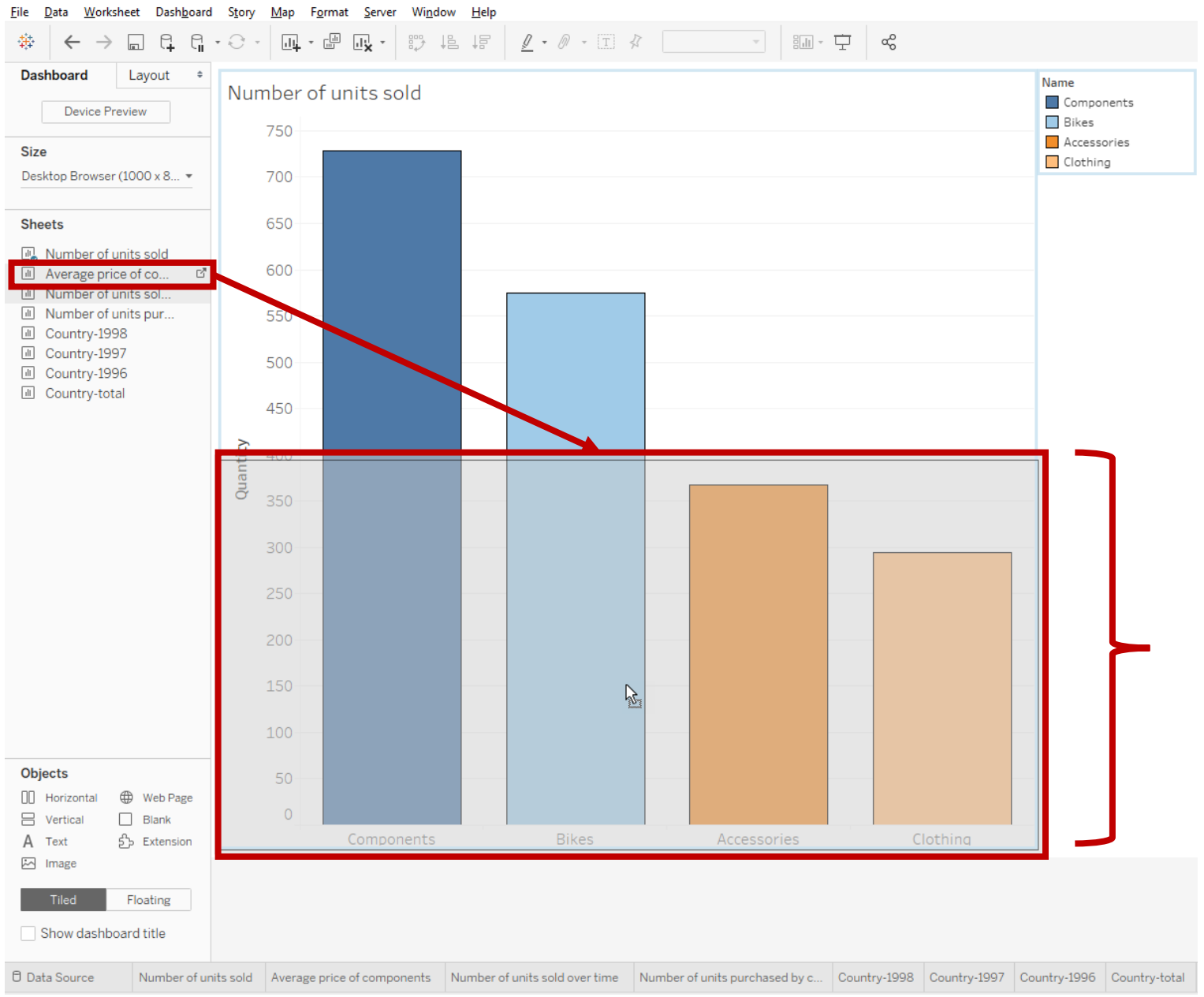
Average price of components



Number of units purchased by company

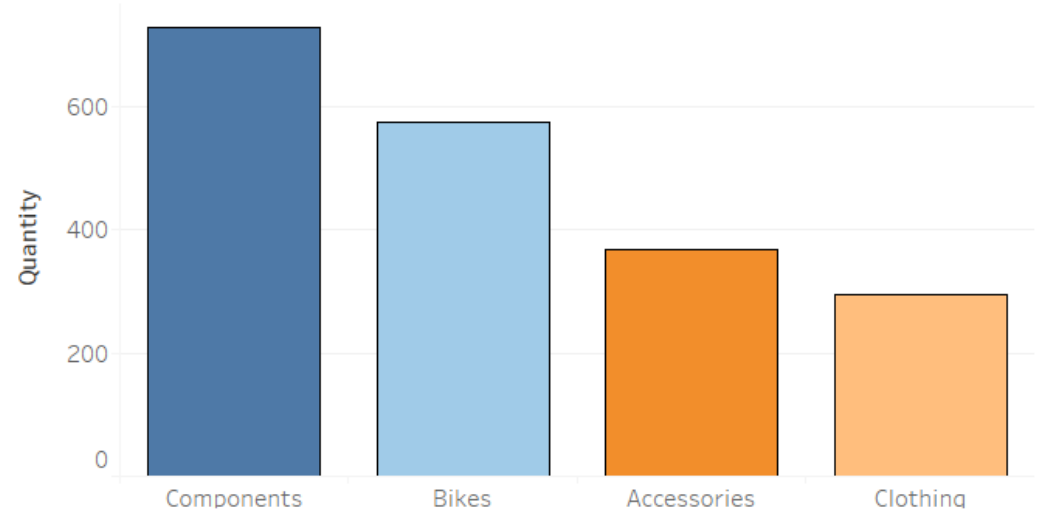


Data Source | Number of units sold | Average price of components | Number of units sold over time | Number of units purchased by c... | Country-1998 | Country-1997 | Country-1996 | Country-total | Dashboard 1 | Dashboard 2

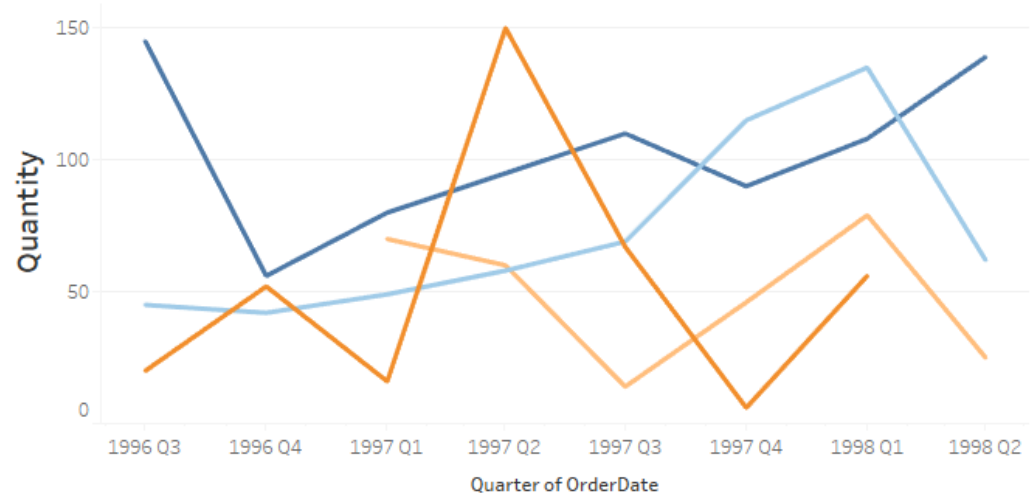


You can place the Sheet in any area in the Dashboard workspace. Notice the shaded area, which indicates the position the Sheet will occupy. The rest of the other Sheets will auto-resize once the new Sheet is in place.

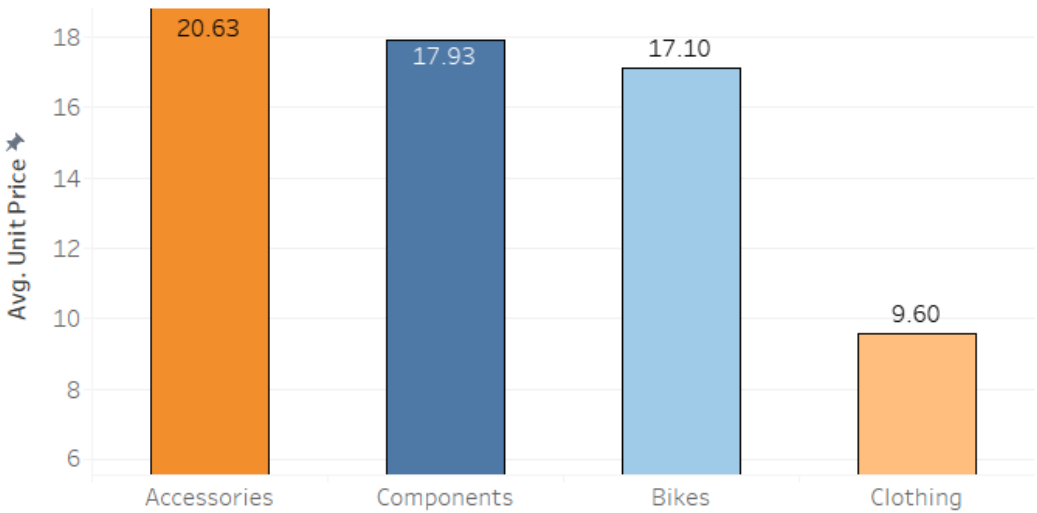
Number of units sold



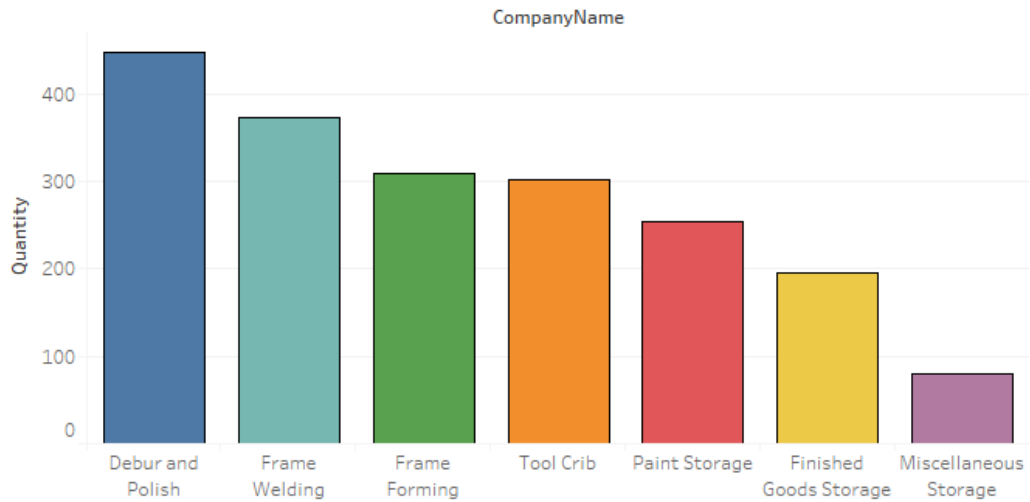
Number of units sold over time



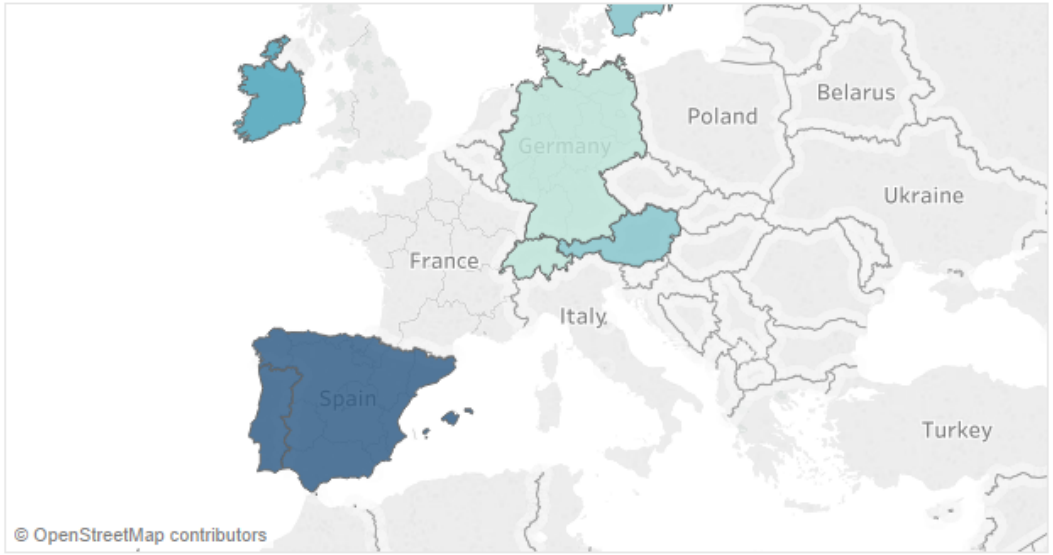
Average price of components



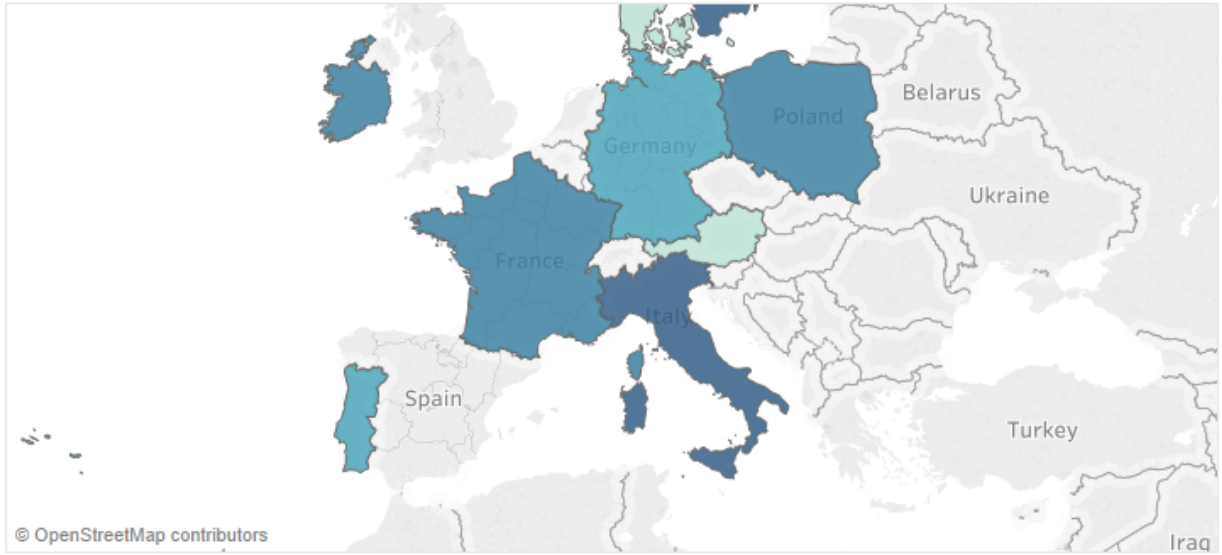
Number of units purchased by company



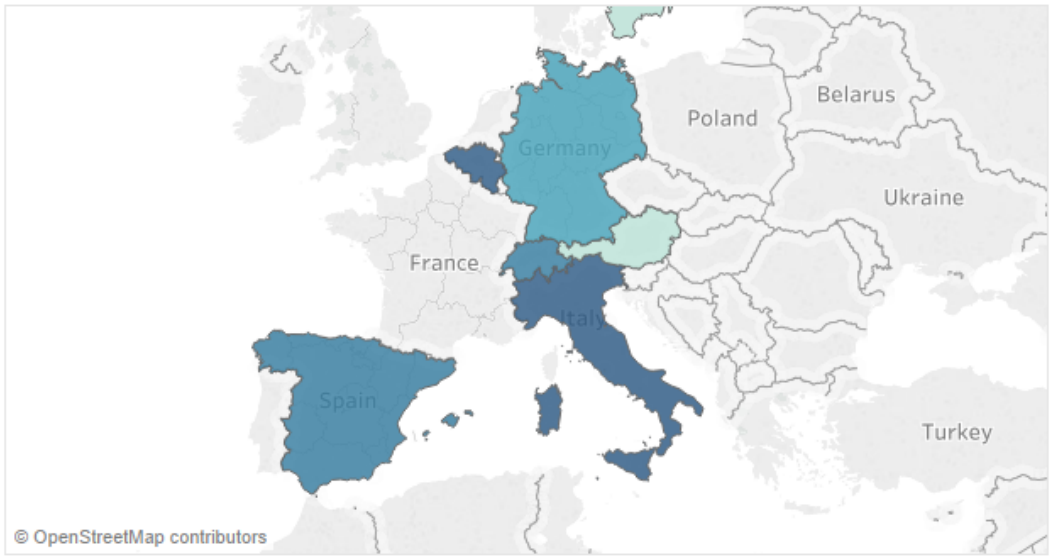
1996



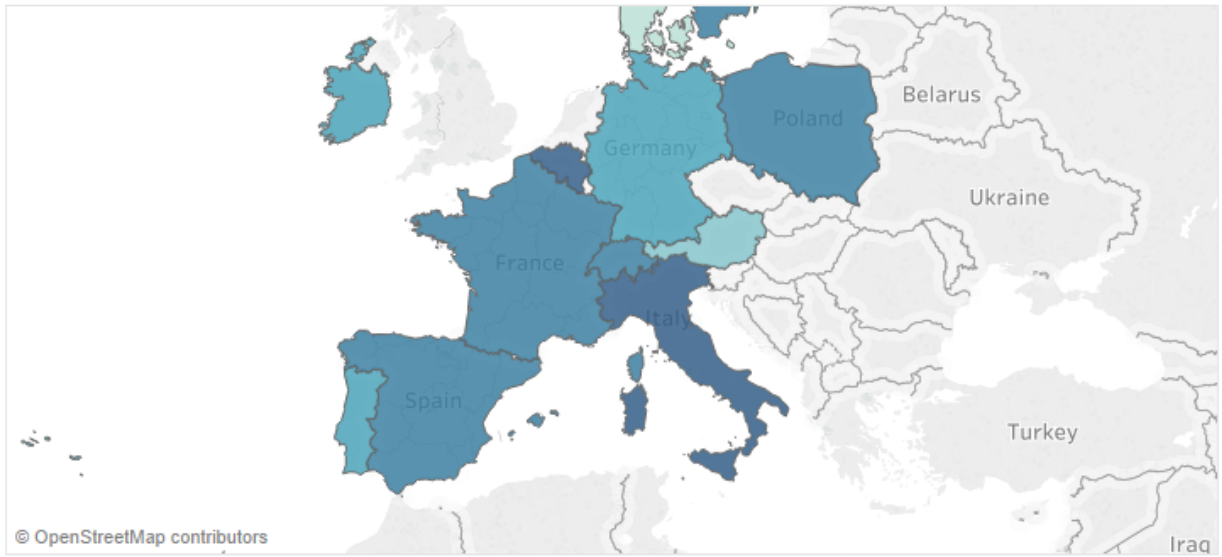
1997



1998



1996-1998



References

Overview of VA Data, Information Systems, National Databases and Research Uses

SQL Tutorials

VA Informatics 411

SQL coding practice style guide