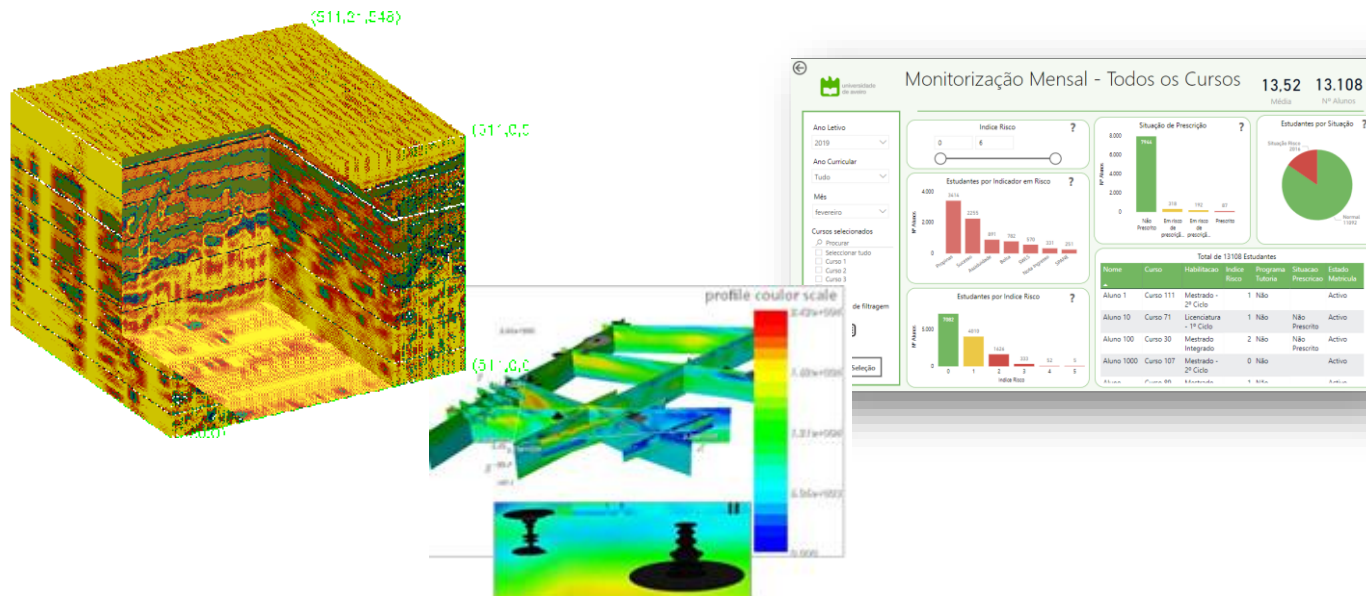




Data Visualization module 2022

Introduction

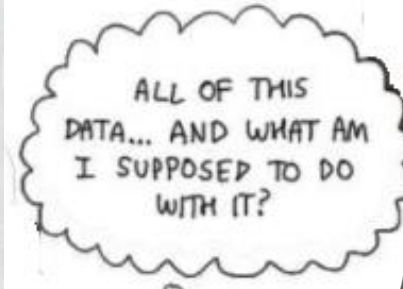


40	100	0.50	0	0.0	0	7.4193	0.0009	0.009	0	1.200	0.015	1.160	2.07
67	201	0.77	0	0.0	0	8.7669	0.0018	0.022	0	1.166	0.018	1.130	1.78
88	201	3.12	0	0.0	0	11.8279	0.0062	0.072	0	0.421	0.015	0.490	0.85
52	183	-0.15	0	0.0	0	8.2405	0.0011	0.015	0	0.425	0.007	0.490	2.60
02	115	0.28	3	0.0	0	11.0625	0.0035	0.035	0	1.567	0.197	1.490	0.56
25	151	1.82	0	0.0	0	6.6890	0.0006	0.007	0	0.955	0.005	0.940	4.38
48	108	-0.51	0	0.0	0	8.6208	0.0015	0.011	0	0.516	0.015	0.590	1.65
50	105	2.69	0	0.0	0	7.6923	0.0012	0.010	0	1.438	0.017	1.430	1.65
81	203	-0.58	0	0.0	0	8.8563	0.0017	0.024	0	0.962	0.014	0.950	1.68
38	106	1.01	0	0.0	0	7.6626	0.0015	0.011	0	0.456	0.015	0.530	1.92
48	144	0.70	0	0.0	0	9.1657	0.0015	0.017	0	0.520	0.015	0.600	1.30
54	198	7.07	0	0.0	0	6.4211	0.0006	0.008	0	0.763	0.003	0.800	2.87
63	135	-0.37	0	0.0	0	9.2438	0.0018	0.020	0	0.535	0.020	0.610	1.46
86	188	-1.27	0	0.0	0	9.4598	0.0026	0.026	0	0.671	0.017	0.730	1.35
65	184	-0.61	0	0.0	0	8.9385	0.0013	0.016	0	0.468	0.013	0.540	1.66
98	180	-0.35	0	0.0	0	9.3109	0.0019	0.024	0	1.041	0.020	1.010	1.44
40	157	-1.40	0	0.0	0	8.3069	0.0011	0.012	0	0.142	0.010	0.160	2.43
60	87	2.24	0	0.0	0	7.7648	0.0020	0.014	0	1.453	0.018	1.460	1.66
72	165	-0.74	0	0.0	0	9.1842	0.0022	0.024	0	0.840	0.017	0.860	1.33
12	158	0.32	0	0.0	0	8.2076	0.0011	0.010	0	0.466	0.015	0.540	2.00
30	111	6.90	0	0.0	0	6.5466	0.0009	0.007	0	0.514	0.005	0.590	3.55
56	130	2.04	0	0.0	0	9.2353	0.0016	0.020	0	0.916	0.004	0.960	1.20
38	104	-0.25	0	0.0	0	7.8503	0.0015	0.009	0	1.150	0.014	1.110	1.90
93	137	4.22	0	0.0	0	10.5345	0.0037	0.035	0	0.391	0.045	0.460	0.67
55	129	-0.53	0	0.0	0	8.7854	0.0019	0.020	0	0.778	0.015	0.810	1.81
38	114	0.97	0	0.0	0	7.5669	0.0010	0.010	0	0.475	0.009	0.550	2.10
09	134	5.96	1	0.0	0	10.3360	0.0055	0.082	2	0.570	0.042	0.640	0.58
64	177	-0.96	0	0.0	0	8.7201	0.0018	0.021	0	0.026	0.013	0.040	1.75
43	186	0.87	0	0.0	0	8.2910	0.0011	0.010	0	0.387	0.012	0.450	1.68
28	157	1.36	0	0.0	0	6.3456	0.0006	0.007	0	1.032	0.005	1.000	4.16
41	114	1.71	0	0.0	0	8.8825	0.0012	0.009	0	1.104	0.018	1.070	1.57
87	136	-1.30	1	0.0	0	9.7391	0.0025	0.028	0	0.800	0.000	0.800	1.07
50	170	1.94	0	0.0	0	8.7350	0.0013	0.017	0	1.035	0.016	1.010	1.39
69	164	1.13	0	0.0	0	10.8416	0.0044	0.044	0	1.150	0.020	1.250	0.80
44	170	1.65	0	0.0	0	7.4752	0.0008	0.009	0	1.164	0.008	1.130	2.70
68	129	0.76	0	0.0	0	9.6309	0.0020	0.018	0	0.450	0.030	0.520	1.22
34	257	2.90	0	0.0	0	6.6231	0.0006	0.010	0	0.616	0.005	0.680	4.70
65	89	1.42	0	0.0	0	9.1849	0.0022	0.014	0	0.906	0.024	0.910	1.11

The problem...



Data visualization?



Machine learning?

Statistics?



What is Data Visualization?

- Visualization is focused on how to **visually represent and explore large amounts of data**
- Taking advantage of the **human visual system capacities**
- Providing “**insights**” concerning the phenomenon behind the data

What it **is not**:

- just “pretty pictures”!

Why and how to represent data visually?

- The human visual system is a most powerful pattern seeker

“seeing is understanding...”

- We easily see patterns displayed in certain ways

but not in others ...



(Ware 2019)

An exercise in preattentive processing: how many “3”?

69704259347493
58728294954642
44396854634235
6658789376

(Nussbaumer Knaflitz, 2015)

69704259**3**47493
58728294954642
44**3**968546**3**4235
6658789**3**76

C. Nussbaumer Knaflic, Storytelling with Data ,Talks at Google, 2015
<https://www.youtube.com/watch?v=8EMW7io4rSI>

Why represent data visually?

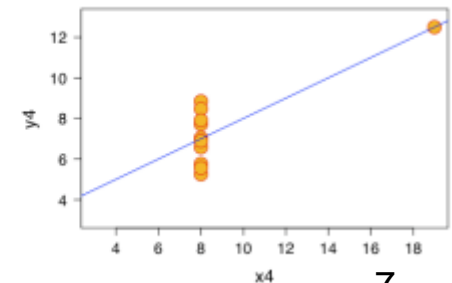
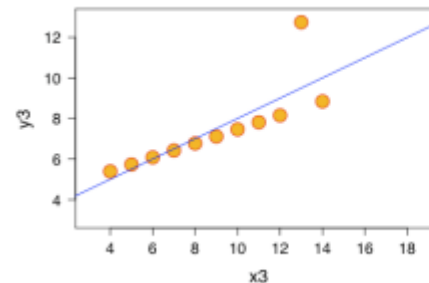
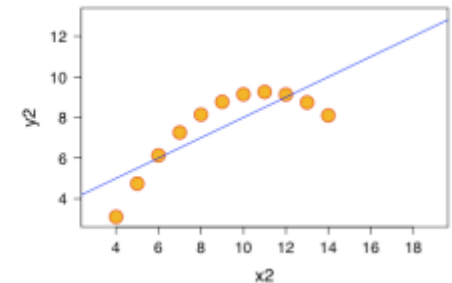
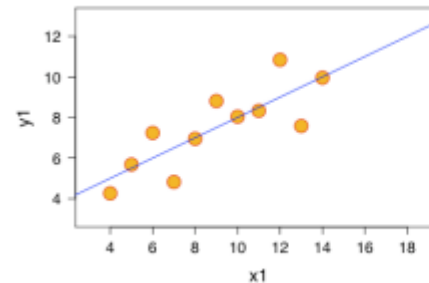
Vis helps in situations where seeing the dataset structure in detail is better than seeing only a brief summary of it.

(Munzner, 2014)

Anscombe's Quartet: Raw Data								
I		II		III		IV		
x	y	x	y	x	y	x	y	
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58	
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76	
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71	
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84	
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47	
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04	
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25	
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50	
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56	
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91	
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89	
mean	9.0	7.5	9.0	7.5	9.0	7.5	9.0	7.5
var.	10.0	3.75	10.0	3.75	10.0	3.75	10.0	3.75
corr.	0.816		0.816		0.816		0.816	

Ascombe quartet: data sets with the same simple statistical properties

(Tuft, 1983)



This module:

- Objective, bibliography and tools
- Introduction to Data Visualization
- Data and phenomena: types and pre-processing
- Human-in-the-loop process: perceptual and cognitive aspects
- Visualization of quantitative data:
 - 1D and 2D Data – main methods; exercises
 - 3D and nD data - main methods; exercises
- Visualization of other types of data
 - networks, hierarchical data, etc.
- Effective Visualization

Visualization Tools

- There are a lot, of different types and with different purposes

(see e.g. <http://selection.datavisualization.ch/>)

+ DATAVISUALIZATION.CH

SELECTED TOOLS

Search...

All


Maps

Charts

Data


Color

Code? ✓




Arbor.js

A library of force-directed layout algorithms plus abstractions for graph organization and refresh handling.




CartoDB

A web service for mapping, analyzing and building applications with data.




Chroma.js

Interactive color space explorer that allows to preview a set of linear interpolated equidistant colors.



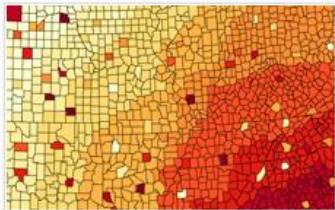
Circos

A software package for visualizing data in a circular layout.



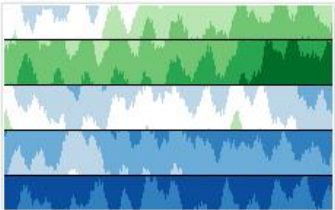
Cola.js

A library for arranging networks using constraint-based optimization techniques.



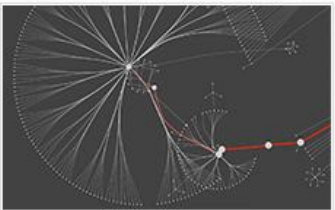
ColorBrewer

A web tool for selecting colors for maps.



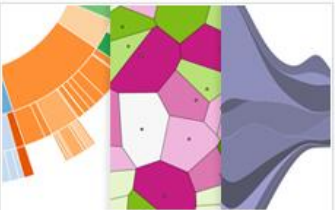
Cubism.js

A library for creating interactive time series and horizon graphs based on D3.js



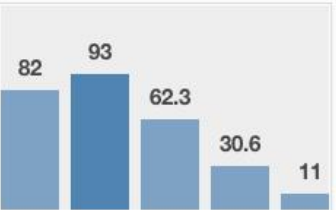
Cytoscape

An application for visualizing complex networks and integrating these with any type of attribute data.



D3.js

An small, flexible and efficient library to create and manipulate interactive documents based on data.



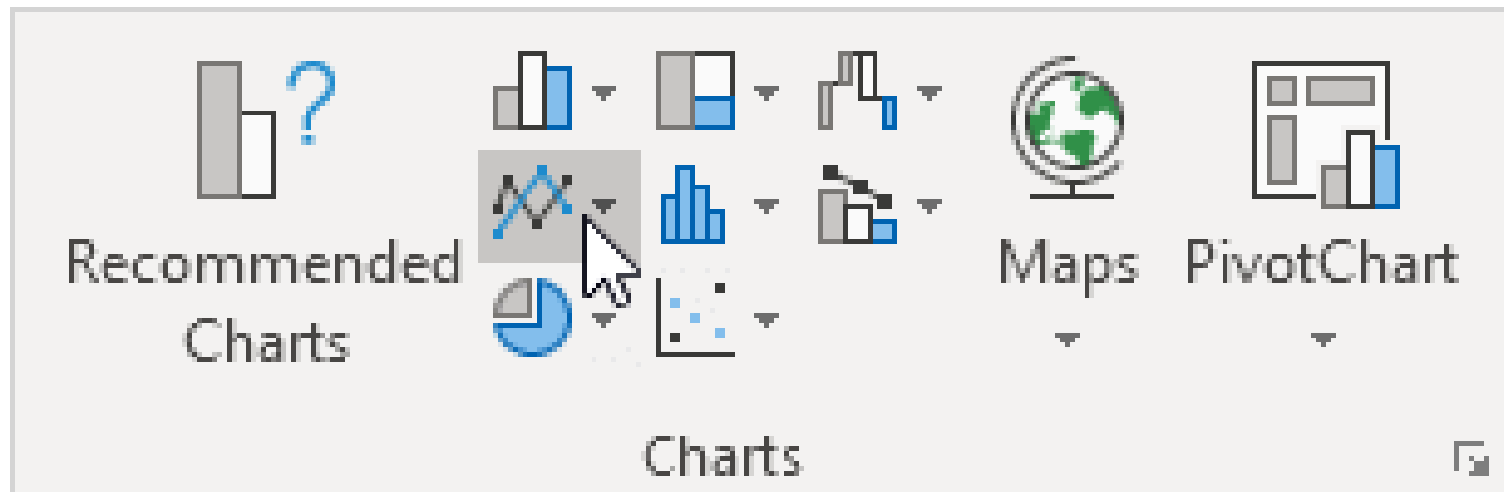
Dance.js

A simple data-driven visualization framework based on Data.js and Underscore.js

We will use

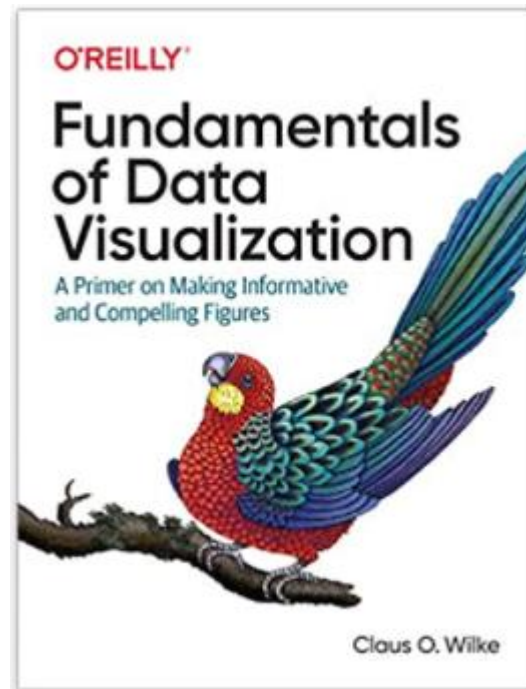
- Excel

(but you may use also other S/W if you master it)



Bibliography

- Camões, J., *Data at Work : Best practices for creating effective charts and information graphics in Microsoft Excel*, Pearson Education, 2016
<https://learning.oreilly.com/library/view/data-at-work/9780134268798/>
- Wilke, C., *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures*, O'Reilly, 2019 <https://clauswilke.com/dataviz/>
<https://learning.oreilly.com/library/view/fundamentals-of-data/9781492031079/>

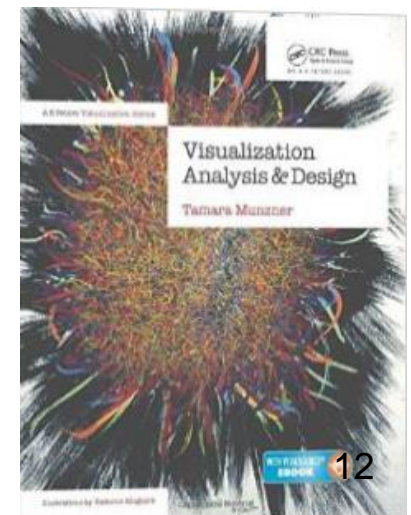
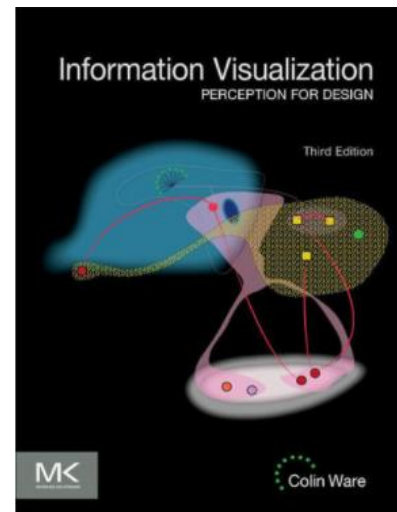
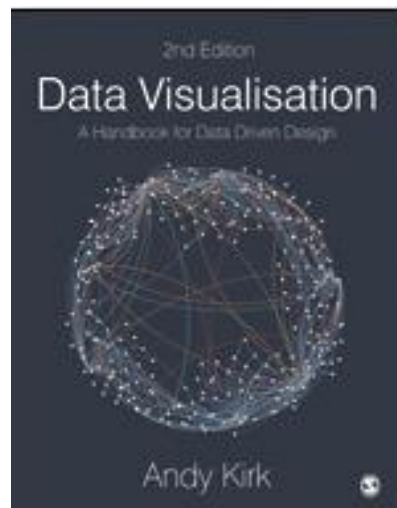
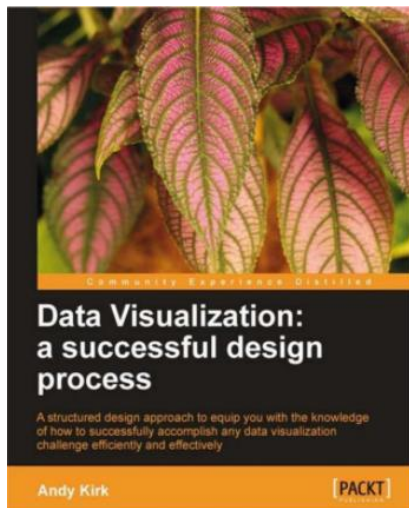


More advanced bibliography

- Kirk, A., *Data Visualisation A Handbook for Data Driven Design*, 2nd. Ed., Sage, 2019
- Ware, C., *Information Visualization, Perception for Design*, 3rd ed., Morgan Kaufman, 2012
- Munzner, T., *Visualization Analysis and Design*, A K Peters/CRC Press, 2014
- Kirk, A., *Data Visualization: A successful design process*, Pack Publishing, 2012
https://books.google.pt/books/about/Data_Visualization.html?id=I4qBVLfD3t4C&printsec=frontcover&source=kp_read_button&redir_esc=y#v=onepage&q&f=false

Explore other books available at the playlist:

<https://learning.oreilly.com/playlists/74bfec5e-4346-48ff-82b4-657fda6922b6>



Interesting links

- <https://excelcharts.com/author/jorge-camoes/>



- <https://eagereyes.org/>



- <http://www.perceptualedge.com/>

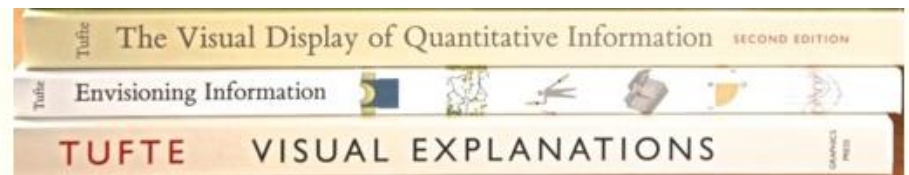


Visual Business Intelligence
for enlightening analysis and communication

- <http://www.thefunctionalart.com/>





- <https://www.edwardtufte.com/tufte>



Moodle

Slides


 [Introduction to the module](#)


 [Introduction to Data Visualization](#)


Practical assignment

 [Practical assignment template](#)

Bibliography

 [Camões, J., Data at Work : Best practices for creating effective charts and information graphics in Microsoft Excel, Pearson Education, 2016](#)

 [Wilke, C., Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, O'Reilly, 2019](#)

 [Kirk, A., Data Visualization: A successful design process, Pack Publishing, 2012](#)

 [More Advanced Bibliography- playlist](#)


Moodle

Slides

 [Introduction to the module](#)

 [Introduction to Data Visualization](#)

 [Data](#)

 [Creating a Visualization](#)

Examples and Pactical assignment

 [Assignment - How Visualization was used in a specific research/development work](#)

 [Template for the assignment - presenting how Visualization was used](#)

 [Using Visualization in the development of Multilayer radiating structures for mm Waves](#)

 [Assignment - Present a Technique](#)

Assessment

During the semester:

Exam – 60%

Practical Assignment - 30%

Attendance and participation – 10%

Alternative at the end of semester:

Exam – 90%

Attendance and participation – 10%

Exam – last session of the module

Practical activities

Bring your own laptop!

Practical assignment (team work)

- Prepare and present an example illustrating the usage of visualization in a specific engineering field
(e.g. chemical, computer, electrical, mechanical, etc.)
or
- Study and present a Visualization technique or concept

- Describe the applicability conditions; how the technique is used, its advantages and disadvantages, and present examples of:

One of the following **techniques**:

- Violin plot
- Stacked bar chart
- Area chart
- Bubble plot
- Tree map
- Sunburst
- Star/radar plot
- Parallel coordinates
- Pareto plot
- Chernoff faces
- Choropleth map
- Graduated map
- Cartogram
- Iso-lines/ iso-contours
- Iso-surfaces
- Small multiple

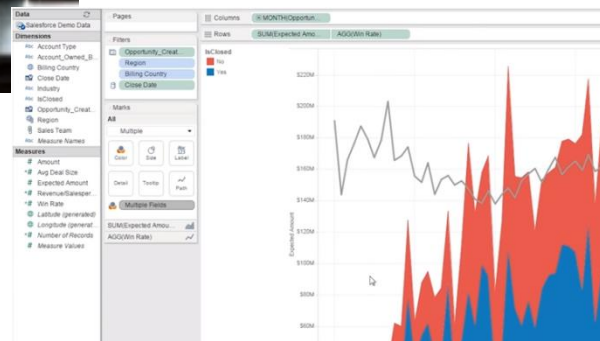
Or one of the following **concepts**:

- Dashboard
- Brushing
- Glyph

Questions regarding the module?



Visualization S/W



Which Visualization Tool?

It depends ...

- Exploratory (discover pattern, multiple views)
or Explanatory (View of the data presenting discovered highlights)?
- Type of data (Maps, Charts, Data,...)
- Developer or non-developer?
- Scientific or information Visualization (2D,3D, structured or not?)
- Interactive or Static?
- Web or local?
- Easy to use or Flexible?
- Protection of data?...

Visualization Tools – Some possible choices

- If you want to produce a few simple charts for a report or paper: Excel, ...
- If you want to produce some charts and have some programming skills: MATLAB, R, python libraries, ...
- If you use some statistics/analytics S/W: Statistica, SPSS, ...
- If you are in a large company: Tableau or Qlickview may be adequate (very powerful and expensive business intelligence S/W)
- If you just want to make a few simple charts for your web page and have programming skills: google charts
- If you want to develop an interactive visualization Web application to visually explore data: D3.js

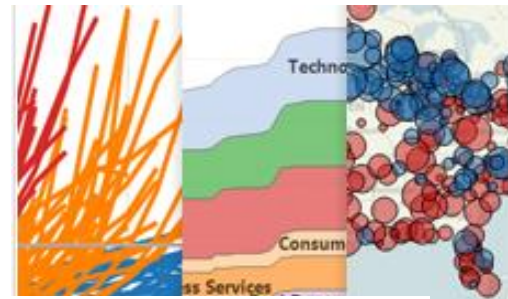
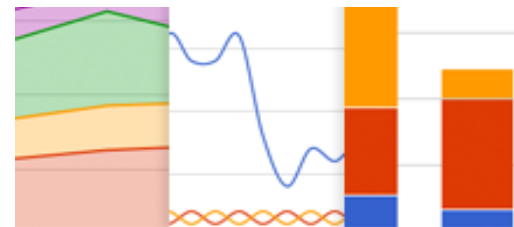


Tableau Public

A desktop application to build and post interactive graphs, dashboards, maps and tables to the web.



Google Chart Tools

A collection of simple to use, customizable and free to use interactive charts and data tools.

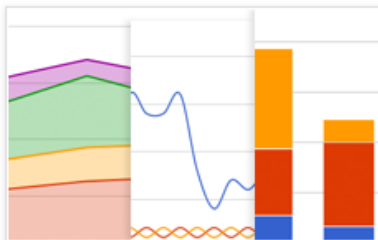


D3.js

An small, flexible and efficient library to create and manipulate interactive documents based on data.

Visualization S/W

- There are a lot of tools, of different types and with different purposes from very simple to very complex ...
- Some interesting and widely used tools:



Google Chart Tools

A collection of simple to use, customizable and free to use interactive charts and data tools.



D3.js

A small, flexible and efficient library to create and manipulate interactive documents based on data.



R

A software environment for statistical computing and graphical techniques.

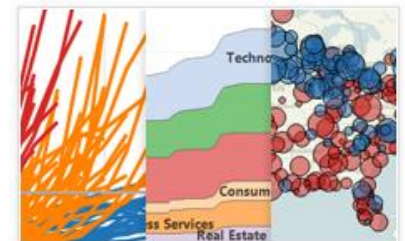


Tableau Public

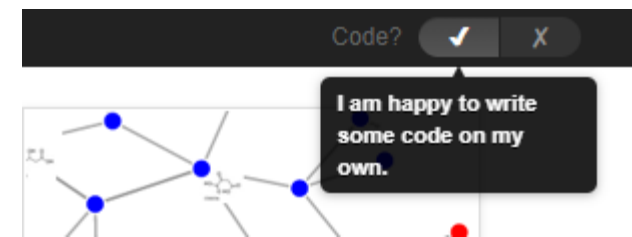
A desktop application to build and post interactive graphs, dashboards, maps and tables to the web.

see e.g.

<https://www.kdnuggets.com/2020/05/top-10-data-visualization-tools-every-data-scientist.html>

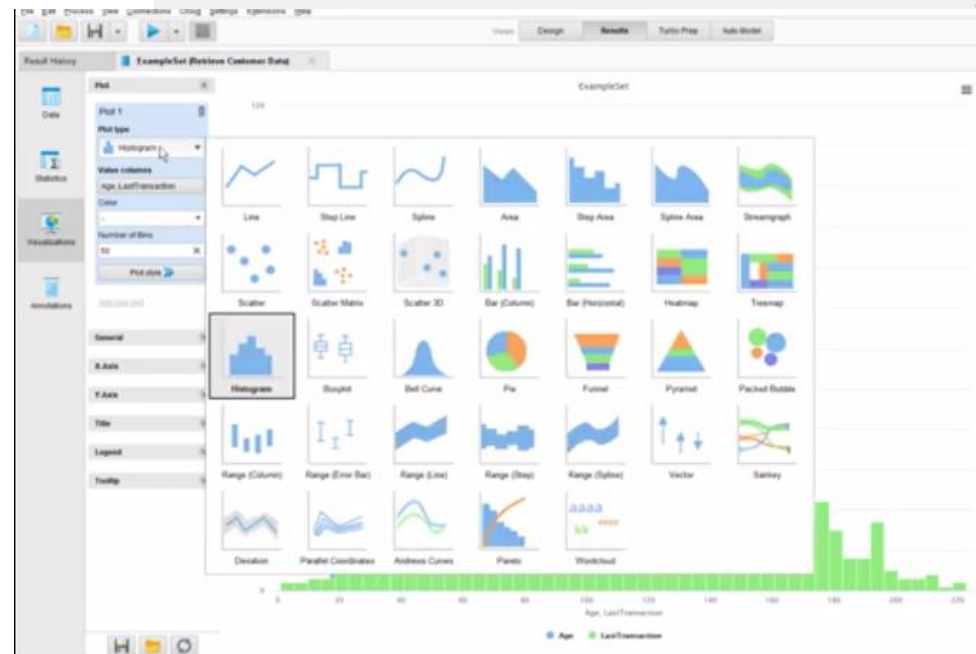
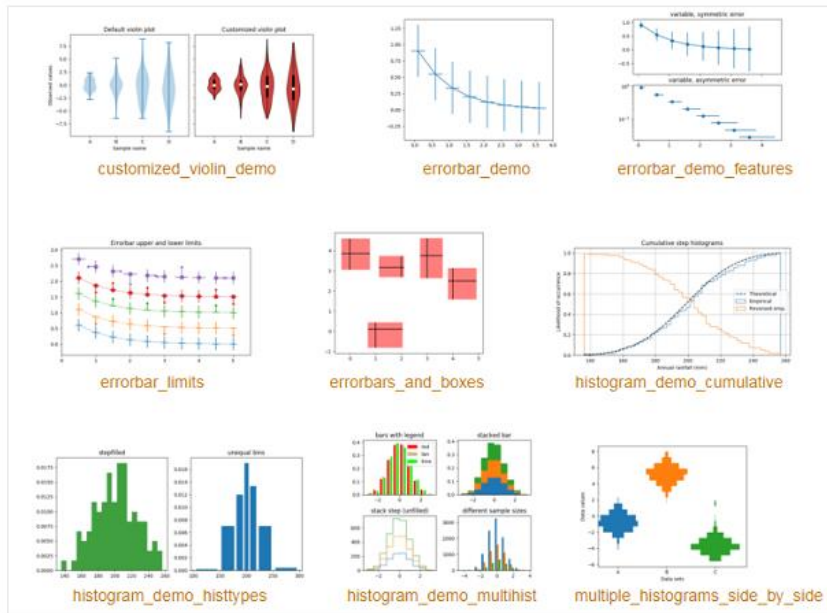
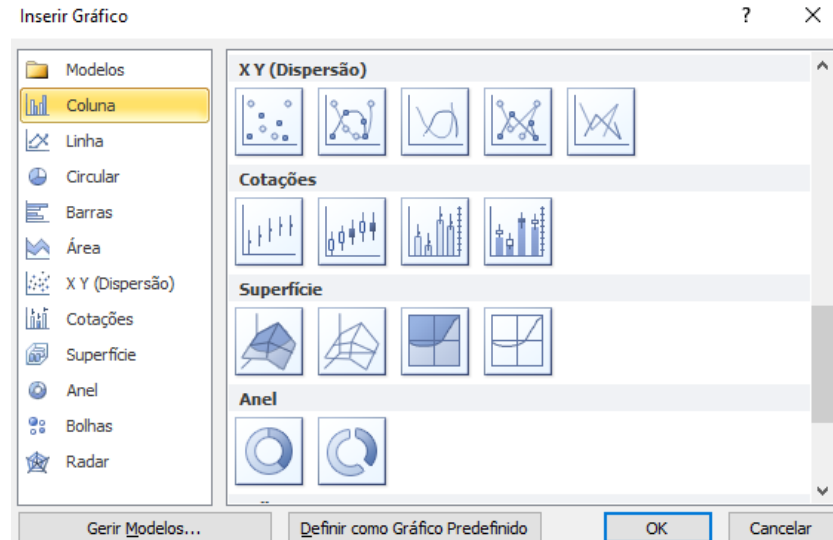
<https://www.kdnuggets.com/2019/04/7-qualities-big-data-visualization-tools.html>

<http://selection.datavisualization.ch/>



We may use the Visualization capabilities of other S/W or online tools

- Excel
- SPSS
- Rapidminer
- Weka
-
- Python graphics libraries (e.g. Bokeh)
- ...



Bokeh

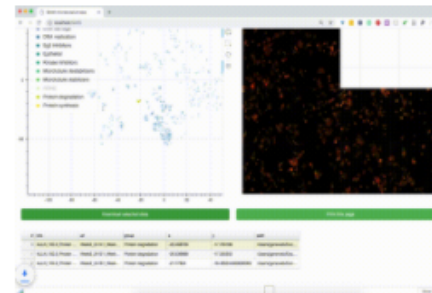
(bokeh.org)

User Showcase

Dask

Dask is a tool for scaling out PyData projects like **NumPy**, **Pandas**, **Scikit-Learn**, and **RAPIDS**. It is supported by **Nvidia**, **Quansight**, and **Anaconda**.

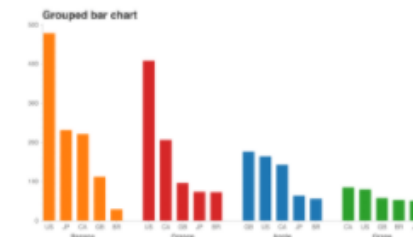
The **Dask Dashboard** is a diagnostic tool that helps you monitor and debug live cluster performance.



Microscopium

Microscopium is a project maintained by researchers at **Monash University**.

It allows researchers to discover new gene or drug functions by exploring large image datasets with Bokeh's interactive tools.



Chartify

Chartify is an opinionated high-level charting API built on top of Bokeh, created by **Spotify**.

With smart default styles, consistent tidy data format, and a simple API, it's easy for you to concentrate on your work.

Panel

Panel is a tool for polished data presentation that utilizes the Bokeh server. It is created and supported by **Anaconda**.

Panel makes it simple to create custom interactive web apps and dashboards by connecting user-defined widgets to plots, images, tables, or text.

