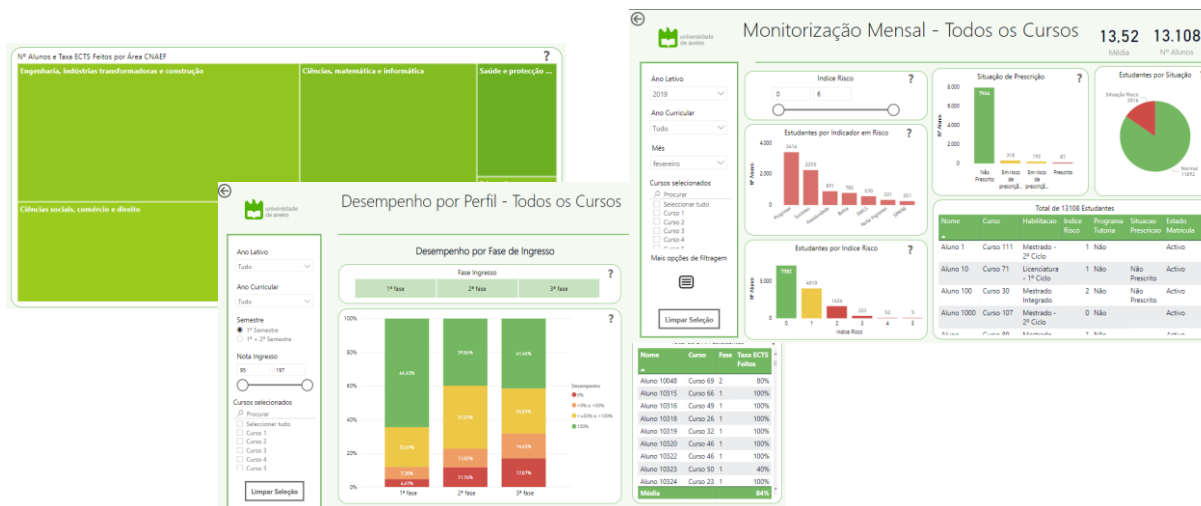
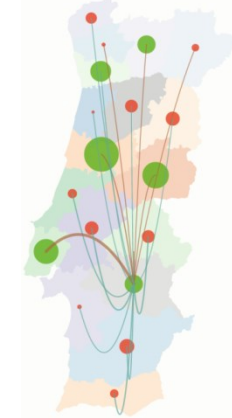
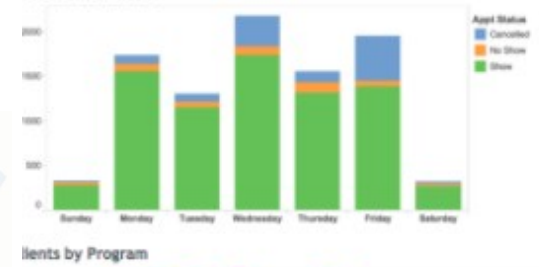




# Information Visualization course 2021 Introduction



0	10	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	8.2485	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	100	-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	1.38
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	7.7640	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
32	158	0.32	0	0.0	0	8.2876	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	138	2.04	0	0.0	0	9.2353	0.0016	0.020	0	0.916	0.004	0.960	1.28
38	104	-0.25	0	0.0	0	7.8503	0.0015	0.009	0	1.150	0.014	1.110	1.98
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	0.0018	0.018	0	0.475	0.009	0.550	2.18
09	134	5.96	1	0.0	0	10.3360	0.0055	0.082	2	0.578	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	0.07	0	0.0	0	8.2918	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	8.0825	0.0012	0.009	0	1.184	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	0.88
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	9.6389	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



Visualization?



Machine learning?

Statistics?



# What is Visualization?

- Visualization is a field of Computing 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”!

This course:

- an introduction to: Data and Information Visualization  
Computer Graphics
- Information Visualization

Course web page: <http://sweet.ua.pt/bss/disciplinas/VI/VI-home.htm>

all materials are available in Moodle

# Outline:

## **Introduction to Data and Information Visualization**

### **Information Visualization:**

- Main issues
- Data and Design
- Representation
- Presentation
- Interaction
- Evaluation

### **Introduction to Computer graphics:**

- Geometric transformations (2D, 3D) and Visualization (2D, 3D)
- Introduction to visibility, illumination, surface rendering and color models



# Visualization Tools

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

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

The screenshot shows the website 'datavisualization.ch' with a red header bar containing the text '+ DATAVISUALIZATION.CH' and 'SELECTED TOOLS'. A search bar is on the right. Below the header is a navigation bar with tabs for 'All', 'Maps', 'Charts', 'Data', and 'Color'. The main content area displays a grid of 10 tool cards, each with a thumbnail image, a title, and a brief description.

Tool Name	Description
<b>Arbor.js</b>	A library of force-directed layout algorithms plus abstractions for graph organization and refresh handling.
<b>CartoDB</b>	A web service for mapping, analyzing and building applications with data.
<b>Chroma.js</b>	Interactive color space explorer that allows to preview a set of linear interpolated equidistant colors.
<b>Circos</b>	A software package for visualizing data in a circular layout.
<b>Cola.js</b>	A library for arranging networks using constraint-based optimization techniques.
<b>ColorBrewer</b>	A web tool for selecting colors for maps.
<b>Cubism.js</b>	A library for creating interactive time series and horizon graphs based on D3.js
<b>Cytoscape</b>	An application for visualizing complex networks and integrating these with any type of attribute data.
<b>D3.js</b>	An small, flexible and efficient library to create and manipulate interactive documents based on data.
<b>Dance.js</b>	A simple data-driven visualization framework based on Data.js and Underscore.js

# 2021 Gartner Magic Quadrant for Analytics and Business Intelligence Platforms

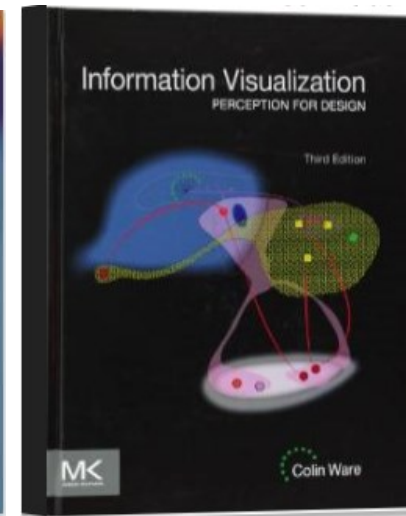
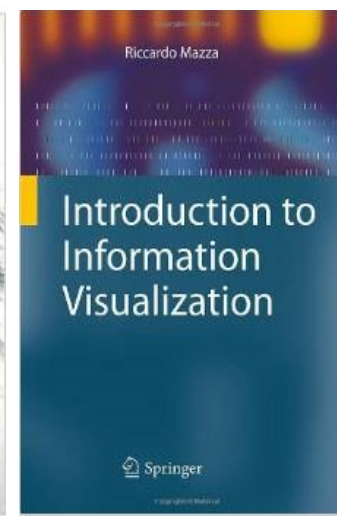
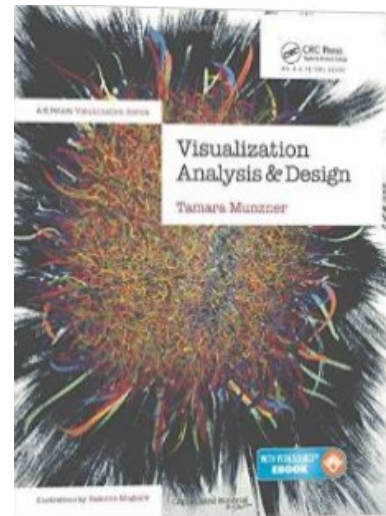
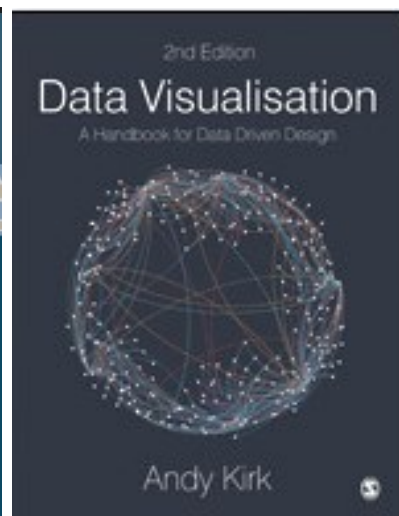
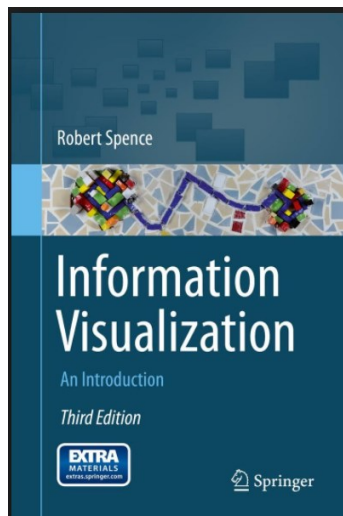


Note: the report is available upon request



# Main Bibliography - Visualization

- Spence, R., *Information Visualization, An Introduction*, Springer, 2014
- Munzner, T., *Visualization Analysis and Design*, A K Peters/CRC Press, 2014
- Kirk, A., *Data Visualisation A Handbook for Data Driven Design*, 2nd. Ed., Sage, 2019
- Mazza, R., *Introduction to Information Visualization*, Springer, 2009
- Ware, C., *Information Visualization, Perception to Design*, 3rd ed.,Morgan Kaufmann, 2012



# Playlist with several books to read online (VPN)

<https://learning.oreilly.com/playlists/f68d0022-1b58-4374-9af5-280d221d4c7e>

## Other Bibliography

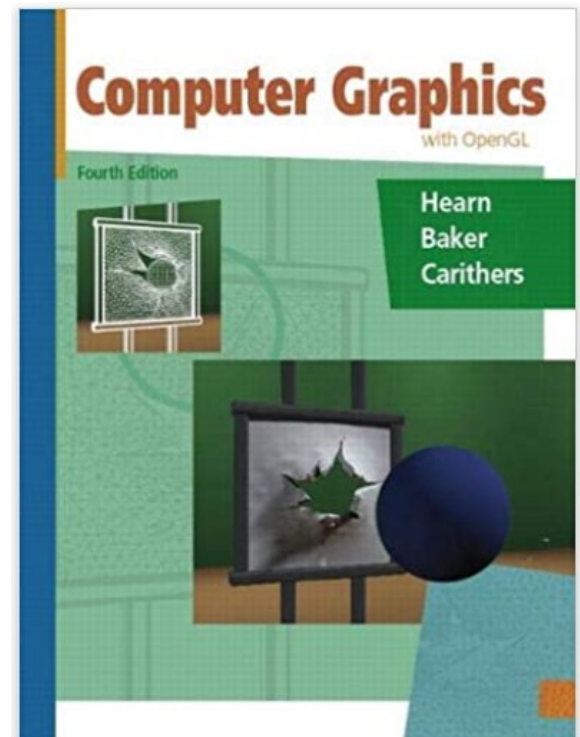
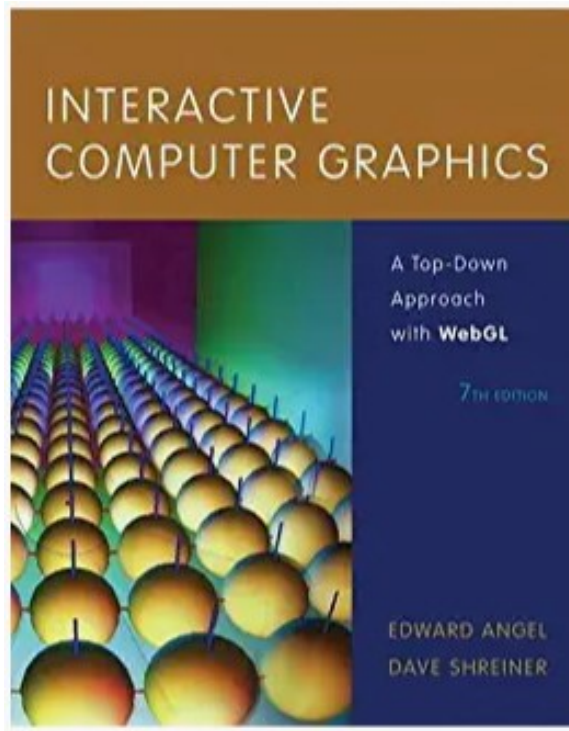
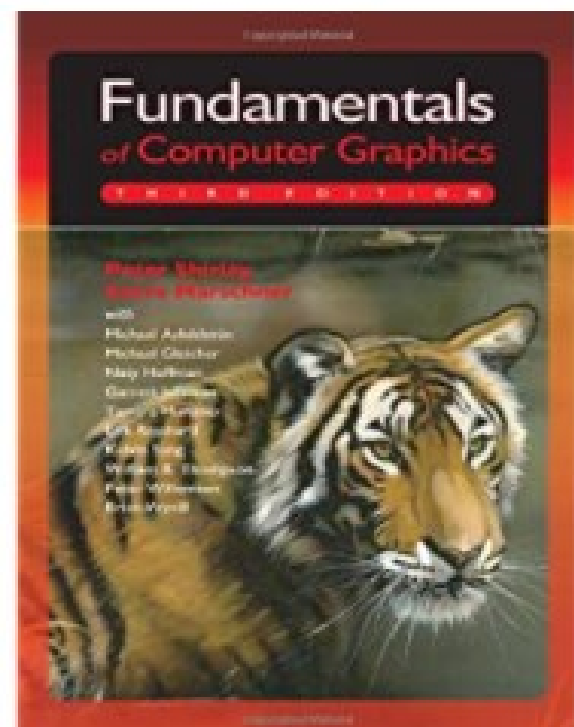
- Spence, R., *Information Visualization, Design for Interaction*, 2nd ed., Prentice Hall, 2007
- Kirk, A., *Data Visualization: A successful design process*, Pack Publishing, 2012  
[https://books.google.pt/books/about/Data\\_Visualization.html?id=I4qBVLfD3t4C&prints\\_ec=frontcover&source=kp\\_read\\_button&redir\\_esc=y#v=onepage&q&f=false](https://books.google.pt/books/about/Data_Visualization.html?id=I4qBVLfD3t4C&prints_ec=frontcover&source=kp_read_button&redir_esc=y#v=onepage&q&f=false)
- Bederson, B. , B. Shneiderman, *The Craft of Information Visualization: Readings and Reflections*, Morgan Kaufmann, 2003
- Card, S., J. Mackinlay, and B. Shneiderman, *Readings in Information Visualization: Using Vision to Think*, Morgan Kaufmann, 1999
- Keim, D., Kohlhammer, J., Ellis, G., & Mansmann, F., *Solving problems with Visual Analytics*, Eurographics, 2012
- Keim, D., Rossi, F., Seidl, T., Verleysen, M., & Wrobel, S. (2012). *Information Visualization, Visual Data Mining and Machine Learning* (Dagstuhl Seminar 12081). Dagstuhl Reports, 2(2), 58–83. <http://doi.org/10.4230/DagRep.2.2.58>

## Other Bibliography – “classical” books and papers

- Bederson, B. , B. Shneiderman, *The Craft of Information Visualization: Readings and Reflections* Morgan Kaufmann, 2003
- Card, S., J. Mackinlay, and B. Shneiderman, *Readings in Information Visualization: Using Vision to Think*, Morgan Kaufmann, 1999
- Tufte, E., *The Visual Display of Quantitative Information*, Graphics Press, 1983
- Tufte, E., *Envisioning Information*, Graphics Press, 1990
- Friendly, M., "[Milestones in the history of thematic cartography, statistical graphics, and data visualization](#)", 2009
- Few, S., “Data Visualization for Human Perception”. In: Soegaard, M. and Dam, R. (eds.). *The Encyclopedia of Human-Computer Interaction*, 2nd Ed. The Interaction Design Foundation  
[https://www.interaction-design.org/encyclopedia/data\\_visualization\\_for\\_human\\_perception.html](https://www.interaction-design.org/encyclopedia/data_visualization_for_human_perception.html)
- Keim, D., Rossi, F., Seidl, T., Verleysen, M., & Wrobel, S. (2012). *Information Visualization, Visual Data Mining and Machine Learning* (Dagstuhl Seminar 12081). Dagstuhl Reports, 2(2), 58–83. <http://doi.org/10.4230/DagRep.2.2.58>
- Heer, J., M. Bostock, M., & V. Ogievetsky,. “A tour through the visualization zoo”. *Communications of the ACM*, vol 53, no. 6, pp. 59-79, 2010.

# Bibliography – Computer Graphics

- Shirley, P. M. Ashikhmin, S. Marschner, *Fundamentals of Computer Graphics*, 3rd Edition, 3rd ed., A K Peters/CRC Press, 2021
- Angel, E., D. Shreiner, *Interactive Computer Graphics: A Top-Down Approach with WebGL*, 7th ed, Pearson, 2014
- Hearn, D., M. P. Baker, W. Carithers, *Computer Graphics with OpenGL*, 4th ed., Prentice Hall, 2010



## To probe further Scientific Journals/Conferences

IEEE Transactions on Visualization and Computer Graphics

IEEE Computer Graphics and Applications

Computer Graphics Forum

Computers and Graphics

Information Visualization



IEEE Vis (<http://ieevis.org/>)

Eurovis (<http://eurovis2019.org/>)

Information Visualization (<http://www.graphicslink.co.uk/IV2019/index-fr.html>)

## On-line courses

Information Visualization - NYU



<https://www.coursera.org/specializations/information-visualization>

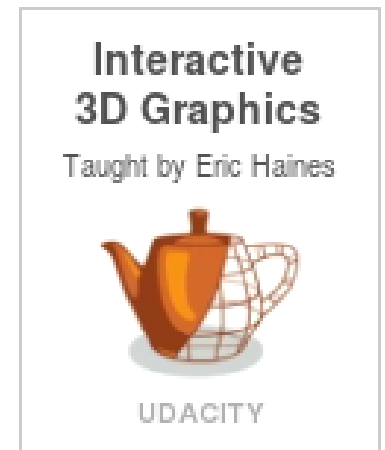
Data Visualization and D3.js



<https://www.udacity.com/course/data-visualization-and-d3js--ud507>

Interactive 3D Graphics, by Eric Haines

<https://www.udacity.com/course/interactive-3d-graphics--cs291>



## Interesting links

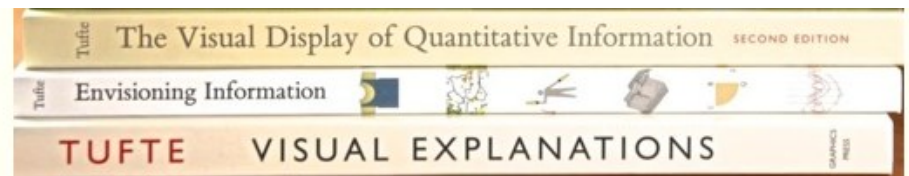
- <http://www.infovis-wiki.net/>
- <https://eagereyes.org/>
- <http://www.perceptualedge.com/>
- <http://www.thefunctionalart.com/>
- <https://www.edwardtufte.com/tufte>



@agereyes



**Visual Business Intelligence**  
for enlightening analysis and communication



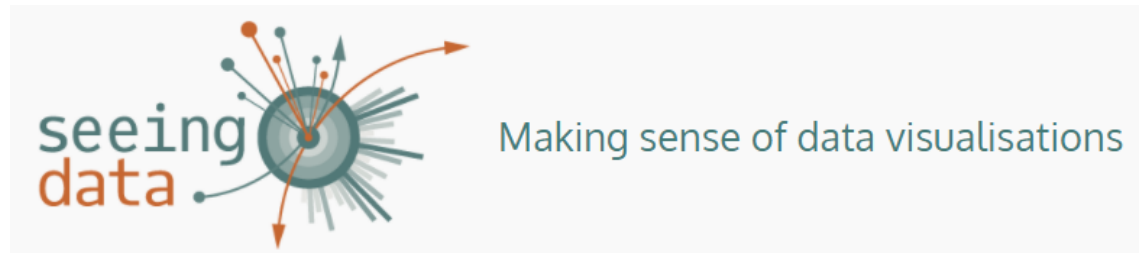


# Interesting links

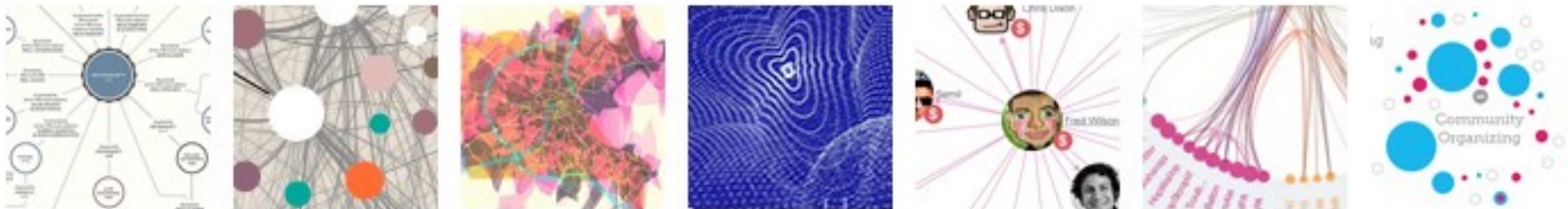
- <https://medium.com/multiple-views-visualization-research-explained>



- <http://seeingdata.org/>



- <http://www.visualcomplexity.com/vc/>





# Sessions

(subject to minor adjustments)

**0** - Introduction to the course and to DataVis and InfoVis

**0Lab** – Introduction to Google Tool Charts

**1** - Introduction to the course and to DataVis and InfoVis

**1Lab** – Introduction to SVG

**2** – Main issues in InfoVis (Data and Design cycle) + Paper presentation

**2Lab** – Introduction to D3

**3** - Representation: coding of value + Paper presentation

**3Lab** – Introduction to D3 - mini-project – a Vis application (select a topic)

**4** - Evaluation methods + Paper presentation

**4 Lab** - Evaluation of an application

**5** – Representation: coding relation + Paper presentation

**5 Lab** – D3 – mockup evaluation (LFP)

**6** – Follow-up of the 2<sup>nd</sup> assignment

**6Lab** - D3; mini-project (slides with design proposal)

**7** – Presentation + Paper presentation

**7Lab** - D3; mini-project

**8** - Interaction + Paper Presentation

**8Lab** – mini-project

**9** – Introduction to Computer Graphics + Paper presentation

**9Lab** – D3; mini-project

**10** - Presentation and demo of the mini-project

**10Lab** – Presentation and demo of the mini-project

**11** – Introduction to Computer Graphics + Paper presentation

**11Lab** – Introduction to Three.js

**12** – Introduction to Computer Graphics + Paper presentation

**12Lab** – Three.js exercises

**13** – Introduction to Computer Graphics

**13Lab** – Three.js exercises

**Dates to submit mini-project and Three.js exercises TBA**

# Assessment

- Exam – 40%
- Mini-project - design, implementation and evaluation of a visual data exploration application – 40%
- Computer Graphics exercises – 10%
- Paper presentation – 10%

**Notice:** Working Students must contact [bss@ua.pt](mailto:bss@ua.pt) until **October 23** to discuss their practical assessment deadlines

# Assignments

- Practical assignments are performed in groups of two students
- Paper presentation
  - 23/Oct/21 – select a paper and a presentation date (links in Moodle)
- Design, implementation and evaluation of a Visual Data Exploration application using UCD, with the following deliverables:
  - 8,6/Nov/21 - select a topic
  - LFP usability test
  - Follow-up – presentation and submission of requirement analysis and proposed design (15 slides)
  - Presentation and demo of the application
  - date TBA – submission of the application
- Computer Graphics exercises
  - date TBA - submission of Three.js exercises

# Design and implementation of a Visual Data Exploration Application Using a Human-Centered approach:

- Select a Data set to visualize
- Characterize target users, scenarios and identify interesting questions
- Propose a conceptual model for the application (including visualization idioms and interaction styles)
- Develop and evaluate a low fidelity prototype with users
- Develop the application using D3 (or other platform, subject to approval)
- Evaluate the application using at least an analytical method

## Analyzing and presenting a paper:



- Select an **InfoVis** long paper from:

- IEEEVis2020

- <http://ieevis.org/year/2020/info/papers-sessions>

- EuroVis2021

- <https://www.eurovis.org/index.php/for-attendees/program/>

Or from another recent conference or journal of the field (subject to approval)

- Propose it until **23/Oct/2021 to [bss@ua.pt](mailto:bss@ua.pt)**  
Indicating preferences concerning presentation date (link in Moodle)
- Read the **presentation guidelines** (available in Moodle)
- Make a presentation and submit the slides

### Help:

Laramee, R. S. (2011). How to Read a Visualization Research Paper: Extracting the Essentials. *IEEE Computer Graphics and Applications*, May/June, 78–82.

- Don't forget that students who work must contact the lecturer during the two first weeks to establish assessment details
  - Students profile?
  - Volunteers to make the first paper presentation?
  - Any doubts, questions?