

Lesson 1: Introduction to Visual Analytics

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What will you learn from this lesson?

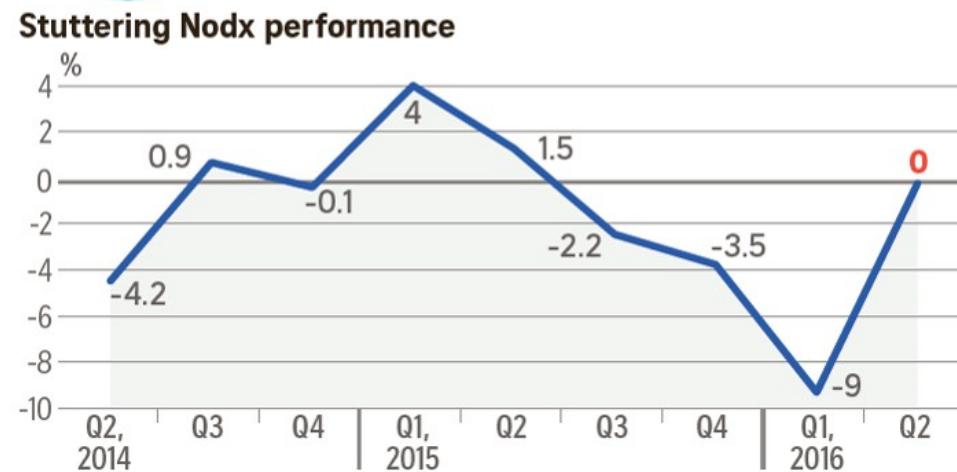
- Motivation of Visual Analytics
- What is Visual Analytics
- Learning from the history of visual analytics
- Data Visualisation tools

Motivation of Visual Analytics

The World is full of charts that lie!



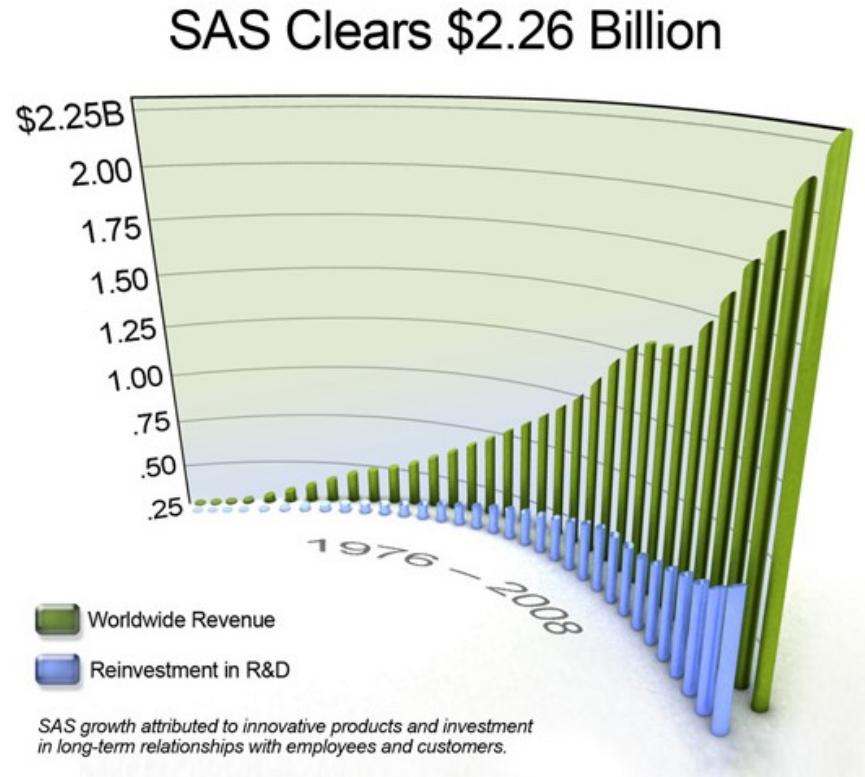
Non-oil domestic exports (Nodx) growth was flat in the second quarter. For the first half this year, **Nodx fell 4.5 per cent** compared with the same period last year.



We need to get smarter about visual information

Motivation of Visual Analytics

Junk charts are good for advertising but not for understanding.



Motivation of Visual Analytics

Data rich, information poor



Source: <http://omnitele-com.s3.amazonaws.com/2015/04/big-data-ocean-crop.jpeg>

Motivation of Visual Analytics

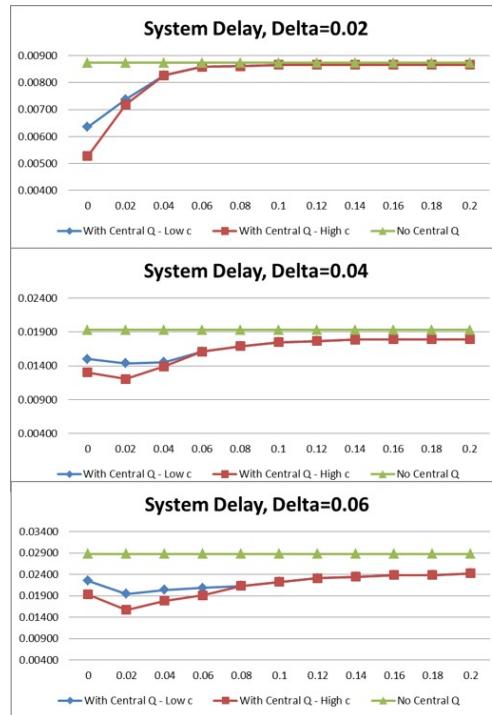
The World is buried in data,

Just SHOW me the number

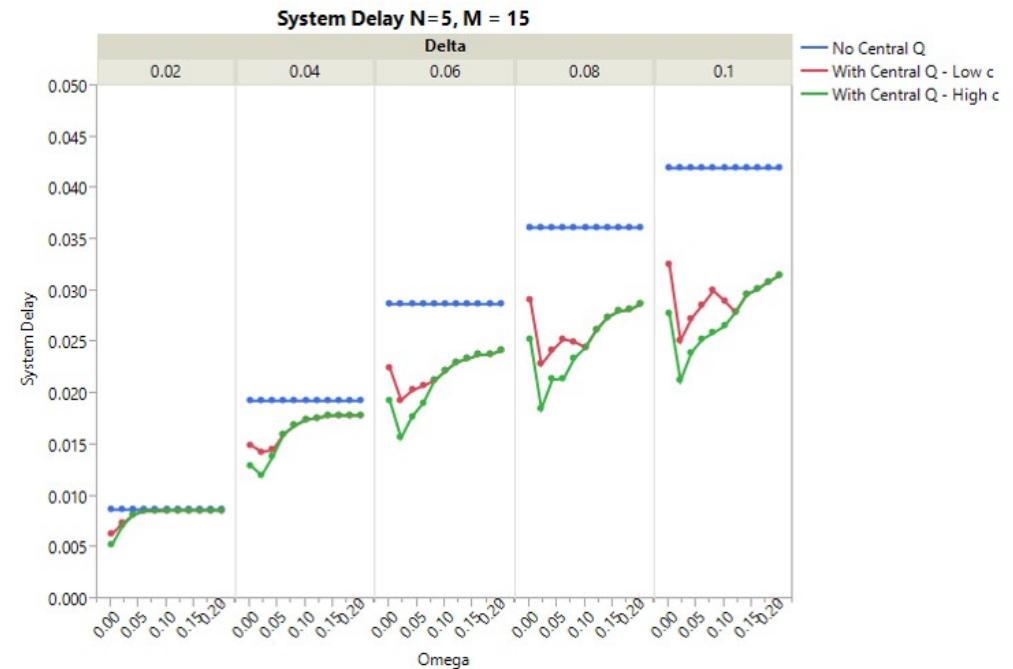
B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Z	AA	AB	AC	AD	
1	Country Exchange	Name	Forer	Symbol	ISIN	SEDEON	Closette	MoopU	Industry	Suppliers	Today Close	1 Week (1 Month)	2 Month	3 Month	1 Day Chg	1 Day Chg	1 Day Chg	1 Week (2 Weeks)	1 Month	1 Month	2 Month	2 Month	3 Month					
2	AT	YIE	Ertiga Gr- EUR	ERTIGA.YI	AT0000007388531	12.75	3E+09	SE+03	Financial	Bank	10.75	10.69	10.27	7.75	11.04	16.2	-0.075	-0.075	-0.063	-0.056	0.245	0.265	0.4545	0.707	0.0763	0.157	-0.2	
3	AT	YIE	Rofitex EUR	ROFITEX.YI	AT000000720471	21.21	1E+09	SE+03	Financial	Bank	22.65	25	15.95	14.52	16	15.2	-0.054	-0.065	-0.052	-0.058	0.052	0.061	0.4550	0.507	0.325	0.374	0.05	
4	AT	YIE	Westar EUR	WESTAR.YI	AT000000720471	10.11	1E+09	SE+03	Financial	Bank	10.11	10.11	10.11	10.11	10.11	10.11	-0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001	0.001	0.001	0.001	-0.001	
5	AT	YIE	Vicente EUR	VICENTE.YI	AT0000007559775	1.59	1E+09	SE+03	Financial	Bank	5.5	5.5	5.5	5.5	5.5	5.5	-0.001	-0.001	-0.001	-0.001	0.001	0.001	0.001	0.001	0.001	0.001	-0.001	
6	AT	YIE	Maribor EUR	MARIBOR.YI	AT0000007606175	2.2	3E+09	SE+03	Financial	Bank	21.02	24.40	21.49	22.85	25.60	21.04	-0.021	-0.029	-0.049	-0.049	0.076	0.076	0.092	0.092	0.092	0.092	-0.04	
7	AT	YIE	Andrea's EUR	ANDREAS.YI	AT0000007619176	23.16	9E+09	SE+03	Financial	Industries	24.47	23.51	19.79	24	20.3	20.6	-0.071	-0.054	-0.067	-0.054	0.054	0.054	0.055	0.055	0.055	0.055	-0.05	
8	AT	YIE	Vivian's EUR	VIVIANS.YI	AT0000007619176	21.63	9E+09	SE+03	Financial	Industries	22.05	21.3	19.23	19.11	24.6	24.2	-0.019	-0.021	-0.005	-0.005	0.165	0.231	0.203	0.149	-0.121	-0.089	0.1	
9	AT	YIE	OMV AG EUR	OMVAG.YI	AT0000007619176	28.52	4E+09	SE+03	Oil & Gas	Oil & Gas	24.39	33.04	21.29	20.72	23.29	18.73	-0.077	-0.052	-0.067	-0.043	0.187	0.256	0.282	0.282	0.282	0.282	-0.04	
10	AT	YIE	Telkom EUR	TELKOM.YI	AT0000007635081	11.4	4E+09	SE+03	Telecom	Telecom	10.06	10.43	10.49	9.95	11	10.3	-0.049	-0.047	-0.067	-0.064	0.067	0.067	0.102	0.147	0.193	0.064	0.073	0.104
11	AT	YIE	Verbind EUR	VERBIND.YI	AT00000076469107	28.53	2E+09	SE+03	Financial	Bank	20.36	29.92	26.12	25	23.97	32.56	-0.013	-0.015	-0.044	-0.044	0.045	0.045	0.062	0.062	0.062	0.062	-0.01	
12	AT	YIE	Arivis E- EUR	ARIVIS.EI	AT0000007659676	2.27	5E+09	SE+03	Financial	Bank	2.32	2.02	2.15	1.47	2.10	2.51	-0.022	-0.024	0.026	0.026	0.0356	0.0356	0.055	0.055	0.055	0.055	-0.01	
13	AU	ASX	Bendigo AUD	BENDIGO.XA	AU000000759203C	0.19	2E+09	SE+03	Financial	Bank	7.92	7.4	6.3	6.84	10	11	0.031	0.034	0.036	0.036	0.0355	0.0355	0.1473	0.1377	-0.081	-0.035	-0.21	
14	AU	ASX	Securcorp AUD	SECURCORP.XA	AU0000007559584	6	8E+09	SE+03	Financial	Bank	6.14	6.17	5.4	5.2	7.5	8.31	-0.023	-0.028	-0.028	-0.028	0.24137	0.111	0.005	0.058	0.058	0.058	-0.21	
15	AU	ASX	National AUD	NATIONAL.XA	AU0000007624097	20.11	4E+09	SE+03	Financial	Bank	21.09	19.79	19.55	17.51	18.93	20.95	-0.017	-0.017	-0.046	-0.037	0.0934	0.0934	0.1479	0.1222	0.058	0.1851	-0.07	
16	AU	ASX	Busk et ALB AUD	BUSKALB.XA	AU0000007676324	8.44	1E+09	SE+03	Financial	Bank	8.3	7.94	7.04	6.83	7.4	9.45	-0.095	-0.091	-0.063	-0.056	0.183	0.183	0.2359	0.0458	0.1665	0.3859	-0.9	
17	AU	ASX	Australia AUD	ANZAUSTRALIA.XA	AU0000007655886	16.55	15.25	14.05	13.05	13.05	12.17	15.25	-0.049	-0.049	-0.054	-0.053	0.02697	0.02697	0.02693	0.02693	0.02693	0.02693	0.0315	0.0315				
18	AU	ASX	Westpac AUD	WESTPAC.XA	AU0000007676546	15.03	6E+09	SE+03	Financial	Bank	13.14	12.35	12.10	16.65	15.64	16.53	-0.003	-0.003	-0.003	-0.003	0.0035	0.0035	0.144	0.223	0.1455	0.2153	0.2206	0.2324
19	AU	ASX	Common AUD	CBRALX.XA	AU0000007625035	34.73	5E+09	SE+03	Financial	Bank	3.59	4.06	4.06	29.8	26.9	20.8	-0.008	-0.007	-0.01	-0.004	0.0054	0.0054	0.2417	0.1654	0.0708	0.2311	0.4075	
20	AU	ASX	Bluescope AUD	BLUESCOPE.XA	AU0000007553205	2.57	5E+09	SE+03	Basic Materials	Metals & Mining	2.73	2.59	2.26	2.92	3.55	3.45	-0.078	-0.078	0.015	0.015	0.0422	0.0422	0.2514	0.1935	0.2235	0.2235	-0.01	
21	AU	ASX	CSR AUD	CSR.XA	AU0000007359461	1.23	2E+09	SE+03	Financial	Bank	12.75	11.95	11	10.2	12.45	17.9	-0.053	-0.053	-0.048	-0.048	0.0422	0.0422	0.2556	0.1655	0.0512	0.162	-0.1	
22	AU	ASX	Ikeda Res AUD	IKEDARES.XA	AU0000007559009	4.03	1E+09	SE+03	Basic Mfg	Metals & Mining	4.1	4.4	4.2	4.2	4.25	4.44	-0.027	-0.027	-0.024	-0.024	-0.04	-0.04	0.0685	0.0685	0.0685	0.0685	-0.0591	
23	AU	ASX	OneSteel AUD	ONESTEEL.XA	AU0000007293721	2.25	2E+09	SE+03	Basic Mfg	Metals & Mining	2.30	2.35	1.86	1.8	2.43	2.33	-0.055	-0.054	0.024	0.024	0.2457	0.2457	0.25	0.2522	0.0618	0.1851	-0.07	
24	AU	ASX	Ashmore I AUD	ASHMOREI.XA	AU0000007545486	1.29	2E+09	SE+03	Financial	Bank	1.23	1.21	1.21	1.25	1.14	1.28	-0.032	-0.032	-0.073	-0.073	0.0597	0.0597	0.209	0.2454	0.071	0.158	0.2254	
25	AU	ASX	Newcrest AUD	NEWCREST.XA	AU0000007667010	32.73	2E+09	SE+03	Basic Mfg	Metals & Mining	55.54	53.66	51.78	51	50.05	52.04	-0.024	-0.024	-0.028	-0.028	0.0322	0.0322	0.158	0.2127	0.0558	0.0558	0.2244	
26	AU	ASX	Ernst Bill AUD	ERNSTBILL.XA	AU0000007441536	3.12	8E+09	SE+03	Financial	Bank	3.59	3.61	3.61	3.21	3.05	3.65	-0.061	-0.061	-0.042	-0.042	0.0234	0.0234	0.075	0.157	0.1875	0.0452	0.1431	0.076
27	AU	ASX	Lion Lgr AUD	LIONLGR.XA	AU0000007420074	3.04	8E+09	SE+03	Financial	Bank	3.04	3.04	3.04	3.04	3.04	3.04	-0.005	-0.005	-0.005	-0.005	0.0044	0.0044	0.0044	0.0044	0.0044	0.0044	-0.001	
28	AU	ASX	Portsea E AUD	PORTSEA.EXA	AU0000007446446	3.57	3E+09	SE+03	Financial	Bank	2.9	2.9	2.9	2.9	2.9	2.9	-0.001	-0.001	-0.001	-0.001	0.0049	0.0049	0.0052	0.0052	0.0052	0.0052	-0.001	
29	AU	ASX	Palms E AUD	PALMS.EXA	AU0000007446446	3.4	2E+09	SE+03	Financial	Bank	3.51	3.41	3.0	2.76	3.26	3.65	-0.041	-0.041	-0.02	-0.02	0.0353	0.0353	0.0393	0.0393	0.0393	0.0393	-0.044	
30	AU	ASX	Rio Tinto AUD	RIOTINTO.XA	AU0000007220092	56.57	4E+09	SE+03	Basic Mfg	Metals & Mining	56.88	55.59	57.75	46.2	55.65	57.05	-0.005	-0.005	-0.005	-0.005	0.1925	0.1925	0.2147	0.1776	0.0965	0.2228	0.0546	
31	AU	ASX	Indescri Plc AUD	PLC.AXA	AU0000007470042	2.12	5E+09	SE+03	Basic Mfg	Metals & Mining	2.2	2.2	2.03	2.03	2.1	2.1	-0.033	-0.033	-0.034	-0.034	-0.0234	-0.0234	0.0556	0.0556	-0.026	-0.026	-0.04	
32	AU	ASX	Orcio Inv AUD	ORCIINV.XA	AU0000007470042	15.14	14.15	14.15	17.76	17.54	15.54	15.54	15.54	15.54	15.54	15.54	-0.023	-0.023	-0.023	-0.023	0.0572	0.0572	0.1102	0.0811	0.0505	0.1937	-0.07	
33	AU	ASX	Lightfoot AUD	LEFLX.AXA	AU000000729227	15.26	2E+09	SE+03	Financial	Bank	20.15	15.25	18.24	17.76	25.23	25.23	-0.043	-0.042	-0.026	-0.026	0.0031	0.0031	0.0443	0.0443	0.0443	0.0443	-0.005	
34	AU	ASX	Boylealz AUD	BLDAUSTRALIA.XA	AU0000007298470	3.61	2E+09	SE+03	Financial	Bank	3.68	3.41	2.98	2.32	3.05	3.65	-0.053	-0.053	-0.061	-0.061	0.051	0.051	0.2622	0.2627	0.2343	0.2101	0.0306	0.1807
35	AU	ASX	James Mt AUD	JMCAUSTRALIA.XA	AU0000007423717	4.2	8E+09	SE+03	Financial	Bank	4.01	4.05	3.75	3.25	3.79	4.45	-0.033	-0.033	-0.035	-0.035	0.0329	0.0329	0.1772	0.2923	0.3752	0.3752	0.0714	
36	AU	ASX	Lend Los Aus	LLCAUSTRALIA.XA	AU0000007520204	6.43	3E+09	SE+03	Financial	Bank	6.42	6.25	5.82	5.03	6.73	7.03	-0.009	-0.008	-0.014	-0.014	0.0174	0.0174	0.1721	0.2826	0.3643	0.444	-0.044	
37	AU	ASX	Dover I AUD	DOVIY.AXA	AU0000007445573	4.45	1E+09	SE+03	Financial	Bank	4.61	4.29	4.15	3.81	4.76	5.35	-0.025	-0.025	-0.037	-0.037	0.0226	0.0226	0.1723	0.2237	0.2237	0.2237	0.2555	
38	AU	ASX	United G AUD	UGLAUSTRALIA.XA	AU0000007341171	9.15	2E+09	SE+03	Financial	Bank	9.23	7.89	7.5	6.02	8	9.05	-0.003	-0.003	-0.045	-0.045	0.1224	0.1224	0.2055	0.2054	0.1446	0.2507		
39	AU	ASX	Perpetua AUD	PPT.AXA	AU0000007458216	26.84	1E+09	SE+03	Financial	Financial	27.64	27.02	25.5	23.88	30.12	34.5	-0.023	-0.023	-0.023	-0.023	0.0565	0.0565	0.1234	0.1355	-0.123	-0.042	-0.22	
40	AU	ASX	ASX Ltd AUD	ASXALX.AXA	AU0000007232304	29.35	5E+08	SE+03	Financial	Financial	30.05	29.44	29	26.10	27.15	32.72	-0.021	-0.021	-0.023	-0.023	0.0565	0.0565	0.1211	0.1301	0.0811	0.1010	-0.1	
41	AU	ASX	AMP Ltd AUD	AMPALXA.XA	AU0000007403955	4.7	9E+09</																					

Motivation of Visual Analytics

Spreadsheet: A great hammer but lousy screwdriver



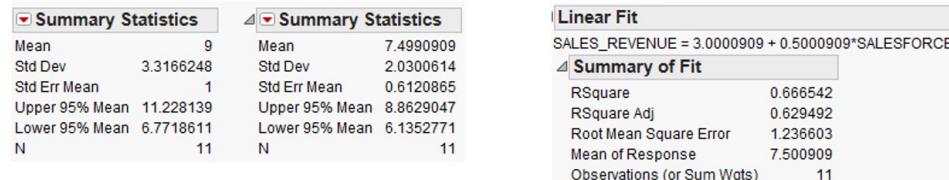
Visual analytics come to the rescue



Motivation of Visual Analytics

When statistics failed!

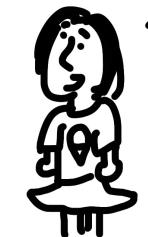
SALESFORCE A	SALES_REVENUE A	SALESFORCE B	SALES_REVENUE B	SALESFORCE C	SALES_REVENUE C	SALESFORCE D	SALES_REVENUE D
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24	6	6.13	6	6.08	8	5.25
4	4.26	4	3.1	4	5.39	19	12.5
12	10.84	12	9.11	12	8.15	8	5.56
7	4.82	7	7.26	7	6.42	8	7.91
5	5.68	5	4.74	5	5.73	8	6.89



I just can't make sense
of this data.



Have you tried
looking at the
pictures?



fresh spectrum

Data analysis without data
visualisation is no data analysis

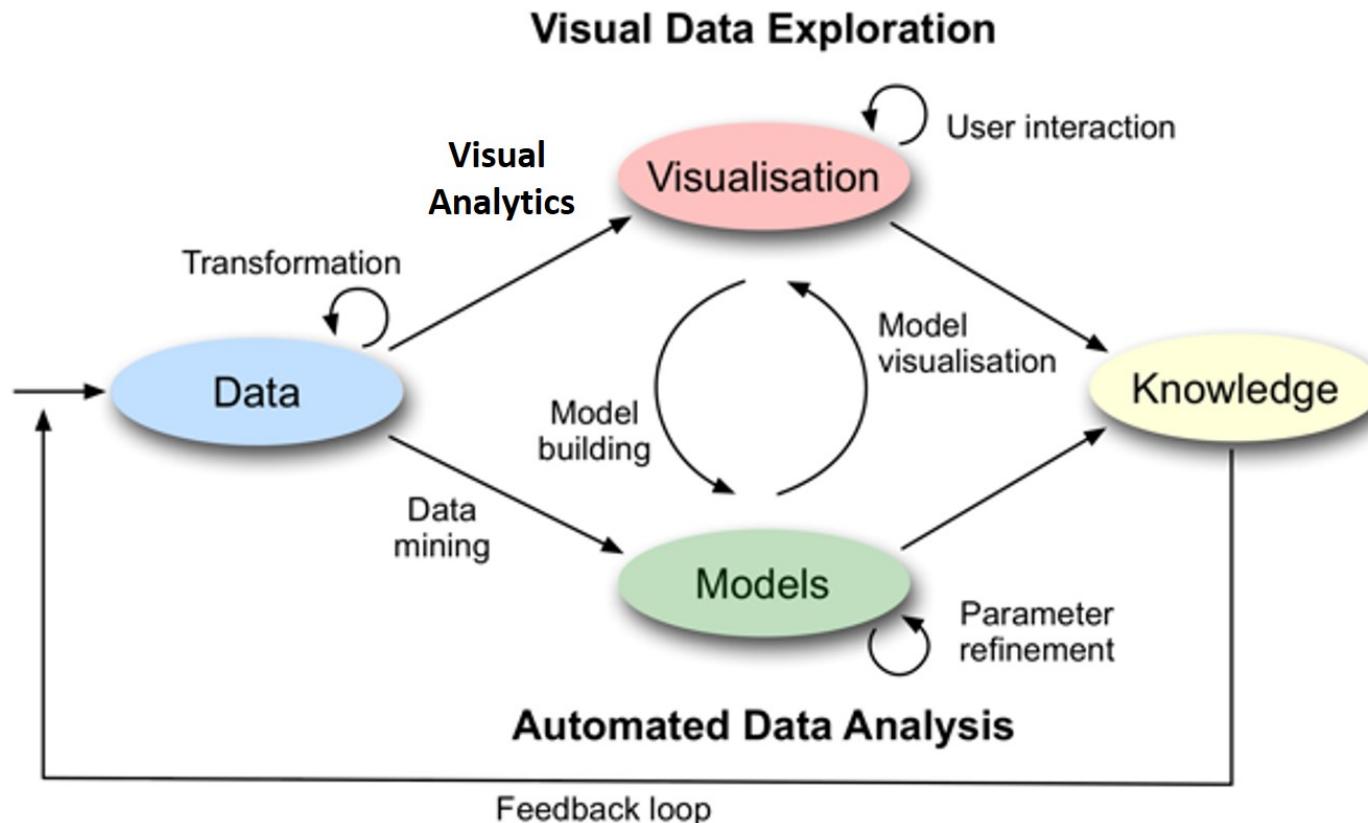
Motivation of Visual Analytics

Analytical graphics reveal the truth



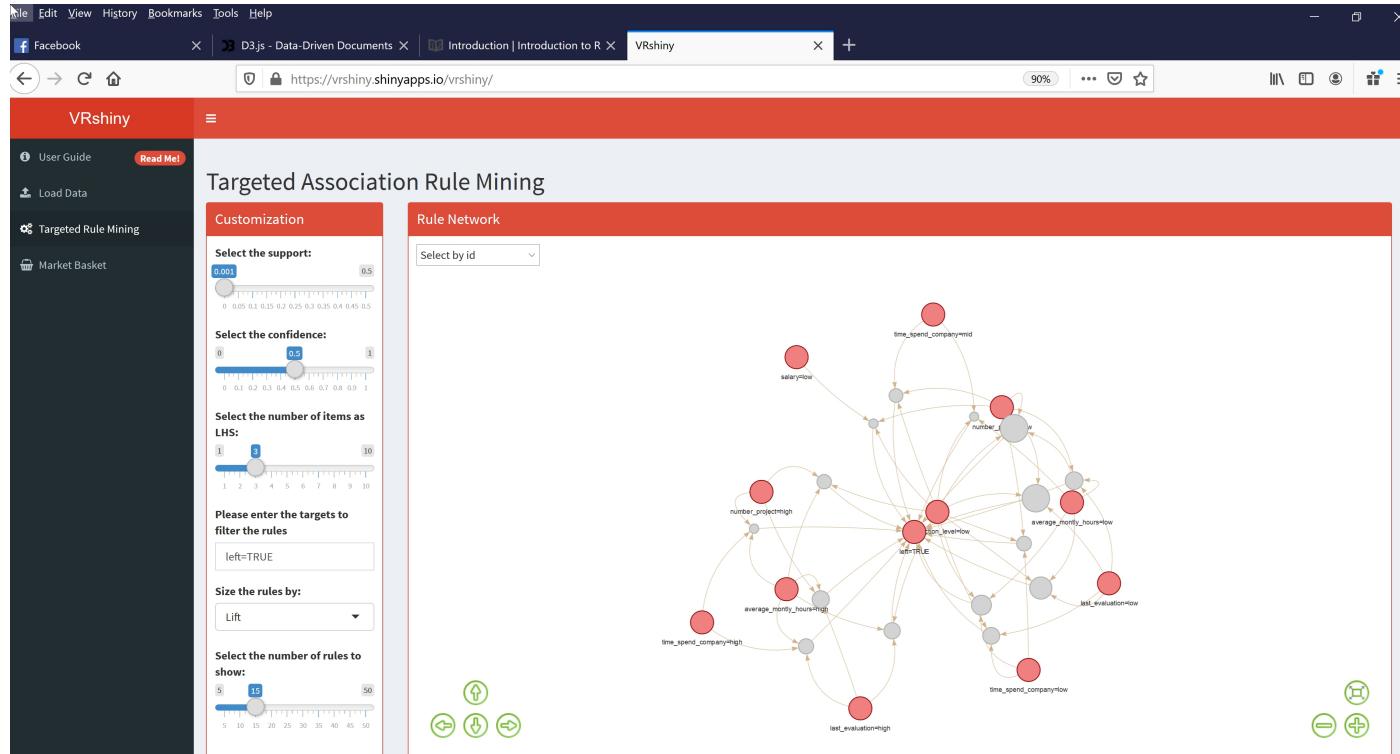
Motivation of Visual Analytics

Is there a place for Visual Analytics in knowledge discovery?



Motivation of Visual Analytics

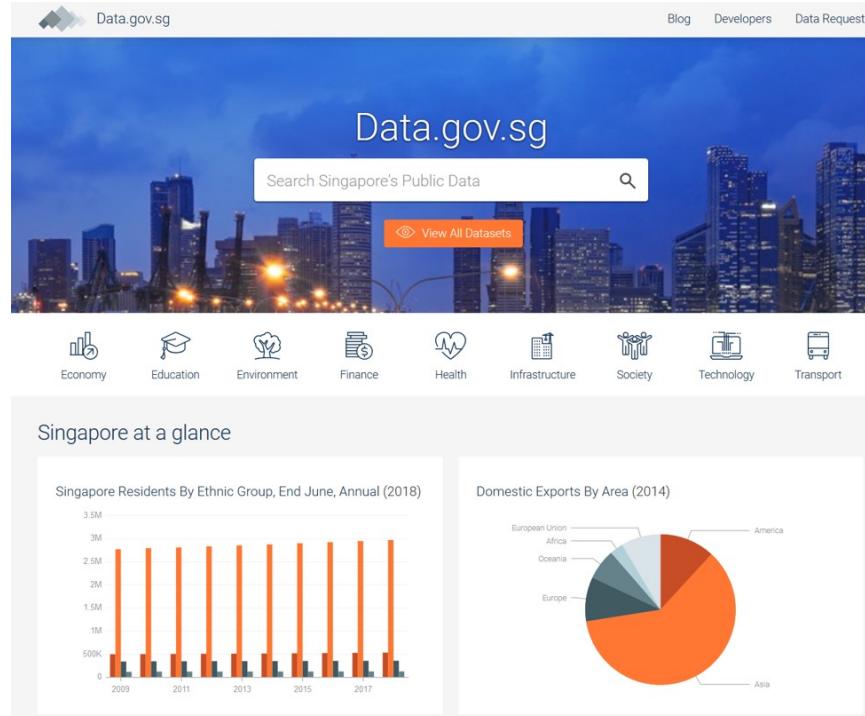
Free and Open Source Analytics Web Apps



Visit the link at <https://vrshiny.shinyapps.io/vrshiny/>

Motivation of Visual Analytics

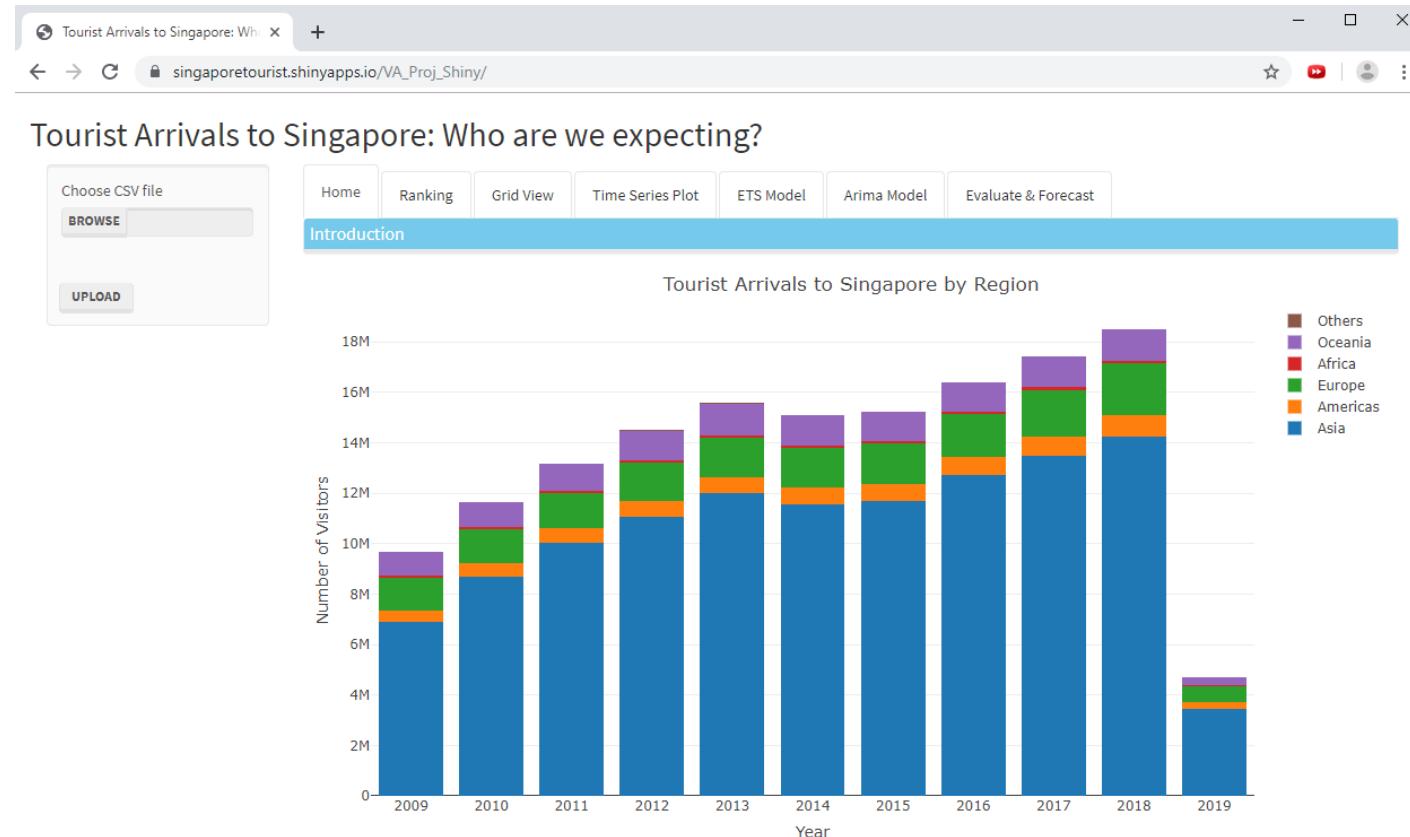
Open data need to be unlocked!



Visit the link at <https://data.gov.sg>

Motivation of Visual Analytics

Democratising Data and Analytics with Visually-driven Web Apps



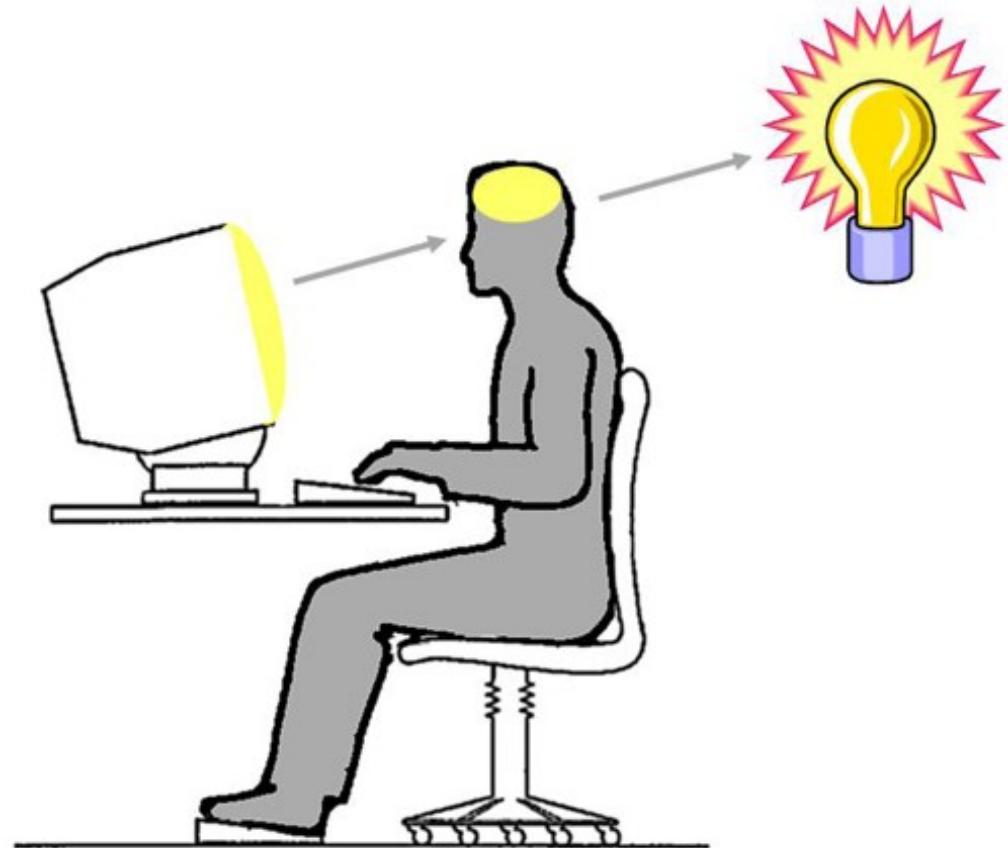
Visit the link at https://singaporetourist.shinyapps.io/VA_Proj_Shiny/

What is Visual Analytics?

Visual Analytics is the craft of **analytical reasoning** supported by:

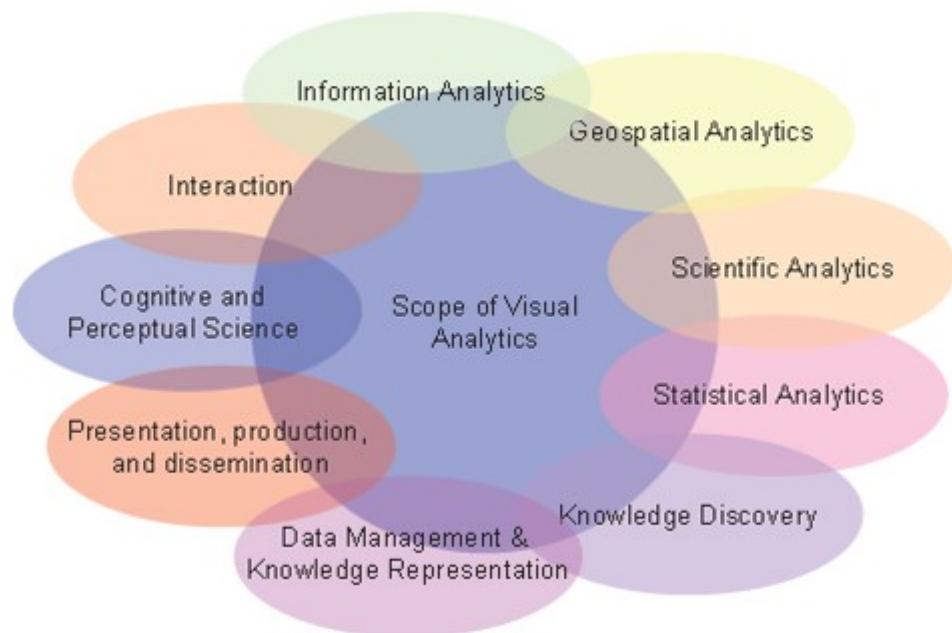
- Data Science and Analytics
- Data Visualisation
- Human-Computing-Interaction (HCI)
- Interface Design
- Visual Storytelling

The marriage of data analytics and visualizations



What is Visual Analytics?

Science of Visual Analytics



Aims of Visual Analytics

*Detecting the expected,
discovering the unexpected*

What is Visual Analytics?

Visual Data Sense-making

Visual Analytics' greatest strength is its use for **sense-making**.

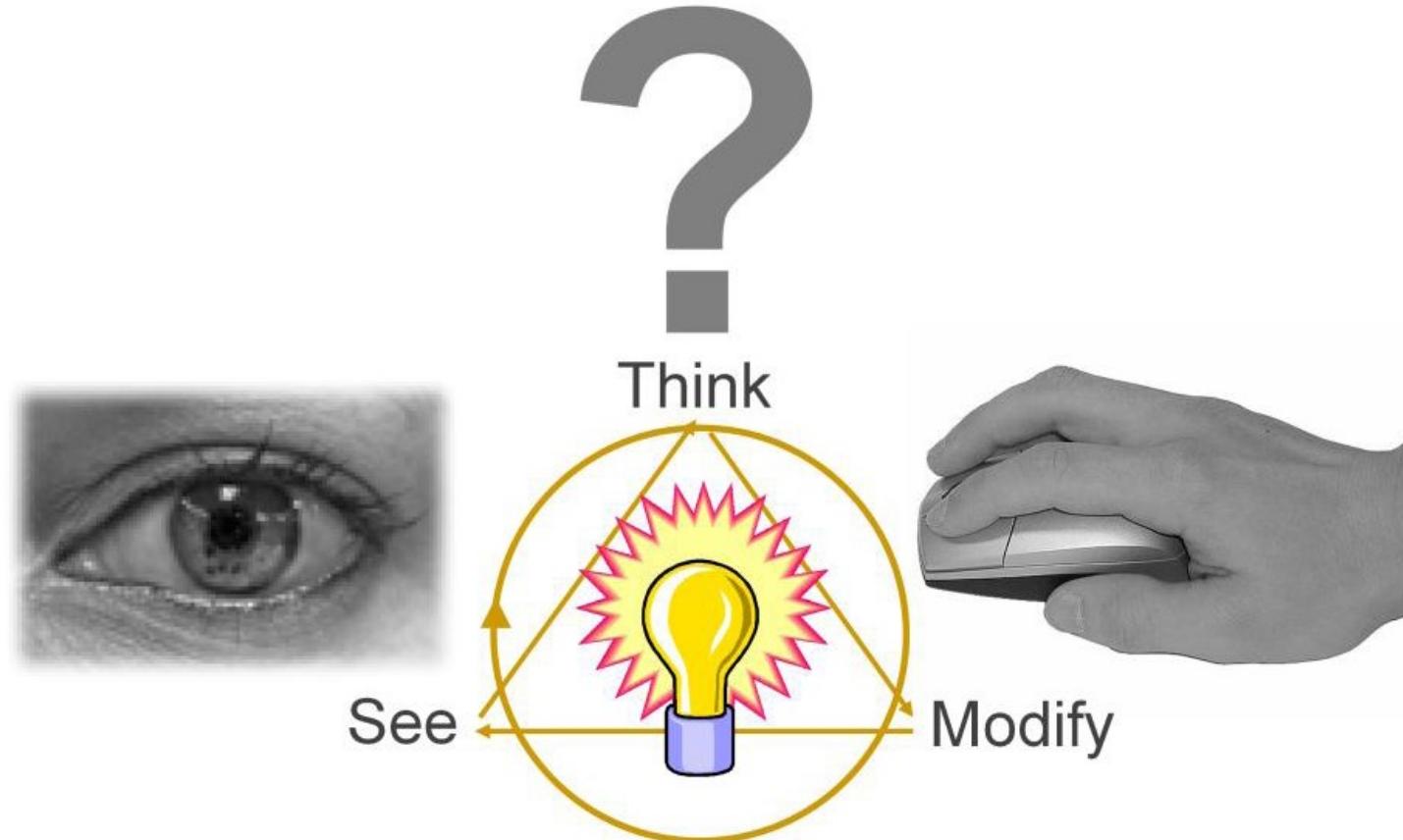
*When you have eliminated
the impossible, whatever
remains, however
improbable, must be the
truth.*

- Sherlock Holmes



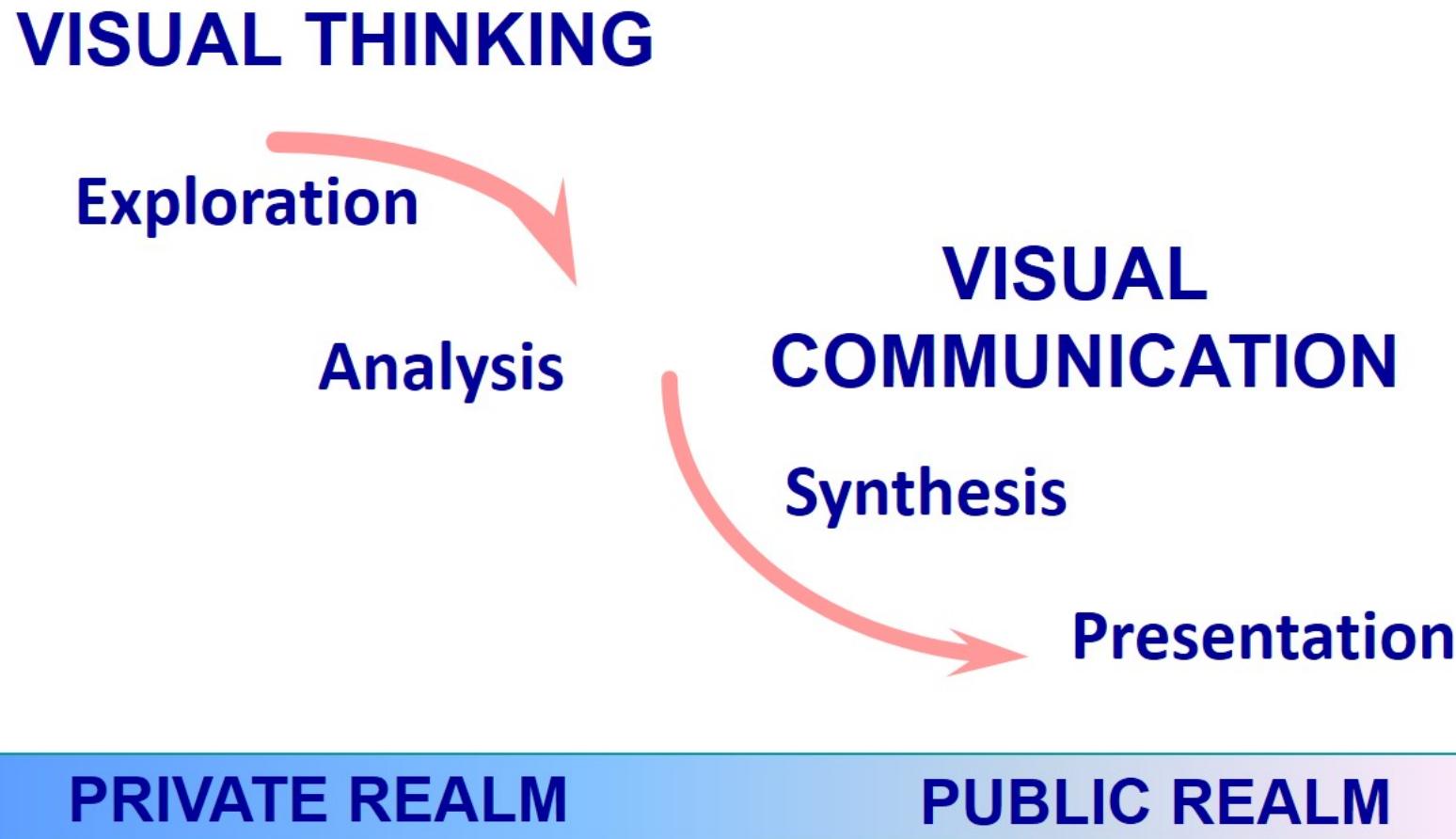
What is Visual Analytics?

Visual Analytics Framework



What is Visual Analytics?

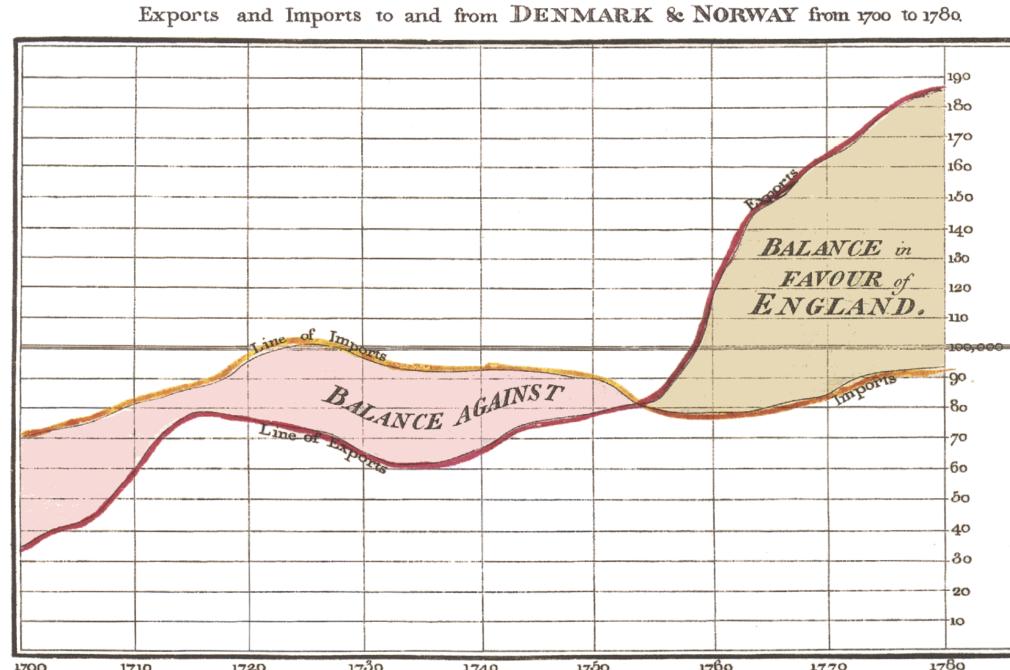
Visual Analytics require a shift of mindset



What is Visual Analytics?

Learning from the history of Visual Analytics

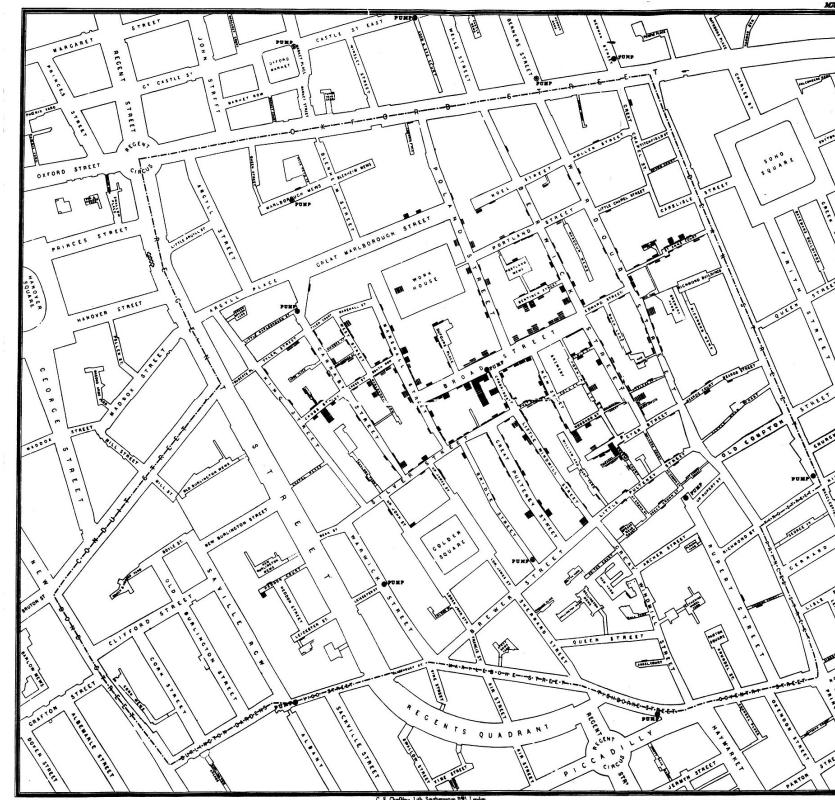
Commercial and Political Atlas by William Playfair (22 September 1759 – 11 February 1823)



What is Visual Analytics?

Learning from the history of Visual Analytics

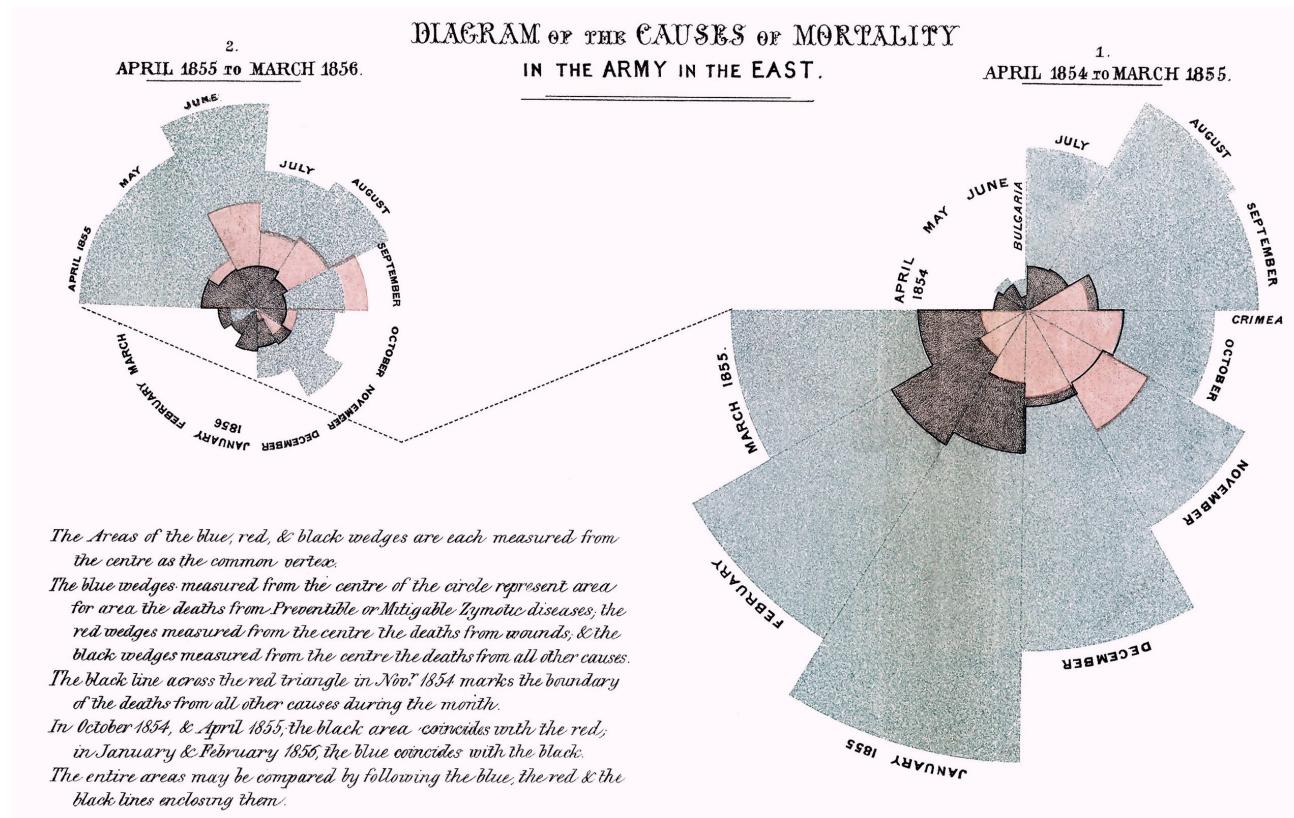
Cholera and the Pump on Broad Street (John Snow, 1854).



What is Visual Analytics?

Learning from the history of Visual Analytics

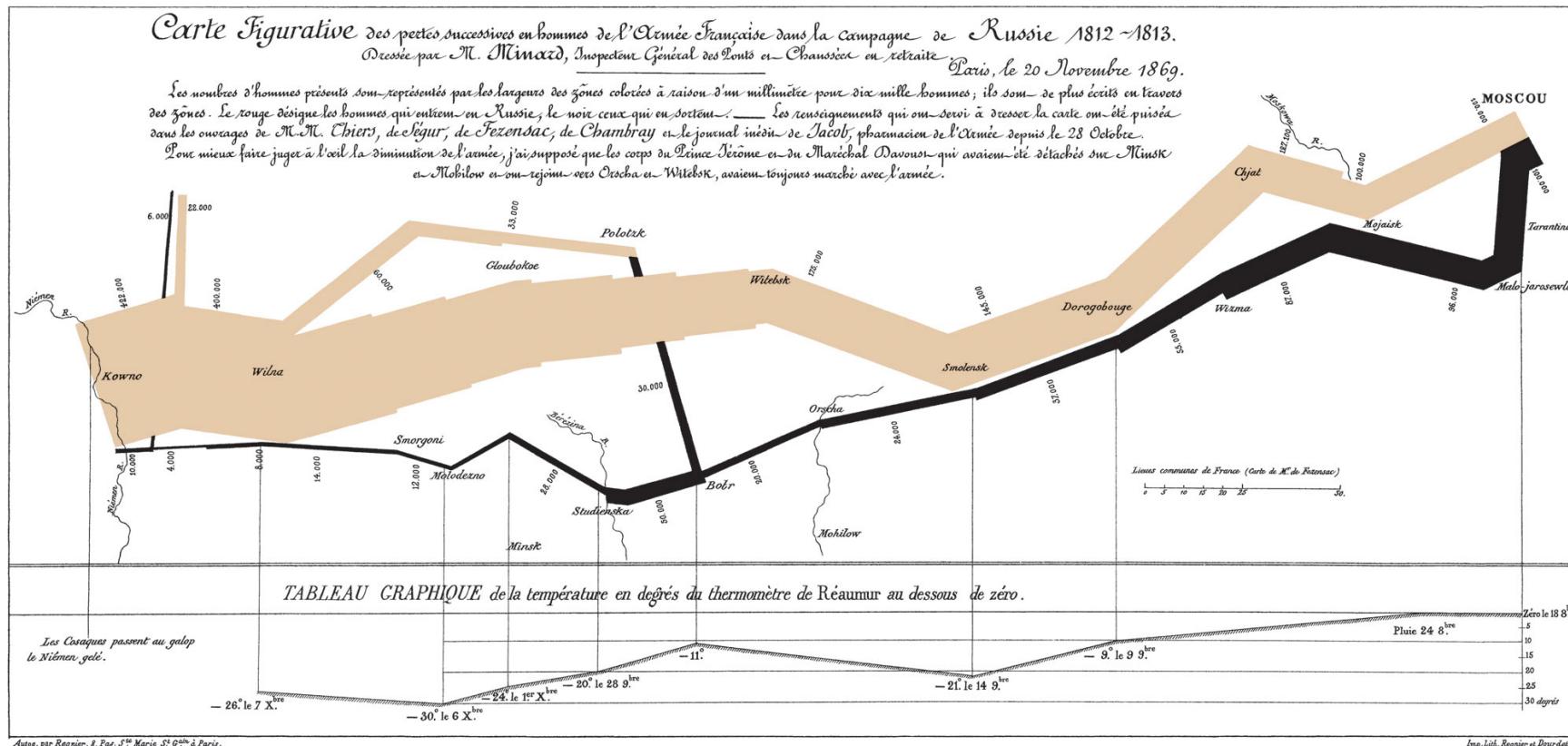
Florence Nightingale: The compassionate statistician (12 May 1820 – 13 August 1910)



What is Visual Analytics?

Learning from the history of Visual Analytics

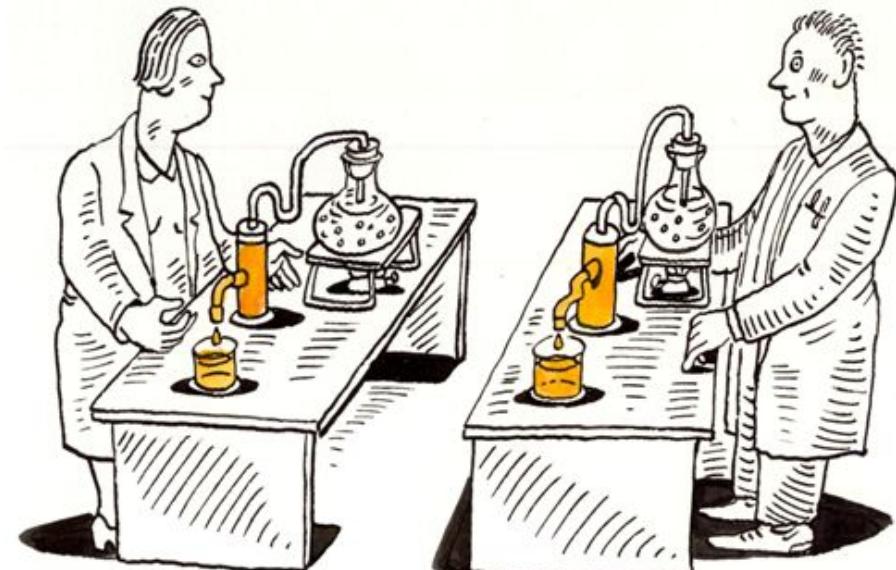
Plot of Napoleon's ill-fated Russian campaign of 1812-1813 (Charles Joseph Minard, 1861)



What is Visual Analytics?

Visual Analytics must be Reproducible

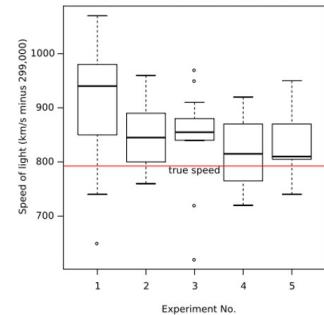
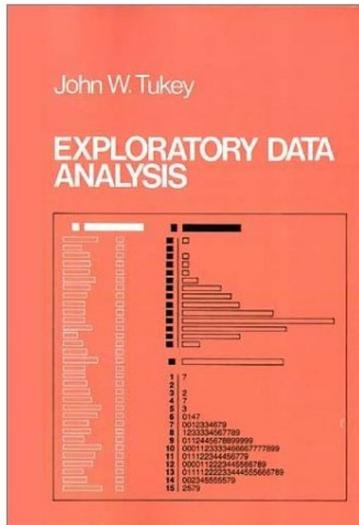
- For every result, keep track of how it was produced.
- Avoid manual data manipulation steps.
- Archive the exact versions of all external programmes used.
- Version control all custom scripts.
- Record all intermediate results, where possible in standard formats.
- For analysis that include randomness, note underlying random seeds.
- Always store raw data behind plots.
- Generate hierarchical analysis output, allowing layers of increasing detail to be inspected.
- Connect textual statements to underlying results.
- Provide public access to scripts, runs, and results.



Milestones in the history of Visual Analytics

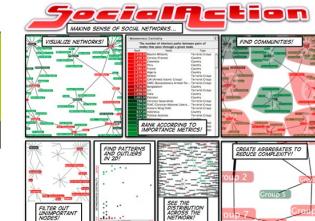
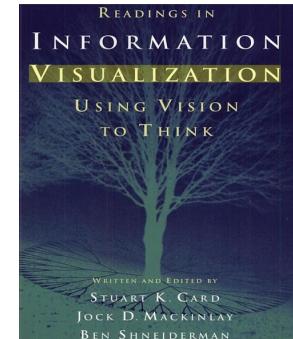
Exploratory Data Analysis by John Tukey (June 16, 1915 – July 26, 2000)

Exploration is the key!



The Craft of Information Visualization, 2003 (Ben Shneiderman)

Interaction is the key!



Source: https://en.wikipedia.org/wiki/Ben_Shneiderman

Data Visualisation Toolkits

- Commercial-off-the-shelf
 - Visual analytics toolkit such as Tableau, JMP, PowerBI, Qlik Sense/View & TIBCO SpotFire.
 - Specialised data visualisation applications such as TreeMap from Macrofocus (<https://www.macrofocus.com/>)
- Open source
 - Specialised data visualisation applications such as Gephi (<https://gephi.org/>)
 - Data visualisation API library such as D3.js (<https://d3js.org/>)

COS Data Visualisation Toolkit

Magic Quadrant for BI and Analytics Platforms



COS Data Visualisation Toolkit

Data Visualisation Centric



Power BI



Sense™



SAS® VISUAL ANALYTICS

BI Centric



QlikView

MicroStrategy

ORACLE
BUSINESS INTELLIGENCE



Programmable Data Visualisation Library

- Javascript
 - D3.js (<https://d3js.org/>)
- Python
 - Matplotlib (<http://matplotlib.org/>)
 - Bokeh (<http://bokeh.pydata.org/en/latest/>)
 - Plotly (<https://plot.ly/python/>)
- R, Base Graphics
 - lattice (<https://cran.r-project.org/web/packages/lattice/index.html>)
 - ggplot (<https://ggplot2.tidyverse.org/>)
 - plotly R (<https://plot.ly/r/>)
 - R Shiny (<https://shiny.rstudio.com/>)

Tableau: A data visualisation tool for everyone

- Theory to practice
 - The Grammar of Graphics
- Science to product
 - VisQL
 - Show Me
 - Polaris



Highly recommended blogs

- Perceptual Edge (<https://www.perceptualedge.com/>)
- Junk Charts (http://junkcharts.typepad.com/junk_charts/)
- The Functional Art (<http://www.thefunctionalart.com/>)