

Lesson 1: Introduction to Visual Analytics

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2019-04-28 (updated: 2022-01-03)

What will you learn from this lesson?

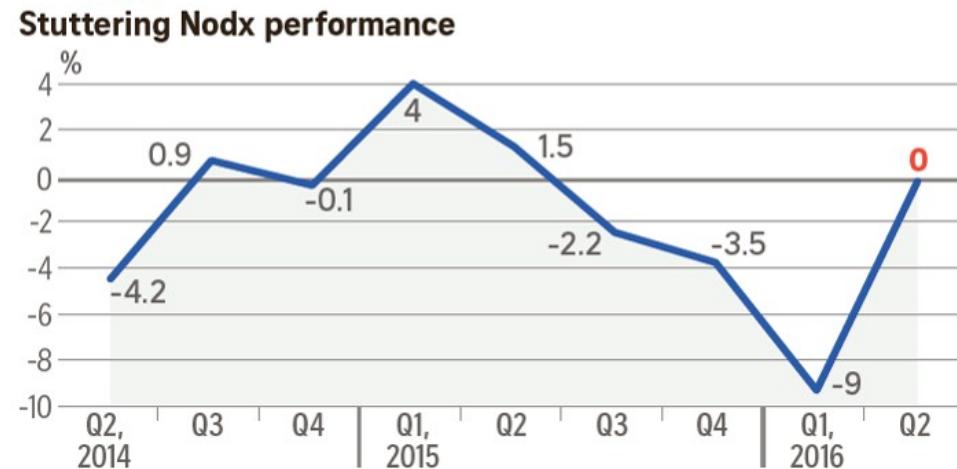
- Motivation of Visual Analytics
- What is Visual Analytics
- Learning from the history of visual analytics
- Data Visualisation tools

Motivation of Visual Analytics

The World is full of charts that lie!



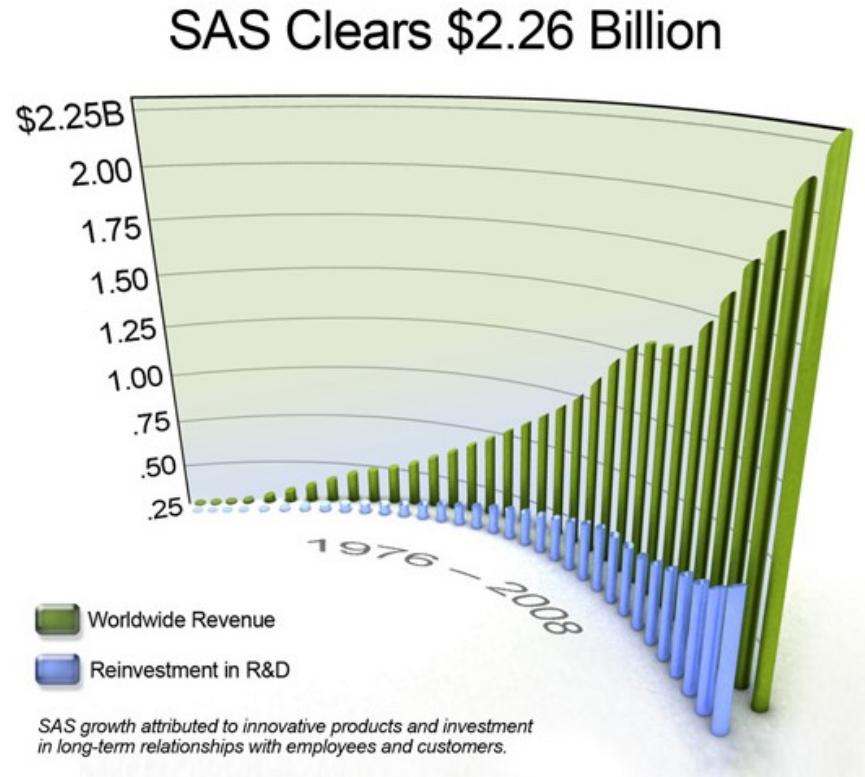
Non-oil domestic exports (Nodx) growth was flat in the second quarter. For the first half this year, **Nodx fell 4.5 per cent** compared with the same period last year.



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

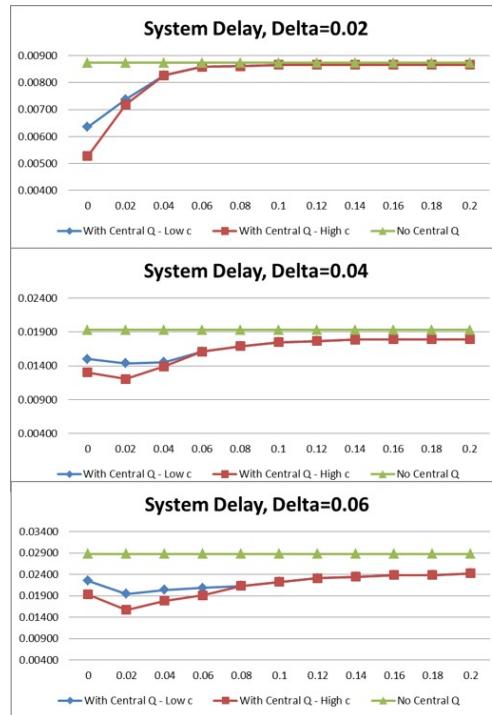
The World is buried in data,

Just SHOW me the number

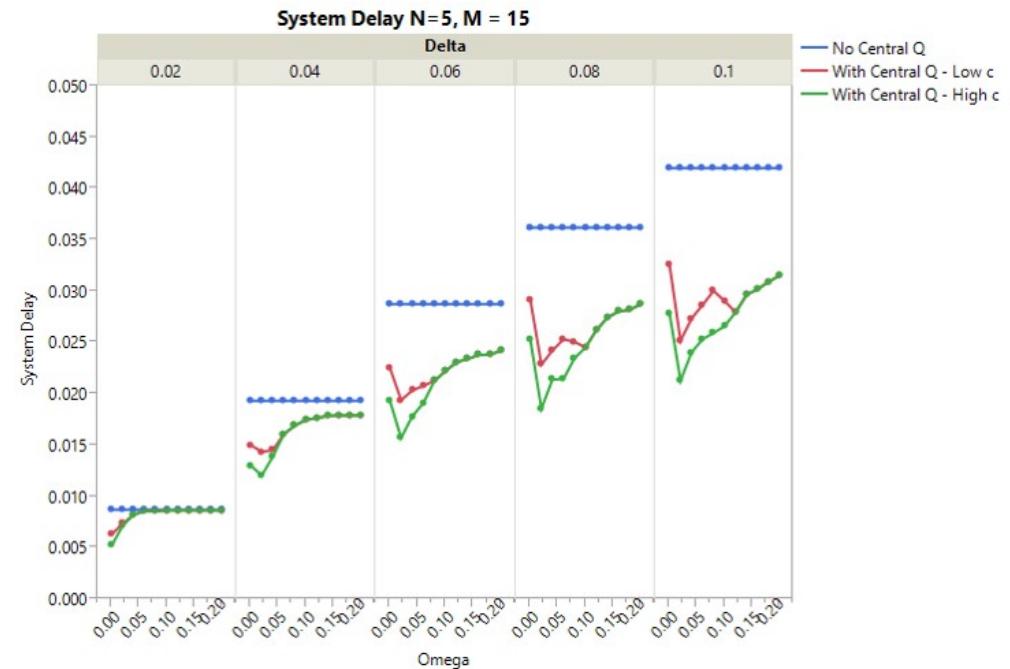
B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD		
1	Country Exchange	Name	Forer	Symbol	ISIN	SEDEON	Closette	MoopU	Industry	Suppliers	Today Close	1 Week (1 Month)	2 Month	3 Month	1 Day Chg	1 Day Chg	1 Day Chg	1 Week (2 Weeks)	1 Month	1 Month	2 Month	2 Month	3 Month							
2	AT	YIE	Ertiga Gr- EUR	ERTIGA.YI	AT000000538853	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	-0.058	0.245	0.263	0.4545	0.707	0.0763	0.157	-0.2			
3	AT	YIE	Rofitex EUR	ROFITEX.YI	AT000000520471	21.21	1E+09	SE+03	Financial	Bank	22.65	25	15.95	14.52	16	18.2	-0.054	-0.065	-0.052	-0.058	0.0532	0.0681	0.4550	0.507	0.3256	0.3754	0.05			
4	AT	YIE	Westar EUR	WESTAR.YI	AT000000520471	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	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	-0.001			
5	AT	YIE	Vicente EUR	VICENTE.YI	AT000000559375	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	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	-0.001			
6	AT	YIE	Maribor EUR	MARIBOR.YI	AT000000560615	2.2	3E+09	SE+03	Financial	Bank	21.02	24.40	21.49	22.88	25.60	21.04	-0.021	-0.029	-0.049	-0.049	0.0785	0.0785	0.0785	0.0785	0.0785	0.0785	-0.001			
7	AT	YIE	Andrea's EUR	ANDREAS.YI	AT000000519176	23.16	3E+09	SE+03	Financial	Industries	24.47	23.51	19.79	24	20.3	20.6	-0.071	-0.054	-0.067	-0.054	0.0542	0.0593	0.0557	0.05	0.0542	0.0593	-0.001			
8	AT	YIE	Vivian's EUR	VIVIANS.YI	AT000000519455	21.63	3E+09	SE+03	Financial	Industries	22.05	21.3	19.23	18.11	24.6	24.42	-0.019	-0.021	-0.005	-0.005	0.165	0.231	0.0303	0.0749	-0.021	-0.089	0.1			
9	AT	YIE	OMV AG EUR	OMVAG.YI	AT000000516159	25.2	4E+09	SE+03	Oil & Gas	Gas Oil & Gas	24.39	33.84	21.29	20.72	23.29	18.73	-0.077	-0.052	-0.067	-0.043	0.087	0.256	0.263	0.2644	0.2557	0.0641	0.241	-0.001		
10	AT	YIE	Telkom EUR	TELKOM.YI	AT000000513508	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	0.0644	0.0667	0.0667	0.0702	0.0437	0.0501	-0.001			
11	AT	YIE	Verbind EUR	VERBIND.YI	AT000000516691	28.53	2E+09	SE+03	Financial	Bank	28.36	29.92	26.12	25	23.97	32.56	-0.013	-0.015	-0.024	-0.024	0.0449	0.0446	0.0446	0.0446	0.0446	0.0446	-0.001			
12	AT	YIE	Arivis E- EUR	ARIVIS.EI	AT000000513569	2.27	5E+09	SE+03	Financial	Real Est.	2.32	2.02	2.5	1.47	2.10	2.50	-0.022	-0.022	0.026	0.026	0.0356	0.0356	0.0356	0.0356	0.0356	0.0356	-0.001			
13	AU	ASX	Bendigo AUD	BENDIGO.XA	AU00000051920C	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	0.3	0.473	0.3974	0.3737	-0.01	-0.035	-0.2		
14	AU	ASX	Suncorp AUD	SUNCORP.XA	AU000000515598	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	0.2437	0.111	0.005	0.0518	0.5185	-0.2	-0.2327	-0.2		
15	AU	ASX	National AUD	NATIONAL.XA	AU000000516240	20.1	4E+09	SE+03	Financial	Bank	21.09	19.79	19.55	17.51	18.93	20.95	-0.017	-0.017	-0.046	-0.057	0.0504	0.0504	0.0504	0.1479	0.2522	0.0518	0.1551	-0.001		
16	AU	ASX	Busk I AUD	BUSKI.XA	AU000000516762	8.44	1E+09	SE+03	Financial	Bank	8.3	7.94	7.04	6.82	7.4	9.45	-0.095	-0.091	-0.063	-0.056	0.0583	0.0583	0.0583	0.2359	0.0458	0.0465	0.0389	-0.001		
17	AU	ASX	Australia AUD	ANZAX.XA	AU000000516558	16.55	15.25	14.05	13.05	13.05	12.17	15.25	-0.049	-0.049	-0.058	-0.058	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269	0.0269							
18	AU	ASX	Westpac AUD	WBAX.XA	AU000000516546	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	0.0003	0.0003	0.0003	0.1441	0.223	0.1455	0.2153	0.2206	0.0324	-0.001
19	AU	ASX	Common AUD	CBAX.XA	AU000000512503	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	-0.01	0.0504	0.0503	0.0503	0.0503	0.0503	0.0503	-0.001			
20	AU	ASX	Blucosco AUD	BLUCOSCO.XA	AU000000515332	2.57	5E+09	SE+03	Business M	Group	2.73	2.29	2.29	2.29	3.55	3.45	-0.078	-0.078	0.0152	0.0152	0.0152	0.0152	0.0152	0.0152	-0.001					
21	AU	ASX	CSR AUD	CSRAX.XA	AU000000513941	1.2	2E+09	SE+03	Business M	Group	12.75	11.95	11	10	14.25	17.9	-0.053	-0.053	0.048	0.048	0.0422	0.0422	0.0422	0.0422	0.0422	0.0422	-0.001			
22	AU	ASX	Ikeda Res AUD	IKEDARE.XA	AU000000513575	4.03	1E+09	SE+03	Business M	Group	4.1	4.4	4.2	4.2	4.25	4.44	-0.027	-0.027	-0.024	-0.024	-0.04	-0.04	-0.0455	-0.0455	-0.0455	-0.0455	-0.0455	-0.0455	-0.001	
23	AU	ASX	OneSteel AUD	OSTAX.XA	AU00000051293721	2.25	2E+09	SE+03	Business M	Group	2.30	2.35	1.80	1.8	2.43	2.33	-0.055	-0.054	0.024	0.024	0.2457	0.121	0.025	0.25	0.3502	-0.074	0.074			
24	AU	ASX	Ashmore I AUD	ASHMORE.I.XA	AU00000051545865	1.29	1E+09	SE+03	Business M	Group	1.23	1.21	1.21	1.25	1.14	1.28	-0.032	-0.032	-0.073	-0.073	0.0597	0.29	0.054	0.071	0.0508	0.2288	0.2254			
25	AU	ASX	Newcrest AUD	NCMIA.XA	AU000000516701	32.73	2E+09	SE+03	Business M	Group	55.54	53.66	51.78	51	50.05	52.04	-0.024	-0.024	-0.028	-0.028	0.04	0.04	0.0522	0.0538	0.0538	0.0538	0.0538	0.0538	-0.001	
26	AU	ASX	Ernst Bill AUD	ERNSTBIL.XA	AU000000514455	3.12	8E+09	SE+03	Business M	Group	3.59	3.61	3.61	3.21	3.15	3.03	-0.005	-0.005	-0.005	-0.005	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	-0.001			
27	AU	ASX	Lion Lgr AUD	LOLAX.XA	AU000000516204	1.43	1E+09	SE+03	Business M	Group	1.43	1.43	1.43	1.43	1.43	1.43	-0.001	-0.001	-0.001	-0.001	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	-0.001			
28	AU	ASX	Portsea E AUD	PORTSEA.E.XA	AU000000516646	3.57	3E+09	SE+03	Business M	Group	2.9	2.9	2.9	2.9	2.9	2.9	-0.001	-0.001	-0.001	-0.001	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	-0.001			
29	AU	ASX	Palmsol E AUD	PALMSOL.E.XA	AU000000516646	3.4	2E+09	SE+03	Business M	Group	3.51	3.41	3.41	3.41	3.56	3.56	-0.047	-0.047	-0.047	-0.047	0.0353	0.0353	0.0353	0.0353	0.0353	0.0353	-0.001			
30	AU	ASX	Rio Tinto AUD	RIOTINTO.XA	AU00000051220902	56.51	1E+09	SE+03	Business M	Group	56.88	55.59	55.75	46.2	55.65	57.05	-0.025	-0.025	-0.005	-0.005	0.0195	0.0195	0.0195	0.0195	0.0195	0.0195	-0.001			
31	AU	ASX	Indesol Pi AUD	INDESOLPI.XA	AU000000516704	2.12	5E+09	SE+03	Business M	Group	2.2	2.2	2.03	2.03	2.1	2.1	-0.003	-0.003	-0.004	-0.004	-0.0234	-0.0234	-0.0234	-0.0234	-0.0234	-0.0234	-0.001			
32	AU	ASX	Orcio Inv AUD	ORCIAX.XA	AU000000516704	15.14	14.16	14.05	17.76	17.76	15.14	15.14	-0.023	-0.023	-0.023	-0.023	0.0077	0.0077	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072	0.0072					
33	AU	ASX	Lightfoot AUD	LEFOOTAX.XA	AU000000512227	15.26	16.04	16.04	15.26	15.26	15.26	15.26	-0.023	-0.043	-0.042	-0.026	-0.003	-0.003	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043					
34	AU	ASX	Boylel Inv AUD	BLDAX.XA	AU000000512847	3.61	2E+09	SE+03	Business M	Group	3.68	3.41	2.98	2.93	3.01	3.55	-0.053	-0.053	-0.067	-0.051	0.0519	0.0519	0.0519	0.0519	0.0519	0.0519	-0.001			
35	AU	ASX	James Ht AUD	JHCAJAX.XA	AU000000514237	4.2	8E+09	SE+03	Business M	Group	4.01	4.05	3.75	3.25	3.79	4.45	-0.043	-0.035	-0.035	-0.037	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	-0.001			
36	AU	ASX	Lend Los Aus	LLCAX.XA	AU000000515204	6.43	3E+09	SE+03	Business M	Group	6.42	6.25	5.82	5.62	6.73	7.03	-0.009	-0.008	-0.008	-0.008	0.0174	0.0171	0.0171	0.0171	0.0171	0.0171	-0.001			
37	AU	ASX	Dover I AUD	DOVIAX.XA	AU000000514557	4.45	1E+09	SE+03	Business M	Group	4.61	4.29	4.15	3.81	4.56	5.35	-0.025	-0.025	-0.037	-0.037	0.0226	0.0226	0.0226	0.0226	0.0226	0.0226	-0.001			
38	AU	ASX	United G AUD	UGLAX.XA	AU000000513411	9.15	2E+09	SE+03	Business M	Group	9.23	7.89	7.5	6.02	8	9.05	-0.003	-0.045	-0.045	-0.045	0.0224	0.0225	0.0225	0.0225	0.0225	0.0225	-0.001			
39	AU	ASX	Perpetua AUD	PPTAX.XA	AU000000516522	26.84	1E+09	SE+03	Financial	Financial	27.64	27.32	25.5	23.88	30.12	34.5	-0.023	-0.025	-0.024	-0.024	0.0207	0.0207	0.0207	0.0207	0.0207	0.0207	-0.001			
40	AU	ASX	ASX Ltd Aus	ASXAX.XA	AU000000512328	29.35	5E+09	SE+03	Financial	Financial	30.05	29.44	29	26.10	27.15	32.72	-0.021	-0.023	-0.003	-0.003	0.0055	0.0051	0.0051	0.0051	0.0051	0.0051	-0.001			
41	AU	ASX	AMP Ltd Aus	AMPAAX.XA</td																										

Motivation of Visual Analytics

Spreadsheet: A great hammer but lousy screwdriver



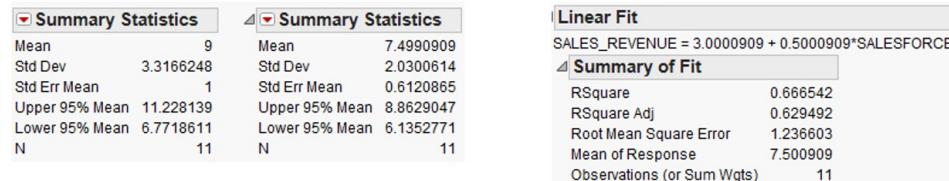
Visual analytics come to the rescue



Motivation of Visual Analytics

When statistics failed!

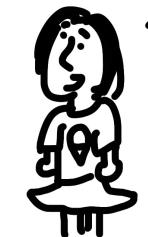
SALESFORCE A	SALES_REVENUE A	SALESFORCE B	SALES_REVENUE B	SALESFORCE C	SALES_REVENUE C	SALESFORCE D	SALES_REVENUE D
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24	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

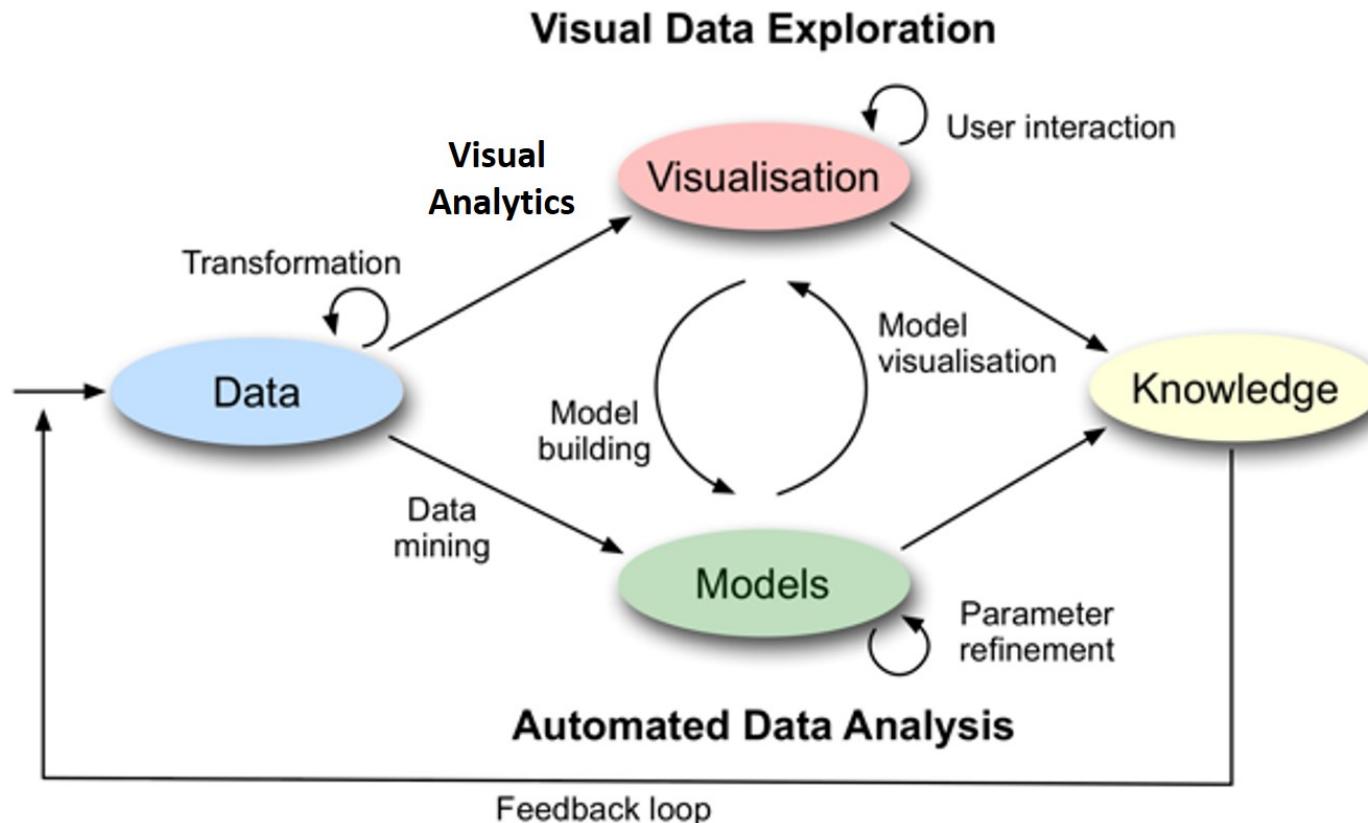
Motivation of Visual Analytics

Analytical graphics reveal the truth



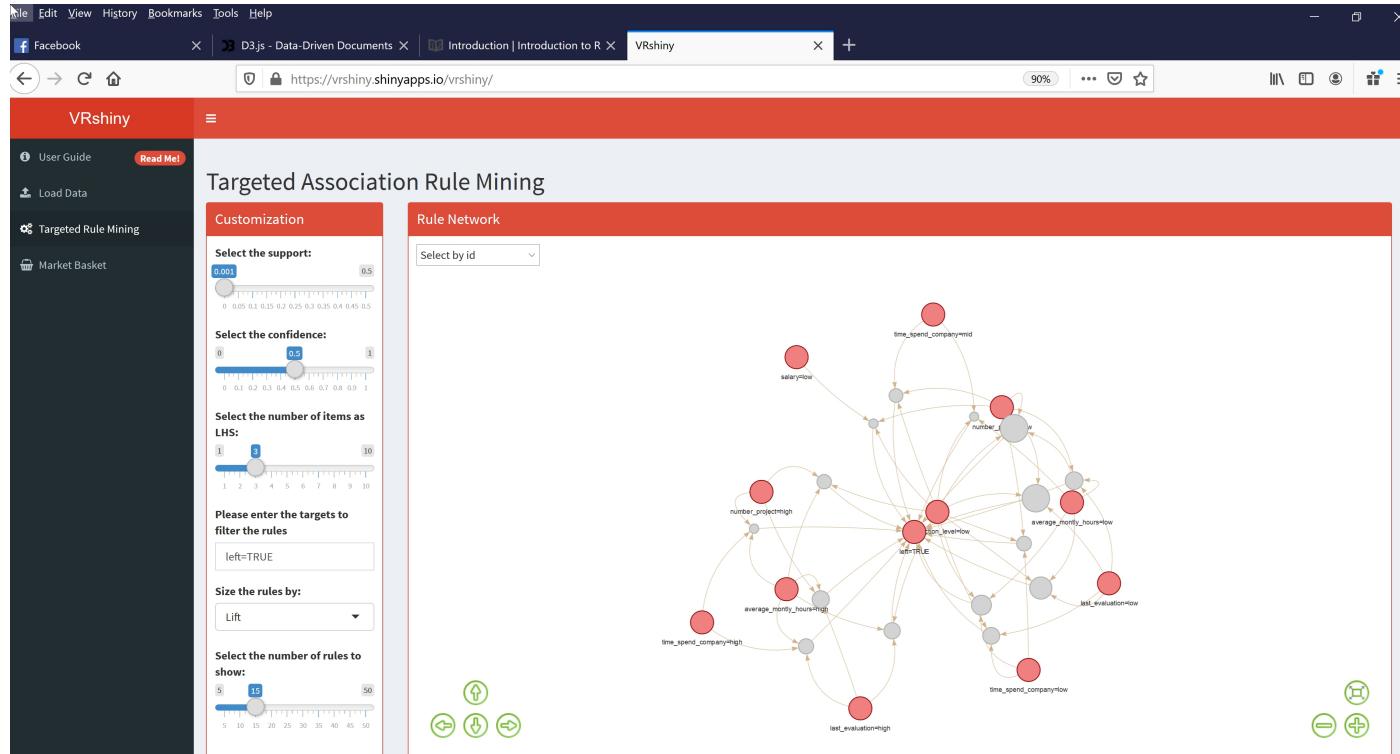
Motivation of Visual Analytics

Is there a place for Visual Analytics in knowledge discovery?



Motivation of Visual Analytics

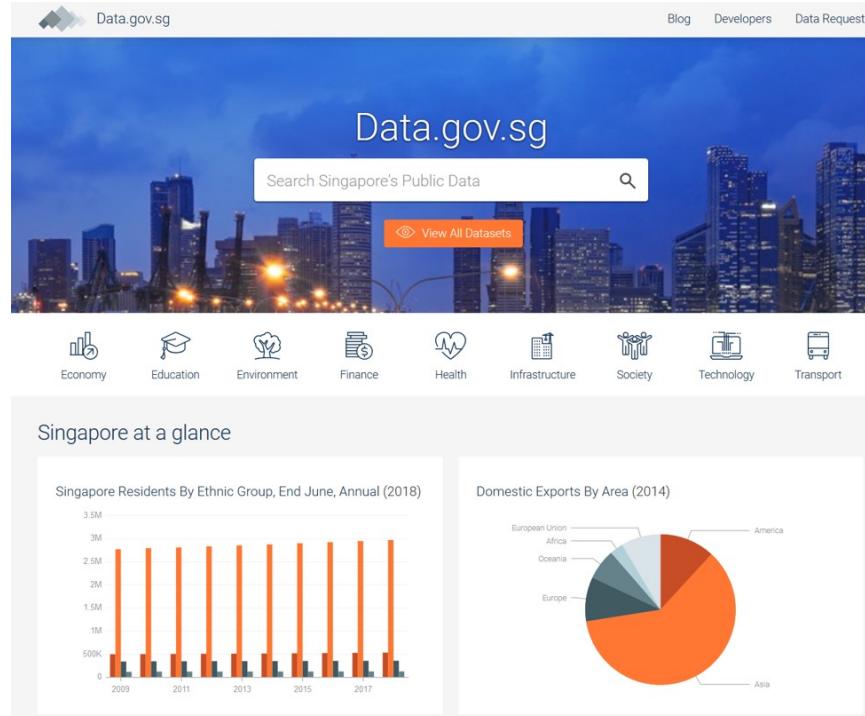
Free and Open Source Analytics Web Apps



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

Motivation of Visual Analytics

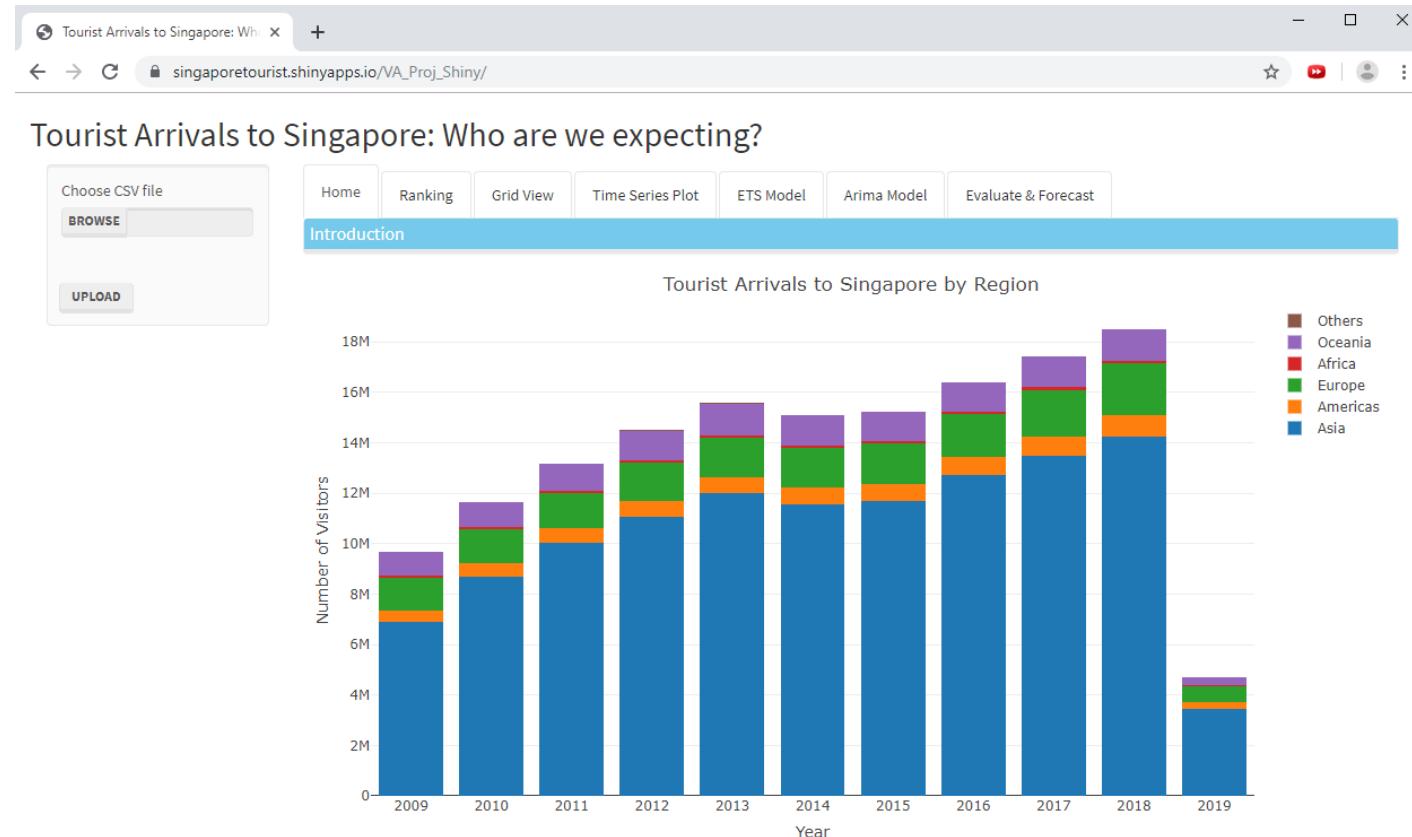
Open data need to be unlocked!



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

Motivation of Visual Analytics

Democratising Data and Analytics with Visually-driven Web Apps



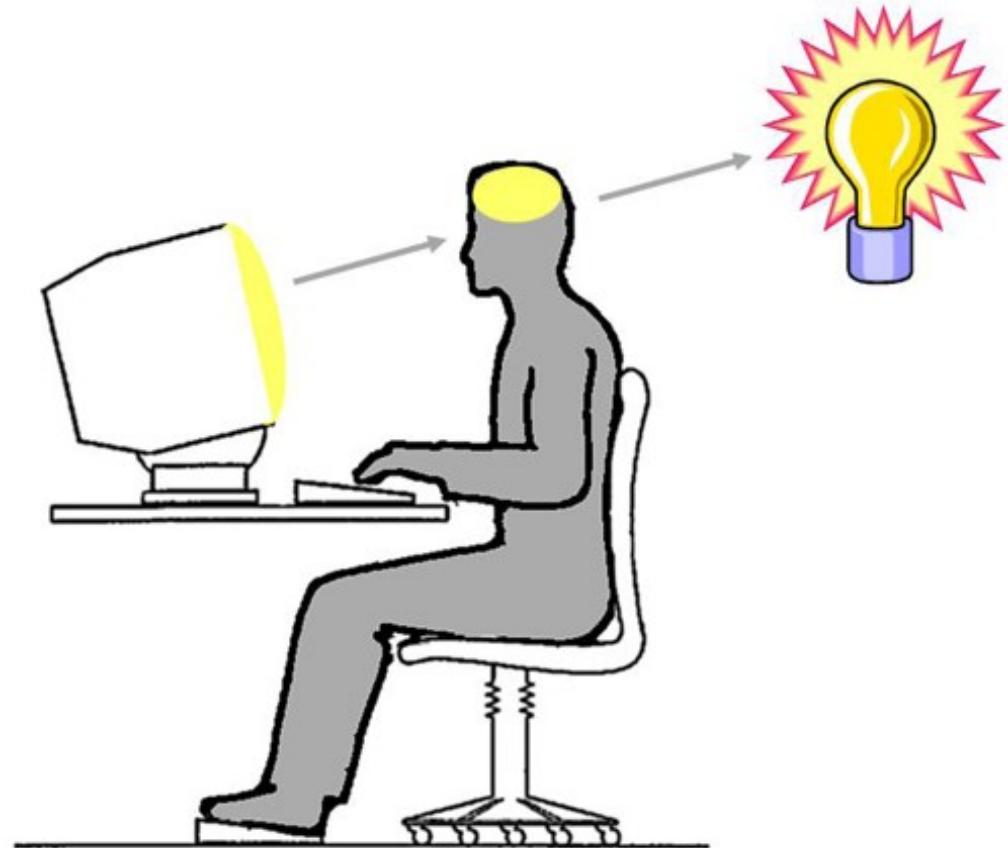
Visit the link at https://singaporetourist.shinyapps.io/VA_Proj_Shiny/

What is Visual Analytics?

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

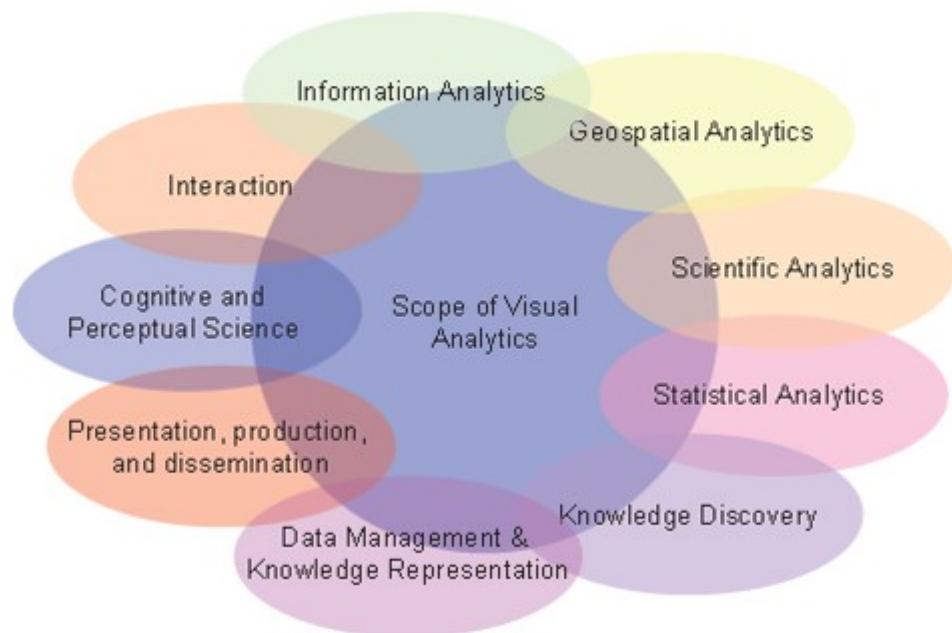
- Data Science and Analytics
- Data Visualisation
- Human-Computing-Interaction (HCI)
- Interface Design
- Visual Storytelling

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**.

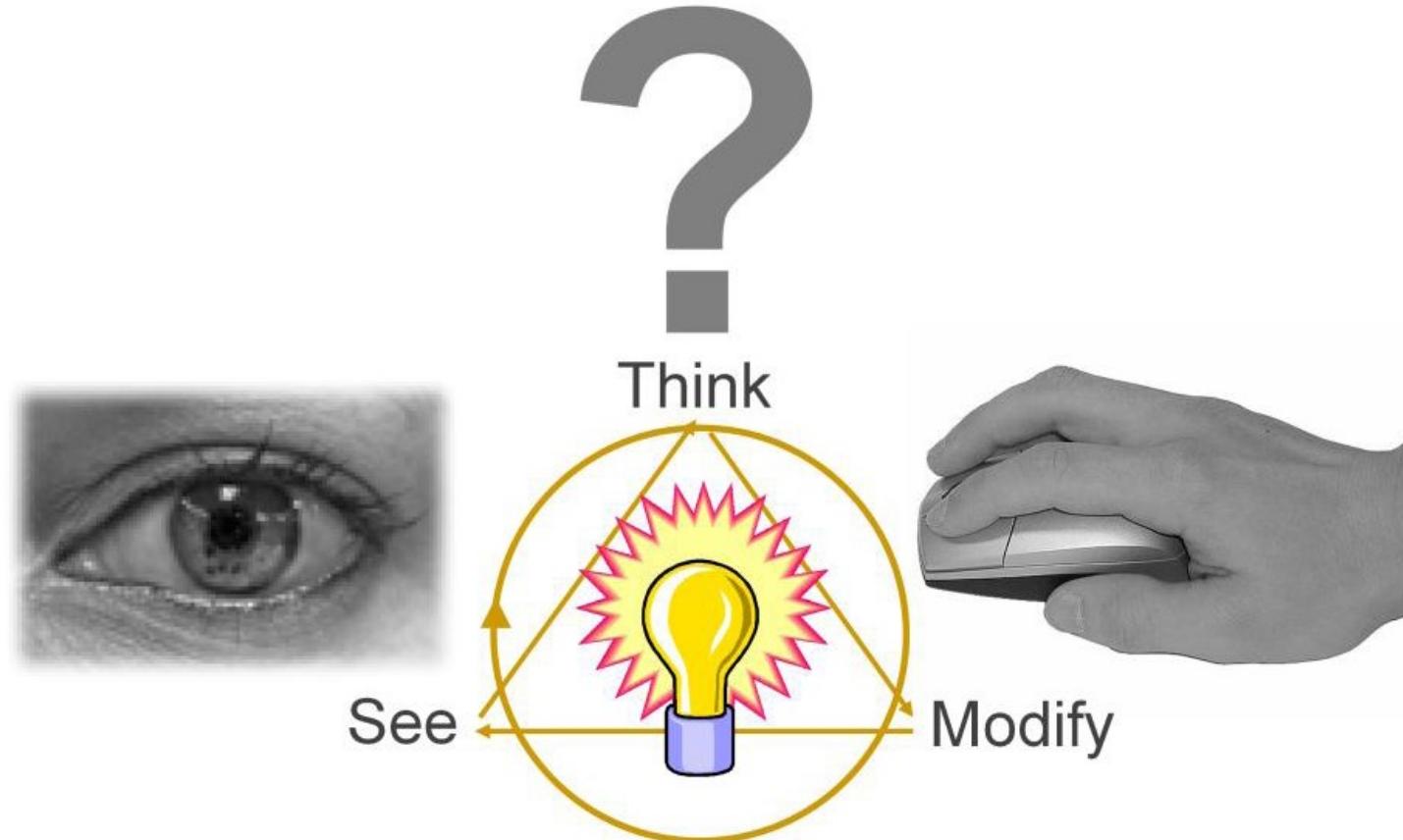
*When you have eliminated
the impossible, whatever
remains, however
improbable, must be the
truth.*

- Sherlock Holmes



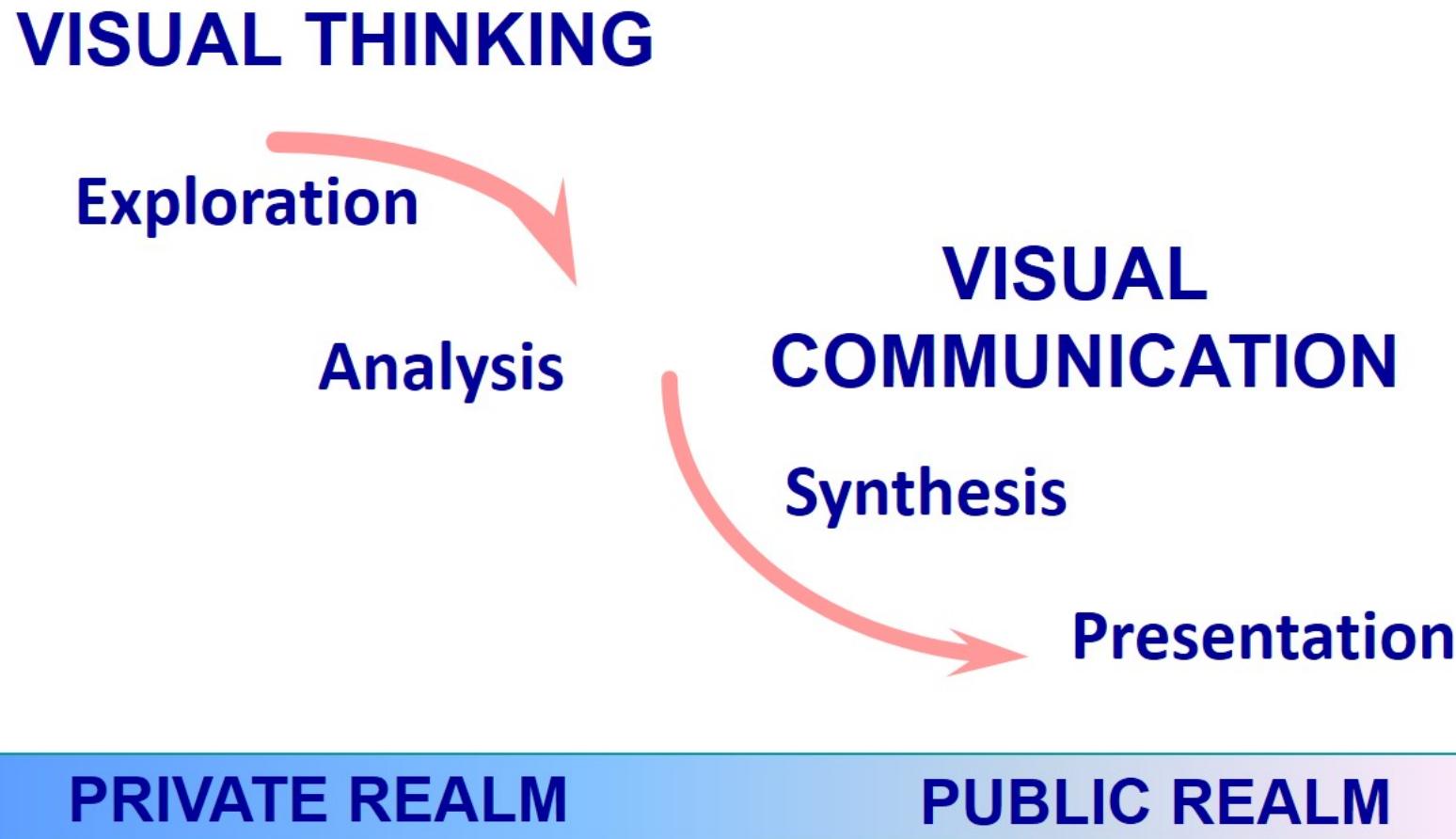
What is Visual Analytics?

Visual Analytics Framework



What is Visual Analytics?

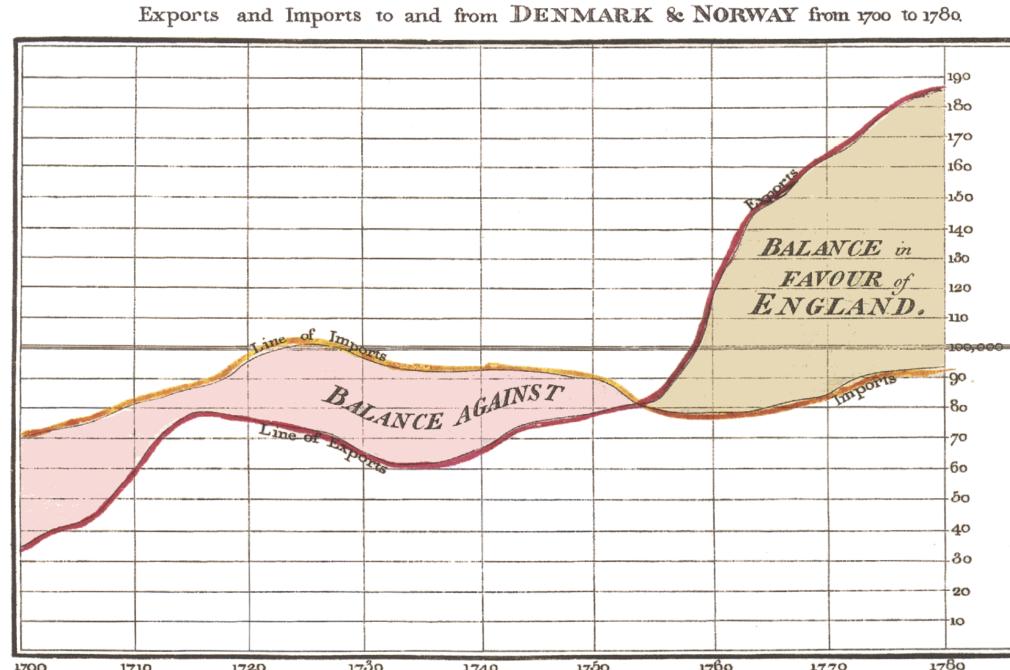
Visual Analytics require a shift of mindset



What is Visual Analytics?

Learning from the history of Visual Analytics

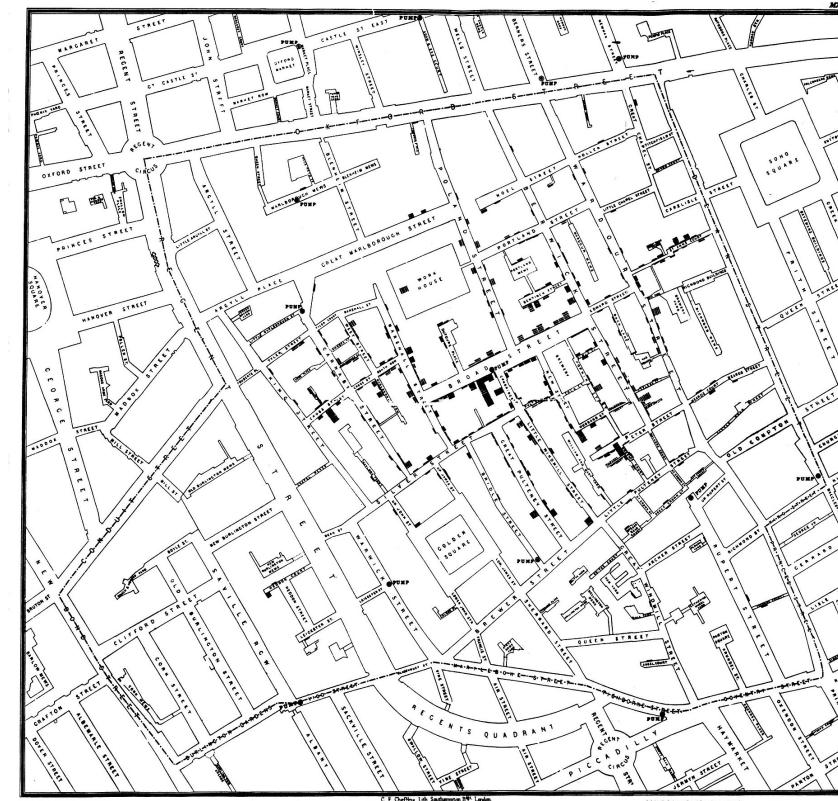
Commercial and Political Atlas by William Playfair (22 September 1759 – 11 February 1823)



What is Visual Analytics?

Learning from the history of Visual Analytics

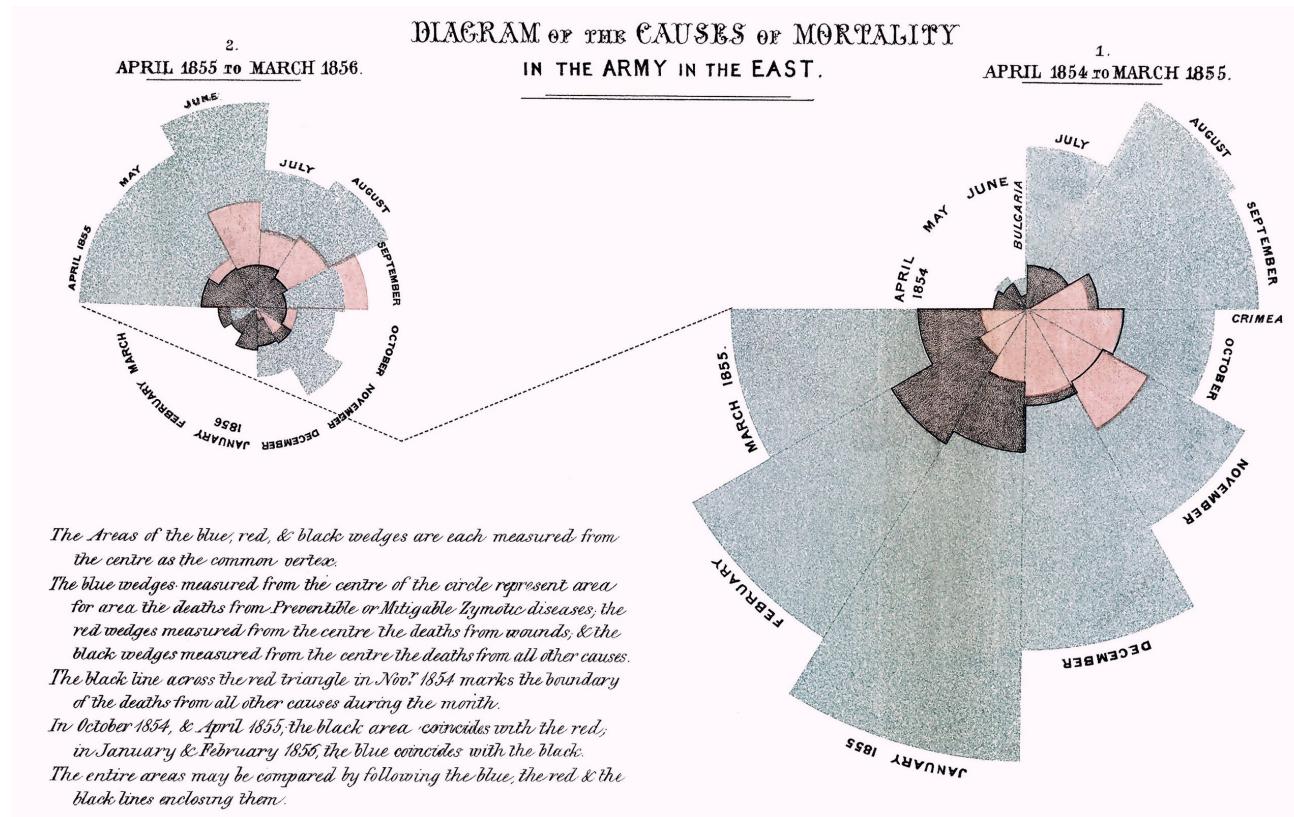
Cholera and the Pump on Broad Street (John Snow, 1854)



What is Visual Analytics?

Learning from the history of Visual Analytics

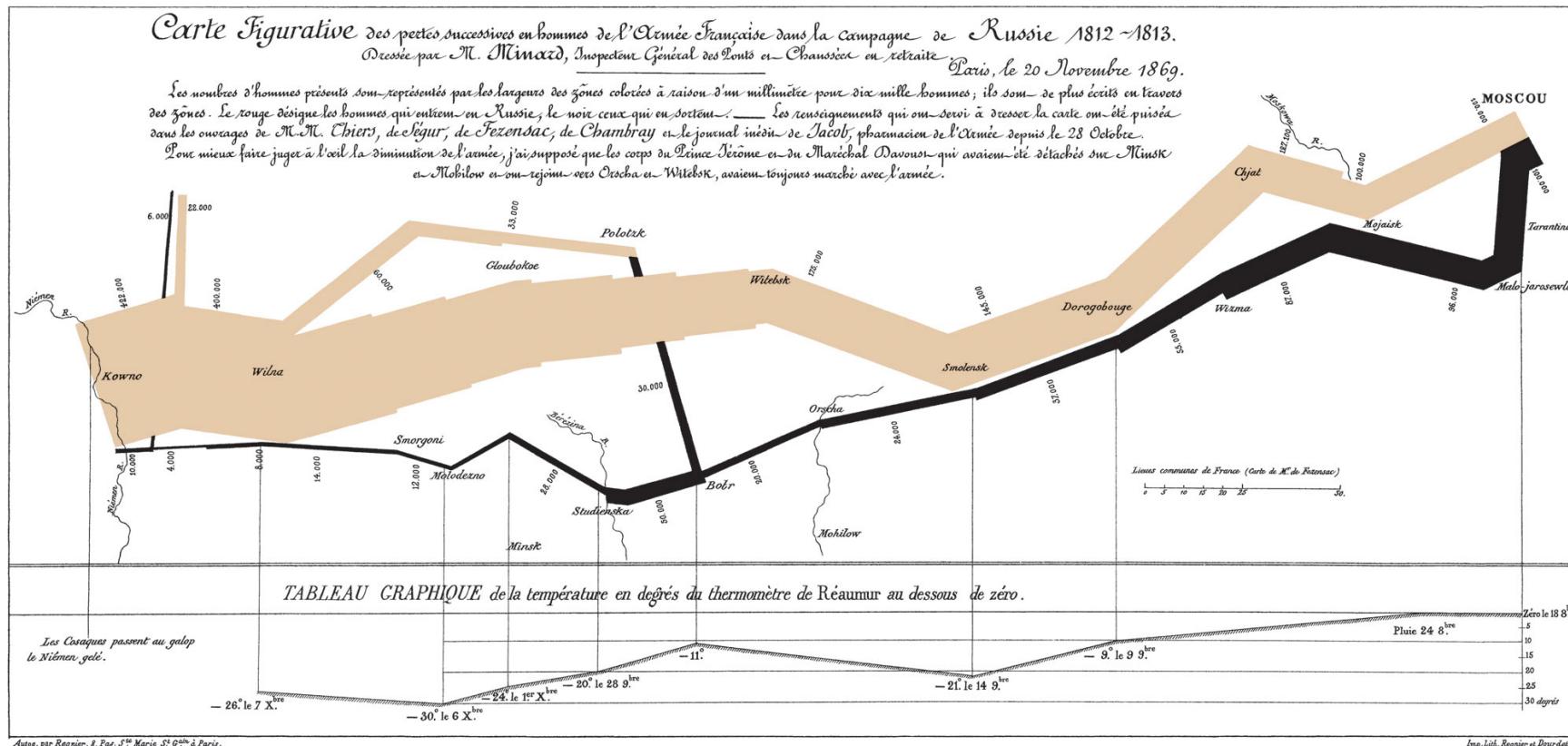
Florence Nightingale: The compassionate statistician (12 May 1820 – 13 August 1910)



What is Visual Analytics?

Learning from the history of Visual Analytics

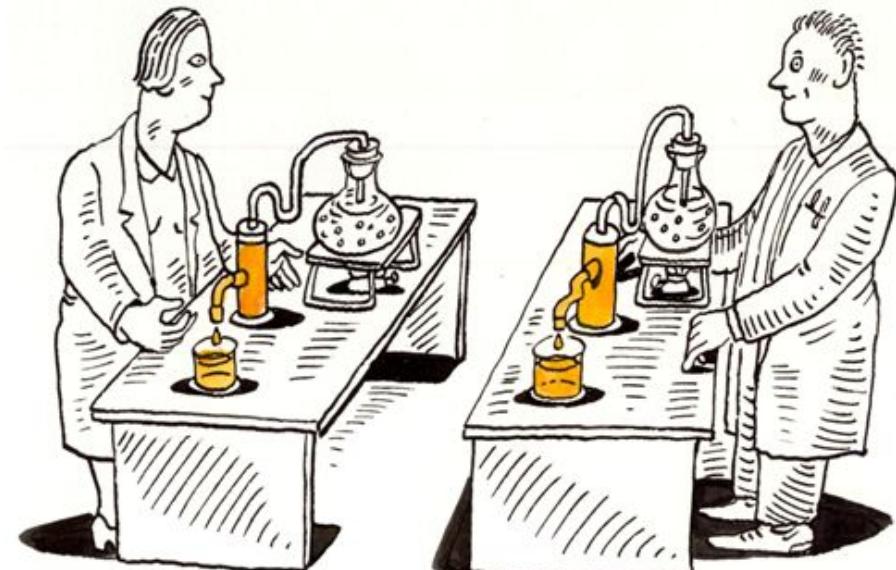
Plot of Napoleon's ill-fated Russian campaign of 1812-1813 (Charles Joseph Minard, 1861)



What is Visual Analytics?

Visual Analytics must be Reproducible

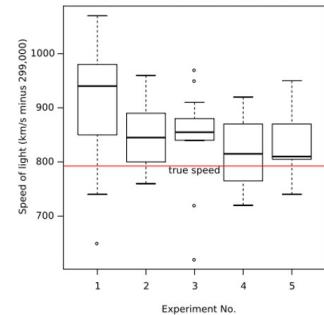
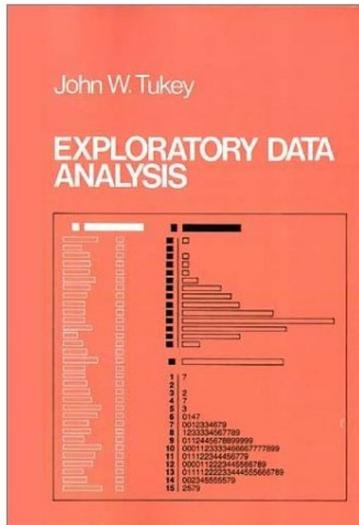
- For every result, keep track of how it was produced.
- Avoid manual data manipulation steps.
- Archive the exact versions of all external programmes used.
- Version control all custom scripts.
- Record all intermediate results, where possible in standard formats.
- For analysis that include randomness, 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

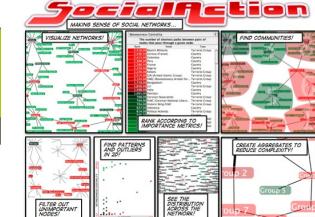
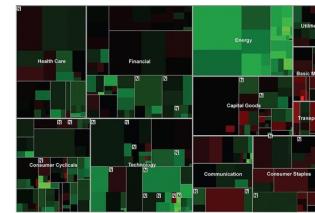
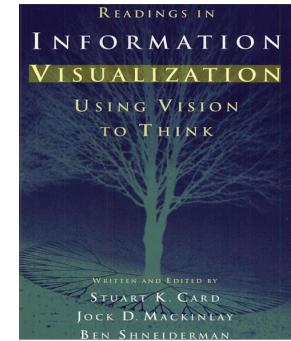
Exploratory Data Analysis by John Tukey (June 16, 1915 – July 26, 2000)

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/>)