

Lesson 1

Introduction to Visual Analytics and Applications

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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

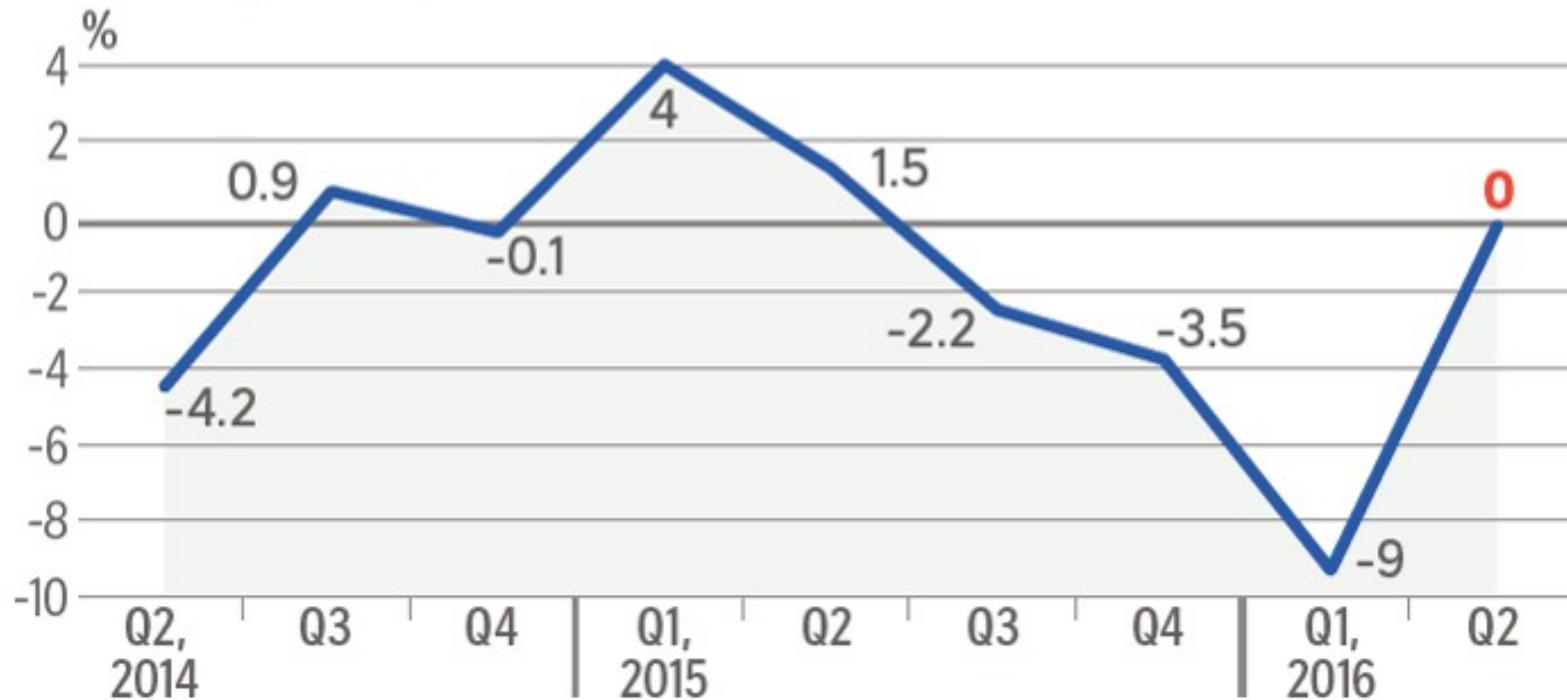
Motivation of Visual Analytics

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.

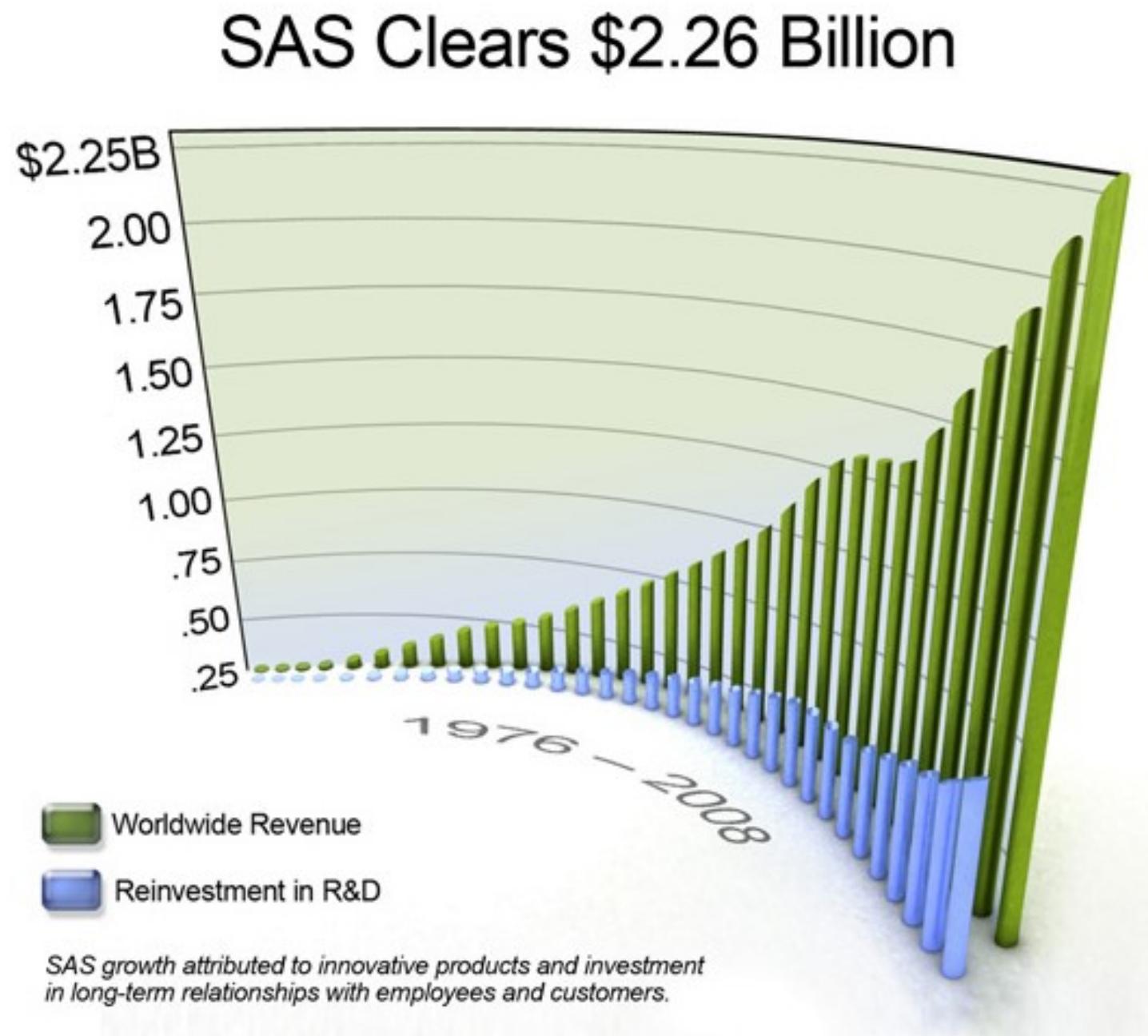
Stuttering Nodx performance



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: [Big Data Ocean](#)

Motivation of Visual Analytics

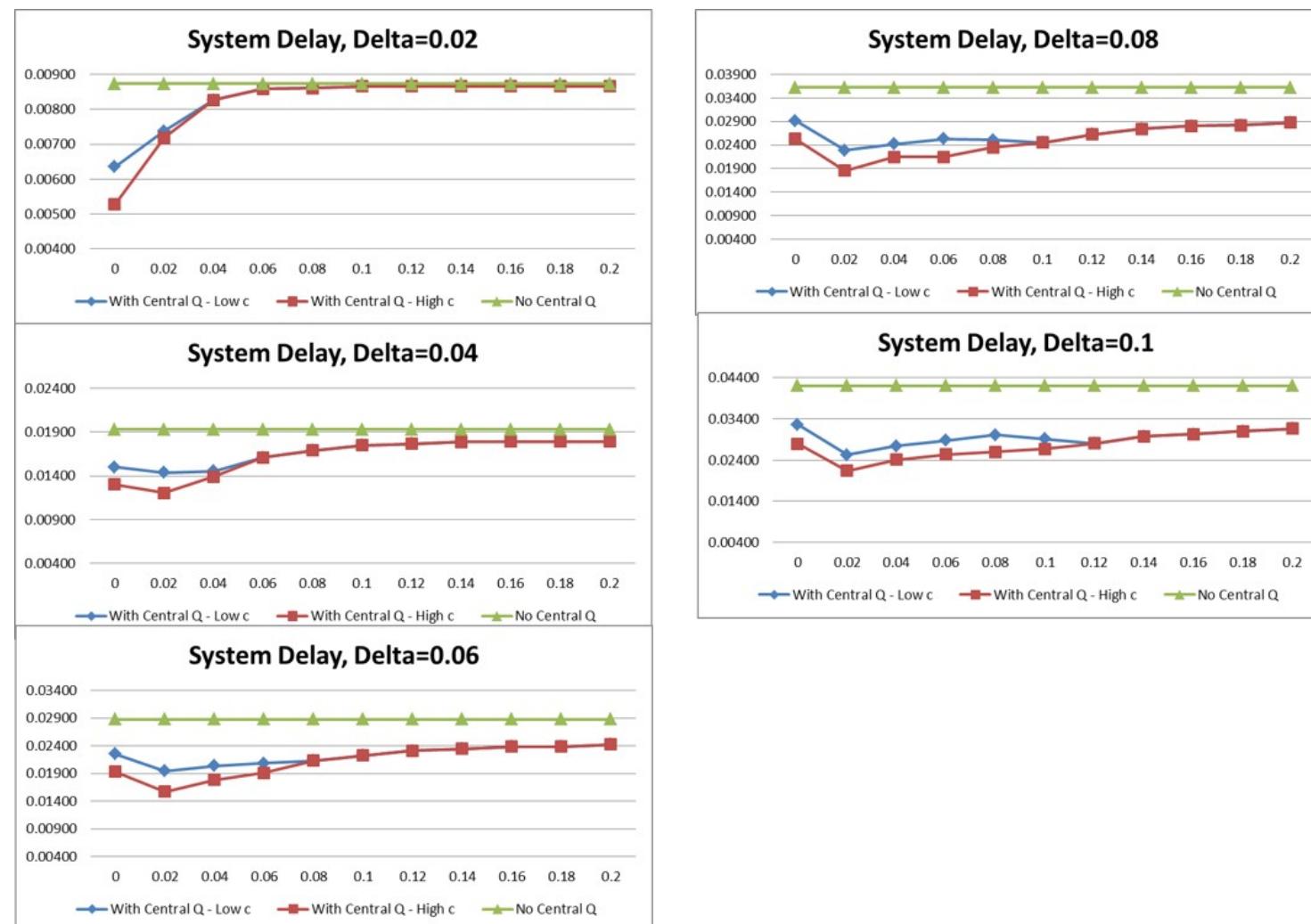
The World is buried in data,

Just SHOW me the number

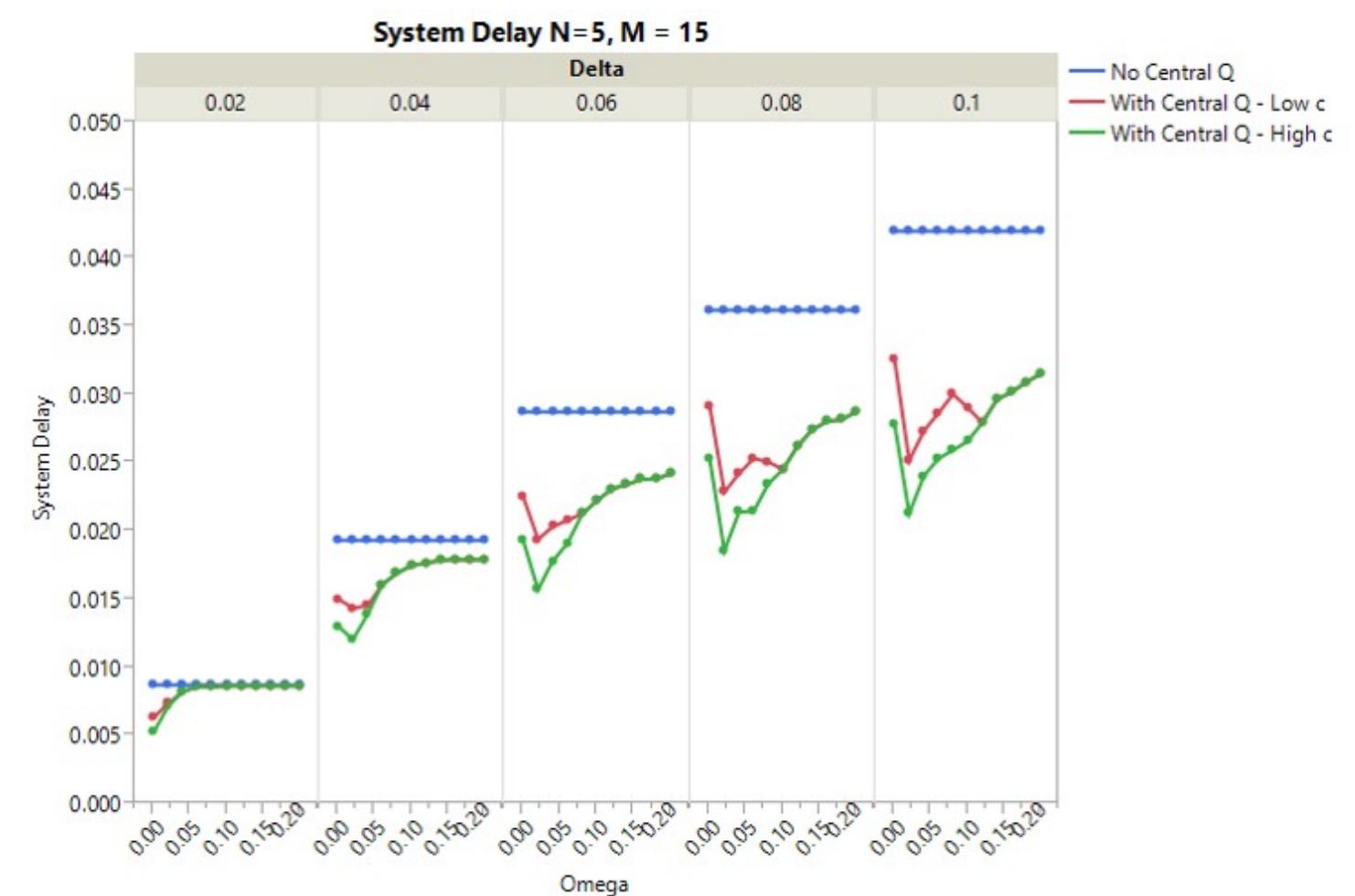
B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
1	Country	Exchange	Name	Forex	Symbol	ISIN	SEOL	Close(Io)	Mcap(Io)	Mcap(U)	Industry	Superset	1 Day	Clo:	1 Week	C 1 Month	2 Month	3 Month	1 Day	C 1 Day	C 1 Week	C 2 Weeks	C 1 Month	1 Month	2 Month	2 Month	3 Month	
2	AT	VIE	Erste Gr.	EUR	ERGT.VI	AT000005263031	12.75	3E+09	3E+09	Financial Banks	13.75	13.63	10.27	7.75	11.84	16.2	-0.073	-0.075	-0.063	-0.086	0.2415	0.2583	0.6452	0.7131	0.0763	0.157	-0.2	
3	AT	VIE	Philips EUR		RIBR.VI	AT00000B07047	21.21	1E+09	1E+09	Financial Banks	22.65	25	13.95	14.62	16	13.3	-0.064	-0.066	-0.152	-0.1636	0.0632	0.0861	0.4508	0.5107	0.3256	0.3734	0.05	
4	AT	VIE	voestalp	EUR	VOES.VI	AT00000494340	9.85	1E+09	1E+09	Basic Mfg Basic Re	10.11	10.47	11.13	12.4	15.22	15.04	-0.026	-0.028	-0.053	-0.0734	-0.12	-0.101	-0.206	-0.173	-0.353	-0.329	-0.3	
5	AT	VIE	Wisaarb	EUR	WBSV.VI	AT000005653373	5.93	5E+08	7E+08	Industria Construc	6.15	5.6	5.5	6.57	10.06	11.5	-0.036	-0.038	0.0583	0.03522	0.0782	0.1035	-0.037	-0.06	-0.411	-0.388	-0.3	
6	AT	VIE	Intercell	EUR	ICELVI	AT00000B067IME	23.2	3E+08	1E+09	Health Cr Health C	21.22	21.48	21.43	22.32	25.68	21.84	0.0933	0.0309	0.0801	0.05631	0.0735	0.1029	0.0122	0.054	-0.037	-0.064	0.061	
7	AT	VIE	Aadritz	EUR	ANDR.V	AT00000B1WVF6	23.16	9E+08	1E+09	Industria Industria	21.47	21.51	19.79	24	23.3	16.16	0.0787	0.0767	0.05362	0.1103	0.1655	-0.035	0.0048	-0.006	0.0238	0.27		
8	AT	VIE	Yaskawa	EUR	VIGR.VI	AT00000B0BKSS	21.63	8E+08	1E+09	Financial Insurance	22.05	21.3	18.23	19.17	24.12	20.19	-0.021	0.0155	-0.0663	0.1865	0.2121	0.1263	0.1743	-0.121	-0.083	-0.1K		
9	AT	VIE	OMV AC	EUR	OMVVA	AT000004651459	25.2	4E+09	5E+09	Oil & Gas Oil & Gas	24.23	23.84	21.23	20.72	22.39	18.72	0.0375	0.0052	0.057	0.03438	0.187	0.2126	0.2162	0.2664	0.1255	0.1661	0.346	
10	AT	VIE	Tekkom	EUR	TELA.VI	AT000004635081	11.4	4E+09	5E+09	Telecom Telecom	10.86	10.43	10.43	3.35	11	10.3	0.0437	0.0474	0.0667	0.06344	0.0867	0.1102	0.1457	0.133	0.0364	0.0737	0.106	
11	AT	VIE	Verbund	EUR	VERB.V	AT000004661607	28.59	2E+09	3E+09	Utilities Utilities	28.36	23.92	26.12	25	29.37	32.56	-0.013	-0.015	-0.044	-0.0649	0.0346	0.1882	0.1456	0.1308	-0.046	-0.012	-0.1	
12	AT	VIE	Atrium E	EUR	ATRV.V	AT000007515864	2.27	5E+08	7E+08	Financial Real Est	2.32	2.02	2.15	1.47	2.18	2.58	-0.022	-0.024	0.1238	0.03966	0.0558	0.1288	0.5442	0.6843	0.0413	0.1301	-0	
13	AU	ASX	Bendigo	AUD	BEN.AX	AU00000003128C	6.19	2E+09	1E+09	Financial Banks	7.32	7.4	6.3	6.84	10	11.1	0.0341	0.0346	0.1068	0.03556	0.3	0.473	0.1974	0.3737	-0.181	-0.035	-0.26	
14	AU	ASX	Suncorp	AUD	SUNLAX	AU000005559084	6	8E+09	5E+09	Financial Banks	6.14	6.17	5.4	5.2	7.5	8.34	-0.023	-0.022	-0.028	0.21917	0.1111	0.5013	0.1558	0.5785	-0.2	0.1237	-0.2	
15	AU	ASX	National	AUD	NAB.AX	AU000006246501	20.1	4E+10	3E+10	Financial Banks	21.09	19.79	18.35	17.51	18.33	20.86	-0.047	-0.046	0.057	0.0305	0.0354	0.1302	0.1473	0.2522	0.0618	0.1833	-0.01	
16	AU	ASX	Bank of I	AUD	BODLAX	AU000005076241	8.44	1E+09	1E+09	Financial Banks	8.3	7.94	7.04	6.84	7.4	3.45	0.0163	0.0174	0.063	0.05606	0.1383	0.1853	0.2333	0.4578	0.1405	0.3835	-0.11	
17	AU	ASX	Australia	AUD	ANZAX	AU000005065586	15.75	3E+10	2E+10	Financial Banks	16.55	15.25	14.05	13.05	13.27	15.25	-0.048	-0.048	0.0328	0.02607	0.121	0.2453	0.2069	0.3582	0.1869	0.3713	0.03	
18	AU	ASX	Westpac	AUD	WBCA	AU000005076146	19.09	6E+10	4E+10	Financial Banks	13.14	12.85	12.13	16.65	16.63	-0.003	-0.002	0.0074	0.00083	0.1144	0.2223	0.1455	0.2753	0.2206	0.0324	0.14		
19	AU	ASX	Commons	AUD	CBA.AX	AU000005215005	34.73	5E+10	4E+10	Financial Banks	35	35.95	31	2.98	26.9	28.3	-0.008	-0.007	-0.01	-0.0664	0.1200	0.2417	0.1654	0.3078	0.2911	0.4875	0.22	
20	AU	ASX	BlueScope	AUD	BSLAX	AU000005553206	2.57	2E+09	2E+09	Basic Mfg Basic Re	2.73	2.55	2.25	2.86	3.53	3.45	-0.079	-0.078	0.0078	0.00123	0.1422	0.2514	0.103	0.2235	-0.272	-0.171	-0.2	
21	AU	ASX	CSR Ltd	AUD	CSRAX	AU000006238641	12	2E+09	1E+09	Basic Mfg Basic Re	12.75	11.65	11.17	10.2	14.25	17.8	-0.053	-0.058	0.048	0.04122	0.0255	0.3614	0.1765	0.5812	-0.158	0.162	-0.1	
22	AU	ASX	Iluka Res	AUD	ILUAX	AU000005957575	4.03	1E+09	1E+09	Basic Mfg Basic Re	4.1	4.4	4.2	4.32	4.25	4.44	-0.017	-0.017	-0.084	-0.09	-0.04	0.0085	-0.067	-0.007	-0.052	0.0361	-0.01	
23	AU	ASX	OneSteel	AUD	OSTLAX	AU000005230721	2.25	2E+09	1E+09	Basic Mfg Basic Re	2.38	2.15	1.605	1.8	2.33	2.33	-0.055	-0.054	0.0321	0.0254	0.2455	0.1102	0.25	0.3302	-0.074	0.0117	-0.01	
24	AU	ASX	Alumina I	AUD	A/CAP	AU000005354585	1.28	2E+09	1E+09	Basic Mfg Basic Re	1.24	1.21	1	1.135	1.14	1.28	0.0323	0.0328	0.0573	0.05091	0.28	0.3454	0.0711	0.1353	0.1228	0.2258		
25	AU	ASX	Newcrest	AUD	NCMLA	AU000005637101	32.73	2E+10	1E+10	Basic Mfg Basic Re	33.54	33.66	31.71	30	31	33.09	-0.024	-0.028	-0.034	0.0322	0.1518	0.031	0.2327	0.0558	0.2248	-0.0		
26	AU	ASX	EHP Billi	AUD	EHPPLAX	AU000005144530	0.91	1E+11	1E+11	Basic Mfg Basic Re	34.61	33.32	31	20.6	30.5	30.5	-0.062	-0.061	-0.042	-0.0485	0.0234	0.0813	0.157	0.1873	0.0452	0.1431	0.07	
27	AU	ASX	Lair Gob	AUD	LGLAX	PG000856518596	3.28	8E+08	5E+08	Basic Mfg Basic Re	3.23	3.4	2.37	3.27	3.15	3.03	-0.055	0.016	-0.035	-0.0416	0							

Motivation of Visual Analytics

Spreadsheet: A great hammer but lousy screwdriver



Visual analytics come to the rescue



Motivation of Visual Analytics

When statistics failed!

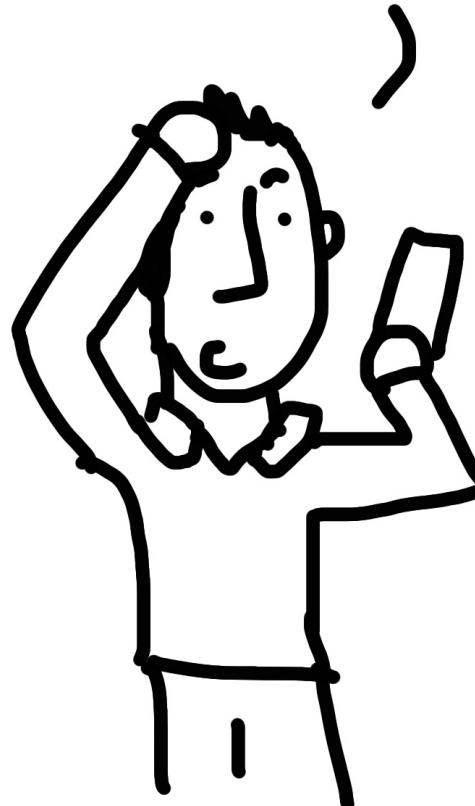
SALESFORCE A	SALES_REVENUE A	SALESFORCE B	SALES_REVENUE B	SALESFORCE C	SALES_REVENUE C	SALESFORCE D	SALES_REVENUE D
10	8.04	10	9.14	10	7.46	8	6.58
8	6.95	8	8.14	8	6.77	8	5.76
13	7.58	13	8.74	13	12.74	8	7.71
9	8.81	9	8.77	9	7.11	8	8.84
11	8.33	11	9.26	11	7.81	8	8.47
14	9.96	14	8.1	14	8.84	8	7.04
6	7.24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

Summary Statistics	
Mean	9
Std Dev	3.3166248
Std Err Mean	1
Upper 95% Mean	11.228139
Lower 95% Mean	6.7718611
N	11

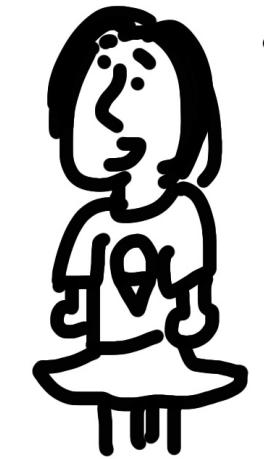
Linear Fit	
SALES_REVENUE = 3.0000909 + 0.5000909*SALESFORCE	
Summary of Fit	
RSquare	0.666542
RSquare Adj	0.629492
Root Mean Square Error	1.236603
Mean of Response	7.500909
Observations (or Sum Wgts)	11

Data analysis without data visualisation is no data analysis

I just can't make sense
of this data.



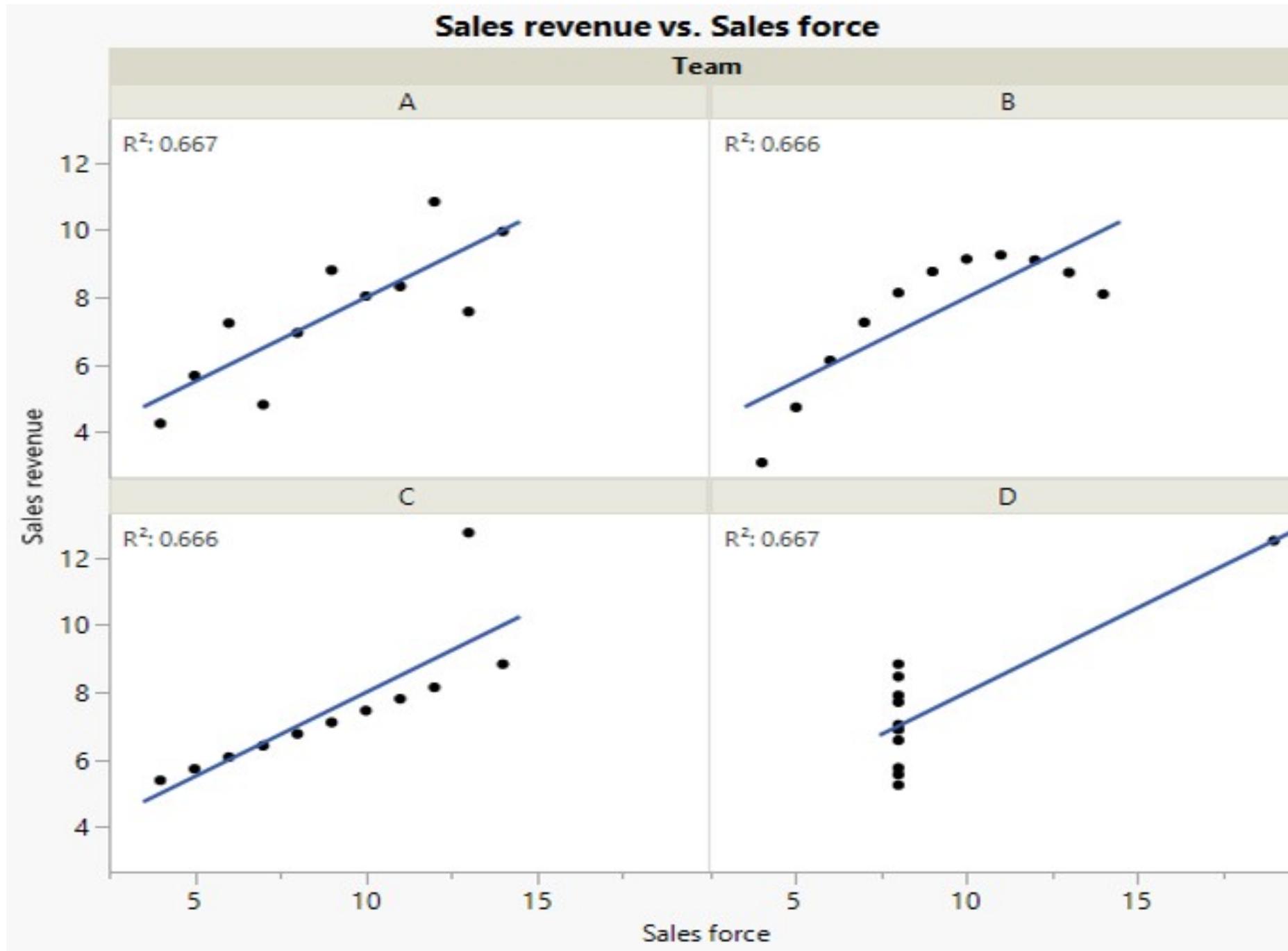
Have you tried
looking at the
pictures?



fresh spectrum

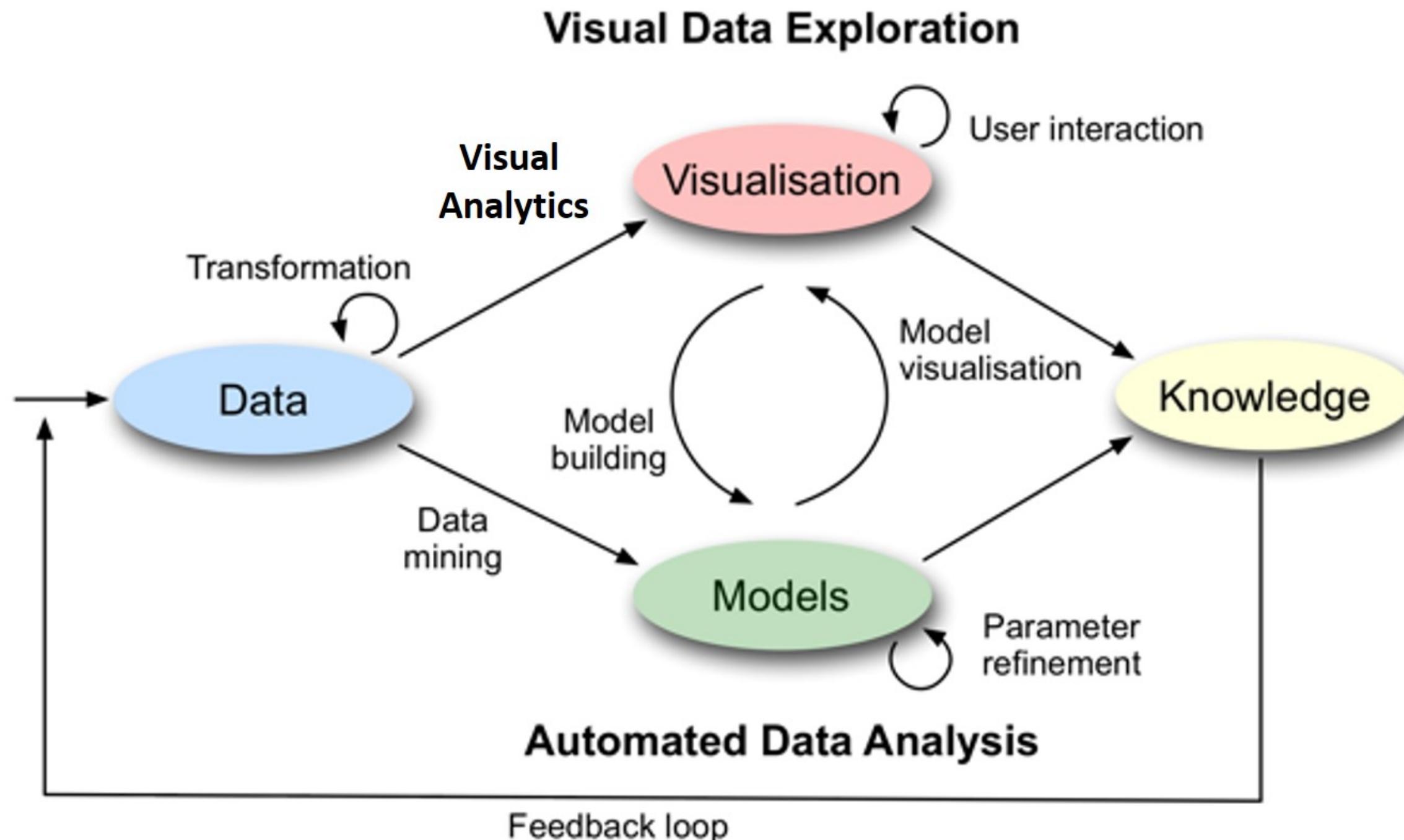
Motivation of Visual Analytics

Analytical graphics reveal the truth



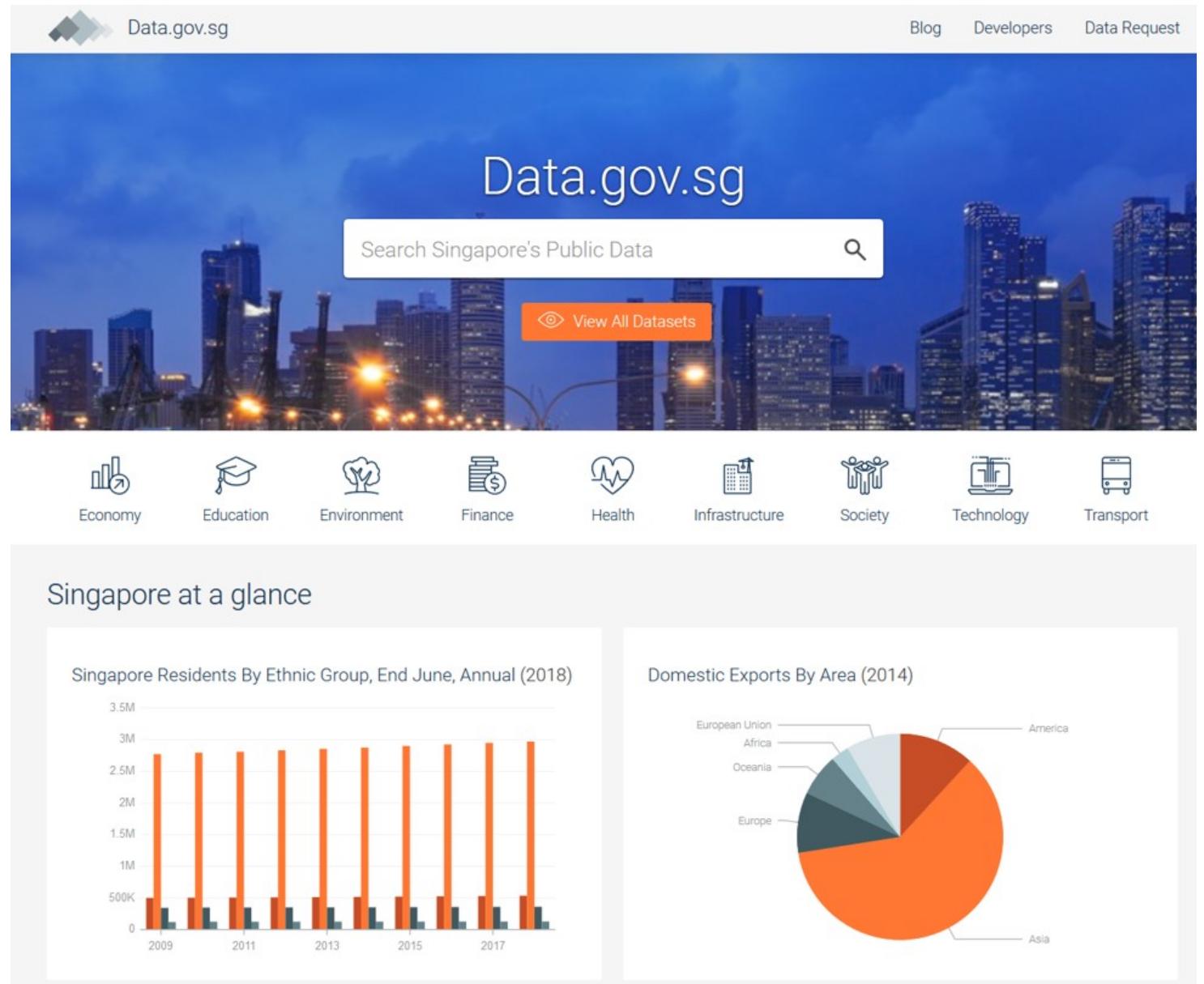
Motivation of Visual Analytics

Is there a place for Visual Analytics in knowledge discovery?



Motivation of Visual Analytics

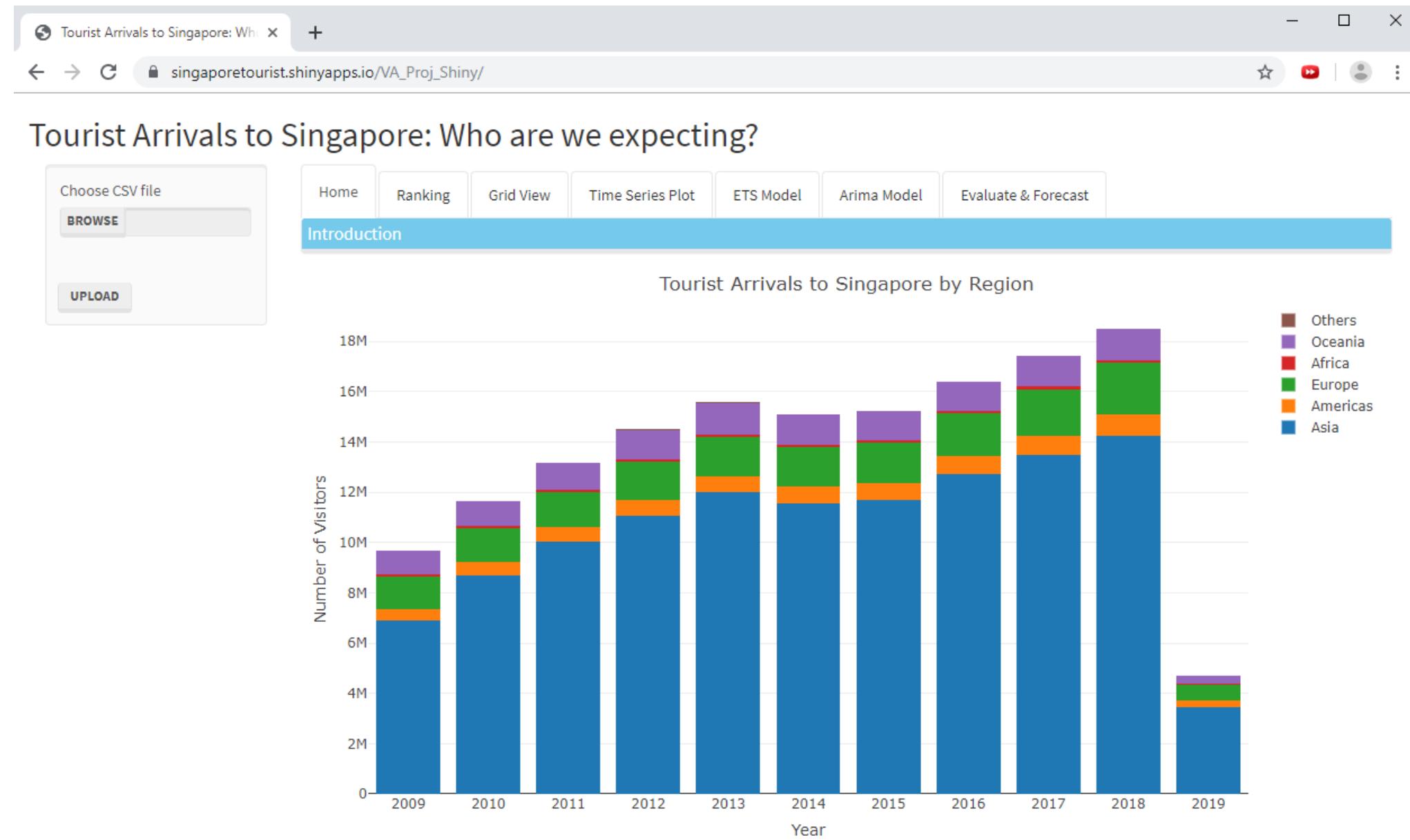
Open data need to be unlocked!



Visit the [link](#)

Motivation of Visual Analytics

Democratising Data and Analytics with Visually-driven Web Apps

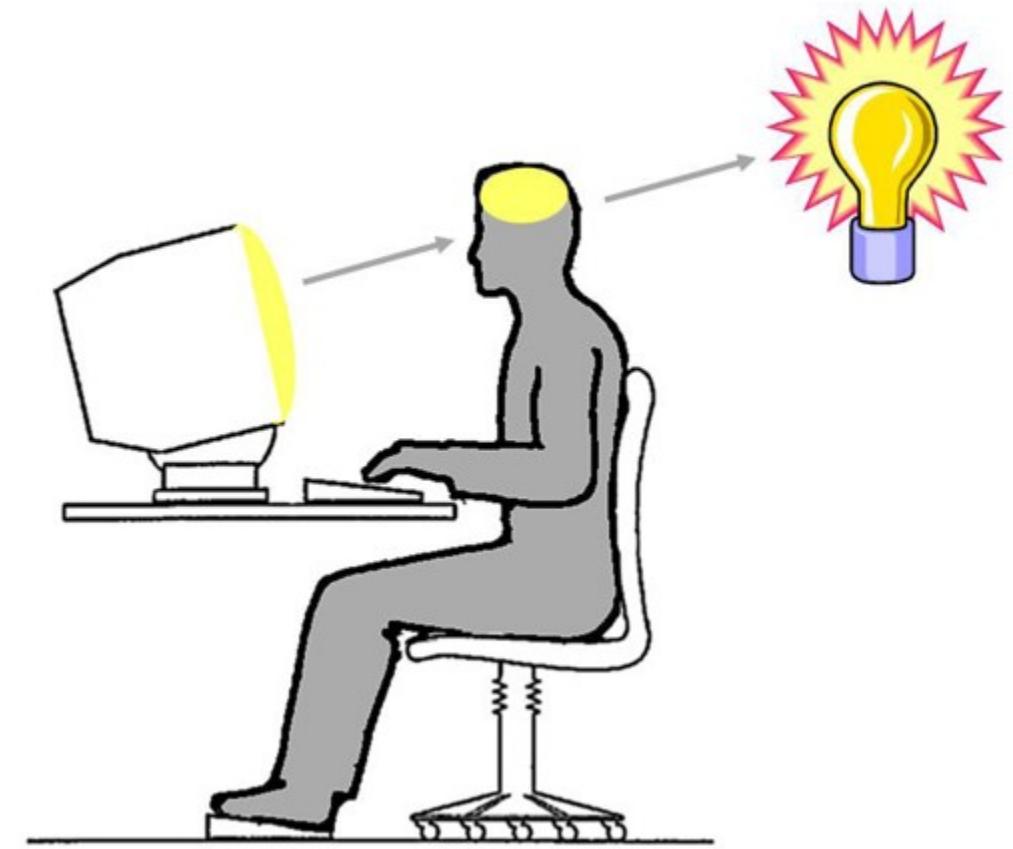


Visit the [link](#)

What is Visual Analytics?

Visual Analytics is the craft of analytical reasoning supported by:

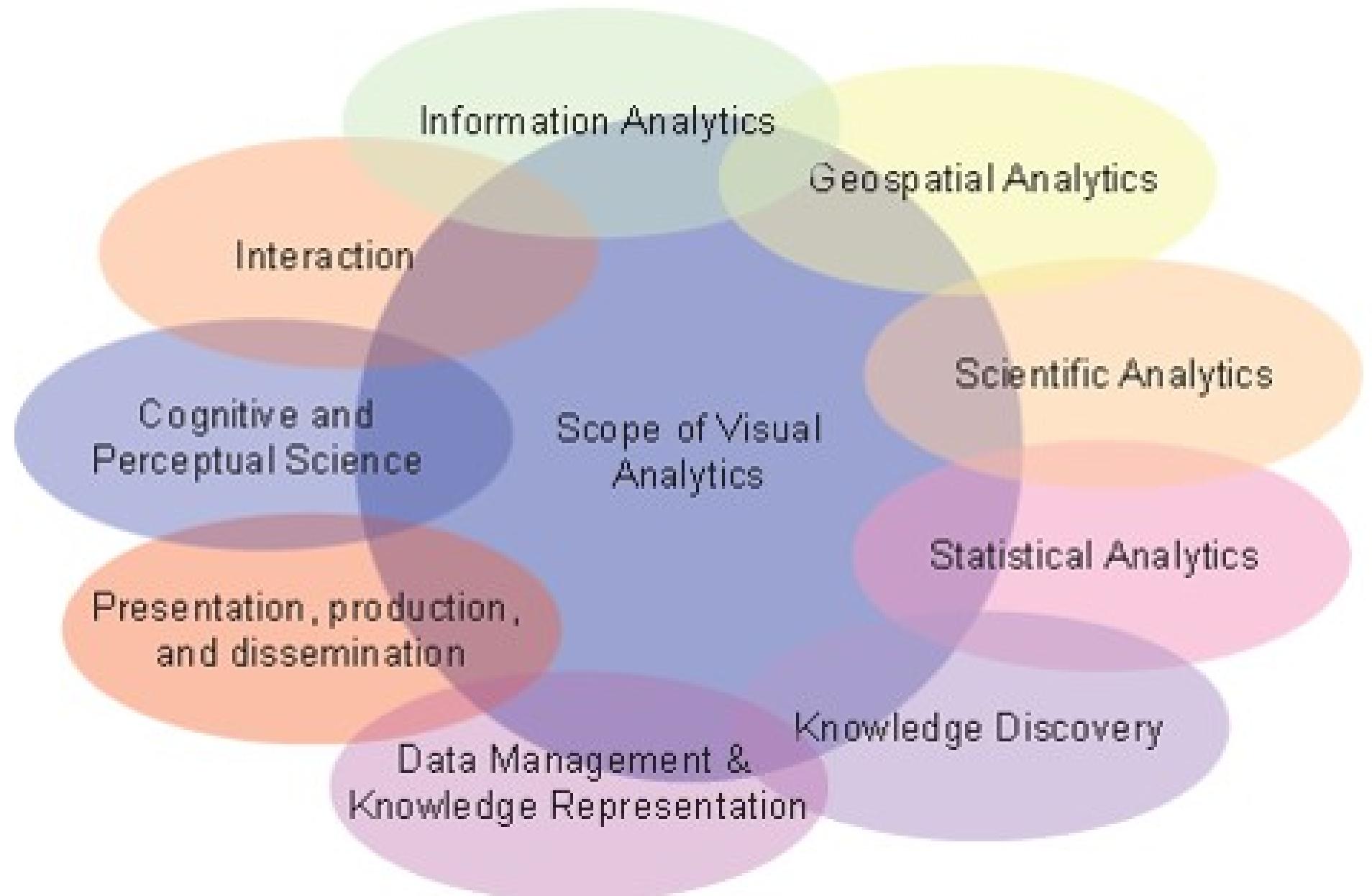
- Data Science and Analytics
- Data Visualisation
- Human-Computing-Interaction (HCI)
- Interface Design
- Visual Storytelling



The marriage of data analytics and visualizations

What is Visual Analytics?

Science of Visual Analytics



What is 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**.

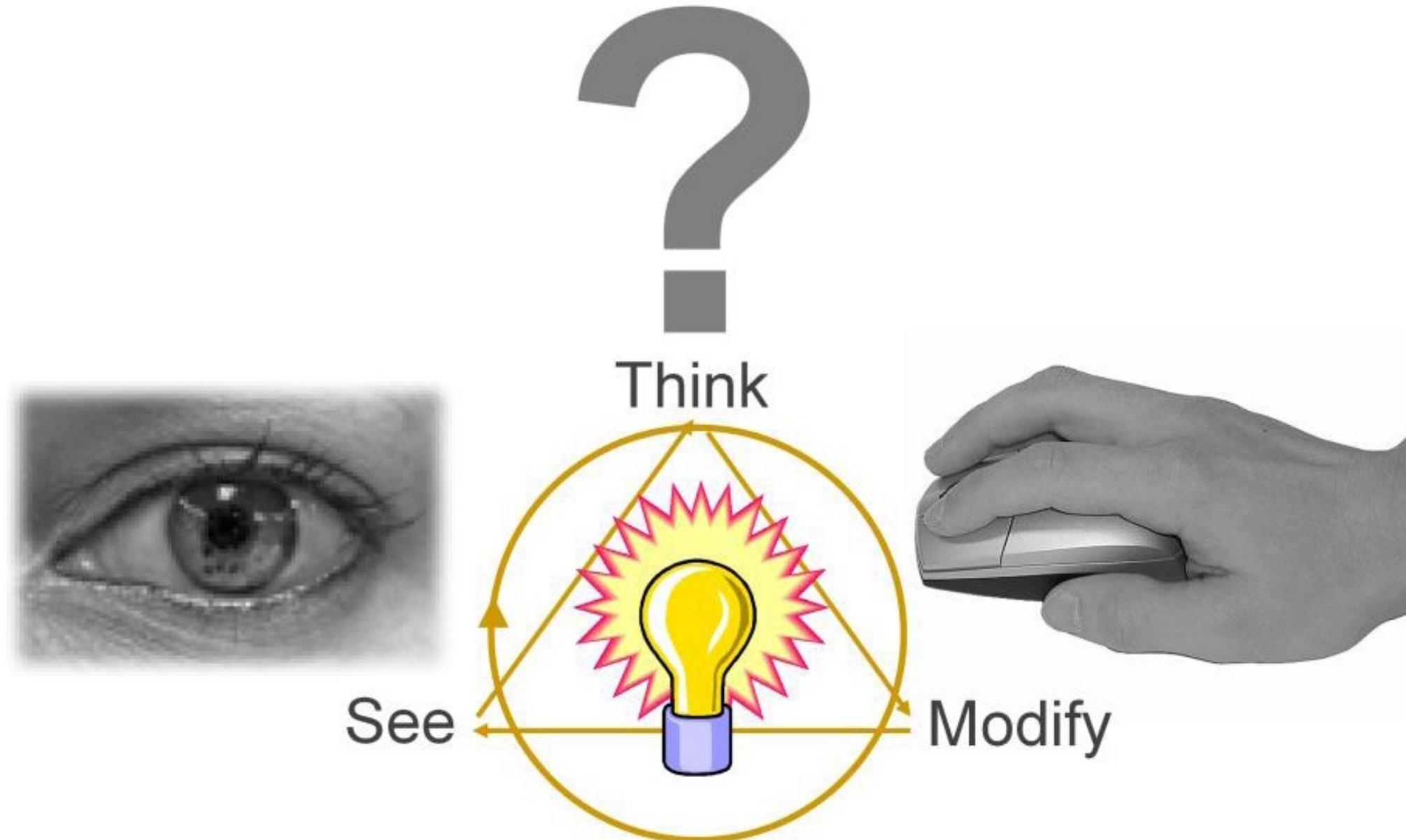
*When you have eliminated
the impossible, whatever
remains, however
improbable, must be the
truth.*

- Sherlock Holmes



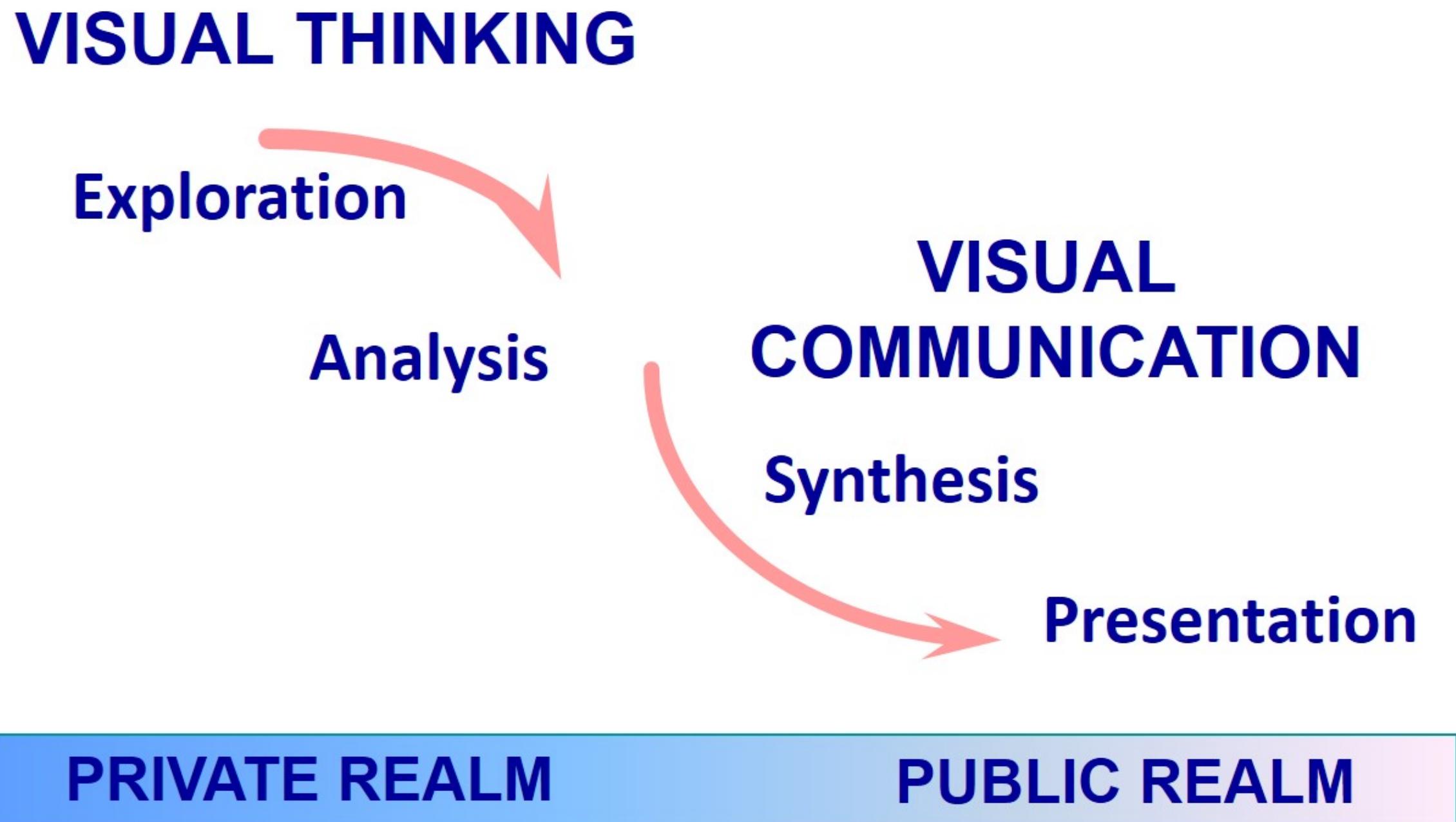
What is Visual Analytics?

Visual Analytics Framework



What is Visual Analytics?

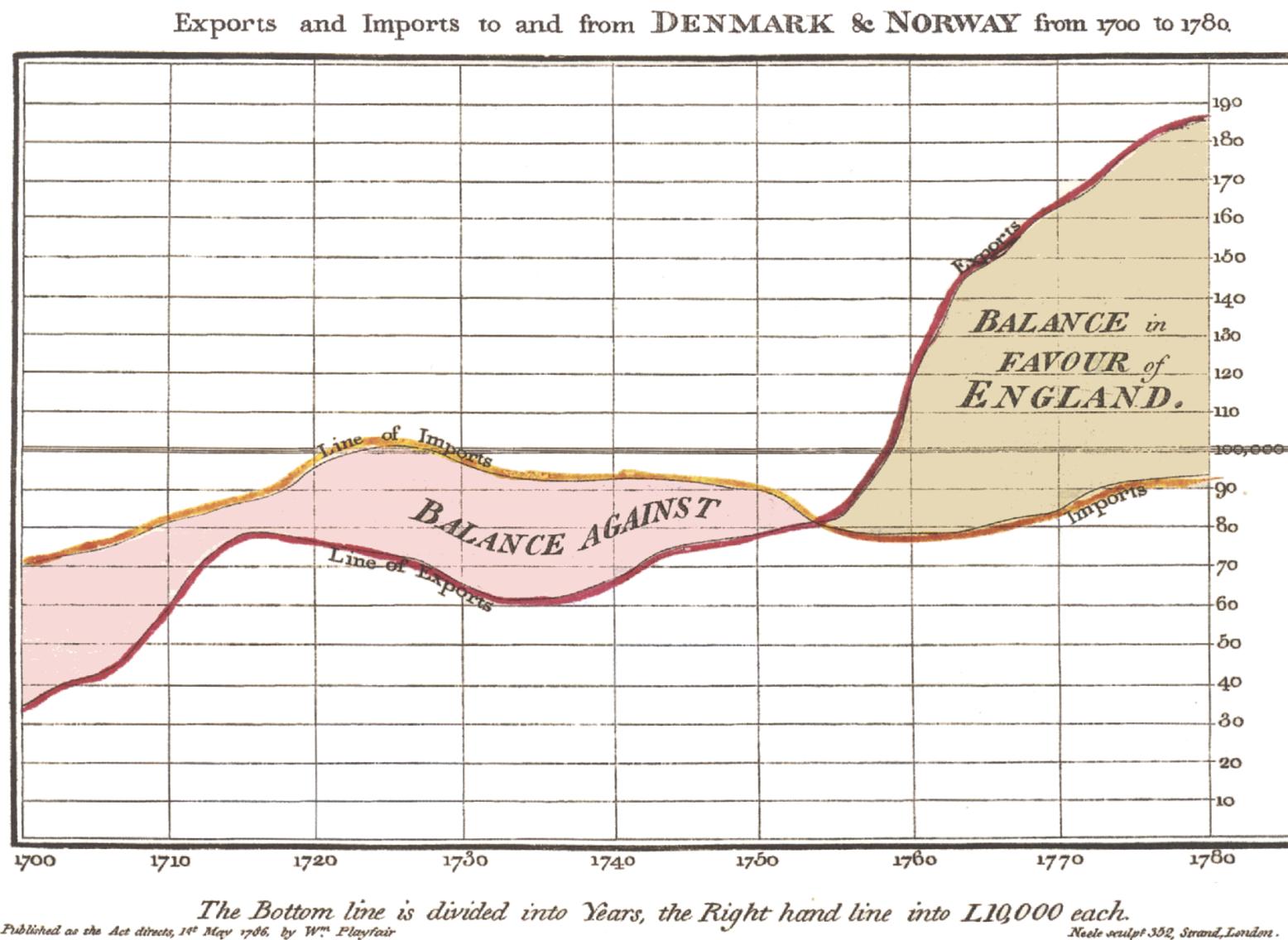
Visual Analytics require a shift of mindset



What is Visual Analytics?

Learning from the history of Visual Analytics

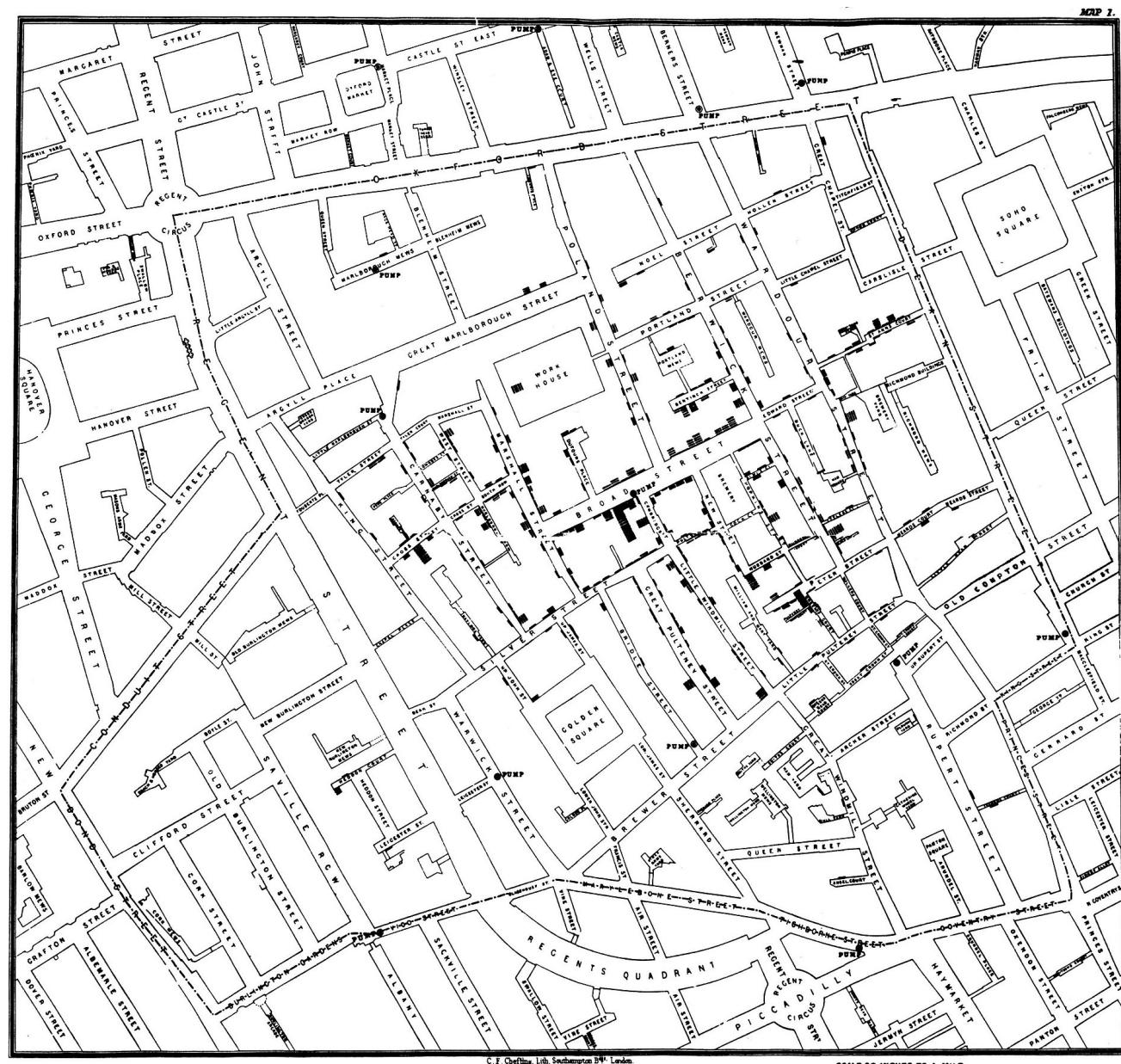
Commercial and Political Atlas by William Playfair (22 September 1759 – 11 February 1823)



What is Visual Analytics?

Learning from the history of Visual Analytics

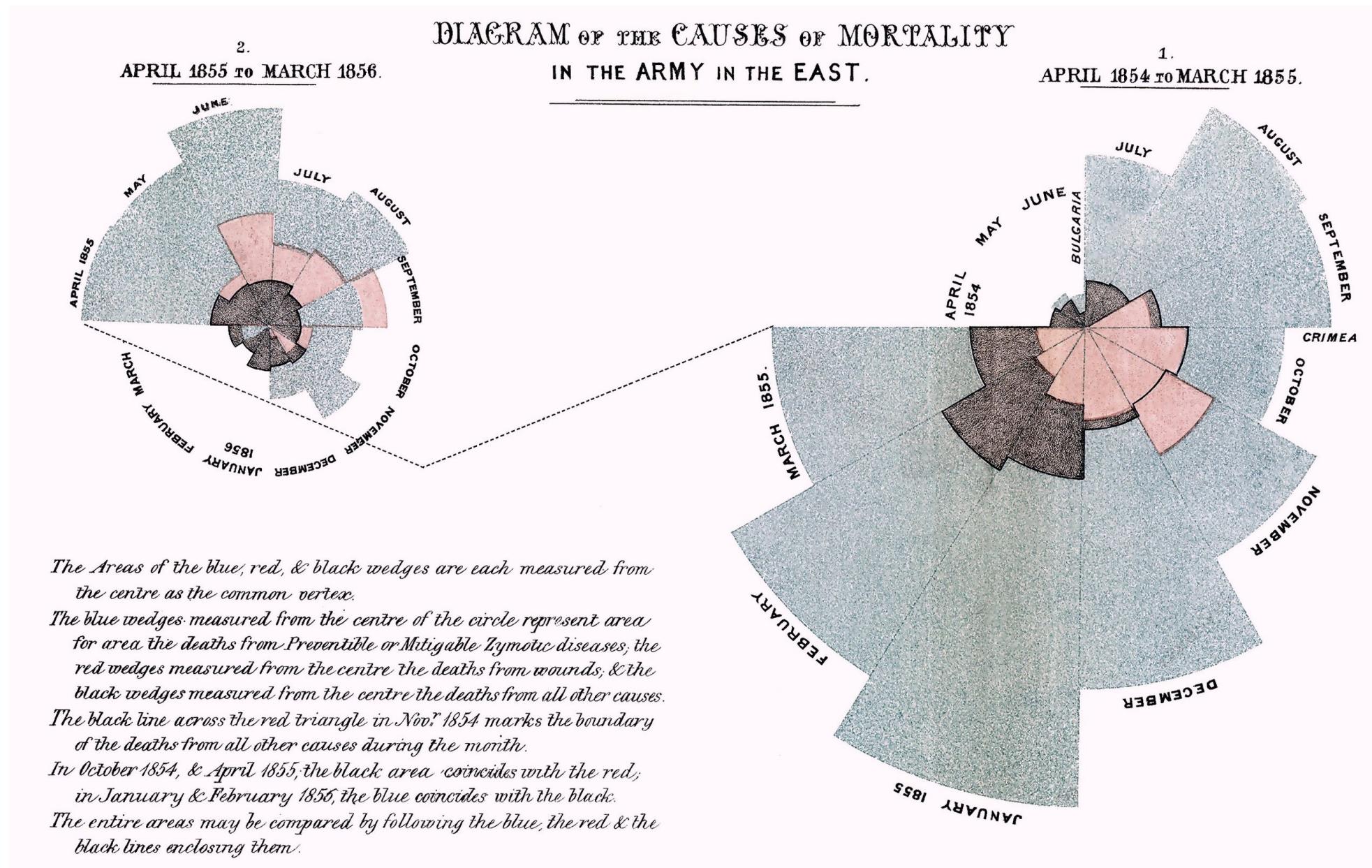
Cholera and the Pump on Broad Street (John Snow, 1854).



What is Visual Analytics?

Learning from the history of Visual Analytics

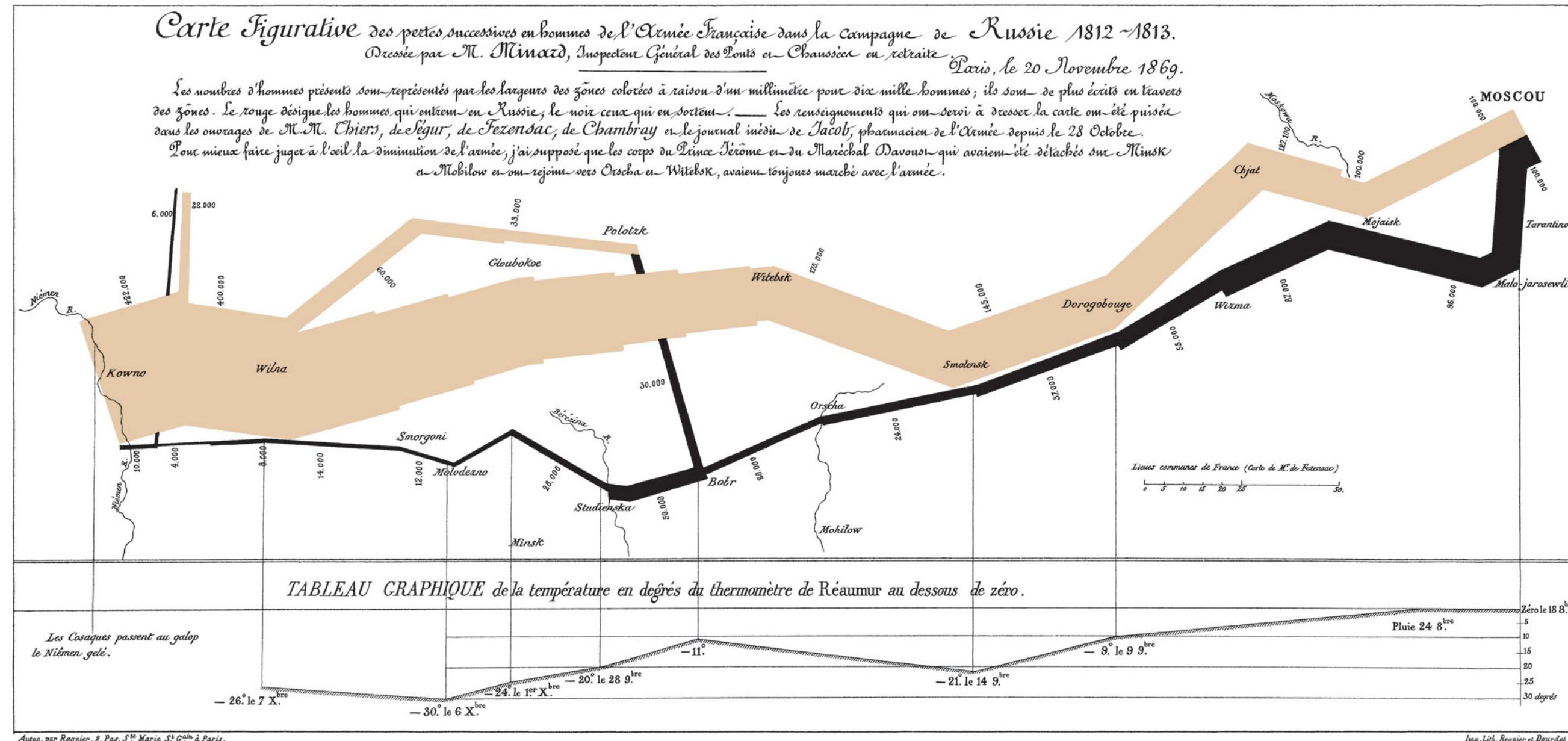
Florence Nightingale: The compassionate statistician (12 May 1820 – 13 August 1910)



What is Visual Analytics?

Learning from the history of Visual Analytics

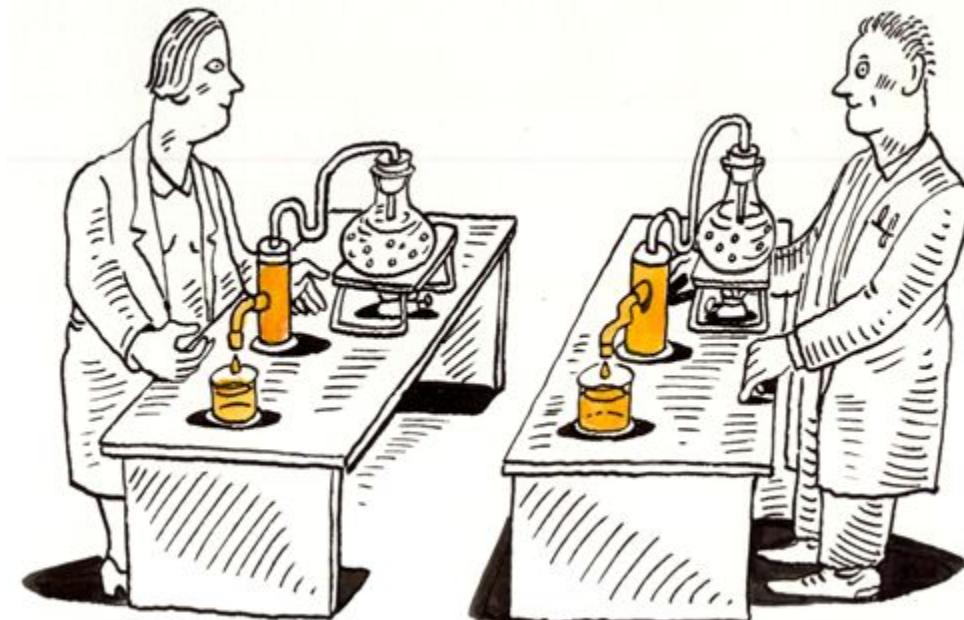
Plot of Napoleon's ill-fated Russian campaign of 1812-1813 (Charles Joseph Minard, 1861)



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, when 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.



Reference: [Ten Simple Rules for Reproducible Computational Research](#)

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](#)
- Open source
 - Specialised data visualisation applications such as [Gephi](#)
 - Data visualisation API library such as ggplot2, plotly, and [D3.js](#)

COS Data Visualisation Toolkit

Magic Quadrant for BI and Analytics Platforms

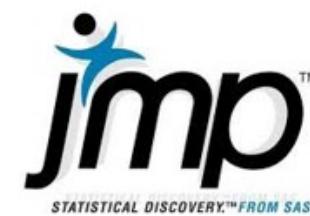


COS Data Visualisation Toolkit

Data Visualisation Centric



Sense™



SAS® VISUAL ANALYTICS

BI Centric



QlikView

MicroStrategy

ORACLE
BUSINESS INTELLIGENCE



Tableau: A data visualisation tool for everyone

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

The collage features the Tableau logo at the top left. Below it is a laptop screen showing a detailed, layered area chart. To the left of the laptop is a smartphone. To the right is a graphic for 'VizQL' with the text 'Breakthrough Technology'. At the bottom are four individual portraits of men.

Programmable Data Visualisation Library

- Javascript
 - [D3.js](#)
- Python
 - [Matplotlib](#)
 - [Bokeh](#)
 - [Plotly](#)
- R, Base Graphics
 - [lattice](#)
 - [ggplot](#)
 - [plotly R](#)
 - [R Shiny](#)

Data Visualisation Toolkit for Data Journalism

- [Flourish](#)
- [Datawrapper](#)

Highly recommended blogs

- Perceptual Edge
- Junk Charts
- The Functional Art

