

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

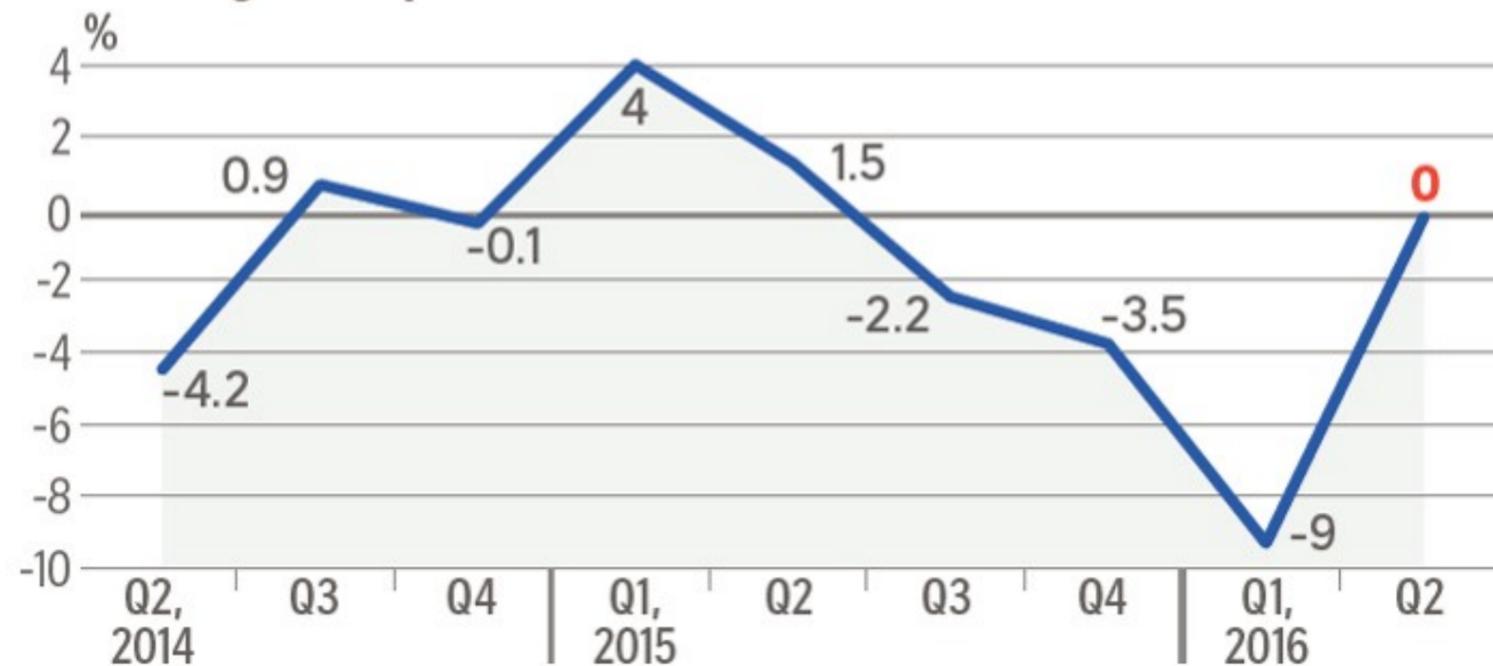
Motivation of Visual Analytics

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

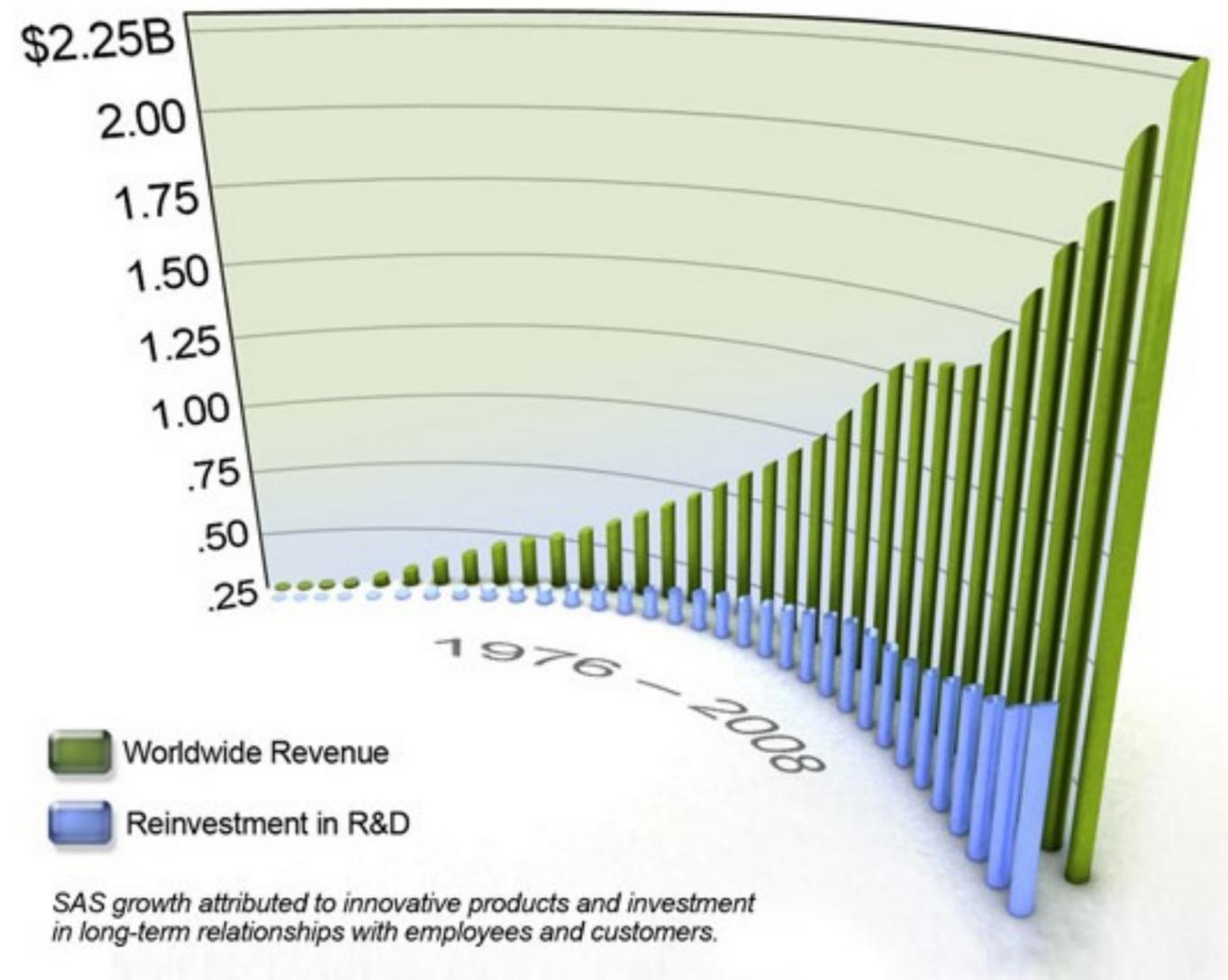


We need to get smarter about visual information

Motivation of Visual Analytics

Junk charts are good for advertising but not for understanding.

SAS Clears \$2.26 Billion



Motivation of Visual Analytics

Data rich, information poor

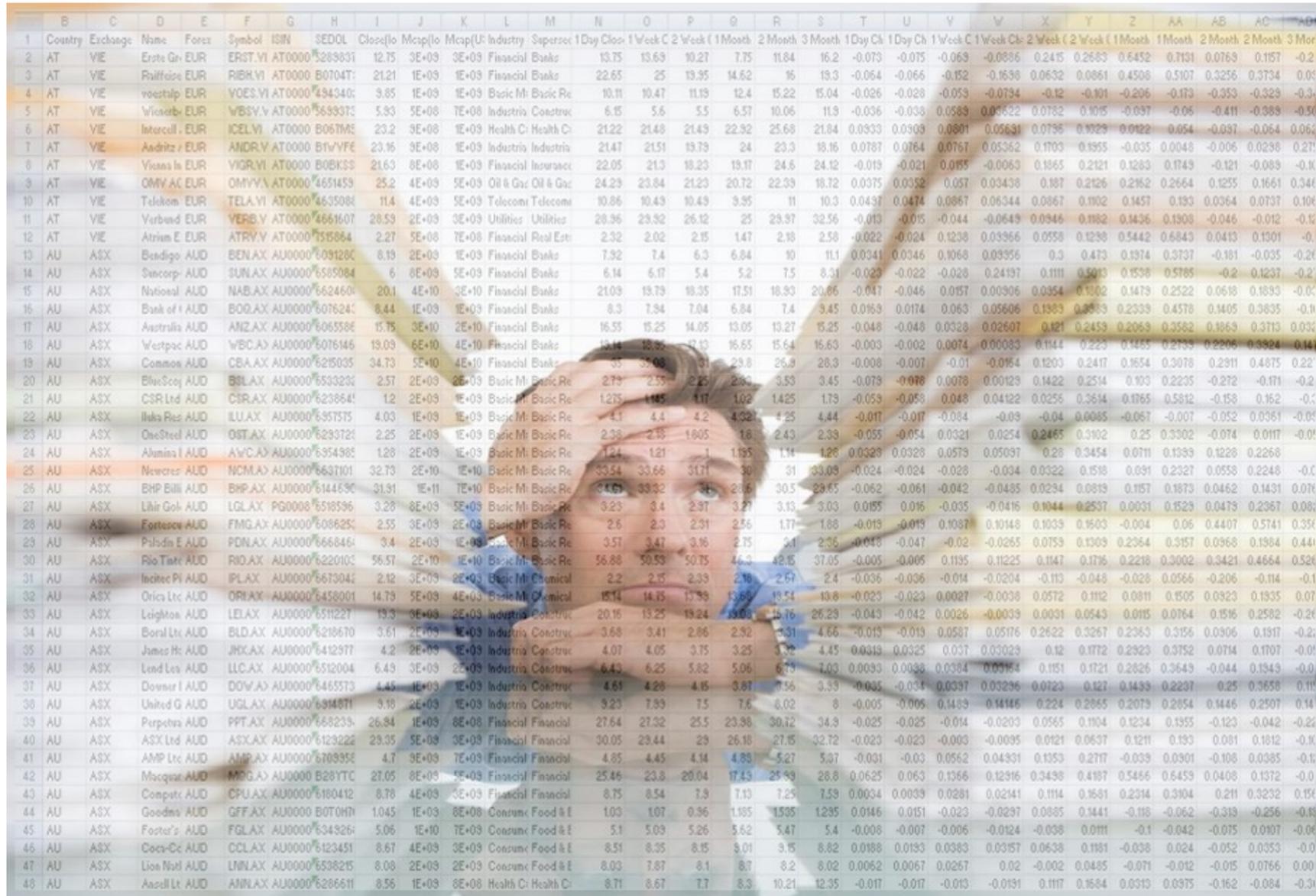


Source: [Big Data Ocean](#)

Motivation of Visual Analytics

The World is buried in data,

Just SHOW me the number

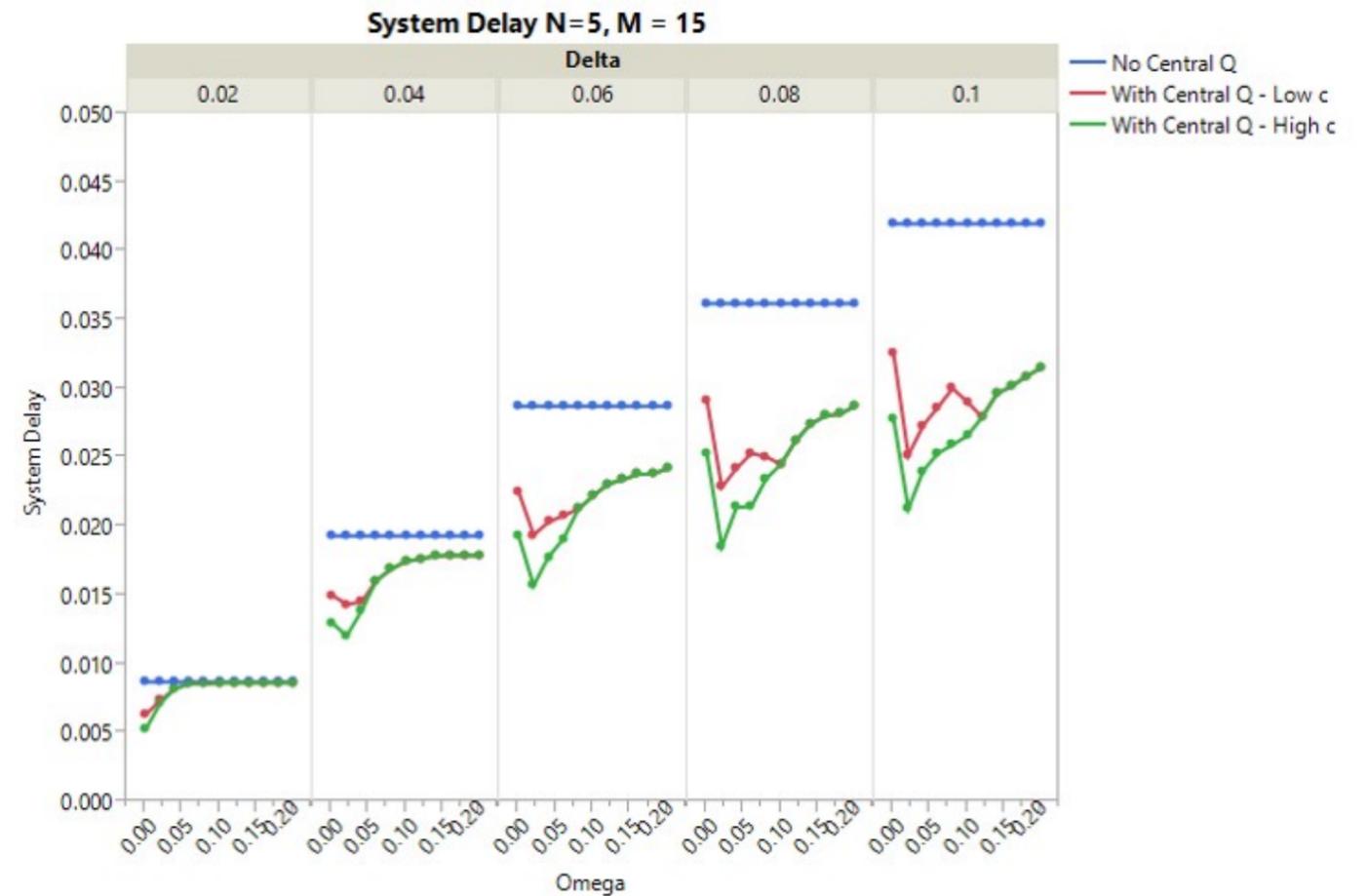
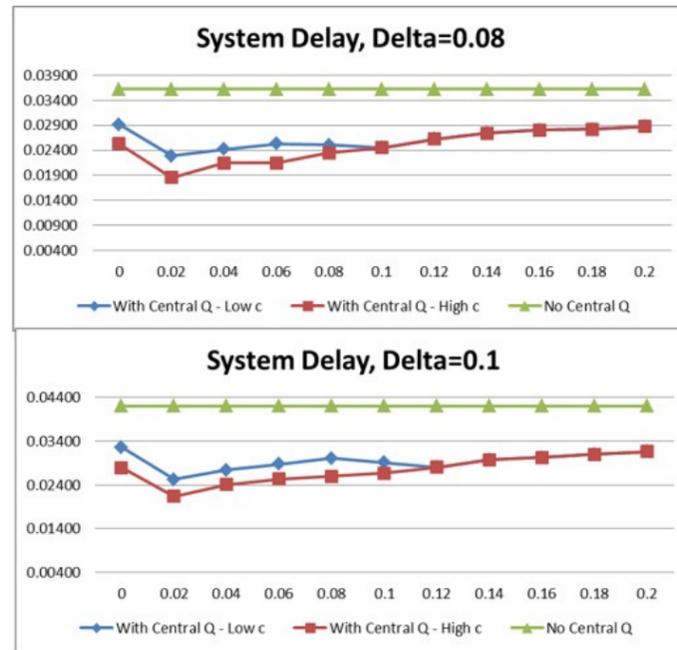
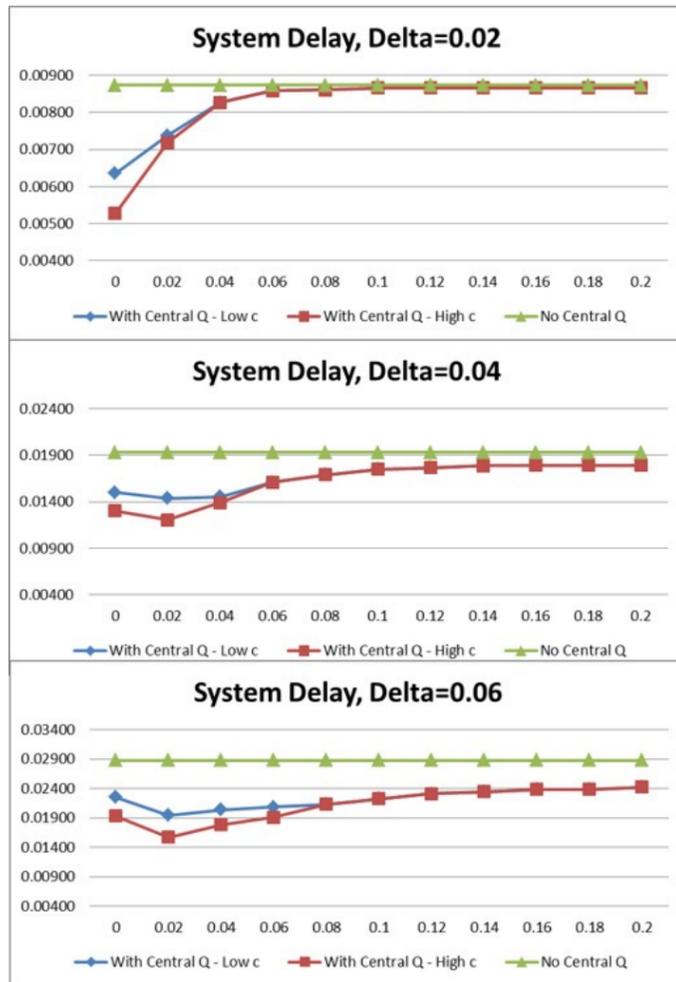


	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
1	Country	Exchange	Name	Forez	Symbol	ISIN	SEDOL	Close	Mcap	Mcap(U)	Industry	Supersec	1Day Clos	1Week C	2Week	1Month	2Month	3Month	1Day Ch	1Day Ch	1Week C	1Week Ch	2Week	2Week	1Month	1Month	2Month	2Month	3Month
2	AT	ViE	Erste Gr	EUR	ERST.YI	AT0000528931		12.75	3E+09	3E+09	Financial Banks		13.75	13.69	10.27	7.75	11.84	16.2	-0.073	-0.075	-0.063	-0.0886	0.2415	0.2683	0.6452	0.7131	0.0763	0.1157	-0.2
3	AT	ViE	Raiffeis	EUR	RIFK.YI	AT0000807047		21.21	1E+09	1E+09	Financial Banks		22.65	25	13.95	14.62	16	19.3	-0.064	-0.066	-0.152	-0.1638	0.0632	0.0861	0.4508	0.5107	0.3256	0.3734	0.0
4	AT	ViE	voestalp	EUR	VOES.YI	AT0000434340		3.85	1E+09	1E+09	Basic Mf Basic Re		10.11	10.47	11.19	12.4	15.22	15.04	-0.026	-0.028	-0.053	-0.0734	-0.12	-0.101	-0.206	-0.173	-0.353	-0.323	-0.3
5	AT	ViE	Wolfsbr	EUR	WBSY.V	AT0000569371		5.93	5E+08	7E+08	Industria Construc		6.15	5.6	5.5	6.57	10.06	11.9	-0.036	-0.038	0.0583	0.0522	0.0782	0.1005	-0.097	-0.06	-0.411	-0.389	-0.5
6	AT	ViE	Intercell	EUR	ICEL.V	AT0000806786		23.2	3E+08	1E+09	Health Ci Health Ci		21.22	21.48	21.43	22.92	25.68	21.84	0.0303	0.0303	0.0801	0.05631	0.0796	0.1029	0.0922	0.054	-0.037	-0.064	0.06
7	AT	ViE	Aandritz	EUR	ANDR.V	AT0000819776		23.16	9E+08	1E+09	Industria Industria		21.47	21.51	19.79	24	23.3	18.16	0.0787	0.0764	0.0761	0.05362	0.1703	0.1955	-0.035	0.0048	-0.006	0.0238	0.27
8	AT	ViE	Vestas In	EUR	VIGR.YI	AT0000808333		21.63	8E+08	1E+09	Financial Insurance		22.05	21.3	18.23	19.17	24.6	24.12	-0.019	-0.021	0.085	-0.0063	0.1065	0.2121	0.1263	0.1749	-0.121	-0.089	-0.1
9	AT	ViE	OMV AC	EUR	OMV.YI	AT0000565153		25.2	4E+09	5E+09	Oil & Gas Oil & Gas		24.23	23.84	21.23	20.72	22.39	18.72	0.0375	0.0352	0.057	0.03438	0.187	0.2126	0.2862	0.2664	0.1255	0.1661	0.34
10	AT	ViE	Telekom	EUR	TELA.YI	AT0000463508		11.4	4E+09	5E+09	Telecomi Telecomi		10.86	10.49	10.49	9.95	11	10.3	0.0437	0.0474	0.0867	0.06344	0.0867	0.1902	0.1457	0.193	0.0364	0.0731	0.10
11	AT	ViE	Verbund	EUR	VERB.V	AT0000466107		28.59	2E+09	3E+09	Utilities Utilities		28.96	29.92	26.12	25	23.97	32.56	-0.013	-0.015	-0.044	-0.0649	0.0946	0.1882	0.1436	0.1908	-0.046	-0.012	-0.1
12	AT	ViE	Atrium E	EUR	ATRV.V	AT0000555884		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	0.1298	0.5442	0.6843	0.0413	0.1301	-0.
13	AU	ASX	Bendigo	AUD	BENLX	AU0000509128		8.19	2E+09	1E+09	Financial Banks		7.92	7.4	6.3	6.84	10	11.1	0.0341	0.0346	0.1068	0.09396	0.3	0.473	0.1374	0.3737	-0.181	-0.035	-0.2
14	AU	ASX	Suncorp	AUD	SUNLX	AU0000550584		6	8E+09	5E+09	Financial Banks		6.14	6.17	5.4	5.2	7.5	8.31	-0.023	-0.022	-0.028	0.24197	0.1111	0.5013	0.1538	0.5785	-0.2	0.1231	-0.2
15	AU	ASX	National	AUD	NABLX	AU0000562460		20.1	4E+10	3E+10	Financial Banks		21.09	19.79	17.51	18.93	20.66	20.66	-0.047	-0.046	0.0187	0.00906	0.0354	0.1302	0.1479	0.2522	0.0618	0.1833	-0.0
16	AU	ASX	Bank of	AUD	BODLX	AU0000507624		8.44	1E+09	1E+09	Financial Banks		8.3	7.94	7.04	6.84	7.4	9.45	0.0163	0.0174	0.063	0.05606	0.1383	0.0803	0.2338	0.4578	0.1405	0.3835	-0.1
17	AU	ASX	Australia	AUD	ANZLX	AU0000506588		15.75	3E+10	2E+10	Financial Banks		16.35	15.25	14.05	13.05	19.27	15.25	-0.048	-0.048	0.0328	0.02607	0.121	0.2453	0.2063	0.3562	0.1863	0.3713	0.03
18	AU	ASX	Westpac	AUD	WBCLX	AU0000507616		19.09	6E+10	4E+10	Financial Banks		19.14	18.95	17.13	16.65	15.64	16.63	-0.003	-0.002	0.0074	0.00003	0.1144	0.221	0.1465	0.2733	0.2206	0.3824	0.14
19	AU	ASX	Common	AUD	CBA.LX	AU0000525035		34.73	5E+10	4E+10	Financial Banks		35	35.08	31	29.8	26.8	28.3	-0.008	-0.007	-0.01	-0.0164	0.1203	0.2417	0.1654	0.3078	0.2911	0.4875	0.22
20	AU	ASX	BlueScay	AUD	BBLX	AU0000553320		2.57	2E+09	2E+09	Basic Mf Basic Re		2.73	2.55	2.25	2.63	3.53	3.45	-0.079	-0.088	0.0078	0.00129	0.1422	0.2514	0.103	0.2235	-0.272	-0.171	-0.2
21	AU	ASX	CSR Ltd	AUD	CSRLX	AU0000523864		1.2	2E+09	1E+09	Basic Mf Basic Re		1.275	1.185	1.17	1.02	1.425	1.73	-0.053	-0.058	0.048	0.04122	0.0256	0.3634	0.1765	0.5812	-0.158	0.162	-0.
22	AU	ASX	Iluka Res	AUD	ILU.LX	AU0000535757		4.03	1E+09	1E+09	Basic Mf Basic Re		4.1	4.4	4.2	4.02	4.25	4.44	-0.017	-0.017	-0.034	-0.09	-0.04	0.00885	-0.067	-0.007	-0.052	0.0361	-0.0
23	AU	ASX	OneSteel	AUD	OSTLX	AU0000529372		2.25	2E+09	1E+09	Basic Mf Basic Re		2.39	2.15	1.605	1.8	2.43	2.33	-0.055	-0.054	0.0321	0.0254	0.2485	0.3102	0.25	0.3302	-0.074	0.0117	-0.0
24	AU	ASX	Alumina I	AUD	ALV.LX	AU0000535498		1.28	2E+09	1E+09	Basic Mf Basic Re		1.24	1.21	1	1.195	1.14	1.28	0.0323	0.0323	0.0579	0.05097	0.28	0.3454	0.0711	0.1389	0.1228	0.2268	
25	AU	ASX	Newcrest	AUD	NCLM.LX	AU0000563701		32.73	2E+10	1E+10	Basic Mf Basic Re		33.54	33.66	31.71	30	31	33.09	-0.024	-0.024	-0.028	-0.034	0.0322	0.1518	0.091	0.2327	0.0558	0.2248	-0.0
26	AU	ASX	BHP Bill	AUD	BHP.LX	AU0000514459		31.91	1E+11	7E+10	Basic Mf Basic Re		32.65	33.32	34	29.6	29.65	29.65	-0.062	-0.061	-0.042	-0.0485	0.0234	0.0819	0.187	0.1873	0.0462	0.1431	0.07
27	AU	ASX	Libor Gok	AUD	LGL.LX	PG0000551859		3.28	8E+09	5E+09	Basic Mf Basic Re		3.23	3.4	2.91	3.27	3.13	3.03	0.085	0.016	-0.035	-0.0416	0.1044	0.2537	0.0031	0.1529	0.0479	0.2367	0.08
28	AU	ASX	Fortescue	AUD	FMGLX	AU0000509625		2.55	3E+09	2E+09	Basic Mf Basic Re		2.6	2.3	2.31	2.56	1.77	1.68	-0.019	-0.019	0.1037	0.10148	0.1033	0.1603	-0.004	0.06	0.4407	0.5741	0.35
29	AU	ASX	Pulsin E	AUD	PDNLX	AU0000566846		3.4	2E+09	1E+09	Basic Mf Basic Re		3.57	3.47	3.16	2.75	3.1	2.95	-0.045	-0.047	-0.02	-0.0265	0.0753	0.1309	0.2364	0.3157	0.0368	0.1384	0.44
30	AU	ASX	Rio Tinto	AUD	RIO.LX	AU0000522010		56.57	2E+10	1E+10	Basic Mf Basic Re		56.88	59.59	50.75	46.3	42.15	37.05	-0.005	-0.005	0.1195	0.11225	0.1547	0.1736	0.2218	0.3002	0.3421	0.4664	0.52
31	AU	ASX	Inotec Pl	AUD	IPL.LX	AU0000567304		2.12	3E+09	2E+09	Basic Mf Chemical		2.2	2.15	2.33	2.16	2.1	2.4	-0.036	-0.036	-0.014	-0.0204	-0.113	-0.048	-0.028	0.0566	-0.206	-0.114	-0.1
32	AU	ASX	Orica Ltd	AUD	ORL.LX	AU0000545801		14.79	5E+09	4E+09	Basic Mf Chemical		15.14	14.15	12.99	12.65	12.54	13.6	-0.023	-0.023	0.0027	-0.0038	0.0572	0.1112	0.0811	0.1505	0.0323	0.1335	0.07
33	AU	ASX	Leighton	AUD	LEL.LX	AU0000551127		13.3	3E+09	2E+09	Industria Construc		20.16	13.25	13.24	13.01	13.16	26.29	-0.043	-0.042	0.0026	-0.0039	0.0031	0.0543	0.0115	0.0764	0.1516	0.2582	-0.2
34	AU	ASX	Boral Ltd	AUD	BLD.LX	AU00005218670		3.61	2E+09	1E+09	Industria Construc		3.68	3.41	2.86	2.92	3.31	4.66	-0.013	-0.019	0.0587	0.05176	0.2622	0.3267	0.2363	0.3156	0.0306	0.1817	-0.2
35	AU	ASX	James H	AUD	JHL.LX	AU00005412977		4.2	2E+09	1E+09	Industria Construc		4.07	4.05	3.75	3.25	3.72	4.45	0.0313	0.0325	0.037	0.03023	0.12	0.1772	0.2923	0.3752	0.0714	0.1707	-0.0
36	AU	ASX	Lead Les	AUD	LLC.LX	AU00005312004		6.49	3E+09	2E+09	Industria Construc		6.43	6.25	5.82	5.06	6.73	7.03	0.0093	0.0038	0.0384	0.03994	0.1151	0.1721	0.2826	0.3649	-0.044	0.1349	-0.0
37	AU	ASX	Downer I	AUD	DOWLX	AU00005465773		4.45	1E+09	1E+09	Industria Construc		4.61	4.28	4.15	3.87	3.56	3.33	-0.035	-0.031	0.0397	0.03236	0.0723	0.127	0.1493	0.2237	0.25	0.3658	0.11
38	AU	ASX	United G	AUD	UGL.LX	AU00005314871		9.19	2E+09	1E+09	Industria Construc		9.23	7.99	7.5	7.6	8.02	8	-0.005	-0.006	0.1483	0.14146	0.224	0.2865	0.2073	0.2854	0.1446	0.2507	0.14
39	AU	ASX	Perpetua	AUD	PPT.LX	AU0000568233		26.94	1E+09	8E+08	Financial Financial		27.64	27.02	25.5	23.96	30.72	34.9	-0.025	-0.025	-0.014	-0.0203	0.0565	0.1104	0.1234	0.1955	-0.123	-0.042	-0.2
40	AU	ASX	ASX Ltd	AUD	ASXLX	AU00005129222		23.35	5E+08	3E+09	Financial Financial		30.05	23.44	29	26.18	27.15	32.72	-0.023	-0.023	-0.003	-0.0095	0.0121	0.0637	0.1211	0.193	0.081	0.1812	-0.1
41	AU	ASX	AMP Ltd	AUD	AMPLX	AU00005378935		4.7	9E+09	7E+09	Financial Financial		4.85	4.45	4.14	4.88	5.27	5.07	-0.031	-0.03	0.0562	0.04931	0.1353	0.2717	-0.039	0.0301	-0.108	0.0385	-0.1
42	AU	ASX	Macquar	AUD	MQGLX	AU0000828977		27.05	8E+09	5E+09	Financial Financial		25.46	23.8	20.04	17.43	25.99	28.8	0.0625	0.063	0.1366	0.12916	0.3498	0.4187	0.5466	0.6459	0.0408	0.1372	-0.0
43	AU	ASX	Compete	AUD	CFU.LX	AU00005180412		8.78	4E+09	3E+09	Financial Financial		8.75	8.54	7.9	7.13	7.25	7.59	0.0034	0.0039	0.0281	0.02141	0.1114	0.1681	0.2314	0.3104	0.211	0.3232	0.15
44	AU	ASX	Goodies	AUD	GFF.LX	AU0000807071		1.045	1E+09	8E+08	Consum Food & E		1.03																

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

Summary Statistics

Mean 7.4990909
Std Dev 2.0300614
Std Err Mean 0.6120865
Upper 95% Mean 8.8629047
Lower 95% Mean 6.1352771
N 11

Linear Fit

SALES_REVENUE = 3.0000909 + 0.5000909*SALESFORCE

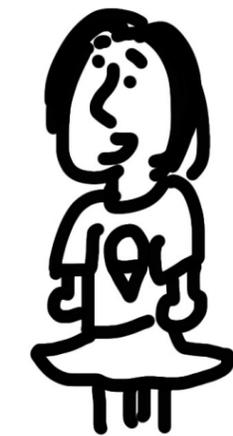
Summary of Fit

RSquare 0.666542
RSquare Adj 0.629492
Root Mean Square Error 1.236603
Mean of Response 7.500909
Observations (or Sum Wgts) 11

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

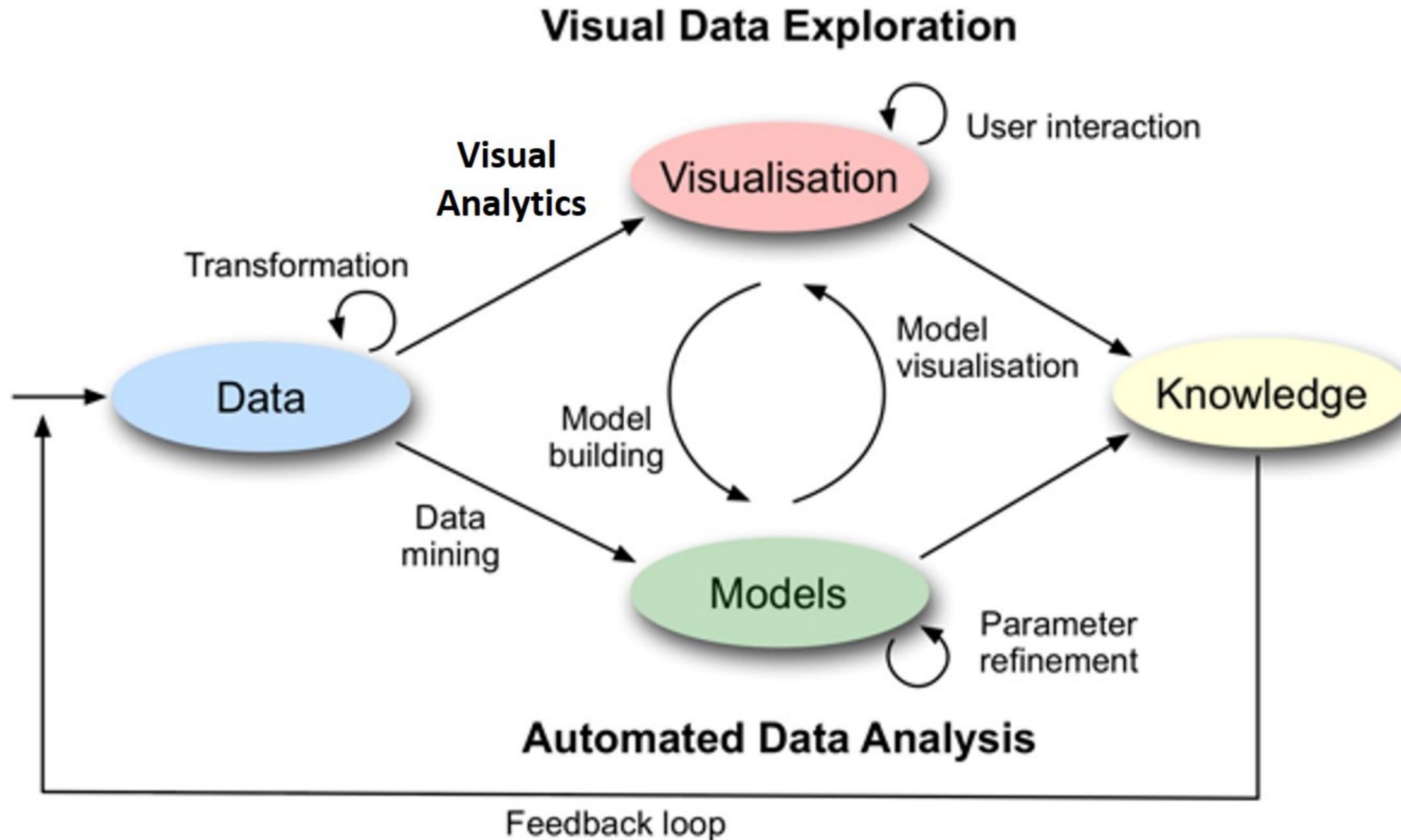
Motivation of Visual Analytics

Analytical graphics reveal the truth



Motivation of Visual Analytics

Is there a place for Visual Analytics in knowledge discovery?



Motivation of Visual Analytics

Open data need to be unlocked!

The screenshot shows the Data.gov.sg website interface. At the top, there is a navigation bar with the logo and links for 'Blog', 'Developers', and 'Data Request'. The main header features the 'Data.gov.sg' logo and a search bar with the placeholder text 'Search Singapore's Public Data'. Below the search bar is an orange button labeled 'View All Datasets'. A horizontal row of icons represents various data categories: Economy, Education, Environment, Finance, Health, Infrastructure, Society, Technology, and Transport. The main content area is titled 'Singapore at a glance' and contains two data visualizations:

- Singapore Residents By Ethnic Group, End June, Annual (2018):** A grouped bar chart showing the number of residents in different ethnic groups from 2009 to 2017. The y-axis ranges from 0 to 3.5M. The chart shows a steady increase in the total number of residents over the period.
- Domestic Exports By Area (2014):** A pie chart showing the distribution of domestic exports by region. The largest share is from Asia, followed by America, Europe, Oceania, and Africa.

Visit the [link](#)

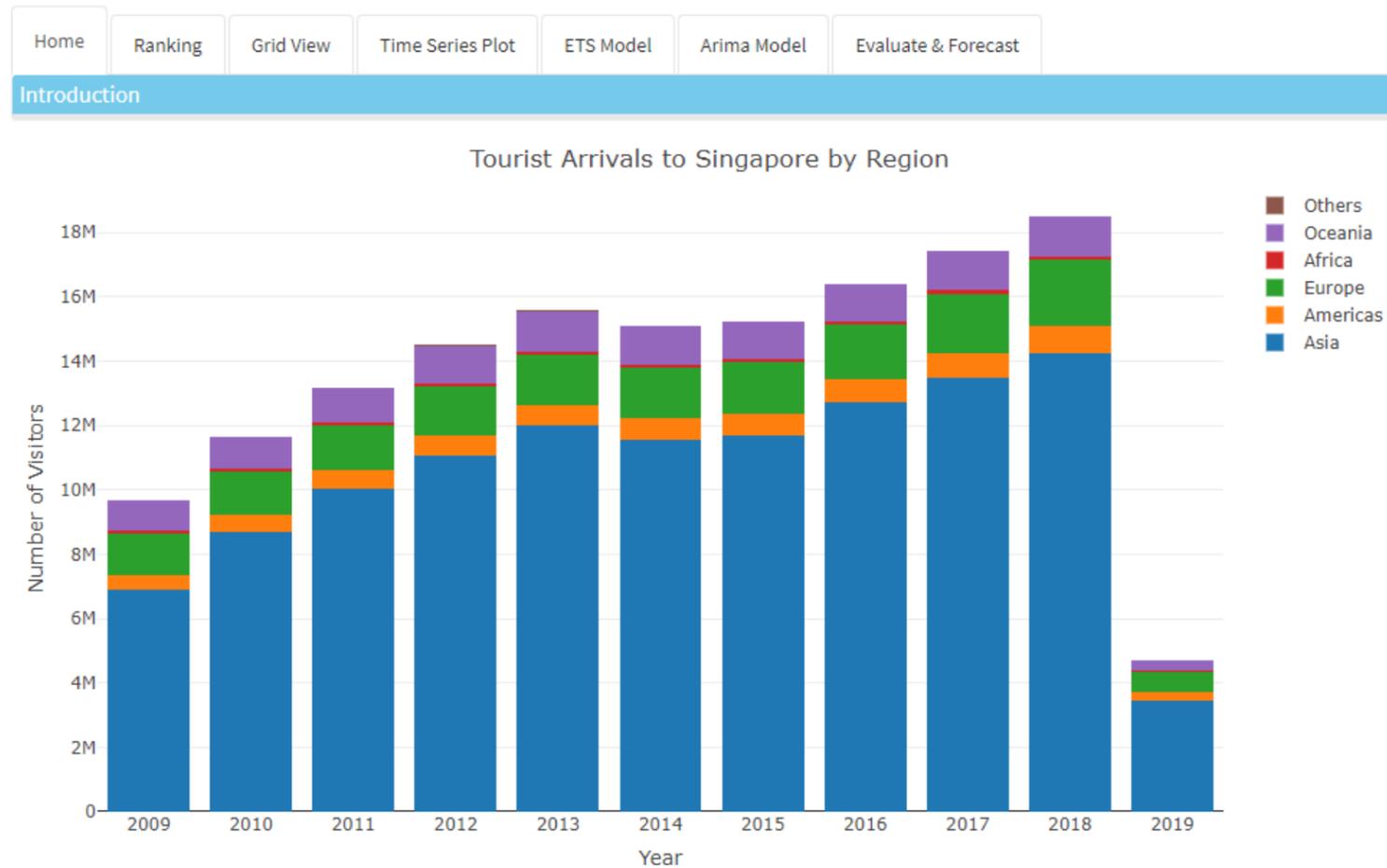
Motivation of Visual Analytics

Democratising Data and Analytics with Visually-driven Web Apps



Tourist Arrivals to Singapore: Who are we expecting?

Choose CSV file

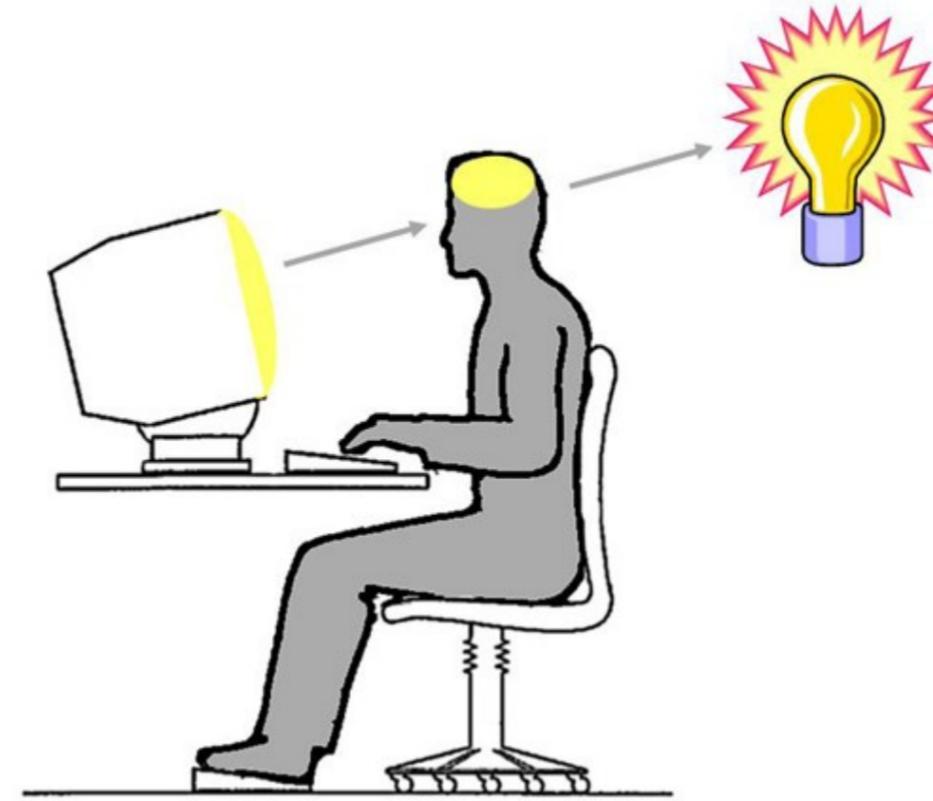


Visit the [link](#)

What is Visual Analytics?

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

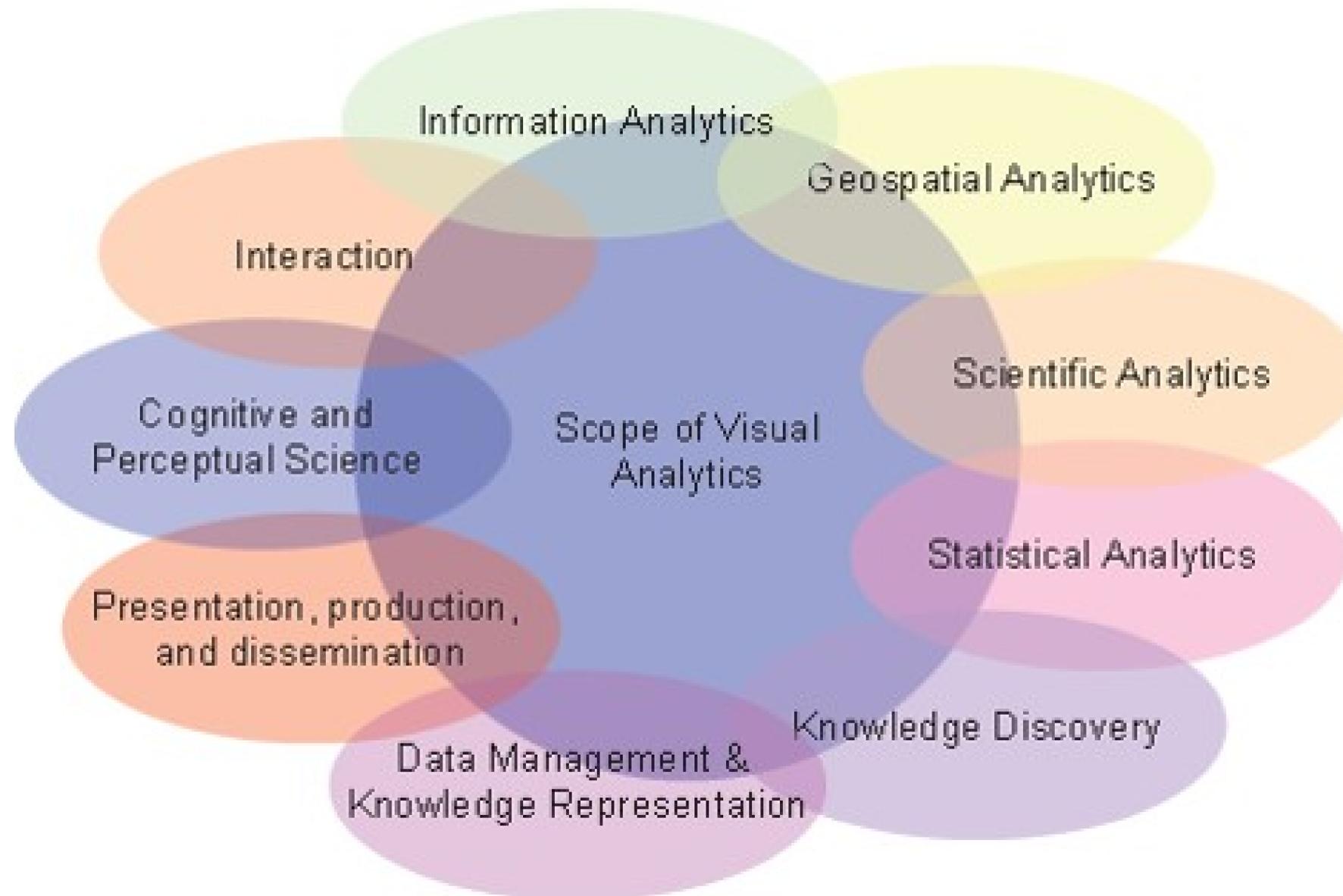
- Data Science and Analytics
- Data Visualisation
- Human-Computing-Interaction (HCI)
- Interface Design
- Visual Storytelling



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.

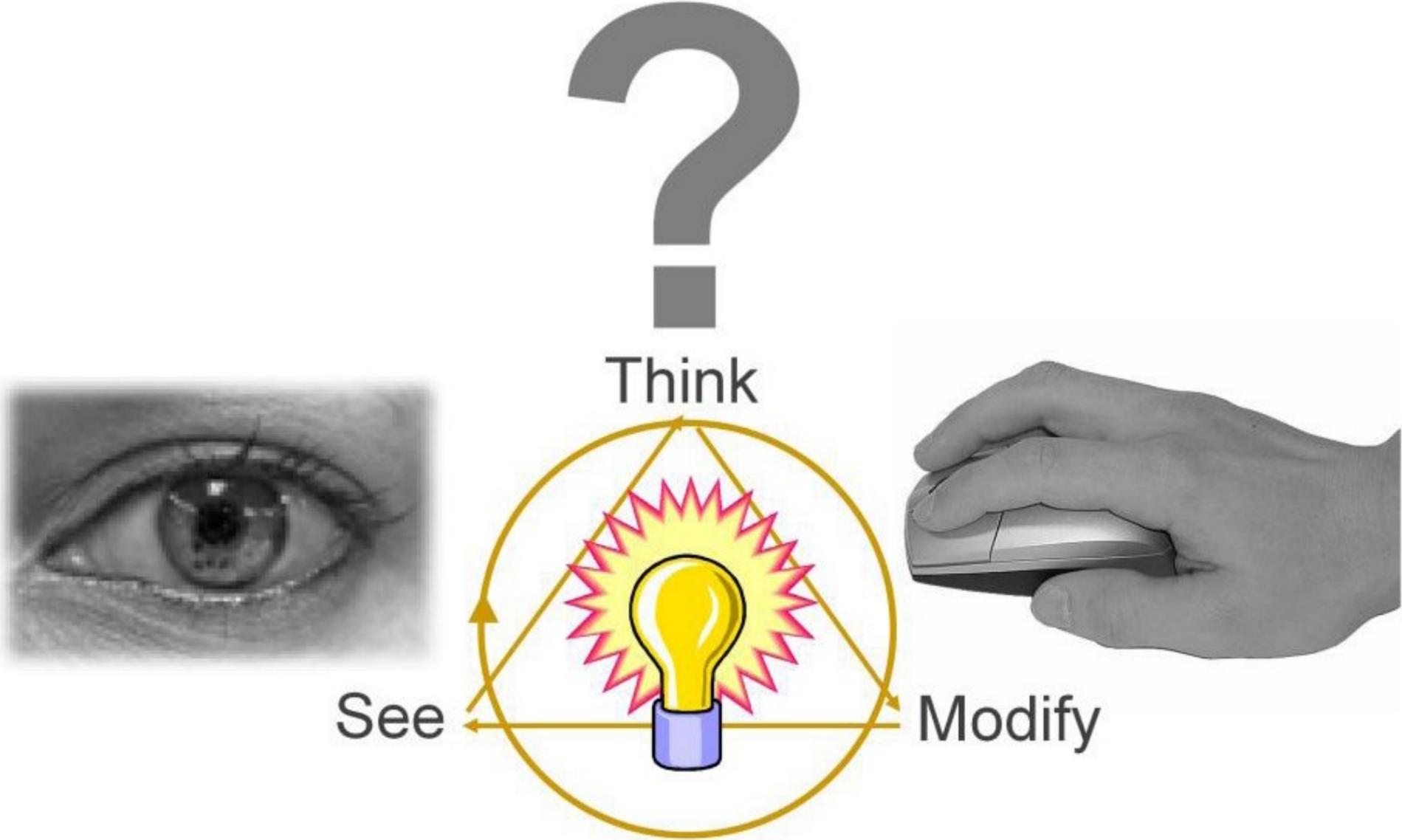
*When you have eliminated
the impossible, whatever
remains, however
improbable, must be the
truth.*

- Sherlock Holmes



What is Visual Analytics?

Visual Analytics Framework



What is Visual Analytics?

Visual Analytics require a shift of mindset

VISUAL THINKING

Exploration

Analysis

VISUAL COMMUNICATION

Synthesis

Presentation

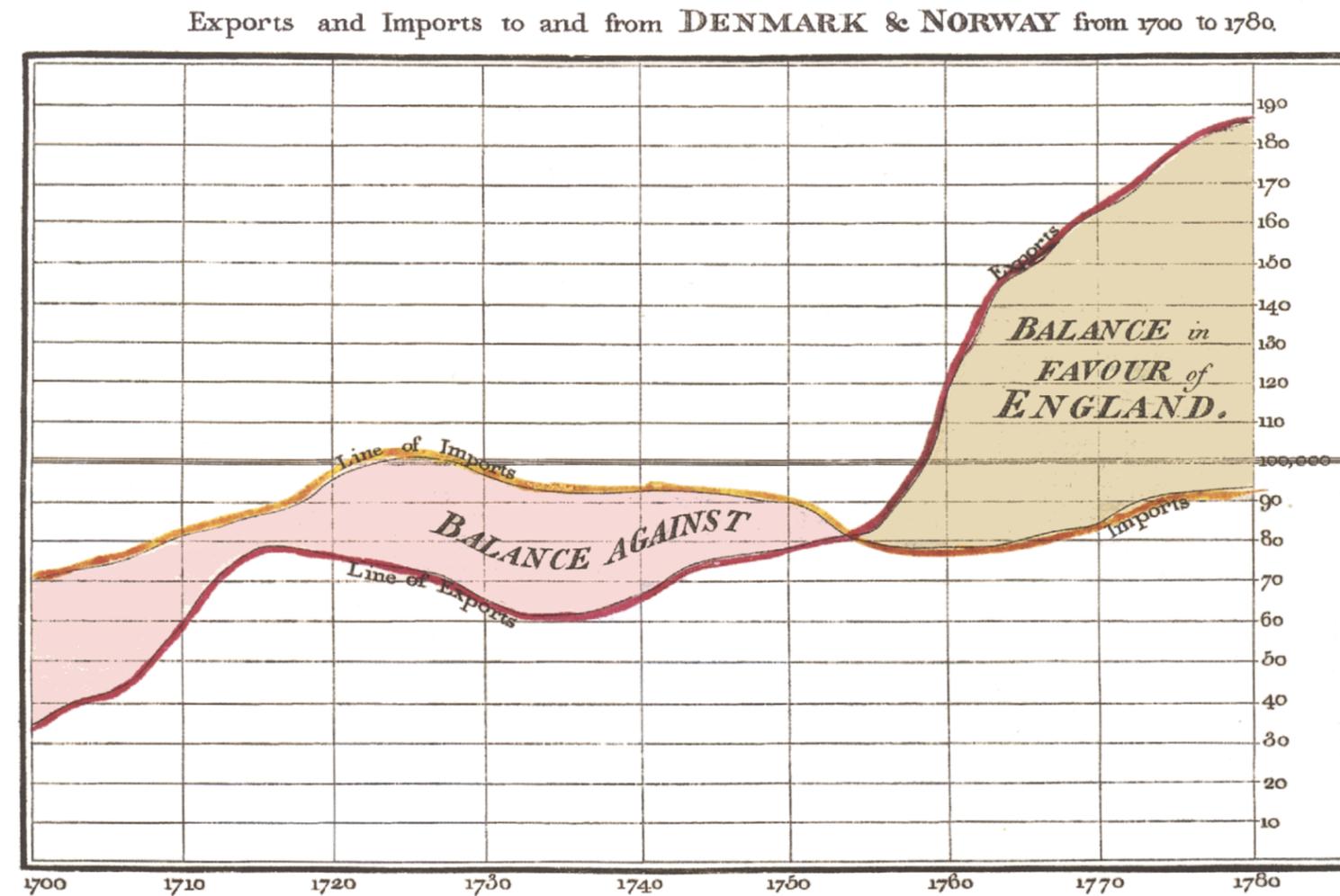
PRIVATE REALM

PUBLIC REALM

What is Visual Analytics?

Learning from the history of Visual Analytics

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

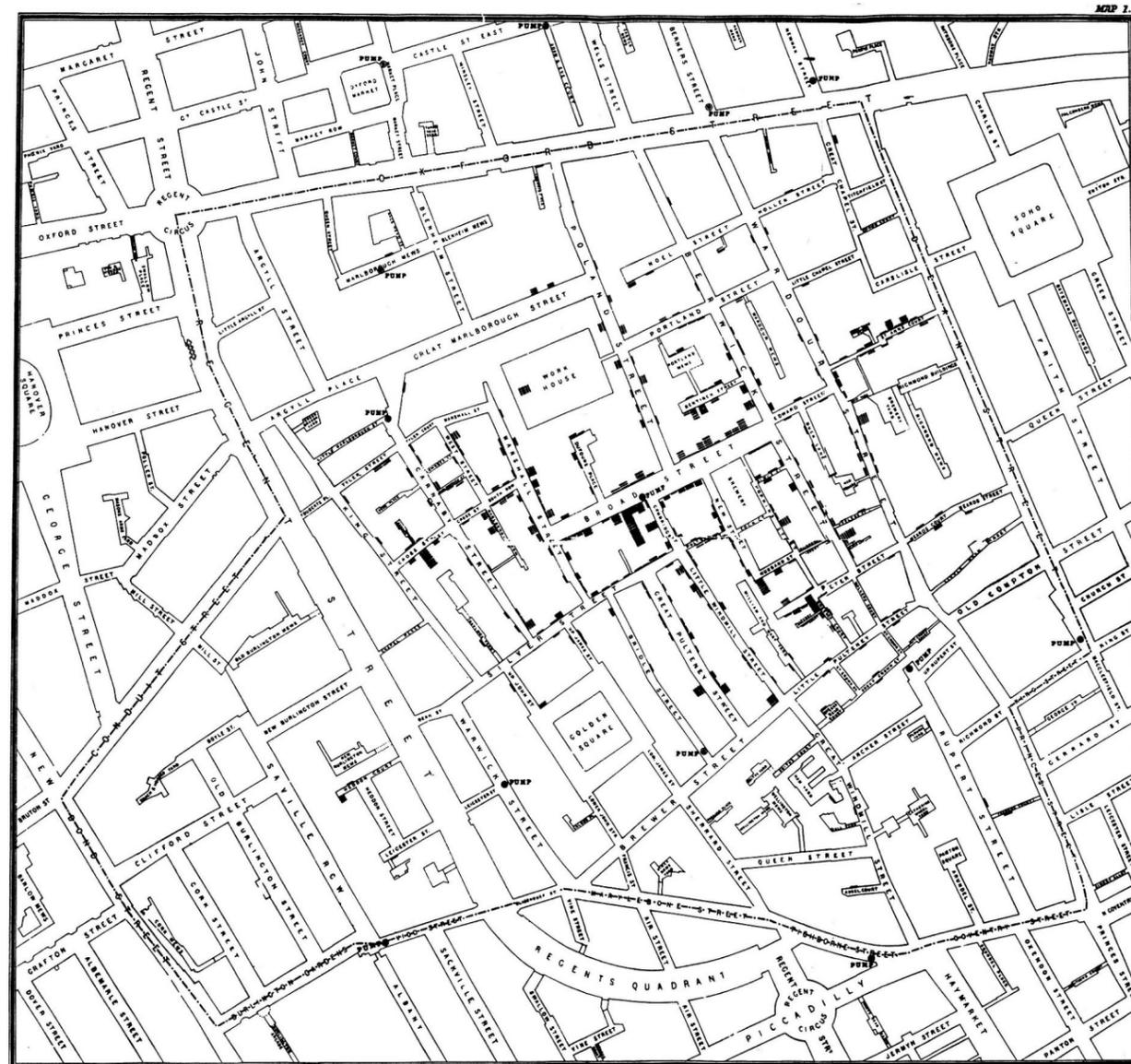


The Bottom line is divided into Years, the Right hand line into 110,000 each.
Published as the Act directs, 14th May 1786. by W^m Playfair. No. 352, Strand, London.

What is Visual Analytics?

Learning from the history of Visual Analytics

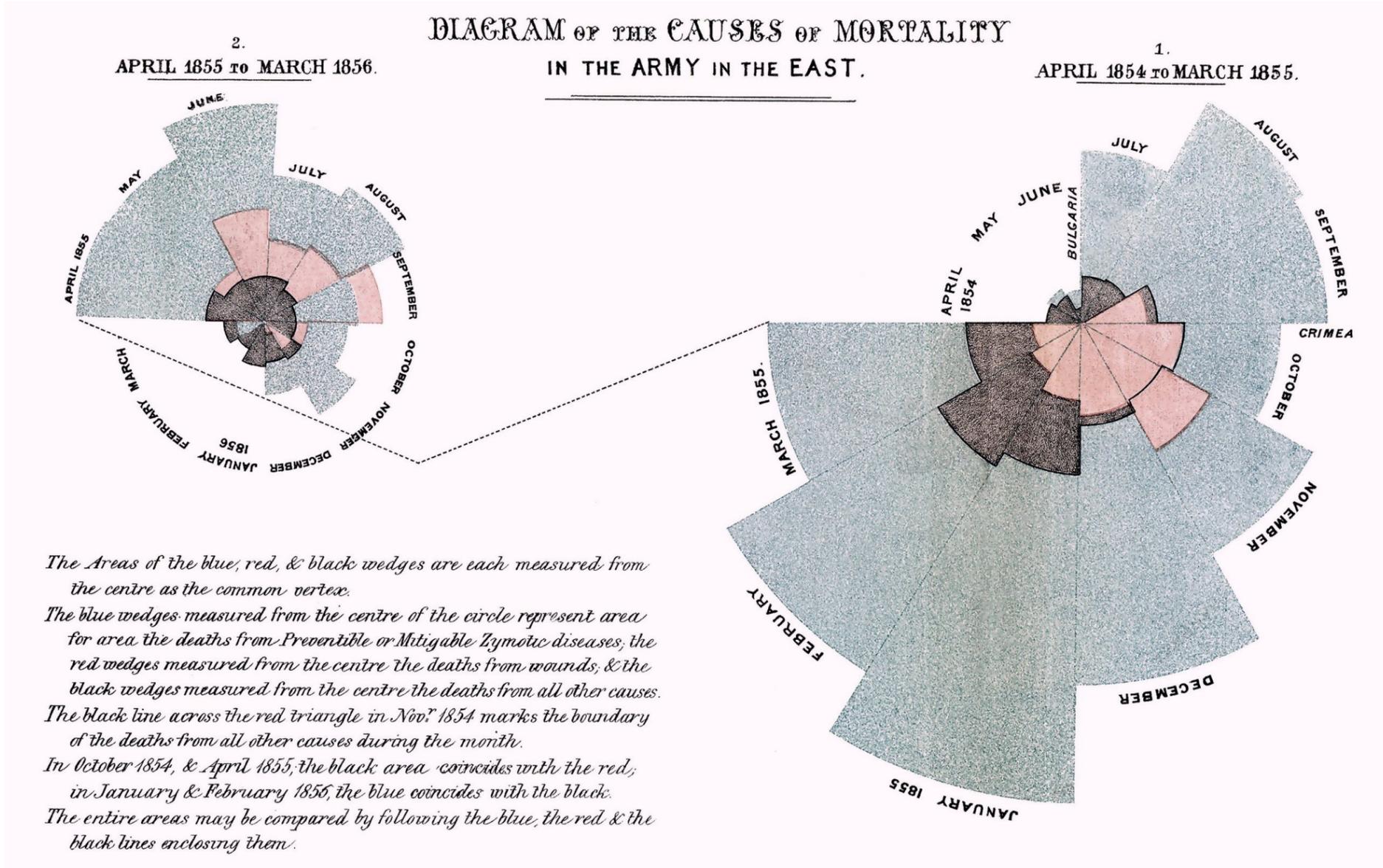
Cholera and the Pump on Broad Street (John Snow, 1854).



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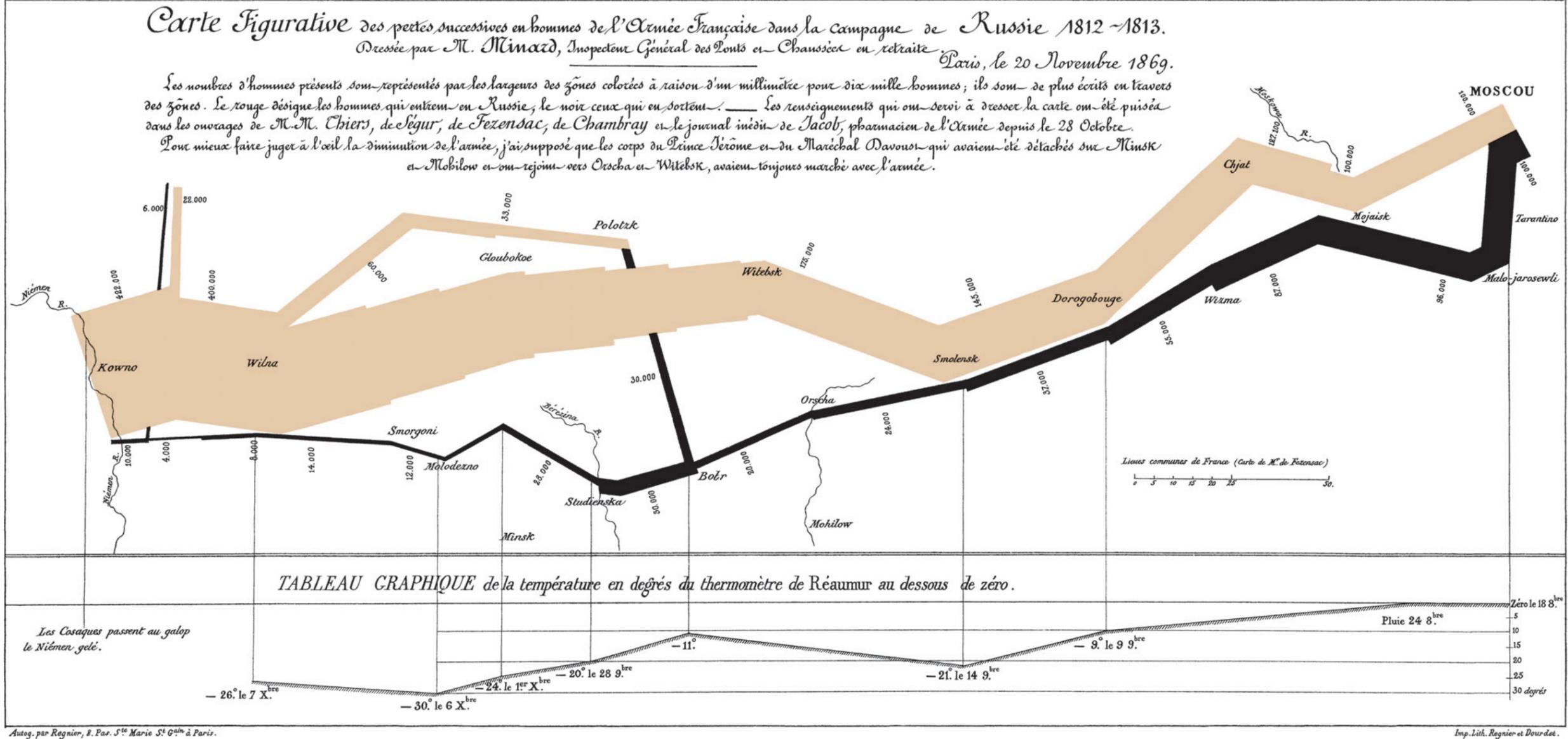
Florence Nightingale: The compassionate statistician (12 May 1820 – 13 August 1910)



What is Visual Analytics?

Learning from the history of Visual Analytics

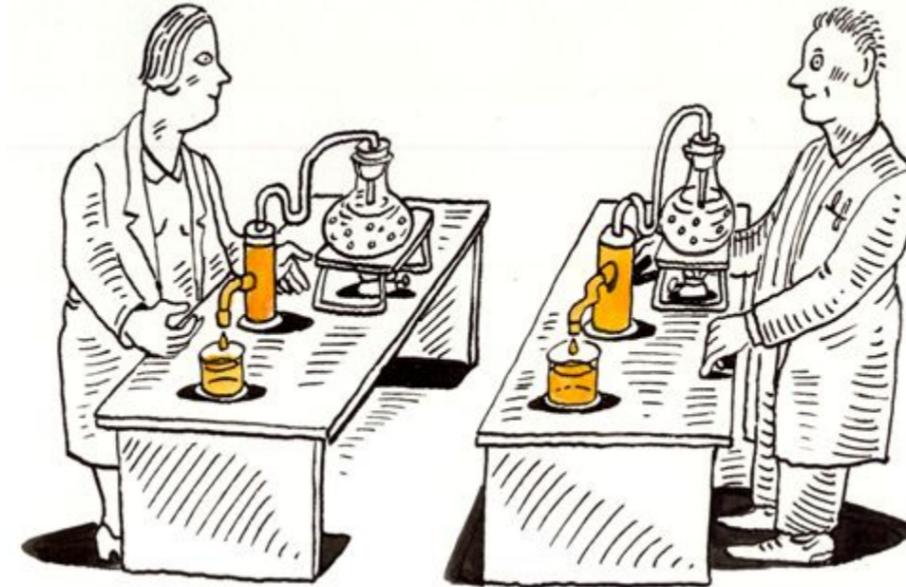
Plot of Napoleon's ill-fated Russian campaign of 1812-1813 (Charles Joseph Minard, 1861)



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



SAP Lumira®
Ignite Creative Ideas

Tableau: A data visualisation tool for everyone

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



Breakthrough
Technology



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](#)

