

# Lesson 1

# Introduction to Visual Analytics and Applications

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# What will you learn from this lesson?

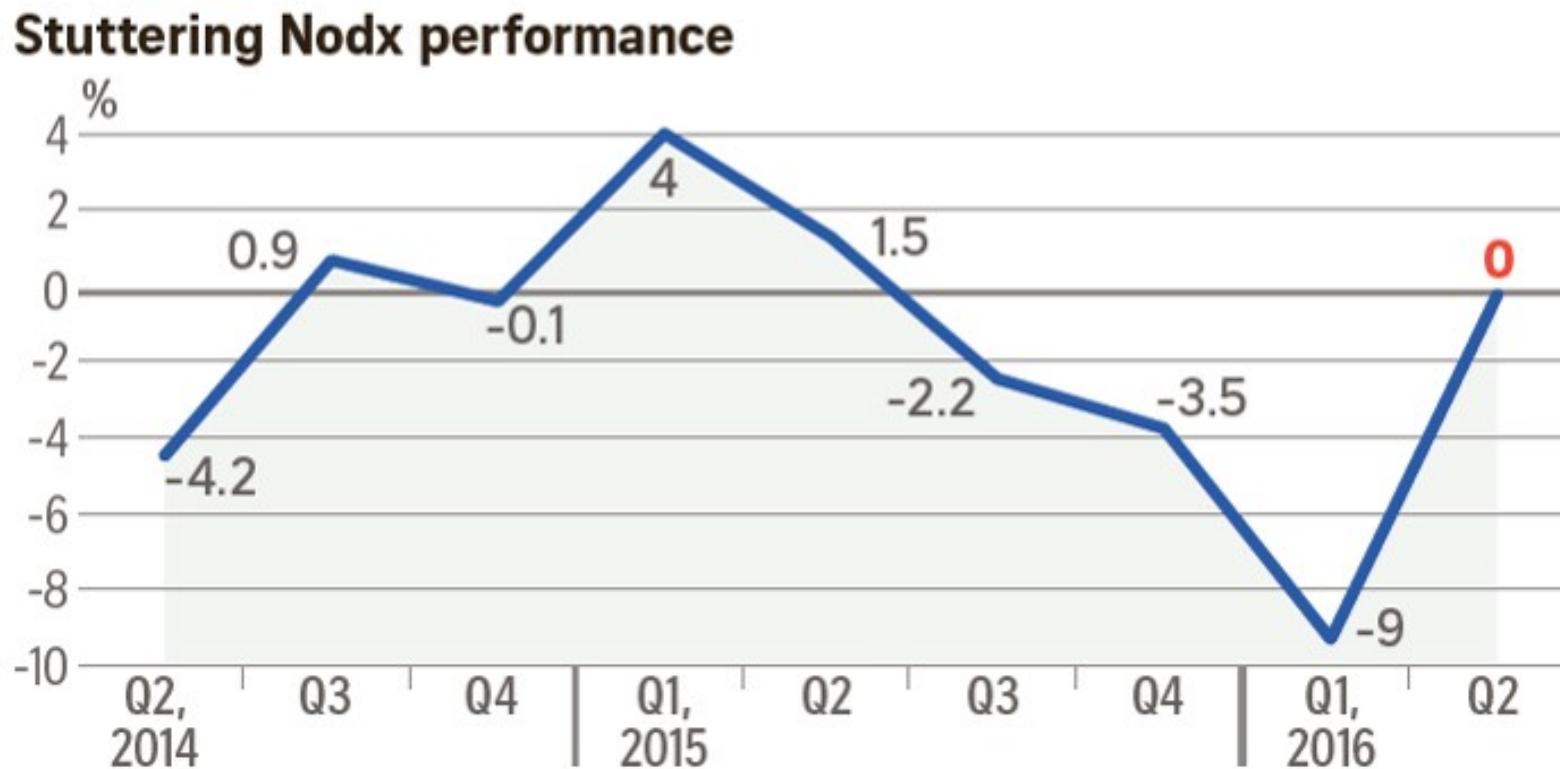
- Motivation of Visual Analytics
- What is Visual Analytics
- Learning from the history of visual analytics
- Data Visualisation tools

# Motivation of Visual Analytics

The World is full of charts that lie!



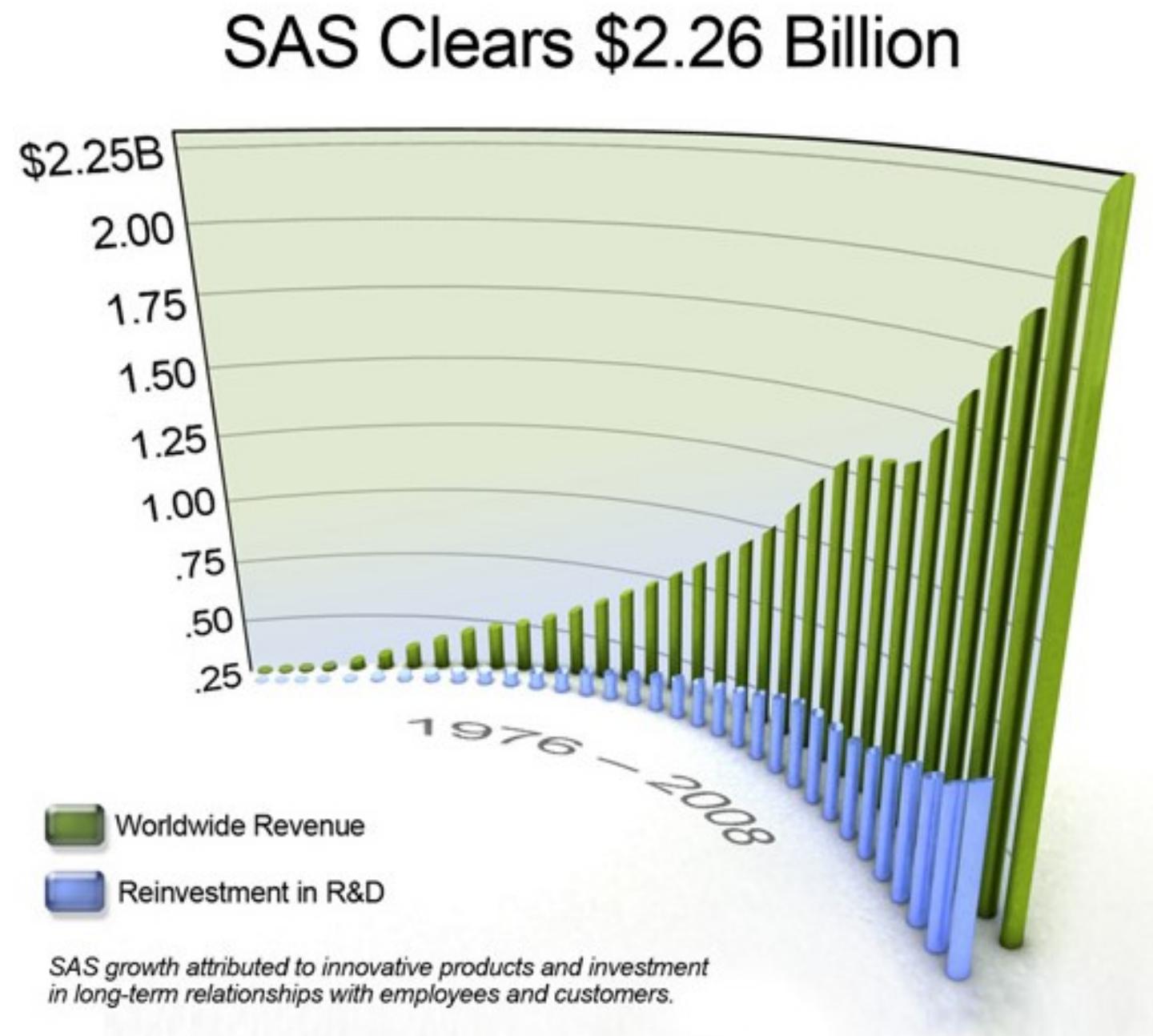
Non-oil domestic exports (Nodx) growth was flat in the second quarter. For the first half this year, **Nodx fell 4.5 per cent** compared with the same period last year.



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

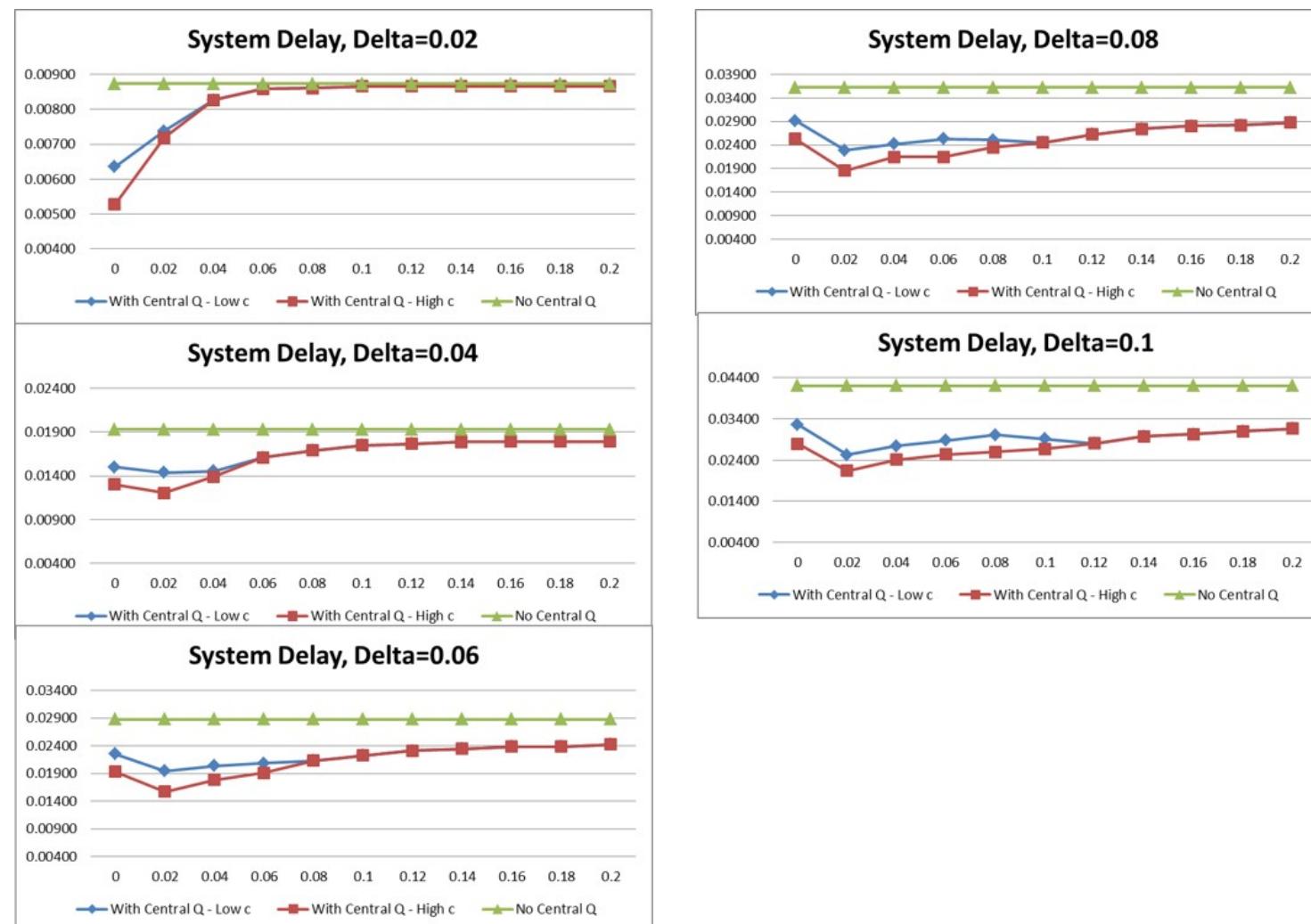
The World is buried in data,

Just SHOW me the number

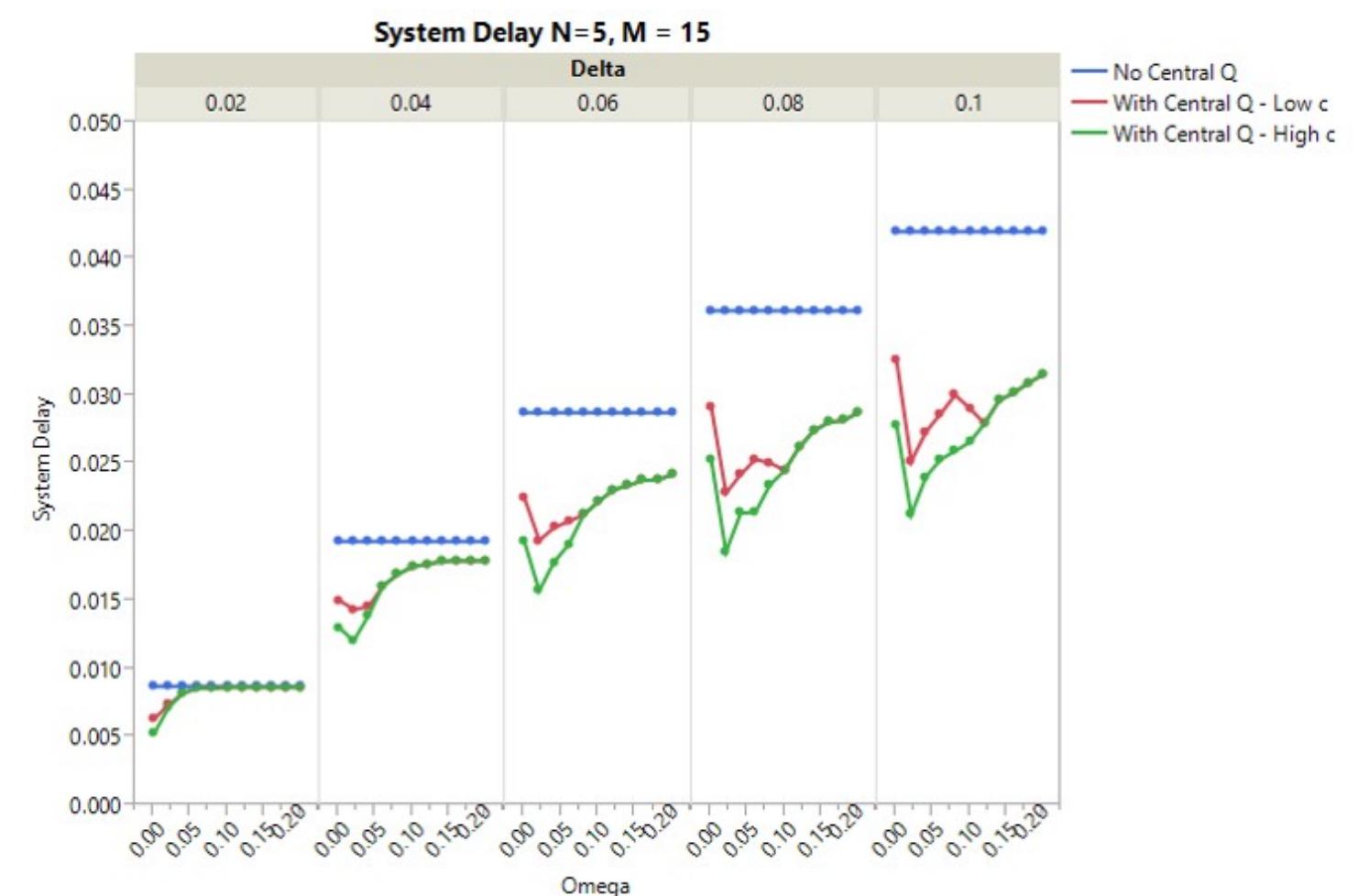
B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
1	Country	Exchange	Name	Forex	Symbol	ISIN	SEOL	Close(Io)	Mcap(Io)	Mcap(U)	Industry	Superset	1 Day	Clo:	1 Week	C 1 Month	2 Month	3 Month	1 Day	C 1 Day	C 1 Week	C 2 Weeks	C 1 Month	1 Month	2 Month	2 Month	3 Month	
2	AT	VIE	Erste Gr.	EUR	ERGT.VI	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	YIGR.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	9.35	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	6.44	1E+09	1E+09	Financial Banks	6.3	7.34	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	29.8	26.8	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	1.15	1.14	1.28	0.0323	0.0328	0.0573	0.05091	0.28	0.3454	0.0111	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	EHPLAX	AU000005144530	0.91	1E+11	1E+11	Basic Mfg Basic Re	34.61	33.32	34	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

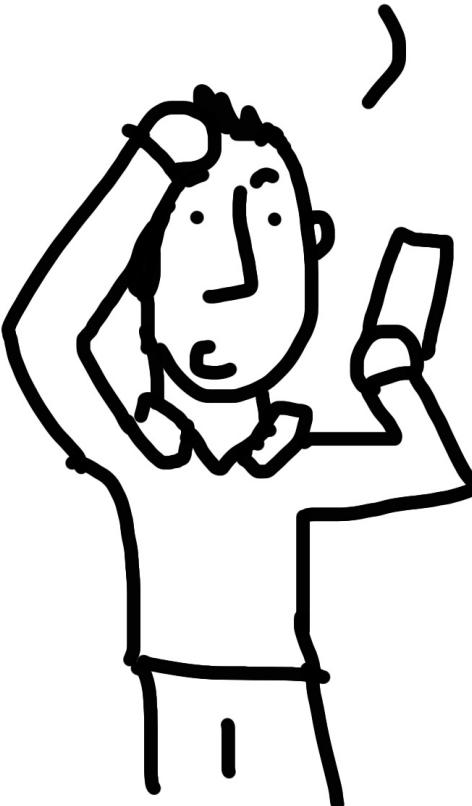
Summary Statistics	
Mean	7.4990909
Std Dev	2.0300614
Std Err Mean	0.6120865
Upper 95% Mean	8.8629047
Lower 95% Mean	6.1352771
N	11

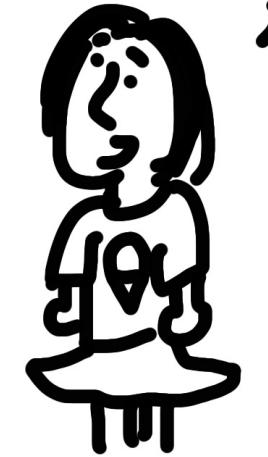
Linear Fit	
SALES_REVENUE	= 3.0000909 + 0.5000909*SALESFORCE
Summary of Fit	
RSquare	

Data analysis without data visualisation is no data analysis

I just can't make sense  
of this data.



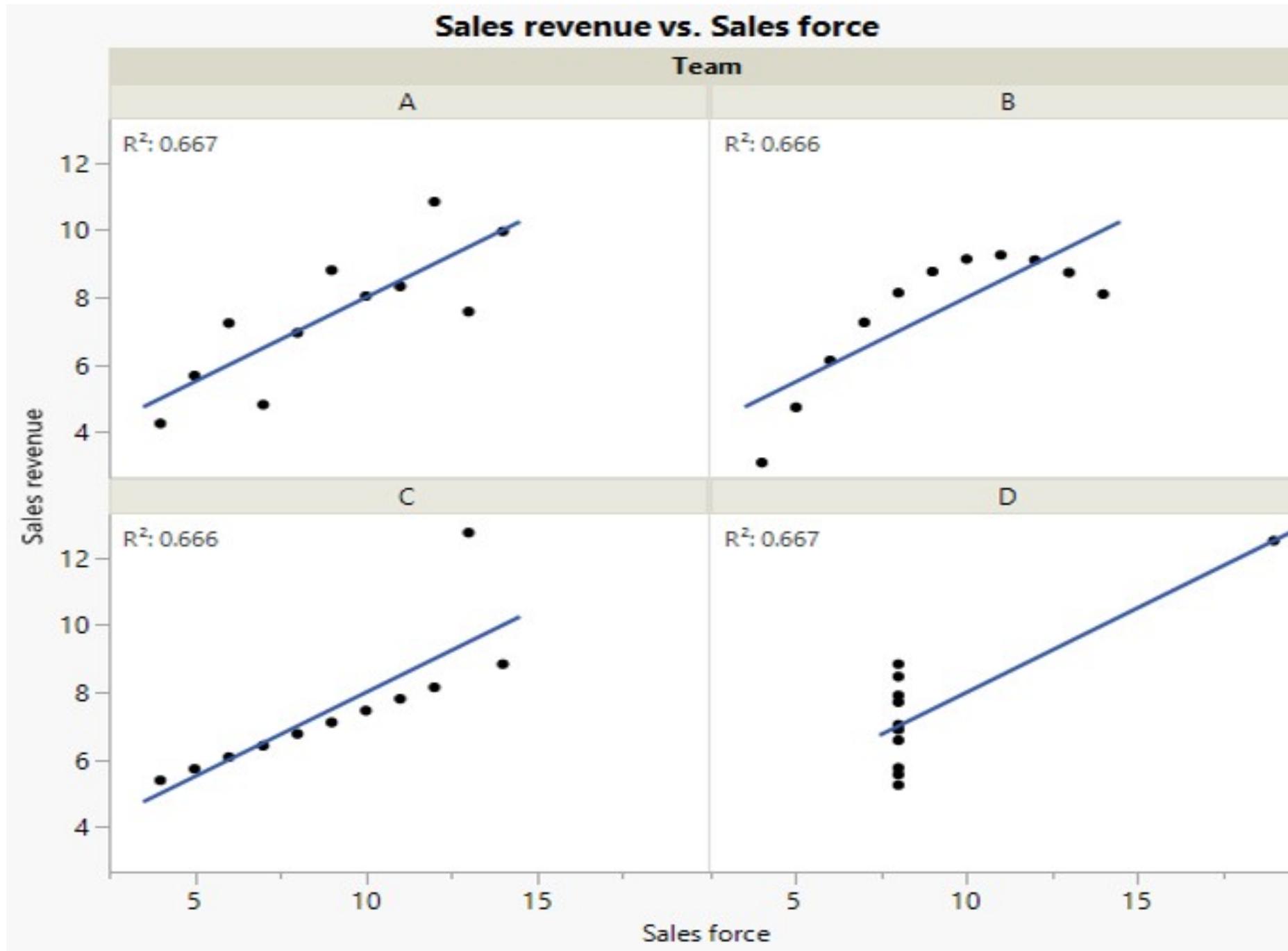
Have you tried  
looking at the  
pictures?



fresh spectrum

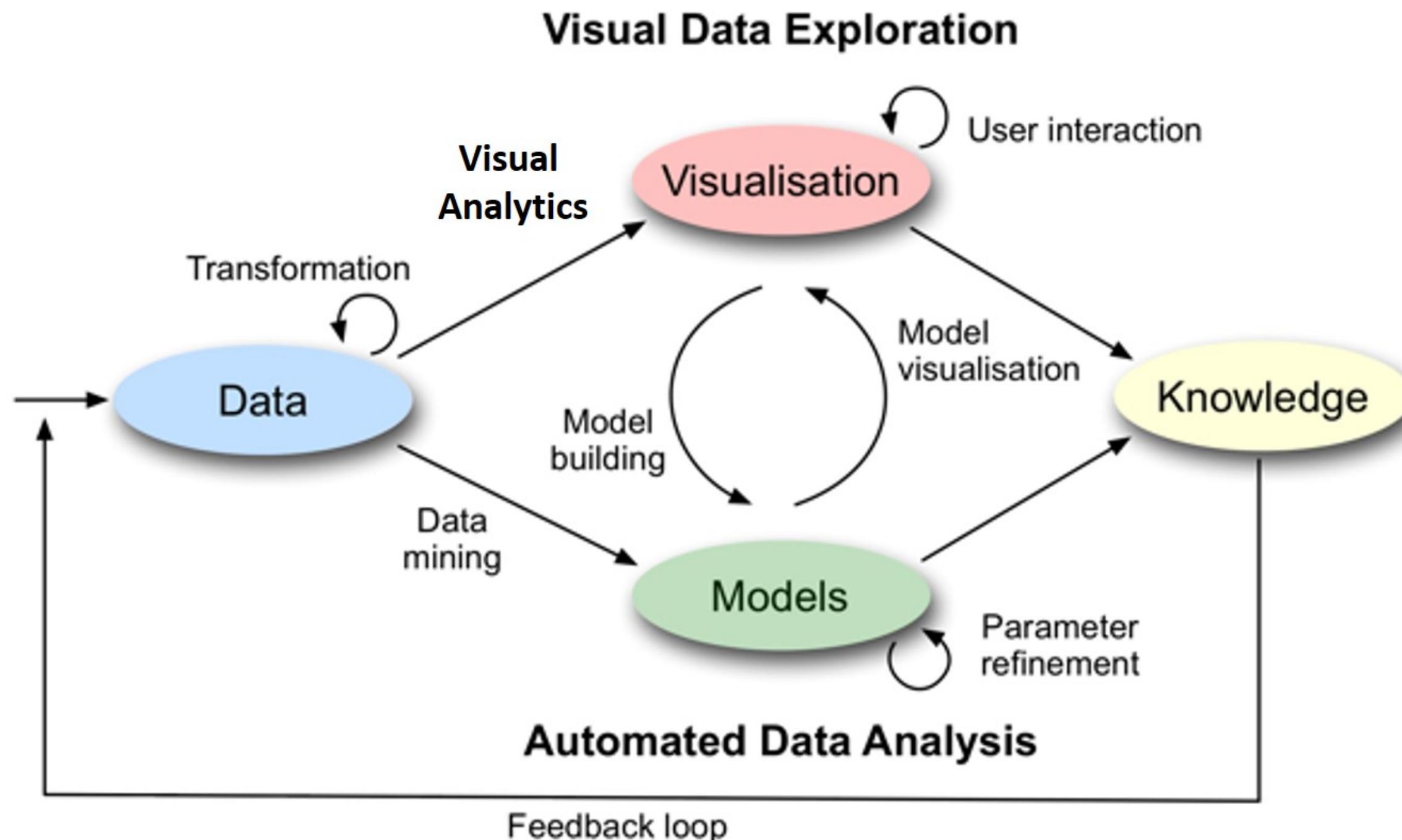
# Motivation of Visual Analytics

Analytical graphics reveal the truth



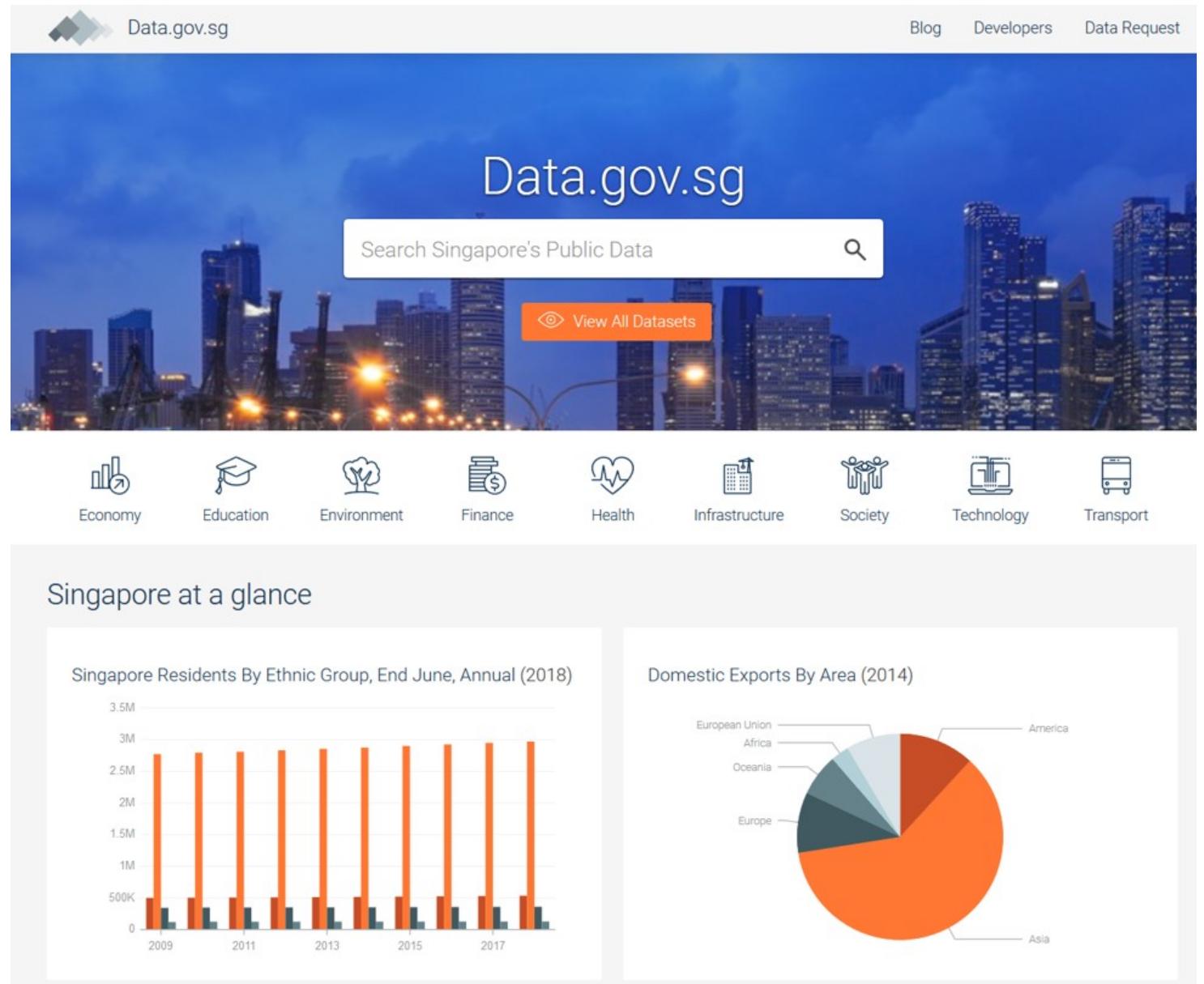
# Motivation of Visual Analytics

Is there a place for Visual Analytics in knowledge discovery?



# Motivation of Visual Analytics

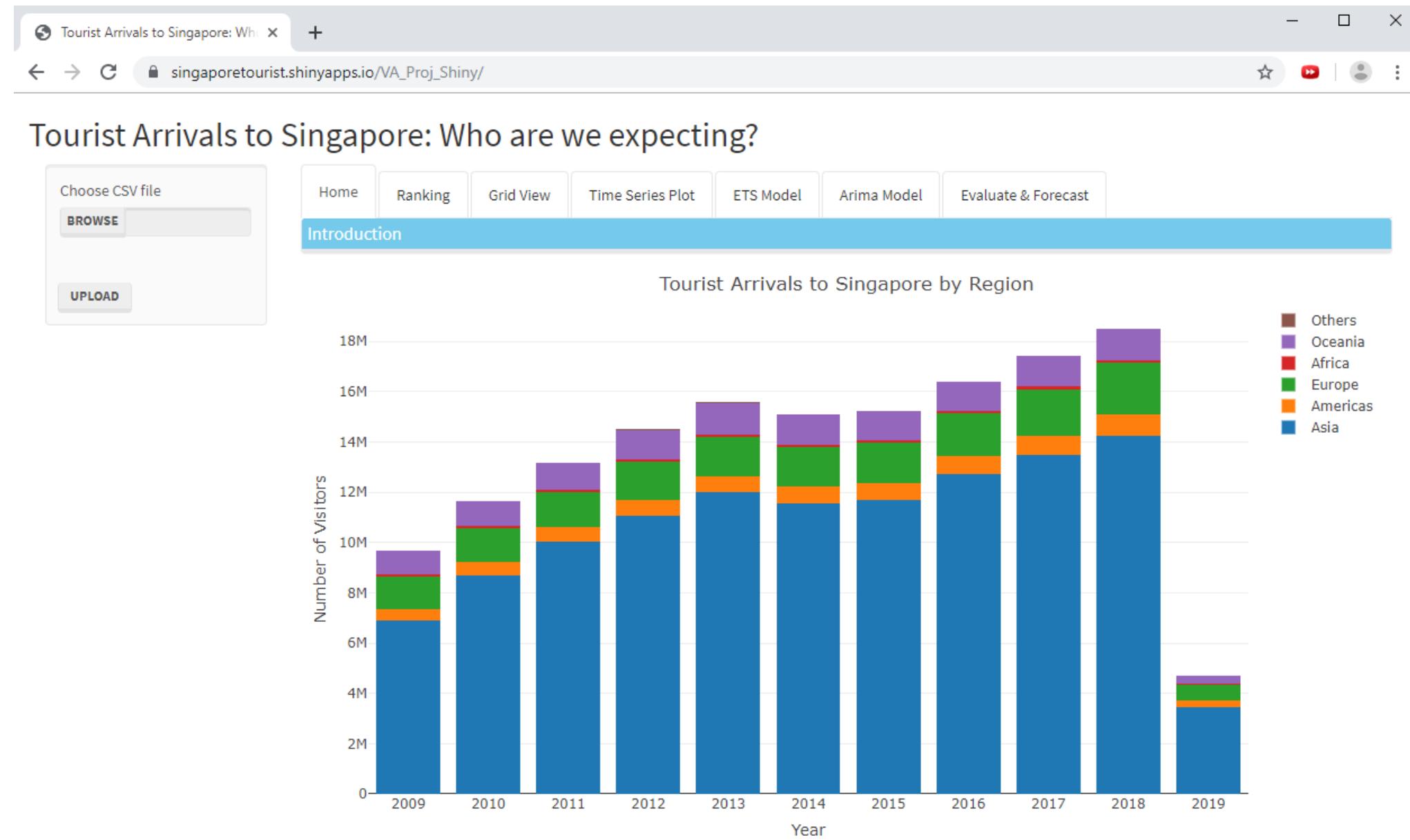
Open data need to be unlocked!



Visit the [link](#)

# Motivation of Visual Analytics

## Democratising Data and Analytics with Visually-driven Web Apps

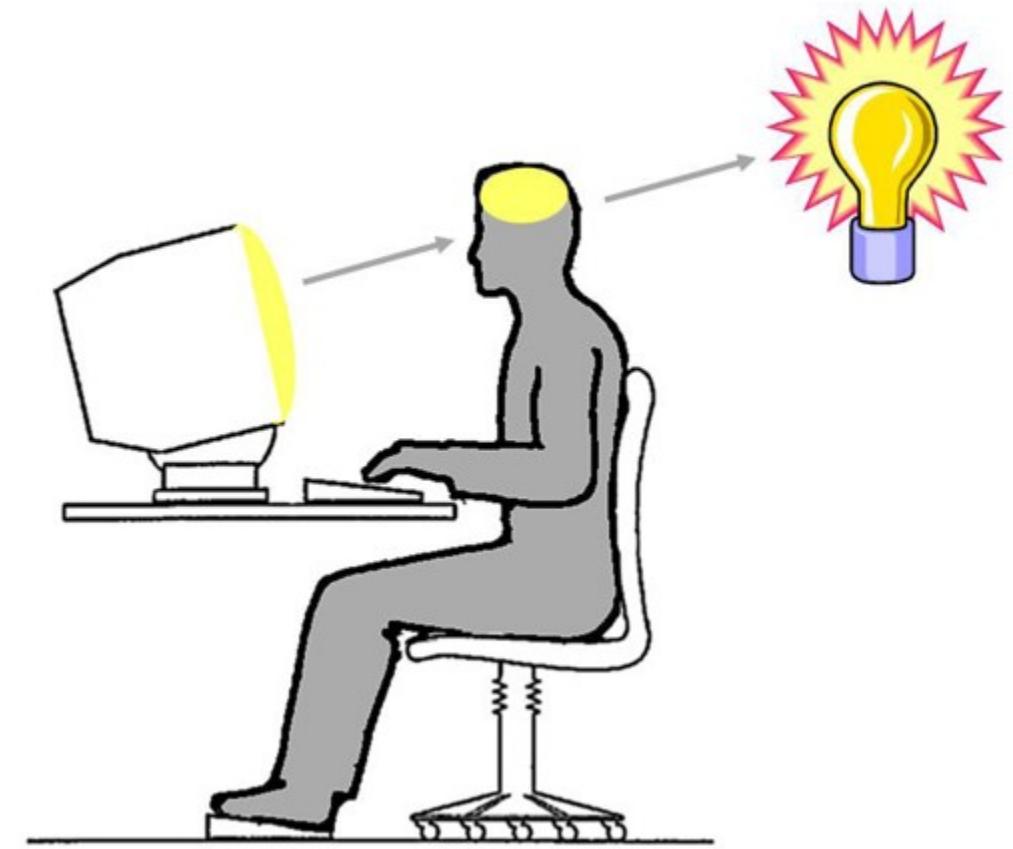


Visit the [link](#)

# What is Visual Analytics?

Visual Analytics is the craft of analytical reasoning supported by:

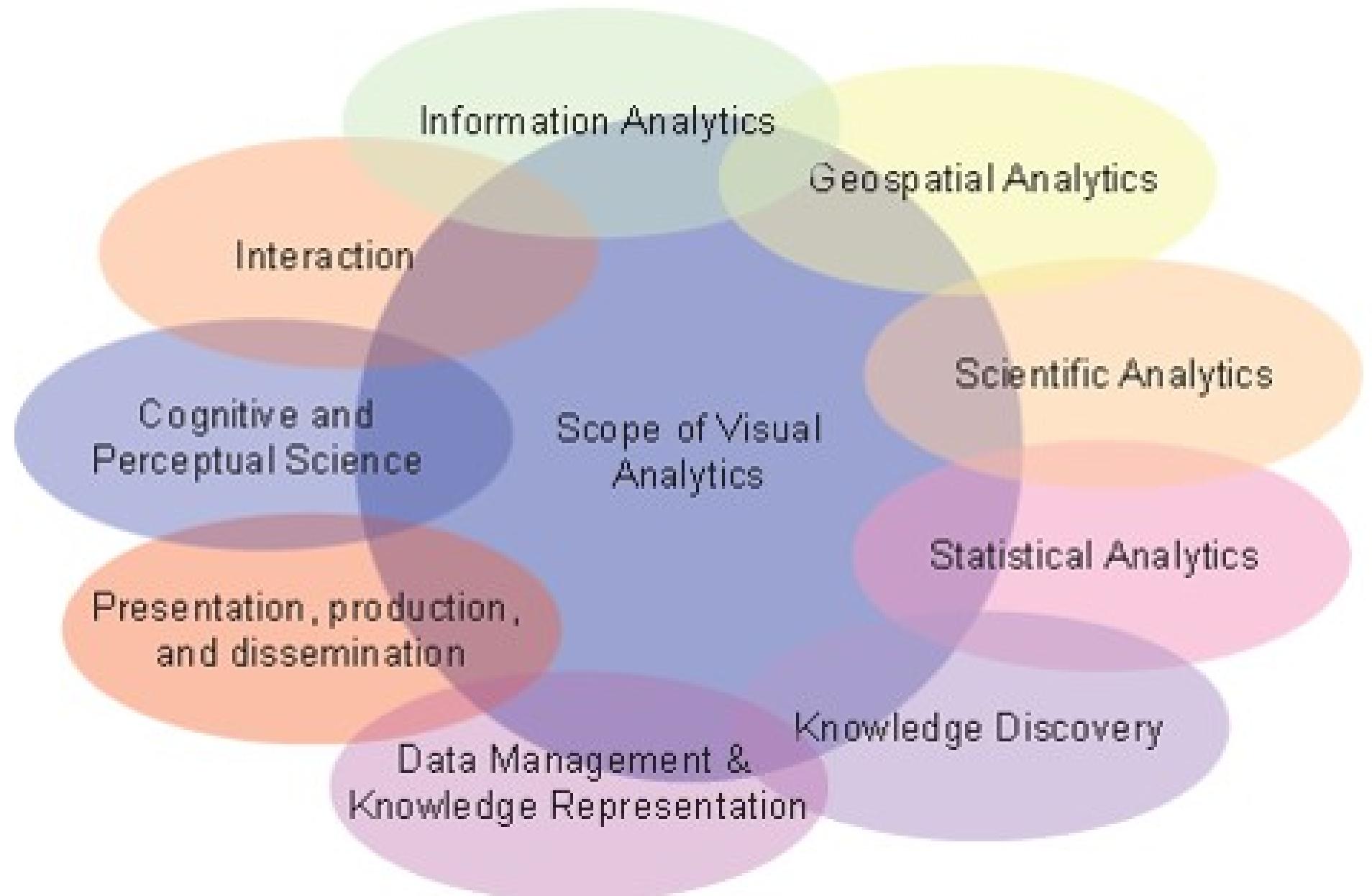
- Data Science and Analytics
- Data Visualisation
- Human-Computing-Interaction (HCI)
- Interface Design
- Visual Storytelling



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**.

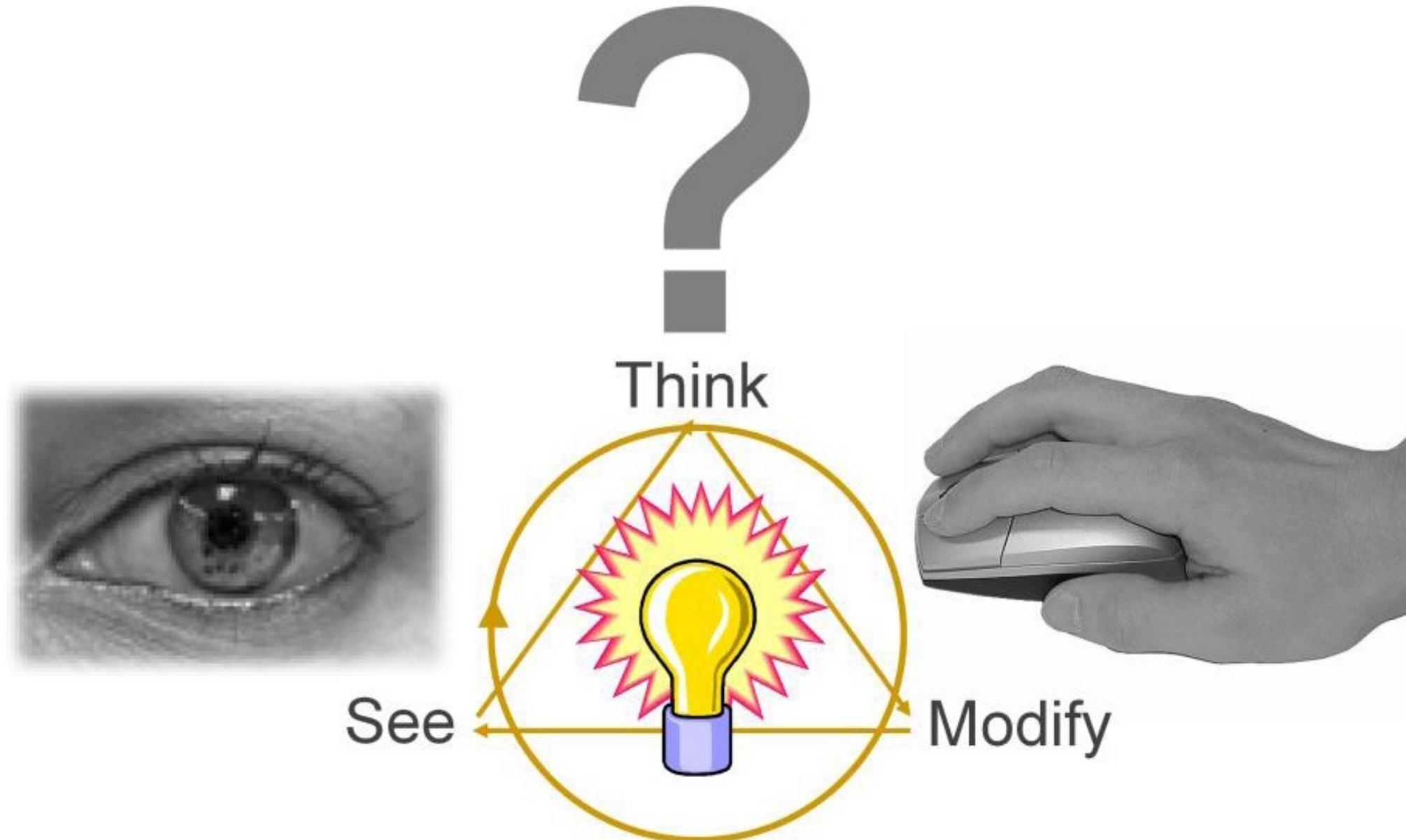
*When you have eliminated  
the impossible, whatever  
remains, however  
improbable, must be the  
truth.*

- Sherlock Holmes



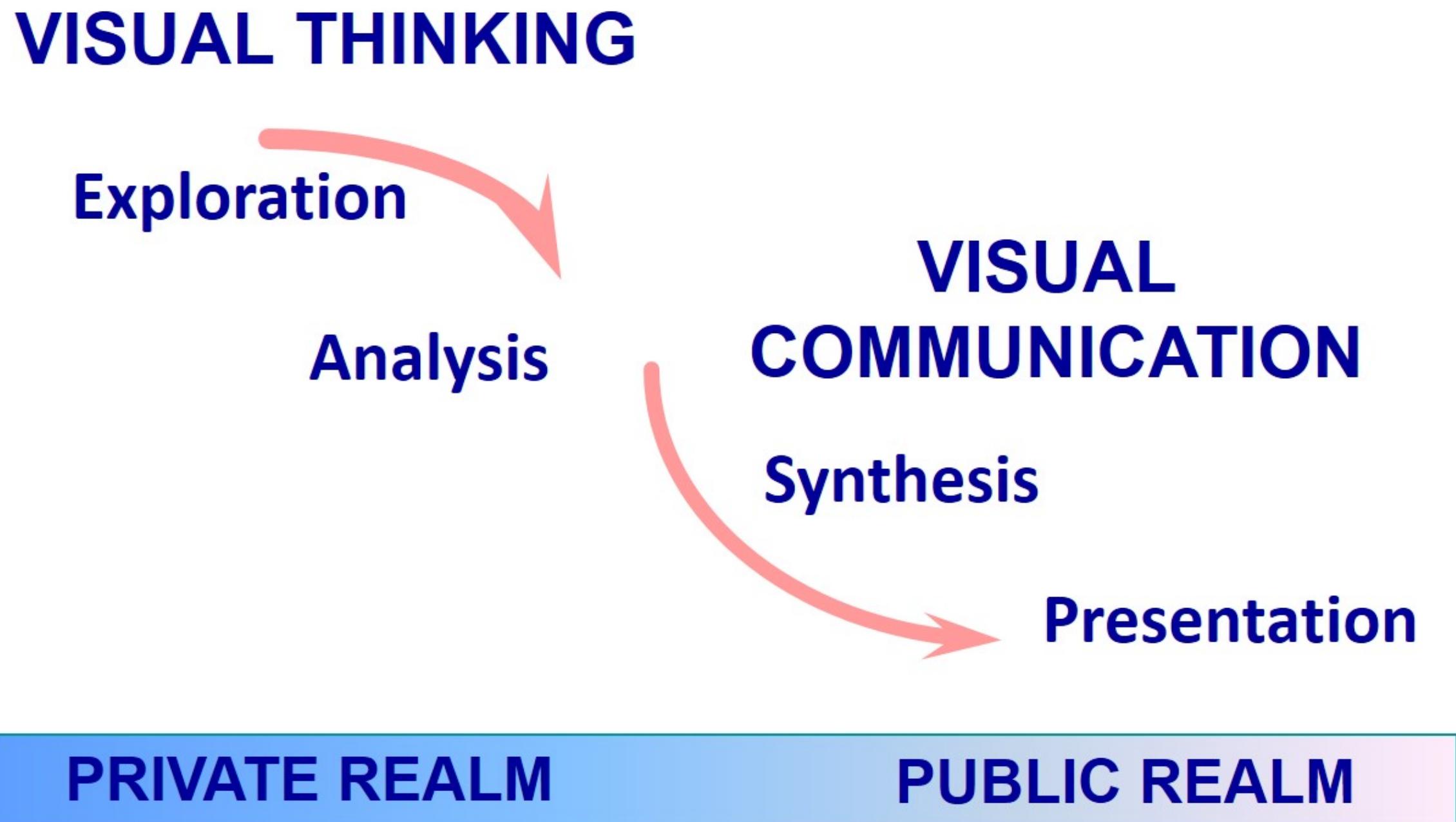
# What is Visual Analytics?

## Visual Analytics Framework



# What is Visual Analytics?

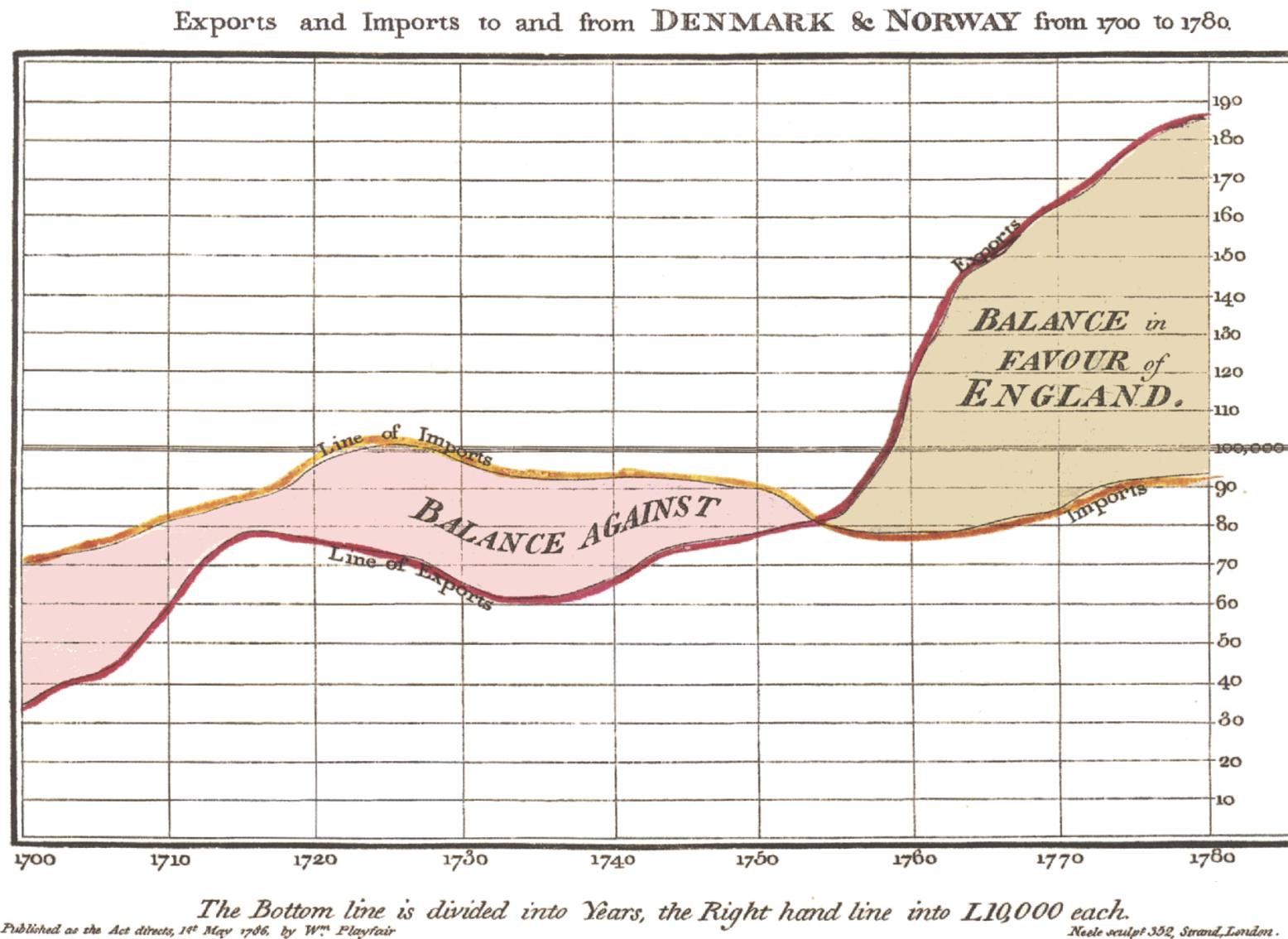
Visual Analytics require a shift of mindset



# What is Visual Analytics?

## Learning from the history of Visual Analytics

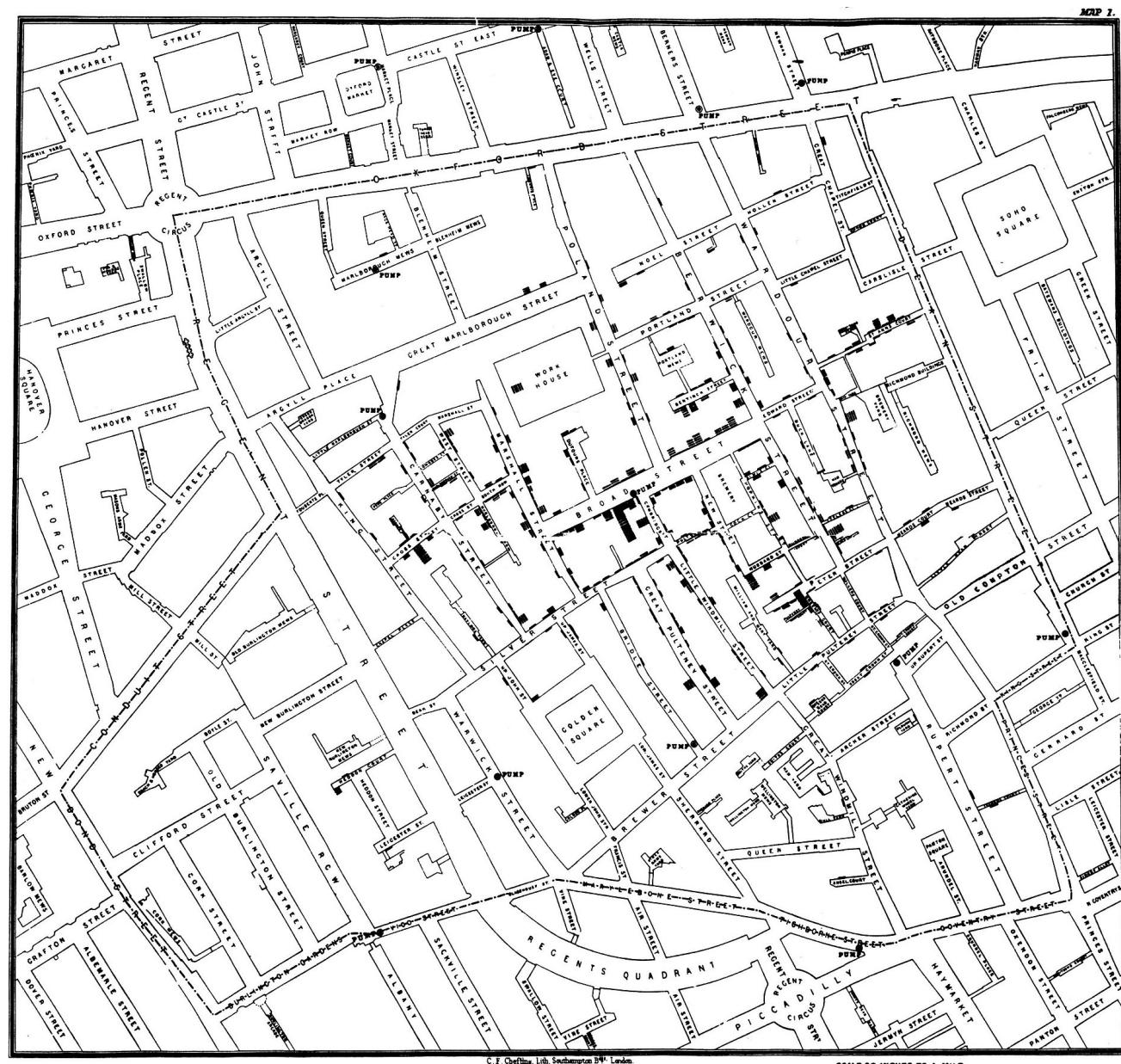
Commercial and Political Atlas by William Playfair (22 September 1759 – 11 February 1823)



# What is Visual Analytics?

## Learning from the history of Visual Analytics

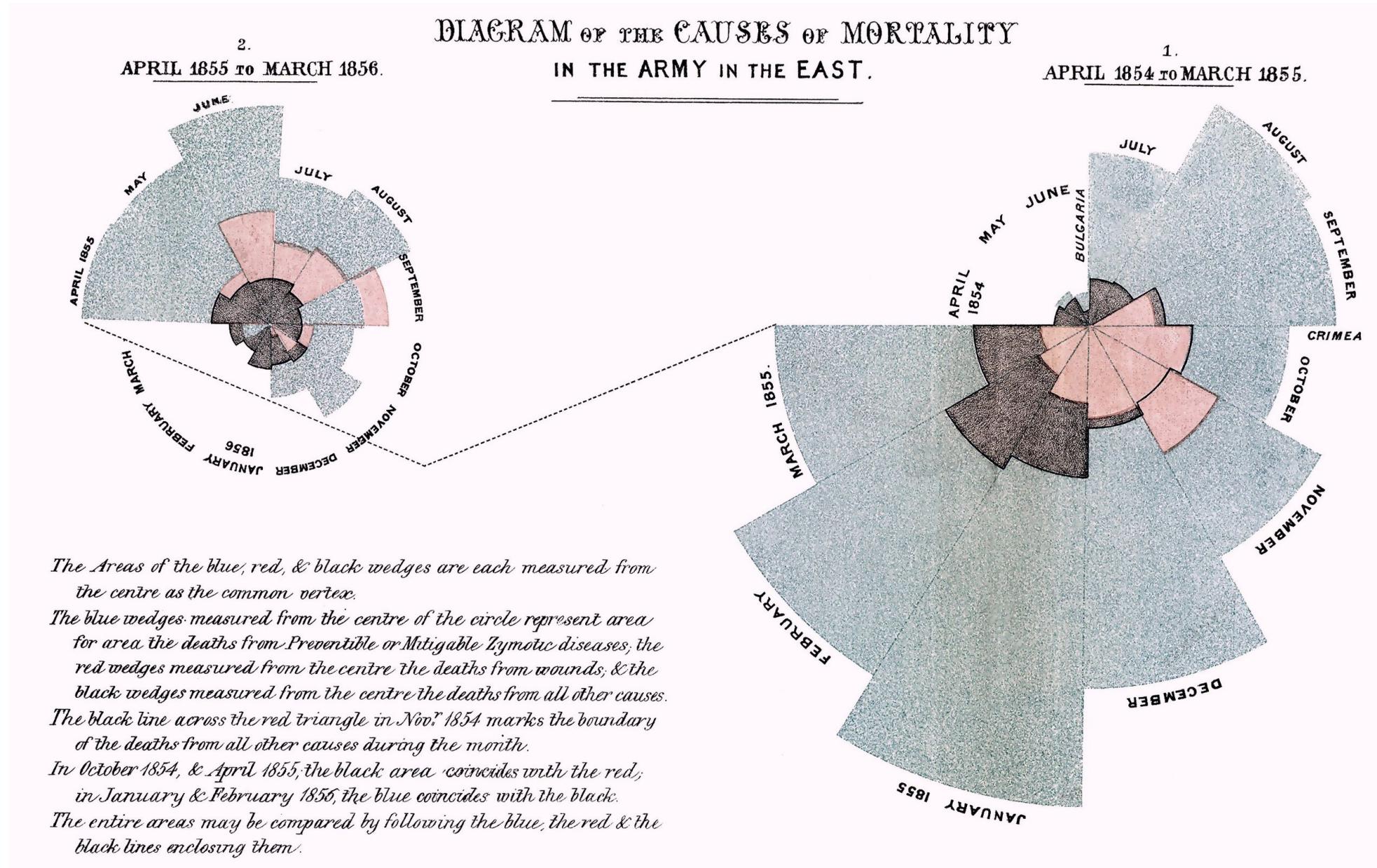
Cholera and the Pump on Broad Street (John Snow, 1854).



# What is Visual Analytics?

## Learning from the history of Visual Analytics

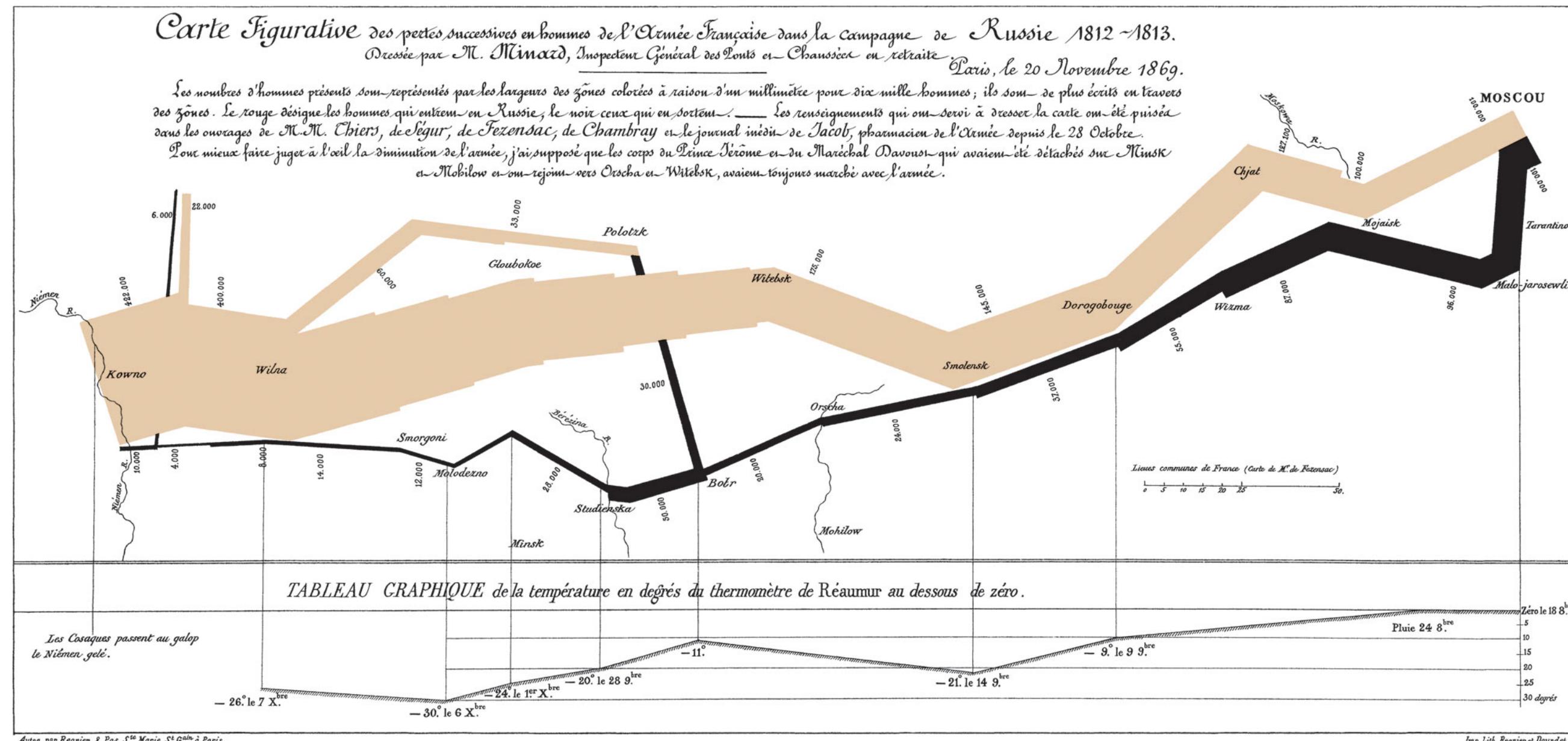
Florence Nightingale: The compassionate statistician (12 May 1820 – 13 August 1910)



# What is Visual Analytics?

## Learning from the history of Visual Analytics

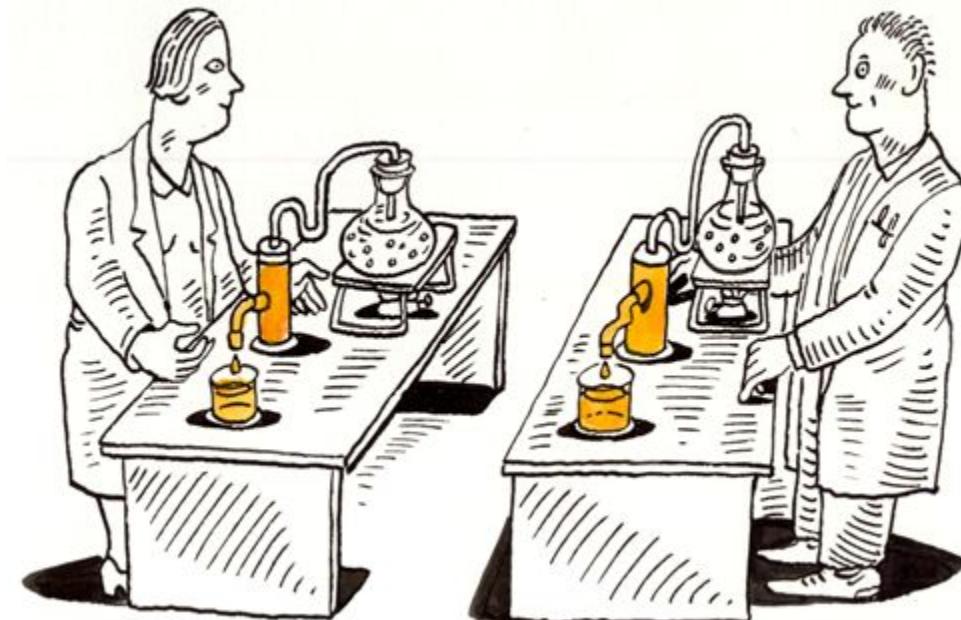
Plot of Napoleon's ill-fated Russian campaign of 1812-1813 (Charles Joseph Minard, 1861)



# 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

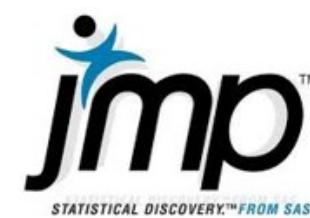


# COS Data Visualisation Toolkit

## 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. To its right is a laptop screen showing a detailed area chart with multiple stacked layers of data, overlaid with a callout bubble for 'United Kingdom'. Below the laptop is a smartphone. To the right of the laptop is a dark rectangular box with the text 'VizQL' in white and 'Breakthrough Technology' below it. At the bottom right are four individual portraits arranged in a 2x2 grid.

# 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

