

AI UX & Data Visualisation Design Principles (CA6002)

Associate Professor Goh Wooi Boon

College of Computing and Data Science
Nanyang Technological University

email: aswbgoh@ntu.edu.sg



1

1

Chapter 1.1 – Introduction

Contents

- What is Data Visualisation?
- Importance of Data Visualisation
- What will You Learn in this Course



© A/P Goh Wooi Boon (CCDS/NTU)

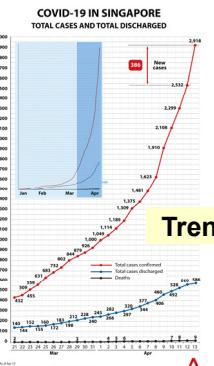
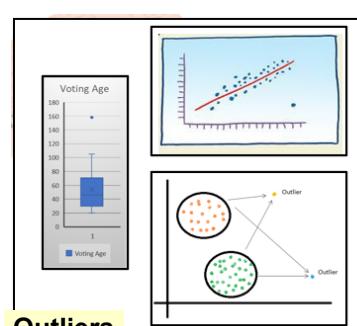
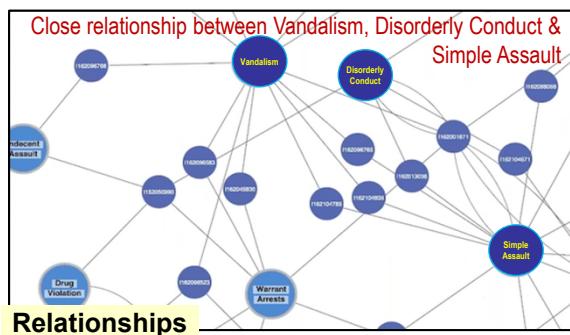
2

2

Introduction

What is Data Visualisation?

- Data visualisation is the **representation of data or information** in a graph, chart, map or other **visual format**.
- **Visual elements** are used to provide an accessible way to **see and understand** trends, outliers, patterns and relationships in the data.



3

3

Importance of Data Visualisation

The visual creature

- About half the human brain is directly or indirectly devoted to **visual processing**.
- Humans are much better at remembering **pictures** than words^[1]. Students given **visuals** to go along with lectures have also been shown to have **better retention** than students listening to lectures without visual aids^[2].
- The McGurk effect seems to also suggest that the **visual** sensory modality can **dominate** the auditory modality.

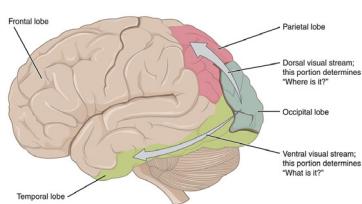


Image from Wikimedia

BBC video on McGurk Effect - <https://youtu.be/G-IN8vWm3m0>

4

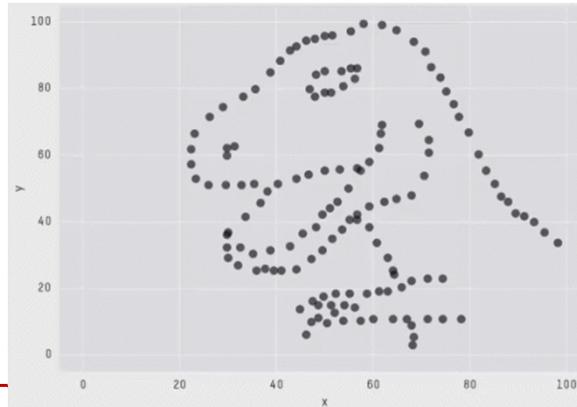
4

Importance of Data Visualisation

Blinded by statistics

- Basic statistical analysis alone may not provide useful insights into how datasets can have **differing characteristics** despite having **similar statistical parameters**.

12 datasets of 2D points with similar statistical parameters



X Mean: 54.2659224
Y Mean: 47.8313999
X SD : 16.7649829
Y SD : 26.9342120
Corr. : -0.0642526

DataSaurus Dozen by Matejka & Fitzmaurice (CHI2017)



5

5

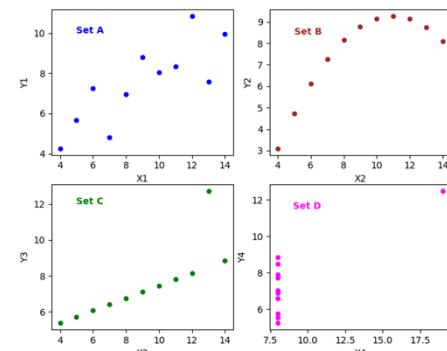
Importance of Data Visualisation

Blinded by statistics

- Basic statistical analysis alone may not provide useful insights into how datasets can have **differing characteristics** despite having **similar statistical parameters**.
- Statistician Francis Anscombe^[3] used the **Anscombe's Quartet**^[3] of four datasets to show why **visualisation** is a **crucial part of data analysis**.

Set A		Set B		Set C		Set D		
X1	Y1	X2	Y2	X3	Y3	X4	Y4	
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	9.13	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	
Mean	9.00	7.50	9.00	7.50	9.00	7.50	9.00	
Correlation Coefficient	0.82		0.82		0.82		0.82	
Std Dev	3.16	1.94	3.16	1.94	3.16	1.94	3.16	1.94

Anscombe's Quartet



[3] Anscombe, F. J. (1973). "Graphs in Statistical Analysis". American Statistician. 27 (1): 17–21

6

6

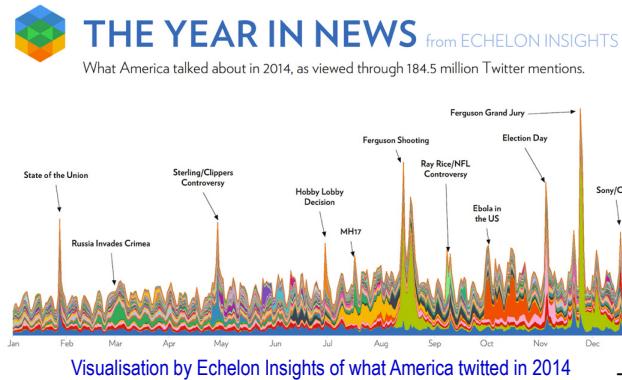
Importance of Data Visualisation

Seeing insights in big data

- The amount of data being generated is increasing rapidly. Gathering **meaningful insights** from such **big data** is not possible without good data visualisation.
- Good visualization allows users to easily identify relationships and patterns **hidden inside** the large data sets.



[4] Big Data Visualization. Value it brings & techniques in requires - <https://www.sonsoft.com/blog/big-data-visualization-techniques>

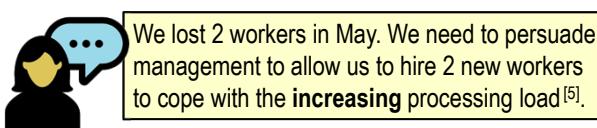


7

Importance of Data Visualisation

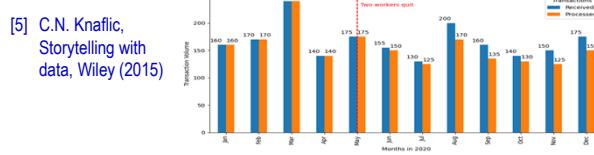
Telling the story

- Data visualisation can help **communicate the message** embedded in the data.
- Telling a visual story that conveys the **intended message** requires designing clear visualisation that understands how **humans perceive** visual information.



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Transactions	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	Received	160	170	240	140	175	155	130	200	160	140	150	175
3	Processed	160	170	240	140	175	150	125	170	135	130	125	150

Excel data of transactions received and processed over year 2020



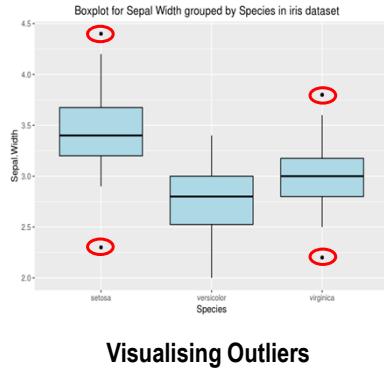
8

8

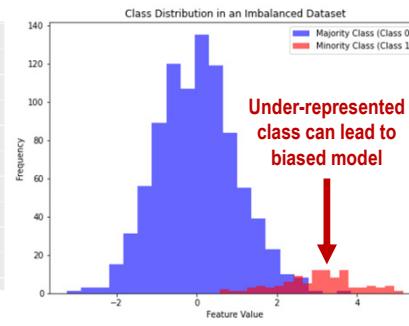
Importance of Data Visualisation

Visualise Attributes of Machine Learning Datasets

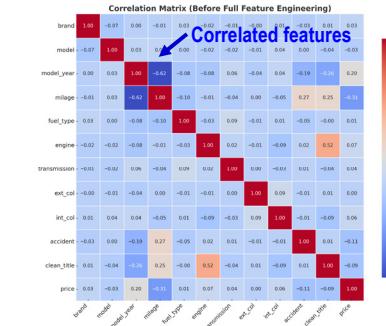
- Visualisation of datasets used in machine learning algorithms can help identify **anomalies** (e.g. outliers), **imbalance** in the dataset and uncover **hidden patterns** that can help in the selection of appropriate features for the ML algorithm training.



Visualising Outliers



Visualising Data Imbalance



Visualising Feature Relationships

9

9

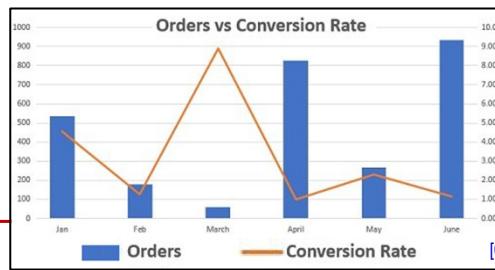
Visualising Datasets

Is There An Ideal Way?

- There are many ways to visualise a dataset.
- Choosing the best way to visualise the dataset will depend on:
 - The data **types** (e.g. its scale of measure, spatial (geodata), temporal, etc)
 - The **context** and **relationship** within the data (e.g. highest value, part of a whole)
 - The **purpose** of the visualisation (e.g. identify trends, compare values, show composition, communicate a specific message)



NANYANG
TECHNOLOGICAL
UNIVERSITY
SINGAPORE



[6] Chart from: <https://www.optimizeSMART.com/what-type-of-chart-to-use-to-compare-data-in-excel/>

10

10

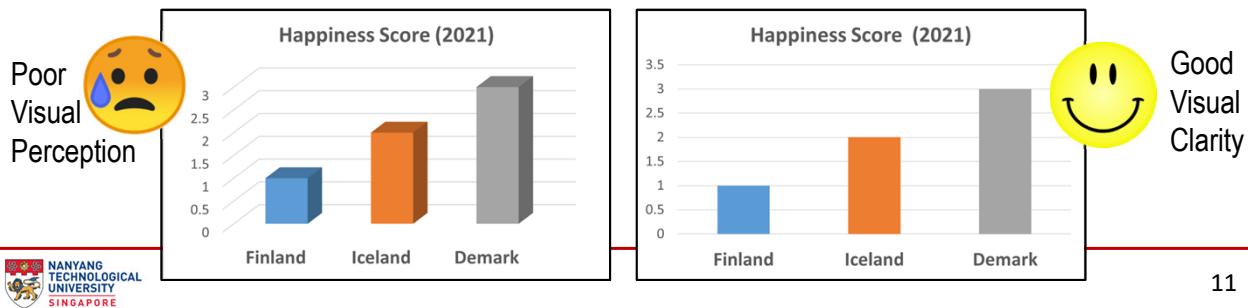
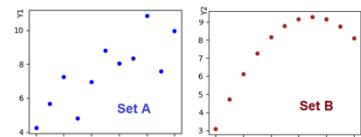
Visualising Datasets

What Is Considered A Good Visualisation?

- A good visualisation shows **connections** within the data that are too complex to explain with words or is **hidden** from non-visual analysis.
- A good visualisation makes it **easier** to quickly understand the information presented and grasps meaningful **insights** embedded within the data.

	Set A		Set B	
	X1	Y1	X2	Y2
Mean	9.00	7.50	9.00	7.50
Correlation Coefficient	0.82		0.82	
Std Dev	3.16	1.94	3.16	1.94

From Anscombe's Quartet

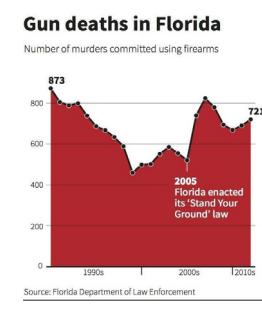
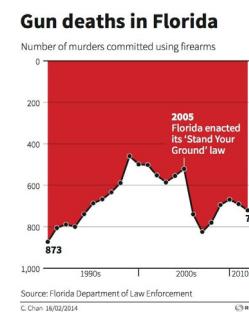


11

11

Ethical Visualisation Staying True

- Ethics are the set of **moral principles** that guides a person's **decision** and **actions**.
- In data visualisation, there are many opportunities to **manipulate** and **distort** the message a person perceives using misleading or untruthful data representation.
- Ethical conduct** is an important part of **your responsibility** when you design and present visual information.
- Your professional integrity** requires you to be mindful of how your audience will interpret the information you present in your visualisation.
- So, communicate **clearly & truthfully**.



[7] BusinessInsider.com, This Chart Shows An Alarming Rise In Florida Gun Deaths After 'Stand Your Ground' Was Enacted - <https://www.businessinsider.com/gun-deaths-in-florida-increased-with-stand-your-ground-2014-2>

12

12

Welcome to Data Visualisation for AI (Part 1)

What will you be learning in this course?



The Person – the theory of human visual perception and its implications in designing effective data visualisation.



The Process – from preparing the data to choosing and implementing the right visualisation solution for displaying and exploring various types of data.



The Practice – solve data visualisation problems through thoughtful visual design, prompt engineering and code verification/modification.



The Purpose – learn to design visualisation to assist in the exploration of AI datasets and create narratives that are effective in communicate your intended message.



13

13

Summary

Introduction

- Data visualisation is the transformation of data into a **visual form** so that **meaningful information** embedded within it can be made **more accessible**.
- Data visualisation is important to any disciplines or individual who **deals with data** and the need to **extract** or **share insights** from these data.
- Effective data visualisation serves two main purposes. It allows us to **explore** the dataset to gain useful insights and it allows us to **communicate** effectively what the data is telling us.



Data Visualisation

14

14

References for Introduction

- [1] Neural correlates of the episodic encoding of pictures & words - <https://www.pnas.org/content/95/5/2703.full>
- [2] Bui, D.C. & McDaniel, M.A. (2012) – Enhancing learning during lecture... <https://www.sciencedirect.com/science/article/abs/pii/S2211368115000200>
- [3] Anscombe, F. J. (1973). "Graphs in Statistical Analysis". American Statistician. 27 (1): 17–21
- [4] Big Data Visualization. Value it brings & techniques in requires - <https://www.scnsoft.com/blog/big-data-visualization-techniques>
- [5] C.N. Knaflic, Storytelling with data, Wiley (2015)
- [6] Chart from: <https://www.optimizesmart.com/what-type-of-chart-to-use-to-compare-data-in-excel/>
- [7] BusinessInsider.com, This Chart Shows An Alarming Rise In Florida Gun Deaths After 'Stand Your Ground' Was Enacted - <https://www.businessinsider.com/gun-deaths-in-florida-increased-with-stand-your-ground-2014-2>



Note: All online articles were accessed between Jul to Aug 2025

15

15