4.1 Weber's Law

(To be Done Before Week #6 and #7)

(1) Using Powerpoint *(or any application where you can create grey level squares with any intensity values*), create eight reasonable-sized and equally-spaced squares with incrementing Red, Green, Blue (R, G, B) intensity values as shown in Figure 1.

(2) With the eight grey level squares displayed within a white background, state which two squares have intensity levels that are most difficult to tell apart.

(3) Now change your background to totally black, that is, the grey value of (0,0,0). Now see if the same two squares that you had problem distinguishing are still the same ones. If not, which two squares do you now find most difficult to distinguish? Can you explain why the background intensity can influence your ability to discriminate the grey value intensity?

(4) If you only had these eight discrete grey values to encode a set of ordinal values from your dataset, what background would you use on your chart to maximise your available distinguishable discrete luminance (intensity) attribute.

(5) How would you change the given set of discrete grey values to improve the discriminability of these eight intensity attributes if you would like to use a white background?

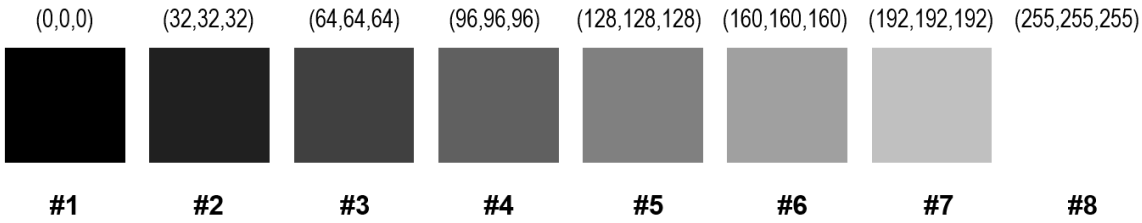


Figure 1 – Eight grey valued squares with equal intensity increments. The white square (#8) cannot be seen as it has the same intensity value as the white background.

4.2 Effective Visual Story

(1) Table 1 shows the average measured levels of a fictitious hormone called *Vitalis* in a population based on age group, gender and BMI. The visual story you want to communicate is that the **only group** with increasing levels of Vitalis as they **age** are **females** with **BMI < 25**.

Design an appropriate chart to make this story **stand out visually** while providing all the information shown in the table.

	Levels of the hormone Vitalis			
	Males		Females	
Body Mass Index (BMI)	Under 60 years	60 years or over	Under 60 years	60 years or over
Under 25	255	230	380	550
25 or over	440	325	720	500

Table 1 – Average Vitalis levels measured in the sampled population under the various categories.

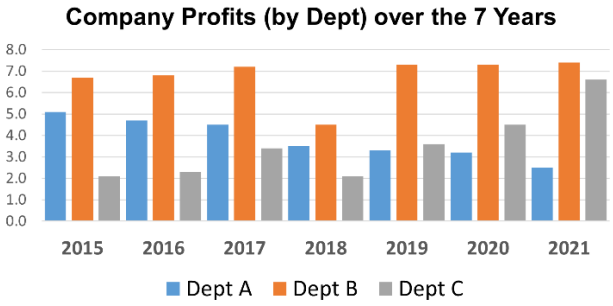
Note: The Excel file "*Hormone Vitalis – Excel.xlsx*" with Table 1 is given to you. You can generate your chart in Excel or use "*Hormone Vitalis – CSV.csv*" and do the plot in Matplotlib.

4.3 Applying Gestalt Principles

(1) The table in Figure 2(a) shows the annual profit of each department (A, B and C) in an imaginary company. The data table, along with its bar chart shown in Figure 2(b) can be found in the Excel file "*Changing Profits – Excel.xlsx*". An equivalent *CSV* version of the dataset is also provided (if you want to do the visualization in Python).

	Profits in last 7 years (S$ M)		
Year	Dept A	Dept B	Dept C
2015	5.1	6.7	2.1
2016	4.7	6.8	2.3
2017	4.5	7.2	3.4
2018	3.5	4.5	2.1
2019	3.3	7.3	3.6
2020	3.2	7.3	4.5
2021	2.5	7.4	6.6

(a)



(b)

Figure 2 – (a) The data table showing how each department contributes to the company's changing profit each year (2015 to 2021). (b) A bar chart showing each department's annual profit.

(2) **Presentation by Department Head** – As the head of department (Dept C), you are making a **Powerpoint** (PPT) presentation to your Chief Executive Officer (CEO) to request for more resources to maintain the current strong growth in your department. Apply appropriate Gestalt principles to improve the design of the presentation shown in Figure 2(b).

Note: *You can use more than one chart in your PPT (if you wish), add animation, sequence overlay, etc to make build your case and communicate your purpose clearly and effectively.*

In your presentation design, communicate the following:

a) Firstly, you must show the annual profits for all three department over the 7 years but make sure the presentation is primarily focused on your department's performance over these years.

b) Show clearly the changing trend of the company's overall profits from one year to the next.

c) Highlight the really challenging year for the company and your department.

d) Communicate clearly how well your department has been performing over the last 7 years, especially after that very challenging year for the company.

e) Show how your Dept C's percentage contribution to the company's overall profit has been growing over the years.

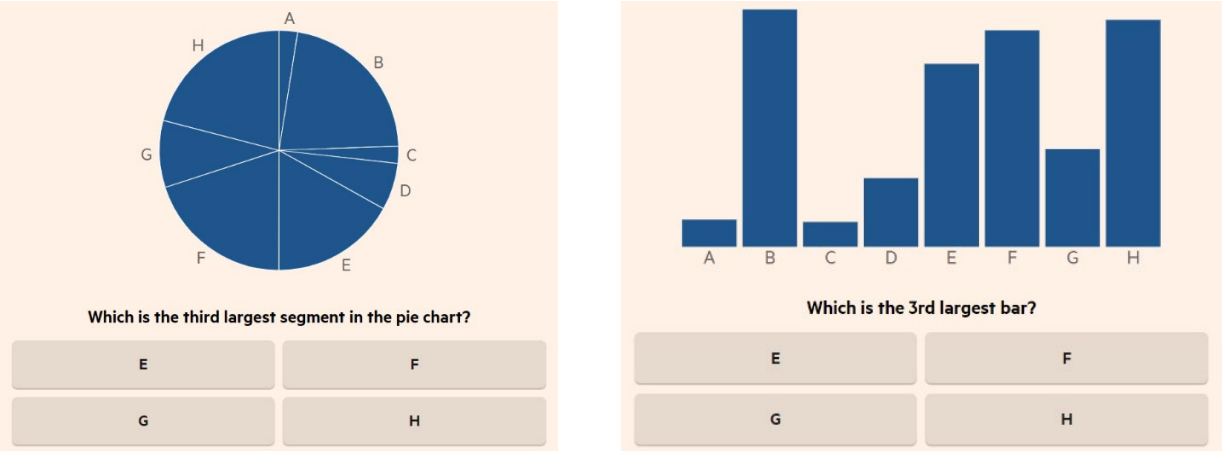
(3) **Presentation by CEO** – As the CEO of the company, you are making a **Powerpoint** (PPT) presentation to Board of Directors to re-distribute the limited resources in the company. You need to make a case that the poorest performing department will need to be restructured to re-allocated resources to the department with the strong growth trajectory. In your visualisation, apply appropriate Gestalt principles to visually communicate the following:

a) Compare the performance of the three departments over the last 7 years with the goal of highlighting the profit trend of the poorest performing department (Dept A) and the department with the strong growth potential (Dept C).

b) The changing percentage contributions of each department to the company's overall profits.

4.4 Making it Easy for Others

(1) Financial Times provides an interesting online quiz entitled "*The science behind good charts*", which was found at https://ig.ft.com/science-of-charts/ (**Note**: subscription may be needed for access to FT website and link may be outdated). This online quiz helps you appreciate the feeling when you are at the receiving end of poorly designed data visualisations.



(a) (b)

Figure 3 – (a) Pie Chart and (b) Bar chart taken from (https://ig.ft.com/science-of-charts/)

(2) Figure 3 shows two questions taken from that FT quiz. Redesign the pie chart and the bar chart to make it "really-really" easy for someone taking the quiz to answer the question correctly.

(3) Show what further improvements to the visualisation you would incorporate if your purpose is to get the audience to focus **specifically** and **precisely** on that third largest value in that dataset.

(4) Using the Excel file "*FT Pie and Bar – Excel.xlsx*" or the CSV file "*FT Pie and Bar – CSV.csv*" provided, implement your improved version of the pie and bar charts in parts (2) and (3).

(5) Describe what Gestalt principles were employed in improving your visualization.

(6) Which of the two types of charts would you use if your purpose is to show how close entity **F** is to the next two highest rivals?

(7) Are the exact differences between entity **F** and its top two rival entities **B** and **H** easy to visually estimate? If not, why is this so?

(8) How can you make the differences between entity **F** and its top two rivals more apparent by:

a) using the Gestalt principle of continuity.

b) using the Gestalt principle of enclosure.

(9) Implement these improvements on the chart you have selected.

Note: You do not have to develop codes to implement every one of your improvement ideas. You can generate the basic pie or bar chart (using Excel or Python) and use appropriate applications with drawing tools (e.g. in Powerpoint, Word, Paint, etc) to add the additional improvement visuals into your base chart (exported out as an image file). You should spend more time thinking about the design instead.

4.5 Selecting Colour Palettes

(1) Describe what are categorical (qualitative), sequential and diverging colour palettes; and under what condition would it be appropriate to use each of them. Using the Python Seaborn functions, create an example of each one of these palettes with 9 discrete and distinctive colours.

(2) **Children Growth Rate** - The CSV file "*Children Growth Rate – CSV.csv*" charts the average yearly growth of boys and girls. There are interesting observations about the relative heights of boys and girls as they age from birth (0 years) to when they are 20 years old. Using **two stacked bars**, similar to that shown in Figure 4, and an **appropriate colour palette**, create a visualisation that will facilitate the comparison of growth rates between the gender. What did you observe?

Note: The children average growth rate dataset was modified from data obtained from *Disabled World* website at https://www.disabled-world.com/calculators-charts/height-weight-teens.php.

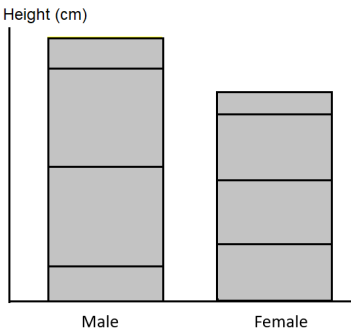


Figure 4 – A Sample Stacked Bar Chart

4.6 Less Colour but More Clarity

(1) Figure 5 shows a data visualisation that presents the results from a survey regarding the work-life balance of various professional groups. List down what you think are poorly designed aspects of the visualisation that compromised the **accessibility** of the information presented.

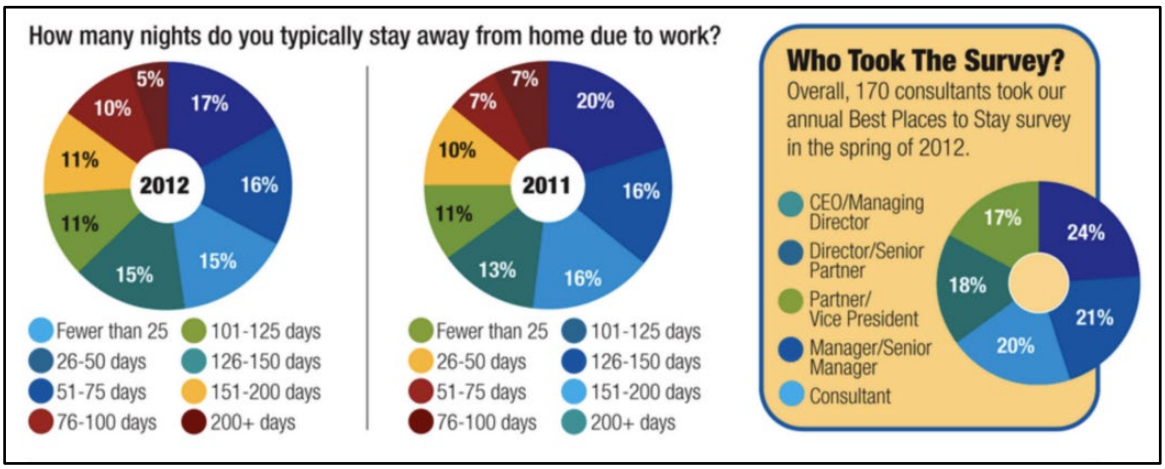


Figure 5 – A poorly designed visual that was featured in https://towardsdatascience.com/color-in-data-visualization-less-how-more-why-348514a3c4d8.

(2) **No constrain redesign** – You are given no constraints in terms of chart type, number of charts, number of colours, use of annotations, etc. Redesign an improved version of the visual shown in Figure 5. Your new visualisation design must incorporate and show all the data and legend information present in Figure 5.

(3) **One-colour only redesign** – Complete the redesign as in part (2) with no constraints except that now you can only use one colour (this one colour excludes the black for your text and borders and the white for your background).

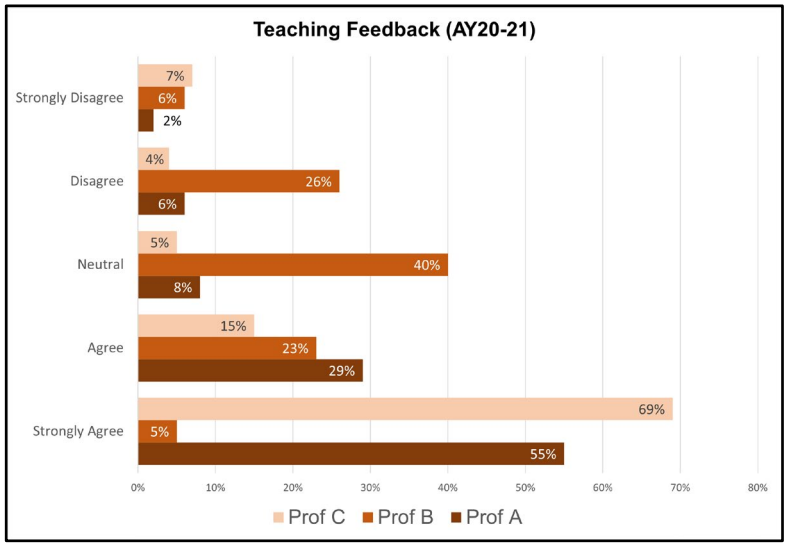
Note: Those interested to create the visual can use the data in "*Away at Work – Excel.xlsx*" file.

4.7 Critical Eye and Creative Fix

(4) **Teaching Feedback Performance**. Figure 6(b) shows a fictitious clustered bar chart. It was created from the data table in Figure 6(a) of collated questionnaire responses tabulated as a percentage (%) of all responses received for each Professor **A**, **B** and **C** during a recent student teaching feedback survey. The survey was done based on a 5-point Likert scale, with the most favourable response stated as "Strongly Agree" and the least as "Strongly Disagree".

Likert Rating	Prof A	Prof B	Prof C
Strongly Agree	55%	5%	69%
Agree	29%	23%	15%
Neutral	8%	40%	5%
Disagree	6%	26%	4%
Strongly Disagree	2%	6%	7%

(a)



(b)

Figure 6 – (a) Data table of teaching feedback score percentages over a 5-point Likert scale for three professors. (b) A clustered bar chart comparing the teaching performances of the 3 professors.

(5) Is the data visualisation shown in Figure 6(b) effective in comparing and communicating the relative teaching performances of the three Profs **A**, **B** and **C** based on their respective distribution of 5-point Likert-based responses? Your comments should touch on the following:

a) The choice of chart for the purposes stated above.

b) The choice of colours used in the chart.

c) Relevant Gestalt principles that have or have not been exploited to make the visualisation more effective.

(6) Carefully consider the nature of the data and the intended purposes of the visualisation, then design an improved version. Implement your new design using the data from the Excel file "*Teaching Feedback - Excel.xlsx*" or the CSV file "*Teaching Feedback – CSV.csv*" provided.

(7) Describe the rationale for your improved visualisation design, which should cover the following:

a) Reasons for your choice of the particular chart type.

b) Choice of colours or colour palette used in the chart.

c) Relevant Gestalt principles you have employed in your improved design.

(8) What can you infer when comparing the relative teaching feedback distributions of Profs **A**, **B** and **C**?

4.8 Psychological Principles for Effective Graphics

(1) **Melting Antarctica Sea Ice**. Study the line chart in Figure 7, which shows the data of the Antarctica sea ice extents from 1980 to 2023.

a) What do you think is the main message the line chart is attempting to communicate to the reader?

b) Identify which of Stephen Kosslyn's eight psychological principles of effective graphics were employed by The Straits Times to create the infographics shown. You may list more than one. (see Lecture notes chapter 7). For each of the principles that you have identified, describe how it was used to convey the intended message more effectively.

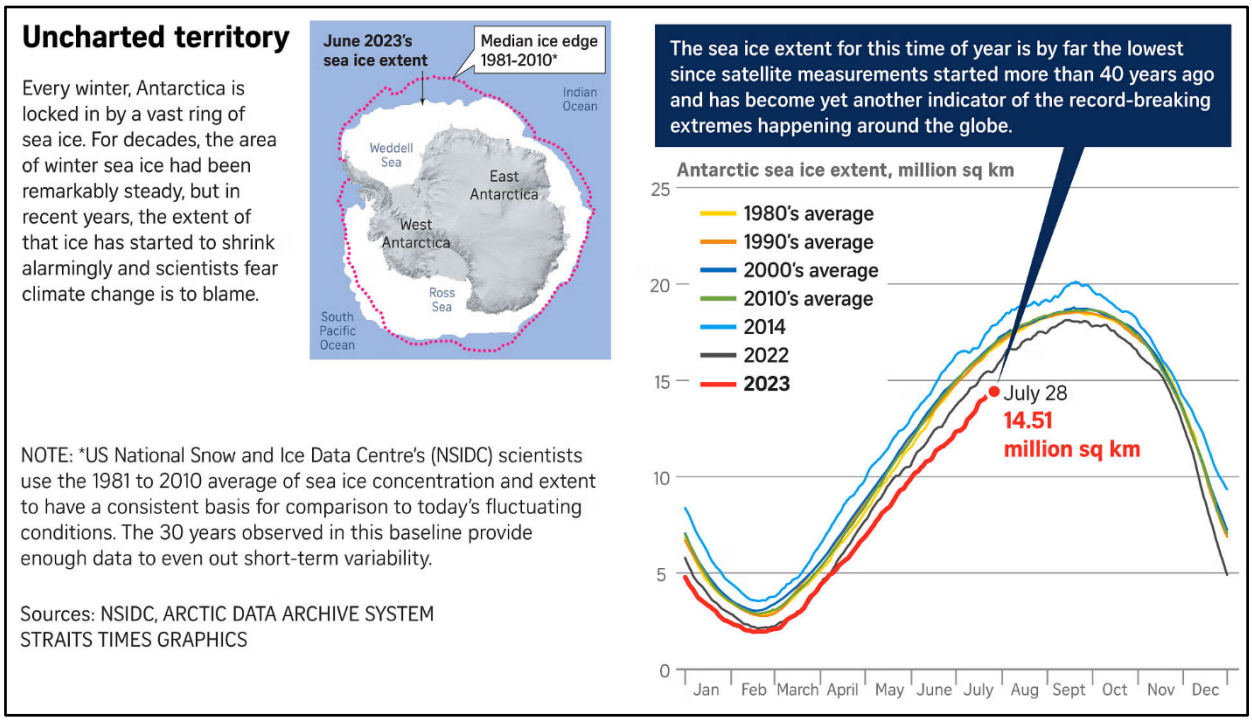


Figure 7 – The infographics illustrating the sea ice extent variations around the Antarctica from 1980 to 2023. This data visualisation was taken from an article in The Straits Times entitled "Antarctica's record low sea ice worries climate scientist", which was published on 30 July 2023. Link to article: https://www.straitstimes.com/world/antarctica-s-record-low-sea-ice-worries-climate-scientists.