Hyperiondev

TASK

Data Visualisation I

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Introduction

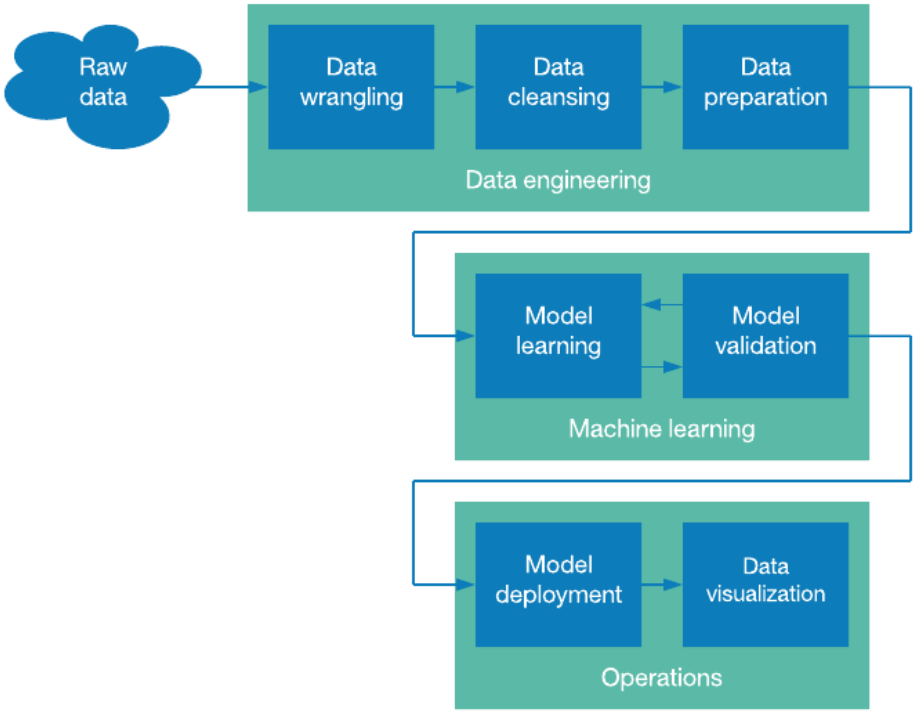
WELCOME TO THE DATA VISUALISATION I TASK!

As science and technology advances, it is inevitable that the amount of information and data we possess increases significantly. With such large amounts of data, how do we effectively find patterns and new information within our data and convey our findings? Data visualisation helps us with this.

Data visualisation is also commonly referred to as information visualisation or infoViz. It is important because it allows easy communication of data. Imagine looking at your raw datasets in CSV format and trying to find something useful in the data. Then imagine later trying to explain your findings to someone else through text! It is often much better to represent data with visualisation.

THE DATA SCIENCE PIPELINE

There are various tasks that data scientists perform to analyse data in a meaningful way. Different people describe these steps differently. The steps don't have to be carried out in a strict order. However, the diagram below broadly shows the steps that are usually involved in the data science pipeline:



(Jones, 2018)

Data wrangling is defined as "the process by which you identify, collect, merge, and preprocess one or more data sets in preparation for data cleansing" (Jones, 2018). Once you've wrangled the data into a format with which you can work, you **clean the data** by fixing any errors in the data set. This could involve dealing with missing data, correcting formatting issues and fixing, or removing, incorrect data. You can then prepare the data for machine learning. You will learn more about machine learning soon.

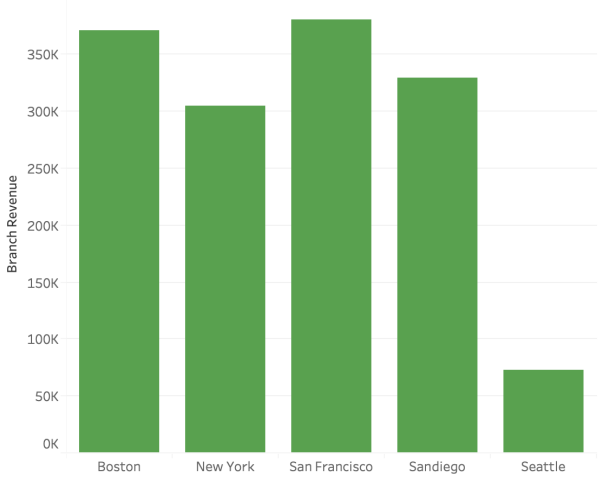
Evidently, the first job undertaken by a data scientist is to gain a clear understanding of the data that they are working with. The data scientist needs to understand what data they have, what format it is in, what format it needs to be converted to, what is wrong with the data and how to fix problems. Various visualisations (such as graphs, tables and charts) are used to gain this insight into the data.

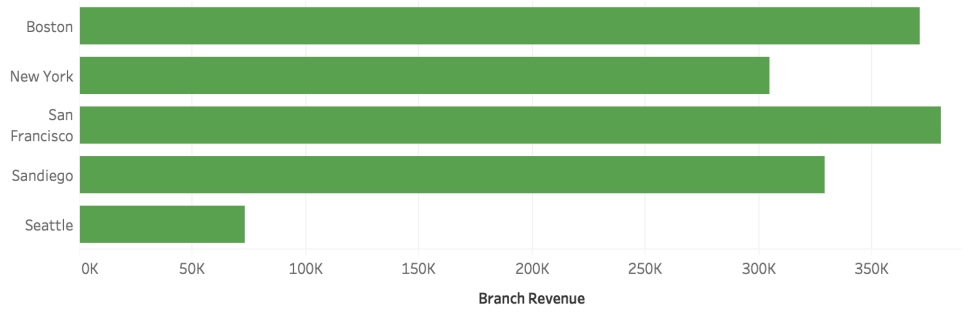
Therefore, data visualisation is important at both the end of the data science pipeline (to present the findings of a study) and in the initial phase (data engineering phase) of the data science pipeline to help gain an understanding of data.

DATA VISUALISATION TECHNIQUES

Depending on what you want to find from your dataset, you need to choose appropriate visualisations. Here are some of the basic visualisation techniques:

- **Bar Chart:** a bar chart/graph is also known as a column chart. It uses either horizontal or vertical bars to show and compare values across categories. One axis shows categories and the other axis shows the discrete value scale.





Best used for data that is:

- Discrete
- Categorical (see the note below)

Things to keep in mind:

- Doesn't work well with too many categories of data (too many bars are hard to look at). For instance, if you're showing rainfall in mm for each day of a year, you would end up with 365 bars!
- You can colour code the categories for patterns to stand out.

Take note:

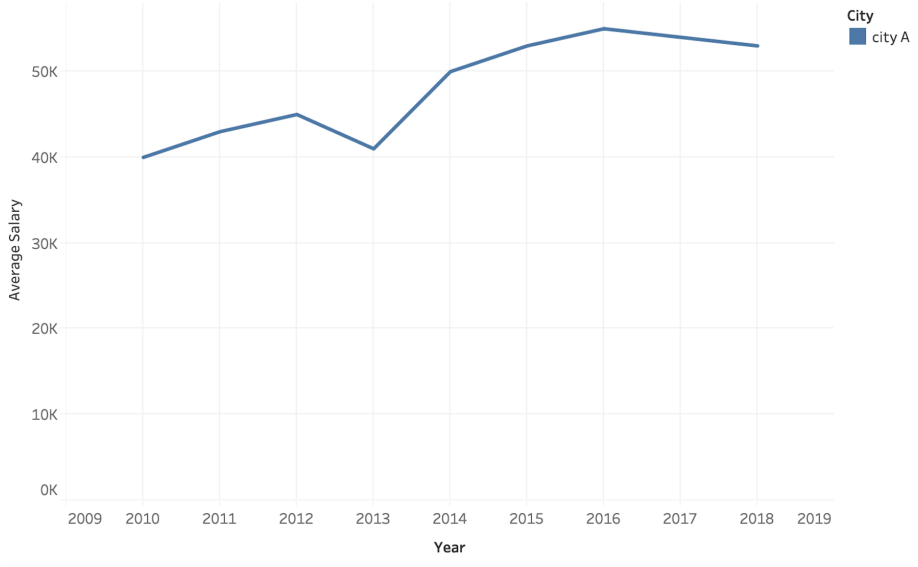
In data science, we work with different types of statistical data. Data can be numerical (the data can be measured using numbers), categorical (data represent characteristics such as a person's age, education level, etc.) or ordinal (numerical and categorical data mixed).

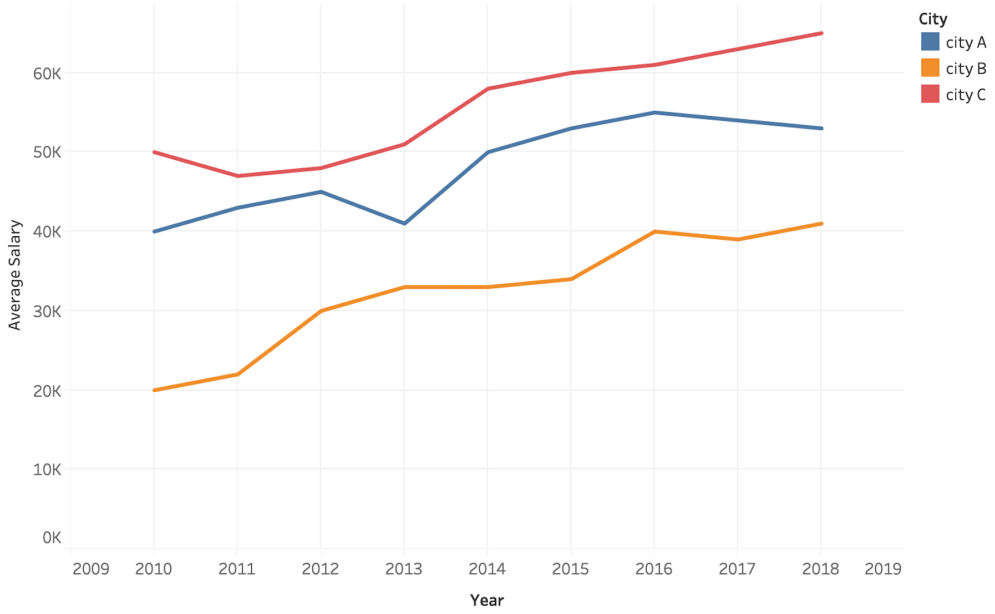
Numerical data can be either:

- *Discrete: data can be counted (e.g. the number of students in a class, number of people in a city, etc.), or*
- *Continuous: data can't be counted, but can be measured (e.g. a person's blood pressure, weight, height, etc.*

*For more information, see the short description of types of statistical data **here**.*

- **Line graph:** a line graph shows values over a time period. Multiple line graphs can show and compare many different categories over a time period. Typically, one axis shows data values, while the other axis depicts time.





Best used for data that is:

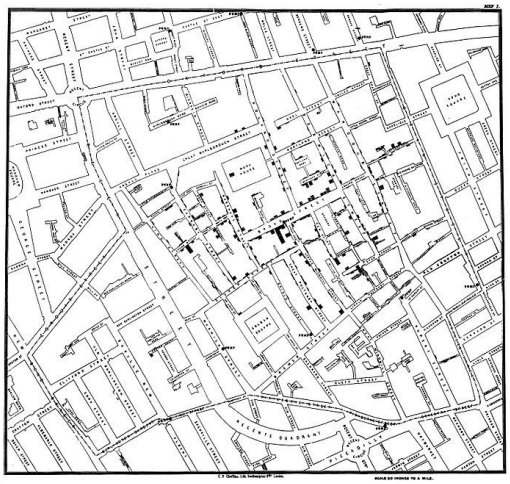
- Linear/continuous
- Time series

Things to keep in mind:

- Lines can be colour coded
- Time is often the x-axis

A note from our coding mentor
Masood

Did you know that one of the most famous data visualisations in history is a map by Dr. John Snow? (I'm not talking about the Game of Thrones character!)



In London, during the mid-18th-century people were suffering from cholera outbreaks. Many thought it was spread by air, but he hypothesised that it was spread through contaminated water.

He drew out a map showing the deaths from cholera by streets and houses. There was an obvious cluster on Broad Street, where a pump was located.

After the local authorities removed it, the number of deaths reduced dramatically. This visualisation not only saved many lives but also changed the way we looked at diseases.

APPROACH TO DATA VISUALISATION

1. Start with a processed and cleaned dataset

If you have raw data (not processed and not cleaned), it would likely contain issues such as missing data, unstructured data, incorrect input or unnecessary information. Thus, it is important to clean your data before visualisation. The process of cleaning your data so that you are able to use it for analysis and visualisation is sometimes referred to as data wrangling. Sometimes you may have to take different parts of your dataset to create different visualisations.

2. Know your dataset

Knowing where your dataset comes from allows you to have a better understanding of the data background and what you want to find. Knowing it well can also help you to organise and plan your visualisations more appropriately. You may become familiar with your dataset during the process of cleaning and wrangling (see the previous step).

3. Determine what you want to find

The purpose of having data is to find information that can be helpful to achieve our goals. Think about what you are trying to find. For example, if you are working with data from a school class, you may start with a question like, “Which students have the lowest scores?”. The objective here would be to ascertain which students are performing most poorly, so that you may provide extra support or tutorial classes to these students.

Often, you don’t exactly know what to look for, or it may happen that you find something in your dataset that you weren’t expecting! If you cannot think of a very specific objective, you can go for a broader goal. For instance, in the example we just considered, you can begin your analysis by aiming to look at student scores in general (not necessarily the lowest scores).

4. Create data visualisations

Depending on your data types and what you want to find, plan out the types of visualisations that you want to create. Some people often start with a quick sketch of the visualisations.

Note: You may go back and forth between step 4, 5 and 6. Often you may find yourself interchanging steps 5 and 6.

5. Refine your visualisation

If you have decided on the visualisations you are doing, or if you already have existing visualisations, you would likely want to refine them further. This means making the visualisations more aesthetically pleasing and easier for the target audience to understand. Some examples of improving your visualisation would be: changing the colours, making the borders thicker, enlarging your titles/fonts, etc. You may want to solicit other people's opinions since aesthetics can be subjective.

When deciding how your visualisation is going to look, always keep in mind who your audience is. For instance, if your audience is a group of data science experts, then you can choose complicated visualisations such as a scatterplot matrix, but if your audience consists of generalists, you should create a simpler visualisation such as a bar graph.

6. Note down your findings

Once you have your visualisations, you need to look for patterns, make inferences, dig deeper and conclude what you have found. The initial stages of this analysis can add to your original goals and research question, as mentioned in step 3.

EXAMPLE: APPROACH TO DATA VISUALISATION

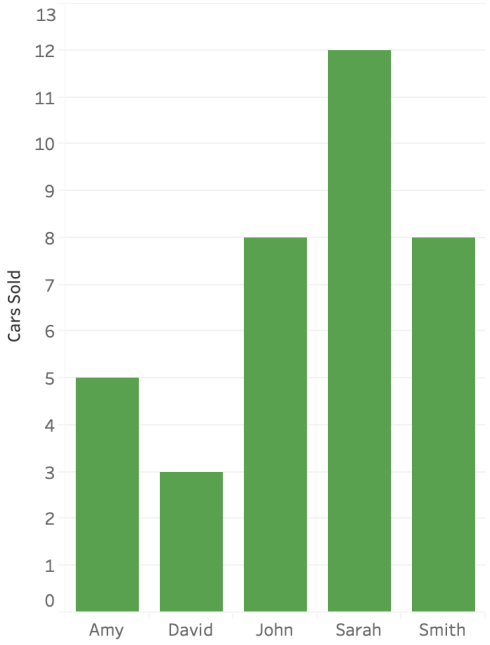
1. Start with a processed and cleaned dataset

month (2018)	salesPerson	carsSold
February	Amy	2
February	Smith	6
April	Sarah	3
May	John	7
May	Sarah	9
January	Amy	3
June	John	1
June	Smith	2
August	Sarah	3

2. Know your dataset: above is the processed sales data of a small car dealer. You have chosen to look at the months of Jan - August in 2018, the sales team and the number of cars sold.

3. Determine your objectives: in this dataset aimed at the car dealership, what would be useful to find? Perhaps who has sold the most and least number of cars? Any pattern in the months?

4. Creating your visualisation: a bar graph can suitably represent this dataset.

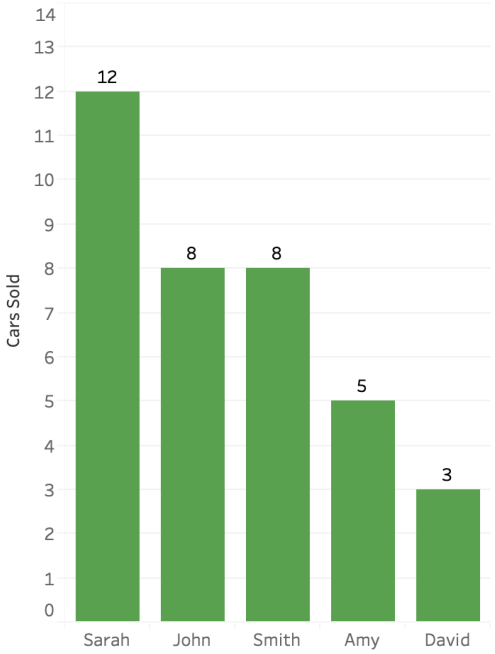


5 & 6. Note down findings & perfect your visualisation: We can see that Sarah has sold the most cars and David has sold the least. From this visualisation, the car dealership can:

- Reward the best salesperson (Sarah).
- Provide more training for worst salespeople (David and Amy).

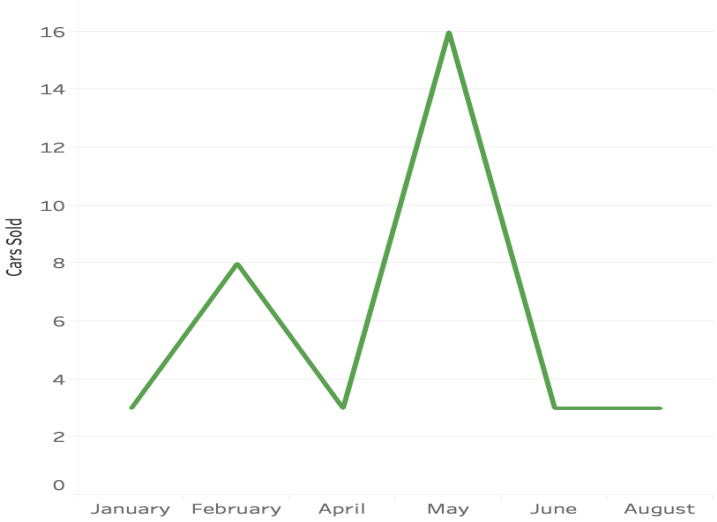
If we were to make the bar graph more aesthetically pleasing and easier to understand, we can implement a few changes:

- Descending order: quickly shows the order
- Label the value of cars sold: immediately know how much each person sold



Or perhaps we can improve the graphs first before drawing conclusions, especially if it is a big dataset and a more complicated graph.

But what about a time trend in sales? Sometimes you may want to use different visualisations on the same dataset to discover or convey more information.



If you create a line graph with the same dataset, you can arrive at further conclusions: It seems that May was the best month for sales, while June and August were slower. Through this information, the car dealership may:

- Create more promotions starting June
- Hire more staff during May

Compare the bar graph and line graph to the table data – aren't the visualisations much easier to understand?

Compulsory Task 1

Examine the following graphs below and use some research and background knowledge to make conclusions based on your observations. For each graph, answer the questions associated with the graph in a document titled **data_viz.** Convert your answer document to a PDF before submitting it.

1. The following bar graph shows the gender wage gap in 26 countries based on data collected by the **OECD**. The gender wage gap is calculated by finding the difference between male and female median wages and dividing by male median wages. It is represented as a percentage in this graph.

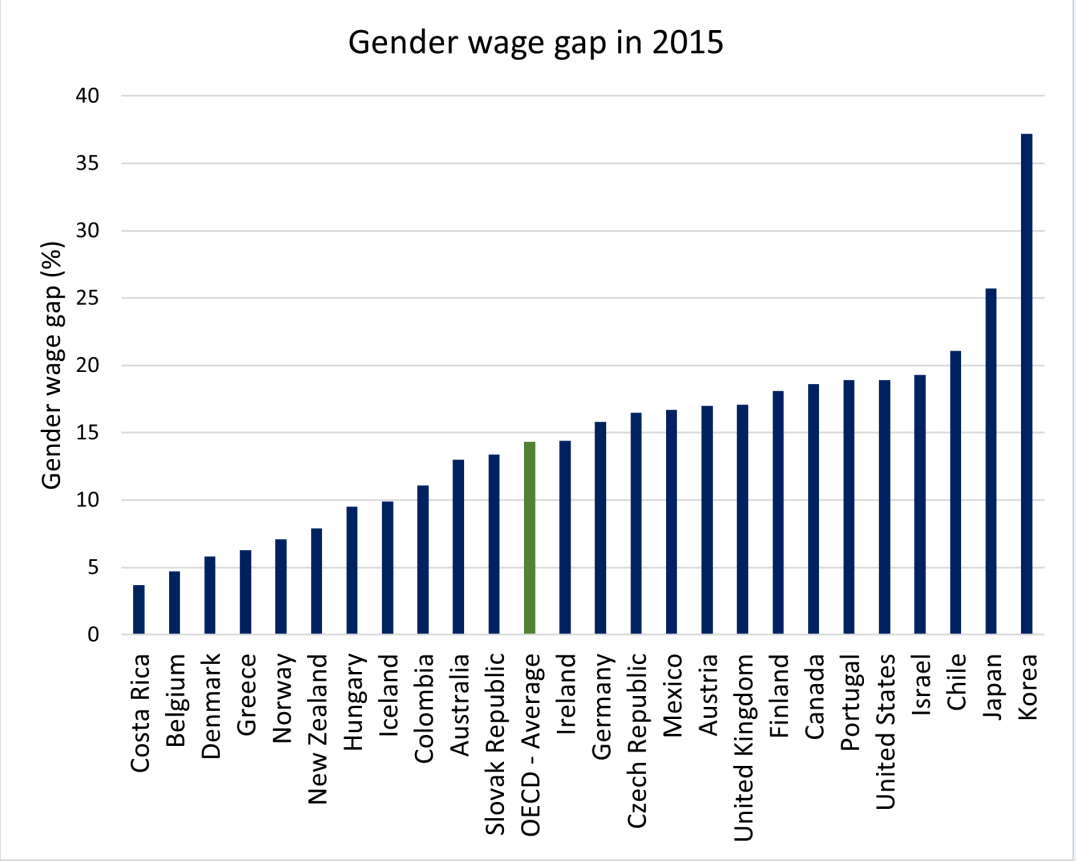


Figure 1: Gender wage gap in 2015 (**Source**)

- Which three countries have the lowest gender wage gap?
- Which three countries have the highest gender wage gap?

- Do some research on the country with the lowest gender wage gap and comment on why you think it succeeded in achieving a low gender wage gap in 2015 (max. 150 words).

2. The following line graph shows the sale of isopropanol from May 2019 to March 2020 in the United States of America. The sales are measured using US cents per weight (lb) of product (US CTS/lb). Focus on the general trend of the three lines on the graph rather than what each of the lines refers to specifically when answering the questions.

Figure 2: Isopropanol sales from May 2019 to March 2020 (**Source**)

- Explain what is happening in the graph during March 2020 with regards to isopropanol sales (max. 100 words).
- Describe a possible reason for the observation you made about isopropanol sales in March 2020 (max. 100 words). **Hint:** Isopropanol is the main ingredient in hand sanitiser.

3. Below, the bubble plot (a scatter plot with variable dot size) shows carbon dioxide (CO_2) emissions per person in tonnes vs. the gross domestic product (GDP) per capita (average per person). No unit is given for the GDP per capita, however, the US dollar is typically used when comparing different countries (Callen, n.d.). Each dot represents a country. The colours of the dots refer to the continent to which the country belongs. The size of the dot refers to the size of the population in the country. The larger the dot, the larger the population.

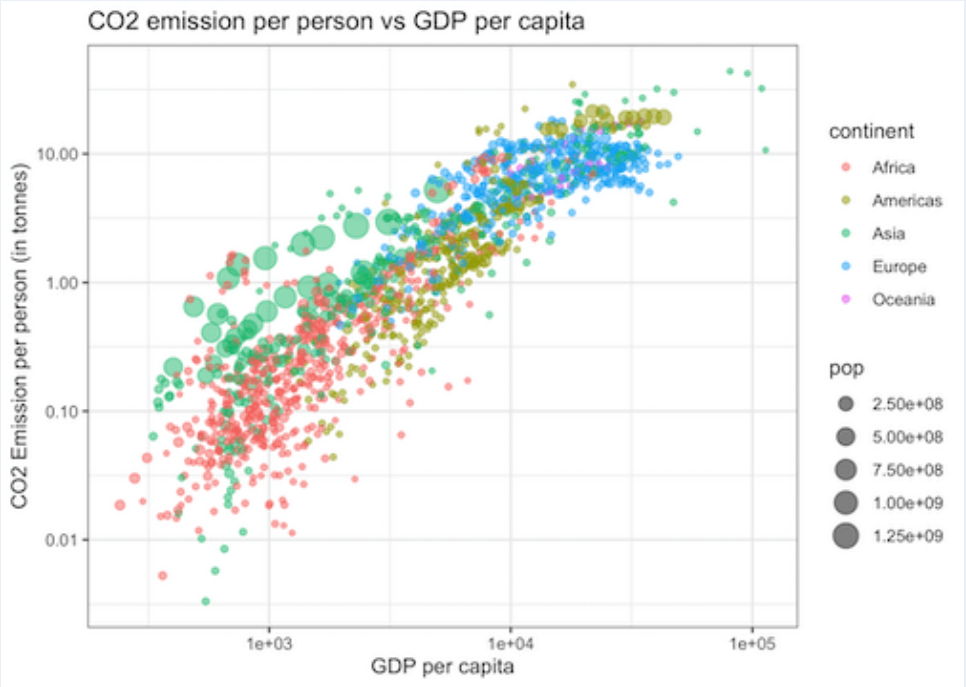


Figure 3: CO_2 emissions per person vs GDP per capita

- Discuss the relationship between CO_2 emissions per person and GDP per capita for each continent listed in the figure legend (max. 350 words).

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