Visualisation Design Coursework 1

COMP0034 — Application Programming for Data Science

Table of Contents

Target audience

Main target audience:

- Hotel chain business owners

Other target audiences:

- Restaurant chain business owners
- Other hospitality business owners such as café owners

The target audience for the choropleth map is mainly hotel and hospitality business owners who are looking for finding a country to open a new hotel. This target audience wants to learn and compare different countries to see which countries have the highest number of international tourist arrivals as it is advantageous for them to open a hotel in those countries to increase revenue and profits (1) . They also would want to see the top countries in a specific region, for opening hotels in that specific region. This target audience is professional and may have a familiarity with the data since tourism is a crucial factor affecting the revenue of the hospitality industry (2).

Another goal of this dashboard in the future, after visualizing the necessary information for the best country and or/region to open their business location, is for hospitality business owners to have the chance to advertise and collaborate by posting their locations of, for example, any existing or planned hotel. This allows other hospitality businesses such as restaurants to contact the existing or planned business, who may have also used the dashboard to find the best country to open their business. This can allow the opening of a restaurant within or next to a hotel, thereby increasing profits and revenue for both (3).

All the visualisations use the same target audiences, with the same main goals outlined before and in the persona (in the Persona section below).

Target audience questions answered by entire app:

1. Which countries have the highest average number of arrivals over at least the last 10 recorded years?
2. For each year, which countries have the highest number of arrivals?
3. What are the rankings of countries in terms of the highest average number of arrivals over at least the last 10 recorded years?
4. How many arrivals are there in the countries with the highest number of arrivals each year?
5. What are the highest countries within each region (official groups of countries recognized by the world data bank (4)) for the highest number of tourist arrivals for any given year?
6. Are there any gaps or inconsistencies (possible anomalies) in number of arrivals over the years for different countries?
7. What are the trends (e.g. positive, negative or no correlation) over at least 10 years, for a particular country?
8. How do the trends (e.g. positive, negative or no correlation) compare between two countries?
9. Can I download the data so I can analyze it myself or use it for methods such as machine learning algorithms to make predictions?

Non-data science visualization question:

10. Can I have interactivity in the ability post my own location and be able to collaborate with other members of the hospitality sector?

Persona for main target audience: Hotel business owners

Jonathon Jones

age: **32**
residence: **London, United Kingdom**
education: **MSc Business Finance at UCL**
occupation: **Hotel chain business owner**
marital status: **Married, two children**

"I want an easy, simple way to choose some locations for my hotels, in countries that have large numbers of tourists, to increase my revenue."

"I usually spend my working days in my office in Central London or working from my home office."

Comfort With Technology

INTERNET

SOFTWARE

MOBILE APPS

SOCIAL NETWORK

Criteria For Success:

Successfully running hotels with sufficient revenue to pay my staff, facilities and rent makes me feel successful. The Covid-19 pandemic greatly hindered my profits and progress for my business and has caused me to work a lot more to try to increase revenue, so I spend less time with my family.
I am happy with the restrictions lifted, and the number of people using my hotels slowly returning back to normal but it is still nowhere near the levels it was at pre-pandemic. For success, I believe in sufficient revenue generated by my hotels but also an adequate work-life balance to spend time with my family.

Needs

- To determine the best location to set up hotels with the most number of international tourists.
- To increase revenue generated by the hotels with increased tourist use.
- To ensure that enough income is generated to pay staff.
- To ensure enough income is generated by increased tourist arrivals using the hotels to pay for facilities and property rent.
- To find a location that has been proven to have a consistent increase in levels of tourist arrivals over at least 10 years for future-proofing.
- To possibly locate multiple hotels in country region groups with a large number of tourists.

Values

- High level of planning for all tasks.
- Learning about new technologies and applications.
- Learning new business strategies to improve overall business profits and growth.
- Spending time with my wife and two children while balancing my difficult job.
- Networking and socialising with other people, building business partners but also friendships.

Wants

- To have increased attraction and popularity to existing hotels.
- To be able to access the app at any time on demand.
- To have increased profits for personal use and leisure and to spend on my family.
- For the webapp to be quick and efficient to use and shouldn't take more than 15 minutes, given my busy schedule.
- To use the app on a smaller portable device using WiFi or data, like my mobile phone.
- To spend less time on my business and more time with my family.

Fears

- Not finding a location to increase tourists using my hotels.
- Complicated app layouts with unnecessary information.
- Not understanding the information and trends for a successful hotel location.
- Too much time being wasted on the app, taking away from time working and spending time with family.

HOPE HOTELS LTD.

Figure 1 - Persona for Hotel Business Owners

Visualisation 1: Choropleth Map

1.1 Questions the visualisation is intended to address

1. For each year, which countries have the highest number of arrivals?
2. What are the highest countries within each region (official groups of countries recognized by the world data bank (4)) for the highest number of tourist arrivals for any given year?
3. How many arrivals are there in the countries with the highest number of arrivals each year?
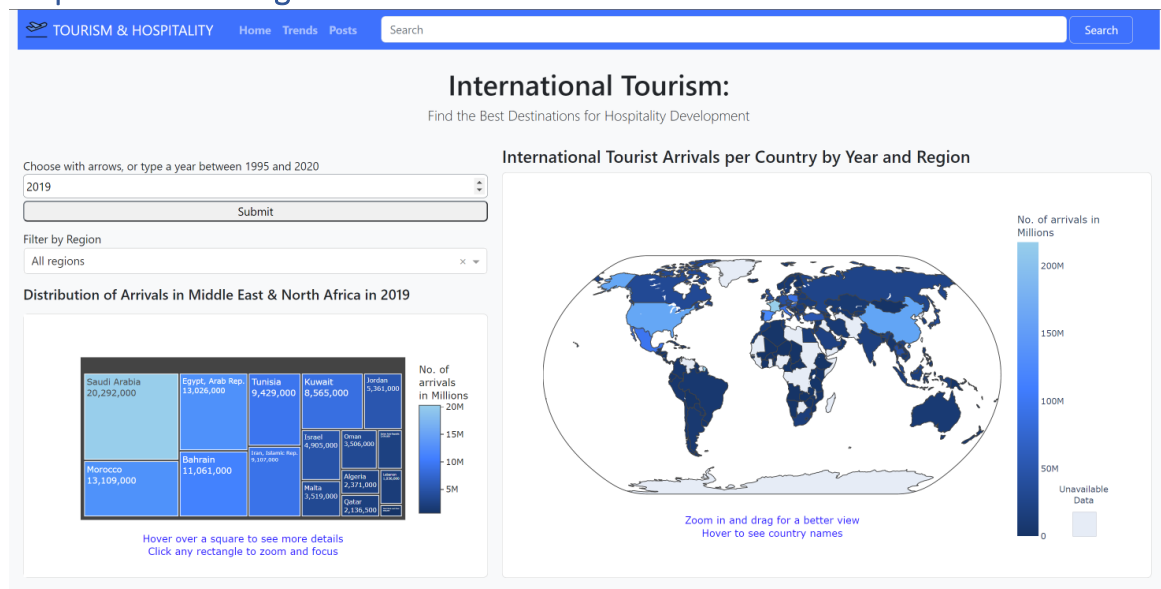
1.2 Implemented Design Screenshot

Figure 2 - Choropleth figure, also showing navigation bar

1.3 Explaining the design

A choropleth map was used as it is very powerful in utilizing a colour scale to represent the range of one type of data variable in a geographical context (5). That is true for this case, where there is one variable being represented: the number of arrivals in a specific year. In the original state of the figure without call-backs run, it shows the data for all regions unfiltered and shows how the number of arrivals is distributed among every country. The navigation bar chosen was a primary bootstrap blue. The main colour chosen for the colour scale was a custom range of blue shades, with the middle colour of the colour scale the exact same blue as the navigation bar. This was done first of all for visual consistency (6) as consistent colours are easier on the eye and therefore more effective at communication the desired information rather than distracting with colours. The second reason is that it has been found that blue conjures emotions of professionalism (7) and trust so is a good choice for a more professional target audience, like the ones I am targeting which are hotel business owners and any other hospitality business owners.

Two types of interactive functions were added, which change both the choropleth and the tree map (which will be discussed later). The first type was an input field for choosing a year between 1995 and 2020, which were the years of data available. The year can be either typed or the arrow keys can be clicked to choose a year. Then the submit button must be clicked for the output figure to change. This type of input was chosen over a year slider as the user can quickly type or choose a year of their choice which saves some time over sliding a slider over the large range of 25 years. Additionally, there was a

lot of data columns of 25 different years, which means that there would be visibly too many options across the span of the page. This does not look visually appealing. Also, that many options do not fit the screen in a responsive manner when the user uses a smaller screen device such as a phone as the text would be too close together (8). This was one of the user's requirements in the persona (Figure 1). Hence, due to these reasons, the input field was added, with a caption to inform the user the range of years, saving a lot of space as well as exhibiting very good responsive behaviour on smaller screens. The submit button outline was also made slightly darker to alert the user to click it for the charts to update the year.

The second type of interactivity added was the dropdown selector to choose a region from the 7 world data bank defined regions (4) . This was intended to answer the second target audience question, which allows the user to select a particular region. This type of selector was chosen as there are only 7 regions which is a good low amount of items in a dropdown to prevent the user being overwhelmed with options (9) . It was also used as it helps to preserve screen space and allow space for the other figure in the same column, the tree map.

It was decided to place the chart in one column that is slightly wider than the second column which contains the dropdown, which leaves enough space that for the choropleth to be viewed clearly. It also leaves some room for compromise to ensure the tree map in the column beside it can also be clear. The "natural earth" projection type was also used as it had an aesthetically pleasing round shape and was visually clearer than the other possible 2D projections, such as "mercator", for example shown in Figure 3 below. That type made the important continents of focus with most of the available data like Europe and Asia small but made Antarctica needlessly large, which is unnecessary since there was no data for Antarctica in the dataset.
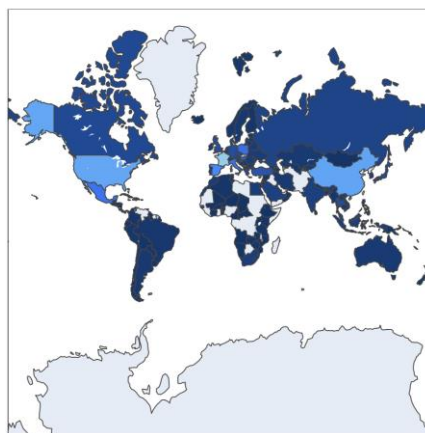

Figure 3 - "mercator": Alternate projection example for choropleth (not used)

The columns were also set to update their layout on medium sized and smaller screens like tablets and phones, such that the entire second column with the interactive elements and tree map and would move position to be below the choropleth. 87% of employees in businesses are expected to use their mobile phones (10) so responsiveness is essential to our target audience who are business owners.

The map has a hover label that includes both the exact country name and informs the user of the number of arrivals in each country, therefore it intends to addresses the first target audience question.

An additional grey coloured shape (matching the missing countries on the choropleth) and an annotation was added to create a custom legend next to the normal legend of the colour scale. This was to inform the user that the grey sections were countries with missing data, which was a problem of the original dataset provided to me, but this was done to prevent misleading the user into thinking that colour represents the top countries for arrivals. This is also why I ensured the highest part of the colour

scale to represent those top countries was a bright blue, almost turquoise colour to allow it to stand out.

1.4 Evaluation of design

For the choropleth map, the dataset was for number of arrivals from the international tourism dataset which was pre-prepared.

This map effectively communicates the locations of top countries for number of tourist arrivals and it answers successfully the target audience question of which countries have the highest number of arrivals per year with the carefully varying colour scale. This scale is not only visually appealing with its consistency with the overall blue theme, but also conveys a sense of assurance and professionalism(7). Therefore. this colour scale is perfect for the very professional target audience. Additionally, the interactivity succeeds in allowing the user to change the year easily with buttons or the freedom to type and also allows freedom to choose a region which only shows the colour for countries in the chosen region. Consequently, this interactivity answers the first two target audience questions well.

The ability to hover is an extremely powerful feature as it allows the target audience user to gather an insight on exactly what country and its number of arrivals in that year is and thereby answers the third target audience question well.

A weakness of the map is that it doesn't have the ability to show labels of each country without hovering, which makes it hard to simply glance at the map and know which country is which for users without that knowledge. This weakness is more prevalent for a user using a phone where they don't have the option to simply hover over the country and see the name and details. However, this can be overcome by the user simply clicking each country and dragging and zooming in on the map to view a specific country. Also, it can be argued in the context of the target audience, an international hospitality business owner may already be familiar with the countries since international tourism is a crucial form of income for this sector (2).

Another weakness is the responsiveness of the choropleth figure itself when a large size screen is resized to be slightly less wide, it is the only chart that does not resize to fit the screen, despite having a responsive bootstrap container and relevant settings. I tried to fix this issue in many ways, but I could not find a resolution and found it to be a bug on the plotly side. Although it may look slightly unattractive on the small screens, which is what the user wanted in the persona, it wasn't a need. Furthermore, the user can still see the map on a small screen by simply dragging the map or the screen horizontally.

Additionally, in the dataset there were so many different countries (around 195). Similarly, the range of number of arrivals ranged from relatively smaller magnitudes of 100 thousands to relatively very high magnitudes of 100 millions Therefore, it was hard to easily distinguish the colours between countries that are in the lower quartile of this range. However, the aim of the countries is to convey the top countries in arrivals which are easily distinguishable by the light colours, so this is a good tradeoff. The weakness is only significant when "All regions" are selected, which shows every country on the same map but when each individual region is selected, the colour scale range adjusts better to rank between just the countries within a particular region, which is therefore still very useful. By highlighting these countries, this figure answers very well the first 2 target audience questions.

Visualisation 2: Tree map chart

2.1 Questions the visualisation is intended to address

1. For each year, which countries have the highest number of arrivals?
2. What are the highest countries within each region (official groups of countries recognized by the world data bank (4)) for the highest number of tourist arrivals for any given year?
3. How many arrivals are there in the countries with the highest number of arrivals each year?
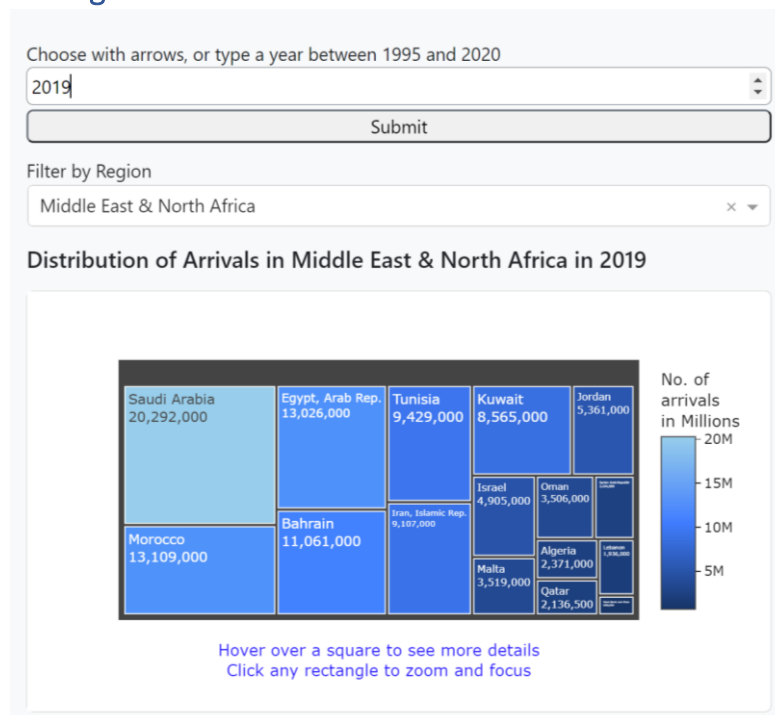
2.2 Implemented Design Screenshot

Figure 4 - Tree map with interactivity

2.3 Explaining the design

The call backs and interactivity options are connected to the choropleth figure in the first visualisation and so will not be repeated but they answer the same target audience questions as before and follow the same reasoning (see Visualisation 1 section).

The tree map was chosen to allow the user to better visualise the same information that the choropleth map uses, but in a simple and clearer way. It was chosen as this is one of the best ways to visually present many different tiles of data from tens to hundreds of data (11) . It therefore, exceeds the pie chart in its ability to present proportional data when there is a lot of data. This was the case with my dataset. The tree map filters and displays data for a selected region, but still has a lot of data in each region, so the pie chart was not used as the slices would be so small and converge to lines.

Another reason why the tree map was chosen is because it allows the powerful feature of being able to click on each square, consequently zooming into only that country and its data to effectively see the number of arrivals, even for a small square. It therefore intends to help the target audience hospitality business owners to choose a specific country in a more interactive and fluid manner.

The choice of colours of blue was again deliberate and compliments the choropleth with the exact same colour scale for the magnitude of number of arrivals to convey the same professionalism and consistency (6, 7).

A display for all regions at once was not included as there are 195 countries which is way to many to show on any chart or display method at once and may cause the hospitality business owners to be overwhelmed (12) . The figure also has a well-positioned title above the tree map itself and dynamically updates when a user changes the selection. It also prevents a change of the title when "all regions" is selected to inform the user that all regions is not on the tree map but only on the choropleth.

2.4 Evaluation of design

The ability to click individual square in this way, is extremely powerful as it acts as a visual aid to the choropleth map which could not show labels for the countries. This easily enables the hotel business owners to answer the first two target audience questions of showing the specific countries with the highest arrivals. The passive label as well as the hover label shows the number of arrivals and thereby successfully answers the third target audience question of how many arrivals exactly per country.

A weakness of the tree map is when there are large amounts of data being shown, Therefore it is harder to see the proportionally smaller squares representing low levels in number of arrivals are harder to see relatively to the larger squares. However, this problem was much more severe in the other possible methods such as pie chart and stacked bar charts which I evidenced in the markdown when trying. Additionally, those options don't allow the option of labelled segments and ability to interact an click the segments. Hence this tree map does the best job at answering all three target audience questions to allow the hospitality business owners to set up a hotel in the best country locations.

Another weakness is the inability to show all regions at once which may slightly hinder the ability of business owner of seeing an overall view of the countries. However, this is quite unnecessary as the target audience question doesn't really ask for all countries at once but rather the higher end in all mentioned questions, so the map still does an exceptional job at answering them.

Visualisation 3: Bar chart

3.1 Questions the visualisation is intended to address

1. Which countries have the highest average number of arrivals over at least the last 10 recorded years?
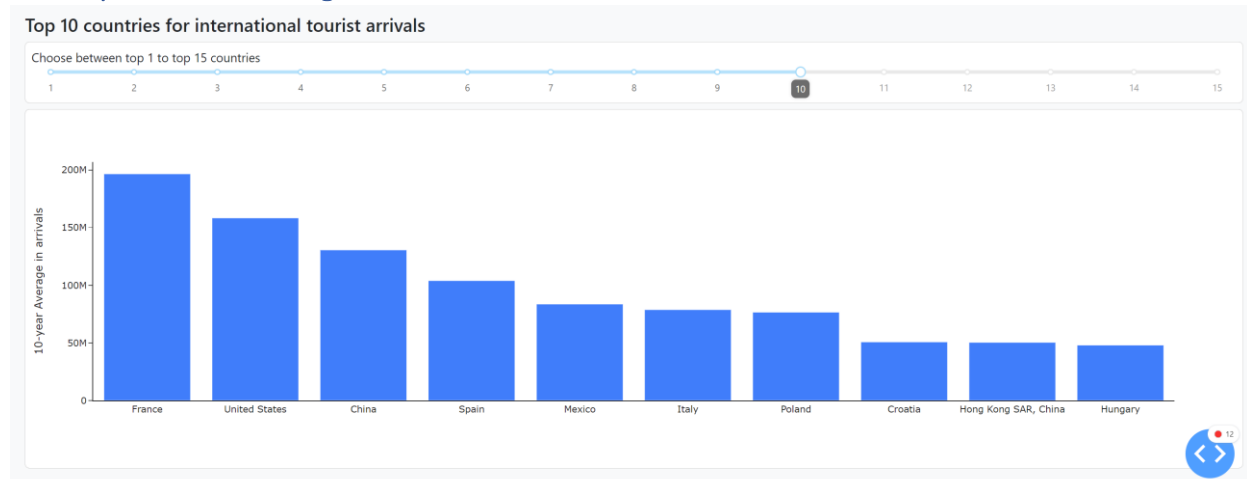
3.2 Implemented Design Screenshot

Figure 5 - Bar chart for rankings

3.3 Explaining the design

The bar chart was chosen to represent the rankings as the bars make it easy to quicky and simply understand the hierarchy of a dataset, simply with the height of bars (13). The bar colour was chosen as the exact same blue colour as the navigation bar and the other charts on the page, in order to, again convey consistency, which is valuable in a dashboard to make it less visually distracting (14) . Additionally, the use of the blue colour was used as it generally evokes emotions of professionalism (7) and trust so is a good choice for a more professional target audience, like the ones I am targeting which are hotel business owners and any other hospitality business owners. Therefore, it is a suitable colour choice. Another smaller consideration for the reason why colour blue chosen for every chart rather than red, for example is to account for individuals with colour-blindness since red-green colour blindness is the most common form (15). A colour scale was not used as the heights of the bars are sufficient to show scale and ranking.

The bars were chosen to be laid out across the entire width of the page. This is to ensure when a high number of rankings is chosen, for example, 13 with the slider, the bars would appear larger and wider. For the smaller screens such as phones that the target audience would like for the app to be used on, this will look more visually appealing. Hence, this layout across the screen was used with a responsive container.

Interactivity was added in the form of a slider as this is a good way to represent a low number of choices, or rankings in this case in the full view of the user. The user can easily select which ranking they desire by sliding to it rather than having to select the number from a dropdown. Tooltips were added to make the chosen state of the graph output more obvious and clearer. The tick labels were removed off the x axis as they can be distracting (16)when there are words rather than numbers directly below the bars. The y axis tick labels were kept since they represent numerical data and make the positioning of the bars relative to the data it represents (number of arrivals) clearer to the hospitality business owner. The x axis title was also removed as it is obvious from the graph title and the bar labels themselves

10

what the bars represent, in this case the country names. There is also hover data which clearly shows the exact 10-year average of arrivals for each country bar.

3.4 Evaluation of design

The bar chart does an excellent job at answering the target audience question as it displays in terms of the height of the bars, the top countries for tourist arrivals. Therefore, it allows the hotel or hospitality business owner to efficiently choose a location for their hotel with a visual representation of the best locations. The slider feature is also powerful at formatting the rankings to show as many ranks as the user requires and fluidly updates the chart accordingly.

A weakness of the design is the fact that the user may have to hover over the bar to see the exact numbers which may be difficult for the target audience if they are using a phone or smaller device without a mouse. This can be improved by putting a passive label inside each bar. On the positive side, hovering increases the interactivity and therefore engagement with the dashboard app by the hospitality business owners.

Visualisation 4: Line chart with markers for one country and stats card

4.1 Questions the visualisation is intended to address

1. Are there any gaps or inconsistencies (possible anomalies) in number of arrivals over the years for different countries?
2. What are the trends (e.g. positive, negative or no correlation) over at least 10 years, for a particular country?
3. What are the maximum, minimum and averages for each country over at least 10 years?
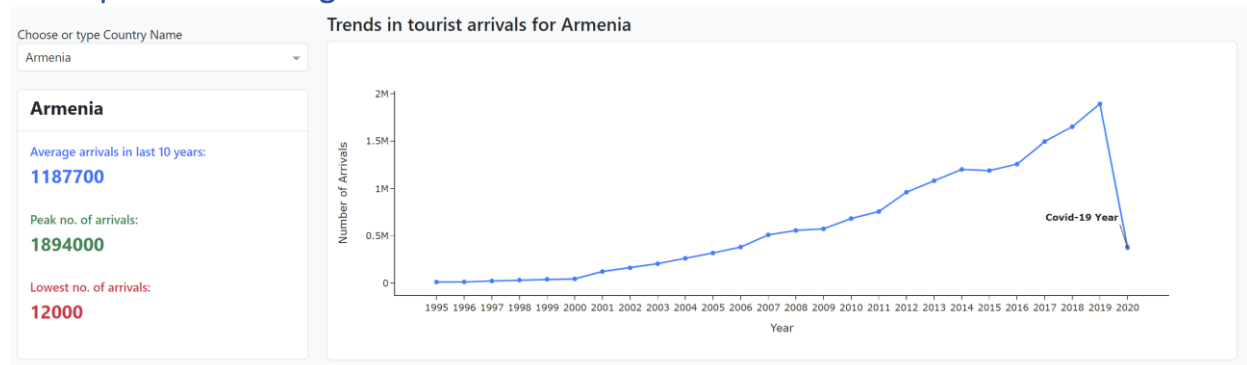
4.2 Implemented Design Screenshot

Figure 6 - First line chart for trends and stats card

4.3 Explaining the design

A line chart with markers was used for this visualisation to answer the above target audience questions. The colour of the line was chosen to be the same blue as the navigation bar and the other features of the app to again maintain consistency and therefore improve the aesthetic nature of the app (6) , as well as tailoring to a professional audience like the hospitality business owners with the blue itself (7) .

Markers were enabled in this case since the data values were discrete points of data corresponding to the axis ticklines exactly which is a common use case for markers (17) . This means there are no points between the ticklines, therefore it makes it clearer to the reader to distinguish each point as a specific year if they need to. It is also useful to include markers to highlight specific important data points (17) . In this case an annotation was added to highlight that the sudden drop in the 2020 year (for countries that had data in that year) was because of covid-19. This was done to avoid misinforming the user into thinking the drop was due to other reasons like a lack of popularity in that country which otherwise may cause them to avoid setting up a hotel in that country (18) .

A stats card was added on the left to highlight key statistics such and allows the user to easily see what country they have selected, other than reading the changing title of the graph. The colour red was used for the lowest value text which is a common use of that colour to alert the user negatively (19) while green text was used to highlight the positive peak value in a country over the years available. The blue average text is a neutral and calm colour that shouldn't alert the users emotions as much (19) relatively since it is only showing averages.

An interactive dropdown was added with the ability to search for any country because it can be visually draining to go through an entire list of many countries in a dropdown (9) .

4.4 Evaluation of design

Overall, the design clearly answers the second target audience question of showing trends very well as by looking at the line shape and overall slope, the user can see if the number of arrivals has a positive, negative or no correlation or over time. An increasing line of data, for example, shows a positive correlation for a country and allows the hotel or hospitality business owner to see that country has withstood the test of time with an increasing number of arrivals. This means they can choose to open a hotel in that location to maximise profits with the increased tourism in that area.

The line chart also properly answers the second target audience question of showing gaps and anomalies. It easily shows anomalies by a point or points being disproportionately away (above or below) from the overall trend of points. It also shows gaps in data by the line not being connected at the gaps and therefore the hotel owners can analyse this information as required.

The stats card perfectly answers the third question by showing the minimum, peak and average for 10 years of the data and allows a hospitality business owner to see important statistics to setup a hotel in that country.

A weakness is that the dropdown has too many options which is visually draining as mentioned before, however this was the best way to select an individual country to answer the target audience question to analyse trends and find anomalies and gaps.

Visualisation 5: Line chart with for comparing 2 countries

4.1 Questions the visualisation is intended to address

1. How do the trends (e.g. positive, negative or no correlation) compare between two countries?
2. Are there any gaps or inconsistencies (possible anomalies) in number of arrivals over the years for different countries?

4.2 Implemented Design Screenshot
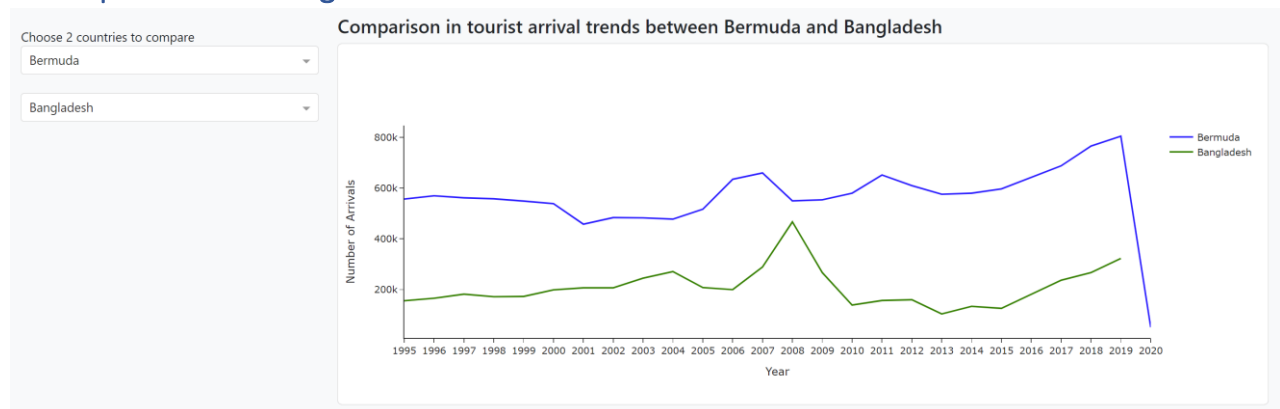
4.3 Explaining the design

This chart type was chosen without markers to prevent distracting the user (20) from the main target question which was to compare any two countries. Again, the blue chosen was to match the overall blue with the same reasonings as before. The legend was chosen to be on the right side to clearly distinguish the countries by line colour and prevent misinformation.

A dropdown selector was again used to compare 2 countries. It was decided to separate the two dropdown instead of one multiple choice dropdown. This is because if I allowed multiple choice, there would be too many countries lines and generally more than 5 are visually distracting (21) .

Line charts rather than scatter were chosen since the points are joined up and the differences can be seen between two country data columns can be seen more clearly.

4.4 Evaluation of design

The line chart for comparing 2 countries does a very good job at distinguishing between the 2 lines and the fact there are not points of data, it is less distracting and focuses more on the trends of the data such as positive correlation relating to an increasing line, for example.

A weakness of this chart design is the lack of comparative statistical data. Although it does visually show the differences in the trends like of two countries. For example, Libya has an overall negatively decreasing line slope which suggests negative correlation between the time period over the years compared to number of arrivals.

However, in comparison to another country line like Curacao, we can see the line and points tend to increase in slope such that the two lines cross. This shows how the Curacao country is much better to put a hotel in terms of the target audience user as hotel owner since it has been proven to be an increasingly popular country so better to choose to build a hotel here for revenue and longevity. As well as the difference between two countries for number of arrivals each year, it also shows the difference in actual levels as tourism arrivals between two countries which further helps the target audience to

decide, if the two countries have positive correlation and increase, the final choice of where to build a hotel is left down to which line is higher. This is because the higher line indicates more number of arrivals and hence answers the second target audience question extremely well.

A weakness is that a stats card could have been included to compare the percentage differences over the given year period in order to compare the countries better. This may have answered the target audience question of comparing trends between two countries better. However, this was decided not to be included to avoid repetition since the previous chart had a stats card.

Another weakness is that there could have been an annotation on the year 2020 to indicate a drop due to covid-19, which was indicated in the previous chart but in this chart the positioning of the marker would not position accurately, possibly due to there being 2 lines. However, this is the reasoning behind there being 2 line charts as the first line chart in the previous visualisation addresses this issue. This lack of annotation may mislead the user if the have not used the previous one as they might wonder why there is a sudden drop in a positively increasing trend line.

A prevalent weakness with most visualisations that have multiple countries, is that the lines for countries with very low relative number of arrivals compared to a country with very high causes the lower line to appear quite squashed. This may misinform the hotel business owner when comparing trends as they may not be able to clearly see the increase or decreasing trend nature of a country and therefore slightly hinders the ability of the design to answer the first target audience question.

Additional features that answer target questions and user requirements

Additional feature 1 Download Button:

1.1. Questions the feature is intended to address

1. Can I download the data so I can analyze it myself or use it for methods such as machine learning algorithms to make predictions?

1.2 Implemented Design Screenshot

Click to download the dataset as an Excel file

Download data as Excel
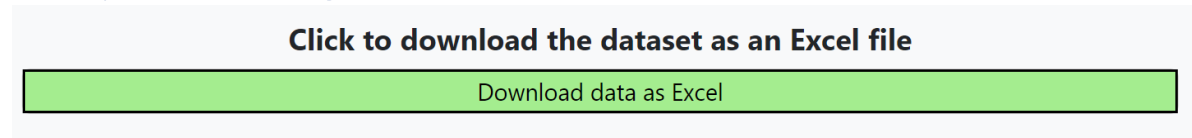
1.3 Explaining the design

The design was green button with a darkened black outline for the download and chosen to be green to represent a positive emotion in the user while still allowing it to stand out and be seen amongst the other charts.

1.4 Evaluation of design

The design does a perfect job at being able to download the prepared data set for the hospitality business owners and easily answers the target audience question.

Additional feature 2 Location posts page with working login functionality to access ability for user to post their own location

2.1 Questions the feature is intended to address
Non-data science visualization question:

1. Can I have interactivity in the ability post my own location and be able to collaborate with other members of the hospitality sector?

2.2 Implemented Design Screenshot:
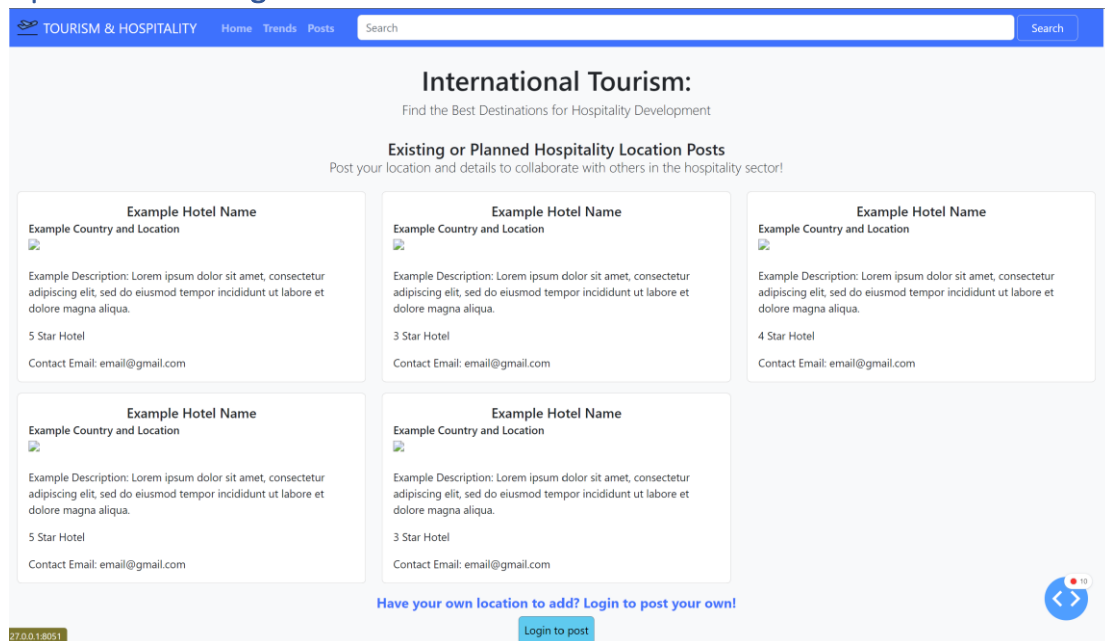
2.3 Explaining the design
The design is explained in the README.md markdown.

2.4 Evaluation of design
 It is also evaluated in the markdown.

References:

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