Data Visualisation and Visual Analytics - 32146

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Assignment 2 – Graph Visualization Design

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Table of Contents

1. Graph Visualization

Directional Node-Link approach is selected as the graph visualization metaphor to represent the flights' data. Figure 1 shows the representation of flights data in a graphical manner. It follows the basic properties of the node-link graph, where nodes represent the cities and the links between various node represent the flight path. Node-link approach was most suitable to represent the given data as the given data attributes can be easily represented by nodes and edges. The reasons for selecting the node-link approach are summarised as follow:

- There are 20 cities, and these cities have 46 'From -> To' relationships with each other; thus node-link approach is chosen in order to increase the readability of the graph.
- Cities can be easily represented as nodes, while the use of lines and arrows to represent the relation between the various nodes makes the cognition process easier.
- The different colour of the lines (edges) represents different Air-Space Class; this further makes the graph more natural to read and understand. The symbol key or legend for this representation is provided in table 1.
- The price of different flights is simply labelled on the links, again very easy to read.
- Finally, from the given data, it is inferred that a particular aircraft model will have a particular engine model. This information is used to club both these data attributes together in order to represent them with the help of the arrowhead, different colour of the arrowhead represents different aircraft model and in turn different engine model as well. The symbol key or legend for this representation is provided in table 2.

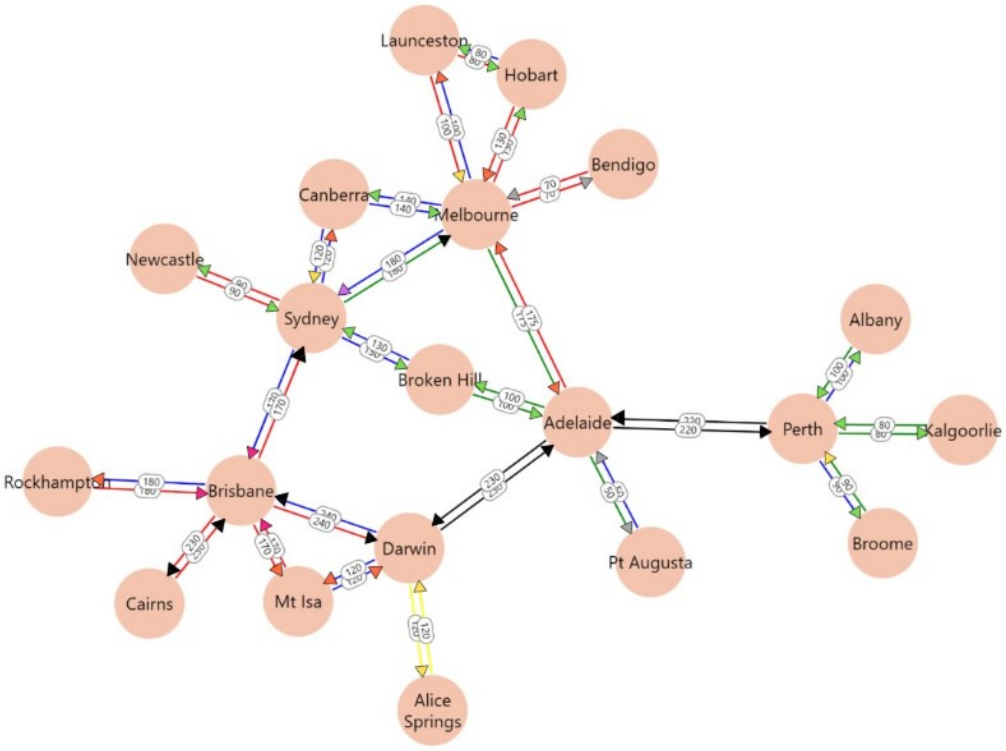

Figure 1: Flights Data Visual Representation

Air Space Class	Symbol
A	
B	
C	
D	
E	

Table 1

Aircraft Model	Engine Model	Symbol
A330-203	CF6-80E142	
B737-3B7	CFM56-3B1	
B737-476	CFM-56-3	
A320-232	V2527-5A	
A330-243	772B-60	
A330-202	CF6-80E142	
B717-200	UNKNOWN	

Table 2

2. High-Level Model

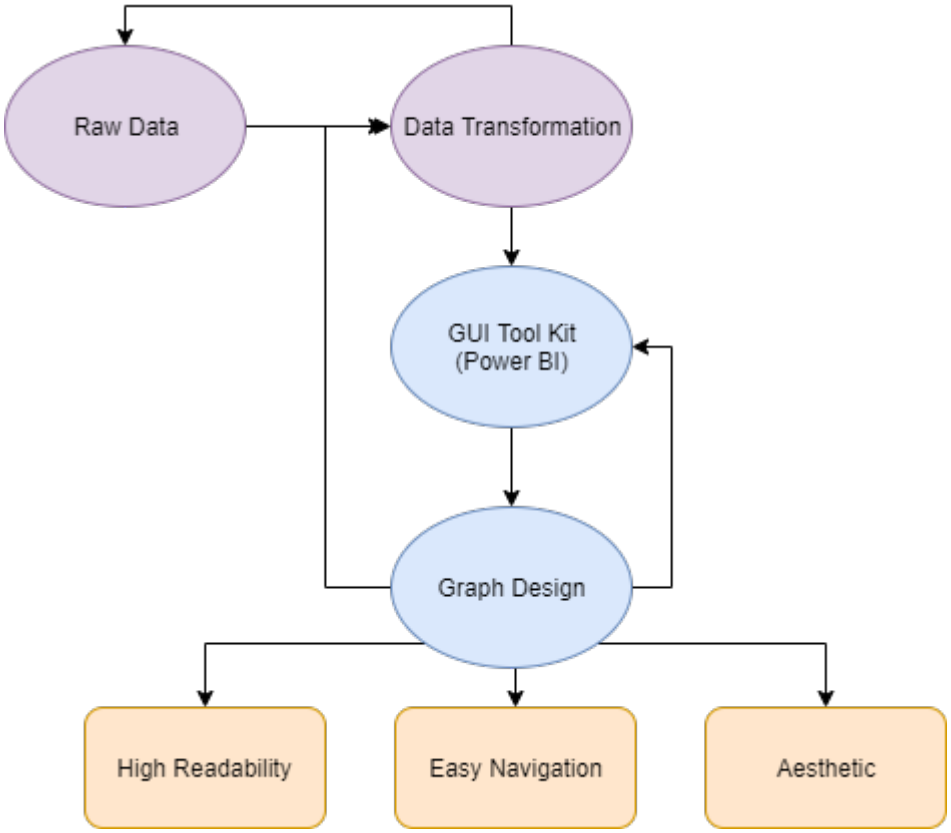

Figure 2: High-Level Model for Graph Design

The proposed high-level model for the design of the graph is shown in figure 2. The first step is to transform the given data in order to design the desired graph layout. This step includes data transformations such as creating a column to specify the colour for different Air Space Class and categorising Aircraft and Engine models. This is a repetitive process. The next step is to use a graphical user interface tool kit, in this case, PowerBI, to design the graph using the transformed data. This is also a repetitive process. These steps are repeated to attain the desired graph design.

The graph design is focused on three characteristics: Readability, Navigation and Aesthetics. The graph should have high readability, and at the same time, it should be easy to navigate. The graph should also follow aesthetic rules such as avoiding edge crossing, and edges must be straight lines, etc.

3. Visualization Design Specification

The graph is based on Node-Link approach. There are 20 nodes and 46 edges in the graph. Each node represents a city while edges represent the flight from a city to another city. The relationship between various nodes is conveyed by the directed edges (arrows) while the colour of the arrows represents the aircraft and engine model. The colour of the edges represents the air space class, and finally, the labels on the edges represent the price of the flights.

3.1 Layout Design Specification

3.1.1 Edge-Crossing

Due to the small size of the graph, the nodes were arranged in such a manner that no edge crossing occurred.

3.1.2 Objects Node-Overlap

The distance between nodes was increased in order to provide adequate space between every node. The small size of the graph and increasing the distance between the nodes helped to avoid any node overlapping.

3.1.3 Readability

The graph was designed, keeping in mind the importance of high readability. In order to enhance the readability of the layout different visual techniques were used, such as the use of different colours edges to represent different air space class and different colour directed arrows to represent different aircraft and engine model. Also, the only text used was implemented inside the nodes in order to make the layout look spacious and attain high readability.

3.1.4 Labelling Techniques

The labelling of nodes was done inside the node shape. Other than the node labels, all the other labels were represented with the help of different symbols, and a symbol key was provided in the form of a table.

3.2 Graphics Design Specification

3.2.1 Graphics Objects

- Node - The cities are represented by nodes which have a circular shape.
- Edge - The edges are straight lines that represent the relation between various nodes; also, the colour of the edge represents the air space class.
- Arrow Head – The arrowheads at the end of each edge are used to represent aircraft and engine model. Seven different colours are used to represent different aircraft and engine model.

- Label – The labels have the shape of an eclipse, and the text inside them denotes the price of the flight.

3.2.2 Graphic Attributes

The cities are represented by light orange coloured circles. The edge colouring was based on the air space classes, and class A was represented with red due to the high wavelength of red colour; all the other edge colours were chosen randomly. The arrow colours were also chosen randomly. To represent the price, eclipse shape was chosen, which was placed in the centre of every edge.

3.2.3 Domain-Specific Attributes

- Cities - The cities can easily be mapped onto the nodes.
- Price – The directional edges, in this case, represent the flight direction, so it makes sense to map the numerical values of the price as a label onto the edges of the graph.
- Air Space Class – Since each edge already represents a flight, air space class can be easily mapped as the colour of the edge.
- Engine and Aircraft Model – The relation between the model of the aircraft to its engine model made it possible to map these two attributes onto a single graphical object. They were mapped as different colours of the arrowhead.

3.2.4 Data Scale Problem

The selected graph layout algorithm will scale well with an increase in data size. Computational cost while running the selected graph layout algorithm will not be a problem because the graph layout follows a straightforward design. If the data attributes increase substantially, then techniques such as clustering may need to be implemented to deal with the computational cost. Edge filtering algorithm is another option that can be considered when dealing with large data sets.

3.2.5 Readability

The readability of the domain-specific attributes can be enhanced by following the aesthetic graph rules such as avoiding the edge crossing or keeping the graph symmetrical, in order to increase the human cognition process. Another method to increase the readability is to minimize the use of text to represent different data attributes, using more visual representation methods will make it easier for anyone to read the graph as humans are naturally better at understanding visual data rather than texts.

4. Navigation Design Specification

The graph uses zoom and pan navigation scheme. This navigation scheme was selected for this graph because of the ease of use of it. Since the selected graph design is simple in terms of the graphic objects used, the process of zoom can be applied easily. Zooming process in this context uses geometric zooming; meaning it zooms merely into the selected area. Another technique that is used is called filtering; a viewer can apply various available filters in order to view only the flight data with selected information.

4.1 View Transformations

4.1.1 View Design and Transformation

The zoom and pan technique create a zoomed-in version of what appears on the screen and is very simple to use. Figure 3 shows an overview of the graph on the left and a zoomed-in view of the graph on the right. In this case, the viewer has zoomed in onto Sydney, and the viewer can now easily view all the flight data related to Sydney; the viewer can also pan around the graph to view the neighbouring information on the graph.

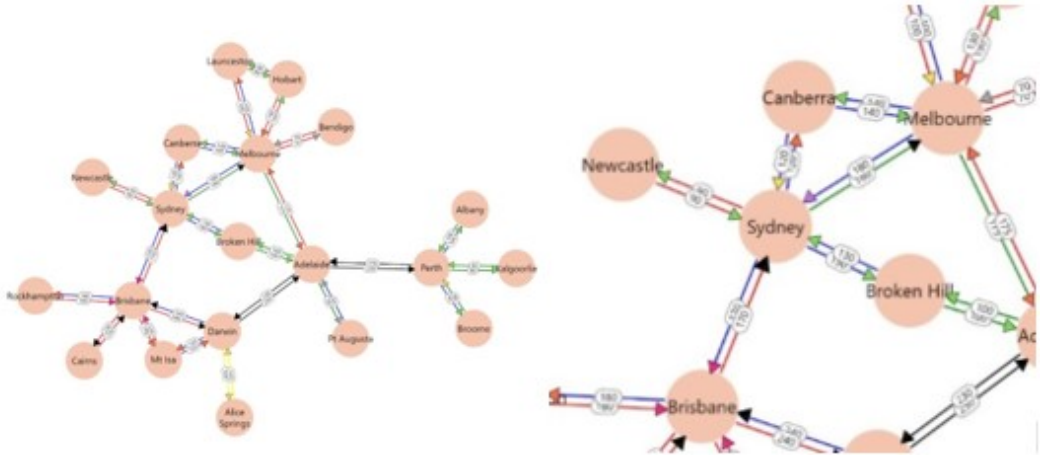

Figure 3: Zoom and Pan Approach

The filtering technique is used to filter and narrow down the information set. Figure 4 and 5 show two examples of the filtering technique; in figure 4, the viewer has transformed the graph to only show the flights with A330-203 as aircraft model. Figure 5 shows the flights which are prices less than 100$.

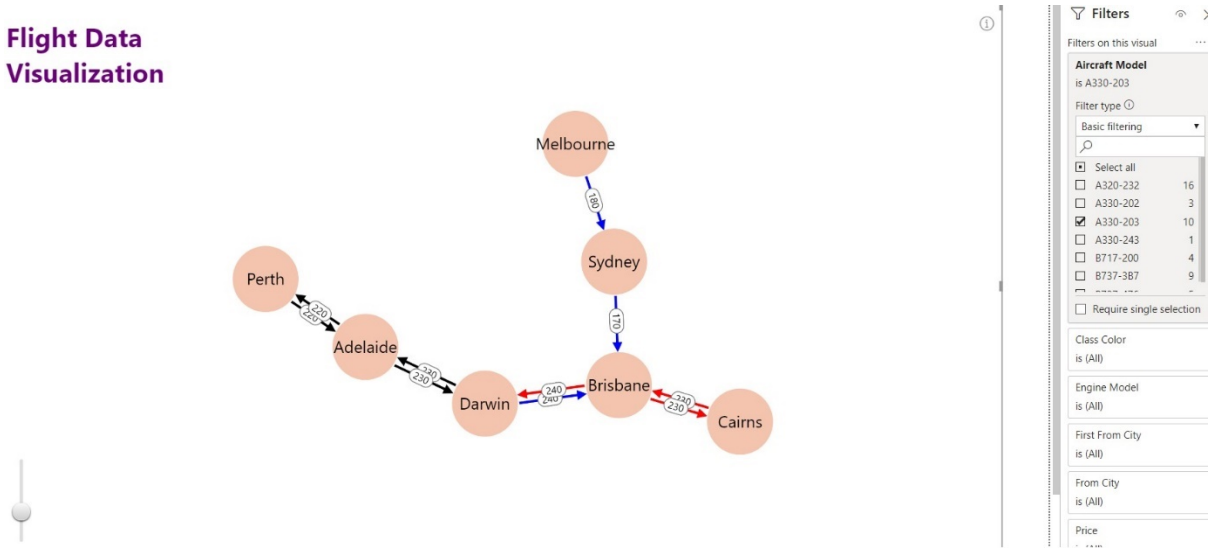

Figure 4: Filter Aircraft Model

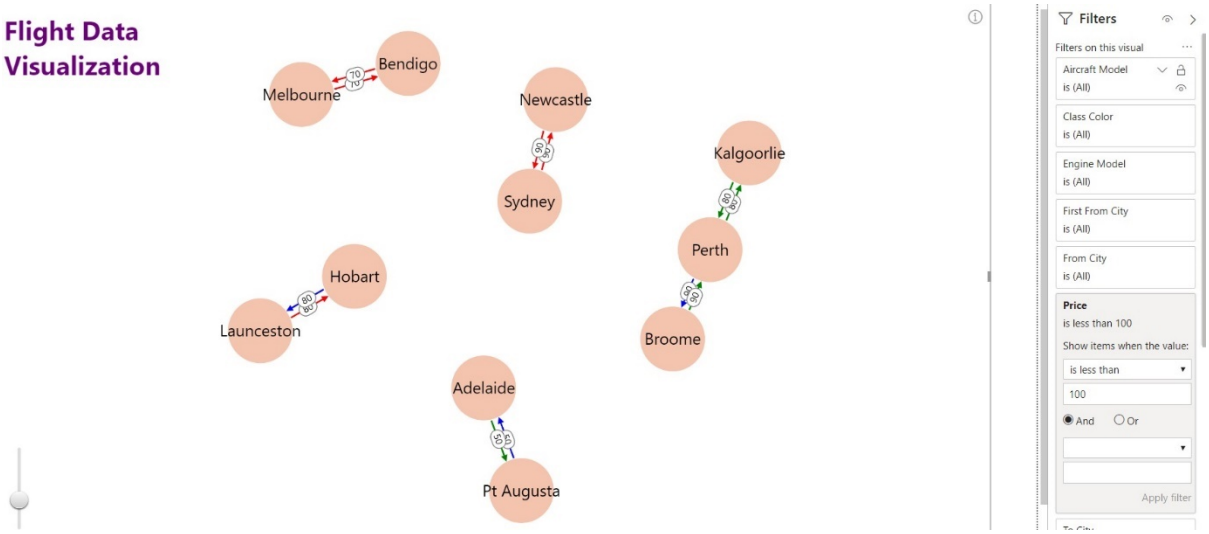

Figure 5: Filter Price

4.1.2 Human Cognition Process

The transformations provide more excellent readability, thus increasing the human cognition process. The zooming helps the viewer to focus on a particular area of interest; this makes it easier for the viewer to concentrate on the part of the graph that is of interest to him.

The filtering transformations also significantly increase the human cognition process by transforming the graph as discussed in the previous section. Overall, both of these transformations enhance the readability of the graph to a great extent.

4.2 HCI Design

The human-computer interaction is the study of how humans interact with computers.

4.2.1 Navigation Scheme Efficiency

The efficiency of the navigation scheme is evaluated using the fitts' law. The fitts' states that if the target, which in this case is the graph layout, is small in size and at the same time the distance of the target is considerable then it requires more time for a human being to navigate that target. In the case of the selected graph layout design, the size of the size is appropriate for anyone to be able to navigate quickly; also the distance between the nodes remains the same, so it can be argued that the graph has excellent efficiency with respect to the fitts' law. Also, when the graph is zoomed in, the size of the graph increases and the distance between the nodes decreases, thus according to the fitts' law, the efficiency increases.

The navigation and filtering techniques are implemented in order yo increase the usability of the graph. For example, if a user wants to see the flights flying from Sydney, the user can easily zoom in on the node that represents Sydney and see the outbound and inbound flight data at a glance. Also the user can filter the flights based on the aircraft model with a single click.

References

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