Due
04/05/2015

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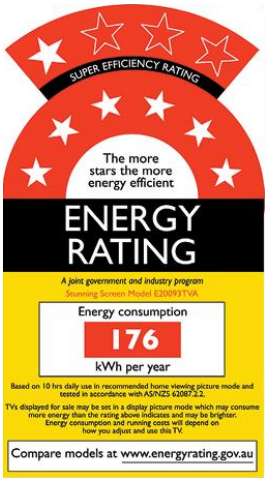

COSC3000 PROJECT REPORT – SCIENTIFIC VISUALISATION

THE FOLLOWING REPORT IS A PRELIMINARY INVESTIGATION INTO THE VISUALISATION AND ANALYSIS OF DATA PERTAINING TO THE ENERGY RATING OF AVAILABLE AND APPROVED BRANDED TELEVISIONS SOLD IN AUSTRALIA. THIS IS ACHIEVED THROUGH THE VISUALISATION OF DATA CLASSIFIED AS EITHER UNIVARIATE, BIVARIATE OR MULTIVARIATE. IT IS HOPED THAT THESE VISUALISAIONS WILL AID THE GENERAL PUBLIC TO MAKE INFORMED DECISIONS WHEN PURCHASING TELEVISIONS.

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1 INTRODUCTION

The Australian Government outlines the importance of energy efficiency in households in a conscious effort to decrease global greenhouse gases.

"*Global greenhouse gas emissions from fossil fuel use continue to grow each year, despite attempts to limit them through…energy efficiency measures. The effectiveness of these measures has been largely offset by population growth and increasing uptake of more affordable electrical appliances.*" (McGee, 2013)

In another statement by the government, it is revealed that around 33% of household energy use comes from household appliances with the television in front of the fridge/freezer for the appliance with the highest energy use (Brown, 2013).

The objective of this investigatory report is to highlight through a variety of data visualisation methodologies and analyses how various factors influence the energy efficiency of televisions. The report aims to present data in a visualised form targeted towards data-challenged consumers so that they may find meaning and understanding from the information presented to them. Factors relating to the ERL (Energy Rating Label): CEC (Comparative Energy Consumption) and star rating, and screen type (screen specifications such as screen area and size) will be the main focus of this exploration. The data will be limited to branded televisions sold in Australia which are currently available and approved in order to increase the relevance of this study.

2 REVIEW OF DATA

2.1 DATA SOURCE

The multi-dimensional dataset was sourced from the Australian Government's online data repository available for download in .csv format with a mixture of number and text entries[1]. Due to the official nature of the data's collectors, it can be counted as a reliable form of real data. While information such as the timespan the data was collected was not mentioned, the dataset is updated daily with the original published date being 17/04/13. This fact proves its relevance.

A report for the Department of Climate Change and Energy Efficiency (Energy Efficient Strategies, 2011) outlines standard assumptions that should be considered with certain data fields. Section 3 details the background of how star ratings are calculated as illustrated in the following segment.

"…the standard assumes a usage of 10 hours per day in active or "on" mode, while the remainder of the time is in passive standby mode…"

In addition, star ratings range from 1 to 10 stars. In this case, 1 star is the worst for energy efficiency while 10 is the best.

2.2 DATA PREPARATION

To make the dataset more clear and compatible with MATLAB a number of changes were carried out. Values had to be rewritten (i.e. Republic of Korea instead of "Korea, Republic of") for standardising and readability. All the commas that existed in the dataset had to be replaced with dashes; otherwise they were treated as delimiters and pushed the entries in the affected rows across into other columns. Values had to be standardised (i.e. Sony+SONY to SONY, Kogan+KOGAN to KOGAN) so there would be no duplicates when plotting data. Irrelevant entries were culled. Data was considered irrelevant if it was outside the scope of the investigation. Furthermore, if the data entries were blank, or had too many zeros to be visualised in a meaningful way it was removed. Data was also removed if every row in the corresponding field had a unique value because there was no meaningful way to interpret it. Of the original 3887 rows of data, only 683 remained to be visualised and analysed.

[1] https://data.gov.au/dataset/energy-rating-for-household-appliances

3 DATA ANALYSIS

Data was identified and split up into three distinct groups: univariate, bivariate and multivariate. The univariate visualisations were designed to be a quick visual take in of a large amount of data. The aim of bivariate visualisations was to highlight certain trends in relationships between two fields. While multivariate visualisations were designed to highlight a greater insight into the relationship between multiple fields.

3.1 UNIVARIATE

The first method of visualisation was the sorted bar chart. It was decided this was the best technique to establish the overall feel of the data. Histograms were found to not be clear with their joined bins especially for large ranges of data with largely varying numbers of occurrences. Each bin labelled with its numerical value–in an ascending order with spaces separating the bin sections–clearly shows the maximum and minimum values of certain fields. The following figures relate to the Country of Origin, Star Rating, Brand Name and Screen Tech as these attributes are what consumers are most likely to look for when in the market for an appliance.

The data in the figures below shows a large number of single digit occurrences which was thought odd, considering that the television market is quite large. However, the original dataset did not have a field with the number of units exported. As a result, this data does not reflect the amount of units in Australia and should be taken as a generalisation of attributes from existing units.

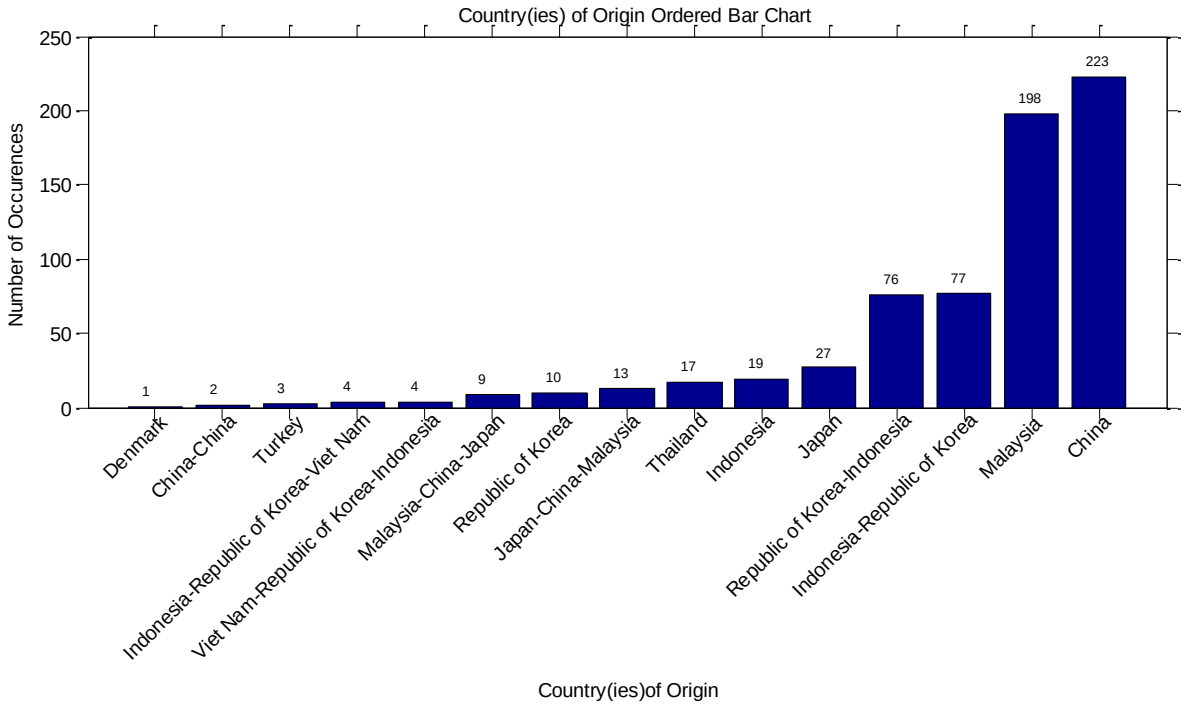

Figure 1 Ordered occurrences for countries which export televisions to Australia

Figure 1 shows that Denmark is the country with the least exports to Australia, while China has the most. It is also interesting to note that while the majority of exports come from China, Malaysia also has a high export number, with the rest of the combined countries exporting a small amount in comparison. In addition, it was curious to see that televisions are not always constructed in the same country.

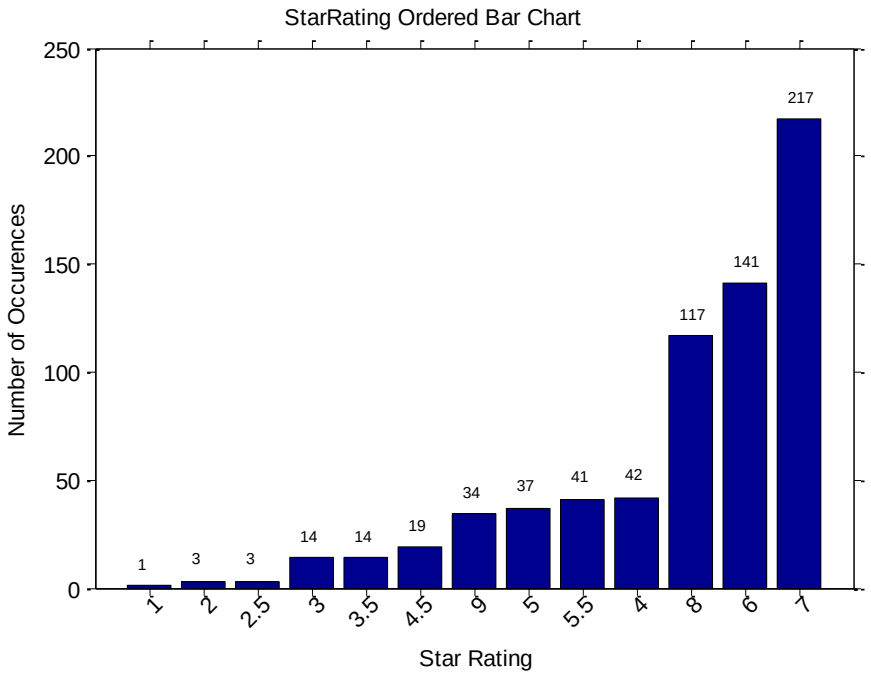

Figure 2 Ordered occurrences for television star ratings

Figure 2 surprisingly shows that the maximum star rating of the imported televisions had a higher rating of 7. It was unexpected to see that the majority of the lower energy efficiency star ratings (1, 2, 2.5, 3, 3.5, 4.5) were not frequent given the 'reduce carbon emissions' message by the government (McGee, 2013). More televisions seem to be produced with energy efficiency in mind; however the dataset did not have a field on how many people purchased energy efficient televisions.

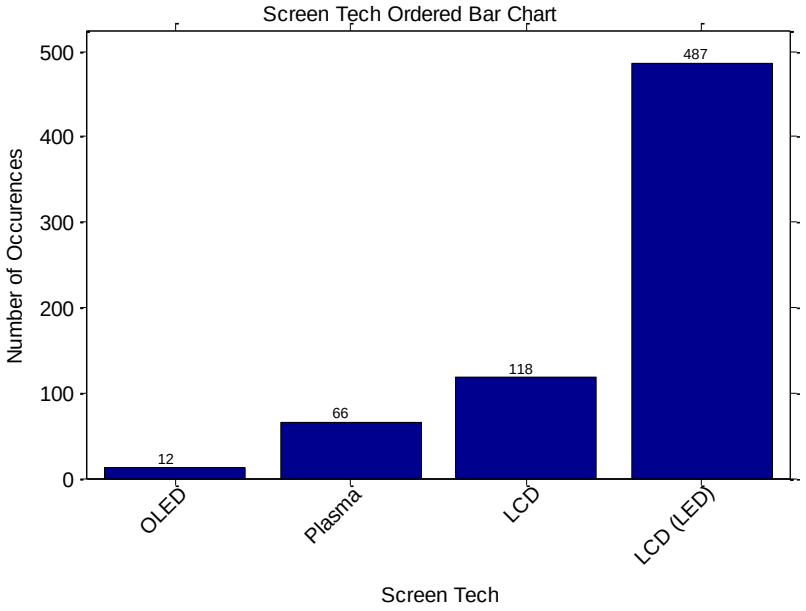

Figure 3 Ordered occurrences for television screen tech types

It can be seen in Figure 3 that the majority of imported televisions have LCD (LED) screens, while the minority has the OLED screen. It was unexpected to see that around 70% of the screen tech for imported televisions was dominated by LED.

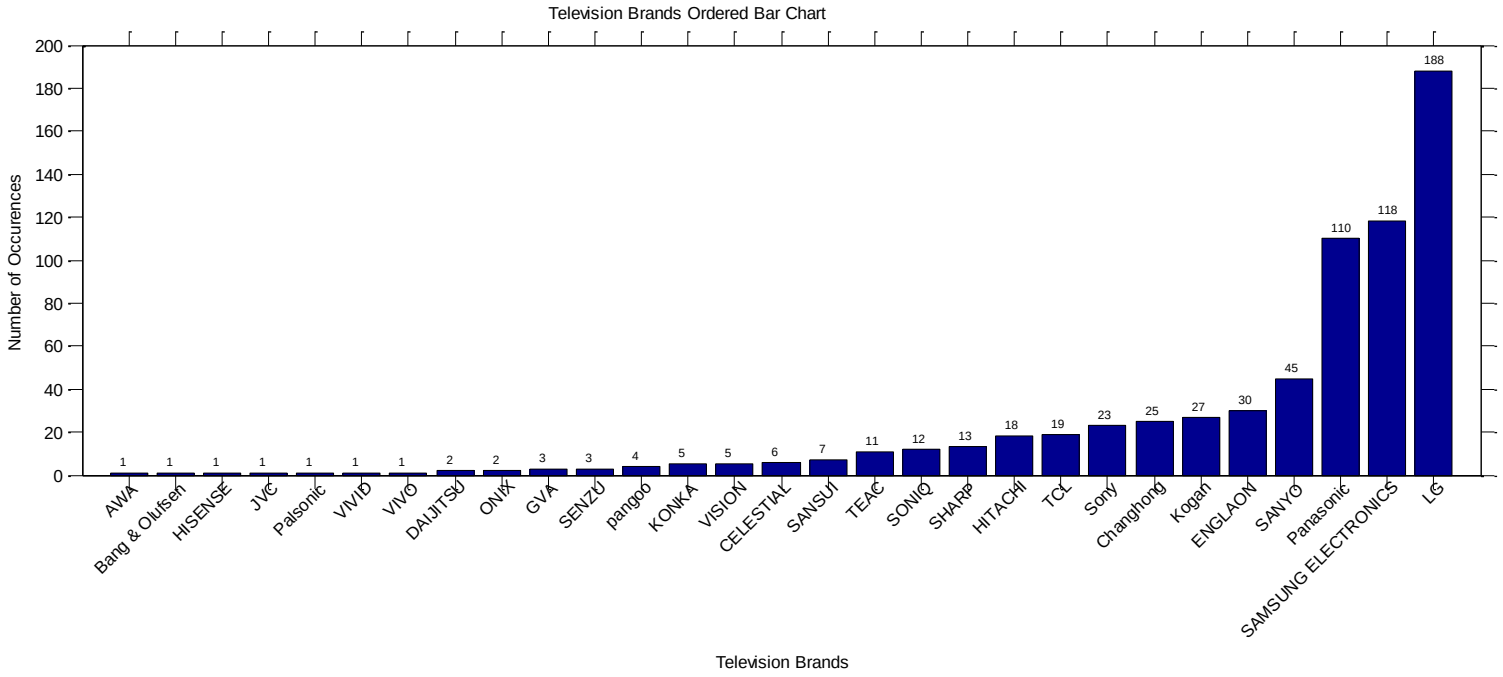

Figure 4 Ordered occurrences for Television Brands

Figure 4 shows that well-known brands such as LG, Samsung Electronics and Panasonic corner the brand market of televisions. It was interesting to see that so many television brands exist.

As illustrated in Figures 1-4, bar charts offer an obvious minimum and maximum visualisation. However, this method is not without limitations. Ordered bar charts have no proven relationships between fields, they are only observations. For example, looking at all four figures and no other forms of visualised data, one might conclude that the majority of televisions sold from China have a star eating of 7 an LED screen and have the LG brand. Because bar charts cannot effectively illustrate relationships between fields, bivariate and multivariate data visualisations were used as supplementary information.

3.2 BIVARIATE & MULTIVARIATE

The second method towards creating a more meaningful visualisation was the scatterplot. Scatterplots were considered as the most suitable method of visualisation because while showing the relationship of two fields, trends were easier to see. Figure 5 illustrates an expected growth, as the diagonal size increases, the area increases also. One point of data stood out (it had a smaller screen area for a larger diagonal size) but was considered as an error due to it being a once off occurrence. A heavy clustering of data indicated that most of the TVs have screen sizes ranging from around 50cm-175cm or a screen area ranging from around 1000cm^2-11500cm^2.

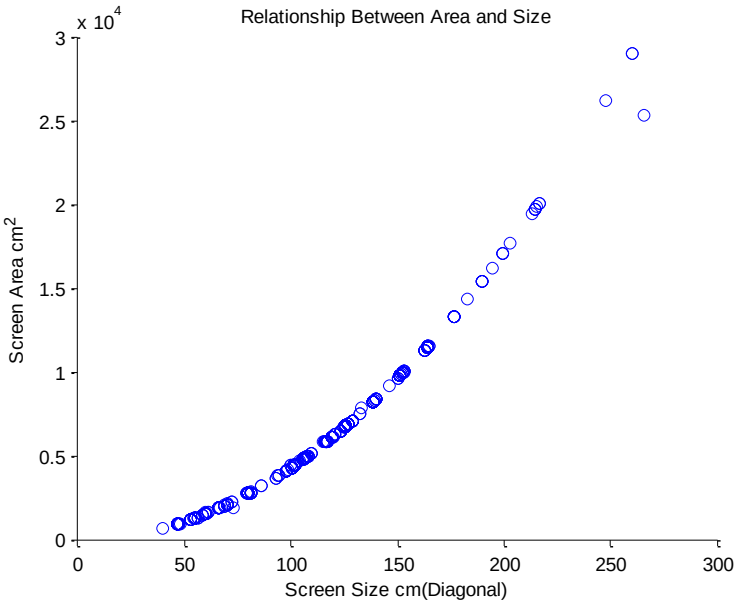

Figure 5 Screen size/Screen area relationship

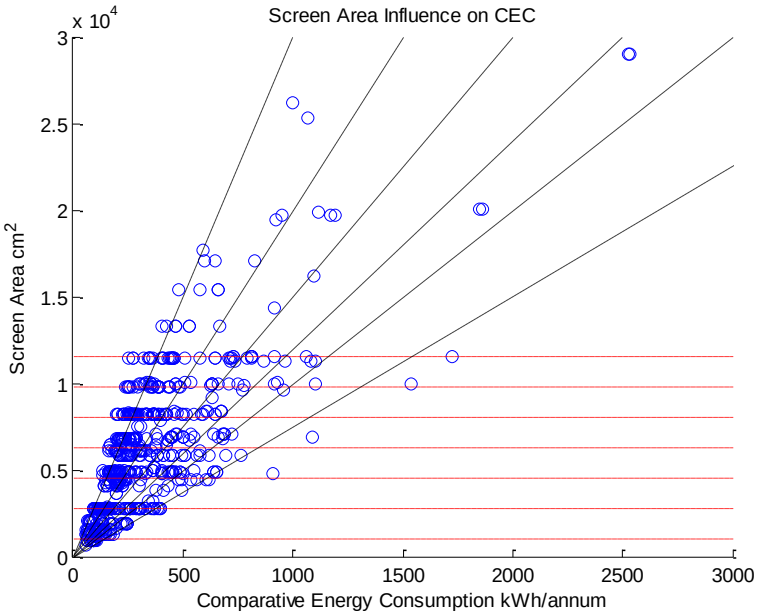

Figure 6 Screen area/CEC relationship

The expected relationship established in Figure 5, and the clustering of screen sizes prompted a closer look at how screen size influences CEC values. There are two interesting trends identified in Figure 6. The first (red lines) shows that for the same screen area, the CEC values increase. The second (black lines) shows that as the area increases, the CEC values do as well. This result was expected, as a larger screen area usually means a larger area to power, leading to a larger amount of energy consumption, and a higher CEC value. It was interesting to see that the main cluster of plots between 100kWh/annum-1000kWh/annum corresponded to the clustering in Figure 5.This finding further cemented the idea that screen size influences CEC values. However, the one colour circle overlapping so many others, as well as the red lines trend left a confusing visualisation. The solution was to plot the same figure, but grouped by colour and marker type.

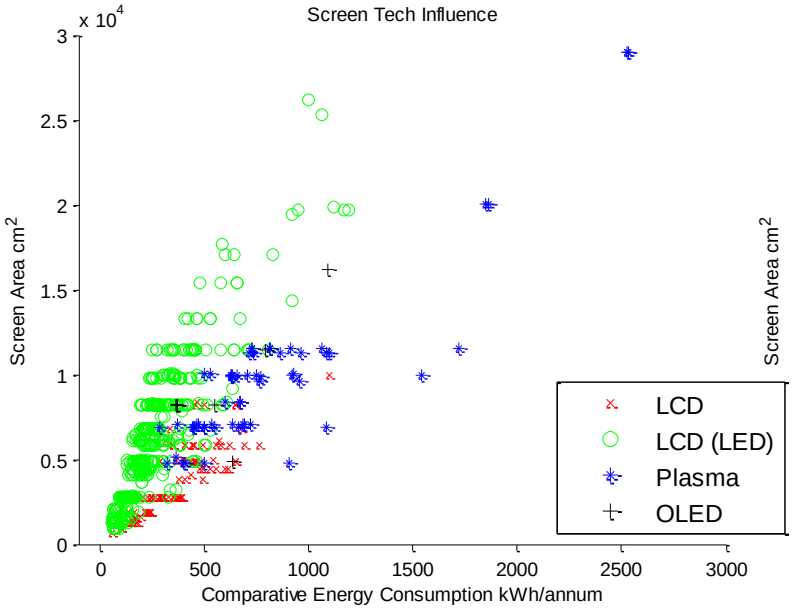

Figure 7 Screen tech grouping of screen area/CEC relationship

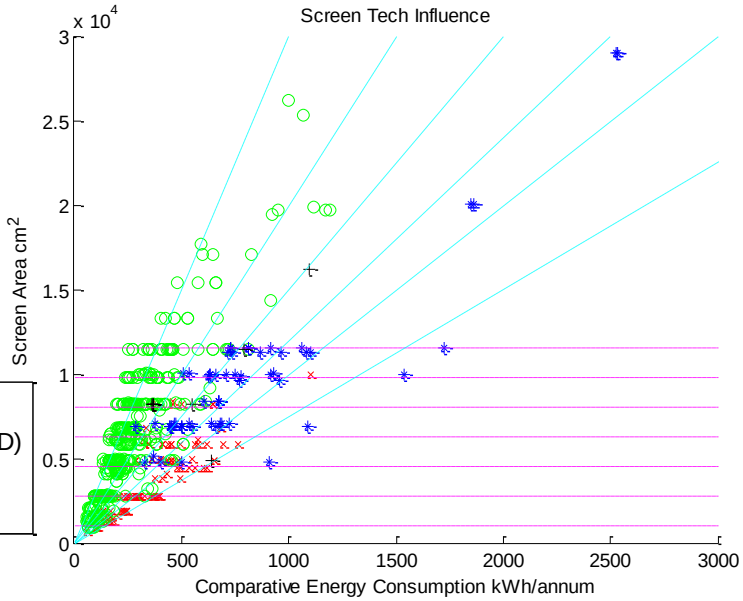

Figure 8 Figure 7 with trend lines

Screen tech types were decided on to be a method of grouping to establish what sort of relationship this factor had towards CEC. Figure 7 shows the results from Figure 6 grouped by colour and marker style to highlight the four screen tech types. It was interesting to see that the LED televisions were consistently on the left side of the data plots. This was interpreted to be that compared to LCD, OLED and Plasma screen types LED is a better performer with primarily lower CEC values for increasing screen areas. Plasma was identified to be the lowest performer overall with higher levels of CEC compared to the other screen types.

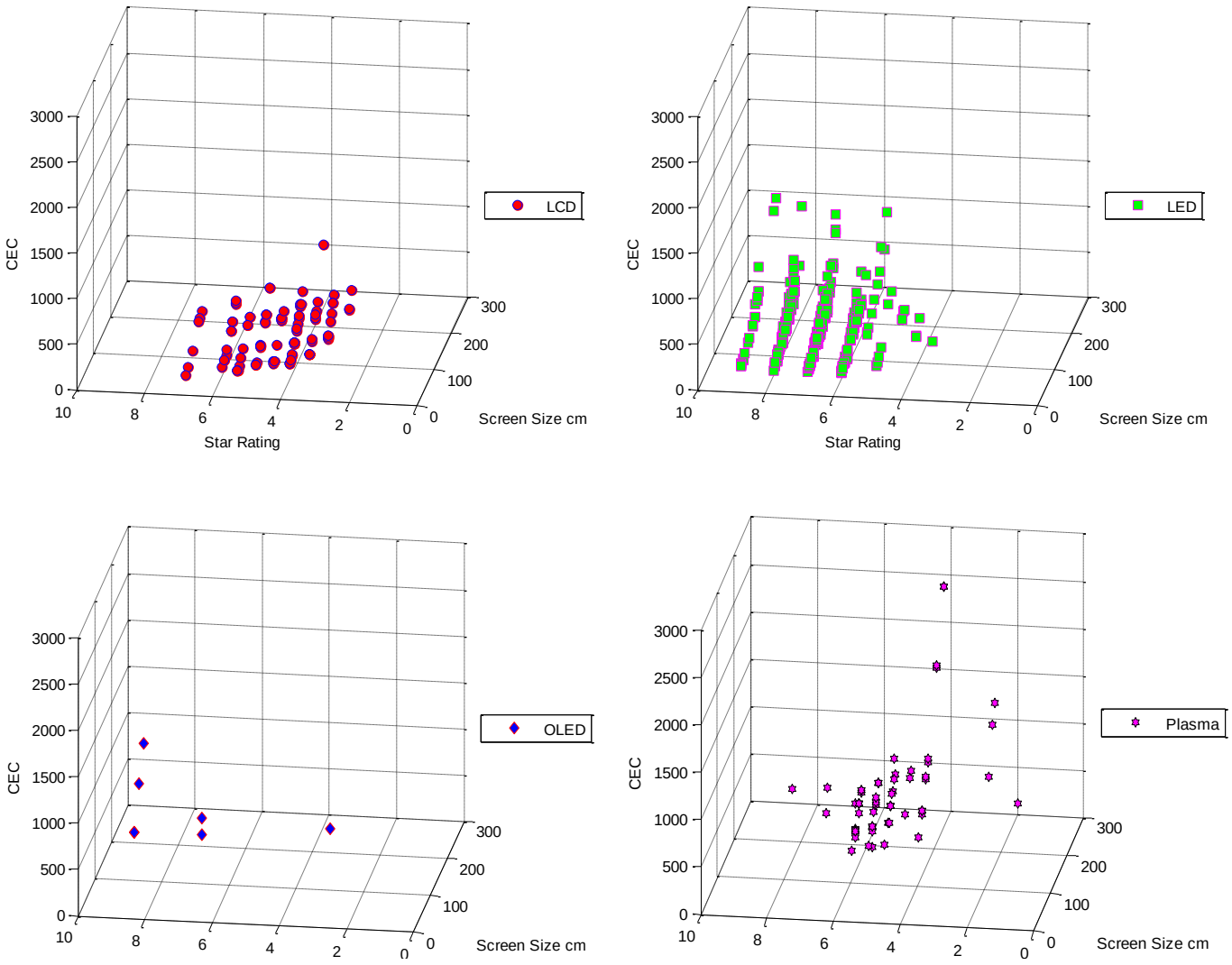

Figure 9 Subplots of CEC vs star rating vs screen size grouped by a screen tech type.

3D plotting was used as an extension of the previous figures to further highlight trends within each subsection separately (with CEC, star rating and screen size). Most of the LED plots were in their expected quadrant around the 6-9 rating due to the trend highlighted in Figure 8. The LCD plot points were also expected (around 3-6). OLED surprisingly had most of its plots around the 9 star rating. While LED, LCD and OLED had spaced out grouping, Plasma had the most of its points plotted around 4-6 rating. This was interpreted that Plasma televisions are poor choices for energy efficiency with their higher CEC values and medium star ratings. *Figure A1* in the *Appendix* shows a combined version of the subplots.

The star rating factor was plotted against the CEC values to highlight any relationships between the two fields. This visualisation did not follow the expected trend: the lower the star rating, the higher the CEC value. Instead it showed that there were higher CEC values with higher star ratings, similar to the red lines trend identified in Figure 6. Figure 10 was also replotted, and grouped by Screen Tech as another method to establish a different view from what the 3D plot showed.

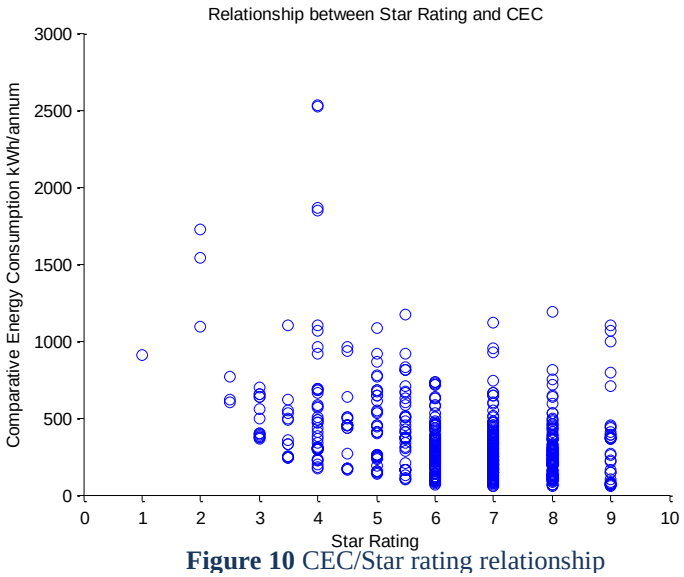

Figure 10 CEC/Star rating relationship

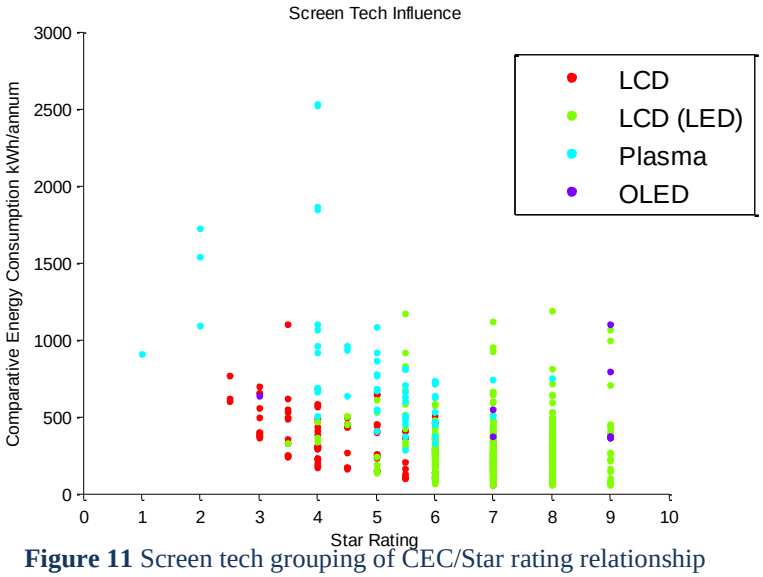

Figure 11 Screen tech grouping of CEC/Star rating relationship

Figure 11 supports what was shown in Figure 9 with clear clustering of each group. In addition, it can be seen that between star ratings 1 to 6 there is an apparent decline in the CEC values. This was an expected trend (lower energy efficiency means a higher CEC value). It should be noted though that similarly to Figure 7, a higher star rating does not mean a lower CEC value which can be seen with the vertically plotted points at each star rating point. *Appendix Figure A2 & A3* show Figure10 grouped by different fields (Country and Brand) both of which had no influence on energy efficiency, but were just for interest.

4 DICUSSION

4.1 CONCLUSION

While the dataset was classified as multi-dimensional at the beginning of this study, after the preparation and visualisation, conclusions were drawn that this dataset did not have substantial dimensions. A contributing factor may have been a lack of knowledge and time to visualise data more effectively. Another factor could have been the limited scope of the data which was narrowed down to two main groups (ERL and screen specifications). This choice was due to the target of this study being the general public and as a result more comprehensive visualisation methods were not considered. Another reason could be that the data provided from the government site was not meant for in depth analysis. From the visualisations that were conducted, the following points summarises the information gathered.

- Multiple visualisations of the same or similar data did not shed new information but confirmed original suppositions.
- The screen area and diagonal size of televisions are related (the bigger size the size, the bigger the area).
- Plasma TVs generally have larger CEC values with larger screen areas, while LED televisions have smaller CEC values with larger screen areas.
- Plasma TVs generally have a smaller spread across lower to medium star ratings; with LED TVs generally having a larger spread across medium to high star ratings.

In conclusion, an LED television with a screen area of 20000cm^2 can have a star rating of 9 and expend around1000kWh/annum, while a Plasma TV with a screen area of around 20000cm^2 can have a star rating of 4 and expend around 2000kWh/annum. If nothing else, this study has highlighted that certain screen techs have higher energy efficiency than others and that a higher star rating or smaller screen area does not necessarily mean a lower CEC level.

5 REFERENCES

Brown, J. (2013). *Home entertainment and office equipment*. Retrieved from Your Home: http://www.yourhome.gov.au/energy/home-entertainment-and-office-equipment

Energy Efficient Strategies. (2011, 06 01). *Tracking the Efficieny of Televisions.* Retrieved from Energy Rating Australian Government Web Site: http://www.energyrating.gov.au/wp-content/uploads/Energy_Rating_Documents/Library/Home_Entertainment/Televisions/Tracking-the-Efficiency-of-Televisions-final-v3.pdf

McGee, C. (2013). *Energy*. Retrieved from Your Home: http://www.yourhome.gov.au/energy

6 APPENDIX

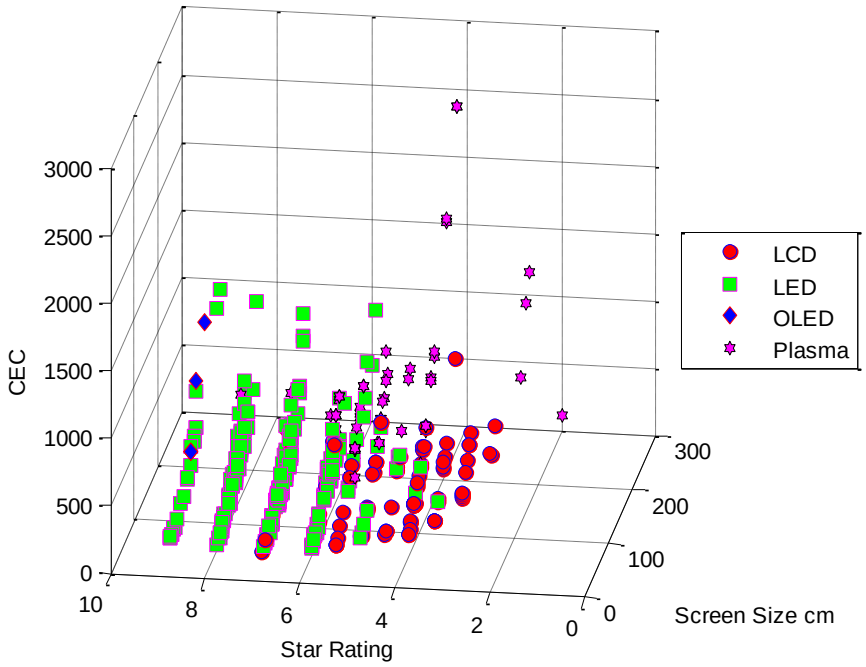

Figure A1 Shows in greater detail the combined subplots.

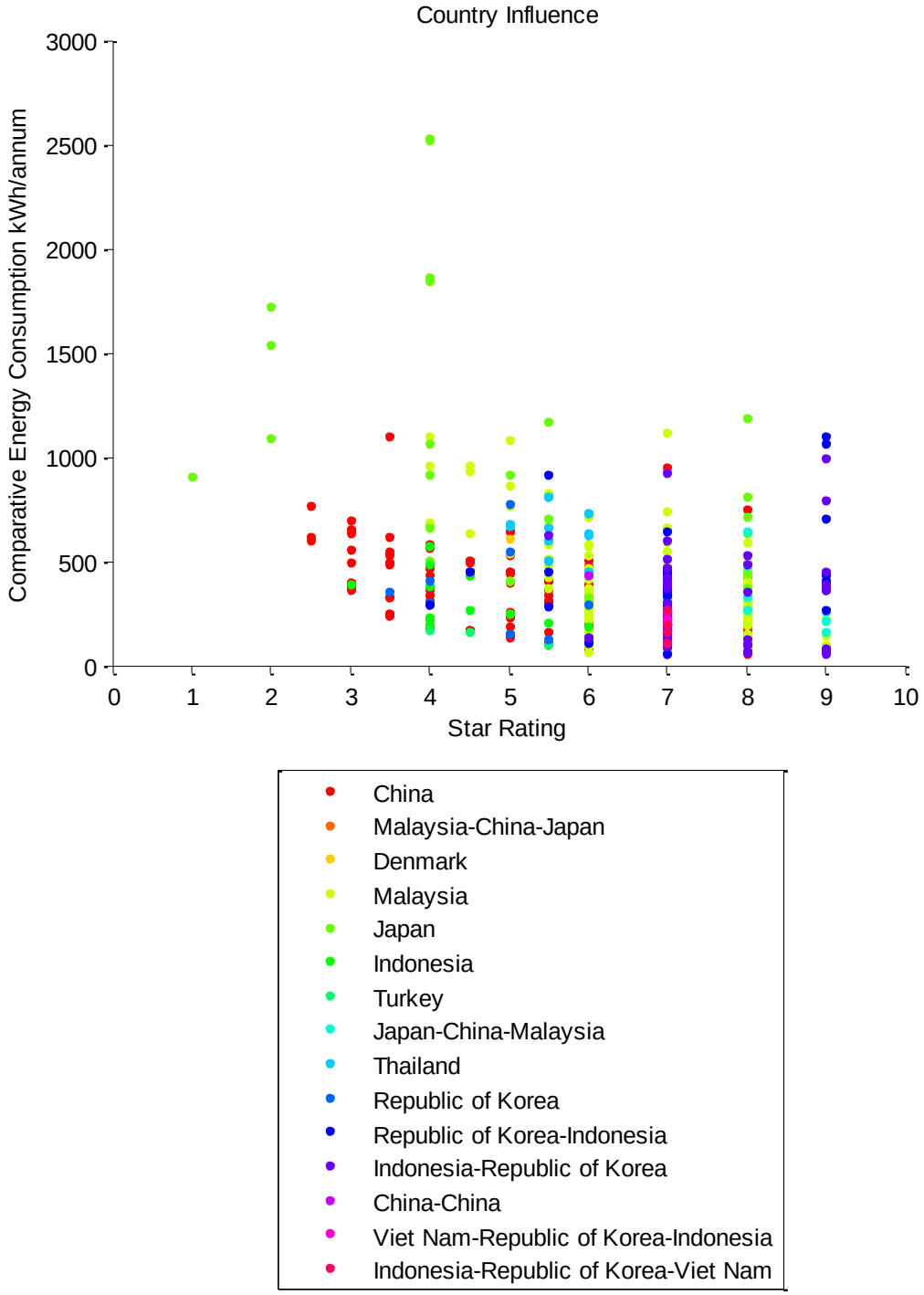

Figure A2 Country grouping of Star Rating, CEC relationship

By observation, China seems to export quite a few televisions with lower energy ratings; however this visualisation does not do a very good job of showing multiple plots on the same point.

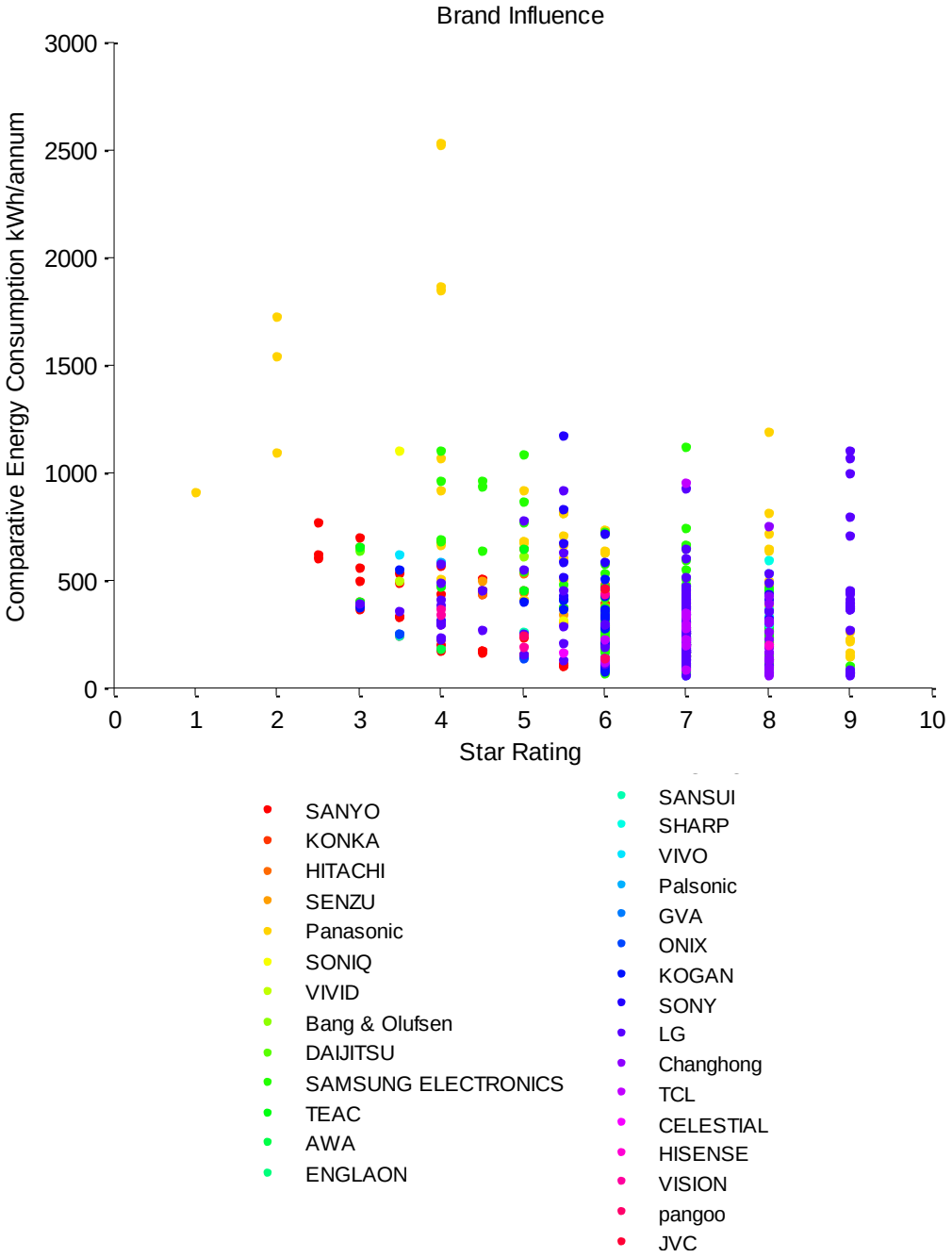

Figure A3 Brand grouping of Star Rating, CEC relationship

By observation, a lot of the purple, dark blue and some yellow coloured plots are at the higher end of the star rating spectrum (roughly SONY, LG and Panasonic). This clustering was interesting as both LG and Panasonic were identified in Figure 4 as highly exported brands. Similarly to Figure A2, this visualisation does not clearly show multiple plots on the same point.

6.1 PERSONAL CONCLUSION

I was extremely proud that I was able to use MATLAB in a meaningful way other than calculating irrelevant simple line graphs and was able to understand the visualisations (my goal was achieved!). Given the choice to do this assignment again, I would have loved to learn other ways to visualise more effectively, or have more time to practice my newly learnt skills. I felt that this time around I did not know enough to use a variety of different methods of visualisation.

If there was more time, the following points are where I would have liked to have taken my topic.

- Finding which televisions most people purchase
- Which state in Australia has the highest energy efficiency rate for television users
- Which country globally has the highest energy efficiency rate for television users
- Introduce a more user friendly colour-scheme (i.e. a colour-blind colour-scheme)