Visual Inference Test of the Hexagon Tile Map for Spatial Distributions

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Abstract—The abstract goes here. On multiple lines eventually.

Index Terms—statistics; visual inference; geospatial; population

Introduction

Geo-spatial statistics are often presented on the geographic map base. To present geo-spatial population statistics, information for individuals within each geographic region are often aggregated. A choropleth map is the common display to present aggreagated statistics for geographic units, and they are often used to present statistics regarding the population. This visualisation method involves drawing the administrative boundaries and filling them with colour to communicate the value of the statistic. In Australia, there are many sets of administrative boundaries that define subdivisions of the population at various granularities.

When presenting population statistics on a geographic map base, the size of the regions can allow errornous conclusions to be drawn about the state of the statistic over the entire population. This occurs as large regions filled with a consistent colour or pettern can draw the attention of map readers, and small regions are not paid equal attention.

Background and Motivation

Australian Cancer Atlas

- Communicating spatial distributions
- Trend over geographic space
- Trend over communities and populations

The Australian Cancer Atlas explores the burden of cancer on Australian communities. There are many cancer types presented, and they can be explored on an individual or aggregate level. The Australian communities examined are Statistical Areas at Level 2 (SA2)("Australian Statistical Geography Standard (ASGS)" 2018) used by the Australian Bureau of Statistics. Bayesian spatial smoothing has been applied to incorporate the statistics of neighbouring areas, for both privacy and stability of the estimates. The statistics that can be mapped are the diagnoses (Standardised Incidence Rates) and excess deaths for each SA2, communicated as the difference from the Australian average of the statistics. The values of the statistic for each are communicated using a diverging colour scheme. Dark blue represents areas with values much less than the Australian average, and represents areas much greater than the Australian average.

Visual Inference

- Communicating data through visualisations
- Effective displays for types of data
- Testing the effectiveness

Classical statistical inferences involves hypothesis testing, the process of rejecting a null hypothesis in favour of an alternative. This approach relies on data, the appropriate distributions and their assumptions.

Line up protocol

The lineup protocol presents a method for visual inference testing.

> "In this framework, plots take on the role of test statistics, and human cognition the role of statistical tests." Buja et al. (2009)

The line up protocol involves placing a "guilty" data visualisation in a lineup of "innocents". Where the guilty data set contains structure, and the innocents are equivalent to a null data set. In a grid of visualisations, an observer is asked to pick the display that is most different, if they select the data set containing structure, they have identified the guilty hidden within the group innocents. The guilty data is identified as different from the innocent data with probability $1/m$, where m is the number of null plots plus 1 to account account for the guilty data set. When the guilty data set is chosen, the null hypothesis that it was innocent is rejected with a $1/m$ chance or type I error of being wrong.

The lineup protocol can be used in a variety of tsting scenarios. The choropleth map is best used for testing spatial structure in a data set.

Population focussed displays

Map creators have the ability to present spatial statistics in alternative displays that can highlight the population.

This work aims to show that a hexagon tile map display is a viable alternative to the geographic map base for presenting population statistics. The same data will be shown on a choropleth map, and on a hexagon tile map. Comparing the results of participants who see the choropleth to those who see a hexagon tile map will show that population related distributions are spotted more frequently in a hexagon tile map display.

Methodology

Described the methods used to undertake the research including details of

This methodology section explains the various aspects of the research:

1. The overall structure of the research

A survey was created to test the effectiveness of the hexagon tile map display.

The online crowdsource platform Figure-Eight was used to recruit participants.
Each participant saw three test displays orienting them to the task. They then took an online survey evaluating 12 displays. A line up protocol was implemented to arrange 12 maps in each display. Individual displays were created by a combination of plot type, and spatial trend model. The researchers contrasted the different plot designs, as hexagon tilemap and geography in the lineups were created using the same data, and same null positions within the lineup.

The researchers compared the length of time taken, and the accuracy of the participants choices.

2. The subject populations

There were 97 participants in the study. Each participant was randomly allocated to either group A or group B when they begun the survey. This resulted in 42 participants allocated to group A, and 53 participants allocated to group B.

Demographics were collected regarding the study participants.

3. The variables being manipulated and measured? The variables that were changed between groups were the type of plot shown and the trend. The variables measured as a result of the changes were probability of detection and the time taken to submit responses.

The levels of the factors measured in the experiment were: • Plot type: Geography, Hexagons • Trend: Locations in two population centres, Locations in multiple population centres, South-East to North-West

Factor combinations to be examined by each participant amount to 6 (2x3) lineup displays. A participant cannot see the same data for both plot types. Four simulated sets of data will be generated for each treatment. This will generate 24 lineups (12 will be geographic maps, and 12 will be hexagon tile maps). Participants will evaluate 12 lineups, 6 of each plot type. Appendix A shows the experimental design visually.

4. The conditions under which the research was conducted? Each participant used the internet to access the survey. The participants determined the setting and time of day of the survey. There were many factors that could have determined the conditions under which the research was undertaken. Many factors or variations in conditions may have had an impact on the results.
5. The methods of data analysis used? The data analysis methods used in order to analyse and collate the results were ...
6. Limitations of the data collection? The data collection may have been influenced by several limitations.

Research Questions: 1. Are spatial disease trends, that impact highly populated small areas, detected with higher accuracy when viewed in a hexagon tile map display? 2. Are people faster in detecting spatial disease trends, that impact highly populated small areas, when using a hexagon tile map display? 3. Do people find hexagon tile maps more difficult to read than choropleth maps? 4. Are the reasons for choosing a plot different depending on the type of display? 5. Does an Australian resident find the choropleth map easier to read than the hexagon tile map?

For each plot evaluation the subject will provide these responses: - Their choice of plot from a lineup - Reason for choice of plot - Time taken to respond - Perceived difficulty in making a choice

Results

1. Type

2. Trend
3. Interaction of type and trend
4. Demographics of participants

The results section describes the findings of the research. When outlining these findings, it is best to give the most central findings first and then move on to the more peripheral results. For example, the overall measure of learning would be given first and then the measures of different types of learning.

Probability of detection:

Time taken

Modeling

Discussion

Conclusion

The conclusion goes here.

Acknowledgment

The authors would like to thank...

Bibliography styles

Here are two sample references: (???; ???).

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