

An Art-based Approach to Visual Analytics

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Abstract

In this paper, we propose an art-based approach to visual analytics. We argue that while artistic data visualizations have mainly been designed to communicate the artist's message, certain artistic styles can be very effective in exploratory data analysis as well and data visualizations can benefit from more than just the aesthetics inspired by art. We use the ancient Warli style of tribal paintings, found in western India to demonstrate the use of artistic styles for visual analytics over open data provided by the Indian government.

Categories and Subject Descriptors (according to ACM CCS): I.3.3 [Computer Graphics]: Picture/Image Generation—Line and curve generation

1. Introduction

Artistic data visualization as a means to communicate the artist's message has flourished in recent years [VW07] extending into physical representations, [ric08] as well. On the other hand, the established importance of aesthetics in information visualization [Lan09] has led researchers to incorporate artistic techniques to create engaging data visualisations [VPDH], [Hea01].

In this paper, we propose an art-based approach to visual analytics. We argue that while artistic data visualizations have mainly been designed to communicate the artist's message, certain artistic styles can be very effective in exploratory data analysis as well and data visualizations can benefit from more than just the aesthetics, [Lan09], inspired by art. An example is the Warli style of tribal paintings, found in western India and believed to date back to 2500 BC. Warli art has been practiced by tribes in Western India through wall paintings depicting complex scenes, involving festivals, rituals and dances, from the lives of the Warli people (the reader is encouraged to google 'Warli art' to see examples of traditional Warli paintings).

While a number of traditional folk art forms are prevalent in India such as Madhubani [Mad] and Aipan [Aip], Warli art lends itself as a strong medium for data visualization due to the following attributes of its inherent pictorial language. Firstly, the descriptive nature of Warli symbols can be leveraged to create semantically meaningful visual representations of data attributes. Secondly, 'wee things' [Gro14], small multiples [Tuf90] and repetitive symbols [Chr09], all

characteristics of Warli paintings, are known to be effective techniques for making visual comparisons of data. Thirdly, the graphical symbols used in Warli paintings are simple and can be easily created even with little artistic ability or training. Further, while we are advocating the use of Warli style for objective visual analysis of data, it may be used to convey a subjective message by choosing appropriately designed symbols.

We have built a tool to visually analyse open data provided by the government of India in various categories such as health, labour and education. The contributions of our work are (a) a novel Warli art based approach to visual analytics and (b) the design of multiple Warli data visualizations for comparison of data and we show examples of these in the paper.

The rest of the paper is organised as follows. We describe Warli visual analytics approach in section 2 and present results in section 3. Related work is presented in section 4 and future work in section 5.

2. Warli Visual Analytics

In order to create effective visualizations based on Warli art, we first identified the elements of Warli paintings that could aid in visualization of data. We list them below.

- Descriptive glyphs: Warli paintings use simple glyphs composed using primitive shapes such as triangles and lines yet are extremely illustrative. Also, as reported in [BRG*12], while visual metaphors are known to aid

memorization of information, very detailed metaphors may negatively impact visual search apart from requiring high pixel resolution in order to be discriminable.

- Repetition of glyphs: The same glyph is often repeated in circular or spiral patterns. This can be useful in representation and comparison of quantities.
- Colour scheme: Warli paintings are traditionally drawn in a dark maroon background with glyphs and other embellishments in white. This colour scheme (a) creates a good contrast aiding easy cognition of glyph shapes and (b) equalises attention on all glyphs. Further, it has a strong aesthetic value.

Next we describe the process of creating a Warli art based visualization.

Glyph Selection We use Warli style glyphs at two levels. Firstly, government data is organised under different sectors such as labour, power and health. We use a glyph to represent a sector. Sector glyphs are then included in the menu to select them for visualization. They are also used in the visualization to create groups of data attributes from the sector they represent.

Secondly, we represent data attributes with appropriate Warli style glyphs. For example as shown in figure 1, data on the number of villages electrified in the given year is represented using a hut glyph with a glowing bulb. Each glyph has been created in an SVG editor, in the Warli style and added to a repository for reuse.

Geometric Mapping As most of our data attributes are quantitative, we map data values to repetitions of glyphs in different patterns such as circular, spiral and rectangular. The choice of pattern is based on the dimensions of the glyphs. For example, glyphs with almost square bounding boxes are better fitted in rectangular patterns, whereas those with height is greater than width may be placed in circular or spiral patterns also. This is a trend observed in traditional Warli paintings as well.

While we do not map data attributes to dimensions (height and width) of glyphs as a specific design decision, we permit modification of compositional elements of the glyph based on data values. For example, to visualize the fulfilment of electricity requirement, our main glyph is an electricity tower with incoming connections representing demand of electricity and outgoing proportional to the percentage of electricity supplied.

Layout and Interaction Our Warli visualizations are primarily of two types. The first, named State Warli, is a view of a single state for a given year visualizing data from multiple categories. The layout we use for such visualizations is similar to that of most traditional Warli paintings which have a large central motif and pan out radially. We display one sector in a circular central division and the rest in the four quadrants around it.

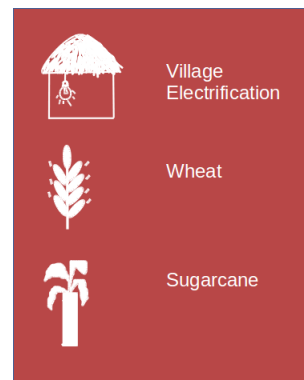


Figure 1: Warli Style Glyphs

The second type, named Comparison Warli, is designed to facilitate comparison of data. We provide a visual menu for selecting data for comparison. We show a political map of India with state boundaries using which users may select a maximum of four states to visualize data for. Next, the user selects data categories such as power and health, each of which has a number of attributes. Each category has a representative glyph which acts as a toggle button for it in the menu. Finally, the user selects one or more years for which data should be drawn.

Based on the state, year and category combination chosen by the user, the canvas is partitioned into a maximum of four divisions. Attributes from the same category are arranged with spatial proximity to each other and separated from those in other categories using a border of glyphs representing the category. The borders are drawn in a clockwise order starting from the top and centre of the visualization.

Depending on the options chosen by a user, the visualization is drawn with reflective symmetry along the horizontal or vertical central line. The same data attributes thus get aligned on either side of the line of reflection, aiding comparison as well as adding aesthetic symmetry to the visualization.

3. Warli visualizations for Indian Government Data

State Warli We now describe the State Warli visualization for the western state of Gujarat, figure 2. At the centre we display data from agriculture industry, one of the largest contributors to the GDP of India. We use a coxcomb plot to visualize production data for the top five crops grown in a state in the three agricultural seasons in India. Label L in the figure shows crops grown in the Kharif (monsoon) season, from July to October, label M shows Rabi (winter) season, from October to March and N shows summer season from April to June. A sector represents the area under cultivation for a crop. Each crop is represented by a glyph and the repetitions of crop glyphs are proportional to its production. Colour in-

tensity variation on the background hue is linearly mapped to areas under cultivation. We allow this deviation from the colour scheme in order to make the sectors easily distinguishable.

The top left quadrant in the visualization shows Labour and Employment data. The three circles A, B and C depict employment counts for the trade, manufacturing and services industries respectively. The glyphs at the centres of the circles represent the industry type and the density of person glyphs are proportional to the employment counts. The spirals below represent the total male and female working population for the state.

The top right quadrant in figure 2 depicts data from the Power sector. The top row shows the amount of energy generated from different sources such as biomass (F), windmills (G) and hydro-electric (H). Each energy source is represented by a glyph and the repetitions of the glyph type are proportional to the amount of energy from the source. As is clear the state of Gujarat generates maximum energy from wind mills. The electricity tower (I) in the figure represents the percentage of requirement of electricity met by the state with incoming connections representing demand and outgoing representing supply. Finally, the huts (K) depict the number of villages that have the supply of electricity in the state.

The bottom left quadrant depicts health data for the state. The top row shows the number of doctors (O) and hospitals (P) while the crude death rate is represented in the second row (Q). The bottom row (R) shows vaccination data for Polio, Measles and BCG with assessed need for these proportional to the number of children waiting to get in to the hospital and number coming out proportional to percentage of children vaccinated. We draw a guide line at the bottom to help perceive the difference in two numbers.

Finally the bottom right quadrant visualizes data from the Education sector. The top row shows the number of schools (S) and colleges (T) while the number of literate males (U) and females (V) are shown in the bottom row. We also include a map of India (W) with the selected state filled in to highlight which state the Warli visualization has been drawn for.

Comparison Warli Next we describe the Warli visualization for comparison of data from multiple states and/or sectors. Figure 3 shows Power sector data for four states. The right hand panel displays the menu for data selection. Four states have been selected by clicking on the map of India (A), power sector by clicking the power icon (B) and year 2010 (C). The corresponding Warli visualization is drawn on the left. A tooltip (D) is displayed on clicking on a glyph. It can be observed that the state of Rajasthan (top left) produces the least energy and has the lowest number of villages with electric supply out of the four. Further, the state of Maharashtra (bottom left) has the largest shortfall in meeting the demand of electricity.

Figure 4 shows a comparison Warli with data from two sectors Health and Education for the two states West Bengal, lower half, and Jharkhand, top half, which was formed in the year 2000. It can be easily observed that Jharkhand has a larger number of hospitals than West Bengal but few doctors and a higher crude death rate. Further, while there is not much difference in the number of schools and colleges in the two states, the number of literate males and females is much less in Jharkhand.

4. Related Work

The Isotype [Chr09] was a method to display social statistics pictorially in order to communicate them to less educated groups. It was based on analytical principles such as mapping quantities to repetitions of symbols but never to their size. Our Warli visualizations are similar to Isotype in both these respects, however, they differ in style and arrangement of the glyphs, colour scheme and layout.

Glyph-based visualizations have been extensively studied in literature [BKC*13]. While a large body of work has focussed on data-driven glyphs, we use glyphs primarily as a semantic channel [CF12] to depict the semantics of the data attribute it represents.

5. Conclusions and Future Work

The use of culture specific visualization makes data engaging and accessible to the local population and allows for a traditional art form to serve a useful function in addition to aesthetics. We have presented a novel Warli art based approach to visual analytics and demonstrated it on public data. To the best of our knowledge this is the first attempt at using Warli art for visual analytics and a number of questions are yet to be answered. We list a few below.

Effectiveness of the Visual Encoding We plan to conduct a user study, in future, to analyse the effectiveness and limitations of the proposed Warli art based approach. Further, the effectiveness of different layouts and arrangements of glyphs needs to be studied.

Authoring Warli Data Visualizations Based on the results of the user study, we would like to create a tool easy authoring of Warli data visualizations with a reusable repository of Warli style icons and guidelines for selecting appropriate Warli style arrangements.

Interactivity and support for visual analytics tasks There is a lot of scope for adding interactivity to Warli data visualizations. For example, it is possible to add a temporal dimension and show changes in attributes over time as animated transitions of glyphs. Further, the visual analytics tasks of brushing, filtering and linked views may be supported.

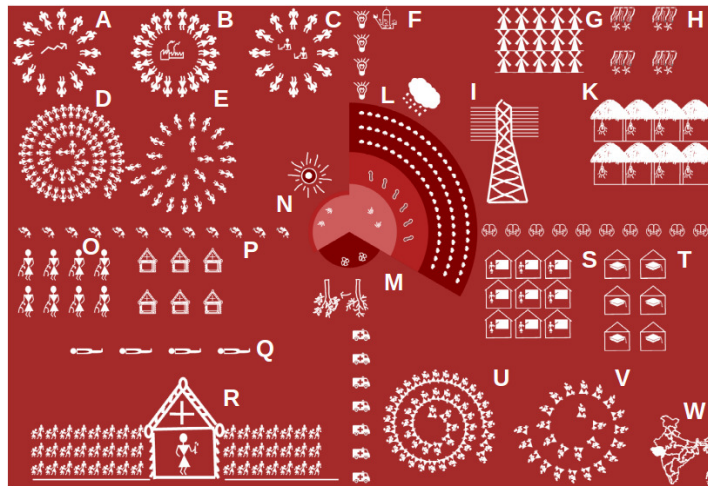


Figure 2: State Warli for Gujarat (W)

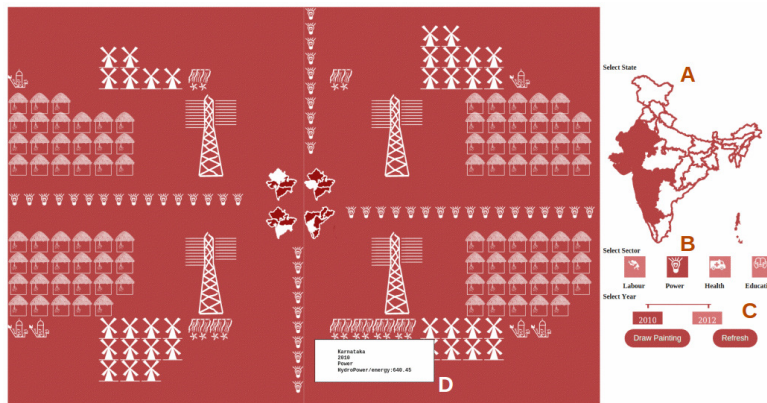


Figure 3: Comparison Warli for Power Sector for four states

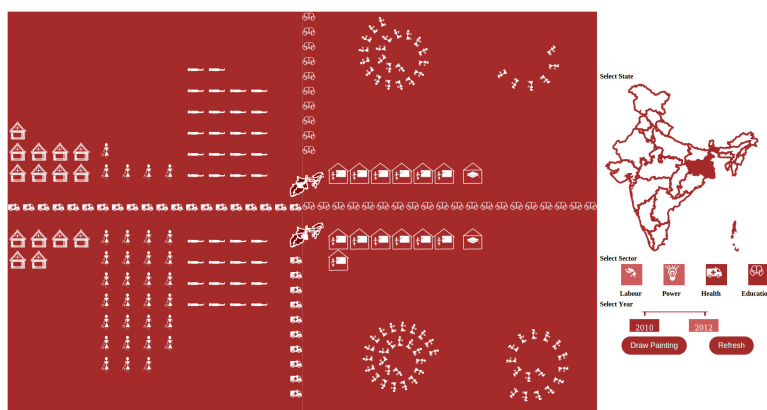


Figure 4: Comparison Warli for Health and Education for two states, Jharkhand, top half and West Bengal, lower half.

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