PreserVis, a Visual Analytic System for Traffic and Pollution Patterns - Multi-Challenge Award for Compelling Synthesis of Information

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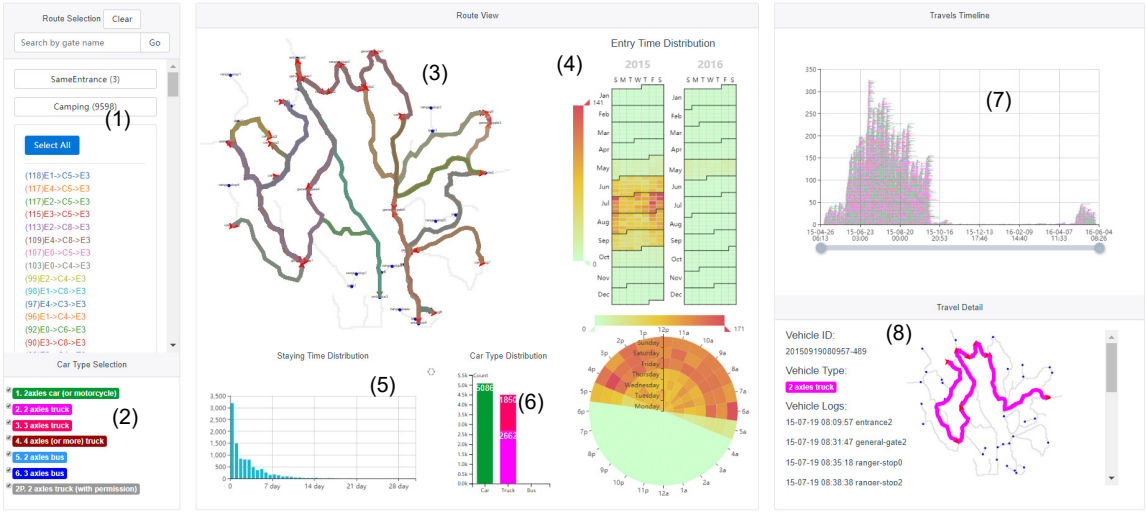

Figure 1: PreserVis view for Mini Challenge 1 (Selecting routes in (1) (route selection) and car types in (2) (car type selection) provides the dataset for the rest charts. Hovering the mouse pointer over a certain route in (3) (map view) lets (4) (entry time heatmap) (5) (staying time histogram) (6) (car type distribution) and (7) (stacked entries timeline) show its detailed information. Time intervals in (5) can be selected so that the dataset in (4) (6) (7) and (8) can be filtered. Selecting one specific entry in (7) will display its car id and records in (8) (entry details).)

Abstract

In this report, we propose PreserVis, a data visualization system for inspecting the pattern of the transportation and pollutant release in Boonsong Lekagul Nature Preserve in VAST Challenge 2017. Intuitive clustering and novel visualization methods are used to discover the patterns hidden in the datasets.

Keywords: PreserVis, VAST Challenge, data visualization.

1 Introduction

The theme of VAST Challenge 2017 is to explore the reasons why the number of a kind of bird, Rose-Crested Blue Pipit is decreasing in Boonsong Lekagul Nature Preserve. It is divided into three Mini Challenges and a Grand Challenge.

Mini Challenge 1 (MC1) is related to the transportation in the preserve. With the records of the vehicles passing through the preserve in a 13-month period, we discovered 9 traffic patterns and some other outliers. Mini Challenge 2 (MC2) requires the discovery of the unexpected patterns in the data of the monitors' readings of different chemical pollutants and further the localization of the source of each pollutant. In Mini Challenge 3 (MC3), 12 remote sensing images with 6 spectra were provided, based on which we developed the patterns of different areas and analyzed the changes along the timeline. This system shows the result of our work and provides an interactive method to inspect the findings in MC1 and MC2.

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2 Analysis And System

The datasets have been pre-analyzed and cleaned using Python, and serve as the input for PreserVis, a system based on HTML, CSS, JavaScript, d3.js and ECharts which displays the various properties of traffic patterns in MC1 and the release patterns of chemical pollutants in MC2, thus providing a systematic and interactive interface to explore the datasets.

2.1 Mini Challenge 1

Firstly, all the records are sorted into entries by their car ids as suggested in the given data description. Then the entries having the same paths in the preserve are clustered into one route. By investigating the crucial records of each route, obvious patterns can be discovered whose purposes can be determined intuitively by their paths in the preserve.

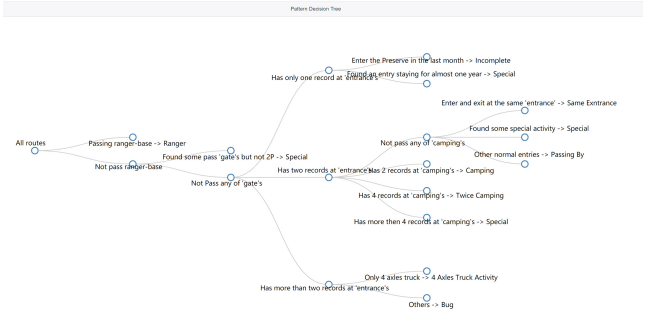

Figure 2: Pattern decision tree according to records

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As shown in Figure 2, patterns of transportation are discovered by checking the occurrence of passing certain set of positions. For example, if a vehicle enters the preserve, heads directly to the camping area, stays for several hours and finally leaves the preserve, then it is obvious that this vehicle enters the preserve for short-time camping, and thus its pattern can be determined as "Camping".

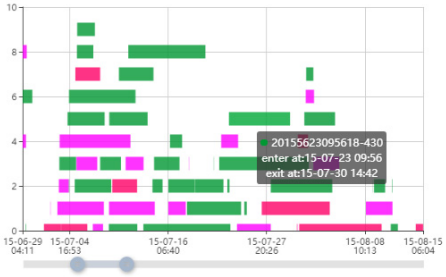

Figure 3: Stacked timeline

As shown in Figure 1, via PreserVis, the user can get an overview on the routes or the patterns by viewing their paths on the map, and the distribution of entry time, staying time as well as car types. To provide a convenient way to view individual entries, a stacked timeline chart is developed ((7) in Figure 1). As shown in Figure 3, each bar represents a single entry which uses colors to represent the car type and endpoints to indicate its entry and exit time. Not only can users click on the bar to view its detailed information, but this chart also reflects the overall heat of traffic in the preserve with the height representing the total number of vehicles in the preserve at a certain time.

Besides the various charts shown in figure 1, the speed distribution of vehicles is also analyzed. To get the distance information in the preserve, the provided map image is processed in pixels to extract coordinates of route points and gate points. Then, Depth First Search (DFS) recursion is adopted to find the route points between any two gates. Instead of simply counting the number of route points to measure the distance, which will probably enlarge the length of curve path, broken lines are used to fit the original route by taking one points from every five ones. Combining the distance gotten from this method with the timestamps in the records, we find that almost all the vehicles are running over the speed limit in the preserve (25 mph). According to the researches respectively by Mitchell and Reijnen, the noise level will rise as the speed of cars get higher [1] and high level of noise will reduce birds' density [2].

2.2 Mini Challenge 2

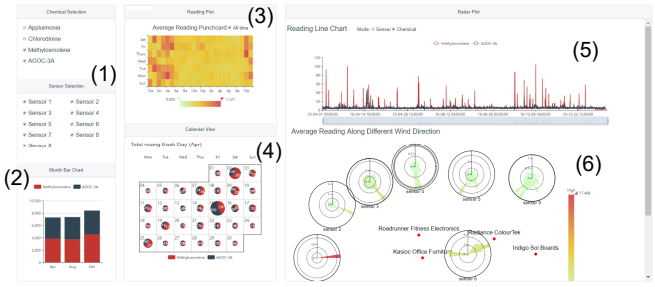

Figure 4: PreserVis view for Mini Challenge 2 (Selection in (1) (pollutants and sensors selection panel) filters the data for the rest charts. Clicking on the month/day in (2) (monthly total reading chart) and (4) (daily average reading chart) sets the corresponding time interval for (5) (reading-time line charts) and (6) (Polar bar chart). (3) is a day-time average reading punch-card to view the timely pattern of pollutants release.)

This challenge requires the discovery of unexpected behaviors of sensors in the original dataset. Through the multiple manipulation of the dataset using Python, we discovered 6 patterns of abnormal behavior. After these data were cleaned, the focus was on how to match the pollutant sources to the companies.

After this, another part of PreserVis was built to inspect the various properties of the pollutant release pattern. As shown in Figure 4, the user can select the pollutants and sensors to be inspected in the left panel, and view their timely distribution in the middle panel. The detailed records can be checked in the right panel together with a polar bar chart to determine the sources of pollutants.

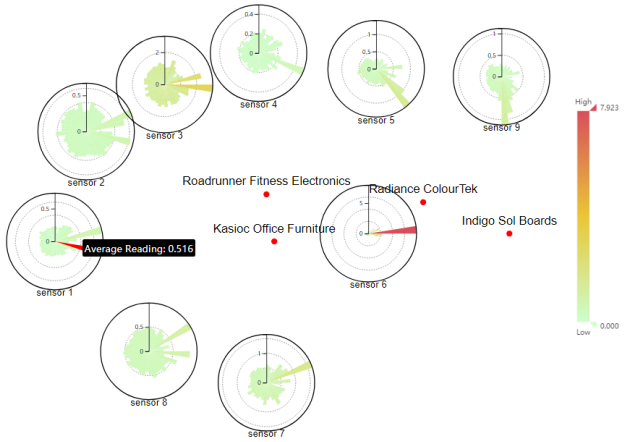

Figure 5: Polar bar chart in PreserVis for MC2

As a visual combination of the sensor reading data and wind data (after linear interpolation), polar bar plots, with each bar representing the average reading of the times when the wind comes from the corresponding direction, can easily reflect the source of pollutants for each sensor. Then, we place such charts of sensors and companies on their corresponding positions on the map. For example, as shown in Figure 4, the pollutant involved in the figure can be determined as coming from "Indigo Sol Board" with great certainty as all of sensors 4-9 have large bars pointing to it. This novel visualization method provides an visual way to locate the pollutant source to a specific company.

3 Conclusion

With the above two views of PreserVis, the user can get information about the traffic and pollution patterns from macroscope to microscope by filtering the portion and inspecting their properties. Applying this system to the VAST Challenge 2017, Mini Challenge 1 and 2 can be solved easily. We hope that the novel charts developed in this system can bring inspiration to the related fields of research.

References

[1] P. Mitchell. "Speed and Road Traffic Noise," *The UK Noise Association,* Dec. 2009. [Online]. Available: http://www.ukna.org.uk/uploads/4/1/4/5/41458009/speed_and_road_traffic_noise.pdf

[2] R. Reijnen, R. Foppen, C. Ter Braak and J. Thissen. The Effects of Car Traffic on Breeding Bird Populations in Woodland. III. Reduction of Density in Relation to the Proximity of Main Roads. *Journal of Applied Ecology*, Vol. 32, No. 1, pp. 187-202, Feb. 1995.