Visual Analytic Design for Characterizing Air-Sampling Sensor Performance and Operation

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ABSTRACT

Analysis and exploration of similar continuous data for various air-sampler sensor have been performed by developing a processing tool. The analysis and design for characterizing sensor data have been stated and described. Continuous 24X7 sensor data and metrological data leads the layout choices for the analytical design. Such design choices are helpful to understand the pattern of similar reading for various devices at a time. In this paper, we describe the use of the mentioned design choices for to identify pattern, unusual behavior. We used this tool and design choice to solve VAST 2017 mini challenge 2.

KEYWORDS: Air-sampler, vector dot-product, multi-label data, multi-variate data.

1 INTRODUCTION AND PROBLEM STATEMENT

This paper explores process for the visual analysis to characterize continuous multi-dimensional sensor reading and metrological data over 3 months and can be referred with Jo Wood's design [3]. The Overview and data illustration is described in the VAST Challenge 2017 Mini Challenge 2 and can be referred in detail at (http://vacommunity.org/VAST+Challenge+2017). Mini challenge 2 involves understanding and characterize the routine behaviour of air-sampler sensors for four chemicals being released by four factories to investigate the downfall of the poor Rose-crested blue pipit birds in Boonsong Lake Nature Preserve. Reading of chemical release of four factories detected by nine air-sampling sensors and metrological data each for 3 months are to explore the analysis. Sensors also referred as Monitors are installed at various location around 4 factories; chemicals being release are Appluimonia, Chlorodinine, Methylosmolene and AGOC-3A and their impact on birds are in order as mentioned. Sensor datafile includes chemical release reading at a given time by a specifies Monitor and Metrological datafile have wind-direction and wind-speed for a given time. Figure 1 shows an example of behaviour of 9 sensor for 3 months.

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2 CHARACTERIZING OPERATION

Analysis of continuous-multivariate and multi-labeled patterns of chemical release can be understood as type of problem being solved by multiway-dependencies exploration or by visual analysis by untangle-Map [1]. Three month-multilabel data helped in analyzing the various pattern of chemical release. Since the air-sampler sensors are in various ways (figure 4 right); sensor 6 lies at center while sensors 7,9,3,4 located at farthest location. Sensor data file provides hourly reading value for each over 3 months and hence analyzing this 24X30X3 (Hourly X Days X Month) continuous data for nine air samplers gives less patterns to explore. Plot of daily continuous-temporal data provides a better solution. This encompasses all 9-sensor's pattern comparison but also to investigate but requires an additional data processing stage. figure 1 shows characterizing the reading as low-level (sensors 1,2,9), mid-level (sensor 3,4,5,7,9) and high-level (sensor 6).

In the coming subsection, we will elaborate the method and technique applied in solving three mini-challenge 2 questions.

2.1 Mapping: Vector Dot-Product

Further exploring of spikes or any unusual behaviour in chemical reading pattern requires exploration of geolocation and mapping and mapping with meteorological data: wind-direction. Distance vector calculation of factor-sensor and win-direction combination proved to be efficient way of analysing routine and anomalous pattern in chemical release. This is a three-step strategy; calculate distance vector between factory and sensor (A); convert wind-direction to vector value (B); calculate their dot product (A. B) (figure 3). Similar steps are performed for all 9 air-samplers and four factories.

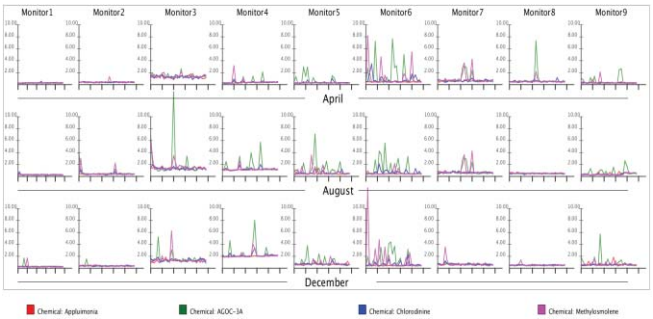

Figure 1: Behavior of nine air-sampler.

2.2 Anomalous Behavior

To analyse routine pattern and spike to find their abnormal behaviour each chemical release reading plotted along with vector

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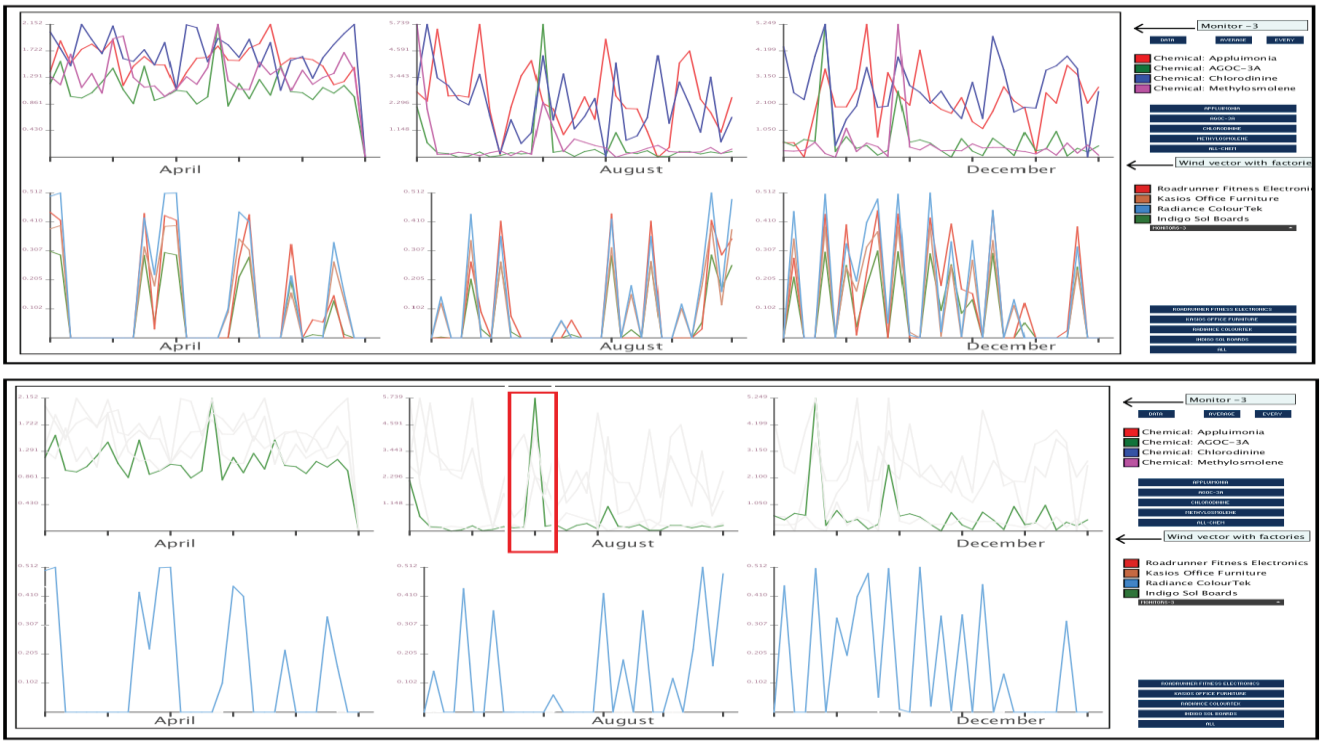

Figure 2: Mapping of Chemical reading with vector dot-product of factories-sensor with wind-direction. (bottom) highlighted.

dot-product plot. Application in figure 3 provides interaction to explore the three-month reading of chemicals for all nine air-sampling sensors (figure 2-top); plot of vector dot-product for 9X4 (sensor X factories) combination (figure 2 below). Some of the spikes in figure 1 are observed as anomalous and hence they are matched and compared with vector dot-product plot to verify that a temporal chemical release steep rise is because of actual release or problem with air-samplers. For example: sensor 3 August's spiked for chemical AGOC-3A is an abnormal behaviour as all dot-product are zero. From figure 2(top) for the sensor 3 and for August month reading we can see that there is spike for chemical AGOC-3A and it is an abnormal behaviour proved in figure 2(bottom).

2.3 Sensor-Chemical Analysis

Chemical reading plot of air-sampler varies; to identify which chemical being detected by which sensor similar technique is applied as in 2.2. Each chemical plot is mapped manually with vector dot-product. Based upon the reading we analysed that sensors detects one or more chemical in different range.

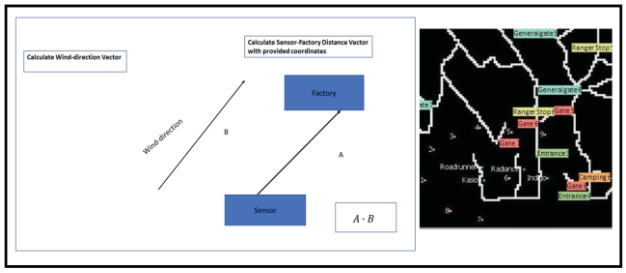

Figure 3: Vector dot-product and Map snapshot.

2.4 Factory-Chemical Analysis

Four factories may or may not release all 4 chemicals and hence with mapping of air-sampler reading (figure 2) with vector dot-product (figure 2). For example, factory named – kaisos office furniture is responsible for release of chemical Methylosomolene. The similar but continuous real-time monitoring is used at a critical patient department [2]

3 Conclusion

Analysis and exploration of air-sampler data and identification of anomalous behaviour along with investigation i) which sensor detect which chemical ii) which factory responsible for which chemical release performed with a straightforward design choice and distance-vector dot-product. an interactive visual analytics system built on above-mentioned task aiding ornithologist to find that unusual heavy emission of chemical in some days of month by three factories caused the downfall of poor Rose-Crested Blue Pipit birds.

References

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