Addressing VAST 2016 Mini Challenge 2 with POLAR Kermode, Classifier, Excel on a Power Wall and Data Timelines.

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ABSTRACT

We describe our approach to addressing Mini Challenge 2 of the 2016 IEEE VAST Challenge. We describe four tools: POLAR Kermode, Classifier, Excel with conditional formatting on a power wall and Data Timelines.

Keywords: Visual Analytics, Information visualisation, spatiotemporal analysis, HVAC data.

Index Terms: H.5.1 [User Interfaces]: Information Visualisation.

1 INTRODUCTION

The IEEE VAST 2016 Mini-Challenge 2 (MC2) [1] presents a set of analysis questions given two weeks of sensor data gathered from a fictitious three story building housing the company GASTech. The data are drawn from proximity (prox) card readers which track employee locations and movements through the building and around 400 Heating Ventilation and Air Conditioning (HVAC) sensors which monitor various things such as thermostat setting and CO2 levels. The challenge involves identifying typical daily movements of employees, interesting HVAC patterns, anomalies in either, and relationships between prox card and HVAC data.

We describe the software and some hardware we used to address this challenge. These included two in-house software tools used for analyzing proximity card data: Polar Kermode and Classifier; and an Excel spreadsheet with conditional formatting viewed on a power wall and another in-house tool called Data Timelines for viewing the HVAC data.

2 POLAR KERMODE

Polar Kermode is a development of Patterns of Life Atlas [2]. Figure 1 shows the Polar Kermode interface in geospatial mode displaying most of the prox data for the two week period. On the left is a Watch List which lists prox card ID's organised by department. The user can select all or none of the data for display, data by department or data by individual ID. Next to the Watch List is a map of the building showing its three floors. Small coloured data points on the map show card locations at a given point in time. The timeline on the right shows how card locations distribute over a selected time period. Data point colour is mapped between views. In geospatial mode data point colour is determined by a colour map superimposed over the building map.

The map and the timeline can be zoomed and panned and are linked by cross-filtering. The colour map is static relative to the frame of the map view. This has the effect that when the map is zoomed or panned, data point colours are updated dynamically as they change position in the map view frame. This allows the map to use a full colour palette at all zoom levels and means that the spatial resolution of data points increases with map zooming in both views.

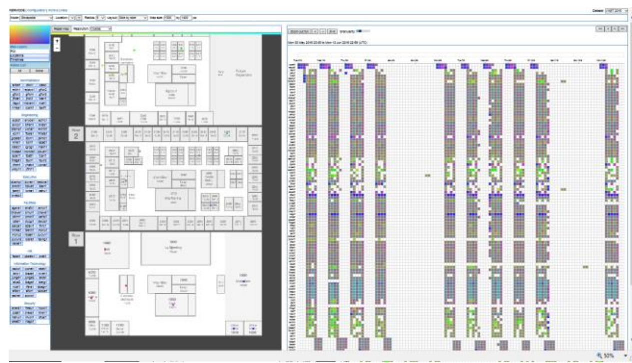

Figure 1: POLAR Kermode in geospatial mode. The colour map is static relative to the frame of the map view to provide greater spatial resolution on both views as the map is zoomed.

With Polar Kermode the user can also define one or more locations (areas) of interest (proximity to location mode). When they do this colour coding on the timeline indicates when particular prox cards are at these locations.

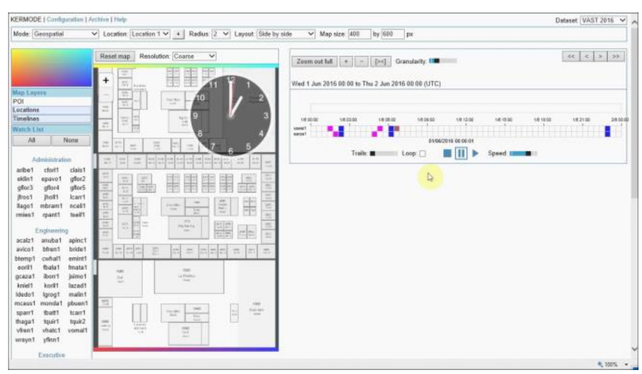

Figure 2: POLAR with animation. The analogue clock shows current time. A black clock face indicates night - a white clock face indicates day.

The system also an animation feature (figure 2) allowing the user to animate data over time. Keyboard shortcuts support play, fast forward, and jumping back repeat interesting periods. An analogue clock shows current time with a black clock face indicating night time - a white clock face indicating day time.

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3 Classifier

Classifier (figure 3) aggregates proximity card data and shows the estimated location of employees over a selected time period. Time is on the horizontal axis, employee ID on the vertical access and locations and aggregated location types are encoded by colour. Black indicates a card has not yet been seen, grey indicates that it has been seen for the last time and bright green shows that the card has left the building. This tool also helps in visualising work patterns. One interesting trend made obvious by this perspective is the horizontal streaks of single colour. These may represent cards that are left in the building outside of business hours

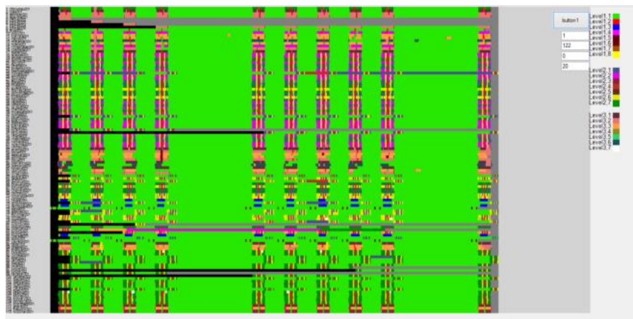

Figure 3: Classifier - One interesting trend made obvious by this view is the horizontal streaks of a single colour which may represent cards left in the building outside of business hours.

4 Excel on a Power Wall

We loaded the HVAC sensor data into an Excel spreadsheet and used conditional formatting to show variations in data values. We used colour coding schemes reflected sensor type. Anything to do with temperature was coded yellow (low) to red (high), hazium sensor data were coded white (low) through to blue (high), and data from all other sensors (such as power in various parts of the system) were coded white (low) through to black (high).

We ran the spreadsheet on a 3.7m x 1.5m powerwall (figure 4). This was a 50 mega-pixel tiled display constructed from six 4k monitors in a 3x2 arrangement. It provided a helpful tool for identifying patterns and anomalies which could be further explored by checking values and plotting line graphs of selected sensors using Data Timelines.

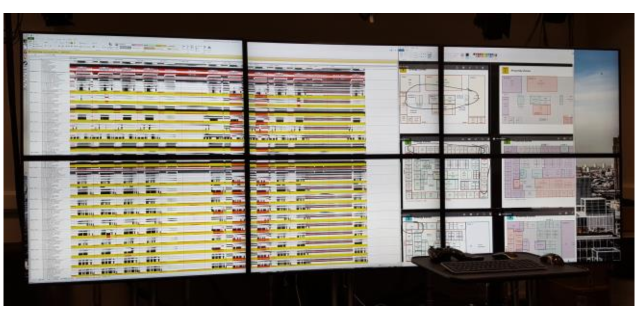

Figure 4: The spreadsheet viewed on a 50 mega-pixel power wall. This provided a tool for identifying patterns and anomalies in the HVAC data. Building maps to the right to provided context.

For example, figure 5 shows an extract for floor 2 zone 6 during the first two days. The patterns for both zones are very similar on each day, except for a clear anomaly (red) in the second half of the second day. Around 1pm air inlet temperature increases suddenly from 12 degrees to 40 degrees and then drops again. This coincides with the start of a three-hour high in thermostat cooling set points and an increase in temperature, followed by an unusual pattern of activity in Inlet Mass Flow Rate and Reheat Damper position.

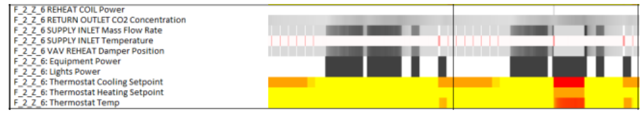

Figure 5: Shows HVAC patterns over two days with a sudden increase in air inlet temperature followed by a three-hour high in thermostat cooling set points and an increase in temperature

Data Timelines

Finally, using Data Timelines we selected specific sensors and aligned them to compare levels over time with more visual accuracy. In figure 6 we show thermostat heating and cooling set points from a number of zones aligned. The graphs clearly show that set points co-vary across these zones, and significantly that the heating and cooling set points align for a period towards the end of the two weeks.

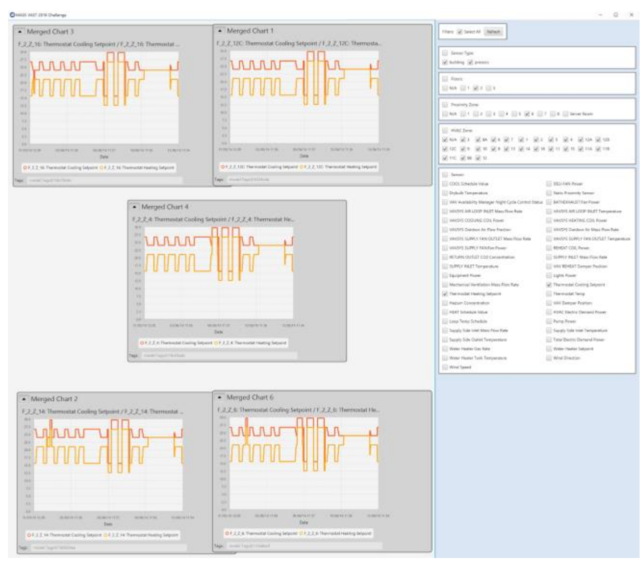

Figure 6: Data Timelines – Aligning thermostat heating and cooling set points from multiple zones shows that these co-vary and that heating and cooling set points align towards the end of the two weeks.

References

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