Zone Heatmap

This visualization provides options to control a heatmap of the 307 area displayed over time to answer questions regarding dwell time and object traffic. The heatmap is a 24 by 32 grid of rectangles consisting of square zones with a side length of 20 pixels. The zones are coloured blue with transparency determined by the value of the selected metric in that zone. The function of each option is explained below.

Area: One of the three areas tracked by Numina sensors at 307. The background image will show the chosen area and the heatmap values are displayed for this area.

Object Type: The type of object to be tracked in the heatmaps. This option is useful for seeing how trends vary between the object types.

Metric: The interpretation of the heatmap opacities. Each metric is calculated for each of the rectangular zones for the day displayed at the top of the heatmap. Each zone is coloured blue and a less transparent zone indicates the value of the metric in that zone is greater. The metrics are

- **Object Count**: The number of objects of the type selected by Object Type passing through the zone.
- **Mean Dwell Time**: The mean dwell time of all objects of the type selected by Object Type passing through the zone.
- **Cumulative Count**: The total number of objects of the type selected by Object Type passing through the zone from the day the sensors start tracking to the day displayed at the top of the heatmap.
- **Absorption Index**: This metric is explained in the next section.

Weekday: If a weekday is selected, then the heatmap will only show data for that weekday. Selecting "All" will display data for all days. This option is useful for seeing how the trend for a specific weekday compares with the general trend.

Show Events Only: If this box is checked, then the heatmap will only cycle through days that are events. If this box is unchecked, then the heatmap will cycle through all days the area was tracked by sensors. This option is useful for comparing trends in non-event days with trends in event days.

Use Date Slider: If this box is checked, then the date input is through the date slider controls. If this box is not checked, then the date is inputted in the Date textbox. This slider enables the viewer to see how object counts and dwell time changes over time.

Date: This option is enabled only if Use Date Slider is unchecked. The user can enter a date containing a month, day, and year. The heatmap will then display data for that day. If the day lies outside the tracked date range, no data is shown. This option is useful for quickly viewing and comparing data for days of interest.

Date Slider Controls: The date slider can be moved left or right to determine the date whose data will be shown in the heatmap. The slider can also be controlled using the buttons. The first button will resume playing the visualization if it was paused. The second button with pause the visualization if it was playing. The third button will reset the slider to the start and pause the visualization. The fourth button will automatically restart the slider when the end date is reached and continue playing the visualization.

Show Advanced Options: If this box is checked, then additional filtering options will be shown.

Minimum Zone Objects: The minimum number of objects that must pass through a zone for a colour to be displayed on the zone. The type of object used is the one set by the Object Type selector. This option is useful for filtering out outliers with few people passing through in the heatmap when mean dwell time is the metric. Such zones do not have sufficient samples passing through to get an accurate measure of mean dwell time.

Zones Shown: The number of zones to be shown. The zones selected to be shown are determined based on Zone Quality. This option is useful to highlight the top zones and to see if they tend to be clustered.

Zone Quality: The selection method to determine the zones that are displayed when Zones Shown is set. This option is useful for highlighting the extremes of the data.

Display Mode: If "Relative" is selected, then the transparency of a zone is determined by comparing the value of that zone with the value of the zone having the highest value. If "Absolute" is selected, then the value of the zone is compared with a fixed number entered in Maximum Zone Value. Using "Relative" is helpful for comparing zones in a single day while "Absolute" enables a more accurate view of the numerical value of a zone.

Maximum Zone Value: Can be used only when "Absolute" is selected for Display Mode. Zones with values at least this parameter are all coloured with the least possible transparency.

Absorption Index

The metric selector in the dwell time heatmap has an absorption index option which is explained below.

The absorption index of a zone answers the following question:

> *What is the probability that an object passes through the zone given that the object has the opportunity to pass through it?*

Suppose Z is a zone with zones adjacent to each of the left, top, right, or bottom edge of Z, which will be denoted by Z_1, Z_2, Z_3, and Z_4, We will define "opportunity to pass through" Z to mean the current zone the object is in is Z_1, Z_2, Z_3, or Z_4. The answer to the question is then

probability that the object passes through Z given the object is currently in one of

Note that if an object passes through Z, then the zone the object passed through before Z must have been one of Z_1, Z_2, Z_3, or Z_4. Thus, the number of times an object has passed through Z and immediately after one of Z_1, Z_2, Z_3, or Z_4 is equal to the number of objects that passed through Z. If N, N_1, N_2, N_3, and N_4 are the number of objects that pass through Z, Z_1, Z_2, Z_3, and Z_4 respectively, then the probability can be written as

$$
= \frac{\dfrac{\text{number of times an object passes through } Z \text{ immediately after passing throug}}{\text{number of times an object passes through one of } Z_1, Z_2, Z}}{\dfrac{\text{number of times an object passes through } Z}{\text{number of times an object passes through one of } Z_1, Z_2, Z_3, \text{ or, } Z_4}}
$$

$$
= \frac{N}{N_1 + N_2 + N_3 + N_4}
$$

which we define to be the **absorption index** of Z and is always between 0 and 1, with a greater value indicating an object is more likely to enter Z if given the opportunity to do so. This index applies only if zones Z_1, Z_2, Z_3, and Z_4 all exist,

which is not the case if Z borders the perimeter of the area. In this case, the absorption index of Z is not defined and is set to 0 in the heatmap.

Using this index, one can determine the properties of a zone that cause it to be more likely to be passed through. These properties can be based on objects present near the zone, location of the zone in the area, and purpose of the zone.

Day Heatmap

This visualization shows dwell time and traffic data not shown by the zone heatmap by removing the location dimension of the data and focusing on the day for an entire area rather than smaller zones. The rectangle in the heatmap represents data for one day of one of the three tracked areas. The y-axis is labeled with the seven weekdays and the x-axis is labeled with the date so each column represents one week. The first tracked day is February 20th, 2019 and the last tracked day is January 10th, 2020 so the rectangles corresponding to the first two and last two days do not represent data and are set to 0. The function of each option is explained below.

Area: One of the three areas tracked by Numina sensors at 307 whose data is displayed by the heatmap.

Object Type: The type of object to be tracked in the heatmap. This option is useful for comparing trends between different object types.

Metric: The interpretation of the heatmap opacities. For each day, the metric is calculated for that day and a transparent blue colour is shown in the rectangle corresponding to that day. A less transparent rectangle indicates that the value of the metric for that day is greater. The options are described in the zone heatmap section.

Show Events Only: If this box is checked, then only rectangles corresponding to event days are shown in the heatmap. This option is useful for comparing trends between non-event days and event days.

Path and event

This webpage section provides a convenient tool for the user to identify where do people pass by and whether they tend to choose a specific route. Users can compare the result of the selected date with the date that event happens, to see whether the location that pedestrians choose to pass by and the route they choose to walk by changes. Users can combine the result they derived from the first part together with the information they obtained from this section to derive a more accurate result.

From the beginning of the section, users can choose which sensor do they want to use, then the query time by default would be 2019/10/18 to 2019/10/19, which users are free to choose which date they want to inspect. Users can also choose whether to display any information about any events.

Note that the user can choose the start date and the end date to be the same. In that case, the dwell time and count distribution will display information for that date, and the user can select a specific time interval for the heatmap.

The top left plot will always show how the behaviour zone split for the sensor they choose. We split these behaviour zones by their functionality. When choosing behaviour zones, we take the phenomenon that near object is larger into account, and make larger behaviour zones for closer object.

The top right plot will show how the dwell time distributed for different behaviour zones. Users can observe the quantile and mean dwell time pedestrians spend on different areas, together with the count plot displayed below, user can have an idea of what number of people tend to dwell what time in a specific area. For example, if user observed 75 quantiles of a chair's dwell time are five but the mean dwell time is 20, then there is a small number of people sitting on the chair for a long time; but if the mean dwell time is between 25 and 75 percent quantile, then most people tend to pass through that place. If the user selected an event, then the top right will display both dwell time and the count for each zone. In addition to displaying the quantile and the mean dwell time and count for the time interval that the user chooses, the website will, in addition, show the average dwell time and count for each zone during the event date. So, the user can easily make a comparison between the date they choose and the date that the event happens.

The bottom left corner displays a heatmap for the time interval that the user chooses. Users can choose a specific hour for the start date and the end date. If the user selects the start date and the end date to be the same, the user can observe how count distributed throughout the day below the heatmap and choose the time interval

where there are pedestrians. User can find the lines that pedestrians often walked by to see which areas do people tends to pass through intuitively. Usually, those areas with multiple lines are where people tend to pass by, and those areas with some dots and abrupt turns are where people tend to dwell. If the user selects an event, then the bottom right will display a heat map for the date that the event happens.

Maintianance schedule

For maintain time, we want to use following plot, letting user find the pattern and come up with own maintenance schedule.

The First graph is a line graph showing the time series of pedestrian amount, which gives user a clear picture of how pedestrian behave. We hope user could identify general pattern of pedestrian count by observing at this graph.

One interesting question to consider is whether every day in a week pedestrian behaves similarly. Therefore, we calculate count of pedestrian for each day of week, and uses two plot to help users identify difference between each day in week.

The first plot shows the distribution for each day of week, we hope user could see there is a difference between count of pedestrian for each day of week. Then user could select two day in a week, for example, Monday and Wednesday, the following plot display the time series for two days the user selects.

Then, user could choose a start date and a day interval within 60 days. The following plot show the amount of visitor during this time, the vertical line indicates the day where the amount of visitor excessed 500. The user could use this plot to identify which day where more than 500 people visit sidewalk.
You could choose a start date, end_date and a hour interval. The following plot show the cumilative amount within the hour interval you choosen. The following dataframe shows amount of visitors between each maintain time, you task is making sure less than 500 padestrian visiting sidewalk during your maintainess time. The red horizontal line indicates the cumulative amount have reached up to 500.

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