Garrett Cheung, Michael Galarnyk, Orysya Stus
DSE 241, Winter 2018

Crime Watch

Abstract

Violent crime in the United States has fallen sharply over the past quarter century. However, there are large geographic variations in crime rates. In particular, while crime rates have been trending down in California, it has been trending up in Los Angeles. In this paper, we evaluate the visualization techniques that help enable the discovery of crime trends in Los Angeles particularly on the young demographic. A key metric of interest is youth victimization (YV), the ratio of number of violent crimes against people 18 or younger due to violent crimes over total crimes committed. Having effective visualizations of Los Angeles' divisions with high YV is vital for the quick and thorough evaluation by law enforcement and families. We developed Crime Watch, an interactive visualization dashboard for identifying high YV divisions that uses many idioms including choropleth, tree, and heat maps. We present the dashboards functionality through image and video media. The design choices are justified through an extensive literature survey. Furthermore, we show our results that the Harbor division has the highest overall YV and Central has the lowest. With Crime Watch, we have provided a user the ability to determine average victim's gender, age, ethnicity as well as type, location, and time of crime for a specific division of the county.

Introduction

While crime rates in general have been trending down in California in recent times, it has been quite the opposite in Los Angeles. For many years, police have tried to reduce homicides and gang-related shootings while dealing with a growing homeless problem. While homicides did indeed reduce from 290 to 271 between 2016 and 2017 [1, 2], property crime increased from 94,555 to 95,495 in the same time period [2]. Violent crimes also rose from 27,446 to 28,481 [2], reflecting a greater trend of rising crime in Los Angeles. From 2010 through 2016, overall crime has risen 9% [3] in Los Angeles with violent crime has rising a staggering 27% [4].

The result of such rising crime is that young children and adults become more and more exposed to it. Studies have shown that 60% of children were exposed to violent crime within the past year [5] with 95% of children in certain districts between the ages of 7-14 witnessing violent acts [6]. Such effects have the potential of leading to lasting physical, mental, and emotional harm. Other effects of exposing youth to violence include "attachment problems, regressive behavior, anxiety, and depression, and to have aggression and conduct problems" as well as other health-related problems, such as "academic and cognitive problems, delinquency, and involvement in the child welfare and juvenile justice systems" [7].

More important than exposure however, is that children can often find themselves the target of crime. Indeed, according to the Los Angeles Police Department, violence is the second leading cause of death against young people. It is estimated that over 3000 of those deaths are due to gunfire. Interestingly, it has also been found that youth violence and crime triple within the hour immediately after school [8]. While not as deeply researched as violent crime, other

types of crime have a negative impact on our youth as well. It has been shown that even nonviolent crimes such as neglect can lead to psychological and developmental problems [9].

With all this in mind, it is of little wonder then, why it is of paramount importance to reduce exposure of crime as a whole to our youth during their most critical developmental stages of their lives. Thus, Crime Watch was created with the intent of protecting Los Angeles' youth of through awareness and education.

Dataset

Raw Data. Crime Watch utilizes the Crime Data from 2010 to Present (A Safe City) provided by the Los Angeles Police Department (LAPD) that is made available through Kaggle [10]. The types of data explored in Crime Watch include crime data (crime incidents and associated metrics), LAPD reporting district shapefiles aggregated to the division level, and modus operandi (MO) codes. The crime data is updated weekly, providing incidents of crime from January 2010 until March 14, 2018. This data is transcribed from original crime reports that are typed on paper and therefore there may be some inaccuracies within the data. Some location fields have missing data that are noted as (0°, 0°). Additionally, address fields are only provided to the nearest hundred block in order to maintain privacy. In the crime data, there are 1.7 million total data incidents with ~270,000 incidents involving youth victim (victims aged 18 or younger). The reporting district shapefile attributes contain geometries of 1,134 LAPD reporting districts aggregated into 21 representative LA Divisions. Finally, the MO code data contain 532 unique MO codes. In the case, that the victim age was protected, the MO code provided information regarding if the victim was 18 years old or younger.

Attributes of Interest. All geometries, reporting districts, and LA divisions were used from the reporting district shapefile data [11]. Although the MO codes were not reported on in Crime Watch (too granular of detail), the MO codes were very useful for data processing. From the crime data, the dashboards developed utilized incident id, date occurred, time occurred, LAPD division information, victim information (age, sex, and racial background), crime information (description, premise, use of weapons, and location of incident). Crime data associated with crime status were not included. Furthermore, we developed a metric called youth victimization (YV) ratio or incidents of youth victimization divided by total incidents of crime, in order to understand where youths were disproportionately victimized.

Initial Data Processing. The following MO codes identified instances of youth victimization in the crime data: the 1217 (Teenager (use if victim's age is unknown)), 1257 (Victim is 6 years old thru 13 years old), 1258 (Victim is 14 years old thru 17 years old), and 1259 (Victim is Newborn-5 years old). Furthermore, victims aged 18 or younger were identified as youth victims. As mentioned, ~16% of the crime data contained instances of youth victimization. Dashboard specific processing and filtering will be discussed below.

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Data Connections. Once processed, the following data joins were created: inner join between LAPD reporting districts shapefile to crime data on reporting district id and left outer join between crime data and MO codes on crime incident id.

Tasks

Audience. Our intention is to create a dynamic, interactive, and geographic tool to evaluate youth victimization. This tool provides current and prospective parents with awareness and education regarding the safety of children in areas of Los Angeles County . While the tool is primarily focused in helping current and prospective parents determine locations to settle down or where to take their children, it has useful applications to county officials and law enforcement as well. By highlighting areas in the city with higher crime rates, law enforcement agents can become more aware of dangerous neighborhoods for children and can direct more attention there. Additionally, all of these groups benefit from another feature of the visualization which is a progression of crime rates over time. Having the ability to view how crime has evolved provides valuable information in important decision making processes.

Limitations in Current Tools. NeighborhoodScout is a website and online database which offers neighborhood reports for real estate, schools, demographics, and crime statistics. In regards to crime statistics, the tool reports the safest LA neighborhoods and compares rates between violent and property crimes. NeighborhoodScout is an accessible tool for the public, but it does not provide the correct visualizations for the general public and parents to understand youth victimization crime incidents throughout LA. Crime Watch enables the general public a means of understanding geography-based youth victimization trends over time, profiling the typical youth victim, examining what type of crimes youths are victimized in, and correlating the time of day to youth victimization.

In order to gain more knowledge about the community, be more cautious, and safeguard youth's safety, Crime Watch considers the following themes and questions:

Time Trends. Historically, where in Los Angeles is the most dangerous for youths? Has youth victimization increased over time? Are there any notables trends of youth victimization over time?

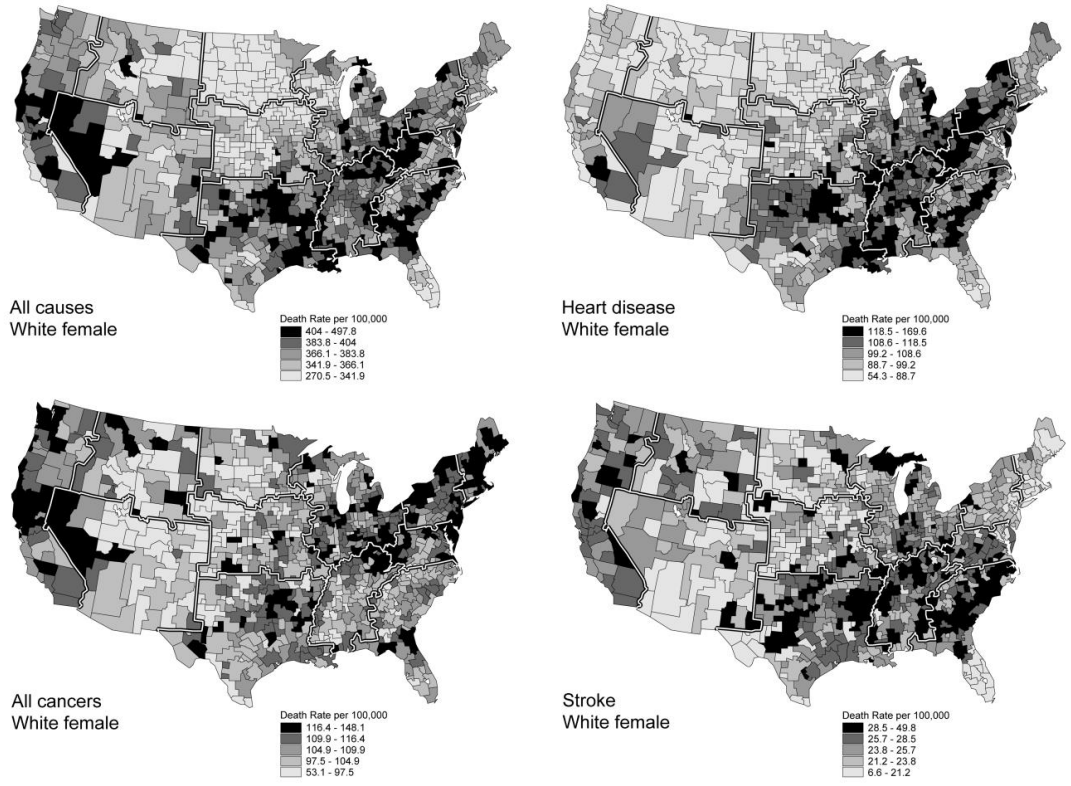
Typical Youth Victims. What is the average age of a youth victim across Los Angeles? What is the race distribution of youth victims? Where are youth victims more likely to be males or females?

Crime Descriptions. What are the types of crimes which are associated with youth victims? Where do crimes associated with youth victims occur? What type of weapons were used in the crimes?

Occurrences By Hour. Are there are notable trends between the hour of crime and the year, month, and day of week?

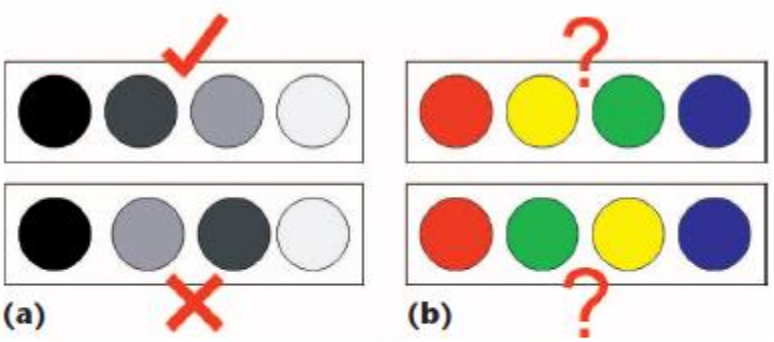
Literature Review

Choropleth Map Comparison. Choropleth maps are often used for visualization questions (using maps to discover patterns). The publication, "Evaluation of Methods for Classifying Epidemiological Data on Choropleth Maps in Series" [12] by Cynthia Brewer et al. had the goal of determining which choropleth classification methods are most suitable for epidemiological rate maps (mortality rates, disease rates, etc.). This was done by having subjects answer a wide range of general map-reading questions that involved individual maps and comparisons among maps in a series. The questions were targeted to ascertain varied scales of map readings, from individual enumeration units, to regions, to whole-map distributions.



One important finding from the study was that matched legends across a series of maps (when possible) increased map-comparison accuracy by approximately 28 percent. This fact informed our visualization and consequently we have the same legend across for the multiple maps on the Time Trend Sheet of the dashboard.

Choosing A Color Map. Choosing the appropriate color map is essential for the effective display and analysis of quantitative data. There are formal ways to make an appropriate color choice based on the task [13]. Studies have shown that there is a quantitatively measurable performance effect based on the color scheme utilized [14].

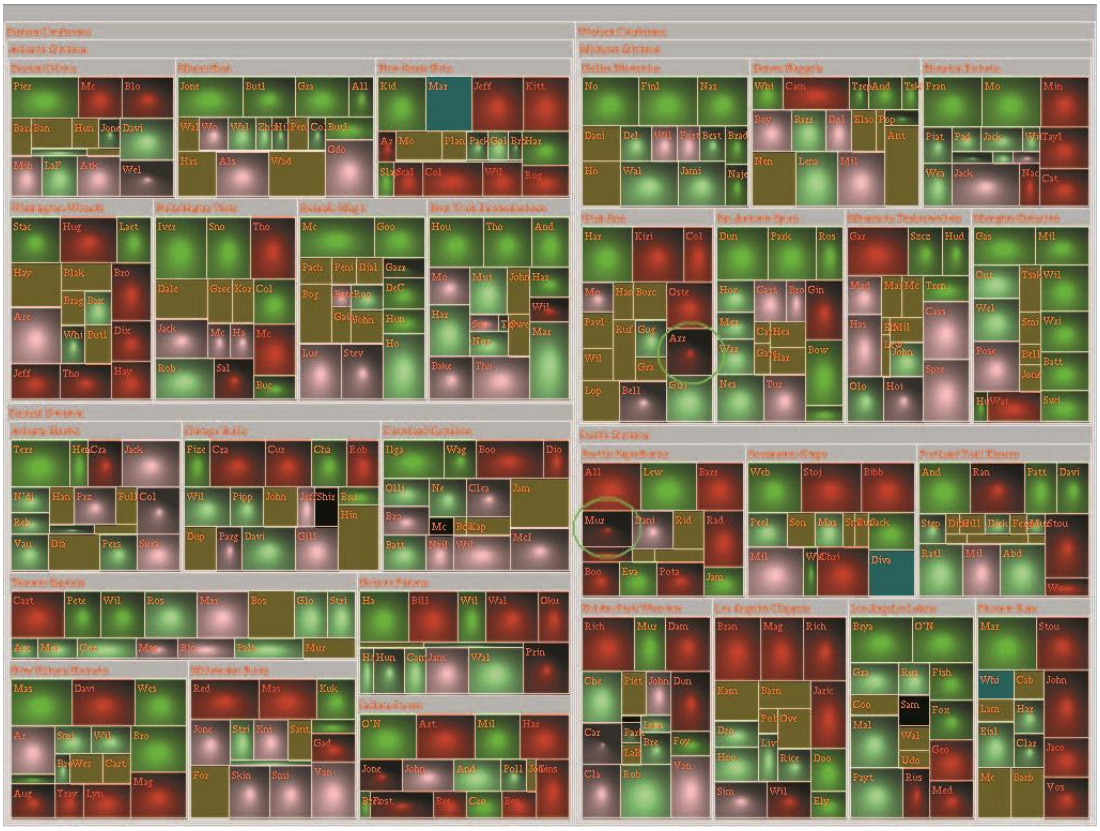


1 Perceptual ordering. (a) We can easily place the gray paint chips in order based on perception, (b) but cannot do this with the colored chips.

For example, a particular color map of interest is the rainbow colormap which, despite being a favorite color map across the sciences [15] is poorly suited for most data tasks and can prove misleading since it is not perceptually ordered and isoluminant. The rainbow color map appears as if it's separated into bands of almost constant hue, with sharp transitions between them. It is recommended to use a diverging color scheme utilizing red to highlight regions of greatest interest. Consequently, this informed our decision to choose a diverging color scheme with red to highlight divisions of high youth victimization whenever possible.

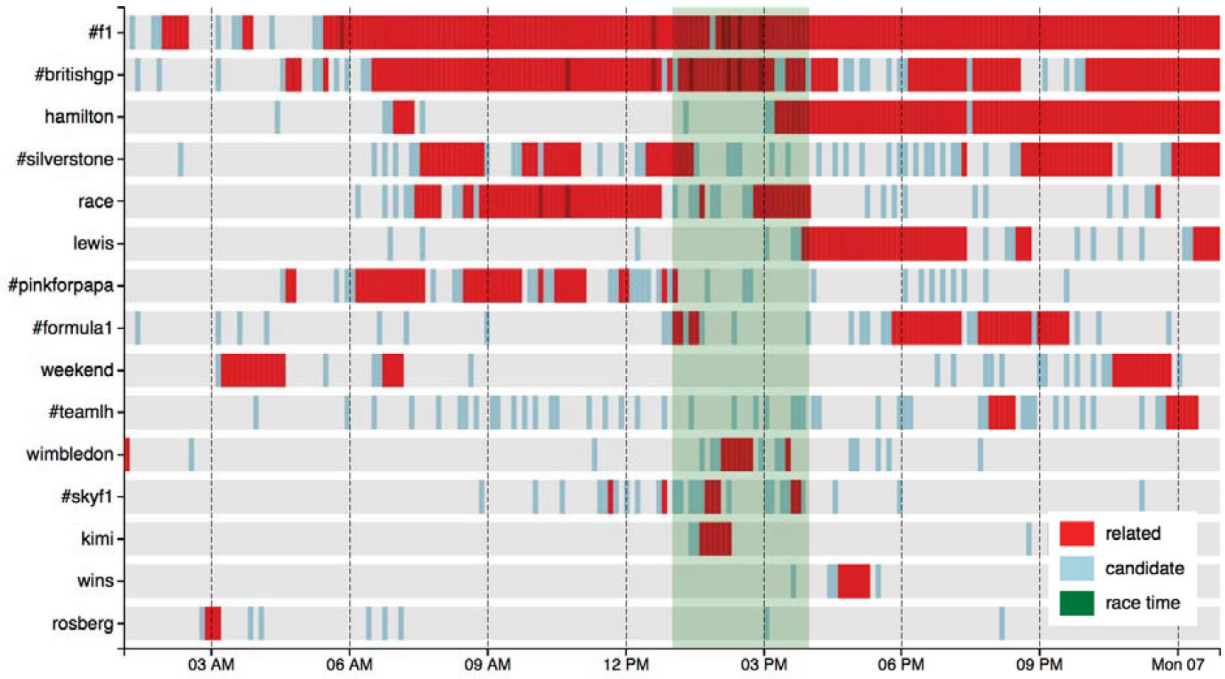
Treemaps. Treemaps, an alternative to node-link tree drawings, are a popular way to visualize hierarchical data. Treemaps are very effective at understanding attribute values at the leaves of a tree. They recursively split the display area into rectangles according to a hierarchical structure and a user-selected criteria [16, 17].

A common issue treemaps face is when the data undergoes changes over time. Viewers of treemaps often find it difficult to track layout and attribute changes from treemaps containing data at different points in time even when viewing two treemaps side by side. There is a lack of direct contrast to highlight the differences. Essentially, if attributes of corresponding data entries are displayed in separate places in different contexts, viewers suffer from making indirect comparisons.



As seen in the image above, the approach used by Tu et al. [17] to combat the problem of comparing treemaps was to create a contrast treemap. Essentially, contrast treemaps are made to allow for the direct comparison of attributes at two separate time points. The mapping techniques described in the paper allow relationships between data entries to be formed automatically and the contrast treemap is built on the relationship data (essentially ratios). This approach removes the need to look back and forth when comparing tree maps. We decided against an approach like this for the sheet Crime Descriptions on the dashboard. A contrast treemap would have been difficult to explain to our stakeholders as well as the fact that we didn't want separate treemaps at different time points.

Heatmaps. Heatmaps take in two categorical key attributes and one quantitative value attribute. They use a 2D matrix alignment of area marks with a diverging color map. Some of the tasks they are good at is finding clusters, outliers, and for summarizing data.



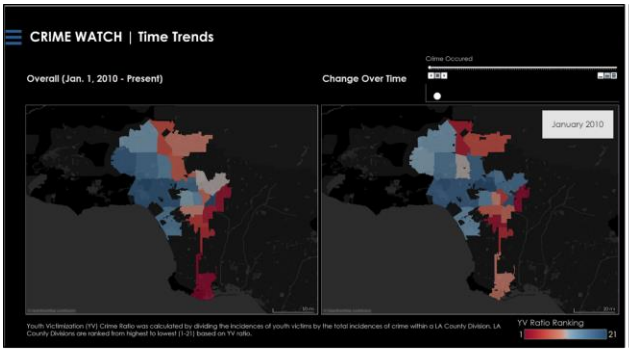
The image above shows a heatmap of related terms in a social network generated on F1 race day. The darker a related keyword is, the higher its relevance to the main keyword. This heatmap illustrates how trending topics related to live events in social media evolve over time. It emphasizes that one of the benefits of using heatmaps is that they visually encode quantitative data with color in a small area and in result are good for providing overviews with a high information density [16, 18].

Visuals into the Dashboard. As Crime Watch is a dashboard, it is important to delve into what types of dashboards work best for different users or tasks. Dashboards are expected to improve human decision making by amplifying cognition and capitalizing on human perceptual capabilities. The paper, “A review of dashboards in performance management: Implications for design and research” [19] explains that dashboards need to evaluated based on their design features and the way users interact with them to make decisions. A user’s decision process is a function of the information system’s features, the decision making environment, and the problem solving skills of the user [20]. Crime Watch’s primary users (stakeholders) are current and prospective parents. Consequently, our dashboard is tailored to them. There needs to be a balance between the complexity and usability of dashboards, where excessive features and feedback might negatively affect decision making and morale. Dashboards can be evaluated based on how well they facilitate the encoding and decoding of information. We incorporated this knowledge into the design of our dashboard.

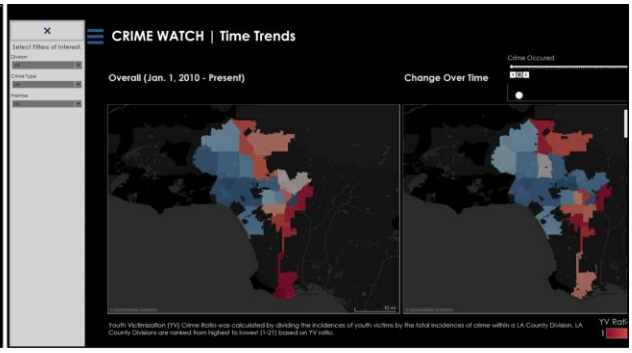
Solution

Dashboard Design Choices. The dashboard sheets were developed in Tableau. In order to achieve a good balance between visual complexity and information utility, the following

dashboard design choices were selected: clear themes specified per dashboard sheet, black background, filter bar hidden at default, ‘Apply’ selection included with each filter, syncing filters across dashboard sheets, consistent legends, informative tooltips, and minimization of visual clutter. Properly labeling the dashboard tabs and sheets with titles allows for easy user navigation throughout the dashboards. Using a black background allowed for the data visualizations to be more striking. Aesthetically, the intention of the choropleth maps was to clearly place LA County as the focus, meaning that the background was darkened and external geographic marks such as roads, county names, bordering states, etc. were removed within Tableau’s Map Layers.



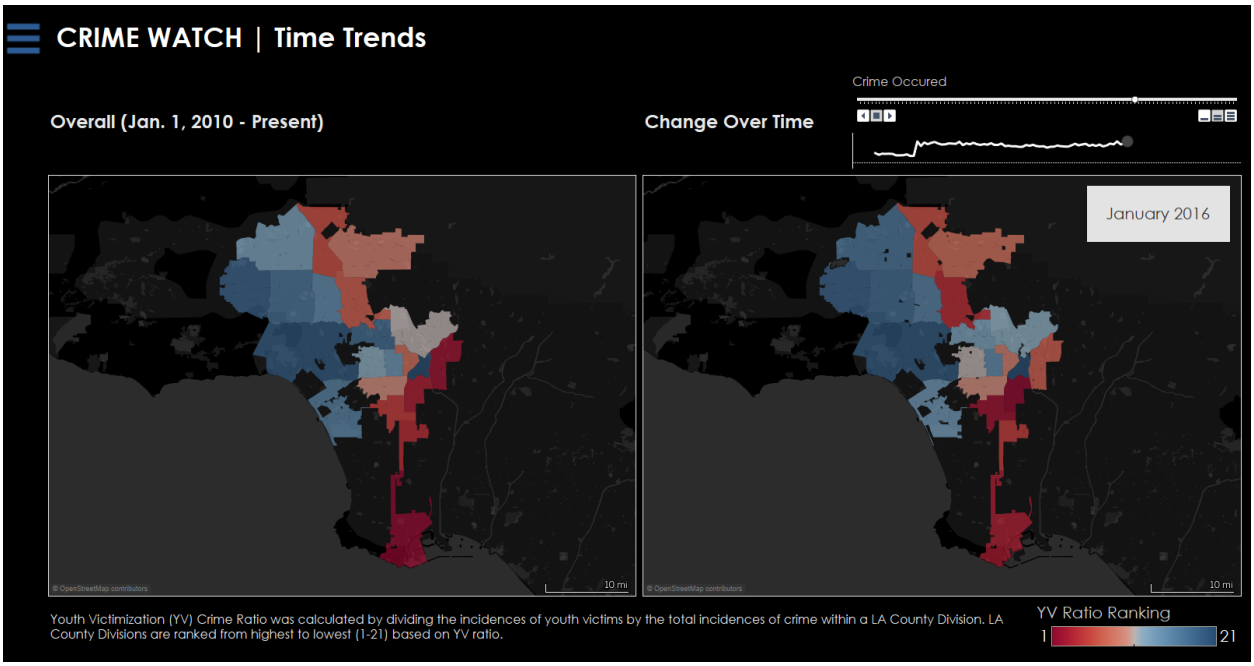
Select Menu Icon



Filter Bar

The images above show the general layout design of our dashboard. A filter bar was hidden from the user’s view at default, to allow for more visual area. A user can select the Menu icon and it will bring up the filter bar. The user can then select the X icon to hide the filter bar. This functionality is standard across many websites and platforms. Each of the filters in the filter bar were customized to include an ‘Apply’ button, a feature which optimizes dashboard performance, especially if a dashboard is displaying millions of rows of data. The following filters were synced throughout the dashboard sheets, as to preserve the context of exploration throughout: Date Occured, Division, Crime Type, and Premise. Furthermore, legends were provided where necessary to support each of the visuals and informative visuals provided key metric breakdown for calculation transparency. Finally, each of the dashboard sheets minimized visual clutter by using animations over time (vs. hundreds of visuals at once), parameter controls to show 1 time granularity at a time (ie. see Occurrences by Hour sheet), and maintained consistent thematically separated sheets.

Sheet Name: Time Trends

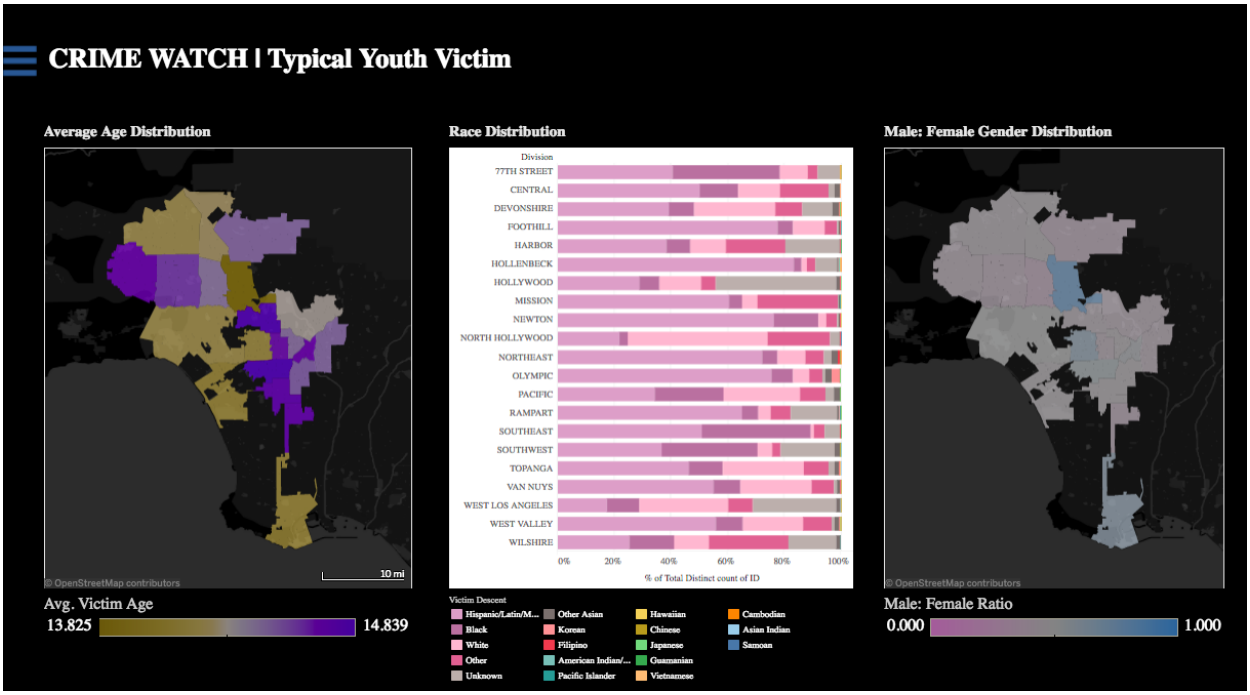


Further Data Processing. No filters were applied.

Data Selected and Visualized. The sheet shows two choropleth maps, where the left map shows the overall crime by division (static) and the right map shows cases by division and month-year as an animation or by interacting with the slider as well as a youth victimization incident timeline above the animation. The choropleth maps show regions as area marks using given geometry (the geometries of Los Angeles divisions), where a quantitative attribute (YV ratio) is encoded with color [16, pg. 181]. The most effective channel used is spatial region, since geographic distributions of the YV ratio can be associated with particular divisions across Los Angeles. The color saturation channel is also used to easily show which divisions have the highest ranked YV ratio (red) and lowest ranked YV ratio (blue). Furthermore, in the right choropleth map depicting the crime by division and month-year, the motion channel is utilized. At default, both the right and left choropleth maps are static as to provide the user with an understanding of visual context. The user must interact with the right choropleth map by either playing the animation or scrolling along the timeline to view the YV ratio distribution for divisions for a particular month-year combination. The legend for both choropleth maps follow the same color saturation color scheme (highest ranked YV ratio is red and lowest is blue) as suggested in Brewer et al. [12]. The side by side view of both pieces of information provide the user with a full understanding of overall the YV ratio distribution and time based trends of YV ratio distribution. Furthermore, a line chart was used to show the trend of youth victimization incidents (quantitative value attribute) over crime occurrence month-year (ordered key attribute) since it expresses value attributes with aligned vertical position and point marks over time [16, pg.155].

Usage. To interact with the right map, the user can either click play or click on the scroll bar, to see both the youth incidents and YV ratio distribution overtime. Furthermore, the user can select a filter to focus his/her analysis on a particular division, crime type, or premise. Finally, hovering over any of the divisions reveal information regarding the overall crime count, youth victim incidents, YV ratio, and YV ratio ranking.

Sheet Name: Typical Youth Victim



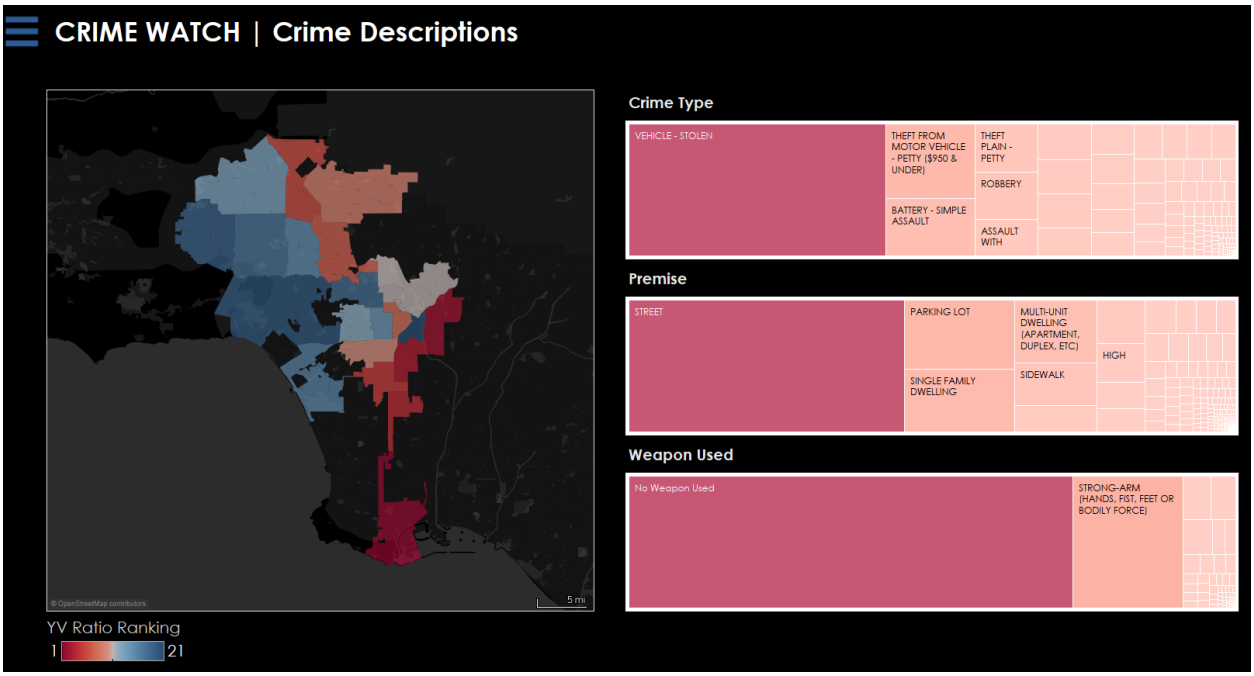
Further Data Processing. Nulls were filtered out for every visualization in the dashboard. It was assumed that filtered out nulls aligned with the existing distributions for age, race, and gender. Calculated average victim age and male: female ratio (larger the value the more male) for analysis.

Data Selected and Visualized. The sheet shows three side by side visualizations, two choropleth maps and a stacked bar chart (values out of 100%). The choropleth maps encode average victim age and male: female ratios (quantitative attributes) while the stacked bar chart encodes the youth incident count (quantitative attribute) across different races and divisions (two key categorical key attribute). For the average age and male: female ratio distributions, the most effective channel used is spatial region, since the geographic distributions of the metrics can be associated with particular divisions across Los Angeles. The color saturation channel is the next most effective channel used, utilizing diverging for both choropleth maps allows for quick visual analysis. For the average age distribution, the younger the average victim the more yellow the division while the older the average victim the more purple. For the male: female ratio

distribution, the legend ranges from 0 or predominantly female victims (pink) to 1 or predominantly male victims (blue). The stacked bar chart allows for part-to-whole relationships, lookup of values, and finding trends in the data [16, pg. 153]. The youth victimization incidents are relative to each division, meaning that for each division the data has been scaled to total 100% as this visual is intended to compare the distributions across divisions. The most effective channel which the race distribution visual utilizes is the length channel to encode the variations of victim occurrences. Next, color hue is utilized to separate the different types of races from one another. The side by side visualizations enable to user to understand the average age, race, and gender distributions by division.

Usage. The user can select a filter to focus his/her analysis on a particular division, crime type, or premise or scrolling along the date occurred filter. For the tooltips, the age distribution visual displays the division and average age, the race distribution displays the division, race, and % of youth victims, and the male: female gender distribution displays the division and male: female ratio.

Sheet Name: Crime Descriptions



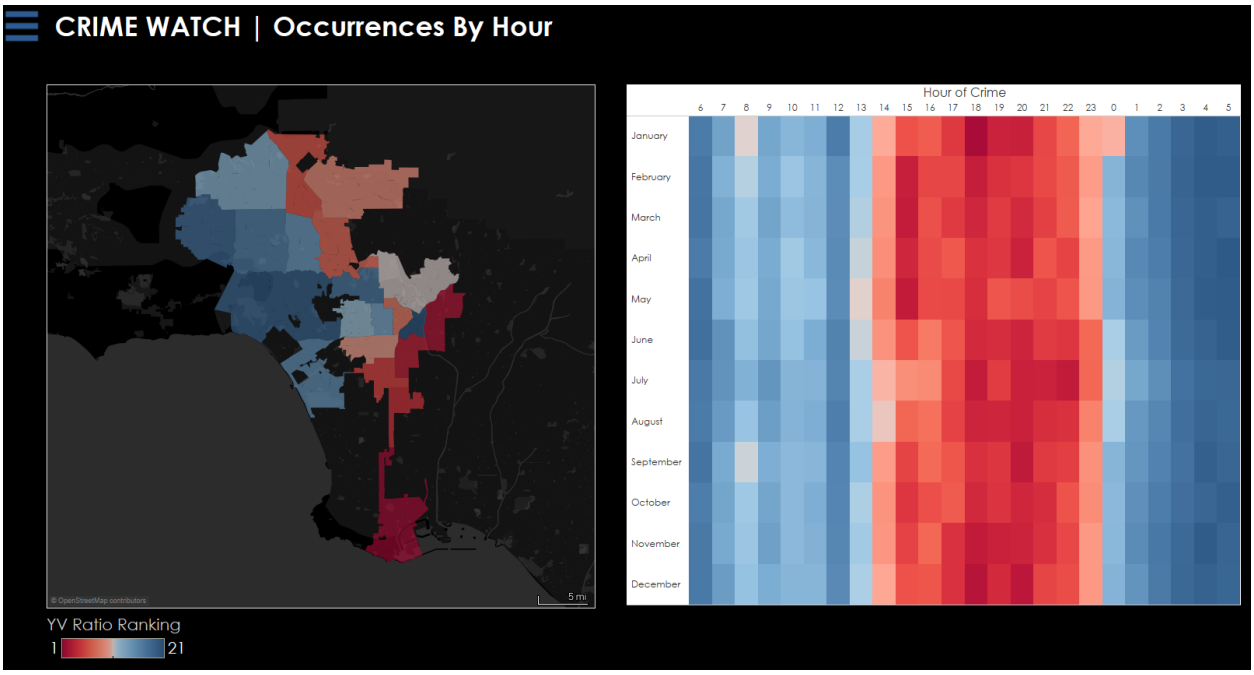
Further Data Processing. No filters were applied.

Data Selected and Visualized. The sheet shows a choropleth map alongside three different treemaps. The choropleth maps show regions as area marks using given geometry (the geometries of Los Angeles divisions), where a quantitative attribute (YV ratio) is encoded with color [16, pg. 181]. The most effective channel used is spatial region, since geographic

distributions of the YV ratio can be associated with particular divisions across Los Angeles. The color saturation channel is also used to easily show which divisions have the highest ranked YV ratio (red) and lowest ranked YV ratio (blue). Treemaps are very effective at spotting the outliers of very large attribute values [16, pg. 214], in this case showing the long tails for crime types, premises, and weapons used. The icicle treemaps utilize the area channel with vertical spatial position and size showing tree depth [16, pg. 214] or a long tail. The youth victim incident count is encoded using the most effective channel, area. While, the categories of crime type, premise, or weapon used are encoded using color saturation and allow the user easier visibility into what should be selected, of course this is a more aesthetic design choice.

Usage. The user has the ability to cross filter within the dashboard, meaning that a select of any of the visuals will filter the other visuals accordingly. Furthermore, the user can select a filter to focus his/her analysis on a particular division, crime type, or premise or scrolling along the date occurred filter. For the tooltips, when hovering over the choropleth maps the overall crime count, youth victim incidents, YV ratio, and YV ratio ranking is shown, while for the treemaps the crime type, premise, or weapon respectively along with the youth victimization count is displayed.

Sheet Name: Occurrences by Hour



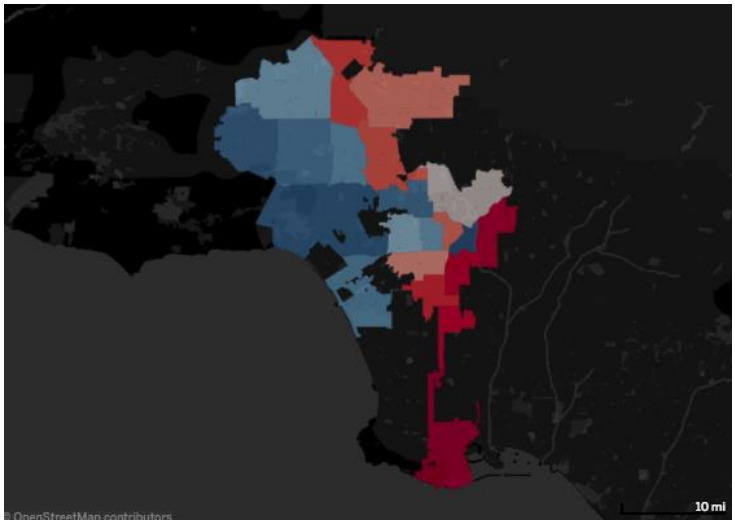
Further Data Processing. It was noted that approximately 30,000 identity theft for all crime occurred at around 12pm. These instances were filtered out from the data because since no one can know when identity theft occurred, the LAPD most likely rounded to exactly 12pm.

Data Selected and Visualized. The image above is the sheet which shows a choropleth maps beside a heatmap, which changes based on parameter control between time granularities: year, month, and day of week. The choropleth maps show regions as area marks using given geometry (the geometries of Los Angeles divisions), where a quantitative attribute (YV ratio) is encoded with color [16, pg. 181]. The most effective channel used is spatial region, since geographic distributions of the YV ratio can be associated with particular divisions across Los Angeles. The color saturation channel is also used to easily show which divisions have the highest ranked YV ratio (red) and lowest ranked YV ratio (blue). Heatmaps are useful to find clusters, outliers, and summarize data [16, pg. 160], in terms of the occurrence by hour heatmap a compact summary can be shown and allow for the user to understand the youth victimized crime counts by hour trends through different time granularities. The time the crime occurred by hour and by time granularity (year, month, or day of week) are the categorical attributes used to summarize the youth victim incidents (quantitative value attribute). The most effective channel used is the area channel which encodes the by hour and by time granularity relationship while color saturation is used to encode the youth victim incident counts (the darker the color the most incidents).

Usage. The user can select the time granularity drop down to view the preferred granularity. Furthermore, the user can select a filter to focus his/her analysis on a particular division, crime type, or premise. Finally, hovering over any of the divisions reveal information regarding the overall crime count, youth victim incidents, YV ratio, and YV ratio ranking while hovering over the cells in the heatmap reveal crime occurrence hour, the time granularity, and % of youth victim by time granularity.

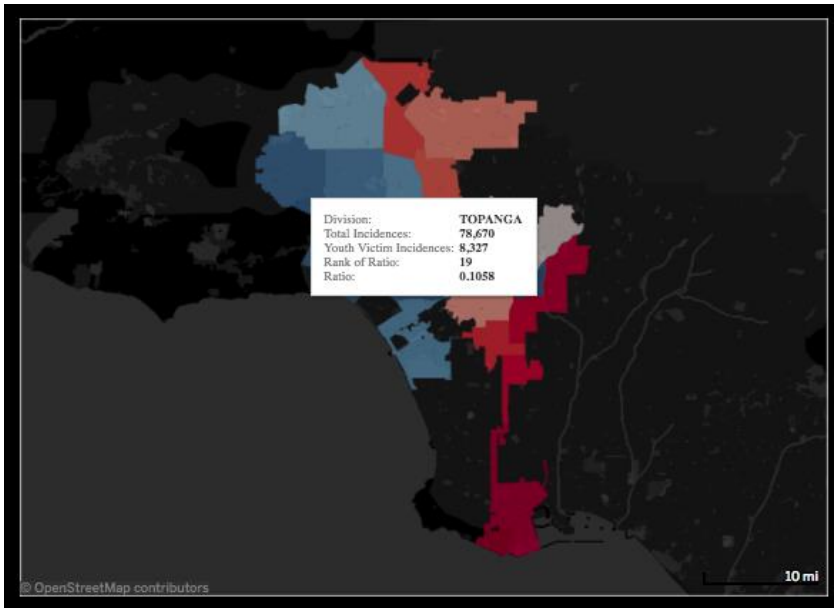
Results

Choropleth Map Comparison.



From this visualization, there are a number of observations and inferences that can be drawn. Using the overall graph, we can firstly see that the top 5 most dangerous neighborhoods are Harbor, Hollenback, Newton, Southeast, and 77th street while the 5 safest are Central, West Los

Angeles, Topanga, Hollywood, and West Valley. It seems that in general, the more dangerous places tend to be further inland while the safer areas are those closer to the ocean. The rest of the divisions reflect this trend with the majority of higher ranked divisions being more east and north than the lower ranked ones. The two exceptions to this trend are Central, which is far east and surrounded by red colored divisions, and Harbor, which borders the ocean. For the Harbor division, which encompasses Long Beach, this does not come at too much of a surprise as Long Beach has a relatively high crime rate with over 1200 property crimes (includes burglaries, grand/petty theft, and arson) and over 200 violent crimes in just 2017 alone (including adult victims) [21]. Central, however, comes as a bigger surprise. The location of central's coordinates pin it in roughly downtown Los Angeles near the arts district and Skid row: well-known high crime areas with an average of 32.5 violent crimes and 100.3 property crimes per quarter year [22]. One possible theory on why youths may be less victimized in this area is that there are simply very few youths in Central due to its reputation. As many already know it is an unfavorable area, many choose other destinations instead, leading to a very low YV score.

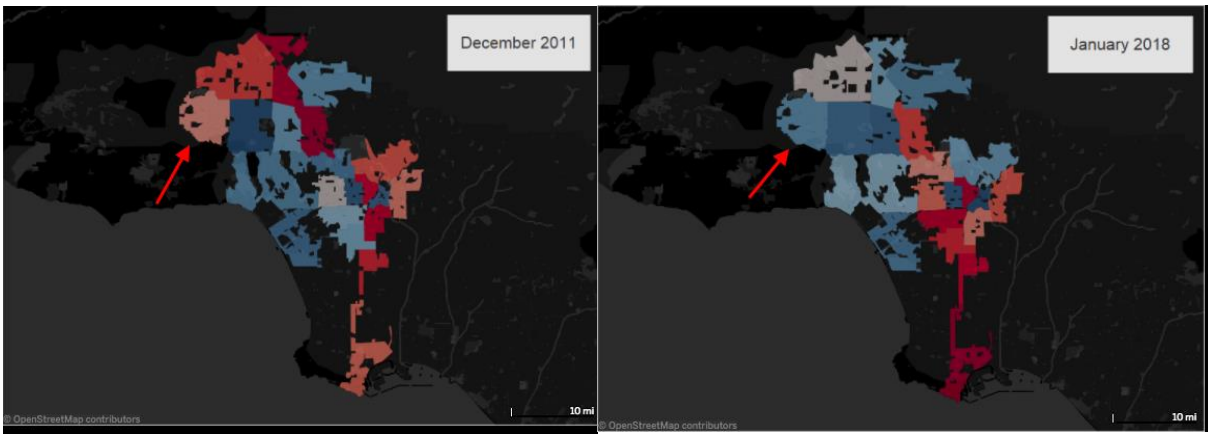


Parents and law enforcement would want to start any research into any area using the choropleth map. By giving an overall breakdown of an area, this map provides a good way to find initial areas of interest. For example, a prospective parent looking to move to Los Angeles may discover that Topanga (highlighted above) would be a great alternative to living outside the main city.

Time Trends.

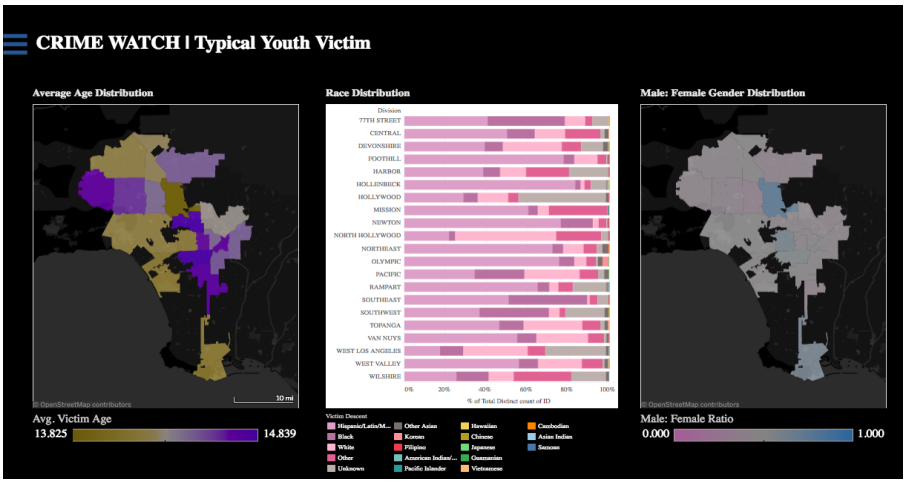
Looking at the time trend, we can clearly see a few patterns. Historically, the western areas around West Los Angeles, Pacific, West Valley, and Van Nuys have remained safe for youths. Areas such as Harbor, 77th Street, Southeast, and Newton have stayed relatively red and thus more unsafe for youths. This also reflects the overall trend noted in the choropleth map. Interestingly, Harbor did not always have a high YV ratio and at one point dropped as low as

15th on the ranking in 2010. However, afterwards starting in 2011, it very rarely dropped outside the top 5 rankings. In contrast, both Devonshire and Mission start off ranked as dangerous neighborhoods but then over time became safer around 2016, although not as safe as West Los Angeles. While we can clearly see the northern regions became safer while the southern got more dangerous, it is not known why this is. Some possibilities come to mind. Perhaps a policy reform caused a proportionate reduction in crime and criminals moved southward towards other areas. Maybe the crime rate in Harbor, 77th street, and southeast simply grew faster. Further investigation would need to be carried out to ascertain the reason. Finally, we can see from the small line chart above the time trend that there is a rather large spike in crimes committed. Between December 2010 and January 2011, total crimes increased dramatically, but then held rather steady afterwards. While it is unknown why, possibilities include more incidents being reported, or simply an increase in criminal activities.



Continuing our Topanga example from before, the prospective parent using the time trend would discover that Topanga holds its rank steady as one of the safer divisions. Further investigation using the filter tools would also serve to highlight that while Topanga did see an increase in assaults and burglaries in late 2011, they have dropped back down to safer levels since.

Typical Youth Victims.

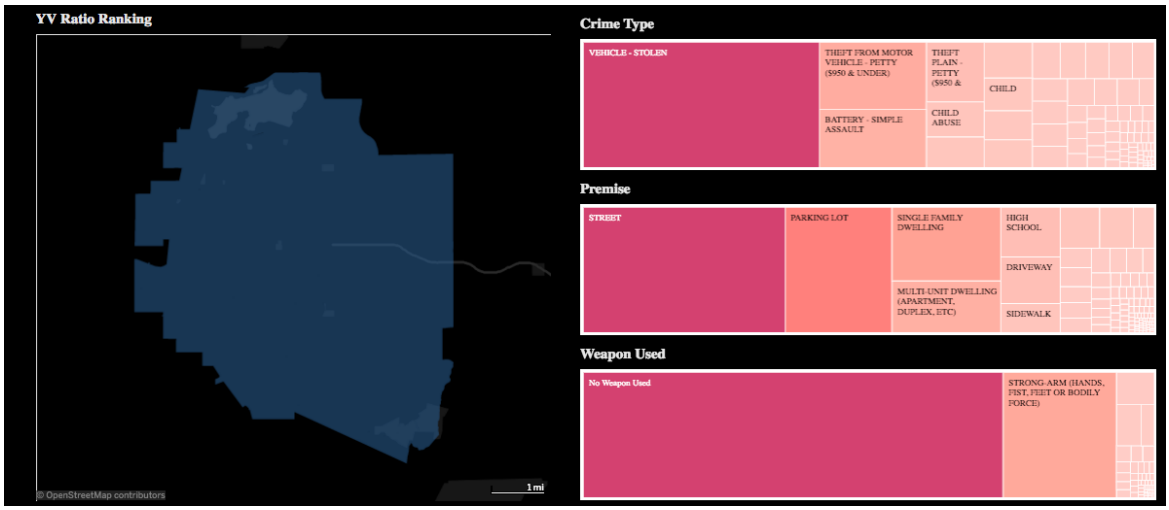


Moving on to the next sheet, we gain insight into the average victim. From the scales and charts, we can see that the average victim age is roughly 14 years old. In addition, there seems to be a trend with victim ages tending to be older within the inner city than in coastal regions. As for ethnicity, the most heavily affected group is Hispanics, followed by Blacks, Whites, and Other. Relatively few Asians of any ethnicity are victimized. Finally, we see that in most divisions, females are slightly more often victims than males. However, the few regions which males are more often victims have high male: female ratio, notably North Hollywood, Harbor, and Wilshire.

Focusing in on Topanga again, we notice that average victim age is 14.68, on the higher end of the overall average. The most affected ethnicity follows the overall, however, with Hispanics, Blacks, and Whites constituting over 80% of victims. Including others that number jumps to well over 90%. As for gender, one would see the male: female ratio is 0.4514, meaning that females are about 18% more likely to be victimized than males.

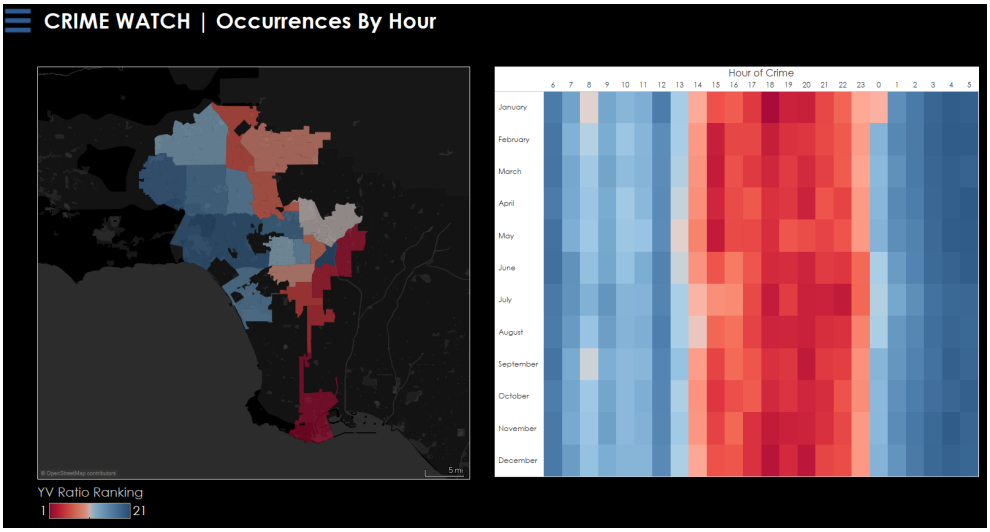
Crime Descriptions.

From this visualization, we notice that the most common type of crime leads the other by a wide margin. For crime type, the most common crime is stolen vehicles, followed by petty theft from motor vehicle. It can also be seen that the most common locations where criminal activity are on the street, parking lots, and homes. Additionally we notice that the vast majority of crimes were “no weapon used” (~200,000 incidents), meaning no physical altercations happened. Crimes with some physical violence are a distant second at around 50,000 incidents. All this tells us that the majority of crimes end in nonviolent altercations in public spaces with possessions being stolen.

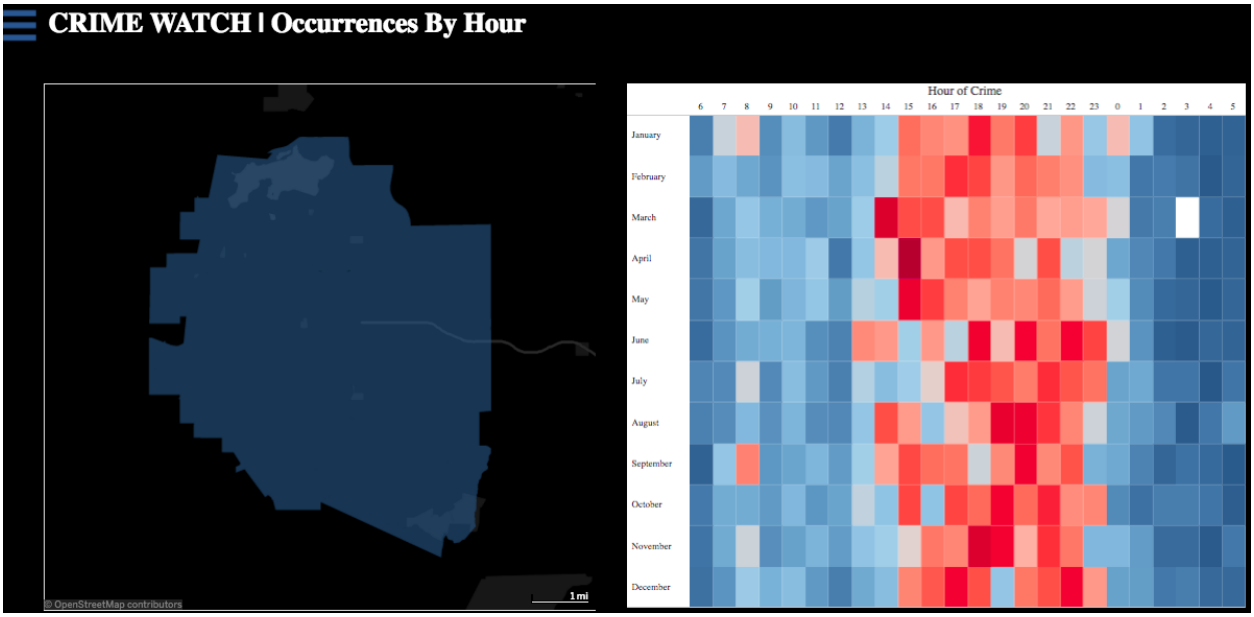


Coming back to our example using Topanga, the prospective parent would notice that the trends for this division reflect those countywide with vehicle stolen, street/parking lot, and no weapon used as the most common crime descriptors.

Occurrences By Hour.



When visualizing crime occurrences by hour, we immediately notice that criminal activities happen very infrequently during the night in comparison to daytime. Most crimes that happen occur during the hours between 3pm and 10pm with slightly lighter activity at 2pm and 11pm. We also see that during the summer hours, criminal activity begins around 2pm as usual but does not pick up until 5pm and continues until 11pm before dropping off around midnight. This shows that not only does criminal activity last longer during summer, but also the peak times are later in the day compared to the other three seasons. We also notice two slight moments of crimes occurring during 8am in both January and September, but not in other months.



When looking at Topanga, specifically, one would notice that hourly patterns of crimes occurring are not as clear as they are county wide. However, the general pattern of 3pm-10pm still holds true with summer hours shifting peak crime later. Even the slight moments at 8am in January/September are present.

Weaknesses and Improvements

One weakness in our solution comes from not having additional metric and attributes to consider. If we had data on population and area (such as square mileage) for each division, we could have devised a better metric for measuring crime rates/crime density.

With additional time, the team would be able to test the tool with members of the target audience to better understand their needs. In doing so, better visual design and features could be developed to further polish the tool.

Another weakness in the visualization is that we are trying to have people classify regions of high youth victimization in a map using color saturation when area (2D size) is a more effective magnitude channel [16]. As a result, we expect our stakeholders to more likely misclassify regions of high youth victimization that are smaller in area just like Pfister et al. [14] noticed in their study.

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Garrett Cheung, Michael Galarnyk, Orysya Stus
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