An Analysis of the Relationship between Crime Incidents and 911 Calls

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ABSTRACT

Crime incidents are a major concern of public safety. Residents can help in crime-fighting by reporting suspicious behavior via call for service (calling 911 in the U.S.). To study this behavior at the city level, we analyze the relationship between crime incidents and 911 calls data. First, we propose an approach to pairing up calls with incidents based on spatiotemporal proximity. Based on the paired up calls and incidents, we define and compute the reporting rate for the studied city. Then we analyze the reporting rate and disaggregate it by types of crimes and neighborhoods. Our analysis reveals that residents are better at reporting shooting incidents than arson or rape incidents, and wealthier neighborhoods tend to have lower reporting rate. City planners can use the reporting rate to engage residents more in reporting suspicious behavior and provide better public safety services.

KEYWORDS

Public safety, crime incidents, 911 calls, reporting rate.

INTRODUCTION

Crime incidents are a major concern of public safety. One way that residents can help in crime-fighting is via call for service, *e.g.,* calling 911 in the U.S. Crime incidents and 911 calls data are collected by police departments to guide public safety services and commonly used in public-safety-related studies. Incidents data can be used to compute crime rate (Hipp, 2007) and enable hot-spot-based predictive policing (Bowers et al., 2004). 911 calls data can be used to measure crime rate instead of crime incidents (Tita & Ridgeway, 2007). Frequently, both datasets are combined as proxies to measure public safety (Burdette & Whitaker, 2005). However, the relationship between these two datasets is rarely studied. In this paper, we propose an approach to model the relationship between calls and incidents. Specifically, we study the reporting rate defined as the percentage of crimes that can be paired up with 911 calls. This reporting rate is important for city planners because it reflects a kind of important residents' behavior: engaging in crime-fighting via calling 911. Such engagement is important for many reasons, *e.g.* it is a form of collective efficacy which is linked to crime reduction (Sampson et al., 1997); it helps discover more crimes independent on the police's patrol choice and thus help mitigate the crime underreporting issue (Tita & Ridgeway, 2007); and the investigation workload, positively correlated with longer sentence, might be lower with than without information from 911 calls (Ray et al., 2017). Disaggregating the reporting rate by types of crimes and neighborhoods, we explore how this indicator could potentially help city planners provide better public safety services.

DATA

The crime incidents and 911 calls data used here are from the Baltimore open data portal (https://data.baltimorecity.gov). Both datasets contain information about time, location and description of each event. The time range we studied is from Jan. 2015 to Feb. 2018. The description of crime incidents data is merged into 8 types: theft & larceny, assault, burglary, robbery, shooting, rape, homicide, and arson. For 911 calls, we first discard calls not related to crimes, (*e.g.* no voice, traffic stop, and tow), and then merge the descriptions into 13 types, which are 8 types of crimes plus 5 types that are likely precursor behavior to crimes, namely abuse, disorderly conduct, insecurity, mental case, and other offense. There are 147k of crime incidents and 986k of 911 calls in the datasets we analyze.

PAIRING UP 911 CALLS WITH CRIME INCIDENTS

A crime incident can be reported by residents within some hundred meters before (behavior like carrying weapons), during (criminal behavior) and after (behavior like fleeing the scene) that incident. Therefore, we propose to pair up a 911 call with a crime incident if that call is spatiotemporally close to that incident, *i.e.,* a call is within a distance radius (D) and a time range (T) of that incident. The best parameters would depend on the duration of crimes (*e.g.* burglary has a longer observation window than a shooting incident) and the geographical layout of the neighborhood (*e.g.* tall building would block residents' vision). The larger D and T are, the more 911 calls would be paired up with crimes along with more noisy calls, *i.e.,* calls reporting unrelated issues with their corresponding crime incidents. To roughly estimate the volume of wrongly paired up calls, we compute the mean of the number of types of paired up 911 calls other than the type of the paired up crime incident (denoted as M). For example, a burglary is paired up with 3 calls, 2 burglary and 1 insecurity (1 type other than burglary) while a shooting incident is paired up with 2 shooting calls (0 type other than shooting), then $M = (2+0)/2 = 1$. The lower M is, the fewer wrongly paired up 911 calls there are. Note that we don't require paired up 911 calls to be the same type as paired up crimes, because residents may witness precursor behavior of crimes, such as reporting armed person before a shooting occurs. We tried different combinations of D and T (Figure 1). D means a 911 call is less than D meters away from the paired up incident; T means the time difference (911 call time minus the incident time) is in the range of [-1 h, T h]. We allow a 911 call to occur before its paired up incident to capture calls that witness precursor behavior to crimes. We set D=100m and T=1h because M increased significantly when D and T is larger. With these parameters, 35% of crimes (5k/147k) and 7% of calls (6k/986k) are paired up.
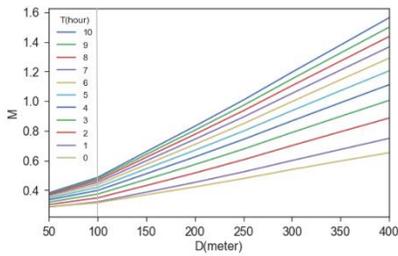
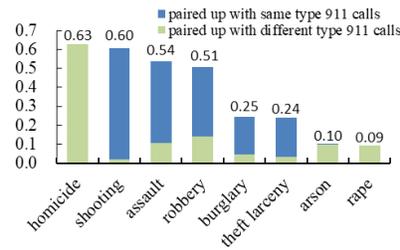Figure 1. Estimate of volume of wrongly paired up 911 calls

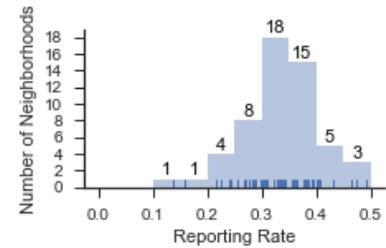Figure 2. Reporting rate by types of crimes

Figure 3. Distribution of reporting rate per neighborhood

ANALYZING REPORTING RATE

As mentioned in the introduction, it is important to engage residents in reporting suspicious behavior by calling 911. And the reporting rate is an indicator of the degree of such engagement. The overall reporting rate for the Baltimore city across all types of crimes is 35% which should be further improved. In the next section, we disaggregate the reporting rate by the types of crimes and neighborhoods respectively. Doing so we can understand what types of crime and which neighborhoods have low reporting rates and provide suggestions for city planners to improve the reporting rates.

Disaggregation by Types of Crimes

We compute reporting rates for 8 types of crimes with all paired up calls. As shown in Figure 2, the reporting rates for homicide, shooting, assault, and robbery are quite high, larger than 50%. Homicide crimes have the largest reporting rate. However, none of the paired up calls is described as homicide calls. Instead, most of them are reporting shootings (1178 out of 1298). Together with the high reporting rate of shooting crimes, we observe that residents are very responsive to shooting incidents. The latter four types of crimes have lower reporting rates. The low reporting rates for burglary and theft & larceny could be due to their stealth nature, especially if those incidents occur at night. Arson and rape incidents are concerning, as they have very low reporting rates even if they are severe violent crimes.

Disaggregation by Neighborhoods

We computed the reporting rate for each of the 55 neighborhoods of the Baltimore city defined by BNIA(https://bniajfi.org/). Most of the neighborhood rates are about 30~40% (Figure 3). Some are low, less than 20%. To understand the difference in reporting rates across neighborhoods, we analysed Pearson correlation between reporting rate and the three indicators of the income level of neighborhoods provided by BNIA in 2015, namely median household income (Coef.=-0.43, p<0.001), percent of family households living below the poverty line (Coef.=0.48, p<0.001) and percent of households with no vehicles available (Coef.=0.54, p<0.001). As shown by the coefficients, the wealthier the neighborhood is, the lower the reporting rate is. This suggests the city planners could encourage wealthier neighborhoods to call 911 to report suspicious behavior.

CONCLUSION

Given the importance of crime incidents and 911 calls data in public safety research, we proposed a method to pairing up calls and crimes. Based on paired up result, we computed reporting rate for the Baltimore city, which is 35%, and disaggregated the reporting rate by types of crimes and neighborhoods. We observed that residents are better at reporting shooting incidents, while arson and rape incidents have very low reporting rates to which city planners should pay more attention. Poorer neighborhoods call 911 more than wealthier ones. Based on this indicator, city planners can prioritize resources to engage residents more in reporting suspicious behavior and improve public safety. Our future research will improve the pairing up approach by considering types of crimes and the analysis of the relationship between reporting rates and neighborhood characteristics.

REFERENCES

Bowers, K. J., Johnson, S. D., & Pease, K. (2004). Prospective hot-spotting: The future of crime mapping?. British Journal of Criminology, 44(5), 641-658.

Burdette, H. L., & Whitaker, R. C. (2004). Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. Preventive medicine, 38(1), 57-63.

Hipp, J. R. (2007). Income inequality, race, and place: Does the distribution of race and class within neighborhoods affect crime rates?. Criminology, 45(3), 665-697.

Ray, K., Borkowski, E. L., Leal, W., & Bales, W. D. (2017). What Happens When Investigating A Crime Takes Up Too Much Time? An Examination of How Optimal Law Enforcement Theory Impacts Sentencing. International Journal of Criminology and Sociology, 6, 215-225.

Sampson, R. J., Raudenbush, S. W., & Earls, F. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. Science, 277(5328), 918-924.

Tita, G., & Ridgeway, G. (2007). The impact of gang formation on local patterns of crime. Journal of Research in Crime and Delinquency, 44(2), 208-237.