Efficient allocation of law enforcement resources using predictive police patrolling

Anonymous Author(s)
Affiliation
Address
email

Abstract

Efficient allocation of scarce law enforcement resources is a hard problem to tackle. In a previous study (1) it has been shown that a simplified version of the self-exciting point process explained in (2), performs better predicting crime in the city of Bogotá - Colombia, than other standard hotspot models such as plain KDE or ellipses models. This paper fully implements the Mohler et.al (2011) model in the city of Bogotá and explains its technological deployment for the city as a tool for the efficient allocation of police resources.

1 Introduction

Criminality is one of the biggest challenges mega-cities face. Among many other decisions, policy makers have to efficiently allocate scarce law enforcement resources on a vast and highly dynamic environment. For example, between 2012 and 2015, all murders and 25% of all crimes in Bogota took place in just 2% of street segments. Yet, these same road segments received less than 10% of effective police patrolling time. Understanding the spatial and temporal dynamics of these so-called *hotspots* is needed to make highly effective police patrolling possible. We develop a *self exciting point process* model to predict crime and present partial results of its deployment on field scenarios in Bogotá, Colombia. We consider 329,793 crimes in Bogota between 2004 y 2014 as georeferenced events with time and date stamps. In a previous study (1) several models for crime prediction were compared in Bogotá: Point models, elipses, KDE and spatio temporal models.

2 Methodology review

The model developed to predict crime occurrences in Bogotá, Colombia, follows closely the methodology proposed by (2). This model is constructed under three assumptions: Criminality concentrates in specific areas, there is higher incidence of crime at certain times and days of the week, and crime spreads from one place to another. With this in mind, crimes are classified between background and aftershock events, the former being those that arise independently given their spatio-temporal location, while the latter occur as triggering of past crimes nearby. Crime appearance is modeled as a self-exciting point process in which the past occurrence of crimes increases the probability of new crimes occurring in the future.

3 Validation

We train the model with data from ten weeks and test its predictive accuracy checking the crimes in the following four weeks. The validation process shows that the proposed model using variable bandwidth predicts a greater number of crimes, on average, than the model with fixed bandwidth or a

Submitted to 33rd Conference on Neural Information Processing Systems (NeurIPS 2019). Do not distribute.

Table 1: Hit rate (crimes predicted in hotspots / total crimes) with 7 weeks of training data and 10% of covered area

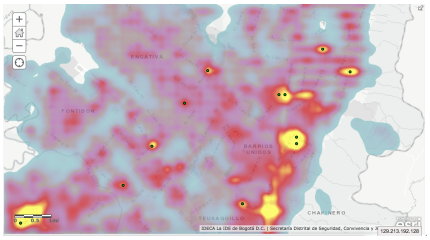
Prediction	KDE	fixed bw	variable bw
Week 1	0.42	0.44	0.57
Week 2	0.44	0.46	0.59
Week 3	0.53	0.54	0.62
Average	0.46	0.48	**0.59**

plain KDE. The results using the non-parametric *Wilcoxon signed-rank test* show that the self-exciting point process modeling of crime performs statistically better predicting crime in the city of Bogotá, Colombia, than other state-of-the-art crime prediction models.

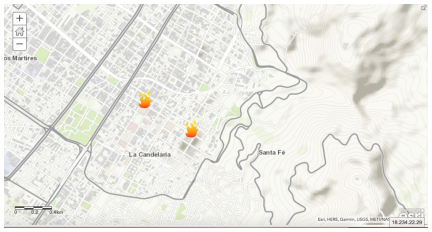
4 Deployment for the allocation of law enforcement resources

4.1 Hotspots prediction

We jointly developed a hybrid application (web and mobile) with local law enforcement authorities and Colombia's main research center on security studies to deploy our model in real-life field scenarios in Bogota.



(a) *Web based view of crime intensity over Bogotá*



(b) *Web based view of critical hotspots over Bogotá*

4.2 Surveillance cameras system

The hotspots model is the principal input used for the prioritization algorithms of cameras in the video surveillance system of Bogotá. The hotspots prediction model allows to prioritize the cameras that must be watched based on the estimated intensity of crime in the locations where cameras are installed.

4.3 Location-allocation of police stations

We solved the problem of location-allocation of police stations in Bogotá by using the crime intensity estimation and optimally assigning the location of stations following one of the following objective funcions: (i) minimize the sum of response times weighted by crime intensity from the police stations to any point of the city and (ii) cover a minimum rate of estimated crime with the minimum number of new located stations. Both of this problems where solved for the rural and urban areas of Bogotá separately, achieving a 37% reduction on the mean response time to priority rural locations by assigning 5 new stations.

References

[1] Barreras, F., Diaz, C., Riascos, A. y M. Ribero. Comparación de diferentes modelos para la predicción del crimen en Bogotá. *Economía y seguridad en el posconflicto.* H. Zuleta, Ed, 2019.

[2] Mohler, G. O., Short, M. B., Brantingham, P. J., Schoenberg, F. P. and Tita, G. E. Self-exciting point process modeling of crime. *Journal of the American Statistical Association Volume 106, Issue 493*, 2011.