ATENEO

Wenceslao González Manteiga
Universidade de Santiago de Compostela

Nonparametric spatiotemporal point process analysis of gunfire violence in the Rio de Janeiro metropolitan area

Abstract: The continuous increase of violent crime in Rio de Janeiro metropolitan area (Brazil) motivated the development of the collaborative mobile app "Fogo Cruzado" which delivers instant alerts every time a user reports a gunfire event. This app helps Rio residents avoid stray bullets and generates a valuable dataset. This study analyses the 5945 gunfire events collected by Fogo Cruzado during 2017. This dataset, which comprises the location and time of occurrence of each gunfire event, is a realization of a spatiotemporal point process marked by the number of injured and mortal victims, and by an indicator of police presence.

As statistical methodology we have applied nonparametric first and second-order inference to analyse spatiotemporal patterns of gunfire in Rio. Kernel intensity estimator allow us to describe the spatial distribution of gunfire and to identify chronic "hotspots". The "nonparametric test for comparison of first-order intensities" is useful to find differences between gunfire patterns with and without fatalities, whereas the kernel relative risk function can detect high mortality risk in areas with low gunfire incidence. A new "log-ratio based first-order spatiotemporal separability test" can detect if the spatial distribution of gunfire, fatalities and police presence varied over time. Finally,"spatiotemporal inhomogeneous K-tests" are applied to test for interactions between gunfire events up to a fixed distance. All the previous exploratory data analysis can suggest that a self-exciting point process with non-separable background component could be a suitable model to predict gunfire hotspots in Rio de Janeiro in the future.

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