

Time of Week Intensity Estimation from Interval Censored Data with Application to Police Patrol Planning

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Abstract : Law enforcement agencies are tasked with crime prevention and crime reduction under limited resources. Having an accurate temporal estimate of the crime rate would be valuable to achieve such a goal. However, estimation is usually complicated by the interval-censored nature of crime data. We cast the problem of intensity estimation as a Poisson regression using an EM algorithm to estimate the parameters. Two special penalties are added that provide smoothness over the time of day and day of the week. This approach presented here provides accurate intensity estimates and can also uncover day-of-week clusters that share the same intensity patterns. Anticipating where and when crimes might occur is a key element to successful policing strategies. However, this task is complicated by the presence of interval-censored data. The censored data refers to the type of data that the event time is only known to lie within an interval instead of being observed exactly. This type of data is prevailing in the field of criminology because of the absence of victims for certain types of crime. Despite its importance, the research in temporal analysis of crime has lagged behind the spatial component. Inspired by the success of solving crime-related problems with a statistical approach, we propose a statistical model for the temporal intensity estimation of crime with censored data. The model is built on Poisson regression and has special penalty terms added to the likelihood. An EM algorithm was derived to obtain maximum likelihood estimates, and the resulting model shows superior performance to the competing model. Our research is in line with the smart policing initiative (SPI) proposed by the Bureau Justice of Assistance (BJA) as an effort to support law enforcement agencies in building evidence-based, data-driven law enforcement tactics. The goal is to identify strategic approaches that are effective in crime prevention and reduction. In our case, we allow agencies to deploy their resources for a relatively short period of time to achieve the maximum level of crime reduction. By analyzing a particular area within cities where data are available, our proposed approach could not only provide an accurate estimate of intensities for the time unit considered but a time-variation crime incidence pattern. Both will be helpful in the allocation of limited resources by either improving the existing patrol plan with the understanding of the discovery of the day of week cluster or supporting extra resources available.

Keywords : cluster detection, EM algorithm, interval censoring, intensity estimation

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