Stockholm University

Mathematical Statistics
Stockholm University
Master Thesis **2015:10**
http://www.math.su.se

Spatiotemporal Outbreak Detection

A Scan Statistic Based on the Zero-Inflated Poisson Distribution

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October 2015

Abstract

Public health authorities continuously monitor reported disease cases, looking for patterns that suggest the beginnings of an outbreak. Such analysis increasingly has to be automatized, not least due to the sheer volume of data that is generated across hospitals and clinics on a daily basis. Scan statistics are statistical methods for detecting disease outbreaks in geographic and temporal clusters, which have seen great development in the last 20 years. This thesis contributes to this development by proposing a scan statistic based on the zero-inflated Poisson (ZIP) distribution, that draws inspiration from a recent article by Cançado et al. (2014). The ZIP distribution is appropriate when some local health centers lack the facilities to diag- nose a given disease or when reported counts are biased downwards; the latter could be due to e.g. underreporting or the lack of access to medical care for uninsured individuals. The performance of the proposed ZIP scan statistic is compared to two other scan statistics, the comparison made on both simulated and real outbreak data. Results from the simulation study indicate that the proposed scan statistic outperforms the two others, being able to more accurately detect outbreaks. Furthermore, an outbreak of the diarrheal disease *cryptosporidiosis* in a German city is analyzed; this outbreak was thoroughly investigated in a recent article by Gertler et al. (2015). A final contribution of the thesis is to provide free software in the form of an R package, scanstatistics, which is available online. This package complements existing R packages for disease surveillance and outbreak detection, such as the surveillance package (Höhle et al., 2015).

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