A Temporal Change-point Framework for Syndromic Surveillance in an Academic Environment

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OBJECTIVE

This paper describes a framework for an aberration detection method − change-point analysis for mean and variance − adapted for Poisson-distributed data, for syndromic surveillance in an academic environment.

BACKGROUND

The H5N1 avian influenza virus is now considered endemic in poultry in some parts of the world and the continued exposure in humans suggests that the risk of the virus evolving into a more transmissible agent in humans − a step towards worldwide pandemic – remains high [1]. Universities, with large assembly of students and student movements determined by the class schedules and travel routes between classes, in addition to the faculty and staff located in close proximity, are extremely susceptible environments to the spread of pandemic events. Moreover, large universities in the U.S. often have a good proportion of international students, who commute to/from their home country within their study period. Therefore, a good surveillance system to detect disease outbreaks is essential to support a system that is robust to this high impact low probability disruptive event.

METHODS

We propose an aberration detection tool, **change-point analysis**, commonly used in industrial application for detecting shift of mean and variance of a Normal process [2]. We analyze the robustness of the method when used for Poisson-distributed data (see Figure 1), as this type of count data is more often encountered in syndromic surveillance [3].

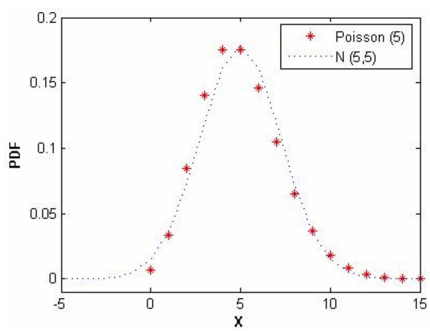

Figure 1 Poisson distribution overlayed on a Normal distribution with the same mean and variance

Compared to other monitoring tools (Shewhart, CUSUM, or EWMA charts), change point analysis gives additional information of **when** the data started to change significantly. As can be seen in Figure 2, the aberration is detected at time 26, but the time of change is estimated as time 24. This gives important information for the epidemiologic investigation to help determine the **onset of the epidemic spread**.

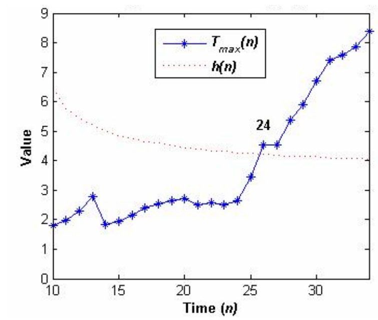

Figure 2 Adapted change-point analysis for count data

RESULTS

For syndromic surveillance in an academic environment, we propose a framework as follows:

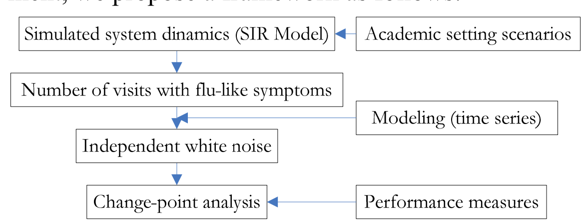

Figure 3 Framework for surveillance

The system dynamics are simulated according to nonlinear modeling of the classical SIR model [4]. The changepoint analysis is fine-tuned to a certain level of sensitivity, specificity, and PVP.

CONCLUSIONS & ONGOING WORK

With the proposed change-point analysis, we hope to achieve a timely detection of aberration essential to slow down or stop epidemic curve. As this is ongoing research, we plan to collect patient visits with flu-like symptoms from the University Health Services at Penn State to apply the change-point analysis.

REFERENCES

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