Distributed Multi-agent Architecture for Decision Support in Public Health Networks

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INTRODUCTION

One of the significant challenges that multi-user biosurveillance systems have is alarm management. Currently deployed syndromic surveillance systems [1–3] have a single user interface. However, different users have different objectives; the alarms that are important for one category of user are irrelevant to the objectives of another category of user. For example, a physician wants to identify disease on an individual-patient level, a county health authority is interested in identifying disease outbreak as early as possible within his local region, while an epidemiologist at the national level is interested in global situational awareness. The objective of a multi-agent decision-support system is not only to recognize patterns of epidemiologically significant events but also to indicate their relevance to particular user groups' objectives. Thus, instead of simply providing alerts of anomaly detections, the system architecture needs to provide analyzed information supporting multiple users' decisions.

METHODS

This paper describes a decision support system designed to address the requirements of a diverse group of experts involved in a collaborative network. The system consists of multiple intelligent models that have the capability to incorporate the dynamics of collaborative teamwork within data analysis algorithms. Furthermore, these models exchange information and emulate group behavior among the human collaborators, which will result in system responses that support cognitive decision-making. Each model targets a particular syndrome or disease type and supports a particular category of user, such as a local, state, or regional health department. Each model encapsulates the decision-making logic of the specific user category, and bases its decisions on both the data available to the user and the information received from other models. In this way, different categories of users will be able to share their analyses, which take into account their proprietary information but do not reveal specific data details. Each model's inference engine is built on an information fusion concept using Bayesian Networks [4].

RESULTS

Models for influenza-like-illness (ILI) were tested with syndromic data collected from several counties of the National Capital Region over a 3-year period. Results showed a significant decrease in false alerts compared to univariate time series detectors based on adaptive regression algorithms and control charts [5]. Results were compared to Public Health Department's annual influenza reports. Models were able to provide timely differentiation of ILI-relevant signals from other anomalies. Because of automated information exchange between neighboring counties, for the county where data were sparse, the timeliness of detections was improved by several days.

CONCLUSIONS

Preliminary results showed that a distributed architecture that supports information exchange has a potential to enhance the decision support capabilities of syndromic systems.

REFERENCES

1. Tsui, F.C., J.U. Espino, V.M. Dato, P.H. Gesteland, J. Hutman, M.M. Wagner. "Technical description of RODS: a real-time public health surveillance system." *J Am Med Inform Assoc 2003*;10:399–408.

2. Mandl, K.D., J.M. Overhage, M.M. Wagner, W.B. Lober, P. Sebastiani, F. Mostashari, et al. "Implementing syndromic surveillance: A practical guide informed by the early experience." *JAMIA 2004*;11:141–150

3. Lombardo, J.S., D.L. Buckeridge (eds.) *Disease Surveillance: A Public Health Informatics Approach*. Wiley-Interscience, Hoboken, NJ 2007; ISBN 978-0-470-06812-0.

4. Mnatsakanyan, Z., S. Murphy, R. Ashar, H. Burkom. "Hybrid Probabilistic Modeling and Automated Data Fusion for Biosurveillance Applications." *PHIN 2006* Atlanta, GA.

5. Burkom H. "Development, Adaptation, and Assessment of Alerting Algorithms for Biosurveillance." *Johns Hopkins APL Technical Digest.* 2003;**24**:335–342.