Chapter 18
Applying Dynamic Causal Mining in Health Service Management

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ABSTRACT

This article describes an application that illustrates the role of data mining technology in identifying hidden causal knoledge from health and medical data repositories. Across the health care and medical enterprises, a wide variety of data is being generated at a rapid rate. Current information technologies tends to focus on a more statical side of causal knowledge and do not address the dynamic causal knowledge. This article shows that the dynamic causal relation data can be captured for treatment, payment, operations purposes and administrative directed insights. Accessing this currently unrealized knowledge potential would enable the delivery of actionable knowledge to medical practitioners, healthcare system managers, policy planners and even patients to make a significant difference in overall healthcare.

LITERATURE REVIEW

Medical and Health Management

Patient record management systems is desired in clinical settings (Abidi, 2001; Heathfield & Louw, 1999; Jackson, 2000). The major reasons include physicians' significant information needs (Dawes & Sampson, 2003) and clinical information overload. Hersh (1996) classified textual health information into two main categories: patient-specific clinical information and knowledge-based information.

Knowledge management capabilities have been incorporated in many clinical systems since the 1980s in order to provide a better understanding and management basis. In the *HELP* system, decision logic was stored to allow it to respond to new data entered (Kuperman, Gardner, & Pryor, 1991). The *SAPHIRE* system performs automatic indexing of radiology reports by utilizing the UMLS Metathesaurus (Hersh, Mailhot,

Arnott-Smith, & Lowe, 2002). The clinical data repository at Columbia-Presbyterian Medical Center (Friedman, Hripcsak, Johnson, Cimino, & Clayton, 1990) is a database used for decision support (Hripcsak, 1993). Another clinical data repository is the University of Virginia Health System (Schubart & Einbinder, 2000). Case based reasoning also has been proposed in Montani and Bellazzi (2002). Janetzki, Allen, and Cimino (2004) use a natural language processing approach to link electronic health records to online information resources.

APPLYING DATA MINING IN MEDICAL AND HEALTH MANAGEMENT

Data mining has been used to extract diagnostic rules from breast cancer data (Kovalerchuk, Vityaev, & Ruiz, 2001). Data mining has also been applied to clinical databases to identify new medical knowledge (Hripcsak, Austin, Alderson, & Friedman, 2002; Prather, Lobach, Goodwin, Hales, Hage, & Hammond, 1997).

Dreiseitl, Ohno-Machado, Kittler, Vinterbo, Billhardt, and Binder (2001) compare five classification algorithms for the diagnosis of pigmented skin lesions. This is similar to the measurement of algorithmic performances in other areas applications (Yang & Liu, 1999). For example, Acir and Guzelis (2004) apply support vector machines in automatic spike signal detection in Electro-EncephaloGrams (EEG). Kandaswamy, Kumar, Ramanathan, Jayaraman, and Malmurugan (2004) use artificial neural network to classify lung sound signals into different categories.

Chrisman et al. (2003) incorporated biological knowledge and expression data using a Bayesian framework. Imoto et al. (2003) incorporated protein-protein interaction, protein-DNA interactions, and transcriptional factor binding site information. Text mining is used to study of protein interaction network inference (Iossifov et al., 2004).

System Dynamics has a number of strengths that make it especially useful in health care settings (Roberts & Hirsch, 1976). Some of the System Dynamics work in health care has been done by Pugh-Roberts Associates (Hirsch & Miller, 1974). The other area in which early work took place was community mental health (Levin & Roberts, 1976).

The Soundview-Throgs Neck community examined the forces contributing to a rapid rise in heroin addiction (Levin, Kirsch, & Roberts, 1972). A generic model of ambulatory care was developed to analyse economic performance of organization (Hirsch & Bergan, 1973). Another model developed for the State of Minnesota examined the factors affecting the success of new organizations, called Human Service Boards (Hirsch, Bergan, & Frohman, 1974). Two comprehensive System Dynamics models were developed to aid manpower policy formulation in dentistry (Hirsch & Killingsworth, 1975) and nursing (Bergan & Hirsch, 1976).

One model reflected the effects of such factors as the "technology gap" between the hospital and nearby community hospitals (Hirsch, Forsyth, Bergan, & Goodman, 1976). A model helped a medical school examine problems in its relationships with affiliated hospitals and restructure those relationships accordingly (Stearns, Bergan, Roberts, & Cavazos, 1978). Models created for project changes in areas' populations, health care consequences of those changes, and shifts in utilization patterns as a result of changes in resources available, insurance coverage, and various health policies (Hirsch & Henderson, 1977). Several modelling efforts, in fact, were designed to stop at the point where a set of causal diagrams had been completed (Stearns, Bergan, Roberts, & Quigley, 1976).

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