Addendum

Achieving Intelligent Clinical Decision Support through Orderset Management

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Abstract. A clinical information system[1] is one with which medics interact to enter orders of symptoms, tests and treatments. Such a system also contains patient demographic information; updated data regarding the patient's condition may be entered by the nurses or automatically through monitoring devices. An orderset is a list of physician orders that shares a common clinical indication and, thus reflects his/her decision with respect to a particular condition. Ordersets may be collected from clinical information systems and filtered to obtain the core of an intelligent decision support system, which may be used by physicians to prescribe diagnostic tests and treatment. This paper examines the possibility of applying instance-based learning techniques to orderset management to achieve the level of machine intelligence required for delivering such decision support.

1 Background

A number of clinical decision support systems that employ AI, neural networks, and fuzzy logic techniques are being developed. These systems integrate with a *computer physician order entry (CPOE)* system and extend its functionality with clinical decision support systems. The goal is to provide the physician with a quick way to prescribe orders which are then automatically entered into the CPOE and, most importantly, to reduce serious prescribing errors[2].

2 Introduction

An orderset is a list of orders that share a common clinical indication (eg. standard admission orders, preop cardiac catheterisation orders, ambulatory pneumonia). A particular orderset is thus associated with a clinical state that may explain a patient condition and thus reflects the physician's decision (or the medical institution's standard practice) with respect to a particular condition. Ordersets serve two potentially conflicting purposes:

- *Uniformity*: limiting the treatment variability by constraining the clinician's choices. This approach is mostly popular with academic medical centres or teaching hospitals.
- *Efficiency*: reducing the navigation effort required by the clinician to select orders. This is appealing to busy physicians as long as the automatically suggested ordersets fit their professional decision.

In a computerised approach, the physician enters orders via a CPOE, and thus this may be the basis for extended future clinical decision support. However every patient is unique and, if future decision support systems are to be widely accepted, they need to take the individual patient into account.

The proposed system shall be specific and attempts to suggest only orders which are relevant to the patient. In being specific however, the decision support mechanism shall not be insensitive to the physician's professional judgement and to make it difficult for him/her to select a different treatment. The ideal system is well balanced and, intelligently presents a menu of all applicable orders without the user having to navigate through a long catalog.

3 Physicians and Automated Decision Support

Physicians and hospital executives are known to differ highly in opinion over whether or not IT should play an important role in hospitals.

A survey conducted by a Chicago-based IT consulting firm, The Kennedy Group reveals that "Forty-eight percent of 31 physician groups surveyed are not at all interested in hospital-supplied technology; the rest express varying degrees of interest."[4] Table 1 shows the reasons provided for their stance on technology.

Table 1. Why Physicians are against CPOE (source: The Kennedy Group)

Do not want to share data	19.2%
Dislike hospital's system	19.2%
High cost	15.4%
Hospital system incompatible with practice's system	19.2%
Multiple hospital systems incompatible with each other	7.7%

Most physicians in community hospitals in the US are in private practice and thus the institution has limited leverage in insisting on deploying a decision support system. Catherine Sprague of The Kennedy Group explains that the physicians relish their clinical autonomy and "are very nervous about affiliating themselves with any one hospital, and they don't trust their data with them." Under these circumstances acquiring enough data to build suitable ordersets would be quite difficult. In the case of one of the most common CPOEs on the US market (Meridian), ordersets are created by and individualised for each physician and, not common across the institution.

However, CPOE is very likely to emerge as the next most important issue health-care information technology as it plays an important role HIPAA compliance and in reducing medical errors. It is interesting to note that a report conducted by the Institute of Medicine indicates that in the US alone 98,000 people die annually as a cause of *preventable medical errors in hospital*! [5] The Leapfrog Group suggests that as many as 50% of serious prescribing errors are eliminated by the introduction of a CPOE.

4 Patient-Centric Ordersets

Static ordersets are widely available but, although they hold generic treatment knowledge, they cannot focus on the needs of the individual patient. The future of clinical decision support lies in systems that make it *easier* for the physician to take the *right* decision. This is only really possible if the ordersets reflect the patient's individual conditions. Moreover, it is evident from Table 1 that 19.2% of the physicians in the field think that hospitals' recommendation to use static ordersets are incompatible with their practice. Physicians are not taught to care for patients based upon specific persisting complaints (as static ordersets suggest) but to analyse patient findings and, to derive hypothesis which may be subsequently refined as more knowledge about the patient is acquired. Reality thus asks for the creation of patient-centric ordersets which are assembled upon accumulated knowledge which is gathered about individual patients.

The proposed mechanism does not simply respond to diagnostic results but interprets them in a way that considers the individual patient. One of the major goals is to achieve ordersets of the right granularity, and thus ones that closely coincide with the conditions that physicians hypothesize on. Rules integrated with these ordersets may then dynamically generate the required patient-centric ordersets. In contrast with static ordersets, those orders which are contraindicated by one of the patient's conditions may be removed. An enhancement of the system would execute the individual rules for each order prior to its inclusion in the dynamically generated orderset. An adjusted order an alternative or a warning may then be communicated to the physician depending on the results.

4.1 Sources of information

We aim to build dynamic ordersets, and thus ones that are not just patient-centric but also willingly accepted by the clinician in practice. Although established preselected ordersets are historically not very popular with physicians in private practice, those provided by the following are worth mentioning as traditionally reliable sources of information:

- *Medical Publishers*: These include handbooks that act as disease-centric guides to diagnosis and therapy based upon a pathophysiological clinical model. This approach is thus in line with our requirement to produce ordersets of the 'right granularity' based on noticeable clinical conditions.
- *Professional Societies*: These societies issue guidelines for conditions and procedures for which a high degree of certainty in the appropriate treatment exists, and thus carry a significant weight with society members. They do not explicitly recommend individual drug or service selections, and leave room for physician practice; thus unfortunaltely these guidelines do not readily translate into recognised ordersets.

Whilst physicians in private practice will only term a working clinical decision support system as one that almost always suggests their desired choices in a generated orderset, they are very unwilling to surrender their clinical knowledge. The alternative is thus to examine past-patient records. A large set of hospital data is available for this project, where hospital, physician and patient identity have been masked but, still hold unique identifiers. The patient records also use standard ICD-9-CM/CPT-4 diagnosis/procedure codes. This provides us with a suitable indication of orders received by patients and the possibility to apply and examine the effectiveness of instance-based learning.

4.2 Learning Strategy

Our strategy on learning consists in isolating the treatment which is determined to be closest to past-patient occurences. Thus the records described above are our training samples and we generalise beyond these examples to decide on which ordersets to suggest. In so doing we hope to be able to obtain orderset which are:

- closest to the patients current condition;
- in line with the physician's general practice, as we are able to use datasets exclusively provided by the practitioner;
- also be in line with the most updated clinical practices as we utilise recent datasets.

One clear disadvantage is the cost of classifying new ordersets and the fact that in seeking to find similar training examples all attibutes of the instances are considered. This poses high inefficiency levels especially when the size of the datasets is very large, and we seek to utilise efficienct indexing for our training samples.[6]

5 Conclusion

This work focuses on achieving good results in learning from records of past patients. In demonstrating these capabilities we concentrate on admittance and discharge orders for in-patients. We hope to succeed to show that a mapping between their conditions and the treatments prescribed may yield good decision-support capabilities for future patients exhibiting similar clinical states.

References

1. E. J. Davidson and W. Chismar, *Examining the Organizational Implications of IT Use in Hospital-based Health Care: A Case Study of Computerized Order Entry* 32nd Hawaii International Conference on System Sciences, 1999
2. W. Raghupathi and J. Tan, *Strategic IT Applications in Healthcare* Communications of the ACM Vol. 45, No. 12, 2002
3. J. Tan and S. Sheps, *Health Decision Support Systems* Aspen Publishers, Inc., Gaithersburg, MD, 1998
4. N. Versel, *Tech survey finds opinions vary on value of hospital IT* Modern Physician Magazine, July 2003
5. Kohn LT, Corrigan JM, Donaldson MS eds. Institute of Medicine *To Err is Human, Building a Safer Health System.* National Academy Press, Washington, DC, 1999
6. T. Mitchell *Machine Learning* McGraw-Hill, 1997, ISBN 0-07-115467-1

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