DESIGN OF INTELLIGENT CLINICAL DECISION SUPPORT SYSTEMS: TECHNOLOGIES AND ISSUES

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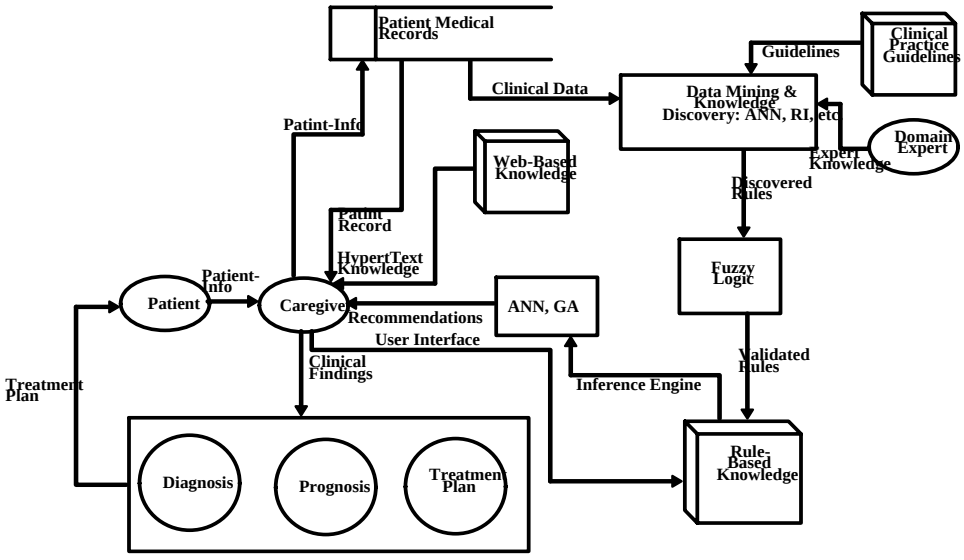
INTRODUCTION

Clinical Decision Support System CDSS are by and large intended to support healthcare workers in the normal course of their duties, assisting with tasks that rely on the manipulation of data and knowledge. A clinical decision support system is not a single information systems or technology. It is an integrated system that frequently includes more than one type of information system or technology including Expert Systems, Artificial Neural Networks, Genetic Algorithms, Fuzzy Logic, Rule Induction, Machine Learning, and Hybrid Intelligent Clinical Systems. Hybrid Intelligent Systems (HIS) is a term used to describe combinations of technologies such as Expert Systems (ES), Artificial Neural Networks (ANN), Rule Induction (RI), Fuzzy Logic (FL), and Genetic Algorithm (GA) based systems. This integrated technology has found widespread use and acceptance in the field of financial services, marketing and manufacturing.

While there are no commercially available systems, this may be attributed to the fact that such systems need to be customized to the requirements. Most research on HIS has been centered on proposals, case studies and laboratory studies of experimental systems. Many strategies have been proposed for the integration of ES and ANN into HIS that is capable of delivering increased performance and overcomes the shortcomings of the individual components.

HYBRID INTELLIGENT CLINICAL DECISION SUPPORT SYSTEMS

In this section I propose a framework for developing a hybrid intelligent clinical decision support system that supports rule induction, fuzzy logic, neural networks, and genetic algorithm. The framework is composed of the following major parts and is illustrated in Figure 1:



User Interface. During consultations both caregiver and patient review data. Observations, management plans, and prescriptions are entered by the caregiver.

Medical Records/Clinical Data Mart. Caregivers need clinical information during consultations and this need could be satisfied by an integrated computerized patient medical record system.
Web-Based Knowledge. The framework is based on the concept of integration of hypertext and rule-based decision support systems. The hypertext knowledge base consists of a set of validated hypertext pages inter-linked using Internet and Intranet capabilities.

Data Mining & Knowledge Discovery. Clinical medical records and databases contain a large volume of information about patients and their medical conditions. Relationships and patterns within this data could provide new medical knowledge. Data mining techniques such as ANN and RI could be applied to discover this hidden knowledge. The discovered knowledge, once it is validated, could be incorporated into the rule-based knowledge.

Fuzzy Logic. One major problem in successful operational zing of expert physician's knowledge and practice guidelines is difficulty in accurately representing and executing clinical rules. Both require reasoning with incomplete and imprecise information. Fuzzy logic could be applied to the domain knowledge in designing rule-based knowledge system.

ANN, GA. In the proposed framework, the reasoning module would be integrated with ANN and GA capabilities. ANN technique could be used for prognosis. GA could be used to optimize the treatments and prescriptions in terms of effectiveness and cost.

DEVELOPMENT OF CDSS AND COGNITIVE EFFORT

Unfortunately, there seems to have been little connection between the technical developments of decision support systems, and the work on the cognitive aspects of clinical decision making. Yet it is the cognitive motivations that should identify which aspects of clinical tasks should be supported by a decision support system.

Given cognitive limitations, the need for clinicians to simultaneously manage a large number of decision inputs and information supplies presents a serious problem, the so-called "knowledge-performance gap". From the perspective of the DSS user the tradeoff between the amount of effort put into problem solving and the benefits expected from it should be left to the user's discretion and not imposed by the system. From the perspective of the DSS designer, the existence of a tradeoff implies that it is difficult to determine the benefits of a DSS precisely in terms of efficiency or effectiveness. Therefore, the lack of an improvement in effectiveness should not necessarily be considered a failure of the DSS if one believes that is should be nondirective. In addition, the designer may face other pressures from organizational forces. For example, the organization may dictate certain desirable problem-solving strategies and direct users toward them. Though these can be built into a decision aid, they may not be used by the decision-maker unless they are implemented with a thorough understanding of the effort factors associated with their use.

CONCLUSIONS

Healthcare has begun to flounder in the mounting flood of data available from automated

monitoring equipment, microprocessor controlled life-support equipment, such as ventilators, ever more sophisticated laboratory tests, and the myriad of minor technological wonders that every hospital and clinic seem to collect.

Clinical Decision Support Systems must be deigned and implemented effectively if they are to be used and influence the behavior of caregivers. In this paper we proposed a framework for developing Clinical Decision Support Systems that identifies data mining techniques, fuzzy logic, Genetic Algorithm, hypertext technology needed to be integrated with traditional medical expert systems. These techniques have desirable characteristics that, when combined, can lead to superior systems. Hybrid Intelligent Systems (HIS) are still in infancy and riddled with challenges, but the concept shows promise. Clearly, HIS is the path that information technology should take to incorporate the new technologies into feasible and commercially viable applications. HIS have served to alter the focus of developers from innovation from within the field to seeking possible solutions and inspiration from outside the field.

References are available upon request.