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Synopsis

Knowledge Processing and Decision Support Systems

Healthcare has undergone a revolution over the last thirty years. Modern healthcare is provided in close co-operation between many professional groups and institutions. Patient management organizations and healthcare networks make it possible to give healthcare providers access to the right information when they need it. The need for sharing information and knowledge is growing: shared records, professional guidelines, prescriptions, shared care protocols, public health information, health care networks, etc.. As a result of this growing demand, the topics of knowledge representation, ontologies and knowledge processing are more than ever core subjects of research and development in health care systems.

“Knowledge Processing and Decision Support Systems” is the title of this section of the Yearbook. It includes five papers. The methods of knowledge representation, reasoning, management of uncertainty and the strategies of using the knowledge bases has traditionally been an active area of research in Medical Informatics. The concepts, methods and techniques embedded within knowledge processing approaches constitute powerful aids to clinical decision making. The papers in this section encompass a variety of application areas: semantic lexicon for medical language processing, computational biology, patient decision support, practice guidelines, repro-

gramming cardiac pacemakers. While knowledge processing issues are addressed in all papers, the main emphasis in some of them is on decision support aspects.

The first paper of the section, by SB Johnson is entitled “A semantic lexicon for medical language processing” [1]. There is a strong emphasis on this topic in the medical domain. The needs for standards, semantics, coding and datasets (language and terminology) are clear and essential.

The objective of the Johnson study is the construction of a resource that provides semantic information about words and phrases to facilitate the computer processing of medical narrative and clinical reports.

While there are many important outcomes in the processing of medical text, one of the most fundamental issues is how to represent the meanings of individual words and phrases in the computer. Since most human knowledge is recorded in linguistic form, computer systems able to understand natural language could access all this information. Such systems would be considerably more flexible, intelligent, interoperable and adapted to medical applications than current systems. So, semantic information is central to the successful development of such systems and to the discipline of medical informatics.

Johnson’s paper investigates how a semantic lexicon can be constructed

by building on the Specialist Lexicon in the Unified Medical Language System (UMLS). The author demonstrates in this work that it is possible to construct a semantic lexicon of more than 75,000 entries automatically from UMLS resources.

The second paper, by RO. Chen and RB Altman, is entitled “Automated Diagnosis of Data-Model Conflicts Using Metadata” [2]. It presents a methodology for helping computational biologists diagnose discrepancies (called “data-model conflicts”) encountered between experimental data and the predictions of scientific models. The ribosome structure problem illustrates how metadata can be used diagnostically.

The authors’ hypothesis is that systematic collection of metadata about a computational process can provide information for supporting automated diagnosis of the conflicts. The implementation, a knowledge based system, GRENDEL, illustrates how to diagnose data-model conflicts using rich representations of scientific information. This produces capabilities for supporting scientific reasoning. The output of the GRENDEL system is a list of the most likely causes of a given data-model conflict. GRENDEL achieves this diagnosis by modeling the computational process that gives rise to the data-model conflict, by generating a diagnostic Bayesian belief network,

and instantiating and performing inference on the diagnostic belief network in order to generate a list of possible diagnoses.

The GRENDEL project is a good example of research orientations today. The methodology presented merges two lines of work: techniques for structured, semantically rich representations of scientific information, and tools for probabilistic diagnosis and capabilities for supporting scientific reasoning.

The paper by LA Lenert and DJ Cher entitled "Use of Meta-analytic Results to Facilitate Shared Decision Making" [3] describes and evaluates an Internet-based approach to patient decision support.

Increased patient participation in the process of health care is one facet of a more global trend of modern societies. Herein citizens no longer passively accept decisions that concern their lives or their environment. Patient empowerment is expected to improve outcome and cost effectiveness (Patient empowerment can be defined as "the increasing ability of patients to actively understand, participate in, and influence their health status" [4]). It is important to ensure that appropriate methods and tools enable the patient to be an active, well informed actor in the health system.

In this paper, a system was developed to help patients with benign prostatic hypertrophy determine whether they wished to use alpha blockers. The system predicts the probability of successful treatment by using mathematical models on the basis of meta-analytic summaries taken from the results of randomized trials of the alpha blocker terazosin.

The paper presents an interesting way to encourage patient participation in medical decision making. Overall, the results of the evaluation show that satisfaction with the system was very high. Patients found the information

useful and most (71%) believed this type of information should be discussed before prescribing medications. Integration of patient preferences into the process of medical decision-making has received growing attention from health professionals. Access to decision support tools on the Internet (e.g., individualized risk assessment, symptom interpretation, search for drug interactions, prognostic calculations) can all help patients better grasp their condition and formalize their expectations.

Practice guidelines are increasingly being used in clinical care to improve its quality. In the last few years they have become important in research, implementation and standardization.

Paul A. de Clercq et al. in "A strategy for developing practice guidelines for the ICU using automated knowledge acquisition techniques" [5] present an approach to implement practice guideline in a reminder system.

The process of guideline development is very time consuming. The hypothesis of the authors is that an automated knowledge acquisition environment would enable physicians to formulate, update and verify guidelines without the assistance of a knowledge engineer. They designed and developed such a tool to facilitate the guideline development process.

Many people working in medical informatics have suggested that the creation of a standard syntax for representing knowledge would facilitate knowledge re-use. This is another point underlined by the authors. The solution proposed for sharing the guidelines with other ICU departments is an "exportable guideline" using the Arden syntax format.

The 58 guidelines entered into the reminder system's knowledge base were tested on a data set of previously admitted patients. The performance of the 27 guidelines that fired is presented in detail. 12 % of the generated reminders were false alarms due to an

incorrect or excessively generic guideline. The guidelines could be improved in such a way as to eliminate false alarms. The results reported demonstrate that the strategy implemented enables medical specialists to improve the quality of computer support in an ICU without the assistance of a knowledge engineer.

The paper by PJF Lucas et al. "An intelligent system for pacemaker reprogramming" [6] is the last article of this section. Modern pacemakers are sophisticated electronic devices and reprogramming them is not an easy task. It has been observed that in many patients a given pacemaker therapy is suboptimal. Pacemaker equipment producers are beginning to realize that some form of intelligent decision support is needed to benefit the patients. In this paper, the process of reprogramming a pacemaker is formalized as a special form of abductive diagnostic reasoning. The process has much in common with the process of diagnostic problem solving. Diagnostic problem solving consists of observing results, finding possible causes of observed abnormalities, suggesting tests capable of discriminating between causes of the problems suspected. From a theoretical point of view, the authors advocate that, for the problem of reprogramming a pacemaker, causal models of abnormal behavior are sufficient as a basis for domain knowledge. The performance of the system has been evaluated using data from actual patients in a retrospective study.

The system actually only covers part of the entire domain and in its present form is capable of assisting cardiologists in dealing with problems in atrial sensing and pacing.

About forty years after the beginning of medical informatics and research in decision support sys-

tems, we record the lack of medical terminology standards, the lack of coherent healthcare information systems, and the lack of a knowledge management culture in healthcare systems. Efforts should be made to promote problem solving and decision support throughout the healthcare system and to transform pilot developments and studies into real applications. The selected papers give evidence of these efforts. They are interesting contributions to the improvement and further development of clinical and biological support.

References

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