KNOWLEDGE ACQUISITION USING SYNTACTIC TIME PATTERNS

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ABSTRACT

For knowledge acquisition based on time oriented data we describe a tool to be used for clinical research in the intensive care setting of liver transplantation. The tool incorporates a time model derived from Allen's concepts [1]. Interactive definition and refinement of concepts can immediately tested on the data. The resulting output covers not only time intervals of the knowledge based classification process but also rule and frame based definitions of concepts. The first evaluation results are very encouraging. This knowledge acquisition tool is seen as one additional tool complementing classical ones as statistical packages, for example.

1. INTRODUCTION

Physicians are used to rely on clinical concepts or hypotheses about physiological processes when diagnosing patients and selecting an appropriate therapy. In the intensive care unit setting, most of these concepts deal with changes of the temporal behaviour of manifestations. Manifestations are symptoms and signs reflecting the actual state of the patient. They are modified by therapeutical interventions, therefor the underlying process (disorder etc.) will be reflected best by the values of parameters and signs before the intervention takes place. However, the physician has to intervene as fast as possible to prevent an disorder from developing in its full strength and then become a high risk for the patient. Consequently, when modeling clinical concepts we have to be aware of the fact that a developing disease can be observed only a very short time free from any influence. Considering the purpose we want to model our concepts for, we can distinguish to main application areas: For decision support a concept (e.g. clinical diagnosis) has to be recognized as early as possible in the patient's course. Information is obtained only from that part of the process developing free from interventions. For retrospective classification tasks we can use the full development of the process (e.g. a typical response pattern to the therapy). The tool we developed
for modeling concepts iteratively in the area of liver transplantation serves both the purposes, decision support and retrospective classification.

Data are stored in the LTX registry in a data base being constructed for research purposes [23], using a time oriented data base for routine data on a daily basis (lab and physiological data, types of immunosuppressive and antibiotics therapy. [6] and [4] deal with objections against obtaining clinical knowledge from routine data bases. We tried for the LTX registry to meet most of them by collecting the data in a prospective manner.

The registry provides a very good basis for our investigations, because a large amount of data is continously monitored. However, although relatively easy obtainable these data only reflect physiological processes. The process behind can only be judged considering the time course and actual state of the patient. Therefor the analysis can not start with the raw data coming directly from the patient (or device resp.). The experienced physician recognizes patterns consisting of changes in time and judges relative changes (mostly of lab values) also adjusting for the clinical context. When modeling this process for computer application, the data are to be transformed and adjusted to cope for the time course in the patient's setting and treatment.

We had to modify standard approaches for several reasons. Disorders develop in a few days, therefore methods from time series analysis do not apply. In situations easy to identify (e.g. beginning of the course) we successfully applied discriminant analysis to develop a score [11] for decision analysis [13]. Linear or logistic discriminant analysis seems to be promising for this purpose. For other approaches see [15] using factor analysis and [16] using synchronization of events.

Time oriented data are stored on a day by day basis, thus the time pattern is not directly accessible by a data base query, for instance. Solutions for these problems have been proposed for specific contexts. For monitoring in an intensive care unit in VM [7], a rule-based approach, predicates are provided to query for time intervals or also on different therapeutic situations. RX [3] can derive simple structured disease episodes and time intervals from manifestations in the data base. These are used to automatically recover causal relationships in the data. Parts of ONYX [14], built to support therapy planning in oncology, detect unusual time-dependent patterns in chemotherapy cycles by enhancing a rule-based knowledge base by an ATN. This also suggested that a combination of methods of statistics and AI may help, as it did in our case.

Hence in the sequel we describe an approach to model time oriented clinical concepts.

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1. We must distinguish between time oriented data bases we are dealing with here and temporal data bases being used to query concurrent events along a time axis of calendar time. These are used to retrieve historical versions of data. The methods applied are in some regard similar to these applied here [10].