Medizinische Anwendungen der AI am IMC

AI Projects at the Section on Medical Expert and Knowledge-Based Systems

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The Subject Matter

The subject matter of this scientific and, to an increasing extent, practical focus of medical computer science is the basic research, practical development, and clinical application of methods and systems for **processing medical knowledge** in the course of interpreting medical findings, providing diagnostic support and therapy advice, giving hints for disease prognosis, guiding patient management, and monitoring hospital and patient's medical data and costs.

Expert systems and knowledge-based systems in medicine help in the manipulation and application of expert medical knowledge. The growing complexity of the fund of knowledge makes the application of such systems more and more indispensable. Provided they are used correctly, they also reduce much of the repetitive and specialised mental efforts made by the treating physician and enable him to devote his attention to the personal care of the patient.

Technically, medical knowledge is processed by computer systems which, on the basis of stored knowledge and current medical and administrative data of a patient, **provide a range of alternative suggestions** in the course of patient care.

The purposes of these decision-oriented suggestions are as follows:

- to ensure quality and to improve **the patient care**,
- to provide comprehensive **quality management** under consideration of medical working processes and administrative conditions, and
- to ensure an efficient and cost-oriented utilization of available **resources**.

The Beginning

The establishment of the Computer Station of the University of Vienna Medical School in 1968, thanks to the efforts of Professor Fellinger (this Computer Station later became the present Department of Medical Computer Sciences), marked the beginning of computer-based diagnosis in our institution [1]. At this time it was suggested that procedures based on mathematical logic should be used to support differential diagnosis in internal medicine. This was tested and proved successful in the fields of hepatology and rheumatology.

Success Achieved thus far

Based on this work, programs for supporting differential diagnosis in internal medicine, namely CADIAG-I, -II [2], and -III were developed. These programs formed attempts to resolve the same medical problems by means of different formal methods of presenting knowledge and drawing logical conclusions (e.g., KLEENE's trivalent logic, predicate logic, fuzzy set theory and fuzzy logic) to follow the human diagnostic process more adequately. They were also tested as part of the medical information system WAMIS [3]. Simultaneously, HEPAXPERT [4] and TOXOPERT [5] were programmed for knowledge-based interpretation of hepatitis and toxoplasmosis serology findings and were integrated into the respective laboratory information systems. Furthermore, the conception of ARDS monitoring in intensive care medicine by means of fuzzy automata, the system is called FuzzyARDS/MONITOR [6], for computer-based optimisation of patient's weaning from the respirator using fuzzy control, denoted FuzzyKBWean [7], were completed and subjected to initial clinical testing.

Current Developments

The ongoing developments were concentrated into the expert system MedFrame [8] which is based on modern client/server architecture. Through this expert system it will be possible to implement differential diagnostic and therapeutic consultation systems as well as knowledge-based laboratory interpretation and monitoring systems for intensive care medicine and hospital hygiene. A large number of interfaces to various information systems and WWW compatibility will be part of MedFrame so that this system will also serve as a worldwide medical knowledge base server. In addition to the above mentioned fields, knowledge bases for rheumatology, hepatology, and gastroenterology (in the course of the CADIAG-IV project) and for monitoring nosocomial infections which is part of the MONI system [9] are either being revised or in the process of being defined.

Implementation as a Clinical Prototype and Evaluation Studies

A series of systems have been created and evaluated as prototypes; in some cases they have been fully integrated into the respective medical information system. Especially worthy of mention are the following: software modules for germ, antibiogram, and cross-infection monitoring which are part of the MONI program, the integration of FuzzyKB-Wean into the patient data management system PICIS and its clinical test operation, furthermore the complete re-implementation of MedFrame as a frame program (expert system shell) for medical expert system applications in the object-oriented data base POET [10] and the evaluation of CADIAG-II/RHEUMA [11] and CADIAG-II/COLON [12]. Of special importance is RHEUMexpert which was developed in cooperation with the Austrian Society of Rheumatology and the industry. RHEUMexpert is a medical documentation system with attached decision support fo the practising physician.

Application in the Course of Health Care or as a WWW Program

Close cooperation with the industry and the municipal authorities of Vienna has made it possible to transform some of our developments into IT products. The routine application of the microbiological data base with the hospital information system connection required for it, and the hospital-wide evaluation of bacteriological findings has been started. The implementation of the tested prototypes for germ, antibiogram, and cross-infection monitoring is currently under way. Also the creation of an IT system for the toxoplasmosis laboratory with integration of the knowledge-based medical report interpretation system TOXOPERT is currently in progress. In keeping with the rapid developments in the field of Internet, several systems have been transformed into WWW applications. Especially

significant in this context is the assembly of the medical knowledge base server MedExpert/WWW with the programs HEPAXPERT-III [13] and ToxoNet [14], a program for calculating the Larsen score for the radiological evaluation of rheumatoid arthritis [15], and with the WWW European study system FuzzyARDS/STUDY [16].

Separating method-oriented basic research and the development of prototypes from clinical routine IT systems has been especially successful in the last two years. This has been achieved by the University-based institutions on the one hand and by the transformation of the prototypes into IT products (through the industry) on the other. Both, method-based applied research as well as the transformation of systems developed on the basis of interdisciplinary cooperation into routinely usable software products were thus achieved in a highly satisfactory manner.

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