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EXPERT WITNESS - A SYSTEM FOR DEVELOPING EXPERT MEDICAL TESTIMONY

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ABSTRACT

Expert Witness is an expert system designed to assist attorneys and medical experts in determining the merit of medical malpractice claims in the area of obstetrics. It this by substitutes the time of the medical expert with the time of a paralegal assistant guided by the expert system during the initial investigation of the medical records and patient interviews. The product of the system is a narrative transcript containing important data, immediate conclusions from the data, and overall conclusions of the case that the attorney and medical expert use to make decisions about whether and how to proceed with the case. The transcript may also contain directives for gathering additional information needed for the case.

The system is a modified heuristic classifier and is implemented using over 600 CLIPS rules together with a C-based user interface. The data abstraction and solution refinement are implemented directly using forward chaining production and matching. The use of CLIPS and C is essential to delivering a system that runs on a generic PC platform. The direct implementation in CLIPS together with locality of inference ensures that the system will scale gracefully. Two years of use has revealed no errors in the reasoning.

1. INTRODUCTION

When preparing a medical malpractice lawsuit, an attorney must identify the relevant facts and use them to decide first if the case has merit. Usually, the attorney consults a medical expert to evaluate the client's medical records and to advise the attorney. The problems for attorneys and clients is that medical experts are both expensive and relatively scarce, the problem of determining fault is tedious and time consuming, and the case load is growing.

Our approach to this problem is to make a preliminary determination of merit without investing large amounts of time from a medical expert. Using an expert system called Expert Witness, the paralegal staff can be guided in their examination of medical records and conducting of client interviews. After data collection, Expert Witness produces a transcript of reasoning that aids the attorney and medical expert in determining the validity of a case. The transcript is very similar to what the medical expert would also have produced, except that it was created with far less expense. By taking this approach, an attorney can determine the preliminary merits of a lawsuit while saving substantial amounts of money. The attorney and medical expert can take on more work. Deserving cases are more likely to be pursued because more cases can be handled overall. Fewer non-meritorious, wasteful cases need be pursued, resulting in saved expense and anguish. Overall, in two years of operation, Expert Witness has been tested in 10 legal offices on numerous cases with no complaints, and based on the success of the system, significant development is planned to greatly expand its coverage.

This paper describes the functional architecture, the implementation, the history, and the plans for expansion of Expert Witness. It begins with a functional overview of the Expert Witness in Section 2. After the functional description, some typical cases are described in Section 3. In Section 4, the implementation of the current system in CLIPS and C is described, as is the history of the project, and the future directions. Results and conclusions are given in section 5.

2. FUNCTIONAL DESCRIPTION

The current domain of expertise for Expert Witness is obstetrical malpractice. The overall context in which Expert Witness determines the extent of medical malpractice is shown in Figure 1. To determine the fault of medical personnel, Expert Witness directs a paralegal in the search for relevant medical facts from patient records and patient interviews. Such information includes the family history, the patient history, the history of the mother prior to birth, the events and medical procedures performed at birth, and subsequent tests and treatment. Expert Witness builds a case file for each client. This multiple client feature allows the paralegal to start and stop data collection corresponding to the availability of information and access to the client. When sufficient data has been collected, a narrative transcript and a fact summary is produced. The narrative transcript is similar to what the medical expert would have produced. It marks the important details, such as confirming or disconfirming evidence, presents reasoning chains based on evidence, suggests further tests, and derives conclusions regarding the viability of the case. The transcripts and the fact summaries are used by the attorney and the medical expert to make the final decision whether malpractice contributed to the client's condition, and also to determine what additional data need collected. The general philosophy embedded in Expert Witness's knowledge is to only make conservative conclusions, based on practice that is well accepted in the field.

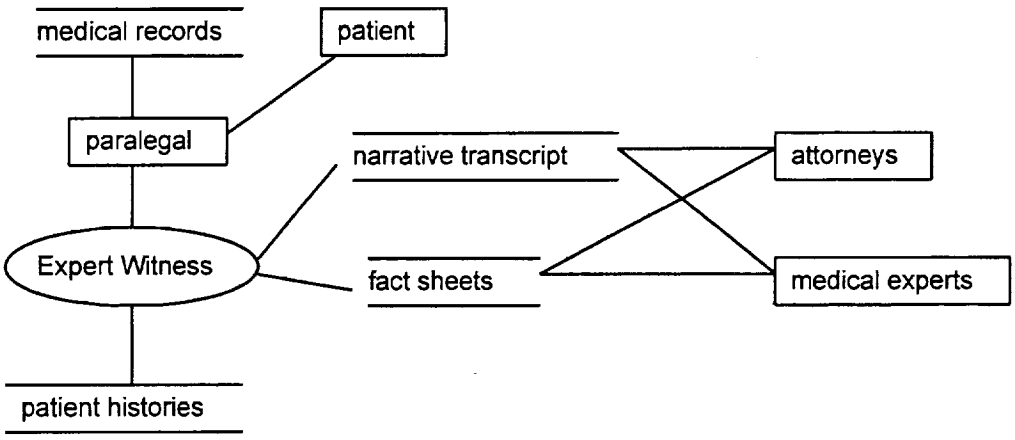

Figure 1. Context of Expert Witness

3. EXAMPLE CASES

The following cases are summaries of two actual cases handled by Expert Witness.

Case I

An infant was born with apgar scores of 8 and 9. The birth weight was six pounds. During the mothers labor, monitoring indicated that the baby was in distress. In response to the data suggesting distress, the physician treated the mother and reviewed the mother's medications. It was found that one of the medications that the mother was taking is known to create false positive findings of fetal distress. Normally, the distress patterns would have lead to a cesarean section. By reviewing the data correctly, the physician avoided an unnecessary surgery which carries added risks for the mother. The Expert Witness program analyzed the data and advised the user that the physician had acted appropriately based upon the facts presented. This analysis prevented a potentially frivolous law suite.

Case II

A child is known to be mentally retarded. The child was born with apgar scores of 2 and 5. During labor, the mother had a biophysical profile which was abnormal. After delivery, the infant developed low blood sugar and seizures. Family history revealed that the mother has a nephew by one of her sisters who is also mentally retarded. The Expert Witness program analyzed the data and advised the user that there appeared to be some improprieties on the part of the physician during the mother's labor that could have contributed to the child's present condition. It also noted, however, that there may have been a pre-existing condition which may be the main contributor to the child's problems. It suggested that further analysis is necessary. This is a case that deserved further in depth analysis by actual expert witness physicians.

4. IMPLEMENTATION, HISTORY, AND FUTURE DIRECTIONS

Expert Witness is used cyclically to build up a patient file. Within each cycle there are two stages, data collection and data inference. Data collection is done interactively as the paralegal presents known information to the system through a text based user interface written in C. Once all known information is provided, the inference phase begins, and the known data are analyzed to determine what conclusions are able to be made and what they are. When more information is needed, additional data are suggested in the transcript. The medical expert may also direct the paralegal to obtain more information. The next cycle of data collection/inference process allows direct entry of any additional information, and produces a more complete narration.

The inference part of the system is written in CLIPS 4.3.[1] Over 600 rules constitute the knowledge base. The basic architecture is an elaboration of the heuristic classification model.[2] Initial data are abstracted from quantitative values to qualitative categories. Matching, based directly on CLIPS rule matching, is used to determine the first level of solutions in the form of direct conclusions in the narrative transcript. Additional reasoning is performed to produce the next level of conclusions, based on the initial level. In contrast to some heuristic classifiers which seek to produce one conclusion and may take the first one that is satisfactory, Expert Witness makes all conclusions that it can. It uses a mix of reasoning methods, using some data to strengthen and some data to weaken conclusions. It does not use certainty factors or other approximate reasoning methods, since the qualitative representation of strength of belief using basic CLIPS was adequate for the conservative reasoning philosophy adopted for the system.

The performance of Expert Witness has been very good. The knowledge used has generally been localized, and the reasoning chains have been kept relatively short. Factoring of the rule base into a number of independent subsystems for determining the first level of conclusions has also helped. The second level conclusions are made using a rule base that is loaded after all first level conclusions have been made.

Expert Witness was built over a period of 5 months beginning in 1991. The initial knowledge engineer and expert was Dr. Ray Lewandowski, a medical consultant and clinical geneticist. The user interface was constructed by David Perkins at Texas A&M University-Corpus Christi. The system has since been used by ten attorneys and their staff. Follow-up consultations are performed with Dr. Lewandowski. Plans are underway to increase the number of users. In the several years since being introduced in the field environment, no incorrect recommendations have been made, and much time has been saved.

Based on the success of the initial system and demands of the users for broadening the scope of application, additional experts are currently being interviewed in the areas of neonatology, expanded obstetrical coverage, and hospital practices and procedures. Additional modules beyond those are in the planning stage. No significant changes to

the structure of the knowledge base are expected. Knowledge should remain localized, and the performance penalty should grow linearly with the number of systems. Each system will be incorporated so that it can function as a stand-alone or integrated component of the entire system.

5. RESULTS AND CONCLUSIONS

The system has since been used continuously since its development by ten attorneys and their staff. In the several years since being introduced in the field environment, no incorrect recommendations have been made, and much time has been saved. Based on this extended success, plans are underway to increase the number of users and the scope of the system's coverage.

A critical success factor for Expert Witness, aside from the quality of the knowledge base, has been the need for it to run on a generic hardware platform. The use of CLIPS has allowed us to keep the system small, while maintaining speed and ease of programming, both because the inference component is small and because it easily interfaced with a compact C user interface.

The second critical success factor derived from CLIPS is the suitability of the forward reasoning and matching to the application and representation of the knowledge. Although CLIPS would have allowed it, no meta-level reasoning was necessary. This simplicity allowed the knowledge base to grow to over 600 rules without greatly affecting the structural complexity of the knowledge or the cost of using it. On the face of it, the plainness of the knowledge representation as rules speaks against this system when compared to more complicated knowledge structures and control regimes, but in reality, the degree of fit between the knowledge and the inference system has allowed us to create and maintain a reasonably large knowledge base cheaply and reliably. This simplicity is crucial for us when we consider expanding the knowledge base as much as fivefold, which we intend to do.

REFERENCES

[1] CLIPS Release Notes, Version 4.3, NASA Johnson Space Flight Center, June 13, 1989.

[2] Clancey, W. J., "Heuristic Classification," *Artificial Intelligence*, **27:3**, December 1985, pp. 289-350.