Object-Oriented Knowledge Modeling Meets Knowledge Acquisition: PROTÉGÉ-II Supports MEDFRAME/CADIAG-4

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A medical diagnostic and therapeutic consultation system, called MEDFRAME/CADIAG-4, is developed to support diagnostic and therapeutic decision making in various subdomains of internal medicine.[1] To encompass some of the limitation of its predecessor systems, MEDFRAME/CADIAG-4 has been completely redesigned to (a) account for today's demands for client/server-based, platform-independent systems, (b) use flexible object-oriented knowledge-modeling techniques, and (c) provide interoperability with medical terminology and knowledge servers.

The object structure of MEDFRAME/CADIAG-4's knowledge base was analyzed using the *Syntropy* method, a second-generation method for object-oriented analysis and design.[2] This method allows for an implementation-independent, but still semantically meaningful representation (and checking) of the knowledge types and relationships that are needed to model a complex knowledge-based system. However, a common shortcoming of such design methods is the lack of appropriate tools to actually *implement* these structures in a usable computer system. Thus, we had to translate the final object model manually into an augmented relational database system. Despite the expressive power of object-oriented representation models, a second gap remains when it comes to actually *acquiring* the specific knowledge instances that will be used for the execution of the resulting system. Although the object model clearly defines what can and should be acquired from either the domain expert (knowledge acquisition) or during the execution of the consultation system (run-time), it does not prescribe reasonable or even useful knowledge acquisition interfaces (neither does the database implementation). Due to the highly complex structure of object-oriented representations, many of our manually constructed user-interface prototypes were error-prone or incomplete at best.

To overcome this shortcoming, we used some of the tools that are provided in the PROTÉGÉ-II system.[3] One important and well-developed part is specifically designed to assist in the automatic generation of knowledge-acquisition tools from so-called *domain ontologies*. Because of their similar background (both approaches use object-oriented class hierarchies and are able to express associations and relations between objects/classes), a manual translation from some parts of the MEDFRAME/CADIAG-4 object-oriented Syntropy model into PROTÉGÉ-II's domain ontology representation was straightforward. However, we had to omit some parts of our knowledge model (such as rules and fuzzy membership functions) because the current implementation of PROTÉGÉ-II can not produce adequate interfaces for them.

On the side of the Syntropy model, we had to augment the existing notation to account for the special knowledge that was required to define adequate knowledge-acquisition tools. These additions include a distinction of relations between objects that are to be suppressed for knowledge acquisition in order to avoid the generation of interfaces that are too complex to navigate. Furthermore, we had to add information that helps the domain experts to gain easy access to knowledge that otherwise would have been 'buried' deep in the object hierarchy (a functionality that is easily captured by our database implementation). However, by generating knowledge-acquisition interfaces from our translated Syntropy model, we discovered some flaws in our design model. Without the use of PROTÉGÉ-II's automatic generation facility, we might have overlooked them in our manually constructed user-interface prototypes and manual translations to the database design.

We are currently experimenting with a more principled way of translating the general structure of the Syntropy model into a meta-ontology that allows us to acquire our specific MEDFRAME/CADIAG-4 object model with the help of PROTÉGÉ-II's knowledge-acquisition tools. The instances acquired from this meta-ontology are then in turn used as a domain ontology. With another application of PROTÉGÉ-II's development cycle, we can then instantiate the final knowledge-acquisition tool for our domain experts. These iterations could be reused when certain aspects of (a) the underlying object model or (b) our domain model are to change.

This research was supported by the "Jubiläumsfondsprojekt Nr. 5433 der Oesterreichischen Nationalbank."

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0195—4210/96/$5.00