

Case-Based Selection of Diagnostic Imaging Procedures

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Selecting the most appropriate diagnostic imaging procedure is a complex task: physicians must weigh the cost, performance and risks of each procedure. ISIS (Intelligent Selection of Imaging Studies) is a developmental case-based decision-support system that helps physicians select diagnostic imaging studies. The system encompasses both episodic and prototypic cases in the domain of radiological procedures such as computed tomography (CT), ultrasound, magnetic resonance imaging (MRI) and angiography.

Each case includes the procedure requested, the clinical information provided and the procedure actually performed. Each case also includes clinical questions to be asked of the referring physician to determine the appropriateness of the requested imaging procedure and to assist the radiologist in formulating a diagnosis. The system contains both successful cases and "failures," such as cases with complications or where the procedure performed was deemed to be inappropriate. There are usually several (if not many) valid indications for each imaging procedure, and there are many factors that can lead one to modify the imaging protocol or to select an alternative procedure. The sophistication of the system will come from its breadth of knowledge about indications and contra-indications for various procedures.

The case base has a distributed representation, and the features indexed allow the system to explain its reasoning. Indexed features are organized hierarchically to allow conceptual generalization. At present, the index is maintained manually. Ultimately this process will become automated or semi-automated, in which the system will create generalizations inductively, or will retrieve old cases and prompt the expert user to identify the differences between the current case and relevant prior cases to understand the exceptions or fine details of the generalized knowledge. The primary goals of the system's knowledge acquisition process are to incorporate the valid indications for imaging procedures and to identify the salient clinical information necessary to interpret them.

In retrieving cases, the system gives preference to prototypic cases, because these cases represent the composite experience of several learned cases. Where a retrieved episodic case presents a serious conflict for the proposed plan, that case, too, will be retrieved to use in adaptation of the imaging plan. The "statistics" slot of each case contains information to indicate the type of case (episode *vs.* prototype). If the case is a prototype, the number of cases which comprise that case will be encoded in the statistics field to indicate the "weighting factor" of the case's importance.

Currently, the system includes cases relative to only one imaging procedure, abdominal ultrasound. After validating the system's indexing and retrieval mechanisms in this limited domain, we will present up to 500 requests for imaging procedures as cases to ISIS. This large number of cases will provide a sufficiently rich memory to allow non-trivial reasoning. The system will then be ready for thorough validation of its knowledge and reasoning, and for clinical trial in comparison to physicians at various levels of expertise. It is this project's ultimate goal to embed ISIS within the clinical functions of our institution's radiology information system.