

## Representing guidelines using domain-level knowledge components

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Guidelines are being used for many different applications including screening, risk assessment, diagnosis, treatment, and monitoring of patients<sup>1</sup> for a variety of medical problems ranging from the acute to the chronic, and from urgent care to continuing management. The Guideline Interchange Format (GLIF) is a representation for computer-interpretable guidelines for such different applications<sup>2</sup>. In GLIF, guidelines are modeled as a flowchart consisting of five basic classes of steps as its nodes for specifying recommendations, decisions, patient states, and simultaneous paths through the guidelines.

These low-level or *primitive* steps provide the flexibility to compose different types of guidelines such as those listed earlier. However, just using low-level steps may cause authoring of guidelines to be cumbersome and time-consuming<sup>2</sup>. We hypothesize that modeling guidelines with primitive steps is cognitively difficult and may cause incorrect representation of a guideline. In addition, specifying guidelines using low-level steps can lead to large and visually complex flowchart representations.

We have introduced a new construct called macro into GLIF for representation of domain-level concepts. Subclasses of macro represent different types of domain-level concepts and contain attributes particular to that concept. Macros enable declarative specification of a procedural pattern in the domain concept. The pattern is then realized by a set of primitive GLIF steps. The definition of the macro and its subclasses include the information necessary to map the macros to the corresponding pattern of primitive GLIF steps. This is a scalable approach for adding domain-level concepts in GLIF. The mapping also enables sharing of guidelines that contain macros. Sites and software tools that recognize the macro subclass can take advantage of the domain-level representation for authoring, visualization, and execution. Sites and tools that do not support a particular type of macro can still share and comprehend guidelines using the primitive steps.

To develop the definition of macros, we analyzed guidelines of different types to identify patterns of

domain concepts that occur in them. Based on the patterns identified, preliminary designs for several macros were developed. For screening guidelines, we created macros such as *At-risk population*, *Screening schedule*, and *Follow-up recommendations*. We conducted informal exploratory testing of the macros that were developed for screening and risk assessment guidelines. Medical informatics fellows in our laboratory, who were familiar with GLIF, authored guidelines using either macros or primitive GLIF steps. The results from the tests indicated that guideline authoring with macros may be conceptually easier, faster, and may help produce more complete guidelines. An issue with the use of macros is that they may limit the expressiveness required for completely and accurately representing guidelines. Our results indicated that careful analysis and design is required for development of macros that can be generalized for variations of the domain concepts.

We plan to develop macros for other types of guidelines such as chronic disease management guidelines and clinical trial protocols. We will incorporate support for macros in our guideline tools in the near future. We would then be able to conduct more extensive and controlled studies to evaluate the usefulness of macros. We intend to develop a schema language for macros that will allow declarative specification of the mapping between domain concepts and the pattern of primitive GLIF steps.

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### References

1. Field M, Lohr K. Guidelines for clinical practice: From development to use. National Academy Press, Washington, DC; 1992.
2. Ohno-Machado L, Gennari JH, Murphy SN, et al. The guideline interchange format: a model for representing guidelines. J Am Med Inform Assoc. 1998;5:357-72.