Connecting Medical Informatics and Bio-Informatics
R. Engelbrecht et al. (Eds.)
ENMI, 2005

Method of GLIF Model Construction and Implementation

D Buchtela[a,b], J Peleska[a,c], A Vesely[a,b], J Zvarova[a,b]

[a]*EuroMISE Center, Prague, Czech Republic*
[b]*Dept. of Medical Informatics, Institute of Computer Science AS CR, Prague, CR*
[c]*2nd Dept. of Medicine, General University Hospital, Prague, CR*

Abstract

Knowledge acquired in medicine is possible to represent by medical guidelines. The most important and nowadays mostly used for formalisation of guidelines is the GLIF (Guideline Interchange Format) model. Final model can be coded in XML (eXtensible Markup Language). Some situations can be modelled only very hard or no ways in a practice use. This paper describes a method of GLIF model construction and implementation in XML. The method specializes in risks of whole process and tries to find a solution to problematical model situations. The GLIF model universality is kept for any medical guidelines.

Keywords:
Medical guidelines, GLIF model, XML implementation

1. Introduction

Knowledge acquired in medicine is possible to represent by medical guidelines, which make decision process in concrete cause easy and in a harmony with guidelines. For computer implementation and processing, it is necessary to have guidelines explicitly structured. The most important and nowadays mostly used is the GLIF (*Guideline Interchange Format*) model. The GLIF model is result of collaboration among Columbia University, Harvard University, McGill University and Stanford University. The main goal of GLIF was to enable sharing of guidelines among institutions and across computer applications.

2. Design and methods

GLIF model

GLIF specifies an object-oriented model for guidelines representation and syntax for guidelines utilization in software systems as well as for their transport. GLIF guidelines are mostly given as a flowchart representing a temporarily ordered sequence of steps. The nodes of the graph are guideline steps and edges represent continuation from one step to the other one. Guideline steps are an *action step*, *decision step*, *branch and synchronization steps* and a *patient state step* [1], [2].

- **Action steps** specify clinical actions that are to be performed. It can be an application of some therapy, carrying out some examination or measurement etc. Action step also may name sub-guidelines, which provide a detail for the action.
- **Decision steps** are used for conditional branching. There are two kinds of decision steps: **Case step** is used, when branching is determined by evaluation of defined logical criteria based on data items. **Choice step** is used when the decision cannot be precisely specified in guidelines themselves and decision should be made by the user.
- **Branch** and **synchronization steps** enable concurrence in the model. Guideline steps that follow branch step can be performed concurrently. Branches with root in branch step eventually converge in a synchronization step. In this step all branches are synchronized after evaluation of synchronizing condition.
- Patient **state step** characterizes a patient's clinical state.

Criteria of conditions

The decision step specifies several criteria of condition for each decision option:

- The **strict-in** criterion is used to specify a decision condition that could be computed automatically (for example if systolic blood pressure is 130 or greater). If a strict-in is true then the control flows to the guideline step that is specified by that decision option's destination
- The **strict-out** criterion is analogous to an absolute contraindication (for example if a patient is gouty he could not be cured by thiazides diuretics). If a strict-out is true then the decision option's destination is forbidden.
- The **rule-in** criteria rank a choice as the best among several options. For example, when there are competing diagnoses for a disease, a pathognomonic condition would be a rule-in for the disease. This criterion is analogous to conditions favouring the use (indications).
- A **rule-out** takes precedence over rule-in when ranking options. If an option contains both a rule-in criterion and a rule-out criterion, and both are evaluated as true, then that option should be the last choice. This criterion is analogous to contra-indications.

The *strict-out* criterion is evaluated at first. If *strict-out* criterion is evaluated as true the rest of criteria is not evaluated. This option is forbidden. In opposite case the *strict-in* criterion is evaluated. If *strict-in* criterion is false too, the *rule-in* and *rule-out* criteria are evaluated. The ranking of *rule-ins* and *rule-outs* is left to the user who may use his or her clinical judgment or may develop their own ranking schemes.

GLIF implementation in XML

GLIF model is graphical so it is necessary to code it in XML form. Syntax for guideline describing language is a part of guideline model specification. In a language form encoded guidelines consist of a sequence of guideline steps. Some attributes of a guideline step contain next guideline steps. It enables sequential representation of a graph structure in the guideline language [3].

```
<GLIF>
<Step>                  = start of step
    <name>              = name of step – identification (ID)
    <type>              = type of step:          action
                                                 case
                                                 state
                                                 subgraph
    <note>              = short description of step
    <text>              = text in a graphical symbol of step
    <tag>               = shadow actions
        <T>
            <ttype>     get     = input parameter get
                        put     = output parameter set
                        open    = open of subgraph or HTML file
                        run     = service application run
            <tparam>            = list of parameters
        </T>
        <T>
        …               next shadow actions
        </T>
    <x>                 = x-coordinate of graphical symbol
    <y>                 = y-coordinate of graphical symbol
    <w>                 = width of graphical symbol
    <h>                 = height of graphical symbol
    <focus>             = highlighting of step:  0 = no
                                                 1 = yes
    <status>            = status of step:        1 = start step of a graph
                                                 2 = end step of a graph
                                                 0 = the rest of steps
    <next>              = next step(s)
        <F>             = one of option attributes
            <nname>     = identification of option
            <nstep>     = name of destination (target step)
            <ncaption>  = caption of option
            <nnote>     = description of option
            <nline>     = coordinates of line to target step
            <priority>  = priority of option
            <nstrictin> = strict-in criteria
            <nstrictout>= strict-out criterion
            <nrulein>   = rule-in criterion
            <nruleout>  = rule-out criterion
        </F>
        <F>
        …               = other options
        </F>
    </next>
</Step>                 = end of step
<Step>
…                       = next steps
</Step>
</GLIF>
```

Figure 1: XML syntax of GLIF model

3. Results and discussion

A GLIF model construction and implementation of text guidelines is not easy. The whole process can be divided to a several stages (see fig.2).

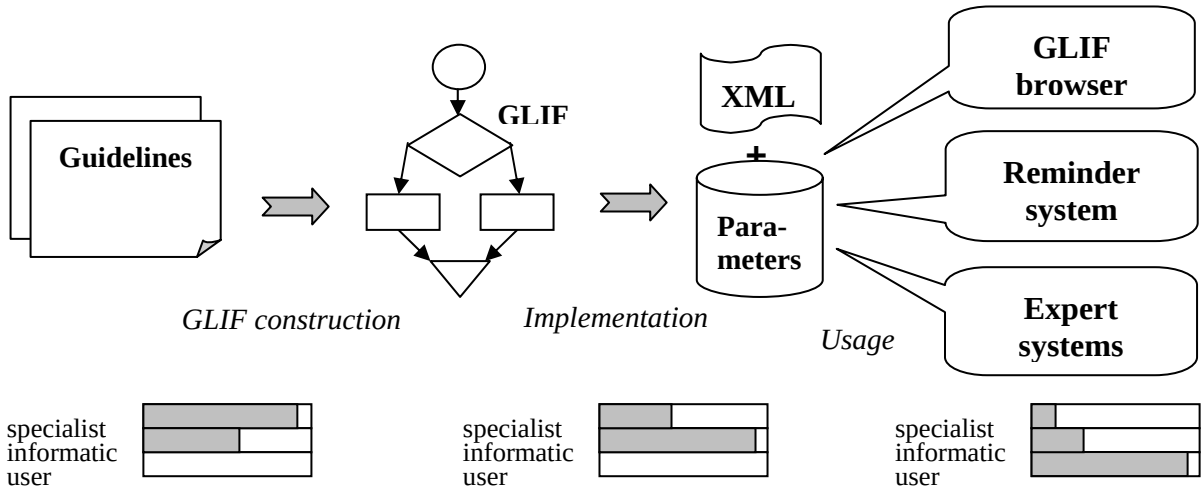

Figure 2: Process of GLIF model construction, implementation and usage

GLIF model construction stage

In a stage of GLIF model construction from text guidelines, it is important to find a logical and process structure of guidelines, all fundamental parameters and their interrelationships. Some data mining method for free text can be used for this construction. However, it's required allow to multiword connections in a automatic search. The search process becomes more complicated and error prone. Cooperation of information and medical specialist (the author of text guidelines is preferred) is more effective.

The result of this cooperation is graphic GLIF model that corresponds to text guidelines. The construction stage is the most important and difficult of all stages.

GLIF model implementation stage

In a stage of GLIF model implementation, the graphic model of guidelines is coded into XML. Besides a list of basic and derived parameters is created. Basic parameters represent directly measurable values. Derived parameters are obtained in arithmetical, logical or logically-arithmetical operation above basic parameters. Informatics and expert's cooperation plays an important role in creation of basic and derived parameters list too.

The result is data model that serves as interface between GLIF model and real input data stored in HER (*Electronic Health Record*). It is important to pay attention to definition of all criteria of condition (*strict-in*, *strict-out*, *rule-in*, *rule-out*) for each decision option. In this criteria evaluation, it often happens that input parameters values are not known. Therefore the criteria are evaluated in three-value (or multi-value) logic.

Well-designed model has to fulfil several conditions for each decision step:

- At most one *strict-in* criterion can be evaluated as true for all possible values of input parameters.
- At least one *strict-out* criterion must be evaluated as false for all possible values of input parameters.

- *Strict-in* or *rule-in* criteria must be evaluated as true at least in one option.
- At least *strict-in* and *strict-out* criteria evaluation should be definite (true or false). If some *strict-in* or *strict-out* criterion is evaluated as unknown, the user will have to insert missing data.

A quantity of essential data is dependent on order of single option evaluations. Therefore it is necessary to set an order of evaluation i.e. to set priority of decision options. The priority is chosen by specialist (see Fig.3).

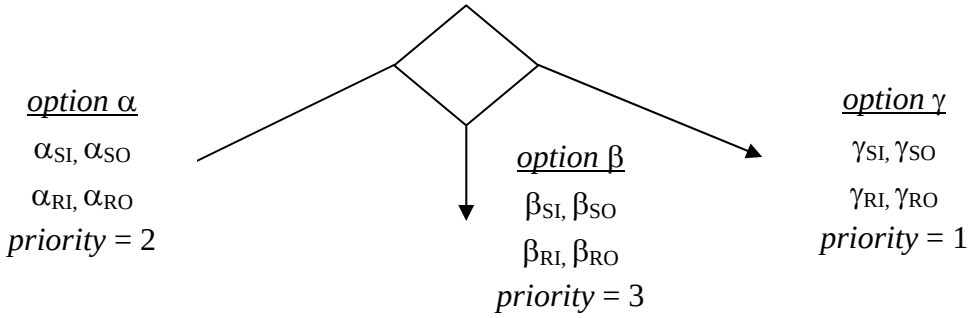

Figure 3: Set of option priority

In modelling of parallel GLIF model branches it is necessary to specify which branch is fixed and which one is optional. That is why the synchronisation conditions are set for each synchronisation step (see Fig.4).

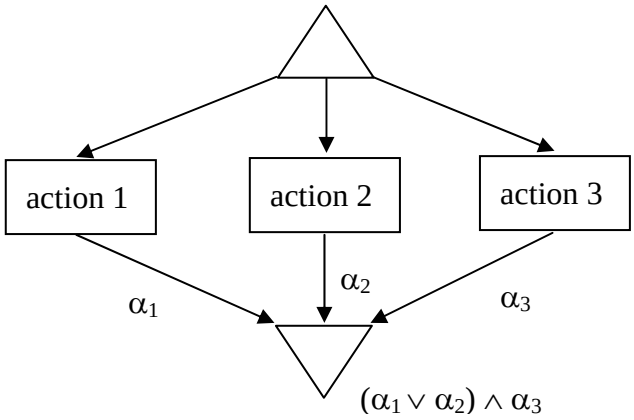

Figure 4: Set of synchronisation condition

GLIF model usage stage

GLIF model coded in XML can be used in several types of applications (see [3],[4]):

- **GLIF browser** - Formalized medical guidelines offer to users a more accessible form of knowledge presentation than a classical text. Moreover, it can show explanatory information with different levels of details. It can be used for education of students and as a decision support system in medical practice.
- **Reminder system** - System checks if input data values are in accordance with medical knowledge. Usually the system verifies if the input value is inside defined

interval. If a stated diagnosis or a chosen treatment is not in agreement with common medical guidelines, the system warns the user and suggests diagnosis that is more probable or more appropriate action.

- **Expert system** – GLIF model or a set of GLIF models create knowledge base of the expert system.

In the EuroMISE Center was developed a general GLIF browser for a few Czech and European medical guidelines as Formalized 2003 European Guidelines on Cardiovascular Disease Prevention in Clinical Practice, 2003 ESH – ESC guidelines for the management of arterial hypertension and others (see http://www.euromise.cz/new/guidelines.php).

4. Conclusion

The GLIF model is designed as a general tool that can present any formalized medical guidelines in a user-friendly manner. In modelling of text guidelines it is necessary to observe some principles. A method of GLIF model construction and implementation in XML contained in this paper describes important aspects and rules for each stage whole process. The result of observance of these rules is well-designed GLIF model, which is usable in several practical applications.

5. Acknowledgement

Research was partially supported by the project AV0Z10300504 of the Academy of Sciences CR.

6. References

[1] Ohno-Machado L., Gennari J. H., Murphy S.,N., Jain N.,L., Tu S., W., Oliver D., et al.: *The GuideLine Interchange Format: A model for representing guidelines*, Journal of the American Medical Informatics Association 1998, 5(4), pp. 357-372.

[2] Ash N., Bernstam E., Greenes R.A., Lacson R., Mork P.,Shortliffe E.H.: *Guideline Interchange Format 3.5 Technical Specification* , online - 12.12.2002, In: http://smi-web.stanford.edu/projects/intermed-web/guidelines/

[3] Buchtela D., Peleska J., Vesely A., Zvarova J.: *Presentation of Medical Guidelines on a Computer*, Transformation of Healthcare with Information Technologies, Ed.: Zielinski K., Duplaga M., Ingram D., IOS Press, Amsterdam, 2004, pp.166-171, ISBN 1-58603-438-3.

[4] Vesely A., Anger Z., Buchtela D., Peleska J., Zvarova J.: *Medical Guidelines Presentation and Comparing with Electronic Health Record*, International Joint Meeting EuroMISE 2004 Proceeding, Ed.: Zvarova J., Hanzlicek P., Peleska J., Preckova P., Svatek V., Valenta Z., Praha, 2004, pp.53, ISBN 80-903431-0-4.

Contact:

Ing. David Buchtela
EuroMISE Center - Cardio
Institute of Computer Science
Pod Vodarenskou vezi 2, Praha 8
Czech Republic
e-mail: buchtela@euromise.cz
url: http://www.euromise.cz