Repositories of Reusable Auxological (Growth) Algorithms for eHealth

Petr Lesný[1], Hana Krásničanová[1], Tomáš Holeček[2], Kryštof Slabý[1] and Jan Vejvalka[1]

[1]Faculty hospital in Prague Motol, V Úvalu 84, 150 06, Prague 5 – Motol, Czech Republic

[2]FMS FHS Charles University, U Kříže 10, 158 00 Praha 5 Jinonice, Czech Republic

Abstract. The auxological (growth) data are suitable for being processed algorithmically by specialized software. Increasing complexity of the pediatric auxology requires the development of algorithm repositories, which allow the users to select and utilize appropriate algorithms. There are many attempts to build such repositories, however their usage is limited. In order to create the modern repository of algorithms (not limited to the pediatric auxology), we have postulated the following key principles: strong philosophical background, explicit description of the semantic paradigm and its binding to the current scientific paradigm, quality management, platform independency and interoperability and trust management. Based on these principles, we have developed and validated the indicator ontology model with strong documentation quality management, implemented as web services under the open source license model. The reference implementation of the algorithm repository operates on the intranet of the Faculty hospital in Prague Motol.

1 Introduction

Auxology is the science of growth. It makes no distinction between growth and development. In this view, growth deviations do not only mean small or tall stature but also e.g. hypotrophy, delayed puberty, alteration of closure of anterior fontanel etc. Good knowledge of pediatric auxology (the science of growth in children) and access to suitable reference data describing relevant population standards allow pediatricians to make timely and correct diagnosis of growth alterations they meet in their practices (growth diagnosis). Monitoring of the auxological parameters is also a most important task in monitoring effect of long-term therapies in children. Auxological (growth) data are mostly numeric and therefore highly suitable for being processed by software.

Many specialized software tools for the analysis of growth are developed, including standalone software tools, web calculators or sophisticated Excel spreadsheets. In our workplace, we have developed three generations of complex tools for analyzing the childrens growth [1-3]; the software was distributed free of charge to all of the pediatricians in the Czech Republic to increase the quality of the diagnosis of growth alterations in children in early stages.

Lesný P., Krásničanová H., Holeček T., Slabý K. and Vejvalka J. (2009).
Repositories of Reusable Auxological (Growth) Algorithms for eHealth.
In *Proceedings of the 1st International Workshop on Open Source in European Health Care: The Time is Ripe*, pages 54-58
DOI: 10.5220/0001827900540058

However the complexity of the growth diagnosis is continuously increasing with new algorithms being published and validated (e.g. the weight to height analysis or total body fat assessment). The diversity of population in the Czech Republic as new member state of the European Union significantly increases, requiring more complex assessment of the childrens growth (requiring e.g. the ethnic background of the child in order to correctly evaluate the growth alterations). There are currently many attempts of creating the collection of biomedical algorithms, including the auxological ones (such as MEDAL [4], S.M.A.R.T.I.E. [5], MedCalc [6] etc.), each using different structures and classifications for documenting of them other algorithm collections are included in the specialized (e.g. pediatric) software, often without proper documentation. The present situation, in which the number of algorithms, reference data and overall knowledge of the childrens growth increase requires more complex approach, such as building the algorithm repositories.

2 Materials and Methods

We have performed retrospective analysis of the current representations of algorithms and algorithm repositories and formulated the “key principles” in the philosophy, documentation and implementation areas, on which the successful solution should be based. Successively, we have implemented the software and validated its usefulness and effectiveness in the field of pediatric auxology.

Table 1. The key principles in the selection of successful solution.

Number	Key principle	Enables
1	Strong philosophical background	Create the ontology for description of the algorithms, data, relationships between them and other required concepts.
2	Semantic information explicitly described and bound to current scientific paradigm	The inclusion of our algorithms’ collection into the Evidence based medicine (EBM) standards.
3	Quality management	Minimize effort required to maintain the algorithm collection and inclusion of the up-to-date knowledge.
4	Platform independency and interoperability.	To minimize the time to adopt the published algorithms for the end users.
5	Trust management	Support users’ decisions about procedural and semantic values of individual components (e.g. the algorithms).

3 Results

3.1 Philosophy

There are many existing classical (Aristotelian) biomedical ontologies and classification systems, such as the MeSH [7], SNOMED [8] or UMLS [9], however if we want to utilize them for description of the biomedical algorithms and their relations, we are seriously limited. Their main problem is, that they are typically structured from the top, whereas the concepts, utilized in the clinical applications of the algorithmic medicine are very 'low-level': none of the systems is currently able to formally represent e.g. "the patient's body height in the morning" (the indicator commonly utilized in the anthropometry) without substantial rearrangements and expansion of the concept tree.

We have therefore utilized the "indicator ontology", in which the data processed by biomedical algorithms are described (in accord with the philosophical tradition of phenomenology represented e.g. by E. Husserl [10]) as **indicators** that can be transformed (in a given context) into other indicators and grouped into indicator classes by their roles in transformations. The simple representation of the indicator ontology which shows the documentable entities (author, citation, context, transformation, indicator class, implementation, validation and review), is on the Figure 1.

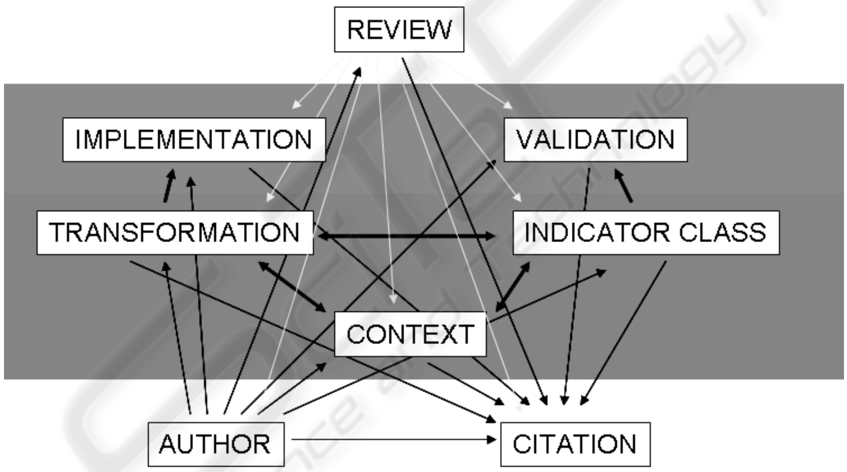

Fig. 1. The basic indicator ontology model, depicting the documentable entities in four layers (the *knowledge source* layer containing the author and citation documentation, the *algorithm layer* containing the transformations, indicator classes and contexts documentation, the *implementation layer* which contains the implementation of transformations and validation of indicators and the *review/trust layer*)

3.2 Documentation

The biomedical algorithms should be fully documented; the semantic information (meaning for the human user) must be explicitly described and available for assessment and validation. The semantic information must be bound to the current scientific paradigm and to evidence based medicine through predefined relations to published and reviewed works. Optimal documentation and review paradigm is the extension of the S.M.A.R.T.I.E. [5] model, which atomizes the semantic information into small documentation blocks. These documentation blocks (e.g. the abstract, method of measurement or limit conditions description) can be then organized by the computer in order to accomplish the often conflicting requirements: (i) present the user with full semantic information and (ii) emphasize to the user the information relevant for the specific situation. The S.M.A.R.T.I.E. model also establishes the basic quality management guidelines, which are similar to those utilized in the peer-reviewed journals; they should be extended by the basic controlled documentation management (e.g. monitoring the change of published data and ensuring the appropriate reaction to it).

3.3 Implementation

Currently there are many possibilities of the implementation, which are summarized in the Table 2; each of them has its advantages and disadvantages. In the biomedical algorithm implementation (translation into the form understandable by programmers), we require the platform independency and possibility of interoperability with other software. We also need to review the implementation, in order e.g. to validate the algorithms before including in specialized third party software.

Table 2. The key principles in the selection of successful solution.

Implementation type	Platform independent	Interoper-able	Easy to use	Allows review
Standalone software application			x	
Precompiled libraries		x		
Published code or pseudo code	x	x		x
Web applications	x		x	
Web services	x	x	x	

Neither of the implementation options in Table 2 alone is sufficient for the algorithm repository implementation. However in order to allow user review of the algorithms, the source code (or pseudo code) of the algorithms should be published, preferably together with the reference implementation. The favored reference implementation, according to Table 2, is the form of web services, which are able to easily interoperate with other software and its usage is platform independent, together with the published code (or pseudo code), which enables the peer reviews of the algorithms' implementation.

3.4 License

According to our key principles, the algorithms' implementation should allow the validation by peer review. More specifically, all the transformations of input indicators to output indicators (all data processing through the algorithms) should be transparent not only in the reference implementation, but also in all of the software products, which utilize the algorithms from the repository. This can be established by adopting the open-source 'viral' model of software publication.

4 Conclusions

We implemented the framework for medical algorithms documentation which is based on the key concepts presented in this work and validated its usability for documenting and utilizing of the auxological algorithms [11]. The implementation is based on the web services and interoperates with standalone Windows and Linux applications, LAMP (Linux – Apache – PHP – MySQL) web pages and even with the Microsoft Office documents (which are capable of calling the web services through the ActiveX objects). The reference implementation is available in open source repository[1] and also utilized in the intranet of the largest childrens' hospital in the middle Europe in Prague Motol.

Acknowledgements

Supported by Czech research project no. 1ET202090537.

References

1. Lesny P., Krasnicanova H.: Graphical monitoring of growth data using a computer software Growth 1. Cesko-Slovenska Pediatrie Supplement (1996) 98.
2. Lesny P., Krasnicanova H.: Growth 2 - software for follow up of the childrens' growth. Prague, Maxdorf (1998).
3. Krasnicanova H., Lesny P.: Compendium of pediatric auxology 2005. Praha, Novo Nordisk (2005).
4. Sen D.: The Medical Algorithms Project. Occupational Medicine (2005) 645.
5. Smart Medical Applications Repository of Tools For Informed Expert (S.M.A.R.T.I.E.) and MedNotes™. IST (2000). http://www.smartie-ist.org
6. Stroud S.D., Erkel E.A., Smith C.A.: The use of personal digital assistants by nurse practitioner students and faculty. J Am Acad Nurse Pract (2005) 67-75.
7. Lipscomb C.E.: Medical Subject Headings (MeSH). Bull Med Libr Assoc (2000) 265-6.
8. Cote R.A., Robboy S.: Progress in medical information management. Systematized nomenclature of medicine (SNOMED). Jama (1980) 756-62.
9. Lindberg C.: The Unified Medical Language System (UMLS) of the National Library of Medicine. J Am Med Rec Assoc (1990) 40-2.
10. Husserl E. Logical Investigations, Investigation I. (translated by J. N. Finday). Routledge, London (2001) 184.
11. Kuba M., Krajicek O., Lesny P., Vejvalka J., Holecek T.: Grid empowered sharing of medical expertise. Stud Health Technol Inform (2006) 273-82.

[1] http://medigrid.sourceforge.net