Automatic Synthesis of Graphical User Interfaces for Health Information Systems

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1 Introduction

2 Basic principles
   - Clinical data models
   - Model Transformation

3 Related work

4 Proposed approach
   - Architecture for code generation
   - Rules repository
   - Strategies for rules definition
   - Current state of work

5 Conclusions
Model-Driven Development (MDD) for Health Information Systems (HIS) is still a challenge.

- Transcribing the clinical’s knowledge to computer systems is not trivial.
- One way of mitigating such problem is the use of **clinical data models** (ex.: openEHR).

**openEHR** models help separate the knowledge of the **clinical** domain from the **technological** domain.

- However, they still demand too much effort to develop HIS implementations.
- Such models are not sufficient for the construction of HIS (e.g. lack of **architectural information**).
Introduction

Objective

- Provide an architecture for the automated code generation of GUI for HIS from clinical data models.
  - MDD techniques based on a repository of reusable rules for model transformation.
- With this architecture, not only the implementation of HIS but also the specification of transformation rules can be simplified.
openEHR is an open and collaborative specification for interoperable clinical data models.

- Metamodels: overall characteristics of the components of the health record.
- Models (archetypes): formal definitions of prescribed combinations of metamodel elements that describe clinical domain concepts.
  - Reuse of domain concepts in healthcare.
  - Reduced dependence among physicians and technologists in the development process.

Example of an archetype in the Eclipse platform.
Basic principles

Model Transformation

Model Transformation

Iuri M. Teixeira, Regina M. Braga, Antônio Tadeu A. Gomes
GUI code generation for HIS from clinical data models
- Do not employ metamodeling and transformation rules.
- Compromises design reuse in MDD.

GUI code generation with metamodeling and model transformations
[Costa, 2011].
- Not restricted to HIS and does not use a common metametamodel.
- Compromises the reuse of clinical concepts and, therefore, the HIS interoperability.

The work [Menárguez-Tortosa et al, 2011] explores the aforementioned concepts, however, does not consider architectural information.
Proposed approach

- Until the submission of this article, two different strategies for defining model transformation rules that combine clinical data models and architectural information were evaluated:
  1. Transformation without explicit architectural information.
  2. Transformation based on architectural annotation models.
- A third strategy is being investigated right now:
  3. Transformation based on Acme models.
Architecture for code generation of GUI for HIS

- **First step**
  - M2M transformation (clinical data models to GUI models)
  - This process is executed through a repository of reusable rules.

- **Second step**
  - M2C transformation (GUI models to GUI code).
  - This process is executed through tools (RichUbi [Cirilo et al, 2010]) that generate code from models.
Rules repository

- Rules are structured according to the openEHR metadata hierarchy to generate different GUI elements.
  - Allows to capture the structure from archetypes information.
  - Also allows to apply **design patterns** on the transformations rules.

```
create target: TARGET from source : SOURCE;

rule Component2Component{
  from source: SOURCE!Component
  to target: TARGET!Component
}

rule Composite2Composite extends Component2Component{
  from source: SOURCE!Composite
  to target: TARGET!Composite
    children <- source.children
}

rule Leaf2Leaf extends Component2Component{
  from source: SOURCE!Leaf
  to target: TARGET!Leaf
}
```
First strategy
Transformation without explicit architectural information.

- Our hypothesis for this strategy is that it leads to a combinatorial explosion of rules (different rules for different combinations among different families of HIS).
- Without further architectural information, the developer will have a cognitive overload in defining applicable rules for different families of HIS.
Inclusion of models for architectural annotations.

Metamodels for annotations allow to create models using property-value pairs.

Second strategy
Transformation based on architectural annotation models
Second strategy
Transformation based on architectural annotation models

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Current state of work – Third strategy
Transformation based on Acme models

- Acme is an Architecture Description Language (ADL)
- Acme has its metamodel specifications mapped onto the Ecore metamodel.
- The current state of the work consists in exploring families of HIS described using Acme’s Ecore metamodel.
Current state of work – Third strategy
Transformation based on Acme models
Conclusions

- Transformation rules are formally specified from the clinical data models.
  - Code generation of GUI for HIS with reuse of domain concepts.
- Employment of Ecore metametamodel allows greater interoperability of software.
- First experiments:
  - Exploration of two families: epidemiological surveillance and prehospital emergency healthcare
    - Conducted under the SPLiCE project (Software-Product Lines in HealthCarE), a software product line for HIS being developed on the National Institute of Science and Technology on Medicine Assisted by Scientific Computing (INCT-MACC).
From openEHR Domain Models to Advanced User Interfaces: A Case Study in Endoscopy.
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Model driven richubi: a model driven process for building rich interfaces of context-sensitive ubiquitous applications.

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[Van Der Linden, 2009] Van Der Linden, H.; Austin, T.; Talmon, J.
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Síntese Automática de Interfaces Gráficas de Usuário para Sistemas de Informação em Saúde

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