Towards Seperation of Medical and Workflow Knowledge in Modeling Clinical Guidelines: A Semantic Web based Framework for Executing Clinical Guidelines

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Abstract

We present a semantic web based framework for modeling and executing Clinical Practice Guidelines (CPG). Our modeling of CPG distinguishes between the medical and workflow knowledge inherent within a CPG. We have developed two OWL-based ontologies—a CPG ontology that models the medial knowledge, and a Clinical Workflow ontology that models the CPG's execution logic using UML Activity Diagrams and OWL-S. We have developed a CPG execution engine based on Place Transition Nets that allows both the verification of a modeled CPG and its execution at the point-of-care.

***Keywords**:*

Clinical practice guidelines, Clinical workflow, Knowledge modeling, Semantic web, Ontology

Introduction

The computerization of Clinical Practice Guidelines (CPG) allows them to be operationalized at the point-of-care. A typical CPG comprises two elements—(i) medical knowledge that describes the clinical activities and recommendations; and (ii) Clinical Workflow (CW) that entails the execution logic, decisional constraints/conditions and ordering of the clinical processes for CPG execution. We argue that modeling of CPG should pursue a clear separation between disease-specific medical knowledge and clinical workflow knowledge that stipulates the execution of the CPG in an institution. In this paper, we present a semantic web based framework—for the modeling of CPG and their institution-specific execution.

Methods

Our framework purports a clear separation between medical and clinical workflow knowledge for modeling a paper-based CPG. In modeling clinical activities/actions, we distinguish between the actual knowledge and its execution in a clinical workflow. To model and execute CPG, we use two ontologies:

Ontologies for Knowledge Modeling

We have developed a *CPG Ontology* (CPGO) that models the disease-specific concepts. CPGO is developed using OWL and it captures the form and function of the CPG's medical knowledge and serves as the domain-specific knowledge. We developed a *Workflow Ontology (WO)* that models the CPG's execution logic, local constraints and data-interface with EMR. The WO ontology captures the executional semantics in terms of the control and data flow for executing the CPG. We use UML Activity Diagrams to model the institution-specific clinical workflow—i.e. the execution logic—using semantically-defined workflow constructs that allow to validate the ensuing workflow. We use OWL-S for the semantic modeling of local constraints and data-exchange interfaces with local clinical information systems. We evaluated both the CPGO and the WO using established ontology verification metrics and found them to be consistent.

Encoding CPG

We encoded five CPG's such that medical knowledge domain was modeled using CPGO, while the workflow knowledge was encoded in WO. The CPG's encoded are for the following conditions: Acute Otitis Media in Children, Locoregional Post Mastectomy Radiotherapy, Osteoporosis OST, Helicobacter Pylori Infection and Treatment of Gallstones.

Execution of CPG

For execution of a CPG we establish interrelationships between the CPGO and WO to realize a CPG-W ontology that is executed through our execution engine based on *Place Transition Nets (PTN)*. The execution model for CPG-W ontology is based on the combined PTN semantics of the UML Activity Diagrams and OWL-S process model. To execute a CPG, we first translate the UML based workflows, described using CPG-W ontology, into PTN. We use the transition firing mechanism of PTN to execute the CPG—the execution moves through state upon the satisfaction of the local conditions.

Conclusion

We presented a Semantic Web based framework for modeling CPG and testing the modeled CPG. The key advantages of the approach are (a) the modeled CPG can be reused in different clinical setting; (b) any changes to a CPG can be done without changing the clinical workflow; and (c) The encoded CPG can be verified before deployment in a clinical setting.

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