

Towards Adaptable Clinical Pathway Using Semantic Web Technology

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1. Introduction

In an ideal world, activities and businesses in healthcare will evolve around a patient. The best quality of service for a patient is treatment planned according to the latest medical knowledge and best practice, and more importantly, according to the patient's medical history and current health condition. Furthermore, the treatment plan should be able to take into consideration the patient's genetic and environmental setting information in order to find the most effective drugs and procedures for a disease or illness. The treatment is then executed via the best breed of the services according to the most efficient workflows.

This world has been envisioned and forecasted by many, yet the way to get there is by no means easy. A concert of advancements has to happen before the realization of that vision. The milestones could include:

- An explicitly expressed and connected knowledge base that includes patient record (medical history, genetic and environmental information), medical knowledge like treatment guidelines, pharmaceutical guidelines and evidence about the effect of prior treatments.
- A methodology that can produce ad hoc clinical pathways (treatment plans) specific to a patient according to guidelines, best practices and most importantly, the patient's past and current condition. This methodology should be able to support the human decision-making process, especially in dealing with complex decisions and the application of judgment.
- A highly integrated and webized system that provides required services utilizing the optimum workflow technology.

The proposed research framework is based on the belief that the above milestones can be achieved using *semantic web technology* and *web services*. This is very much consistent with the vision outlined by the inventor of the Web, Tim Berners-Lee [1].

2. Position

Traditional clinical pathway is a static set of procedures that standardizes care for a majority of patients with a similar diagnosis, procedure, or symptom.

With the reality of Electronic Patient Record quickly approaching, the healthcare sector is demanding the automatic generation of clinical pathways. The framework proposed herein takes a further step beyond the simple automation for the generation of clinical pathways. The term “*adaptable clinical pathway*” is used to denote the step-wise automation of clinical pathways for each patient, in particular, according to the patient’s personal health condition at the time of consultation. Moreover, any new medical discovery or update in medical knowledge or environmental setting changes will be reflected in determining the next step in the current treatment plan. The term “adaptable” is true to its definition here as the clinical pathway will change according to the most current knowledge and up-to-date patient condition.

Figure 1 presents a high-level illustration of the proposed framework.

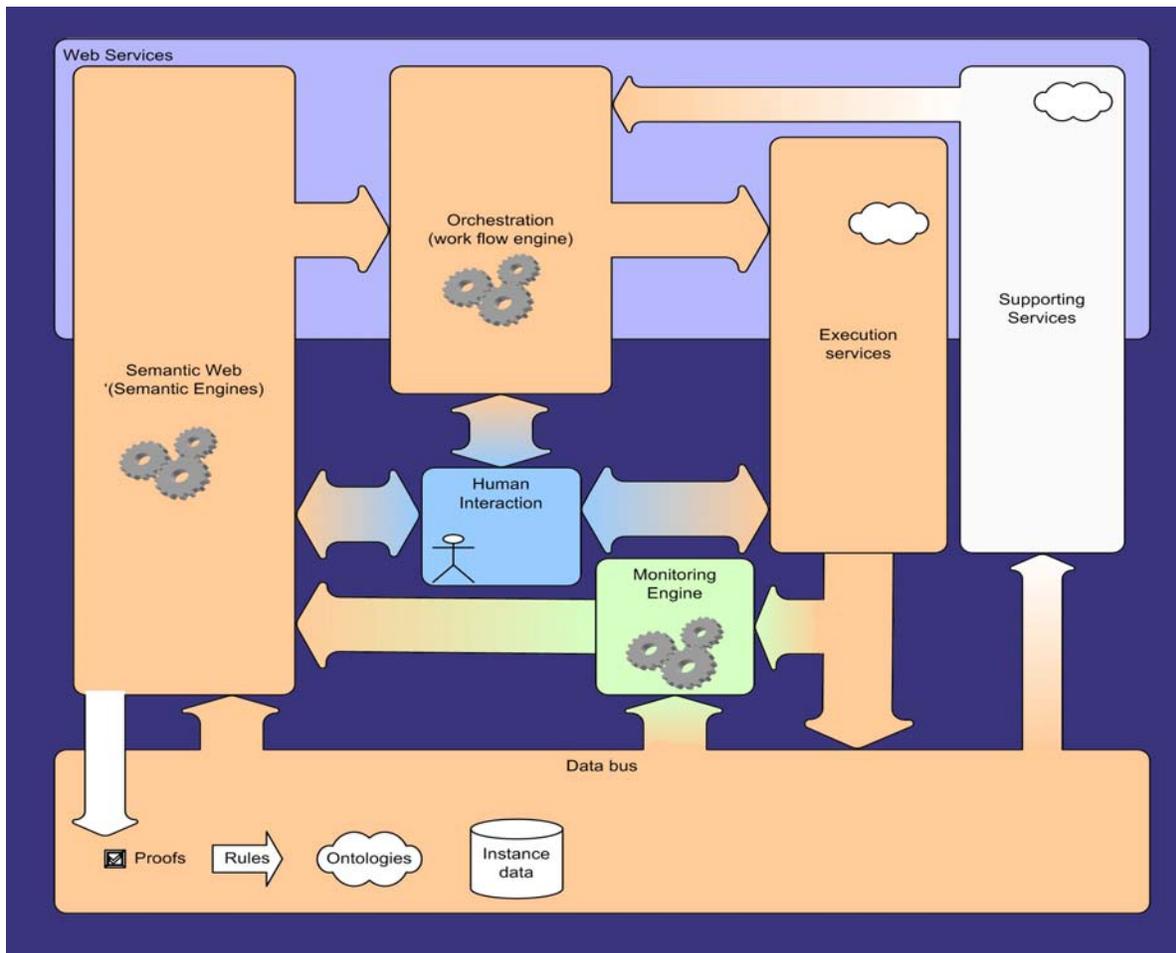


Figure 1. Adaptive Clinical Pathway Framework

3. Preliminary Results

Limited-scale experiments have proven the following concepts:

Concept 1: *Ontology can be used to describe complex problems in the healthcare domain;*

Concept 2: *Ontology of a medical domain can be seamlessly scaled up and down and integrated with the ontology of a different domain when determining adaptable clinical pathways*

The experiments were done using open source projects, Jena [2], Cwm[3] and Euler[4].

Effort is being made to develop ontology based on the Radiation Protection Guideline [5]. This ontology becomes a part of the medical knowledge and is then used in recommending treatment plan for a patient or to prove the conformance to the published guideline for a prescribed treatment.

4. Issues

The following issues require further research and close collaboration of multi-discipline communities.

(1) Ontology development:

- i. Supporting an adaptive clinical pathway requires ontologies across multi-domains, including specialized medical ontology, ontology regarding genotype-information and phenotype-information. It also requires the integration between heterogeneous data sources containing patient records, requiring a common terminology. How should different ontologies be developed and how should they be maintained, validated and connected?
- ii. Since the quality of ontology has the direct influence on patient treatment, what regulation should be imposed on ontology providers? How can we formalize trust?
- iii. How is versioning of ontology to be dealt with?

(2) Web of Proof Engines:

- i. How to trace the evidence used for reasoning and how to trust the evidence?
- ii. How to cope with conflicting evidence, e.g., when using different sources?
- iii. How to build executable and traceable clinical pathways from the results generated by proof engines in the case of un-decidability?

(3) Data Integration:

- i. A large quantity of patient data will be in traditional database, flat files format (for example, a word document) or semi-structured format, such as XML files. How can these data be integrated with ontologies and be accessible by semantic web engines?

- ii. What is the performance when reasoning over a large amount of data from dispersed locations?

5. Conclusion

The proposed framework aims at demonstrating that large scale (real size) medical knowledge and other relevant domain knowledge can be expressed explicitly and quantitatively using Semantic Web technology to improve quality of service in healthcare.

6. References

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