Forward Chaining Inference vs. Binary Decision Support in an Electronic Health Record Application Based on Archetyped Data

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Abstract and Objective

The implementation of computerized health information systems has a potential effectiveness related to the use of decision support engines. Decision engines based on Boolean logic are one of the most prevalent in current implementations, but the complexity of healthcare information does need more robust solutions, especially in fully implemented, semantic-sensitive, electronic health records. The purpose of this paper is to investigate the effects of two common approaches to decision support in Electronic Health Record (EHR) applications. The EHR uses archetyped data based on the multi-level modeling principles initially described in the openEHR specifications which were foundational to the formation of the ISO and CEN 13606 EHR standards. Forward chaining using CLIPS rules was compared to if-then-else constructs in terms of performance and code size. The results showed that forward chaining was much faster and required less coding, besides being more easily to maintain. The accuracy of the forward-chaining engine was 100%, considering the Boolean-based engine as the gold standard. This study confirms the validity of CLIPS-based inference engines for decision support in healthcare.

Keywords:

Computer-assisted decision making, Clinical decision support systems.

Methods

We created a demonstration application using the Open Source Health Information Platform (OSHIP) since it is a full application server based on the *open*EHR specifications and includes the C Language Inference Processing System (CLIPS) forward chaining Rete algorithm based engine. The application was designed as a blood pressure registry system. The use case scenario was to monitor the self reported blood pressure readings from a simulated database of a small town population of patients considered at risk for hypertension. Forward chaining using CLIPS rules was compared to if-then-else constructs in terms of performance and code size. Validity assessment was performed using the accuracy indicator, defined as the proportion of concordant diagnostics between the test and the gold standard over the total number of diagnostics.

The initial testing methods used hand entered data and application timing routines to measure the performance differences in detecting the "at risk" characteristics at each patient entry, across each patient's history and across the population.

Results

The preliminary results show that the CLIPS rules syntax had a higher learning curve initially. But that was short lived and it was quickly found that creating the CLIPS rules in the Python language was less error prone and more rapidly performed than using the normal if/then constructs. The code size for the same number of decision points is approximately 40% less using CLIPS rules and execution time with 100 patient entries is 10 times faster in the CLIPS portion of the code.

Considering the Boolean-based engine as the gold standard, the CLIPS-based engine showed 100% of accuracy, in a validity study performed with a simulated database of hypertensive and non-hypertensive subjects.

Conclusions

The typical data model approach to health care application design and development is well documented to cause interoperability and ongoing software maintenance issues. The information model approach, using a generic reference model built in software with single concept knowledge components represented as runtime, semantically contextual data containers, provide a mechanism of exchanging information between systems based on the same reference model but that may not have necessarily had the same purpose when created. Usually decision support systems are rarely used outside the scenario where they were developed, on account of interoperability issues. Archetypes may provide a solution to this problem and this demonstration aims at comparing two approaches to decision support using archetype based data.