Arden-Syntax-Based Clinical Decision Support Software

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Abstract

We describe an implemented software architecture for clinical decision support (CDS) based on the Health Level Seven (HL7) Arden Syntax for Medical Logic Systems. Arden Syntax's proven applicability as a medical knowledge representation and inference scheme makes it a good candidate for a service-oriented architecture for CDS systems. We developed a package of Arden-Syntax-based software components including compiler, rule engine, server, an integrated development environment (IDE), and web services for interoperability. We report on a large-scale implementation of this software system, which constituted the platform for an automated cockpit surveillance program for early identification and automated monitoring of hospital-acquired infections at 12 intensive care units (ICUs) serving adult patients, and 3 ICUs for neonatal care at the Vienna General Hospital. The Philips Care Vue intensive care medical information systems installed at the ICUs provide the necessary data. Arden Syntax, the service-oriented architecture, the extended medical knowledge packages, and the developed web-based user interfaces create a powerful tool for CDS at the infection control unit of this hospital.

Keywords:

Clinical decision support, Service-oriented architecture, Arden syntax, ICU, Hospital-acquired infections.

Methods

The HL7-maintained medical knowledge representation language Arden Syntax is well-suited as a basis for extended CDS software. An Arden Syntax knowledge base consists of a set of rules known as Medical Logic Modules (MLMs), each of which may contain sufficient logic for specific medical decisions. MLMs may interact with each other by calling or by importing declarations. Service-oriented architectures (SOAs) are considered to be advanced approaches for the development of practical CDS systems. An SOA is essentially a collection of services which can communicate with each other. We developed a package of software that fully implements Arden Syntax and conforms to the SOA requirements. The Java-based system consists of two essential components: an Arden Syntax compiler and an Arden Syntax engine. While the compiler converts MLMs into Java byte code, the engine runs the compiled MLMs. A sub-component known as the MLM manager maintains the compiled MLMs and conceals the specific implementation of MLM storage from the engine. The Arden Syntax engine, compiler, and the MLM manager constitute a stand-alone system which can be run on a single host to verify, compile and run MLMs. As Arden Syntax is meant to work closely with a host system, we developed a Java-based Arden Syntax server encapsulating the Arden Syntax engine. In addition, the Arden Syntax server has to provide for concurrency, multiple executions, asynchrony calls, and be independent of Java. The Arden Syntax server conforms to an Arden Syntax host interface which defines the communication between Arden Syntax engine and server. The communication with Arden Syntax servers follows the Arden Syntax server protocol, based on sending and receiving documents in accordance with the rules of XML. To conform with SOA, the Arden Syntax server provides an external web service interface which is accessible through a network. This feature ensures that any application inside an institution can consume the provided service by simply wrapping the XML document into a SOAP message and transporting it to the Arden Syntax server.

Results

The Arden-Syntax-based CDS software was constructed, implemented, and is routinely used in conjunction with 2 large MLM packages (147 MLMs and 75 MLMs, respectively) for early identification and automated monitoring of hospital-acquired infections at the Vienna General Hospital. Data sources for this application are the Philips Care Vue intensive care medical information systems installed at the hospital's ICUs. The web-based application software provides the hospital's infection control unit with an almost real-time surveillance of hospital-acquired infections for 138 ICU beds.

Conclusion

This large implementation has a) proved the operational capability and scalability of the established software, and b) demonstrated the clinical usefulness of high-level computerized decision support for infection control in a 2,200-bed hospital.