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The Arden Syntax standard for clinical decision support: Experiences and directions

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ABSTRACT

Arden Syntax is a widely recognized standard for representing clinical and scientific knowledge in an executable format. It has a history that reaches back until 1989 and is currently maintained by the Health Level 7 (HL7) organization. We created a production-ready development environment, compiler, rule engine and application server for Arden Syntax. Over the course of several years, we have applied this Arden – Syntax – based CDS system in a wide variety of clinical problem domains, such as hepatitis serology interpretation, monitoring of nosocomial infections or the prediction of metastatic events in melanoma patients. We found the Arden Syntax standard to be very suitable for the practical implementation of CDS systems. Among the advantages of Arden Syntax are its status as an actively developed HL7 standard, the readability of the syntax, and various syntactic features such as flexible list handling. A major challenge we encountered was the technical integration of our CDS systems in existing, heterogeneous health information systems. To address this issue, we are currently working on incorporating the HL7 standard GELLO, which provides a standardized interface and query language for accessing data in health information systems. We hope that these planned extensions of the Arden Syntax might eventually help in realizing the vision of a global, interoperable and shared library of clinical decision support knowledge.

1. Introduction

Decision making in modern medical practice is based on increasingly complex medical knowledge and clinical evidence. This makes it difficult to provide the best possible care in the busy environment typically encountered in healthcare settings. It has been shown that clinical decision support (CDS) systems can significantly improve the quality of treatment if they meet certain design criteria [1].

Arden Syntax is a widely recognized standard for representing clinical and scientific knowledge in an executable format which can be used by such CDS systems. It has a long history: A first draft of the standard was prepared at a meeting at the Arden Homestead, New York, in 1989. The first Arden Syntax specification was published by the American Society for Testing and Materials (ASTM) in the year 1992. Later on, the standard was integrated into Health Level 7 (HL7) [2]. HL7 published Arden Syntax version 2.0 in the year 1999 and has been hosting the development of all newer versions of the Arden Syntax standard ever since. The Arden Syntax Working Group [3] is currently responsible for the active development of the standard within HL7. The present, most recent version of Arden Syntax is version 2.8.

Any common programming language can, in theory, be used to implement CDS systems. However, the Arden Syntax standard was designed for this specific purpose and is equipped with a set of features that make it especially useful for this task. Arden Syntax can be used in a way that makes program code resemble natural language, which, in turn, makes the code easier to understand by non-experts in computer science. It also features a choice of data types that is tailored to the needs of medical documentation, including measures for time and duration. Additionally, the use of Arden Syntax makes it possible to represent decision support logic independently from the programming languages and implementation details chosen for a specific hospital information system (HIS), making it easier to exchange CDS logic between different systems at different sites.

Arden Syntax can be seen as a hybrid between classical production rules and procedural representation of clinical algorithms. The code is organized in self-contained files called Medical Logic Modules (MLMs). The execution of an MLM can be triggered by specific

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data- or time-based events or by a direct call. An example of a simple MLM is shown in Fig. 1. In this paper we provide a brief overview of the basic features of Arden Syntax; a more detailed description can be found in [4].

```
maintenance:
        title: simple body mass index;;
        mlmname: BMI;;
        arden: Version 2.8;;
        version: 1.00;;
        institution: Medexter Healthcare;;
        author: Karsten Fehre;;
        specialist: ;;
        date: 2011-11-01;;
        validation: testing;;
library:
        purpose: body mass index;;
        explanation:
                calculation of body mass index (BMI)
                input: compound list with:
                        (number) size in m,
                        (number) weight in kg,
                        (time) birth date.
                output:
                        If the age is not less than 19 and the classification
                        according to WHO is not normal, a message containing
                        the calculated BMI and its classification will be sent.
;;
        keywords: BMI, body mass index;;
        citations: ;;
        links: http://en.wikipedia.org/wiki/Body_mass_index;;
knowledge:
        type: data_driven;;
        data:

                // Arguments
                (size, weight, birth) := argument;

        ;;
        priority: ;;
        evoke: ;;
        logic:
          // calculation of BMI
          let bmi be weight / (size ** 2); // BMI

          // calculation of AGE
          age := currenttime - birth; // AGE

          // classification
          if the age is less than 19 years then classification := null;
          // This classification is only valid for patients older than 19

          elseif the bmi is less than 18.5 then classification := localized 'under';
          // classified as underweight

          elseif the bmi is less than 25 then classification := null; // BMI normal range

          else let the classification be localized 'over';
           // classified as overweight
          endif;

          bmi := bmi formatted with localized 'msg'; // construct the localized message

          conclude classification is present ; // if there is a classification, execute
           the action slot
        ;;
        action:
          write bmi || classification || "."; // return result
          return classification;
        ;;
        urgency: ;;

resources:
        default: de;;
        language: en
                'msg' : "The patient's BMI %.1f is not in the normal range and is classified as
        ";
                'under' : "underweight.";
                'over' : "overweight."
        ;;
        language: de
                'msg' : "Der BMI %.1f des Patienten ist nicht im normalen Bereich und wird
        klassifiziert als ";

                    'under' : "Untergewicht.";
                    'over' : "Übergewicht."
         ;;
end:
```

Fig. 1. An example of an MLM in Arden Syntax. It calculates the body mass index (BMI) given the parameters size, weight and birth date.