Modernizing Clinical Decision Support: Introducing ArdenSuite Enhanced with Arden Syntax on FHIR

Moritz GROB[a,b], Leonhard HAUPTFELD[b], and Klaus-Peter ADLASSNIG[a,b,1]
[a]*Medical University of Vienna, Center for Medical Data Science, Institute of Artificial Intelligence, Spitalgasse 23, 1090 Vienna, Austria*
[b]*Medexter Healthcare, Borschkegasse 7/5, 1090 Vienna, Austria*

Abstract. We present the latest advancements in clinical decision support tools, focusing on the new ArdenSuite platform, fully integrated with HL7's Arden Syntax version 3.0, which includes FHIR as its data model. The session will highlight significant improvements over previous versions, including the resolution of the "curly braces problem" through standardized data access and the introduction of a state-of-the-art REST API. Participants will explore the updated platform's capabilities through an interactive sandbox environment, designed to demonstrate the ease of medical logic module development and execution. The session aims to showcase how these enhancements can streamline workflows, improve data interoperability, and advance the precision of clinical decision-making.

Keywords. clinical decision support, Health Level Seven (HL7), Arden Syntax, Fast Healthcare Interoperability Resources (FHIR), ArdenSuite

1. Introduction

The Health Level Seven (HL7) Arden Syntax for Medical Logic Systems is an American National Standards Institute (ANSI)-approved formalism for clinical knowledge representation with its latest normative version designated as ANSI/HL7 Arden V2.10-2014 (R2019) [1]. The standard's main objective is to facilitate composition and interpretation of executable medical logic by clinicians and thus provide interoperability between clinical decision support (CDS) systems' knowledge bases via a standardized formal representation, so-called medical logic modules (MLMs) [2].

While supporting concepts from general-purpose programming languages like loops and branches, Arden Syntax offers numerous advantages for CDS implementation as a domain-specific language. MLMs contain both executable logic and metadata in the same file whilst clearly separating them via a strictly defined modular structure. This approach enhances readability, flexibility, and portability of medical logic by encapsulating all necessary information within each MLM, thereby obviating the need for special configuration files and their—often rather tedious—management.

Due to the importance of temporal relationships in the health science domain, Arden Syntax includes specialized operators for temporal reasoning such as BEFORE, AFTER,

[1] Corresponding Author: Klaus-Peter Adlassnig; E-mail: klaus-peter.adlassnig@meduniwien.ac.at.

and AGO as well as duration operators. Furthermore, version 2.9 introduced operators for the implementation of fuzzy logic, making fuzzy sets first-class citizens of the language. Since its inception, a drawback of the standard was that the syntax for external data access was not standardized, leading to site-specific queries dependent on the on-site infrastructure. Since these queries were written inside curly braces "{}", this drawback had been termed "curly braces problem" [3]. Nonetheless, Arden Syntax has proven its utility in applications such as laboratory test result interpretation [4], context sensitive clinical alerting [5], and reducing the overutilization of laboratory tests [6].

2. Topic

On December 11, 2023, the new version 3.0 of the Arden Syntax was published by HL7 as Standard for Trial Use (STU) [7]. This new version, nicknamed "Arden Syntax on FHIR" [8], finally addresses the long-standing "curly braces problem" [2, 3] by incorporating HL7 Fast Healthcare Interoperability Resources (FHIR) version 4.3.0 [9] constructs as a standardized means of external data access. The emergence of this new specification was seized as an opportunity by Medexter Healthcare to entirely overhaul and modernize its ArdenSuite CDS platform [10], complete with a new development environment, which shall be the main subject of this demonstration.

The modernized ArdenSuite fully supports the now-native access to FHIR resources through Arden Syntax 3.0. Access to and computation of medical knowledge in the form of MLMs was fully revamped, now being accessible through a state-of-the-art REST API. In addition, the new suite incorporates support for a wide range of extensions, from accessing external databases to executing MLMs by means of additional web interfaces for CDS Hooks [11].

3. Contents of the Demonstration

The demonstration will be structured into two main parts. First, the basics of Arden Syntax will be presented with a focus on new features in the current version 3.0 [7] of the standard. For this purpose, a web application providing a sort of "sandbox" has been developed, allowing participants delve into and explore MLM development on their own.

The second part will follow with a demonstration of Medexter Healthcare's new version of the all-in-one CDS integration platform ArdenSuite [10], highlighting its novel features.

4. Presenters

Moritz Grob received the B.Sc. degree in biomedical engineering from University of Applied Sciences Technikum Wien, Vienna, Austria, in 2023. He is currently pursuing a master's degree in medical informatics at Medical University of Vienna, Austria, while working as a software developer at Medexter Healthcare. His research has been awarded with the Best Short Paper Award at the 21st International Conference on Informatics, Management, and Technology in Healthcare (ICIMTH 2023) as well as the HL7 Austria and DICOM Austria Student Award 2024.

Leonhard Hauptfeld is a Senior Software Developer and Researcher at Medexter Healthcare. After gaining more than eight years of experience in the industry designing and implementing medical management software for clinics and private practitioners, he received his master's degree in medical engineering from University of Applied Sciences Technikum Wien, Vienna, Austria, in 2023. He is currently researching and presenting new ways of automating hospital infection surveillance while working on bringing the next generation of Arden Syntax to clinical decision support tools.

Klaus-Peter Adlassnig is a Professor of Medical Informatics (now retired) at Medical University of Vienna, Austria. He has been pursuing medical expert and clinical decision support systems research for more than four decades and was the Editor-in-Chief of the international journal Artificial Intelligence in Medicine from 2002 to 2016. In his theoretical and applied research, he introduced fuzzy set theory, fuzzy logic, and related areas into clinical medicine. He co-founded Medexter Healthcare in 2002 and has acted as its CEO and Scientific Head since then. In 2014, he was elected Fellow of the American College of Medical Informatics, and in 2018, he became a Fellow of the International Academy of Health Sciences Informatics. In 2024, he became co-chair of the HL7 Arden Syntax Work Group.

References

[1] Health Level Seven International. Health Level Seven Arden Syntax for Medical Logic Systems, Version 2.10 [Internet]. Ann Arbor (MI): HL7 International; c2019 [cited 2024 April 5]. Available from: https://www.hl7.org/implement/standards/product_brief.cfm?product_id=372

[2] Jenders RA, Adlassnig K-P, Fehre K, Haug F. Evolution of the Arden Syntax: Key Technical Issues from the Standards Development Organization Perspective. Artif Intell Med. 2018;92:10–14. doi: 10.1016/j.artmed.2016.08.001

[3] Jenders RA, Sujansky W, Broverman CA, Chadwick M. Towards improved knowledge sharing: assessment of the HL7 Reference Information Model to support medical logic module queries. Proc AMIA Annu Fall Symp. 1997:308–312. PMCID: PMC2233583

[4] Adlassnig KP, Gawrylkowicz J, Rappelsberger A. Interpretive Knowledge Engines: A New Service for Pathologists to Bridge the Gap to Clinicians. In: Abstracts 31st European Congress of Clinical Microbiology & Infectious Diseases (ECCMID), Vienna, Austria. ESCMID eLibrary: 516

[5] Zeckl J, Adlassnig K, Fossler R, Blacky A, de Bruin JS, Koller W, et al. Context-Sensitive Clinical Alert Packages Written in Arden Syntax. Stud Health Technol Inform. 2017;245:1190–1194, doi: 10.3233/978-1-61499-830-3-1190

[6] Castellanos I, Kraus S, Toddenroth D, Prokosch HU, Bürkle T. Using Arden Syntax Medical Logic Modules to reduce overutilization of laboratory tests for detection of bacterial infections—Success or failure? Artif Intell Med. 2018;92:43–50. doi: 10.1016/j.artmed.2015.09.005

[7] Health Level Seven International. Health Level Seven Arden Syntax for Medical Logic Systems, Version 3.0 [Internet]. Ann Arbor (MI): HL7 International; c2023 [cited 2024 April 5]. Available from: https://www.hl7.org/implement/standards/product_brief.cfm?product_id=639

[8] Csarmann A, Zeckl J, Haug P, Jenders RA, Rappelsberger A, Adlassnig K-P. Arden Syntax on FHIR. In Mantas J, Gallos P, Zoulias E, Hasman A, Househ MS, Charalampidou M, Magdalinou A, editors. Healthcare Transformation with Informatics and Artificial Intelligence, Stud Health Technol Inform. IOS Press: Amsterdam; 2023;305:423–424. doi:10.3233/shti230521

[9] Health Level Seven International. FHIR v4.3.0 [Internet]. Ann Arbor (MI): HL7 International; c2022 [cited 2024 April 9]. Available from: https://hl7.org/fhir/R4B

[10] Medexter Healthcare GmbH. ArdenSuite [computer software]. Vienna: Medexter Healthcare; c2024 [cited 2024 April 5]. Available from: https://www.medexter.com/products-and-services/ardensuite

[11] de Bruin JS, Rappelsberger A, Adlassnig KP, Gawrylkowicz J. Exploring Methods of Implementing Arden Syntax for CDS Hooks. Stud Health Technol Inform. 2020;271:191–198, doi: 10.3233/shti200096