A web-based modeling tool for studying the learning of conceptual modeling

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Abstract: How do we learn conceptual modeling? What are common learning difficulties? Which tool support assists learners in what respect? We report on the design and development of a web-based modeling tool aimed at studying the learning of conceptual modeling by observing learner interactions with graphical model editors. Learner interactions with graphical model editors are tracked, recorded and analyzed at the individual and aggregate learner levels with support for graphically reproducing the learner-editor interactions over time. In this short paper, we report on the current state of the tool development.

Keywords: Learning of conceptual modeling; Web-based modeling tool; Prototyping.

1 Introduction

Viewed as an activity, conceptual modeling involves an intricate array of cognitive processes and performed actions including abstracting, conceptualizing, associating, interpreting, visualizing, and, in group settings, communicating, discussing and agreeing. The learning of conceptual modeling, hence, constitutes a complex and challenging task for learners not only at the introductory level. Designing modeling tool support for learners presupposes a differentiated understanding of learning processes, common learning difficulties, and learning barriers. However, surprisingly little is currently known about the learning of conceptual modeling [SSD14, pp. 488]. Research on learning conceptual modeling has only recently seen increasing interest with contributions, e.g., focusing on business process modeling (e.g. [Pi12]), on cognitive aspects (e.g. [TVC17]), and on learning outcomes (e.g. [SDS16]).

In an attempt to contribute to filling this gap, we embarked on a long-term research program with which we aim to better understand how modelers learn a modeling language resp. modeling method and how tool support assists learners in what respect. As part of that research program, we develop a web-based modeling tool aimed at identifying patterns by recording learner interactions with graphical model editors, e.g., patterns of learning difficulties. The current running prototype explores design and implementation strategies for tracking learner-editor interactions, handling and persistency of tracking data and tracking data analytics.

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2 Tool presentation

Two essential requirements drive the software development, ease-of-use (and installation, configuration) as well as platform independence to the greatest possible extent (based on our primary application scenario of a distance learning context with cohorts of up to 1,500 learners). Hence, in an early design decision, we opted for a web application with a JavaScript-driven browser frontend and an Java EE (Enterprise Edition)-based backend (see Fig. 1). Thus, the tool can be used with popular web browsers and operating systems.

The principle tool operation is as follows: The core component of the web frontend implements the generic handling of nodes and edges on the drawing canvas including higher level features such as creating, reading, and updating entire diagrams. Appropriate resources are dynamically loaded and added to the page as needed, usually in response to user interactions. The created conceptual models are internally represented and stored in the JavaScript Object Notation (JSON) format. Stencil sets are processed by the frontend and provide explicit typing, connection rules, visual appearance, and other features that differentiate a model editor from generic vector-oriented drawing tools.

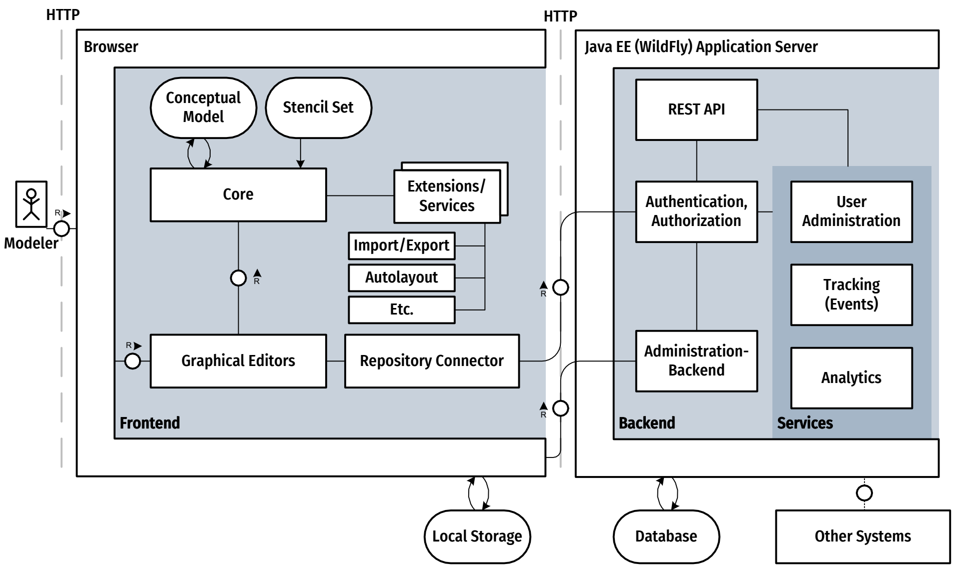

Fig. 1: The software architecture on conceptual design level.

The frontend prototype currently implements two graphical editors we use in an introductory course on conceptual modeling: A variant of the Entity-Relationship Model [Ch76] for data modeling and a subset of the MEMO Organisation Modeling Language [Fr11] for business process modeling (see Fig. 2). With respect to the user interface paradigm, we opted for the widely used stencil set (left) and modeling canvas (right) approach but consider the user interface subject to future research on better supporting the learning process after having identified patterns of learning and learning difficulties.

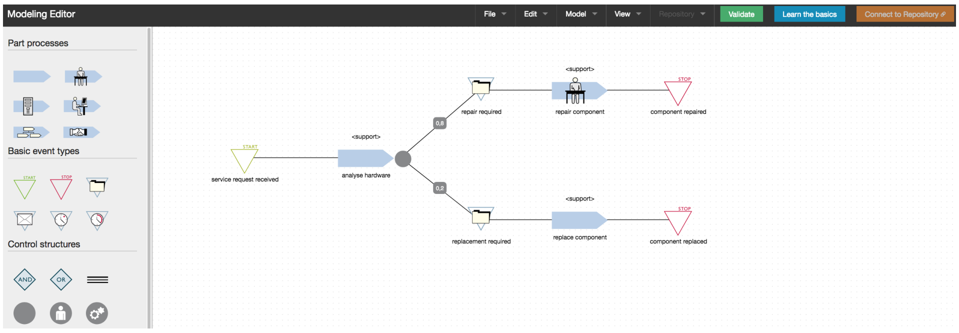

Fig. 2: Overview of the web-based modeling tool.

The backend prototype implements a tracking and an analytic component including algorithms for tracking and functionalities for analyzing learner-editor interactions. In more detail, the prototype implements an algorithm which records the learner-editor interactions while working on, e.g., modeling tasks. An additional analysis interface extends the current prototype, and preliminary comprises two analysis functionalities for reconstructing the learner interactions (see Fig. 3): A step-by-step replay and an automatic replay. Corresponding analytics and visualizations of tracked data will be added in future work.

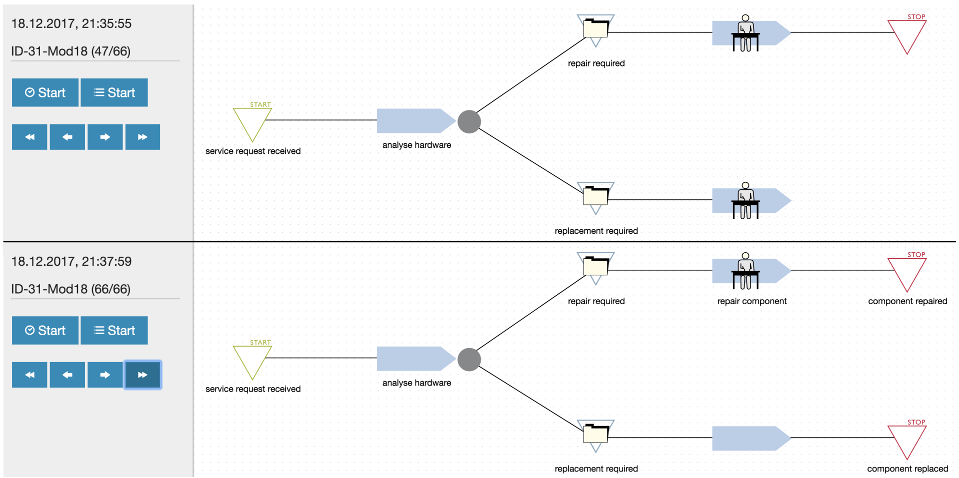

Fig. 3: Overview of the implemented replay analysis.

Please note that due to privacy and security issues, the tool can only be accessed via a VPN connection to the university network at the following link: `http://tool.fernuni-hagen.de`. Further information about the prototype, such as the JSON structure that is used for model serialization, are provided upon request.

3 Limitations and outlook

Observing learning conceptual modeling by learner-editor interaction is a principle limitation of our approach, and neglects other, presumably equally important aspects of the learning process, e.g., learner motivation and willingness-to-learn, use of additional tools outside of our modeling tool, e.g., online tutorial videos etc. In another respect, observing learner-tool interaction is a second- or third-best approach: Asking learners to think out loud (e.g. [Ha16]) while modeling promises further and more detailed insights into their reasoning and is on our agenda as an additional mean of studying the learning of conceptual modeling. We plan to add support for thinking out loud to the prototype in a future version.

Tool development is also confronted with technical challenges, e.g., with performance issues under heavy load which need further investigation and systematic testing (potentially having more than 1,000 students using the tool at the same time). Likewise, the prototype needs further testing of run-time stability under high load which we consider especially important with regard to the implementation of the tracking algorithm. These limitations and challenges remain on our research agenda.

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