TOOL–A Modeling Observatory & Tool for Studying Individual Modeling Processes

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Abstract. We present TOOL, a browser-based modeling tool integrated with a modeling observatory for studying individual modeling processes, e.g., when constructing a data model. To account for the richness and complexity of the cognitive processes involved in conceptual modeling, modelers' modeling processes demand study from multiple, complementary angles and perspectives. TOOL integrates a multi-modal data collection approach including (1) tracking modeler-tool interactions (via the user interface), (2) recording verbal data protocols of modelers' thinking out loud, (3) screen captures, and (4) surveying modelers—to provide a more complete picture at the individual and aggregate modelers level in the quest for identifying patterns of modeling processes and modeling difficulties. We report on the current state of prototype development, discuss the tool and its modes of observation, and outline future work on supporting modelers and on meta-modeling in TOOL.

Keywords: Conceptual Modeling · Modeling Tool · Modeling Observatory · Prototyping

1 Introduction

Viewed as an activity, conceptual modeling involves an intricate array of cognitive processes and performed actions and, hence, is construed as a complex task involving codified and tacit knowledge (cf. [8]). Despite its complexity and relevance (e. g., [10]), surprisingly little is known about individual conceptual modeling processes. Research on observing modeling processes has only recently seen increasing interest with contributions, e. g., focusing on business process modeling [5], learning tool support [9] or on neuro-adaptive modeling environments [14]. To learn more about how conceptual modeling is performed by modelers, which modeling difficulties they encounter and why, and how to overcome these difficulties by targeted modeling (tool) support, we have been researching and developing TOOL, a web-browser-based modeling observatory and tool.

TOOL is part of a long-term research program to better understand individual modeling processes and to develop targeted tool support for modelers while conceptual modeling [11]. Research on TOOL is based on the fundamental

assumption that modeling processes deserve study from multiple complementary angles and perspectives—to account for the richness of the cognitive processes and performed actions involved in conceptual modeling and its complexity. Hence, TOOL implements means to realize mixed method research designs based on multi-modal data collection (e. g., [6, 8]).

2 TOOL Prototype Overview

TOOL comprises a web-based modeling tool for constructing conceptual models (see Fig. 1) and a modeling observatory for studying individual modeling processes and includes corresponding analysis tools. Two essential requirements drive the prototype development: (i) platform independence, and (ii) usability, in particular an intuitive (graphical) user interface. Design considerations, operating principles and essential requirements are outlined in, e. g., [12]. At present, the modeling tool implements two graphical modeling editors for constructing (i) data models with a variant of the Entity-Relationship (ER) Model and (ii) business process models implementing a subset of the Business Process Model and Notation—BPMN 2.0. Both graphical editors are supported by ad-hoc syntax validation to check the syntactic correctness of conceptual models. Syntax checking is currently based on explicit typing and connection rules provided by stencil sets which contain the abstract and concrete syntax as well as specific functions for, e. g., designators of roles.

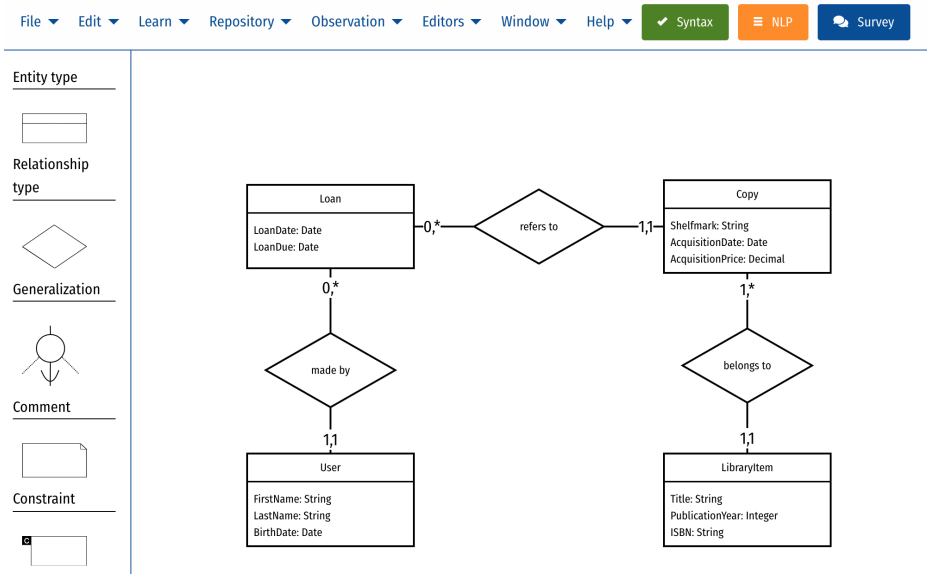

Fig. 1. Overview of the graphical user interface of TOOL.

TOOL supports studies of individual modeling processes in (i) a laboratory or field setting, and (ii) in a virtual setup when used as a modeling observatory (cf. [13]). The modeling observatory provides four data collection approaches to support the study of modeling processes: The observatory supports (1) tracking modeler-tool interactions as timed-discrete events which can be subsequently visualized as (a) step-by-step replays (up to four models at the same time), (b) heatmaps and (c) dot diagrams (see Fig. 2; further details are shown in [8]). Since modeler-tool interactions are a rather restricted mode of observation of individual modeling processes, we opted for additionally recording (2) verbal data protocols by asking modelers to think out loud while modeling—or subsequent to model creation (concurrent and retrospective think-aloud, see [3, 1]). To gain further insights into how modelers operate with the modeling tool respectively its graphical editors, TOOL supports recording (3) screen captures based on WebRTC to provide a video recording of the modeling process. Beyond these modes of observation, TOOL integrates a component for (4) creating surveys and for visualizing their results (see Fig. 2). Depending on the needs of a study, an observation workflow user interface allows for configuring the selection and sequence of observation modes (cf. [13]). A video demonstrator of TOOL is available at: https://vimeo.com/441854796/5237d3782a.

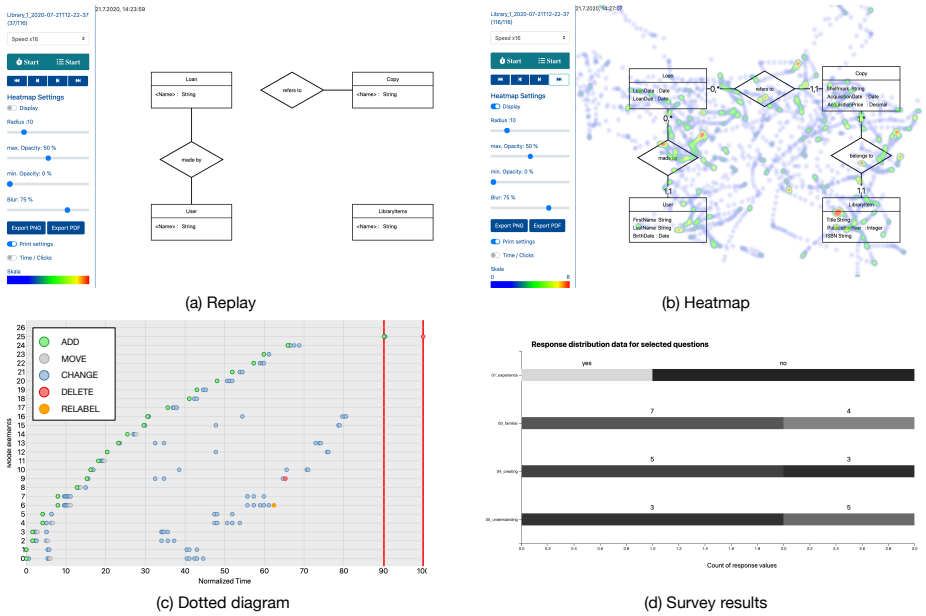

Fig. 2. Overview of the visual analysis components of TOOL.

3 Discussion and Outlook

TOOL has been a research subject for the past seven years and has continuously been under development. TOOL has been made available to students of an introductory course on modeling business information systems, and is currently in use by students to work on modeling tasks in the course material. Performance, scalability and stability of the running prototype have shown robust for the past year uptime albeit with moderate systems loads (60 to 80 students). We have employed TOOL in two exploratory studies on individual data modeling processes. In a first study, we observe eight learners of conceptual modeling working on a data modeling task to identify modeling difficulties these modelers experience [6], while a second study observes eight experienced modelers to discuss similarities and differences in modeling difficulties comparing non-experienced and experienced modelers [7].

To overcome modeling difficulties in labeling modeling elements (e.g., [2, 7]), we extend TOOL by implementing an automated feedback component based on Natural Language Processing (NLP) techniques to provide suggestions on labeling model elements at modeling time. The feedback component is among the first implementations to integrate a web-based data modeling tool with NLP technology, i. e., the Stanford CoreNLP toolkit (cf. [4]) to automatically process and understand an arbitrary natural language description of a modeling task in terms of its morphological structure to identify words and phrases as suggestions for labels for model elements. A preliminary evaluation of the feedback component demonstrates its usefulness by providing sensible and adequate suggestions to modelers. Furthermore, a meta-modeling component is currently developed that allows to implement modeling languages as graphical meta-models rather than text-based stencil sets.

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