Bachelor and Master project

XModeler^{ML} goes persistent – evaluation of different DBMS paradigms and prototypical implementation within the tool

Term: Summerterm 2022/23

Language: English / German

Motivation

Already in the early days of databases, a variety of paradigms for the implementation of database management systems (DBMS) has been established. Initially, the relational database model emerged as the dominant paradigm. However, in the course of changing database requirements due to mass storage and processing of modern information systems, alternative approaches of the so-called NoSQL have been increasingly proclaimed again as a solution for today's database requirements. The research project LE4MM (https://www.wi-inf.uni-duisburg-essen.de/LE4MM/) is focussed on the further development of a versatile, multi-level language engineering tool, the XModeler^{ML}, which simultaneously serves as development and runtime environment for languages and models. In addition, the research project is primarily concerned with multi-level modeling, which is suited to overcome various restrictions of conventional modeling and programming languages. Persistence has been largely abstracted from in the development of the tool so far.

It is the objective of this student project to create an extension of the current implementation of the XModeler^{ML}, which covers a DBMS that allows to persist and retrieve multi-level models. Firstly, this requires the examination and critical comparison of different paradigms for the realization of DBMS in the context of this project, in order to prepare the selection of a suitable DBMS product. Secondly, a corresponding schema has to be implemented within the selected database and the extensions in the front end of the XModeler^{ML} must be made accordingly.

Description

This project provides students with the opportunity to participate in the research project LE4MM and experience the prospects of a new paradigm of modeling and implementing information systems. To achieve the objectives of the project, the project team needs to address the following assignments:

1. getting familiar with the conceptual background of multi-level modeling
2. familiarization with various DBMS paradigms and exemplary products that can be assigned to the corresponding paradigms

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3. working with the XModeler^ML and the frontend development with JavaFX
4. creation of a project documentation, which motivates the topic, considers theoretical foundations, describes its project organization, makes a critical comparison of the individual DBMS paradigms, discusses the selection of individual products, justifies the programming activities and extensions made in XModeler^ML, critically evaluates your artifact and ends in a conclusion with the final state of the project
5. design of a data schema for multi-level models (for this purpose you will be provided with exemplary document instances of the previous persistence solution)
6. setting up and applying an evaluation scheme for the selection or comparison of DBMS paradigms
7. application of different DBMSs in order to get a feeling for the particularities of each of them
8. prototypical implementation in XModeler^ML

It is mandatory that you deal with at least the relational, the graph-oriented and the document-oriented database model within the scope of the project. An implementation within the relational paradigm would furthermore require an extension of the object-relational-mapping (ORM), in such way a that the peculiarities of multi-level modeling are considered here. During the initial setup of your Java development environment with the XModeler^ML project, you will receive assistance from the research group, if necessary.

LE4MM is a conjoint project with Prof Tony Clark, Aston University, Birmingham. That opens the possibility to work together with a student team from Aston university. Further details will be provided at the start of the project, in case you are interested in that opportunity. Anyway, individual performance requirements must be met and have to be made evident to the supervisors on your own.

Expected Outcomes

A schema, which fulfils the purpose of persisting multi-level models, an implementation of the schema within the selected database, the implementation in XModeler^ML in the form of an extension of the frontend developed in JavaFX (e. g. component for configuration of the database connection, replacement of the rudimentarily implemented persistence with the new permanent solution in the well-grounded selected DBMS). In addition, a project documentation must be submitted, which has to show basic scientific foundations, describe your project organization, make the construction of the artifact comprehensible and justify the decisions you have made. Also, the source code has to be handed in. Interim and final presentations will be made in coordination with the supervisors, depending on the progress of the project.

Introductory Literature

- Frank, Ulrich (2014). *Multilevel modeling*. Business & Information Systems Engineering 6(6): 319-337

- Clark, T., Sammut, P., & Willans, J. (2008). *Applied Metamodelling: A Foundation for Language Driven Development* (2nd ed.). Ceteva. Retrieved from http://www.eis.mdx.ac.uk/staffpages/tonyclark/Papers/Applied%20Metamodelling%20%28Second%20Edition%29.pdf
- Skulschus, Marco, and Marcus Wiederstein (2008). *XML schema*. Comelio Medien
- Reinhard Diestel (2010). *Graphentheorie*. 4. Auflage. Springer, Berlin.
- Angles, Renzo, et al. (2017). *Foundations of modern query languages for graph databases*. ACM Computing Surveys 50(5): 1-40.
- Miller, Justin J. (2013). *Graph database applications and concepts with Neo4j*. Proceedings of the southern association for information systems conference, Atlanta, GA, USA.
- Keith, Mike, and Merrick Schnicariol (2009). *Object-relational mapping*. Pro JPA 2. Apress: 69-106.
- O'Neil, Elizabeth J. (2008). *Object/relational mapping 2008: hibernate and the entity data model (edm)*. Proceedings of the 2008 ACM SIGMOD international conference on Management of data.
- Vera, Harley, et al. (2015). *Data modeling for NoSQL document-oriented databases*. CEUR Workshop Proceedings.
- Truică, Ciprian-Octavian, et al. (2021). *The Forgotten Document-Oriented Database Management Systems: An Overview and Benchmark of Native XML DODBMSes in Comparison with JSON DODBMSes*. Big Data Research 25: 100205.

Application Procedure:

Please apply via email to the supervisor Luca Mattei (luca.mattei@uni-due.de). Please attach a short letter of motivation (approximately one A4 page) and a recent performance record ('Leistungsnachweis'). You can apply individually or in a group of **2-3 participants** (in this case each person must still send a separate e-mail, however point to the other members of the group).

To get an idea of the project LE4MM we recommend to have a look at the project's webpages, especially at the provided screencasts.

Application deadline: 12 May 2023, 23:59