Breathing Life into Database Textbooks

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ABSTRACT

Despite its tremendous utility, database systems has often been considered an unexciting topic for undergraduate curricula. To remedy this, we describe a novel interactive electronic textbook for teaching undergraduate database systems courses. Designed for tablets, the textbook embeds a fully capable database. All parts of the textbook – examples, expressions, figures and explanations in the document are live, fully-functional elements of the database. In contrast to canned illustrations and animations, students can interact with each textbook element. The rapid feedback loop with the database allows the user to explore and understand the full scope of valid and invalid queries to the database. Wireless connectivity allows the instructor to perform detailed realtime analysis of classroom performance and provide interactive feedback, merging textbook instruction with in-class demonstrations, allowing for the scaling out of classrooms. We discuss the design of our prototype implementation of this concept.

1. INTRODUCTION & KEY FEATURES

Prior work in pedagogy using "clickers" [5], *interactives* [6, 4] and Read-Eval-Print Loops (REPLs) [2] have focused on basic polls, math, and programming languages – applying it to database education is a compelling opportunity. This interactivity blurs the lines between textbook instruction and in-class exercises, and allows students to appreciate topics without requiring tedious configuration or background instruction. Given the ubiquity of computationally powerful smartphones and tablets amongst students in today's classrooms, we envision a modern interactive electronic textbook (ebook) that embeds SQLite, a feature-rich database directly into the ebook itself. Unlike traditional ebooks with animated figures and popups, the textbook is a live database *sandbox*, with the following key features:- **Interactive Querying:** We build upon the direct manipulation-based Gestural Query Language [3], allowing for intuitive and user-friendly querying using multitouch gestures. **Reactive Text:** Any query representation, when clicked, triggers an execution over sample data. Conversely, any inter-
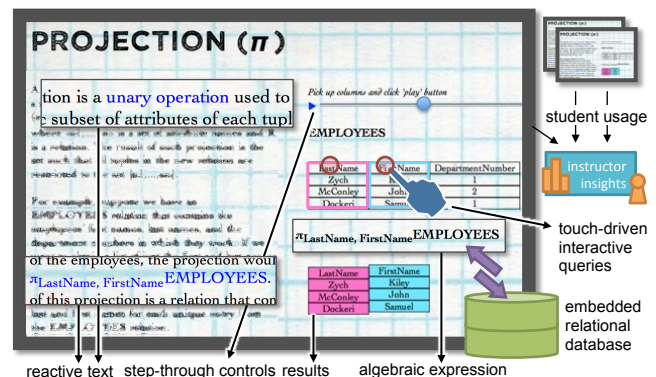
Students can interact with elements of our tablet-based textbook prototype to explore and perform queries. Instructors can analyze usage in real-time to improve the classroom experience.

action with the sample data changes the text to reflect the query, derived using Query-By-Example heuristics. **Algebraic Expressions:** Internal representations, such as the query parse tree can be exposed to teach relational algebra, as shown in the figure. Any updates to the data or the query will update the expression, allowing the student to intuit the algebra by exploration. The network connectivity of the devices makes it prime for integration into MOOC platforms, and enables **Instructor Insights**: All interactions and database states can be collected and mined for real-time insights for the instructor to adapt their teaching.

2. PROTOTYPE: RELATIONAL ALGEBRA

As a first step, we have prototyped a chapter on *relational algebra*, a typically hard-to-teach topic in databases. As shown above, to explore the *projection* operation, tapping on one or more attributes of a relation generates a new projection, with the corresponding algebraic expression being updated in the reactive text. Unlike canned animations with exactly one outcome, the user can try *all* possible combinations and internalize principles of the projection operator.

3. REFERENCES

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