# Practical Course: Database Implementation

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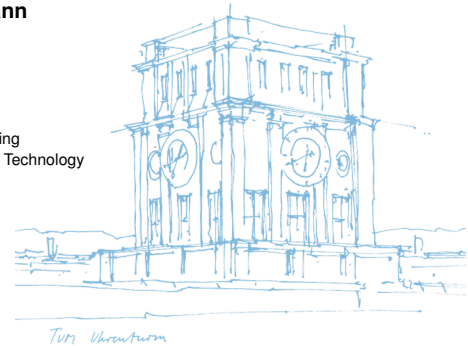
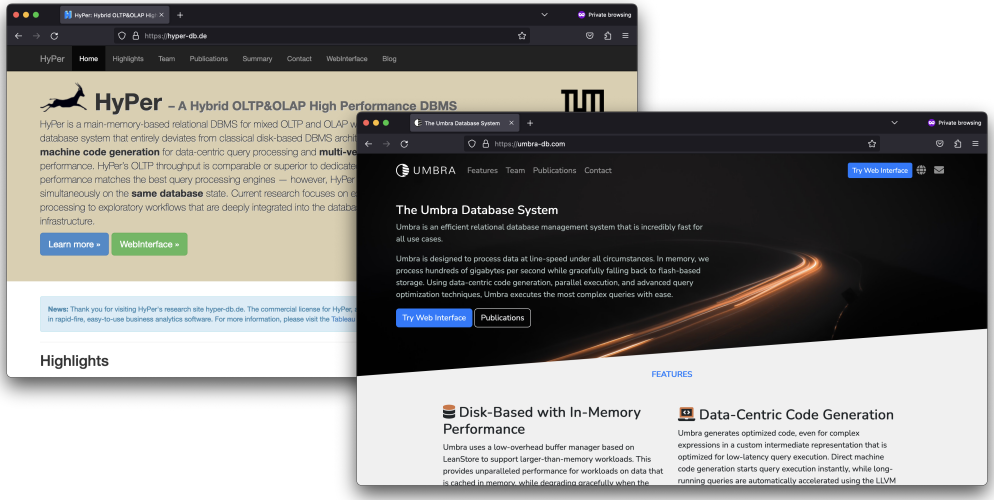


# Motivation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HyPer – A Hybrid OLTP&OLAP High Performance DBMS
HyPer is a main-memory-based relational DBMS for mixed OLTP and OLAP w
database system that entirely deviates from classical disk-based DBMS archi
machine code generation for data-centric query processing and multi-ve
performance. HyPer's OLTP throughput is comparable or superior to dedicate
performance matches the best query processing engines — however, HyPer
simultaneously on the same database state. Current research focuses on e
processing to exploratory workflows that are deeply integrated into the databa
infrastructure.
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News: Thank you for visiting HyPer's research site hyper-db.de. The commercial license for HyPer,
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The Umbra Database System
Umbra is an efficient relational database management system that is incredibly fast for all use cases.
Umbra is designed to process data at line-speed under all circumstances. In memory, we process hundreds of gigabytes per second while gracefully falling back to flash-based storage. Using data-centric code generation, parallel execution, and advanced query optimization techniques, Umbra executes the most complex queries with ease.
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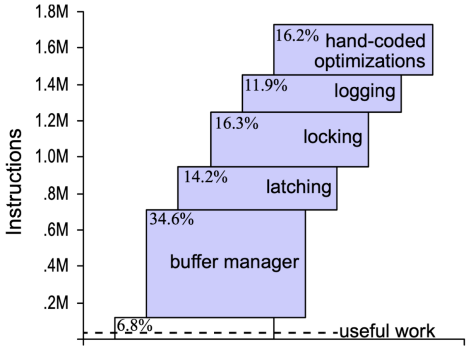
FEATURES
Disk-Based with In-Memory Performance
Umbra uses a low-overhead buffer manager based on LeanStore to support larger-than-memory workloads. This provides unparalleled performance for workloads on data that is cached in memory, while degrading gracefully when the
Data-Centric Code Generation
Umbra generates optimized code, even for complex expressions in a custom intermediate representation that is optimized for low-latency query execution. Direct machine code generation starts query execution instantly, while long-running queries are automatically accelerated using the LLVM

# Motivation

- We build a tiny **main-memory compiling database system**!
- We focus on correctness and *speeeeed*[1] ...

[1] Warning: Query compilation will be slow

# Motivation




| OLTP properties and new platforms | DBMS modification |
|---|---|
| logless architectures | remove logging |
| partitioning, commutativity | remove locking (when applicable) |
| one transaction at a time | single thread, remove locking, remove latching |
| main memory resident | remove buffer manager, directory |
| transaction-less databases | avoid transaction bookkeeping |

Figure 1: *OLTP Through the Looking Glass, and What We Found There* by Harizopoulos et al. (SIGMOD '08)

# Demo

# Contents

- **Data representation** in memory and **query execution**
- Building a **shell** for our DBMS
- **Lexing** and **parsing** SQL
- **Algebra trees** and **query optimization**[2]
- **Code generation** and **execution**
- **Multithreading**

[2] Only predicate pushdown

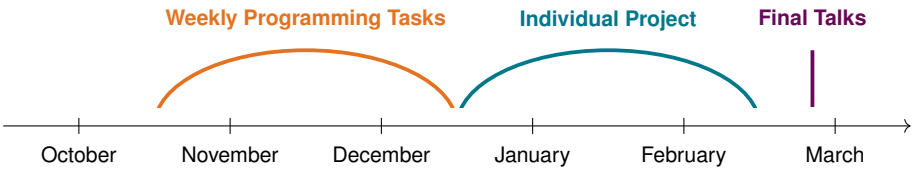
# Course Structure

**Weekly Programming Tasks** ($\sim$ 7 weeks):

- **Weekly meetings** and **assignments**

**Individual Project** ($\sim$ 7 weeks):

- Work on a state-of-the-art topic
- Present **your work** $\rightarrow$ **Final Talks**



# Course Structure

**Weekly Programming Tasks**:

- **1-2 students present their solution** for the previous assignment
- Introduction to a **new topic** + **assignment**
- Code **should** be submitted before next meeting

# Course Structure

**Individual Project**:

- Try to **reproduce a paper**, *or*
- **Implement some fancy feature** in your database, *or*
- Work on a **topic provided by a PhD student** of the chair

→ No more weekly course meetings, instead individual ones with your advisor

# Course Structure

**Final Talk**:

- **Present your project** in 10 to 15 minutes
- **On-site meeting** for all presentations + discussions (usually $\sim$ 3h)
- Date for meeting up to you (e.g., end of lectures vs. end of semester)


GitLab


Mattermost

# Organization

Tasks:

- We provide templates for the programming tasks in C++ and Rust
- The tasks build on each other → Decide early on the programming language!
- You may use helper libraries / crates (e.g., for text formatting, error handling, ...) that do not affect the overall implementation effort

Grading:

- Programming tasks and individual project (including the final talk) are graded roughly 50% each
- We will grade after the final presentations (which is also the deadline for your code)

# Registration

- Solve the qualification challenge: https://db.in.tum.de/teaching/ws2526/imlab/
- **Deadline: 22nd of July**
- Register via the matching system!

Questions?