

Normalized database schema

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Abstract: This thesis proposes a formal framework for the design and evaluation of normalized database schemas, addressing the persistent challenges of data redundancy and update anomalies in relational systems. Building upon classical normalization theory, the study develops a comprehensive schema design methodology that integrates functional dependency analysis with practical implementation constraints. The research introduces an algorithmic approach for systematically decomposing relations into higher normal forms, specifically targeting Boyce-Codd Normal Form (BCNF) and Fourth Normal Form (4NF), while preserving lossless joins and functional dependencies. Through rigorous mathematical formalization and empirical validation across multiple real-world datasets, the proposed schema demonstrates significant improvements in data integrity and storage efficiency compared to ad-hoc design practices. The framework also incorporates a quantitative metric for evaluating schema quality, enabling objective comparison of alternative normalization strategies. Results indicate that the systematic application of the proposed schema design rules reduces update anomalies by approximately 40% while maintaining query performance within acceptable thresholds. This work contributes both theoretical insights into dependency theory and practical guidelines for database practitioners seeking robust, maintainable data models.

Keywords: Database schema, Normalization, Data modeling, Relational database