

An Implementation paper in Typescript on Database Cleaning, Functional Dependency Extraction, and Progressive Normalization from 1NF to Domain-Key Normal Form

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Abstract

The rapid growth of digital information systems and AI automation has increased the importance of designing reliable, consistent, and efficient databases with automation. Inadequately structured databases often suffer from redundancy, update anomalies, insertion anomalies, deletion anomalies, and data inconsistency. Hence, database normalization provides a systematic approach for improving relational database design by organizing data into appropriate relations while preserving data integrity. This research and implementation paper represents automated processes of database cleaning, functional dependency extraction, and progressive normalization of a database. The first process is about uploading database from user's machine to the website which is developed for this purpose and then data pre-processing techniques to identify and remove inconsistencies, duplicate records, missing values, and invalid data entries from the tables of database. Functional dependencies are then extracted to identify relationships among attributes and determine candidate keys. After this, the database is progressively transformed through different normal forms, including First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce-Codd Normal Form (BCNF), Fourth Normal Form (4NF), Fifth Normal Form (5NF), and Domain-Key Normal Form (DKNF). The processes such as lossless join decomposition, dependency preservation, multivalued dependencies, and join dependencies are implemented. The results demonstrate that systematic normalization improves database quality, reduces redundancy, strengthens integrity constraints, and provides a scalable structure for academic information management systems. The study emphasizes the importance of combining automated database cleaning methods with normalization techniques for modern software products and business applications.

Keywords

Typescript, Database normalization, functional dependency, database cleaning, BCNF, multivalued dependency, lossless decomposition, dependency preservation, relational database design, DKNF.