

Identifying Functional Dependencies in a MySQL Relation

1 Introduction

A functional dependency (FD) in a relational database describes a relationship where one or more attributes (the determinant) uniquely determine another attribute. For a relation R , an FD $X \rightarrow Y$ means that each unique value of X corresponds to exactly one value of Y . This document explains how to identify functional dependencies in a MySQL database, using a sample relation and SQL queries to verify the dependencies.

2 Example Relation

Consider a **Student** relation with the following schema:

```
CREATE TABLE Student (  
    StudentID INT,  
    StudentName VARCHAR(50),  
    CourseID INT,  
    CourseName VARCHAR(50),  
    Instructor VARCHAR(50),  
    PRIMARY KEY (StudentID, CourseID)  
);
```

Sample data in the **Student** table:

StudentID	StudentName	CourseID	CourseName	Instructor
1	Alice	101	Math	Dr. Smith
1	Alice	102	Physics	Dr. Jones
2	Bob	101	Math	Dr. Smith

Table 1: Sample data in the Student table

3 Identifying Functional Dependencies

To identify functional dependencies:

1. **Understand the Semantics:** Analyze the attributes based on their meaning. For example:

- StudentID uniquely identifies a student, so $\text{StudentID} \rightarrow \text{StudentName}$.
 - CourseID identifies a course, so $\text{CourseID} \rightarrow \text{CourseName}, \text{Instructor}$.
 - The primary key $\{\text{StudentID}, \text{CourseID}\}$ uniquely identifies each tuple, so $\{\text{StudentID}, \text{CourseID}\} \rightarrow \text{StudentName}, \text{CourseName}, \text{Instructor}$.
2. **Identify Candidate Keys:** The minimal set of attributes that uniquely identify each tuple. Here, $\{\text{StudentID}, \text{CourseID}\}$ is a candidate key.
 3. **List Functional Dependencies:** Based on the semantics:
 - $\text{StudentID} \rightarrow \text{StudentName}$
 - $\text{CourseID} \rightarrow \text{CourseName}, \text{Instructor}$
 - $\{\text{StudentID}, \text{CourseID}\} \rightarrow \text{StudentName}, \text{CourseName}, \text{Instructor}$

4 Verifying Functional Dependencies in MySQL

To confirm an FD like $\text{StudentID} \rightarrow \text{StudentName}$, check that each StudentID maps to exactly one StudentName. Use the following SQL query:

```
SELECT StudentID, COUNT(DISTINCT StudentName) AS NameCount
FROM Student
GROUP BY StudentID
HAVING NameCount > 1;
```

If the query returns no rows, the FD $\text{StudentID} \rightarrow \text{StudentName}$ holds, as each StudentID is associated with only one StudentName.

Similarly, to verify $\text{CourseID} \rightarrow \text{CourseName}, \text{Instructor}$:

```
SELECT CourseID,
       COUNT(DISTINCT CourseName) AS CourseNameCount,
       COUNT(DISTINCT Instructor) AS InstructorCount
FROM Student
GROUP BY CourseID
HAVING CourseNameCount > 1 OR InstructorCount > 1;
```

If no rows are returned, the FD holds.

5 Partial and Transitive Dependencies

- **Partial Dependency:** Occurs when a non-key attribute depends on part of a candidate key. Here, StudentName depends on StudentID, which is part of the key $\{\text{StudentID}, \text{CourseID}\}$.
- **Transitive Dependency:** Occurs when a non-key attribute depends on another non-key attribute through a key. For example, if Instructor determined Department, then $\text{CourseID} \rightarrow \text{Instructor} \rightarrow \text{Department}$ would be transitive.

6 Conclusion

Identifying functional dependencies involves understanding the semantics of the relation, listing dependencies based on business rules, and verifying them using MySQL queries. The process ensures proper database design and normalization, avoiding redundancy and anomalies.