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Department of computer science
Level: 2 LMD
Module: Database

Directed Work 4

Objectives:

The objective of this directed work is to help students understand and apply the principles of database normalization, including First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), and Boyce-Codd Normal Form (BCNF). Students will learn how to identify functional dependencies and candidate keys, eliminate redundancy and anomalies, and decompose relations into well-structured forms. Through practical exercises, they will be able to transform complex database schemas into normalized forms by removing repeating groups, partial dependencies, and transitive dependencies, while ensuring data consistency and integrity.

Exercise 1

Given the following table:

StudentID	StudentName	Courses	Advisor
1001	Alice	Math, Physics	Prof. Smith
1002	Bob	Chemistry	Prof. Johnson
1003	Charlie	Biology, Math, English	Prof. Smith

1. Identify a suitable primary key for the table.
2. Explain why this table is not in First Normal Form (1NF).
3. Convert the table into First Normal Form (1NF) by:
    a. Removing repeating groups
    b. Ensuring atomic values
4. Identify the primary key(s) in the relations obtained after converting the table to First Normal Form (1NF).

Exercise 2

Consider the following relation:

ENROLLMENT(StudentID, StudentName, CourseID, CourseName, Instructor, Grade)

With the following functional dependencies (FDs):

1. StudentID → StudentName
2. CourseID → CourseName, Instructor
3. (StudentID, CourseID) → Grade

Tasks:

1. Identify the candidate key(s) of the relation.
2. Is this relation in First Normal Form (1NF)? Explain briefly.
3. Is it in Second Normal Form (2NF)? Why or why not?
4. Decompose the relation into relations that are in 2NF.
5. List the resulting relations and their keys after decomposition.

Exercise 3

Let the relation

course_boats(nbat, boat_name, sponsor, ncourse, course_name, year, position)

be given, along with the set of functional dependencies (FDs):

- nbat → boat_name
- nbat → sponsor
- ncourse → course_name
- ncourse → year
- (ncourse, nbat) → position

course_boats Table

Nbat	Boat Name	Sponsor	Ncourse	Course Name	Year	Position
102	Tassili	Djezzy	210	Course of Freedom	2016	2
102	Tassili	Djezzy	240	Course of Freedom	2017	1
102	Tassili	Djezzy	270	Course of Freedom	2018	4
103	El Bahdja	BNA	210	Course of Freedom	2016	3
103	El Bahdja	BNA	215	The Grand Tour	2017	3
104	La Colombe	OOREEDO	200	The Grand Tour	2015	2
104	La Colombe	OOREEDO	210	Course of Freedom	2016	1
104	La Colombe	OOREEDO	215	The Grand Tour	2017	2
104	La Colombe	OOREEDO	220	Barberousse Trophy	2017	2
104	La Colombe	OOREEDO	240	Course of Freedom	2017	2
104	La Colombe	OOREEDO	260	Barberousse Trophy	2017	3
104	La Colombe	OOREEDO	265	The Grand Tour	2019	5
104	La Colombe	OOREEDO	270	Course of Freedom	2018	3
105	Hoggar	BNA	220	Barberousse Trophy	2017	1

Tasks:

1. Based on the data given, identify **update anomalies** in the relation.
2. What is the **primary key** of this relation?
3. What is the **highest normal form** of the relation course_boats?
4. **Decompose** the relation course_boats into relations in **Third Normal Form (3NF)**.

Exercise 4

Consider the relation:

PROJECTS(ProjectID, ProjectName, ManagerID, ManagerName, DeptID, DeptName)

With the following functional dependencies (FDs):

1. ProjectID → ProjectName, ManagerID, DeptID
2. ManagerID → ManagerName
3. DeptID → DeptName
4. ManagerID → DeptID

Tasks:

1. Identify all candidate key(s) of the relation.
2. Is the relation in Third Normal Form (3NF)? Justify.
3. Is it in BCNF? If not, explain why.
4. Decompose the relation into BCNF-compliant relations.
5. List the final BCNF relations with their primary keys.