University
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Deliverable #: Title of Lab/Project here (e.g.: Conceptual Design ....)

Data Management Course

UM6P College of Computing

Professor: Karima Echihabi **Program:** Computer Engineering
Session: Fall 2025

Team Information

Team Name	QueryMaster
Member 1	El Mehdi Regagui
Member 2	Yasser Jarboua
Member 3	Adam Ibourg-EL Idrissi
Member 4	Salma Mana
Member 5	Hiba Mhirit
Member 6	Sara Qiouame
Member 7	Douaae Mabrouk
Repository Link	`https://github.com/yasserJarboua/QueryMasters/`

1 Introduction

The Moroccan National Health Services (MNHS) requires a robust database to manage patients, staff, hospitals, departments, appointments, prescriptions, medications, insurance, billing, and emergencies. This deliverable will produce a fully normalized and implemented database solution for the MNHS by first rigorously validating the relational schema against Boyce-Codd Normal Form (BCNF) to ensure data integrity, and then practically realizing it through SQL Data Definition Language (DDL). The database will be populated and managed using Data Manipulation Language (DML), and its operational utility will be demonstrated through a comprehensive set of SQL queries, ranging from simple data retrieval to complex grouped aggregations for analytical reporting.

2 Requirements

This deliverable addresses the following tasks:

- Validate each relation against BCNF and verify lossless join and dependency preservation after decomposition.
- Implement the refined MNHS schema using SQL Data Definition Language (DDL).
- Populate and manage MNHS data using Data Manipulation Language (DML).
- Write and execute SQL queries ranging from simple selections to grouped aggregations and analytics.

3 Methodology

In this lab, we worked on the normalization of all relations in the MNHS project. We reviewed the main concepts related to functional dependencies, normal forms, and the need for decomposition, as well as the essential properties that must be verified, such as dependency preservation and lossless join.

The second part focused on SQL implementation. We worked with DDL (Data Definition Language), which refers to SQL commands used to define and modify the structure of the database, including the creation of tables, the alteration of columns, and the specification of constraints. We also worked with DML (Data Manipulation Language), which consists of commands used to manage and manipulate the data stored in the database, such as inserting, updating, deleting, and querying records. Finally, we applied our SQL knowledge by implementing various queries ranging from simple selections to grouped aggregations and analytical operations.

4 Implementation & Results

4.1 The final refined MNHS relational schema

1. Patient

Primary key: IID
Attributes: CIN, Name, Sex, Birth, BloodGroup, Phone

Functional Dependencies (FDs):

- IID → Name, Sex, Birth, BloodGroup, Phone, CIN
- CIN → IID, Name, Sex, Birth, BloodGroup, Phone

Explanation: CIN is a candidate key since it uniquely identifies each patient. IID is the primary key and determines all attributes.

BCNF Verification: Both determinants (IID, CIN) are superkeys. The relation is in BCNF.

Lossless Joins and Dependency Preservation: No decomposition. Trivially lossless and dependency preserving.

2. ContactLocation

Primary key: CLID
Attributes: Street, City, Province, PostalCode, Phone
FDs:

- CLID → Street, City, Province, PostalCode, Phone

BCNF Verification: CLID is a superkey. The relation is in BCNF.
Lossless & DP: Trivially satisfied.

3. Staff

Primary key: STAFF_ID
Attributes: Name, Status
FDs:

- STAFF_ID → Name, Status

ISA Subtype FDs:

- STAFF_ID → LicenseNumber, Specialty (Practitioner)
- STAFF_ID → Grade, Ward (Caregiving)
- STAFF_ID → Modality, Certifications (Technical)

BCNF Verification: STAFF_ID is the only determinant and is a superkey.
Lossless & DP: Trivially satisfied.

4. Hospital

Primary key: HID
Attributes: Name, City, Region
FDs:

- HID → Name, City, Region

BCNF Verification: HID is a superkey. Hospital is in BCNF.
Lossless & DP: Trivially satisfied.

5. Department

Primary key: DEP_ID
Attributes: Name, Specialty, HID
Inherited Dependencies:

- DEP_ID → Name, Specialty, HID
- HID → HospitalName, City, Region
- DEP_ID → Name, Specialty, HID, HospitalName, City, Region

BCNF Verification: Determinants (DEP_ID, HID) are superkeys in their respective tables.
Lossless & DP: Trivially satisfied.

7. ClinicalActivity

Primary key: CAID
Attributes: Title, Time, Date, IID, STAFF_ID, DEP_ID, ExpID
FDs inside ClinicalActivity:

- CAID → IID, STAFF_ID, DEP_ID, Date, Time

Foreign Key FDs (from referenced tables):

- IID → CIN, FullName, Birth, Sex, BloodGroup, Phone
- STAFF_ID → FullName, Status
- DEP_ID → Name, Specialty, HID

By composition:

$$CAID \to allPatient, Staff, Department, Hospitalattributes$$

BCNF Verification: Only CAID acts as a determinant; it is a superkey.
Lossless & DP: Joins are lossless due to foreign keys; dependencies preserved.

8. Expense

Primary key: ExID
Attributes: Total, InsID, CAID
FDs:

- ExID → Total, InsID, CAID
- CAID → ExID (one-to-one relationship)

BCNF Verification: Both ExID and CAID are superkeys.
Lossless & DP: Trivially satisfied.

9. Prescription

Primary key: PID
Attributes: DateIssued, CAID
FDs:

- PID → DateIssued, CAID
- CAID → Time, Date, IID, STAFF_ID, DEP_ID
- PID → DateIssued, Time, Date, IID, STAFF_ID, DEP_ID

BCNF Verification: PID is the only true determinant and is a superkey.
Lossless & DP: Trivially satisfied.

10. Appointment

Primary key: CAID
Attributes: Reason, Status, Time, Date, IID, STAFF_ID, DEP_ID
FDs:

- CAID → Reason, Status, Time, Date, IID, STAFF_ID, DEP_ID

BCNF Verification: CAID is a superkey.
Lossless & DP: Trivially satisfied.

11. Emergency

Primary key: CAID
Attributes: TriageLevel, Outcome, Time, Date, IID, STAFF_ID, DEP_ID
FDs:

- CAID → TriageLevel, Outcome, Time, Date, IID, STAFF_ID, DEP_ID

BCNF Verification: CAID is a superkey.
Lossless & DP: Trivially satisfied.

12. Medication

Primary key: DrugID
Attributes: Name, Form, Strength, Class, ActiveIngredient, Manufacturer
FDs:

- DrugID → Name, Form, Strength, Class, ActiveIngredient, Manufacturer

BCNF Verification: DrugID is a superkey.
Lossless & DP: Trivially satisfied.

13. Stock

Primary key: {HID, MID, StockTimestamp}
Attributes: UnitPrice, Qty, ReorderLevel
FDs:

- {HID, MID, StockTimestamp} → UnitPrice, Qty, ReorderLevel

BCNF Verification: Composite key is a superkey.
Lossless & DP: Trivially satisfied.

15. Patient–ContactLocation

Primary key: {IID, CLID}
FDs:

- {IID, CLID} → relationship attributes

BCNF Verification: Composite key is a superkey.

16. Patient–Insurance

Primary key: {IID, InsID}
FDs:

- {IID, InsID} → relationship attributes
- {IID, InsID} → Patient attributes, Insurance attributes

BCNF Verification: Determinant is a superkey.

17. Staff–Department

Primary key: {STAFF_ID, DEP_ID}
FDs:

- {STAFF_ID, DEP_ID} → relationship attributes

BCNF Verification: Composite key is a superkey.

5 Discussion

During the completion of this lab, we encountered several challenges, particularly in the normalization stage. We experienced some confusion regarding which functional dependencies should be included and how they affected the decomposition process. Additionally, certain SQL queries were difficult to implement due to their complexity, especially those involving advanced conditions and aggregations. Nevertheless, the lab was highly beneficial, as it provided a deeper understanding of the underlying concepts and strengthened our practical skills in both normalization and SQL.

6 Conclusion

The work carried out in this lab was highly valuable. We learned about the significant importance of normalization and how neglecting it can lead to various issues, including redundancy and inconsistencies within the database. We also strengthened our knowledge of SQL, its different components, its syntax, and its practical use in managing and querying data. In addition, this lab enhanced our understanding of database management as a whole. It helped clarify the connections between all the steps we have completed so far in this project, from the conceptual design to the actual implementation phase.