Database Fundamentals & Design

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Normalization

- The process of decomposing unsatisfactory "bad" relations by breaking up their attributes into smaller relations.

- Normalization Avoids:
  - ✓ Duplication of Data.
  - ✓ Insert Anomaly.
  - ✓ Delete Anomaly.
  - ✓ Update Anomaly.
  - ✓ Frequent Null Values.

Functional Dependency

- a constraint between two attributes (columns) or two sets of columns.
- A → B if “for every valid instance of A, that value of A uniquely determines the value of B”.
- OR …A →B if “there exists at most one value of B for every value of A”
- It is read as: A determines B OR B depends on A.
- The attributes on the left side of the arrow are called determinants.

Functional Dependency (cont.)

- Examples:
- Social security number determines employee name
  SSN -> ENAME
- Project number determines project name and location. PNUMBER -> {PNAME, PLOCATION}
- Employee ssn and project number determines the hours per week that the employee works on the project. {SSN, PNUMBER} -> HOURS
- Activity name determines its Fee.
  Activity -> Fee
- Primary key is a determinant for the other columns.

Normal Forms

- Classes of relations and the techniques for preventing anomalies.

Types of Normal Forms:

- ✓ First Normal Form (1NF).
- ✓ Second Normal Form (2NF).
- ✓ Third Normal Form (3NF).
- ✓ Fourth Normal Form (4NF).
- ✓ Boyce Codd Normal Form (BCNF).
- ✓ Fifth Normal Form (5NF).
- ✓ Domain Key Normal Form (DK/NF).

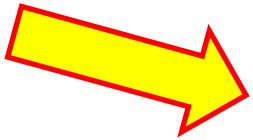
- We are trying to move the relations from 1NF towards 5NF.

1NF

- Relation is in **first normal form** if it contains no multi-valued attributes. (repeating groups).
- To move a relation to the 1NF:
  - ✓ Remove repeating groups or multi-valued attributes to a new table as already demonstrated, “carrying” the PK as a FK.

1NF

Employee table is not in the 1NF.



ID	Name	City	Tel
1	Ahmed	Alex	123456 876537
2	Aly	Cairo	563758
3	Saad	Assiut	435675 987653

- Moving it to the 1NF:

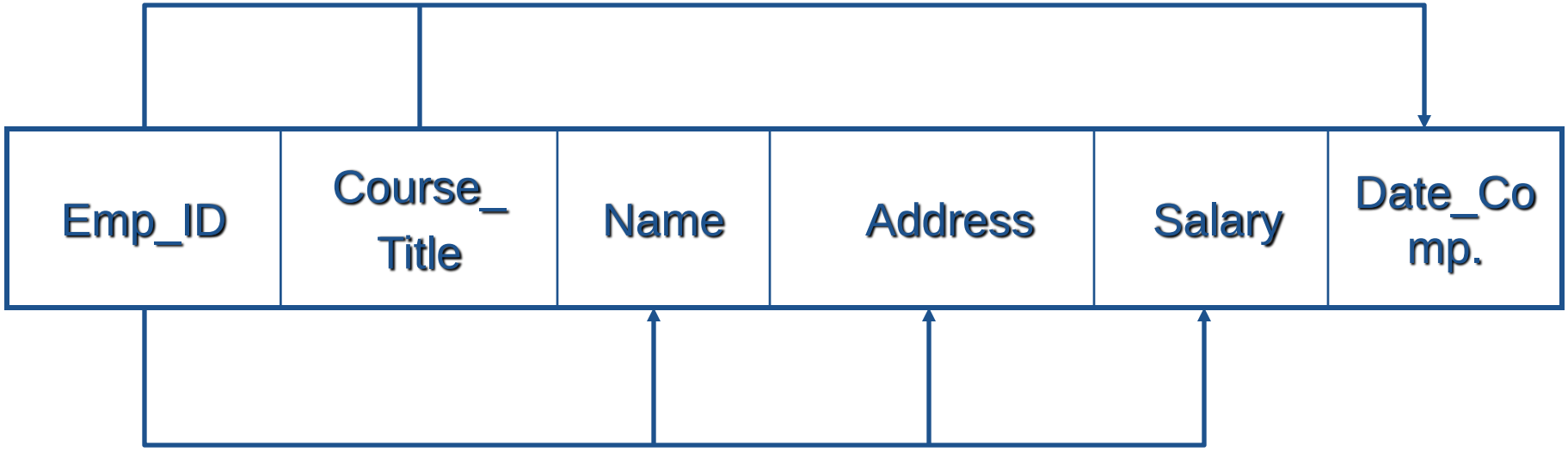
Employee

ID	Name	City
1	Ahmed	Alex
2	Aly	Cairo
3	Saad	Assiut

Emp_Tel

ID	Tel
1	123456
1	876537
2	563758
3	435675
3	987653

2NF



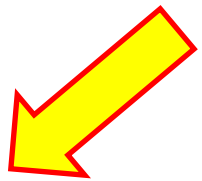
- This relation has Insertion & Deletion anomaly.
- Emp_ID -> (Name, Address, Salary)

Not fully functionally dependant on the primary key.

2NF (cont.)

- A relation is in **second normal form** if it is in first normal form AND every nonkey attribute is fully functionally dependant on the primary key.
- To move a relation to the 2NF:
  - ✓ Remove partial functional dependencies, so no nonkey attribute depends on just part of the key.

EMPLOYEE2 (Emp_ID, Course_Title, Name, Address, Salary, Date_Completed)



- ✓ EMPLOYEE (Emp_ID, Name, adress, Salary)
- ✓ EMP_COURSE (Emp_ID, Course_Title, Date_Completed)

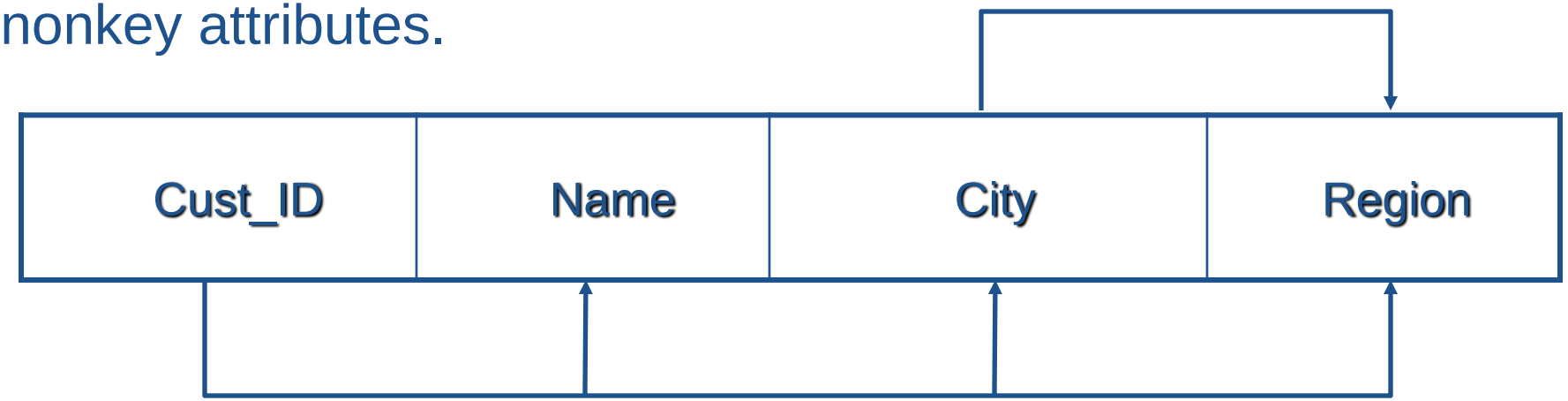
2NF (cont.)

- A relation is in 2NF if it is in 1NF and any one of these is true:
  - ✓ The PK consists of only 1 attribute.
  - ✓ All attributes are part of the PK (no non-key attributes).
  - ✓ Every non key attribute is functionally dependant on the whole PK

3NF

- A relation is in **third normal form** if it is in 2NF, AND no *transitive dependencies* exist.

- Transitive dependency is a functional dependency between nonkey attributes.

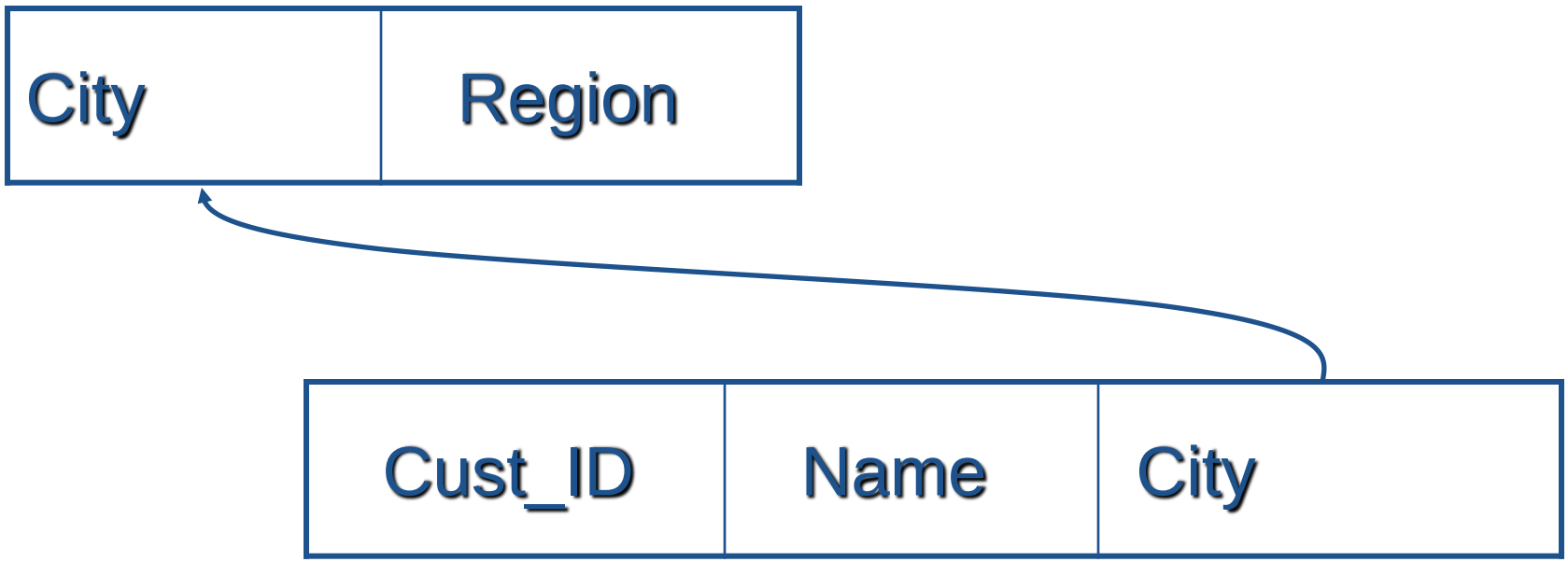


Cust_ID -> City -> Region

Transitive Dependency

3NF (cont.)

- To move the relation to the 3NF:



Case Study

Patient Medication Form

Thank You…