

Example 1: Unnormalized Table (Violates 1NF)

CustomerID	Name	OrderID	ProductID	ProductName	Quantity
101	John Smith	O1, O2	P1, P2	Laptop, Mouse	2, 1

1NF Violation: The **OrderID** and **ProductID** columns contain multiple values in a single cell, violating the atomicity requirement of 1NF.

1NF Normalization Reason: To ensure each column contains only atomic values, eliminating repeating groups and simplifying data manipulation.

1NF Normalized Table:

CustomerID	Name	OrderID	ProductID	ProductName	Quantity
101	John Smith	O1	P1	Laptop	2
101	John Smith	O2	P2	Mouse	1

Example 2: 1NF Table (Violates 2NF)

OrderID	ProductID	CustomerID	CustomerName	OrderDate	ProductName	Quantity	Price
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O1	P1	101	John Smith	2023-01-15	Laptop	2	1000
O1	P2	101	John Smith	2023-01-15	Mouse	1	20
O2	P3	102	Jane Doe	2023-02-20	Keyboard	1	75

2NF Violation:

- Primary Key: {OrderID, ProductID}
- CustomerName is dependent on CustomerID, which is only part of the primary key.
- OrderDate is dependent on OrderID, which is only part of the primary key.
- ProductName and Price are dependent on ProductID, which is only part of the primary key.

2NF Normalization Reason: To remove partial dependencies, ensuring that non-key attributes depend on the entire primary key, not just a part of it. This reduces redundancy (e.g., CustomerName repeating for the same customer) and avoids update anomalies.

2NF Normalized Tables:

OrderID	CustomerID	OrderDate
O1	101	2023-01-15
O2	102	2023-02-20

CustomerID	CustomerName
101	John Smith
102	Jane Doe

OrderID	ProductID	Quantity
O1	P1	2
O1	P2	1
O2	P3	1

ProductID	ProductName	Price
P1	Laptop	1000
P2	Mouse	20
P3	Keyboard	75

Example 3: 2NF Table (Violates 3NF)

EmployeeID	Name	DepartmentID	DepartmentName	Location
1	John Smith	10	Sales	New York
2	Jane Doe	20	Marketing	Los Angeles
3	Bob Johnson	10	Sales	New York

3NF Violation:

- Primary Key: EmployeeID
- DepartmentName and Location are dependent on DepartmentID, which is not a primary key. This is a transitive dependency: EmployeeID → DepartmentID → DepartmentName, Location

3NF Normalization Reason: To eliminate transitive dependencies, ensuring that non-key attributes depend only on the primary key and not on other non-key attributes. This prevents update anomalies (e.g., if the Sales department moves to Chicago, we only need to update one row) and deletion anomalies.

3NF Normalized Tables:

EmployeeID	Name	DepartmentID
1	John Smith	10
2	Jane Doe	20
3	Bob Johnson	10

DepartmentID	DepartmentName	Location
10	Sales	New York
20	Marketing	Los Angeles