

Identify Normalization Issues

1NF Violations (Atomicity)

- author_names contains multiple values (Alice Smith, Bob Jones) → violates atomicity.
- categories contain multiple values (Fiction, Drama) → violates atomicity.

1NF requirement: Each column must contain atomic (indivisible) values.

2NF Violations (Partial Dependency)

- book_title, author_names, categories, publisher_name, publisher_country depend **only on book_id**, not the combination of member_id + book_id.
- member_name depends only on member_id.

2NF requirement: All non-key attributes must depend on the **whole primary key** (no partial dependencies).

3NF Violations (Transitive Dependency)

- publisher_country depends on publisher_name - transitive dependency.
- author_names depend on book_id, if book_id is key for book, but must separate multi-authors.

3NF requirement: No non-key attribute depends on another non key attribute.

Step 2: Normalize to 3NF

Step 2a: 1NF

- Split multi-valued attributes (author_names, categories) into separate rows.

Books Table (after 1NF)

book_id	book_title	publisher_name
B001	The Great Novel	ABC Press

BookAuthors Table

book_id	author_name
B001	Alice Smith
B001	Bob Jones

BookCategories Table

book_id	category
B001	Fiction
B001	Drama

Members Table

member_id	member_name
101	John Doe

Borrowing Table

member_id	book_id	borrow_date	return_date	fine_amount
101	B001	2025-10-01	2025-10-20	5.00

Publishers Table

publisher_name	publisher_country
ABC Press	USA

Step 2b: 2NF

- Check partial dependencies:

Borrowing Table: composite key (member_id, book_id) → attributes (borrow_date, return_date, fine_amount) depend on the full key, not part

Other tables: book_title, publisher_name depend fully on book_id

Publisher table: publisher_country depends on publisher_name

Step 2c: 3NF

- Remove transitive dependencies:

Publisher table: publisher_country depends on publisher_name → already separate → **3NF achieved.**

Authors table: each author_name depends directly on book_id

Categories table: same

Step 3: Explain Improvements

Normal Form	Improvement	Why It Matters
1NF	Split multi-valued fields (author_names, categories)	Each attribute is atomic - easier querying, avoids ambiguity
2NF	Removed partial dependencies (attributes depend on entire key)	Prevents redundant data and update anomalies
3NF	Removed transitive dependencies (publisher_country depends on publisher_name)	Ensures data consistency, reduces redundancy

Step 4: Final Normalized Tables

1. Members

member_id	member_name
101	John Doe

2. Books

book_id	book_title	publisher_name
B001	The Great Novel	ABC Press

3. Publishers

publisher_name	publisher_country
ABC Press	USA

4. BookAuthors

book_id	author_name
B001	Alice Smith
B001	Bob Jones

5. BookCategories

book_id	category
B001	Fiction
B001	Drama

6. Borrowing

borrow_id	member_id	book_id	borrow_date	return_date
1	101	B001	2025-10-01	2025-10-20

7. Fines Table

fine_id	borrow_id	fine_amount	status
F001	1	5.00	Paid