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

Norm al 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

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