

1) ER Diagram for an online book store →

Entities & attributes →

a) Book → ISBN (PK)

 ↳ Title

 ↳ Year

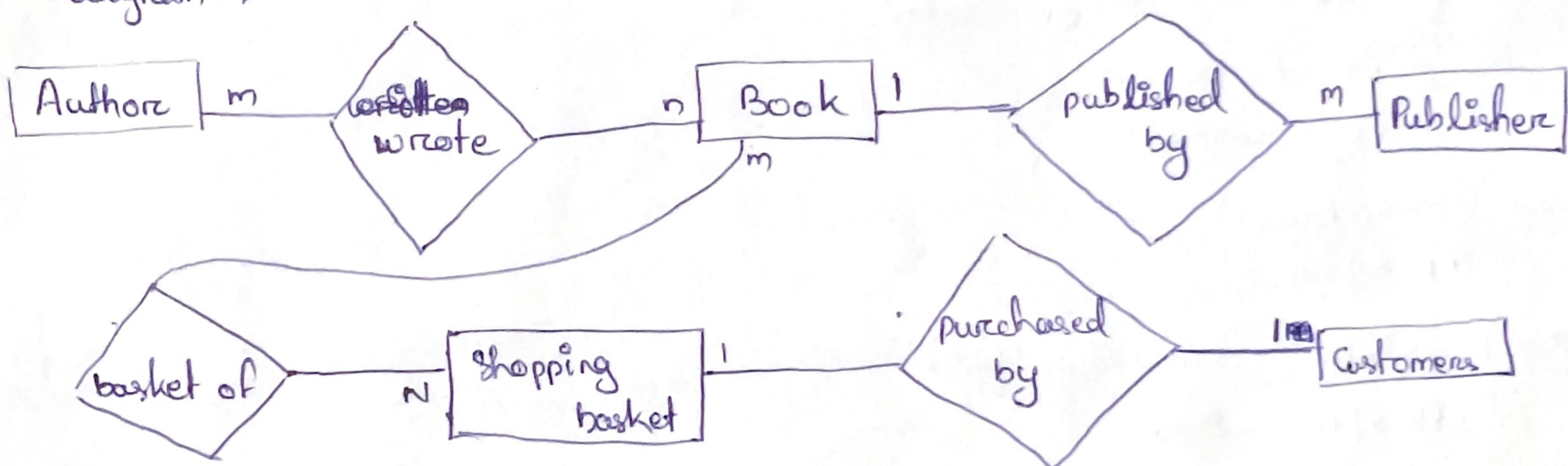
 ↳ Price

c) Publisher → Name (PK)

- ↳ City
- ↳ State } Address → Country &
 pincode
- ↳ Phone_num (Multivalued
 attribute)

e) Shopping-basket → Basket_id (PK)

ER diagram →



Constraints →

- Book and author (m:n, partial participation) → A book can have multiple authors & an author can write multiple books.
- Book and publisher (1:m), Total participation on Book → A book must have a publisher but a publisher can have multiple books.
- Book and Shopping basket (m:n, partial participation on both) → A shopping basket contains multiple books & the same book can be in multiple shopping basket.
- Shopping basket & Customer (1:m, Total participation on shopping basket) → A shopping basket contains only one customer & customer can only have one shopping basket.

2) Relational Schema →

• Customer (Cid, Cname, Phone, Address, City, State, Pincode, DOB, Age)

PK → Cid

Phone → Multivalued Attribute

• Phone (Cid, Phone)

PK → (Cid, Phone)

FK → Cid references customer (Cid)

• Account (AccNo, Balance)

PK → AccNo

• Saving Account (Interest_rate)

PK → AccNo

FK → AccNo references Account (AccNo)

• Checking Account (AccNo, overdraft)

PK → AccNo

FK → overdraft

• Loan (LNo, Amount)

PK → LNo

• Loan Branch (LNo, LAmount, LBranch)

Pk → LNo, LBranch

FK → LNo references Loan (LNo), Branch references Branch (Branch)

• Branch (Branch, Bname, City, Assets)

PK → Branch

• Loan Payment (Pno, Pdate, Pamount, LNo)

PK → Pno

FK → LNo reference Loan LNo

4) $r(A, B, C, D, E, F)$ $F \cdot D \rightarrow ? A \rightarrow BC, CD \rightarrow E, B \rightarrow D, E \rightarrow A ?$

$A^+ \rightarrow BC$ (A gives BC)

$\rightarrow BCD$ (B gives D)

$\rightarrow BCDE$ (CD gives E)

$CD^+ \rightarrow E$

~~-EA~~

$\rightarrow BCE$

$\rightarrow ABCDE$

~~ABEAE~~

$E \rightarrow A$

~~-ABC~~

$\rightarrow ABCD$

$\rightarrow ABCDE$

$AF^+ \rightarrow ABCDF$

~~-D~~ $\rightarrow ABCDF$

$\rightarrow ABCDEF$

$EFT \rightarrow AEF$
 $\rightarrow ABCEF$
 $\rightarrow ABCDEF$

Candidate Key $\rightarrow \{AF, EF\}$?

5) $F = \text{mark} (regd, \text{name}, \text{course_id}, \text{title}, \text{grade})$

A B C D E

$FD = \{ regd \rightarrow \text{name}, \text{course_id} \rightarrow \text{title}, (regd, \text{course_id}) \rightarrow \text{grade} \}$

i.e. $FD = \{ A \rightarrow B, \text{regd} \rightarrow \text{course_id}, AC \rightarrow E \}$

~~AC~~ $A^+ \rightarrow B$ $C^+ \rightarrow D$ $AC^+ \rightarrow ABCE$
 $\rightarrow ABCDE$

So, AC is the candidate key

Prime Attribute $\rightarrow \{A, C\}$

Non Prime Attribute $\rightarrow \{B, D, E\}$

BCNF $A \rightarrow B$ $C \rightarrow D$ $AC \rightarrow E$

3NF

2NF ~~x~~ partial dependency exist ~~x~~ partial dependency exist ~~x~~ partial dependency exist

The given decomposition is not 2NF as it has partial dependencies.

\therefore Partial dependency \rightarrow purpose subset of any candidate key \longrightarrow Non-prime attribute

6) Book (Title, Author, Catalogue_no, Publisher, Year, Price)

Let $\rightarrow (A, B, C, D, E, F)$

$FD \rightarrow \{ (\text{Title}, \text{Author}) \rightarrow \text{Catalog_no}, \text{Catalog_no} \rightarrow (\text{Price}),$

$\text{Catalog_no} \rightarrow \text{Title}, \text{Catalog_no} \rightarrow \text{Publisher}, \text{Catalog_no} \rightarrow \text{Year} \}$

Let $FD \rightarrow \{ AB \rightarrow CF, C \rightarrow A, C \rightarrow D, C \rightarrow E \}$

$AB^+ \rightarrow CF$
 $\rightarrow CDF$
 $\rightarrow CDEF$

$CB^+ \rightarrow \{ABC\}$
 $\rightarrow ABCD$
 $\rightarrow ABCDE$
 $\rightarrow ABCDEF$

Candidate key $\rightarrow \{AB, CB\}$?

PA $\rightarrow \{A, B, C\}$ NPA $\rightarrow \{D, E, F\}$?

| | | | |
|--------------------------------|--------------------------|----------------------------|-----------------------------|
| $AB \rightarrow CF$ | $C \rightarrow A$ | $C \rightarrow D$ | $C \rightarrow E$ |
| 3NF ✓ | ✗ | ✗ | ✗ |
| As left hand side is super key | A is non prime attribute | D is not a prime attribute | E is not a prime attribute. |

The given relation does not satisfy 3NF as it has $C \rightarrow A$, $C \rightarrow D$, $C \rightarrow E$.

→ 3NF decomposition

$$R_1(A, B, C, D, E, F) \xleftarrow{R(ABC(F)) \rightarrow \{AB \rightarrow CF\}} \\ R_2(C, D, E) \xleftarrow{R(CADE) \rightarrow \{C \rightarrow A, D \rightarrow E\}}$$

→ lossless property

→ $AB \rightarrow CF$

$$C \rightarrow A, D \rightarrow E \quad ? \quad \text{All original FDs are preserved.}$$

7) $R(A, B, C, D, E, G)$: $F = ? A \rightarrow BCD, BC \rightarrow DE, B \rightarrow DE, B \rightarrow D, D \rightarrow A ?$

a) $F = ? A \rightarrow BCD, BC \rightarrow DE, B \rightarrow D, D \rightarrow A ?$

→ Closure of AG (AG^+)

$AG^+ = ABCDEG$, contains all the attributes, AG is super key.

b) $F = ? A \rightarrow B, A \rightarrow C, A \rightarrow D, BC \rightarrow D, BC \rightarrow E, B \rightarrow D, D \rightarrow A ?$

$F = ? A \rightarrow BC, B \rightarrow D, C \rightarrow E, D \rightarrow A ?$

↳ canonical cover

c) $ABCDEG^+ = ABCDEG$

$AG^+ = ABCDEG$

$DG^+ = DAGBCE$

{ Candidate key : (AG, DG) }

$PA \rightarrow ? A, D, G ?$

$NPA \rightarrow ? B, C, E ?$

$A \rightarrow BCD$

$C \rightarrow E$

$B \rightarrow D$

$D \rightarrow A$

BCNF

✗

✗

✗

✗

3NF

✓

✓

✗

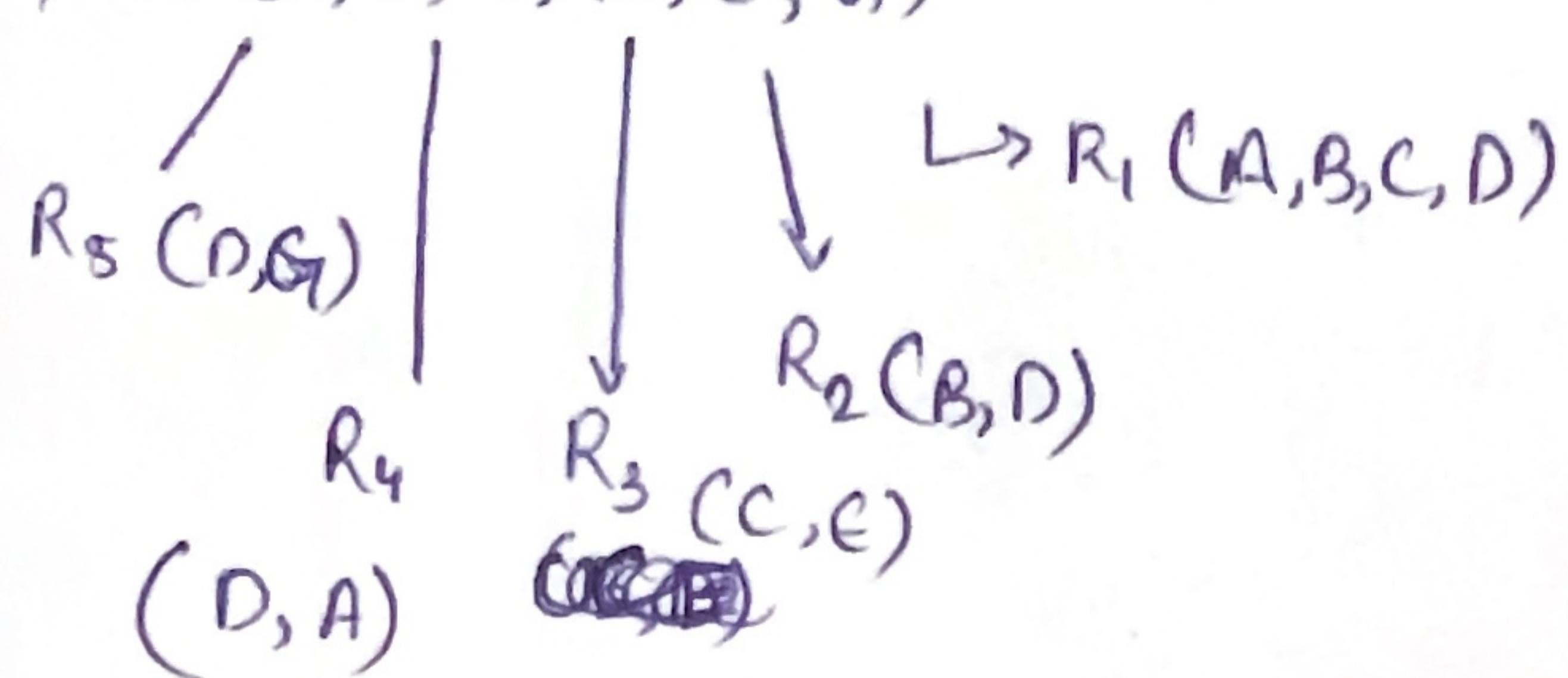
✗

$B^+ = DABCE$

$D^+ = ABCDE$

3NF decomposition is $R_1(A, B, C, D)$, $R_2(B, D)$, $R_3(C, E)$, $R_4(D, A)$, $R_5(D, A)$

d) $R(A, B, C, D, E, G)$



8) $\text{RC PAN, PI, DI, DRUG, QTY, COST}$
lets $\rightarrow A \quad B \quad C \quad D \quad E \quad F$

$$F = \{A \rightarrow B, B \rightarrow C, BD \rightarrow E, DE \rightarrow F\}$$

Candidate key \rightarrow

$$AD^+ = ABCDEF$$

$$\{A, D\} \rightarrow PA$$

$$\{B, C, E, F\} \rightarrow NPA$$

| | $A \rightarrow B$ | $B \rightarrow C$ | $BD \rightarrow E$ | $DE \rightarrow F$ |
|------|-------------------|-------------------|--------------------|--------------------|
| BCNF | x | | | |
| 3NF | x | x | x | x |

$$F = \{A \rightarrow BC, BD \rightarrow E, DE \rightarrow F\}$$

a) 3NF decomposition $\rightarrow r_1(a, b, c)$

$r_2(b, d, e)$

$r_3(d, e, f)$

$r_4(a, d)$

All FDs are represented, & dependency preservation is satisfied.

lossless as $r_4(a, d)$ contains candidate key.

b) BCNF decomposition $\rightarrow r_1(a, b, c)$

$r_2(b, d, e)$

$r_3(d, e, f)$

$r_4(a, d)$

9) (Volume, number, start page, end page, title, year, price)

Set: A B C D E F G

$ABCD \rightarrow E$

$AB \rightarrow P$

$\begin{cases} ABCD \rightarrow G \\ \downarrow \\ P.D \end{cases}$

P. key = (A, B, C, D)

Since it contains PD this schema is not in 2NF new schema:

(A; B, C, D, E, G)

$ABCD \rightarrow E$

$ABCD \rightarrow G$

No, P.D. \rightarrow 2NF

(A, B, F)

$AB \rightarrow F$

No P.D. \rightarrow 2NF

New Schema satisfies 2NF

10) Books (Accession no., isbn, title, author, publisher)

A B C D E

Users (Userid, name, dept.id, dept.name)

F G H I

$A \rightarrow B$

$B \rightarrow C$

$B \rightarrow E$

$B \rightarrow D$ C.K = {F?}

$\underline{F \rightarrow G}$

$F \rightarrow H$

$F \rightarrow I$

A → B

B → CED

F → GH

H → I

BCNF ✓

✗

✓

✗

3NF ✓

✗

✓

✗

2NF ✓

✗

✓

✗

1NF ✓

✓

✓

✓

3)

