NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Lab 3 - Generation of Normalized Database Schema

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Here are the Decomposed relational schemas according to the “Sample ER 2” on the SC2207 Z49 Lab site:

BOOKSTORE(ID)
Keys: {ID}
Primary key: ID
FD(s): No non-trivial FDs
The relation is in 3NF.

CUSTOMERS(CID, Name)
Keys: {CID}
Primary key: CID
FD(s):
1. CID → Name

The relation is in 3NF, since for all FD(s), the LHS has the key CID.
Besides, the relation has only 2 attributes, and must be in BCNF which implies 3NF.

PUBLICATION(PubID, Publisher, Year)
Keys: {PubID}
Primary key: PubID
FD(s):
1. PubID → Publisher, Year

The relation is in 3NF, since for all FD(s), the LHS has the key PubID.
Besides, the relation has only 2 attributes, and must be in BCNF which implies 3NF.

BOOKS(PubID, Title)
Keys: {PubID}
Primary key: PubID
FD(s):
1. PubID → Title

The relation is in 3NF because the LHS of the functional dependency is a key. We used ER approach to deal with inheritance of BOOKS and MAGAZINES, because ER approach provides a middle ground between OO and NULL approach.

MAGAZINES(PubID, Issue, Title)
Keys: {PubID}
Primary key: PubID
FD(s):

1. PubID → Issue, Title

The relation is in 3NF because the LHS of the functional dependency is a key. We used ER approach to deal with inheritance of BOOKS and MAGAZINES, because ER approach provides a middle ground between OO and NULL approach.

ORDERS(OrderID, Date-time, Shipping-address, CID)
Keys: {OrderID, (CID, Date-time)}
Primary Key: OrderID
FD(s):

1. OrderID → Date-time, Shipping-address, CID
2. CID, Date-time → OrderID

Assuming customer cannot file 2 orders at the same time instant.
The relation is in 3NF, since for all FD(s), the LHS has the key orderID or RHS has the key orderID.

EMPLOYEES(EID, Name, Salary)
Keys: {EID}
Primary Key: EID
FD(s):

1. EID → Name, Salary

The relation is in 3NF, since for all FD(s), the LHS has the key EID.

COMPLAINTS(ID, Text, Filed-date-time, EID, Handled-date-time, CID)
Keys: {(CID, Filed-date-time), ID, (EID, Handled-date-time)}
Primary Key: ID
FD(s):

1. ID -> Text, Filed-date-time, EID, Handled-date-time, CID
2. CID, Filed-date-time → ID
3. EID, handled-date-time → ID

Assume customer can’t create 2 complaints at the same time instant.
Assume employee can’t handle 2 complaints at same time instant.
The relation is in 3NF, since for all FD(s), either the LHS has the key ID or the RHS has the key ID

COMPLAINTS-ON-BOOKSTORE (ComplaintID, BookstoreID)
Keys: {ComplaintID}
Primary Key: ComplaintID
FDs:

1. ComplaintID → BookstoreID

The relation is in 3NF, since for all FD(s), the LHS has the key complaintID.

COMPLAINTS-ON-ORDERS (ComplaintID, OrderID)
Keys: {ComplaintID}
Primary Key: ComplaintID
FDs:

1. ComplaintID → OrderID

The relation is in 3NF, since for all FD(s), the LHS has the key complaintID.

STOCKS-IN-BOOKSTORE (Stock-ID, BookstoreID, PubID, Stock-price, Stock-qty)
Keys: {Stock-ID; (BookstoreID, PubID)}
Primary key: Stock-ID
FDs:

1. Stock-ID → Stock-price, Stock-qty, BookstoreID, PubID
2. BookstoreID, PubID → Stock-ID

Assuming that StockID is unique across bookstores and publications(for 1.) . The relation is in 3NF, since for all FD(s), either the LHS has the key stock-ID or the RHS has the key stock-ID.

PRICE-HISTORY(Stock-ID, Price, Start-date, End-date)
Keys: {(Stock-ID, Start-date); (Stock-ID, End-date)}
Primary key: (Stock-ID, Start-date)
FDs :

1. StockID, Start-date → Price, End-date
2. StockID, End-date → Price, Start-date

The relation is in 3NF, since for all FD(s), the LHS contains a key.

Note: in the given ER diagram, all 4 attributes : stock-ID, price, start-date, end-date form a composite key (stock-ID, price, start-date, end-date) which is a superkey but not a key since we can find more minimal keys (stated above). The price will always be determined by the start-date or end-date, in combination with a StockID.

COMPLAINT-STATUS(Complaint-ID, Date, State)
Keys: {(Complaint-ID, Date)}
Primary keys: (Complaint-ID, Date)
FDs:

1. Complaint-ID, Date → State

The relation is in 3NF, since for all FD(s), the LHS has the key (complaint-ID, date).

ORDER-ITEM-STATUS(Item-ID, Date, State)
Keys: {Item-ID, Date}
Primary Key: (Item-ID, Date)
FDs:

1. ItemID, Date → State

The relation is already in BCNF, hence in 3NF. Since the key is on the FD's LHS.

ITEMS-IN-ORDERS(Stock-ID, Item-ID, Item-price, Item-qty, Delivery-date, CID, Comment, Rating, Datetime, OrderID)
Keys: item-ID
Primary Key: item-ID
FDs:

1. Item-ID → Stock-ID, Item-price, Item-qty, Delivery-date, CID, Comment, Rating, Datetime, OrderID
2. CID, Date-time → Comment, Rating
3. OrderID → CID

Assuming all items sold by *Ahamazon* have a unique item ID. Assuming the customer cannot make 2 comments at the same instant.

The relation is not in 3NF because FD2 and FD3's LHS do not contain key B. Therefore we normalise it.

<u>Decomposition</u>
We first need to convert the functional dependencies to a minimal basis.
<u>Step 1: Make all FDs' RHS, one-attributed</u>
S = {
Item-ID → Stock-ID,
Item-ID → Item-price,

Item-ID → Item-qty,
Item-ID → Delivery-date,
Item-ID → CID,
Item-ID → Comment,
Item-ID → Rating,
Item-ID → Date-time,
Item-ID → OrderID,
CID, Date-time → Comment,
CID, Date-time → Rating,
OrderID → CID}

<u>Step 2: Remove redundant FDs</u>

a. Item-ID → CID,
b. Item-ID → Comment,
c. Item-ID → Rating,

CID, Comment and Rating can still be reached with the above removed.

So, the remaining Functional Dependencies are:

S = { Item-ID → Stock-ID,
Item-ID → Item-price,
Item-ID → Item-qty,
Item-ID → Delivery-date,
Item-ID → Date-time,
Item-ID → OrderID
CID, Date-time → Comment
CID, Date-time → Rating
OrderID → CID}

<u>Step 3: Check for redundant attributes in **CID, Date-time → Comment** and **CID, Date-time → Rating**</u>

There are no redundant attributes. Since the RHS cannot be reached if either CID or Date-time is removed.

<u>Step 4: Combine the FDs with the same LHS.</u>

M = { Item-ID → Stock-ID, Item-price, Item-qty, Delivery-date, Datetime, OrderID
CID, Date-time → Comment, Rating
OrderID → CID}

<u>Step 5: For each FD, create a table that contains all attributes in the FD.</u>

R1(ItemID, Stock-ID, Item-price, Item-qty, Delivery-date, Datetime, OrderID)
R2 (CID, Date-time, Comment, Rating)
R3 (OrderID, CID)

<u>Step 6: Remove redundant tables if any.</u>

No redundant tables.

Step 7: If none of the tables contain a key, then create a table with a key.
R1 contains the key: ItemID, so no need to create.

Final relations:
R1(ItemID, Stock-ID, Item-price, Item-qty, Delivery-date, Datetime, OrderID) - **(PK: ItemID)**
R2 (CID, Date-time, Comment, Rating) - **(PK: CID,Date-time)**
R3 (OrderID, CID) - **(PK: OrderID)**

Notes:
- Using ER approach for subclasses
- **Bold** -> many2one from other relation

Red - entity + subclasses
BOOKSTORE(ID)

CUSTOMERS (CID, name)

PUBLICATION(PubID, publisher, year)
- BOOK(PubID, title)
- MAGAZINE(PubID, issue, title)

ORDERS(orderID, date-time, shipping-address, **CID**) from **BY**

EMPLOYEES(EID, name, salary)

COMPLAINTS(ID, text, filled-date-time, **EID, handled-date-time, CID**) from **HANDLED, FILE**

- COMPLAINTS-ON-BOOKSTORE (complaintID, **bookstoreID**) from **ON**
- COMPLAINTS-ON-ORDERS (complaintID, **orderID**) from **ON**

Blue/black - weak entity sets
STOCKS-IN-BOOKSTORE (stock-ID, bookstoreID, pubID, stock-price, stock-qty)

PRICE-HISTORY(stock-ID, price, start-date, end-date)

ITEMS-IN-ORDERS(stock-ID, item-ID, item-price, item-qty, delivery-date, **CID, comment, rating, datetime, orderID**)

ORDER-ITEM-STATUS(item-ID, date, state)

COMPLAINT-STATUS(complaint-ID, date, state)

Appendix C - Individual Contribution Form

Full Name	Individual Contributions to Lab 3 Submission	Percentage Of Contribution	Signature
Weng Pei He	Created relations and discussed on decomposition of relations.	16.67%	Pei He
Tan Jui Kit Justin	Created relations and discussed on decomposition of relations.	16.67%	Justin
Oza Tirth Tusharbhai	Created relations and discussed on decomposition of relations.	16.67%	Tirth
Yang Yichen	Created relations and discussed on decomposition of relations.	16.67%	Yichen
Lim Zheng Yong Shawn	Created relations and discussed on decomposition of relations.	16.67%	Shawn
Yap Shen Hwei	Created relations and discussed on decomposition of relations.	16.67%	Shen Hwei

- BOOKSTORE

ID

- CUSTOMERS

CID	Name

- PUBLICATION

PubID	Publisher	Year

- BOOKS

PubID	Title

- MAGAZINES

PubID	Issue	Title

- ORDERS2

OrderID	Date_time	Shipping_address	CID

- EMPLOYEES

EID	Name	Salary

- COMPLAINTS

ID	Text	Filed_date_time	EID	Handled_date_time	CID

- COMPLAINTS_ON_BOOKSTORE

ComplaintID	BookstoreID

- COMPLAINTS_ON_ORDERS

ComplaintID	OrderID

- STOCKS_IN_BOOKSTORE

Stock_ID	BookstoreID	PubID	Stock_price	Stock_qty

- PRICE_HISTORY

Stock_ID	Price	Start_date	End_date

- COMPLAINT_STATUS

Complaint_ID	Date	State

- ITEMS_IN_ORDERS_1

ItemID	StockID	ItemPrice	ItemQty	DeliveryDate	OrderID

- ORDER_ITEM_STATUS

ItemID	Date	State

- CUSTOMER_FEEDBACK

ItemID	CID	Date	Comment	Rating

- CUSTOMER_ORDERS

OrderID	CID