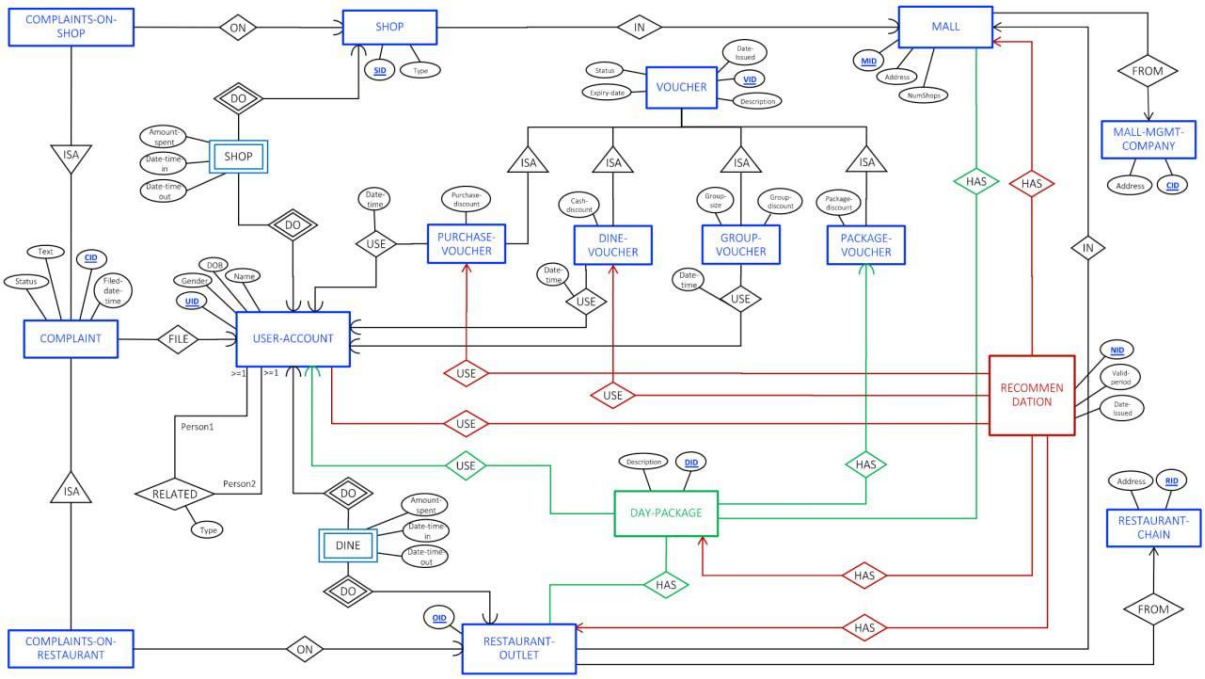

USER_ACCOUNT(<u>UID</u>, Gender, DOB, Name)
Keys: UID
Primary Key: UID
FDs: UID → Gender, DOB, Name
The relation is in 3NF.

RELATED(<u>Person1_UID, Person2_UID</u>, Type)
Keys: {Person1_UID, Person2_UID}
Primary Key: {Person1_UID, Person2_UID}
FDs: {Person1_UID, Person2_UID} → Type
The relation is in 3NF.

VOUCHER(<u>VID</u>, Date-issued, Description, Status, Expiry-date)
Keys: VID
Primary Key: VID
FDs: VID → Date-issued, Description, Status, Expiry-date
The relation is in 3NF.

PURCHASE_VOUCHER(<u>VID</u>, Purchase-discount, UID, Date-time)
Keys: VID

Primary Key: VID
FDs: VID → Purchase-discount, UID, Date-time
The relation is in 3NF.

Notes:

- *UID, Date-time comes from many-to-one relationship with USER_ACCOUNT*

DINE_VOUCHER(VID, Cash-discount, UID, Date-time)
Keys: VID
Primary Key: VID
FDs: VID → Cash-discount, UID, Date-time
The relation is in 3NF.

Notes:

- *UID, Date-time comes from many-to-one relationship with USER_ACCOUNT*

GROUP_VOUCHER(VID, Group-discount, Group-size, UID, Date-time)
Keys: VID
Primary Key: VID
FDs: VID → Group-discount, Group-size, UID, Date-time
The relation is in 3NF.

Notes:

- *UID, Date-time comes from many-to-one relationship with USER_ACCOUNT*

PACKAGE_VOUCHER(VID, Package-discount)
Keys: VID
Primary Key: VID
FDs: VID → Package-discount
This relation is in 3NF.

COMPLAINT(CID, Text, Status, Filed-date-time)
Keys: CID
Primary Key: CID
FDs: CID → Text, Status, Filed-date-time
The relation is in 3NF.

COMPLAINTS_ON_SHOP(CID, numberOfComplaintsOnShop, SID)
Keys: CID
Primary Key: CID
FDs: CID → numberOfComplaintsOnShop, SID
The relation is in 3NF.

Notes:

- *SID comes from many-to-one relationship with SHOP*

COMPLAINTS_ON_RESTAURANT(CID, numberOfComplaintsOnRestaurant, SID)
Keys: CID
Primary Key: CID
FDs: CID → numberOfComplaintsOnRestaurant, SID
The relation is in 3NF.

Notes:

- *SID comes from many-to-one relationship with SHOP*

RESTAURANT_CHAIN(RID, Address)
Keys: RID
Primary Key: RID
FDs: RID → Address
The relation is in 3NF.

RESTAURANT_OUTLET(OID, RID, MID)
Keys: OID
Primary Key: OID
FDs: OID → RID, MID
The relation is in 3NF.

Notes:

- *RID comes from many-to-one relationship with RESTAURANT_CHAIN*
- *MID comes from many-to-one relationship with MALL*

DAY_PACKAGE(DID, Description, UID, VID)
Keys: DID
Primary Key: DID
FDs: DID → Description, UID
The relation is in 3NF.

Notes:

- *UID comes from many-to-one relationship with USER_ACCOUNT*
- *VID comes from many-to-one relationship with PACKAGE_VOUCHER*

MALL_MGMT_COMPANY(CID, Address)
Keys: CID
Primary Key: CID
FDs: CID → Address
The relation is in 3NF.

MALL(MID, Address, NumShops, CID)
Keys: MID
Primary Key: MID
FDs: MID → Address, NumShops, CID
The relation is in 3NF.

Notes:

- *CID comes from many-to-one relationship with MALL_MGMT_COMPANY*

DINE(UID, OID, DineID, Amount-spent, Date-time-in, Date-time-out)
Keys: {UID, OID, DineID}
Primary Key: {UID, OID, DineID}
FDs: UID, OID, DineID → Amount-spent, Date-time-in, Date-time-out
The relation is in 3NF.

SHOP(SID, Type, MID)
Keys: SID
Primary Key: SID
FDs: SID→ Type, MID
The relation is in 3NF.

Notes:

- *MID comes from many-to-one relationship with MALL*

SHOP_VISIT(SID, UID, Amount-spent, Date-time-in, Date-time-out)
Keys: {SID, UID}
Primary Key: {SID, UID}
FDs: {SID, UID} → Amount-spent, Date-time-in, Date-time-out
The relation is in 3NF. The relation is in 3NF.
Notes:

- *MID comes from many-to-one relationship with MALL*

USER_RECOMMENDATION(UID, NID)
Keys: {UID, NID}
The relation is in 3NF.

MALL_DAY_PACKAGE(MID, DID)
Keys: {MID, DID}
The relation is in 3NF.

RESTAURANT_DAY_PACKAGE(OID, DID)
Keys: {OID, DID}
The relation is in 3NF.

RECOMMENDATION(NID, Valid-period, Date-issued, VID, VoucherType, RID, DID, MID)
Keys: NID
Primary Key: NID
FDs:

- NID → Valid-period, Date-issued, VID, RID, DID, MID
- VID → VoucherType

The relation is **not** in 3NF, because VID is not a key and VoucherType is not contained in any key.

Notes:

- *VID comes from many-to-one relationship with PURCHASE_VOUCHER*
- *RID comes from many-to-one with RESTAURANT_OUTLET*
- *DID comes from many-to-one with DAY_PACKAGE*
- *MID comes from many-to-one with MALL*

3NF Decomposition

Step 1: Minimal Basis

Condition 1:

{NID → Valid-period, NID → Date-issued, NID → VID, NID → RID, NID → DID, NID → MID, VID → VoucherType}

Condition 2:

No redundant FDs.

Condition 3:

No redundancy on LHS.

Step 2: In the minimal basis, combine the FDs whose left hand sides are the same

We get:

- NID → Valid-period, Date-issued, VID, RID, DID, MID
- VID → VoucherType

in our minimal basis.

Step 3: Create a table for each FD remained

RECOMMENDATION_INFO(NID, Valid-period, Date-issued, VID, RID, DID, MID)

RECOMMENDATION_VOUCHERS(VID, VoucherType)

Thus, RECOMMENDATION is decomposed into RECOMMENDATION_INFO and RECOMMENDATION_VOUCHERS.