**NORMALIZATION OF COLLEGE DATABASE:**

1. **INGENUITY** = {Year, Events, Coordinator (MVA), Team}

FD’s: {Year, Events} -> Coordinator, Team

Coordinator is MVA, so not in 1NF. Decomposed as-

A = {Year, Events, Coordinator}

B = {Year, Events, Team} {Year, Events} -> Team

Now in 1NF.

All non-key attributes determined by primary key, so in 2NF.

No non-key attributes are transitively dependent on primary key, so in 3NF.

No inter-dependencies between attributes of primary key, so in BCNF.

**Normalized form:** in BCNF but not in 4NF.

*For A*: In 1NF, 2NF, 3NF & BCNF. Not in 4NF because same event can have different years, same coordinators can have different years, same year can have different events & same coordinators can host different events. Year, Events & Team are MVA (multi-value attributes). Hence can’t be decomposed to 4NF.

*For B*: In 1NF, 2NF, 3NF & BCNF. Not in 4NF because same event can have different years, same teams can have different years & same team can host different events. Year, Events & Team are MVA (multi-value attributes). Hence can’t be decomposed to 4NF.

1. **OTHER COLLEGES** = {College Name, R’s Contact no, Representative, Accommodation no, No of Participants}

Primary key = College Name

Candidate key = R’s Contact no

FD’s: College Name -> R’s Contact no, Representative, Accommodation no, No of Participants

R’s Contact no -> College Name, Representative, Accommodation no, No of Participants

All attributes are atomic, so in 1NF.

All non-key attributes determined by primary key, so in 2NF.

No non-key attributes are transitively dependent on primary key, so in 3NF.

Since College Name determines R’s contact no & R’s contact no determines college name. Candidate keys are interdependent. Hence, not in BCNF. So to convert in BCNF, decomposed as following-

A = {College Name, R’s Contact No}

B = {Representative, R’s Contact No, No of Participants, Accommodation No}

No more than 1 MVA in both A & B, so in 4NF.

1. **STUDENT** = {Enrollment ID, Mobile No, Name, Gender, Batch, Branch, Room No, Room Location}

Primary key = Enrollment ID

Candidate key = Mobile No

FD’s: Enrollment ID -> Name, Gender, Batch, Branch, Mobile No, Room No, Room Location

Mobile No -> Enrollment ID, Name, Gender, Batch, Branch, Room No, Room Location

All attributes are atomic, so in 1NF.

All non-key attributes determined by primary key, so in 2NF.

No non-key attributes are transitively dependent on primary key, so in 3NF.

Since Enrollment ID determines Mobile no & Mobile no determines Enrollment ID. Candidate keys are interdependent. Hence, not in BCNF. So to convert in BCNF, decomposed as following-

A = {Enrollment ID, Mobile No}

B = { Enrollment ID, Name, Gender, Batch, Branch, Room No, Room Location}

No more than 1 MVA in both A & B, so in 4NF.

1. **FACULTY** = {Employee ID, Mobile no, Name, Gender, Room No, Room Location}

Primary key = Employee ID

Candidate key = Mobile No

FD’s: Enrollment ID -> Mobile no, Name, Gender, Room No, Room Location

Mobile No -> Employee ID, Name, Gender, Room No, Room Location

All attributes are atomic, so in 1NF.

All non-key attributes determined by primary key, so in 2NF.

No non-key attributes are transitively dependent on primary key, so in 3NF.

Since Employee ID determines Mobile no & Mobile no determines Employee ID. Candidate keys are interdependent. Hence, not in BCNF. So to convert in BCNF, decomposed as following-

A = {Employee ID, Mobile No}

B = { Employee ID, Name, Gender, Room No, Room Location}

No more than 1 MVA in both A & B, so in 4NF.

1. **HOUSE** = {Year, House Name, Captain, Vice Captain}

Primary key = Year, Name

FD’s: Year, Name -> Captain, Vice Captain

1NF decomposition :- {Year, Captain, Name, Vice Captain}

All non-key attributes determined by primary key, so in 2NF.

No non-key attributes are transitively dependent on primary key, so in 3NF.

No inter-dependencies between candidate keys. So in BCNF.

For same year, Name, Captain & Vice captain are MVAs. So not in 4NF and can’t be decomposed to 4NF because of lossy decomposition.

1. **HOUSE** **POINTS** = {Event, Year, House Name, Points}

Primary key = Event, Year, House Name

FD’s: Event, Year, House Name -> Points

In 1NF, 2NF, 3NF & BCNF.

For same year, Event, House Name & Points are MVAs. So not in 4NF and can’t be decomposed to 4NF because of lossy decomposition.

1. **SPORTS EQUIPMENT ALLOCATION** = {Date, Sport, In Time, Out Time, Signature}

Primary key = Date, Sport, In Time

FD’s: Date, Sport, In Time -> Out Time, Signature

In 1NF, 2NF, 3NF & BCNF.

More than 1 MVAs. So not in 4NF and can’t be decomposed to 4NF because of lossy decomposition.

1. **COURIER** = {Order No, Received from whom, Date ,Signature, Enrollment ID, Employee ID}

Primary key = Order No

FD’s: Order No -> Received from whom, Date, Signature, Enrollment ID, Employee ID

Not in 1NF. So 1NF decomposition :-

A = {Order No, Enrollment ID, Employee ID}

B = {Order No, Received from whom, Date, Signature}

*For A:* It's in 1NF, 2NF, 3NF & BCNF, but not in 4NF. So 4NF decomposition as follows-

A1 = {Order No, Enrollment ID}

A2 = {Order No, Employee ID}

*For B:* It's in 1NF, 2NF, 3NF, BCNF & 4NF.

1. **CLUB** = {Club Name, Year, Captain, Coordinators}

Primary key = Club Name, Year

FD’s: Club Name, Year -> Captain, Coordinators

Not in 1NF. So 1NF decomposition :-

A = {Club Name, Year, Captain}

B = {Club Name, Year, Coordinators}

*For A:* It's in 1NF, 2NF, 3NF & BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

*For B:* It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **SPORTS** = {Year, Event, Category, Event type, Winner}

Primary key = Year, Event, Category, Event type

FD’s: Year, Event, Category, Event type -> Winner

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

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1. **KEY ALLOCATION** = {Room No, Date, Location, In Time, Out Time, Signature}

Primary key = Room No, Date, Location, In Time

FD’s: Room No, Date, Location, In Time -> Out Time, Signature

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **ROOM** = {Room No, Room Location, Room type, Rent, Date, In Time, Signature}

Primary key = Room No, Room Location

FD’s: Room No, Room Location -> Room type, Rent, Date, In Time, Signature

Not in 1NF. So 1NF decomposition :-

A = {Room No, Room Location, Room type, Rent }

B = {Room No, Room Location, Date, In Time, Signature}

*For A:* It's in 1NF, 2NF, but not in 3NF. So, 3NF decomposition-

A1 = { Room No, Room Location, Room type}

A2 = {Room type, Rent}

*For A1:* Room No, Room Location -> Room type

In 1NF, 2NF, 3NF & BCNF. Can't be decomposed to 4NF because of lossy decomposition.

*For A2:* Primary key -> Room type

Candidate key -> Rent

In 1NF, 2NF, 3NF. Not in BCNF and can’t be decomposed to BCNF because of lossy decomposition.

*For B:* It's in 1NF, 2NF, 3NF, BCNF & not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **ATHLETICS** = {Category, Year, Event, Position1, Position2, Position3, WV1, WV2, WV3}

Primary key = Category, Year, Event

FD’s: Category, Year, Event -> Position1, Position2, Position3, WV1, WV2, WV3

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Except year all are MVA, and if we decompose than Primary key will not be preserved and lossy decomposition will occur.

1. **RESULTS** = {Category, Year, Event, Points, Best Athlete}

Primary key = Category, Year, Event

FD’s: Category, Year, Event -> Points, Best Athlete

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **Joins** = {Enrollment ID, Club Name, Year}

Primary key = Enrollment ID, Club Name, Year

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **S participates in S** = {Enrollment ID, Year, Event , Event type, Category}

Primary key = Enrollment ID, Year, Event , Event type, Category

FD’s: Enrollment ID -> Category

For B: It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **F participates in S** = {Employee ID, Year, Event , Event type, Category}

Primary key = Employee ID, Year, Event , Event type, Category

FD’s: Employee ID -> Category

In 1NF, but not in 2NF. So 2NF decomposition :-

A = {Employee ID, Category}

B = {Employee ID, Year, Event , Event type}

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **S participates in A** = {Enrollment ID, Year, Event, Category}

Primary key = Enrollment ID, Year, Event, Category

FD’s: Enrollment ID -> Category

It's in 1NF, 2NF, 3NF, but not in BCNF. So, BCNF decomposition-

A = {Enrollment ID, Category}

B = {Enrollment ID, Year, Event}

*For A:* It's in 1NF, 2NF, 3NF, BCNF & 4NF.

For B: It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **S takes K** = {Enrollment ID, Date, In Time, Room Location, Room No}

Primary key = Enrollment ID, Date, In Time

FD’s: Enrollment ID, Date, In Time -> Room Location, Room No

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **S participates in I** = {Enrollment ID, Year, Event}

Primary key = Enrollment ID, Year, Event

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **S has SEA** = {Enrollment ID, Date, In Time, Sport}

Primary key = Enrollment ID, Date, In Time

Candidate key = Enrollment ID, Date, Sport

FD’s: Enrollment ID, Date, In Time -> Sport

It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

1. **Participants** = {Year, Event, College Name, R’s Contact No}

Primary key = Year, Event

R’s Contact No is not scalar, so not in 1NF. Hence, 1NF decomposition as follows-

A = { Year, Event, College Name}

B = { Year, College Name, R’s Contact No}

*For A:* It's in 1NF, 2NF, 3NF, BCNF, but not in 4NF. Can't be decomposed to 4NF because of lossy decomposition.

For B: It's in 1NF, 2NF, 3NF, BCNF & 4NF.

Primary key -> Year, College Name

FD’s: Year, College Name -> R’s Contact No

Only one MVA(R’s Contact No). So in 4NF.

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