DBMS-**VIDHYADHAN**

NORMALIZATION

All the Tables before Normalization:

1. Applicant
2. Pincodes
3. Cities
4. Parent_or_Guardian_Details
5. Education_Details
6. Departments
7. Qualifications(Weak Entity)
8. Conditions
9. Registers
10. Bank_Details
11. IFSC_Details
12. Received_From(n-m)
13. Applied_In(n-m)
14. Donated_In(n-m)
15. Donor
16. Scholarships
17. States
18. Religions(Multivalue)
19. Gender(Multivalue)
20. Programs(Multivalue)
21. Employees(Multivalue)

Proof that relations are in Boyce-Codd Normal Form (BCNF):

1. **'Applicant'** Entity:

    - **'Applicant'** Attributes: {Applicant_Id, Gurdian_Email_Id, Fname, Mname, Lname, College_Id, Semester, Year_Of_Admission, Department_Name, Dob, Gender, Category, Religion, Applicant_Email_Id, Register_Type, Appartment_No, Street_Name,

Pincode, Contact_No, Bank_Account_No, Bank_Account_Holder_Type, Condition_Id}

- Functional Dependencies:
    - ❖ Applicant_Id ➔ Gurdian_Email_Id
    - ❖ Applicant_Id ➔ Fname
    - ❖ Applicant_Id ➔ Mname
    - ❖ Applicant_Id ➔ Lname
    - ❖ Applicant_Id ➔ College_Id
    - ❖ Applicant_Id ➔ Semester
    - ❖ Applicant_Id ➔ Year_Of_Admission
    - ❖ Applicant_Id ➔ Department_Name
    - ❖ Applicant_Id ➔ Dob
    - ❖ Applicant_Id ➔ Gender
    - ❖ Applicant_Id ➔ Category
    - ❖ Applicant_Id ➔ Religion
    - ❖ Applicant_Id ➔ Applicant_Email_Id
    - ❖ Applicant_Id ➔ Register_Type
    - ❖ Applicant_Id ➔ Appartment_No
    - ❖ Applicant_Id ➔ Street_Name
    - ❖ Applicant_Id ➔ Pincode
    - ❖ Applicant_Id ➔ Contact_No
    - ❖ Applicant_Id ➔ Bank_Account_No
    - ❖ Applicant_Id ➔ Bank_Account_Holder_Type
    - ❖ Applicant_Id ➔ Condition_Id

  Let **X =** {Applicant_Id}
- **X^+** = {Applicant_Id, Gurdian_Email_Id, Fname, Mname, Lname, College_Id, Semester, Year_Of_Admission, Department_Name, Dob, Gender, Category, Religion, Applicant_Email_Id, Register_Type, Appartment_No, Street_Name, Pincode, Contact_No, Bank_Account_No, Bank_Account_Holder_Type, Condition_Id}
- Thus, **Primary Key = {**Applicant_Id**}**
- The left side of all the FDs in minimal set of FDs for the relation **'Applicant'** is **{Applicant_Id},** which is the primary key of this relation, so '**Applicant**' is in BCNF.

2. **'Pincodes'** Entity:

- **'Pincodes'** Attributes: {Pincode, City}

- Functional Dependencies:
    - {Pincode} ➔ {City}

  Let **X =** {Pincode}
- **X^+** = {Pincode,City}
- Thus, **Primary Key = {Pincode}**
- The left side of all the FDs in minimal set of FDs for the relation '**Pincodes'** is **{Pincode},** which is the primary key of this relation, so '**Pincodes'** is in BCNF.

3. **'Cities'** Entity:

- **'Cities'** Attributes: {City, State_Name}
- Functional Dependencies:
    - {City} ➔ {State_Name}

  Let **X =** {City}
- **X^+** = {City, State_Name}
- Thus, **Primary Key = {City}**
- The left side of all the FDs in minimal set of FDs for the relation '**Cities'** is **{City},**which is the primary key of this relation, so '**Cities'** is in BCNF.

4. **'Parent_or_Guardian_Details'** Entity:

- **'Parent_or_Guardian_Details'** Attributes: {Email_Id, Fname, Mname, Lname, DOB, Gender, Occupation, Annual_Income, Other_Income, Contact_No}
- Functional Dependencies:
    - Email_Id ➔ Fname
    - Email_Id ➔ Mname
    - Email_Id ➔ Lname
    - Email_Id ➔ DOB
    - Email_Id ➔ Gender
    - Email_Id ➔ Occupation
    - Email_Id ➔ Annual_Income
    - Email_Id ➔ Other_Income
    - Email_Id ➔ Contact_No

  Let **X =** Email_Id
- **X^+** = {Email_Id, Fname, Mname, Lname, DOB, Gender, Occupation, Annual_Income, Other_Income, Contact_No}
- Thus, **Primary Key = Email_Id**

- The left side of all the FDs in minimal set of FDs for the relation '**Parent_or_Guardian_Details**' is **Email_Id,** which is the primary key of this relation, so '**Parent_or_Guardian_Details**' is in BCNF.

5. **'Education_Details'** Entity:

- '**Education_Details**' Attributes: {College_Id, Semester, Year_of_Admission, Department_Name, College_Name, Tuition_Fees, Hostel_Fees, Received_TFWS}
- Functional Dependencies:
    - ❖ {College_Id, Semester, Year_Of_Admission,Department_Name} ➔ College_Name
    - ❖ {College_Id, Semester, Year_Of_Admission,Department_Name} ➔ Tuition_Fees
    - ❖ {College_Id, Semester, Year_Of_Admission,Department_Name} ➔ Hostel_Fees
    - ❖ {College_Id, Semester, Year_Of_Admission,Department_Name} ➔ Received_TFWS

  Let **X = {College_Id, Semester, Year_Of_Admission,Department_Name}**
- **X^+** = {College_Id, Semester, Year_of_Admission, Department_Name, College_Name, Tuition_Fees, Hostel_Fees, Received_TFWS}
- The left side of all the FDs in minimal set of FDs for the relation 'Education_Details' is **{College_Id, Semester, Year_Of_Admission, Department_Name},** which is the primary key of this relation, so '**Education_Details**' is in BCNF.

6. **'Departments'** Entity:

- **'Departments'**Attributes: {Department_Name, Program_Name}
- Functional Dependencies:
    - ❖ Department_Name ➔ Program_Name

  Let **X =** Department_Name
- **X^+** = {Department_Name,Program_Name}
- Thus, **Primary Key = {Department_Name,Program_Name}**
- The left side of all the FDs in minimal set of FDs for the relation **'Departments'** is **{Department_Name,Program_Name}** which is the primary key of this relation, so **'Departments'** is in BCNF.

7. **'Qualifications'** Entity:

- **'Qualifications'** Attributes: {Applicant_Id,Qualification_Type, Passing Year, Percentile}
- Functional Dependencies:
    - ❖ {Applicant_Id,Qualification_Type} ➔ Passing_Year
    - ❖ {Applicant_Id,Qualification_Type} ➔ Percentile

  Let **X =** {Applicant_Id,Qualification_Type}
- **X^+** = {Applicant_Id,Qualification_Type, Passing_Year,Percentile}
- Thus, **Primary Key = {Applicant_Id,Qualification_Type}**
- The left side of all the FDs in minimal set of FDs for the relation **'Qualifications'** is **{Applicant_Id,Qualification_Type}** which is the primary key of this relation, so **'Qualifications'** is in BCNF.

8. **'Conditions'** Entity:

- **'Conditions'** Attributes:{Condition_Id, Is_Orphan, Is_Blacklisted, Is_Phy_Disabled, Has_Any_Backlog}
- Functional Dependencies:
    - ❖ Condition_Id ➔ Is_Orphan
    - ❖ Condition_Id ➔ Is_Blacklisted
    - ❖ Condition_Id ➔ Is_Phy_Disabled
    - ❖ Condition_Id ➔ Has_Any_Backlog

  Let **X=**Condition_Id
- Then **X^+**={Condition_Id, Is_Orphan, Is_Blacklisted, Is_Phy_Disabled, Has_Any_Backlog}
  Thus, **Primary Key = Condition_Id**
- The left side of all the FDs in minimal set of FDs for the relation **'Conditions'** is **Condition_Id**, which is the primary key of this relation, so **'Conditions'** is in BCNF.

9. **'Registers'** Entity:

- **'Registers'** Attributes: {Email_Id,Register_Type,"Password"}
- Functional Dependencies:
    - ❖ {Email_Id,Register_Type} ➔"Password"

  Let **X**={Email_Id,Register_Type}
- Then **X^+** ={Email_Id,Register_Type,"Password"}

- Thus, **Primary Key = {Email_Id,Register_Type}**
- The left side of all the FDs in minimal set of FDs for the relation **'Registers'** is **{Email_Id, Register_Type}**, which is the primary key of this relation, so **'Registers'** is in BCNF.

10. **'Bank_Details'** Entity:
    - '**Bank_Details**' Attributes: {Bank_Account_No, Bank_Account_Holder_Type,IFSC_Code}
    - Functional Dependencies:
        - {Bank_Account_No} ➔ IFSC_Code
        - {Bank_Account_No,Bank_Account_Holder_Type} ➔ IFSC_Code

      Let **X =** {Bank_Account_No,Bank_Account_Holder_Type}
    - Then **X^+ =** {Bank_Account_No, Bank_Account_Holder_Type, IFSC_Code}
    - Thus, **Primary Key = {Bank_Account_No,Bank_Account_Holder_Type}**
    - The left side of all the FDs in minimal set of FDs for the relation '**Bank_Details**' is **{Bank_Account_No,Bank_Account_Holder_Type}**, which is the primary key of this relation, so '**Bank_Details**' is in BCNF.

11. **'IFSC_Details'** Entity:
    - '**IFSC_Details**' Attributes: {IFSC_Code,Bank_Name,Branch_Name}
    - Functional Dependencies:
        - IFSC_Code ➔ Bank_Name
        - IFSC_Code ➔ Branch_Name

      Let **X =** IFSC_Code
    - Then **X^+**={IFSC_Code,Bank_Name,Branch_Name}
    - Thus, **Primary Key = IFSC_Code**
    - The left side of all the FDs in minimal set of FDs for the relation 'IFSC_Details' is **IFSC_Code**, which is the primary key of this relation, so 'IFSC_Details' is in BCNF.

12. **'Received_From'** Entity:
    - **'Received_From'** Attributes: {Scholarship_Id, Applicant_Id, Amount_Received, Received_On}

- Functional Dependencies:
    - ❖ {Scholarship_Id,Applicant_Id} ➔ Received_On
    - ❖ {Scholarship_Id,Applicant_Id} ➔ Amount_Received
    - ❖ {Scholarship_Id,Applicant_Id} ➔ Scholarship_Id(Trivial)
    - ❖ {Scholarship_Id,Applicant_Id} ➔ Applicant_Id(Trivial)

  Let **X =** {Scholarship_Id,Applicant_Id}
- **X^+** = {Scholarship_Id, Applicant_Id}
- Thus, **Primary Key = {Scholarship_Id, Applicant_Id}**
- The left side of all the FDs in minimal set of FDs for the relation 'Received_From' is **{Scholarship_Id, Applicant_Id},**which is the primary key of this relation, so 'Received_From' is in BCNF.

13. **'Applied_In'** Entity:

- **'Applied_In'** Attributes: {Scholarship_Id, Applicant_Id, Applied_On}
- Functional Dependencies:
    - ❖ {Scholarship_Id,Applicant_Id} ➔ Applied_On
    - ❖ {Scholarship_Id,Applicant_Id} ➔ Scholarship_Id(Trivial)
    - ❖ {Scholarship_Id,Applicant_Id} ➔ Applicant_Id(Trivial)

  Let **X =** {Scholarship_Id,Applicant_Id}
- **X^+** = {Scholarship_Id, Applicant_Id}
- Thus, **Primary Key = {Scholarship_Id, Applicant_Id}**
- The left side of all the FDs in minimal set of FDs for the relation '**Applied_In**' is **{Scholarship_Id, Applicant_Id},**which is the primary key of this relation, so '**Applied_In**' is in BCNF.

14. **'Donated_In'** Entity:

- '**Donated_In**' Attributes: {Scholarship_Id, Donor_Id, Donation_Date, Donated_Amount, Receipt_No}
- Functional Dependencies:
    - ❖ {Scholarship_Id,Donor_Id} ➔ Donated_Amount
    - ❖ {Scholarship_Id,Donor_Id} ➔ Donation_Date
    - ❖ {Scholarship_Id,Donor_Id} ➔ Receipt_No
    - ❖ {Scholarship_Id,Donor_Id} ➔ Scholarship_Id(Trivial)
    - ❖ {Scholarship_Id,Donor_Id} ➔ Donor_Id(Trivial)

  Let **X =** {Scholarship_Id,Donor_Id}
- **X^+** = {Scholarship_Id, Donor_Id}
- Thus, **Primary Key = {Scholarship_Id, Donor_Id}**

- The left side of all the FDs in minimal set of FDs for the relation '**Donated_In'** is **{Scholarship_Id, Donor_Id},**which is the primary key of this relation, so '**Donated_In**' is in BCNF.

15. **'Donor'** Entity:

- **'Donor'** Attributes: {Donor_Id, Register_Id, Register_Type, Bank_Account_No, Bank_Account_Holder_Type, Contact_No, Aadhar_No, Fname, Mname, Lname, CIN_No, Company_Name}
- Functional Dependencies:
    - ❖ Donor_Id ➔ Register_Id
    - ❖ Donor_Id ➔ Register_Type
    - ❖ Donor_Id ➔ Bank_Account_No
    - ❖ Donor_Id ➔ Bank_Account_Holder_Type
    - ❖ Donor_Id ➔ Contact_No
    - ❖ Donor_Id ➔ Aadhar_No
    - ❖ Donor_Id ➔ Fname
    - ❖ Donor_Id ➔ Mname
    - ❖ Donor_Id ➔ Lname
    - ❖ Donor_Id ➔ CIN_No
    - ❖ Donor_Id ➔ Company_Name

  Let **X =** Donor_Id
- **X^+** = {Donor_Id, Register_Id, Register_Type, Bank_Account_No, Bank_Account_Holder_Type, Contact_No, Aadhar_No, Fname, Mname, Lname, CIN_No, Company_Name}
- Thus, **Primary Key = Donor_Id**
- The left side of all the FDs in minimal set of FDs for the relation '**Donor**' is **Donor_Id,** which is the primary key of this relation, so '**Donor**' is in BCNF.

16. **'Scholarships'** Entity:

- **'Scholarships'** Attributes: {Scholarship_Id, S_Name, Amount, Starting_Date, Closing_Date, Sch_Description, Income, Is_Orphan, Is_Blacklisted, Is_Phy_Disabled, Has_Any_Backlog}
- Functional Dependencies:
    - ❖ Scholarship_Id ➔ S_Name
    - ❖ Scholarship_Id ➔ Amount
    - ❖ Scholarship_Id ➔ Starting_Date
    - ❖ Scholarship_Id ➔ Closing_Date

- ❖ Scholarship_Id ➔ Sch_Description
- ❖ Scholarship_Id ➔ Income
- ❖ Scholarship_Id ➔ Is_Orphan
- ❖ Scholarship_Id ➔ Is_Blacklisted
- ❖ Scholarship_Id ➔ Is_Phy_Disabled
- ❖ Scholarship_Id ➔ Has_Any_Backlog

Let **X=**Scholarship_Id

- Then $\mathbf{X^+}$ = {Scholarship_Id, S_Name, Amount, Starting_Date, Closing_Date, Sch_Description, Income, Is_Orphan, Is_Blacklisted, Is_Phy_Disabled, Has_Any_Backlog}

  Thus, **Primary Key = Scholarship_Id**

- In Redundancy, what we realised is that these {Is_Orphan,Is_Blacklisted,Is_Phy_Disabled,Has_Any_Backlog} Boolean type attributes takes 4 columns where only 16(2^4) Type of conditions occurs and we can map them to integer values:

{false,false,false,false} maps to 0 that signifies all condition false, then

{false,false,false,true} that signifies Has_Any_Backlog true but else all false

Similarly, all can be mapped as follows:

(0, 'FALSE', 'FALSE', 'FALSE', 'FALSE'),

(1, 'TRUE', 'FALSE', 'FALSE', 'FALSE'),

(2, 'FALSE', 'TRUE', 'FALSE', 'FALSE'),

(3, 'TRUE', 'TRUE', 'FALSE', 'FALSE'),

(4, 'FALSE', 'FALSE', 'TRUE', 'FALSE'),

(5, 'TRUE', 'FALSE', 'TRUE', 'FALSE'),

(6, 'FALSE', 'TRUE', 'TRUE', 'FALSE'),

(7, 'TRUE', 'TRUE', 'TRUE', 'FALSE'),

(8, 'FALSE', 'FALSE', 'FALSE', 'TRUE'),

(9, 'TRUE', 'FALSE', 'FALSE', 'TRUE'),

(10, 'FALSE', 'TRUE', 'FALSE', 'TRUE'),

(11, 'TRUE', 'TRUE', 'FALSE', 'TRUE'),

(12, 'FALSE', 'FALSE', 'TRUE', 'TRUE'),

(13, 'TRUE', 'FALSE', 'TRUE', 'TRUE'),

(14, 'FALSE', 'TRUE', 'TRUE', 'TRUE'),

(15, 'TRUE', 'TRUE', 'TRUE', 'TRUE');

- So, what we made is New Entity Conditions then **Condition_Id** is just value it has mapped from 0 to 15 values so this is just a fixed sized table Kind of new thing but also helpful so this is just optimized thing here and also when applicant's conditions will be mapped into this Table.

So new Scholarship Entity will be

'Scholarships' Entity:

- **'Scholarships'** Attributes: {Scholarship_Id, S_Name, Amount, Starting_Date, Closing_Date, Sch_Description, Income, Condition_Id}
- Functional Dependencies:
    - ❖ Scholarship_Id ➔ S_Name
    - ❖ Scholarship_Id ➔ Amount
    - ❖ Scholarship_Id ➔ Starting_Date
    - ❖ Scholarship_Id ➔ Closing_Date
    - ❖ Scholarship_Id ➔ Sch_Description
    - ❖ Scholarship_Id ➔ Income
    - ❖ Scholarship_Id ➔ Condition_Id

  Let **X=**Scholarship_Id
- Then **X^+**={Scholarship_Id, S_Name,Amount,Starting_Date, Closing_Date, Sch_Description,Income,Condition_Id}
  Thus, **Primary Key = Scholarship_Id**
- The left side of all the FDs in minimal set of FDs for the relation **'Scholarships'** is **Scholarship_Id**, which is the primary key of this relation, so **'Scholarships'** is in BCNF.

17. **'States'** Entity:

- **'States'** Attributes: {Scholarship_Id,State_Name}
- Functional Dependencies:
    - ❖ {Scholarship_Id,State_Name} ➔ Scholarship_Id(Trivial)

- {Scholarship_Id,State_Name} ➔ State_Name(Trivial)

Let **X =** {Scholarship_Id,State_Name}

- **X^+** = {Scholarship_Id, State_Name}
- Thus, **Primary Key = {Scholarship_Id, State_Name}**

- The left side of all the FDs in minimal set of FDs for the relation **'States'** is **{Scholarship_Id,State_Name},**which is the primary key of this relation, so **'States'** is in BCNF.

18. **'Religions'** Entity:

- **'Religions'** Attributes: {Scholarship_Id, Religion}
- Functional Dependencies:
  - {Scholarship_Id, Religion } ➔ Scholarship_Id(Trivial)
  - {Scholarship_Id, Religion } ➔ Religion (Trivial)

Let **X =** {Scholarship_Id, Religion}

- **X^+** = {Scholarship_Id, Religion}
- Thus, **Primary Key = {Scholarship_Id, Religion}**
- The left side of all the FDs in minimal set of FDs for the relation **'Religions'** is **{Scholarship_Id, Religion },** which is the primary key of this relation, so **'Religions'** is in BCNF.

19. **'Gender_'** Entity:

- **'Gender_'** Attributes: {Scholarship_Id,Gender}
- Functional Dependencies:
  - {Scholarship_Id,Gender} ➔ Scholarship_Id(Trivial)
  - {Scholarship_Id,Gender} ➔ State_Name(Trivial)

Let **X =** {Scholarship_Id,Gender}

- **X^+** = {Scholarship_Id, Gender}
- Thus, **Primary Key = {Scholarship_Id, Gender}**
- The left side of all the FDs in minimal set of FDs for the relation **'Gender'** is **{Scholarship_Id,Gender},**which is the primary key of this relation, so **'Gender'** is in BCNF.

20. **'Programs'** Entity:

- **'Programs'** Attributes: {Applicant_Id, Program_Name}
- Functional Dependencies:
    - {Applicant_Id, Program_Name} ➔ {Applicant_Id} (Trivial)
    - {Applicant_Id, Program_Name} ➔ {Program_Name} (Trivial)

  Let **X =** {Applicant_Id, Program_Name}
- **X^+** = {Applicant_Id, Program_Name}
- Thus, **Primary Key = {Applicant_Id, Program_Name}**
- The left side of all the FDs in minimal set of FDs for the relation **'Programs'** is **{Applicant_Id, Program_Name},** which is the primary key of this relation, so **'Programs'** is in BCNF.

21. **'Employees'** Entity:

- **'Employees'** Attributes: {Email_Id, F_Name, M_Name, L_Name, Manager_Email_Id, Scholarship_Id, Contact_No_1,Contact_No_2}
- Functional Dependencies:
    - Email_Id ➔ F_Name
    - Email_Id ➔ M_Name
    - Email_Id ➔ L_Name
    - Email_Id ➔ Manager_Email_Id
    - Email_Id ➔ Scholarship_Id
    - Email_Id ➔ Contact_No_1
    - Email_Id ➔ Contact_No_2

  Let **X =** Email_Id
- Then **X^+**={Email_Id, F_Name, M_Name, L_Name, Manager_Email_Id, Scholarship_Id, Contact_No_1,Contact_No_2}
- Thus, **Primary Key = Email_Id**
- The left side of all the FDs in minimal set of FDs for the relation **'Employees'** is **Email_Id**, which is the primary key of this relation, so **'Employees'** is in BCNF.