**CSCI 4333 Design of Database Systems  
Spring 2022**

**Template for Q1 of HW #8**

NFT’s relation schema with entries for normalization analysis

|  |  |
| --- | --- |
| 1 | Address(AddressId, Street, City, State, ZipCode, Country) |
| Candidate Keys | [1] AddressId |
| Foreign Keys |  |
| Nullable Attributes | State, ZipCode |
| Non-nullable Attributes | AddressId, Street, City, Country |
| Notes | [1] AddressId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: AddressId -> street, City, State, ZipCode, Country**  **[Highest NF]: BCNF** |
| 2 | Member(MemberId, LName, FName, Phone, Email, JoinDate, AddressId) |
| Candidate Keys | [1] MemberId |
| Foreign Keys | [1] AddressId references Address(AddressId) |
| Nullable Attributes | Phone |
| Non-nullable Attributes | MemberId, LName, FName, Email, JoinDate, AddressId |
| Notes |  |
| Normalization Analysis | **[FD]: MemberId-> LName, FName, Phone, Email, JoinDate, AddressId**  **[Highest NF]: BCNF** |
| 3 | Author(AuthorId, AuthorFName, AuthorLName, Description, MemberId) |
| Candidate Keys | [1] AuthorId |
| Foreign Keys | [1] MemberId references Member(MemberId) |
| Nullable Attributes | MemberId, Description |
| Non-nullable Attributes | AuthorId, AuthorFName, AuthorLName, |
| Notes | [1] AuthorId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: AuthorId -> AuthorFName, AuthorLName, Description, MemberId**  **[Highest NF]: BCNF** |
| 4 | Play(PlayId, title, numberOfActs, PrimaryAuthorId) |
| Candidate Keys | [1] PlayId |
| Foreign Keys | [1] PrimaryAuthorId references Author(AuthorId). |
| Nullable Attributes | PrimaryAuthorId |
| Non-nullable Attributes | PlayId, title, numberOfActs |
| Notes | [1] PlayIdId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: PlayId-> title, numberOfActs, PrimaryAuthorId**  **[Highest NF]: BCNF** |
| 5 | Coauthorship(CoauthorshipId, CoauthorId, PlayId) |
| Candidate Keys | [1] CoauthorshipId, [2] CoauthorId, PlayId |
| Foreign Keys | [1] CoauthorId references Author(AuthorId), [2] PlayId references Play(PlayId) |
| Nullable Attributes |  |
| Non-nullable Attributes | CoauthorshipId, CoauthorId, PlayId |
| Notes | [1] CoauthorshipId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: CoauthorshipId-> CoauthorId, PlayId**  **CoauthorId, PlayId-> CoauthorshipId**  **[Highest NF]: BCNF** |
| 6 | Character(CharacterId, PlayName, gender) |
| Candidate Keys | [1] CharacterId |
| Foreign Keys |  |
| Nullable Attributes | gender |
| Non-nullable Attributes | CharacterId, PlayName |
| Notes | [1] CharacterId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: CharacterId-> PlayName, gender**  **[Highest NF]: BCNF** |
| 7 | Appearance(AppearanceId, CharacterId, PlayId) |
| Candidate Keys | [1] AppearanceId, [2] CharacterId, PlayId |
| Foreign Keys | [1] CharacterId references Character(CharacterId), [2] PlayId references Play(PlayId) |
| Nullable Attributes |  |
| Non-nullable Attributes | AppearanceId, CharacterId, PlayId |
| Notes | [1] AppearanceId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: AppearanceId-> CharacterId, PlayId**  **CharacterId, PlayId-> AppearanceId**  **[Highest NF]: BCNF** |
| 8 | Production(ProductionId, Year, Season, StartDate, EndDate, PlayId) |
| Candidate Keys | ProductionId |
| Foreign Keys | [1] PlayId references Play(PlayId) |
| Nullable Attributes | Season, EndDate |
| Non-nullable Attributes | ProductionId, Year, StartDate, PlayId |
| Notes | [1] ProductionId is created as the surrogate primary key. |
| Normalization Analysis | [**FD]: ProductionId-> Year, Season, StartDate, EndDate, PlayId**  **[Highest NF]: BCNF** |
| 9 | StaffRole(StaffRoleId, Name, MemberId, ProductionId) |
| Candidate Keys | [1] RoleId |
| Foreign Keys | [1] MemberId references Member(MemberId), [2] ProductionId references Production(ProductionId) |
| Nullable Attributes |  |
| Non-nullable Attributes | RoleId, Name, MemberId, ProductionId |
| Notes | [1] RoleId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: StaffRoleId-> Name, MemberId, ProductionId**  **MemberId, ProductionId-> StaffRoleId, Name**  **[Highest NF]: BCNF** |
| 10 | Venue(VenueId, Name, AddressId) |
| Candidate Keys | [1] VenueId |
| Foreign Keys | [1] AddressId references Address(AddressId) |
| Nullable Attributes |  |
| Non-nullable Attributes | VenueId, Name, AddressId |
| Notes |  |
| Normalization Analysis | **[FD]: VenueId-> Name, AddressId**  **[Highest NF]: BCNF** |
| 11 | Act(ActId, ProductionId, MemberId, CharacterId) |
| Candidate Keys | [1] ActId, [2] ProductionId, MemberId, CharacterId |
| Foreign Keys | [1] ProductionId references Production(ProductionId), [2] MemberId references Member(MemberId), [2] CharacterId references Character(CharacterId) |
| Nullable Attributes |  |
| Non-nullable Attributes | ActId, ProductionId, MemberId, CharacterId |
| Notes | [1] ActId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: ActId-> ProductionId, MemberId, CharacterId**  **[Highest NF]: BCNF** |
| 12 | Show(ShowId, ProductionId, Date, StartTime, VenueId) |
| Candidate Keys | [1] ShowId |
| Foreign Keys | [1] ProductionId references Production(ProductionId), [2] VenueId references Venue(VenueId) |
| Nullable Attributes |  |
| Non-nullable Attributes | ShowId, ProductionId, Date, StartTime, VenueId |
| Notes | [1] ShowId is created as the surrogate primary key. |
| Normalization Analysis | [FD]:  [Highest NF]: |
| 13 | Category(CategoryId, Category) |
| Candidate Keys | [1] CategoryId, [2] Category |
| Foreign Keys |  |
| Nullable Attributes |  |
| Non-nullable Attributes | CategoryId, Category |
| Notes |  |
| Normalization Analysis | **[FD]: CategoryId-> Category**  **[Highest NF]: BCNF** |
| 14 | PlayCategory(PlayCategoryId, PlayId, CategoryId) |
| Candidate Keys | [1] PlayCategoryId, [2] PlayId, CategoryId |
| Foreign Keys | [1] PlayId references Play(PlayId), [2] CategoryId references Category(CategoryId) |
| Nullable Attributes |  |
| Non-nullable Attributes | PlayCategoryId, PlayId, CategoryId |
| Notes | [1] PlayCategoryId is created as the surrogate primary key. |
| Normalization Analysis | **[FD]: PlayCategoryId-> PlayId, CategoryId**  **PlayId, CategoryId-> PlayCategoryId**  **[Highest NF]: BCNF** |

(2) (25%) List the candidate keys and the highest normal forms for the following relations.

**[a] R(A,B,C,D) {A->D, AB->C}**

CK: AB -> ABCD

1NF: because A->D is partial dependency

**[b] R(A,B,C,D) {A->BD, AB->CD}**

CK: A -> ABCD

BCNF: L side is CK of relation

**[c] R(A,B,C,D) {A->D, D->B}**

CK: AC -> ABCD

1NF: because A is partial dependency

**[d] R(A,B,C,D) {A->D, D->BC}**

CK: A-> ABCD

2NF: D->BC Is transitive

**[e] R(A,B,C,D) {A->CD, D->AB}**

CK: [1]A-> ABCD [2]D-> ABCD

BCNF: L side is CK of relation

Q3.

(a) List all applicable functional dependencies. (Make reasonable assumptions if necessary.)

**GroupId-> GroupName,GroupEmail, ChairId, AdvisorFacId**

**ChairId-> ChairMajor**

**MemberId->MemberMajor**

**If R(A,B,C,D,E,F,G,H)**

**A-> B,C,D,H**

**D->E**

**F->G**

(b) What are the candidate keys?

**(GroupId, MemberId)-> R**

(c) What is the highest normal form? Why?

**Highest is 1NF: D-> E violates 2NF because partial dependency.**

(d) If the highest normal form is not BCNF, can you decompose the relation TD losslessly into component relations in BCNF while preserving functional dependencies? If yes, how. If no, why?

**Yes,**

Assume **R(A,B,C,D,E,F,G,H)**

R0(A,B,C,D,H) FD: A-> BCDH; **NF: BCNF**

R1(D,E) FD: D-> E; **NF: BCNF**

R3(F,G,) FD: F-> G; **NF: BCNF**

(Create lossless join) R4(A,F) **FD: NONE**

Q4.

R(A,B,C,D,E) {A->B, BC->D, D->AE}

1. Show all candidate keys.

**[1] BC, [2]AC, [3]CD**

1. What is the highest normal form (up to BCNF)? Why?

**1NF: There is at least 1 partial dependency**

1. If it is not in BCNF, can you losslessly decompose R into component relations in BCNF while preserving functional dependencies?

R0(A,B) FD: A->B; **NF: BCNF**

R1(B,C,D) FD: BC->D; **NF: BCNF**

R2(A,D,E) FD: D->AE; **NF: BCNF**

Q5.

It is known that for R(A,B,C,D):

1. R has exactly 14 superkeys.

2. B is not a prime attribute.

What are the candidate key(s)?

**CK: [1] A, [2]C, [3]D**

(2^4)-1=15 -1(B by itself) =14

A, AB,ABC,AC,AD,ABCD

D,ABD, BD

C,ACD,CD