Week 6

Part A

**DentalExam Table**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Patient  Num | Appointment  Date | Exam | Patient  Name | Patient  DOB | Dentist  Num | Dentist  Name | Clinic Name | Clinic  Address | Complete  Flag |
| 0127 | 03/09/2023 | Dental,  Periodontal | Sandra  Ho | 13/05/178 | 001 | Carl | Smile  Bright | George St | Y |
| “” | 20/12/2023 | Panoramic | “” | “” | “” | “” | Tooth Fairy | Thomas St | Y |
| “” | 10/10/2023 | Tooth decay,  Bitewing | “” | “” | “” | “” | Pearly  White | Beacon Ave |  |
| 0823 | 03/09/2023 | Orthodontal,  Periapical Cyst | Jeff  Daniels | 07/08/67 | 002 | Sonia | Smile  Bright | George St |  |
| “” | 03/10/2023 | Bitewing | “” | “” | “” | “” | Tooth Fairy | Thomas St | Y |
| 0146 | 04/10/2023 | Periodontal,  Recall | David  Falkner | 16/06/79 | 003 | Brad | Tooth Fairy | Thomas St | Y |
| 0239 | 05/06/2023 | Cleaning | Will  Bosworth | 23/03/98 | 004 | Carl | Tooth Fairy | Thomas St |  |
| 0749 | 09/11/2023 | X-Rays | Lynn  Fields | 17/07/03 | 005 | Brad | Pearly  White | Beacon Ave | Y |

**Primary Key = PatientNum,AppointmentDate,Exam**

Paste the corrected table below.

* Empty/unknown data has been filled with NULL
* “” are fixed by copying above cell value
* No Derived
* One composite Patient Name – split it to 2 columns patient first name and last name
* One multivalued attribute – Exam – should be fixed by copying them into multiple rows

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Patient  Num | Appointment  Date | Exam | Patient First  Name | Patient Last  Name | Patient  DOB | Dentist  Num | Dentist  Name | Clinic Name | Clinic  Address | Complete  Flag |
| 0127 | 03/09/2023 | Dental | Sandra | Ho | 13/05/178 | 001 | Carl | Smile Bright | George St | Y |
| 0127 | 03/09/2023 | Periodontal | Sandra | Ho | 13/05/178 | 001 | Carl | Smile Bright | George St | Y |
| 0127 | 20/12/2023 | Panoramic | Sandra | Ho | 13/05/178 | 001 | Carl | Tooth Fairy | Thomas St | Y |
| 0127 | 10/10/2023 | Tooth decay | Sandra | Ho | 13/05/178 | 001 | Carl | Pearly White | Beacon Ave | **NULL** |
| 0127 | 10/10/2023 | Bitewing | Sandra | Ho | 13/05/178 | 001 | Carl | Pearly White | Beacon Ave | **NULL** |
| 0823 | 03/09/2023 | Orthodontal | Jeff | Daniels | 07/08/67 | 002 | Sonia | Smile Bright | George St | **NULL** |
| 0823 | 03/09/2023 | Periapical Cyst | Jeff | Daniels | 07/08/67 | 002 | Sonia | Smile Bright | George St | **NULL** |
| 0823 | 03/10/2023 | Bitewing | Jeff | Daniels | 07/08/67 | 002 | Sonia | Tooth Fairy | Thomas St | Y |
| 0146 | 04/10/2023 | Periodontal | David | Falkner | 16/06/79 | 003 | Brad | Tooth Fairy | Thomas St | Y |
| 0146 | 04/10/2023 | Recall | David | Falkner | 16/06/79 | 003 | Brad | Tooth Fairy | Thomas St | Y |
| 0239 | 05/06/2023 | Cleaning | Will | Bosworth | 23/03/98 | 004 | Carl | Tooth Fairy | Thomas St | **NULL** |
| 0749 | 09/11/2023 | X-Rays | Lynn | Fields | 17/07/03 | 005 | Brad | Pearly White | Beacon Ave | Y |

1. It is in 1 NF now.

2. relational model for the single relation DentalExam

**DentalExam** (**PatientNum, AppointmentDate, Exam**, PatientFirstName, PatientLastName, PatientDOB, DentistNum, DentistName, ClinicName, ClinicAddress, CompleteFlag)

3. FDs

* Each patient has a unique number, so PatientNum can determine the patient's first name, last name, and date of birth.
* Each dentist has a unique number, which can be used to identify their name.
* Clinic name can determine clinic address
* Business Rule – "A patient may have more than one exam requested at any appointment.", each specific exam has a unique status for completion, indicated by CompleteFlag. So, PatientNum, AppointmentDate, Exam determines DentistNum, ClinicName and completed flag.

PatientNum **🡪** PatientFirstName, PatientLastName, PatientDOB, DentistNum, DentistName

DentistNum 🡪 DentistName

ClinicName 🡪 ClinicAddress

PatientNum, AppointmentDate, Exam 🡪 ClinicName, CompleteFlag

4. 1NF to 2NF

We need to remove partial dependencies.

* To have Partial Dependency you must have composite primary key – In this case YES
* Partial dependency is a dependency where non key is fully dependent on only one part of the composite primary key.

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| **Relation Before normalization –** | **DentalExam** (**PatientNum, AppointmentDate, Exam**, PatientFirstName, PatientLastName, PatientDOB, DentistNum, DentistName, ClinicName, ClinicAddress, CompleteFlag) |
| **Functional Dependencies** | PatientNum **🡪** PatientFirstName, PatientLastName, PatientDOB, DentistNum, DentistName  PatientNum, AppointmentDate, Exam 🡪 ClinicName, CompleteFlag |
| **ONF to 1 NF** | * PatientFirstName, PatientLastName, PatientDOB, DentistNum only dependent on part of composite PK which is PatientNum. So lets split to match functional dependencies -   **DentalExam** (**PatientNum, AppointmentDate, Exam**, ClinicName, ClinicAddress, CompleteFlag)  **Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum, DentistName) |

5. 2NF to 3NF

Fix transitive dependencies

* A non-key is dependent on another non-key, but not in the selected primary key

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| --- | --- |
| **Relation In 2NF** | **DentalExam** (**PatientNum, AppointmentDate, Exam**, ClinicName, ClinicAddress, CompleteFlag)  **Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum, DentistName) |
| **Functional Dependencies** | DentistNum 🡪 DentistName  ClinicName 🡪 ClinicAddress |
| **2NF to 3NF** | * DentistName is only determined by DentistNum. So, lets fix transitive dependency in Patient by breaking to 2 relations. Now DentistNum is a FK or Patient relation.   **Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum\*)  **Dentist** (**DentistNum**, DentistName)   * ClinicAddress is only determined by clinic name. So, lets fix transitive dependency in DentalExam by breaking to 2 relations. Now, ClinicName is a FK of DentalExam relation.   **DentalExam** (**PatientNum, AppointmentDate, Exam**, CompleteFlag, ClinicName\*)  **Clinic** (**ClinicName**, ClinicAddress)   * Now clinic name is not a good PK, names are not usually unique enough to treat as PKs and it may be lengthy in some scenarios. So, lets introduce a surrogate PK for this – ClinicNum   **DentalExam** (**PatientNum, AppointmentDate, Exam**, CompleteFlag, ClinicNum\*)  **Clinic** (**ClinicNum,** ClinicName, ClinicAddress) |
| **3 NF relations** | **Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum\*)  **Dentist** (**DentistNum**, DentistName)  **DentalExam** (**PatientNum, AppointmentDate, Exam**, CompleteFlag, ClinicNum\*)  **Clinic** (**ClinicNum,** ClinicName, ClinicAddress) |

6. 3NF to BCNF

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| **Relation In 3NF** | **Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum\*)  **Dentist** (**DentistNum**, DentistName)  **DentalExam** (**PatientNum, AppointmentDate, Exam**, CompleteFlag, ClinicNum\*)  **Clinic** (**ClinicNum,** ClinicName, ClinicAddress) |
| **Functional Dependencies** | None applicable for this. |
| **3NF to BCNF** | We need consider BC dependencies. To have one we need to have composite PK and only one relation here has composite PK.  **DentalExam** (**PatientNum, AppointmentDate, Exam**, CompleteFlag, ClinicNum\*)  None of the non-keys here determining parts of composite PK. So, it is already in BCNF. |
| **BCNF relations** | **Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum\*)  **Dentist** (**DentistNum**, DentistName)  **DentalExam** (**PatientNum, AppointmentDate, Exam**, CompleteFlag, ClinicNum\*)  **Clinic** (**ClinicNum,** ClinicName, ClinicAddress) |

7.

No, It is not up to BCNF now.

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| **Relation** | **DentalExam (PatientNum, AppointmentDate, Exam, ClinicNum\*, CompleteFlag, AppointmentNum)** |
| **Functional Dependencies** | **PatientNum, AppointmentDate, Exam 🡪 ClinicNum\*, CompleteFlag**  **AppointmentNum 🡪 AppointmentDate** |
| **3NF to BCNF** | We need to consider BC dependencies. To have one we need to have composite PK and this relation here has a composite PK.  **DentalExam (PatientNum, AppointmentDate, Exam, ClinicNum\*, CompleteFlag, AppointmentNum)**  And here we have part of composite primary is fully dependent on a non key. Because AppointmentNum is determining AppointmentDate which is part of composite PK.  2 steps to fix this –  Step1 – Swap more unique non key with less unique part of the primary key  **DentalExam (PatientNum, AppointmentNum, Exam, ClinicNum\*, CompleteFlag, AppointmentDate)**  Step 2 – Fix partial dependency.  Now you have FDs like,  **AppointmentNum 🡪 AppointmentDate**  **PatientNum, AppointmentNum, Exam 🡪 ClinicNum\*, CompleteFlag, AppointmentDate**  So, now there is a partial dependency. Step1 took us to 1 NF. So, fix it by breaking the relation into 2.  **DentalExam** (**PatientNum, AppointmentNum, Exam**, ClinicNum\*, CompleteFlag)  **AppointmentNum** (**AppointmentNum**, AppointmentDate)  It is now in BCNF. |
| **BCNF relations** | **Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum\*)  **Dentist** (**DentistNum**, DentistName)  **Clinic** (**ClinicNum,** ClinicName, ClinicAddress)  **DentalExam** (**PatientNum, AppointmentNum, Exam**, CompleteFlag, ClinicNum\*)  **AppointmentNum** (**AppointmentNum**, AppointmentDate) |

8. Final relational model with RI statements

**Patient** (**PatientNum**,PatientFirstName, PatientLastName, PatientDOB, DentistNum\*)

DentistNum REFERENCES Dentist(DentistNum)

**Dentist** (**DentistNum**, DentistName)

**Clinic** (**ClinicNum,** ClinicName, ClinicAddress)

**DentalExam** (**PatientNum, AppointmentNum, Exam**, CompleteFlag, ClinicNum\*)

ClinicNum REFERENCES Clinic(ClinicNum)

**AppointmentNum** (**AppointmentNum**, AppointmentDate)

**Part B**