Tutorial 9 – Top Down Normalisation

WITH SUGGESTED SOLUTIONS

Answers to Review Questions

1. **Explain the following terms:**

a. *Data redundancy:* storing the same fact multiple times

b. *Update anomaly:* when data is stored redundantly, updates (i.e. insert, update, delete operations) can result in loss of data consistency. A problem that arises with un-normalised relations, e.g: customer_orders(<u>custid, ordid</u>, custname, orddate, …) – updating customer information involves updating all rows that include orders for the customer

c. *Derived attribute:* attribute that can be calculated or derived using some business rule from other attributes

d. *Functional dependency:* X->Y where the value of X gives the value of Y

e. *Partial Functional dependency:* situation where the dependent attribute depends on part of the determinant, e.g. X,Y -> Z ; Z depends only on X, not on Y

f. *Determinant:* left-hand side of a functional dependency

g. *BCNF:* Boyce-Codd NF – is stronger than 3NF

h. *Top-down design:* develop ERD -> translate into relations -> check for BCNF; normalise if needed

i. *Bottom up design:* form relations by collecting attributes from forms, etc. and proceed to normalise by decomposition until all relations are in BCNF

j. *Loss-less decomposition*: decomposition that preserves functional dependencies, allowing the original relations to be reconstituted by joins

k. *Define and explain BCNF:* all determinants must be relation keys

l. *How can BCNF be violated in relations that are in 3NF:* BCNF can be violated if the relation has overlapping keys

m. *How can keys be derived from functional dependencies:* form a set of all determinants to get a superkey and reduce this set by substitution (i.e. using FDs) until irreducible subsets are produced – these are relation keys

Solutions to Problems and Exercises

Top-Down Design

1. Write a list of all the functional dependencies (FDs) that exist for the New Oriental Hospital case study. Use the case study description and the forms in figures 1-5 to decide what are the business rules, and write these as FDs.

    Functional dependencies (for first part of case study)

    -   *PatID → patFname, patLname, patAge, patGender, patDOB, patAddress, patPhone, patRegDate, CompID, compname, compAddress, compPhone, compRep*
    -   *CompID → compname, compAddress, compPhone, compRep*
    -   *PatCID, PatID → wardNo, patAdmDate, patDisDate, patSymp, patDiag, staIdDoc, staIdNurse*
    -   *DrugNo → DrugName, DrugDesc, DrugDosg, DrugMethod, DrugPrice*
    -   *PatCID, PatID, DrugNo → AmtPerDay, Sdate, Edate*
    -   *staffID → staffName*

    Functional Dependencies (for the second part of case study)

    -   *StaffID → First Name, Last Name, Address, Gender, Phone, DOB, Salary Scale, Job Type, Current Salary, Start Date, Pager, Position, Speciality*
    -   *Ward No → Ward Capacity, Ward Name, Ward Extension, Ward Location*
    -   *Ward No, StaffID, Start_Date → Shift, End_Date*
    -   *BillNo → Date, PatientChartID, PatientID*
    -   *PatientID → InsuranceCompanyID*
    -   *PatientChartID, PatientID → BillNO*
    -   *PatientChartID, PatientID, DrugNo → DrugAmount*
    -   *BillNo, DrugNo → DrugAmount*
    -   *MiscNo → Description, Price*
    -   *DrugNo → DrugName, Price*
    -   *PatientChartID, PatientID, MiscNo → MiscAmount*
    -   *BillNo, MiscNo → MiscAmount*

2. Check the list of relations from tutorial8 solution with the list of functional dependencies to justify whether each relation is in 1NF, 2NF, 3NF, BCNF.

    DRUG(drugNo, drugDesc, drugDosage, drugMethod, drugName, drugUnitPrice)

    FD: drugNo-> drugDesc, drugDosage, drugMethod, drugName, drugUnitPrice

    1NF – attributes are atomic
    2NF – no partial dependencies on the key drugNo (single attribute key)
    3NF – no interdependencies between non-key attributes
    Highest Normal Form = BCNF, determinant drugNo is the key

    STAFF (staffID, staFName, staLName, staAddress, staGender, staPhone,

staDOB, staSScale, staJType, staCSalary, staSDate, DocPager, DocSpecialty, NursePosition, StaffType)

FD: staffID-> staFName, staLName, staAddress, staGender, staPhone, staDOB, staSScale, staCSalary, staJType, staSDate, DocPager, DocSpecialty, NursePosition, StaffType

1NF – attributes are atomic
2NF – no partial dependencies on the key staffID (single attribute key)
3NF – no interdependencies between non-key attributes
Single key and single non-key always indicates BCNF

WARD(WardNo, WardName, WardLoc, WardExt, WardCap)

FD: WardNo → WardName, WardLoc, WardExt, WardCap

1NF – attributes are atomic
2NF – no partial dependencies on the key WardNo (single attribute key)
3NF – no interdependencies between non-key attributes
Highest Normal Form = BCNF, determinant WardNo is the key

NURSEWARD(staIDNurse, WardNo, Startdate, Shift)

FD: staIDNurse, WardNo, Startdate → Shift

1NF – attributes are atomic
2NF – no partial dependencies on the key staIDNurse,WardNo,Startdate
3NF – no interdependencies between non-key attributes

Highest Normal Form = BCNF, determinant staIDNurse,WardNo,Startdate is the key

COMPANY (compID, compName, compAddress, compPh, compRep)

FD: compID->compName, compAddress, compPh, compRep

1NF – attributes are atomic
2NF – no partial dependencies on the key compID (single attribute key)
3NF – no interdependencies between non-key attributes
Highest Normal Form = BCNF, determinant compID is the key

PATIENT(patID, patFname, patLname, patDOB, patAge, patAddress, patPhone, patRegDate, CompID)

FD: patID->patFname, patLname, patDOB, patAge, patAddress, patPhone, patRegDate, CompID
1NF – attributes are atomic
2NF – no partial dependencies on the key patID (single attribute key)
3NF – no interdependencies between non-key attributes
Highest Normal Form = BCNF, determinant patID is the key

PATIENTCHART (patCID, patID, patAdmDate, patDischDate, patSymp, patDiag, staffIDDoc, staffIDNurse, wardNo)

FD: patCID, patID->patAdmDate, patDischDate, patSymp, patDiag, staffIDDoc, staffIDNurse, wardNo

1NF – attributes are atomic
2NF – no partial dependencies on the key patCID, patID
3NF – no interdependencies between non-key attributes
Highest Normal Form = BCNF, determinant patCID, patID is the key

PRESCRIBEDDRUG ((drugNo, patCID), patID, drugAmtPDay, Sdate, Edate)

FD: (drugNo, patCID), patID-> drugAmtPDay, Sdate, Edate

1NF – attributes are atomic
2NF – no partial dependencies on the key drugNo, patCID, patID
3NF – no interdependencies between non-key attributes

Highest Normal Form = BCNF, determinant drugNo, patCID, patID is the key

MCHARGES(miscNo, miscDesc, MiscPrice)

FD: miscNo → miscDesc, MiscPrice

1NF – attributes are atomic
2NF – no partial dependencies on the key miscNo (single attribute key)
3NF – no interdependencies between non-key attributes

Highest Normal Form = BCNF, determinant miscNo is the key

MISCITEMUSED(miscNo,(patCID, patID), miscAmt)

FD: miscNO, patCID, patID → miscAmt
1NF – attributes are atomic
2NF – no partial dependencies on the key miscNO, patCID, patID
3NF – no interdependencies between non-key attributes
Highest Normal Form = BCNF, determinant miscNO, patCID, patID is the key

BILL(BillNo, BillDate, (patCID, patID))

FD: BillNo → BillDate, patCID, patID
patCID, patID → BillNo
1NF – attributes are atomic
2NF – no partial dependencies on the key BillNo
3NF – no interdependencies between non-key attributes