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Terakreditasi BAN PT A (Unggul) | QS STARS RATING SYSTEM 2019 | JABEE | CPA AUSTRALIA | ICAEW CHARTERED ACCOUNTANTS

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DATABASE DESIGN & MANAGEMENT

SI10317

PROGRAM STUDI SISTEM INFORMASI

UIVERRSITAS TARUMANAGARA

Course Schedule

1 Entity Relationship Modeling dan Alternative ER Notation – Appendix C

2 Exercises

3. Enhanced Entity–Relationship Modeling

4. Exercises

5. Normalization dan Exerises

6. Advanded Normalization dan Exercises

7. Reiew and the *DreamHome* Case Study

8. Presentasi Project UTS

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Course Schedule

9. Methodology—Conceptual Database Design
10. Methodology—Logical Database Design
11. Exercises: Case Study Appendix A, B1, B2
12. Presentasi Project: Case Study
13. Query Processing
14. Distributed DBMSs—Concepts and Design
15. Replication and Mobile Databases
16. Presentasi Project UAS

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More on Functional Dependencies

- **The complete set of functional dependencies for a given relation can be very large.**
- **Important to find an approach that can reduce the set to a manageable size.**

Inference Rules for Functional Dependencies

- **Need to identify a set of functional dependencies (represented as X) for a relation that is smaller than the complete set of functional dependencies (represented as Y) for that relation and has the property that every functional dependency in Y is implied by the functional dependencies in X.**

Inference Rules for Functional Dependencies

- **For example, functional dependencies A → B and B → C in a relation implies that the functional dependency A → C also holds in that relation. A → C is an example of a transitive functional dependency and was discussed previously lectures.**

Inference Rules for Functional Dependencies

- **Let A, B, and C be subsets of the attributes of the relation R. Armstrong's axioms are as follows:**

(1) **Reflexivity:** If B is a subset of A, then $A \rightarrow B$

(2) **Augmentation:** If $A \rightarrow B$, then $A,C \rightarrow B,C$

(3) **Transitivity:** If $A \rightarrow B$ and $B \rightarrow C$, then $A \rightarrow C$

Inference Rules for Functional Dependencies

- **Further rules can be derived from the first three rules that simplify the practical task of computing X+ (X+ dibaca closure dari X). Let D be another subset of the attributes of relation R, then:**

(4) **Self-determination:** $A \rightarrow A$

(5) **Decomposition:** If $A \rightarrow B,C$, then $A \rightarrow B$ and $A \rightarrow C$

(6) **Union:** If $A \rightarrow B$ and $A \rightarrow C$, then $A \rightarrow B,C$

(7) **Composition:** If $A \rightarrow B$ and $C \rightarrow D$ then $A,C \rightarrow B,D$

Minimal Sets of Functional Dependencies

- Every dependency in X has a single attribute on its right-hand side.
- We cannot replace any dependency $A \rightarrow B$ in X with dependency $C \rightarrow B$, where C is a proper subset of A, and still have a set of dependencies that is equivalent to X.
- We cannot remove any dependency from X and still have a set of dependencies that is equivalent to X.

Contoh pada relasi StaffBranch untuk menghasilkan ketergantungan fungsional menerapkan tiga kondisi tsb:

- staffNo → sName
- staffNo → position
- staffNo → salary
- staffNo → branchNo
- staffNo → bAddress
- branchNo → bAddress
- bAddress → branchNo
- branchNo, position → salary
- bAddress, position → salary

StaffBranch

staffNo	sName	position	salary	branchNo	bAddress
SL21	John White	Manager	30000	B005	22 Deer Rd, London
SG37	Ann Beech	Assistant	12000	B003	163 Main St, Glasgow
SG14	David Ford	Supervisor	18000	B003	163 Main St, Glasgow
SA9	Mary Howe	Assistant	9000	B007	16 Argyll St, Aberdeen
SG5	Susan Brand	Manager	24000	B003	163 Main St, Glasgow
SL41	Julie Lee	Assistant	9000	B005	22 Deer Rd, London

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Boyce–Codd Normal Form (BCNF)

- **Based on functional dependencies that take into account all candidate keys in a relation, however BCNF also has additional constraints compared with the general definition of 3NF.**

- **Boyce–Codd normal form (BCNF)**
  - **A relation is in BCNF if and only if every determinant is a candidate key.**

Boyce–Codd Normal Form (BCNF)

- **Difference between 3NF and BCNF is that for a functional dependency A → B, 3NF allows this dependency in a relation if B is a primary-key attribute and A is not a candidate key. Whereas, BCNF insists that for this dependency to remain in a relation, A must be a candidate key.**

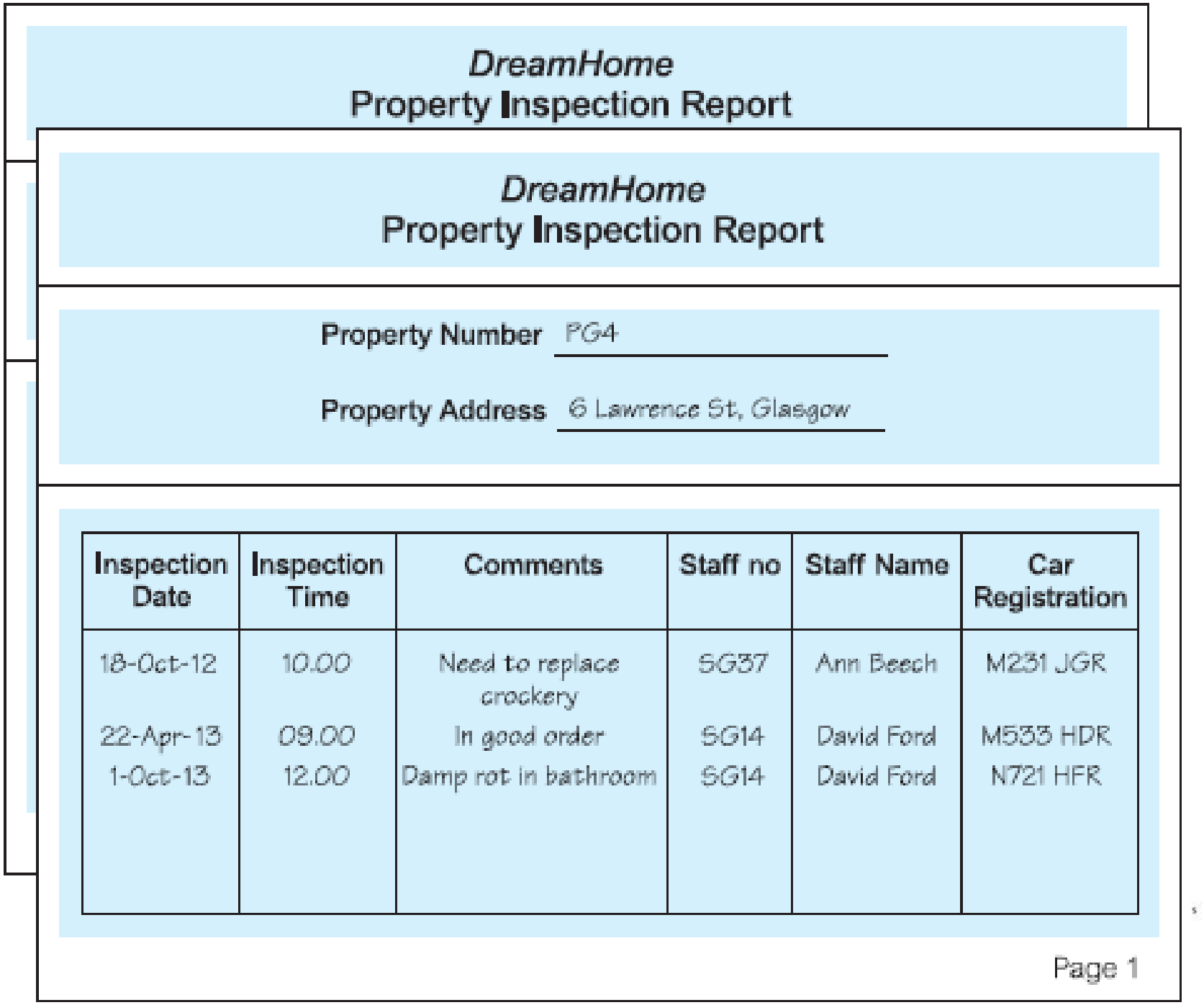
- **Every relation in BCNF is also in 3NF. However, a relation in 3NF is not necessarily in BCNF.**

Boyce–Codd Normal Form (BCNF)

- **Violation of BCNF is quite rare.**

- **The potential to violate BCNF may occur in a relation that:**
  - **contains two (or more) composite candidate keys;**
  - **the candidate keys overlap, that is have at least one attribute in common.**

Review of Normalization (UNF to BCNF)



DreamHome
Property Inspection Report

DreamHome
Property Inspection Report

Property Number PG4

Property Address 6 Lawrence St, Glasgow

Inspection Date	Inspection Time	Comments	Staff no	Staff Name	Car Registration
18-Oct-12	10.00	Need to replace crockery	SG37	Ann Beech	M231 JGR
22-Apr-13	09.00	In good order	SG14	David Ford	M533 HDR
1-Oct-13	12.00	Damp rot in bathroom	SG14	David Ford	N721 HFR

Page 1

Review of Normalization (UNF to BCNF)

StaffPropertyInspection

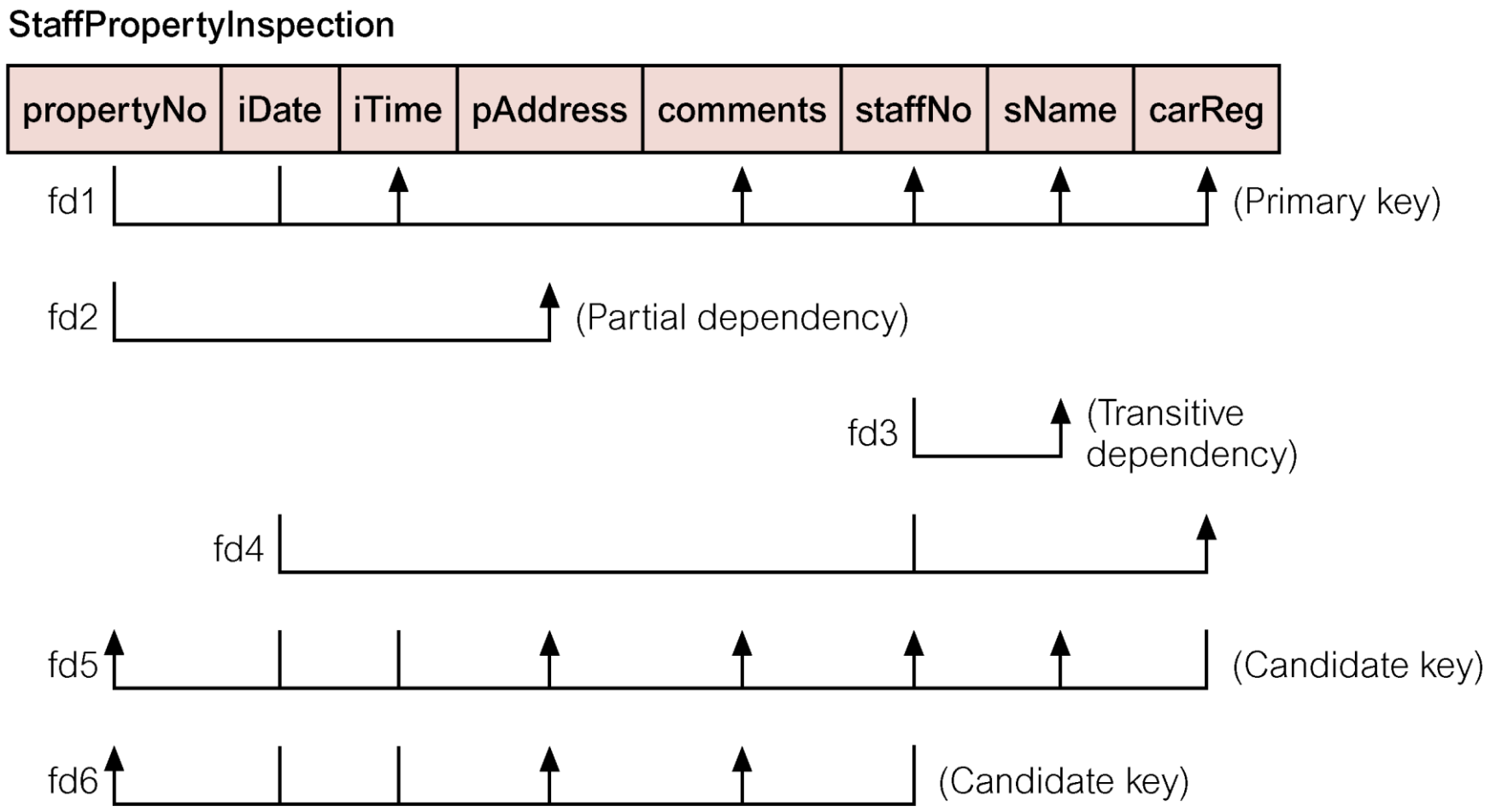
propertyNo	pAddress	iDate	iTime	comments	staffNo	sName	carReg
PG4	6 Lawrence St, Glasgow	18-Oct-12 22-Apr-13 1-Oct-13	10.00 09.00 12.00	Need to replace crockery In good order Damp rot in bathroom	SG37 SG14 SG14	Ann Beech David Ford David Ford	M231 JGR M533 HDR N721 HFR
PG16	5 Novar Dr, Glasgow	22-Apr-13 24-Oct-13	13.00 14.00	Replace living room carpet Good condition	SG14 SG37	David Ford Ann Beech	M533 HDR N721 HFR

1NF

StaffPropertyInspection

propertyNo	iDate	iTime	pAddress	comments	staffNo	sName	carReg
PG4	18-Oct-12	10.00	6 Lawrence St, Glasgow	Need to replace crockery	SG37	Ann Beech	M231 JGR
PG4	22-Apr-13	09.00	6 Lawrence St, Glasgow	In good order	SG14	David Ford	M533 HDR
PG4	1-Oct-13	12.00	6 Lawrence St, Glasgow	Damp rot in bathroom	SG14	David Ford	N721 HFR
PG16	22-Apr-13	13.00	5 Novar Dr, Glasgow	Replace living room carpet	SG14	David Ford	M533 HDR
PG16	24-Oct-13	14.00	5 Novar Dr, Glasgow	Good condition	SG37	Ann Beech	N721 HFR

Review of Normalization (UNF to BCNF)



1NF – 2NF

fd1	propertyNo, iDate → iTime, comments, staffNo, sName, carReg	(Primary key)
fd2	propertyNo → pAddress	(Partial dependency)
fd3	staffNo → sName	(Transitive dependency)
fd4	staffNo, iDate → carReg	
fd5	carReg, iDate, iTime → propertyNo, pAddress, comments, staffNo, sName	(Candidate key)
fd6	staffNo, iDate, iTime → propertyNo, pAddress, comments	(Candidate key)

2NF

Property (propertyNo, pAddress)
PropertyInspection (propertyNo, iDate, iTime, comments, staffNo, sName, carReg)

2NF – 3NF

Property Relation

fd2 propertyNo → pAddress

PropertyInspection Relation

fd1 propertyNo, iDate → iTime, comments, staffNo, sName, carReg

fd3 staffNo → sName

fd4 staffNo, iDate → carReg

fd5′ carReg, iDate, iTime → propertyNo, comments, staffNo, sName

fd6′ staffNo, iDate, iTime → propertyNo, comments

2NF – 3NF

To transform the PropertyInspection relation into 3NF, we remove the transitive dependency (staffNo → sName) by creating two new relations called Staff and PropertyInspect with the form:

Staff	(staffNo, sName)
PropertyInspect	(propertyNo, iDate, iTime, comments, staffNo, carReg)

3NF

Property	(propertyNo, pAddress)
Staff	(staffNo, sName)
PropertyInspect	(propertyNo, iDate, iTime, comments, staffNo, carReg)

3NF - BCNF

Examine the Property, Staff, and PropertyInspect relations to determine whether they are in BCNF. Recall that a relation is in BCNF if every determinant of a relation is a candidate key. Therefore, to test for CNF, we simply identify all the determinants and make sure they are candidate keys. The functional dependencies for the Property, Staff, and PropertyInspect relations are as follows:

3NF - BCNF

Property Relation

fd2 propertyNo → pAddress

Staff Relation

fd3 staffNo → sName

PropertyInspect Relation

fd1′ propertyNo, iDate → iTime, comments, staffNo, carReg

fd4 staffNo, iDate → carReg

fd5′ carReg, iDate, iTime → propertyNo, comments, staffNo

fd6′ staffNo, iDate, iTime → propertyNo, comments

3NF - BCNF

Relation Properti dan Staf sudah dalam bentuk BCNF.

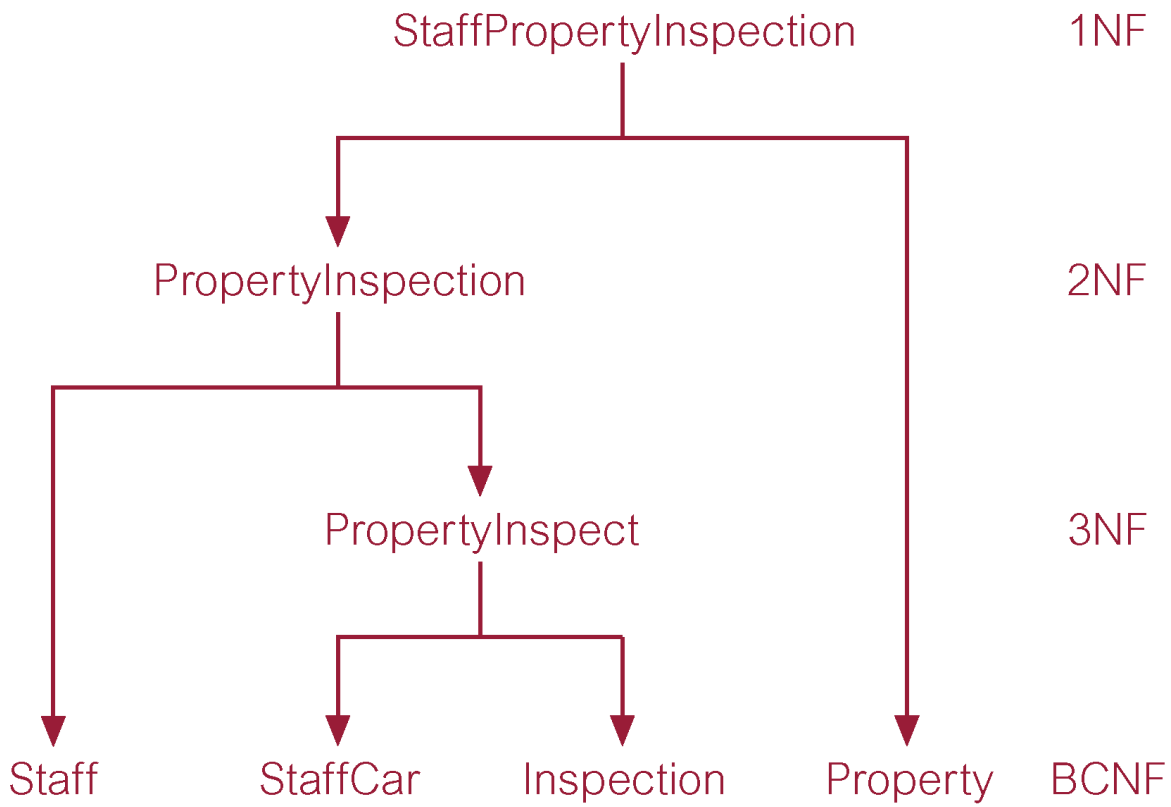
Relation PropertyInspect belum dalam BCNF karena adanya determinan (staffNo, iDate), yang bukan kunci kandidat. Ini dapat mengakibatkan relation PropertyInspect mengalami anomali pembaruan. Misalnya, untuk mengganti mobil yang dialokasikan dengan nomor staf SG14 pada 22-Apr-03, kita harus memperbarui dua baris yang berbeda.

3NF - BCNF

Untuk mengubah relasi PropertyInspect menjadi BCNF, kita harus menghapus ketergantungan tersebut dengan membuat dua relasi baru yaitu StaffCar dan Inspection menjadi seperti berikut:

StaffCar (staffNo, iDate, carReg)
Inspection (propertyNo, iDate, iTime, comments, staffNo)

Review of Normalization (UNF to BCNF)



BCNF

Property (propertyNo, pAddress)

Staff (staffNo, sName)

Inspection (propertyNo, iDate, iTime, comments, staffNo)

StaffCar (staffNo, iDate, carReg)

Fourth Normal Form (4NF)

- **Although BCNF removes anomalies due to functional dependencies, another type of dependency called a multi-valued dependency (MVD) can also cause data redundancy.**

- **Possible existence of multi-valued dependencies in a relation is due to 1NF and can result in data redundancy.**

Fourth Normal Form (4NF)

- **Multi-valued Dependency (MVD)**
  - **Dependency between attributes (for example, A, B, and C) in a relation, such that for each value of A there is a set of values for B and a set of values for C. However, the set of values for B and C are independent of each other.**

Fourth Normal Form (4NF)

- **MVD between attributes A, B, and C in a relation using the following notation:**

  A –>> B

  A –>> C

Fourth Normal Form (4NF)

- **A multi-valued dependency can be further defined as being trivial or nontrivial.**

  A MVD A –>> B in relation R is defined as being trivial if (a) B is a subset of A *or* (b) A ∪ B = R.

  A MVD is defined as being nontrivial if neither (a) nor (b) are satisfied.

  A trivial MVD does not specify a constraint on a relation, while a nontrivial MVD does specify a constraint.

Fourth Normal Form (4NF)

- **Defined as a relation that is in Boyce-Codd Normal Form and contains no nontrivial multi-valued dependencies.**

4NF - Example

BranchStaffOwner

branchNo	sName	oName
B003	Ann Beech	Carol Farrel
B003	David Ford	Carol Farrel
B003	Ann Beech	Tina Murphy
B003	David Ford	Tina Murphy

BranchStaff

branchNo	sName
B003	Ann Beech
B003	David Ford

BranchOwner

branchNo	oName
B003	Carol Farrel
B003	Tina Murphy

Fifth Normal Form (5NF)

- **A relation decompose into two relations must have the lossless-join property, which ensures that no spurious tuples are generated when relations are reunited through a natural join operation.**

- **However, there are requirements to decompose a relation into more than two relations. Although rare, these cases are managed by join dependency and fifth normal form (5NF).**

Fifth Normal Form (5NF)

- **Defined as a relation that has no join dependency.**

5NF - Example

(a) **PropertyItemSupplier** (Illegal state)

propertyNo	itemDescription	supplierNo
PG4	Bed	S1
PG4	Chair	S2
PG16	Bed	S2

When this tuple is added to relation.

(b) **PropertyItemSupplier** (Legal state)

propertyNo	itemDescription	supplierNo
PG4	Bed	S1
PG4	Chair	S2
PG16	Bed	S2
PG4	Bed	S2

This new tuple must also be added to exist in any legal state of the relation.

5NF - Example

PropertyItem

propertyNo	itemDescription
PG4	Bed
PG4	Chair
PG16	Bed

ItemSupplier

itemDescription	supplierNo
Bed	S1
Chair	S2
Bed	S2

PropertySupplier

propertyNo	supplierNo
PG4	S1
PG4	S2
PG16	S2

Exercises

14.8 On completion of Exercise 13.16 examine the 3NF relations created to represent the attributes shown in the relation displaying employee contract data for an agency called *Instant Cover* in Figure 13.20. Determine whether these relations are also in BCNF. If not, transform the relations that do not conform into BCNF.

Figure 13.20
Table displaying sample data for the *Instant Cover* agency.

NIN	contractNo	hours	eName	hNo	hLoc
1135	C1024	16	Smith J	H25	East Kilbride
1057	C1024	24	Hocine D	H25	East Kilbride
1068	C1025	28	White T	H4	Glasgow
1135	C1025	15	Smith J	H4	Glasgow

Exercises

14.9 The relation shown in Figure 14.11 lists members of staff (staffName) working in a given ward (wardName) and patients (patientName) allocated to a given ward. There is no relationship between members of staff and patients in each ward. In this example assume that staff name (staffName) uniquely identifies each member of staff and that the patient name (patientName) uniquely identifies each patient.

Figure 14.11
The WardStaffPatient relation.

wardName	staffName	patientName
Pediatrics	Kim Jones	Claire Johnson
Pediatrics	Kim Jones	Brian White
Pediatrics	Stephen Ball	Claire Johnson
Pediatrics	Stephen Ball	Brian White

(a) Describe why the relation shown in Figure 14.11 is not in 4NF.
(b) The relation shown in Figure 14.11 is susceptible to update anomalies. Provide examples of insertion, deletion, and update anomalies.
(c) Describe and illustrate the process of normalizing the relation shown in Figure 14.11 to 4NF.

Exercises

14.10 The relation shown in Figure 14.12 describes hospitals (hospitalName) that require certain items (itemDescription), which are supplied by suppliers (supplierNo) to the hospitals (hospitalName). Furthermore, whenever a hospital (h) requires a certain item (i) and a supplier (s) supplies that item (i) and the supplier (s) already supplies *at least one* item to that hospital (h), then the supplier (s) will also supply the required item (i) to the hospital (h). In this example, assume that a description of an item (itemDescription) uniquely identifies each type of item.

(a) Describe why the relation shown in Figure 14.12 is not in 5NF.
(b) Describe and illustrate the process of normalizing the relation shown in Figure 14.12 to 5NF.

Figure 14.12
The HospitalItemSupplier relation.

hospitalName	itemDescription	supplierNo
Western General	Antiseptic Wipes	S1
Western General	Paper Towels	S2
Yorkhill	Antiseptic Wipes	S2
Western General	Antiseptic Wipes	S2

Thank You

Reference: Database Systems A Practical Approach to Design, Implementation, and Management Fourth Edition.

Thomas M. Connolly and Carolyn E. Begg

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