پوهنتون کابل

پوهنحی کمپیوترساینس

Introduction to Database and Data Models

Lectures 08, 10

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Introduction to Database and Data Models - Relational Model

08

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2010

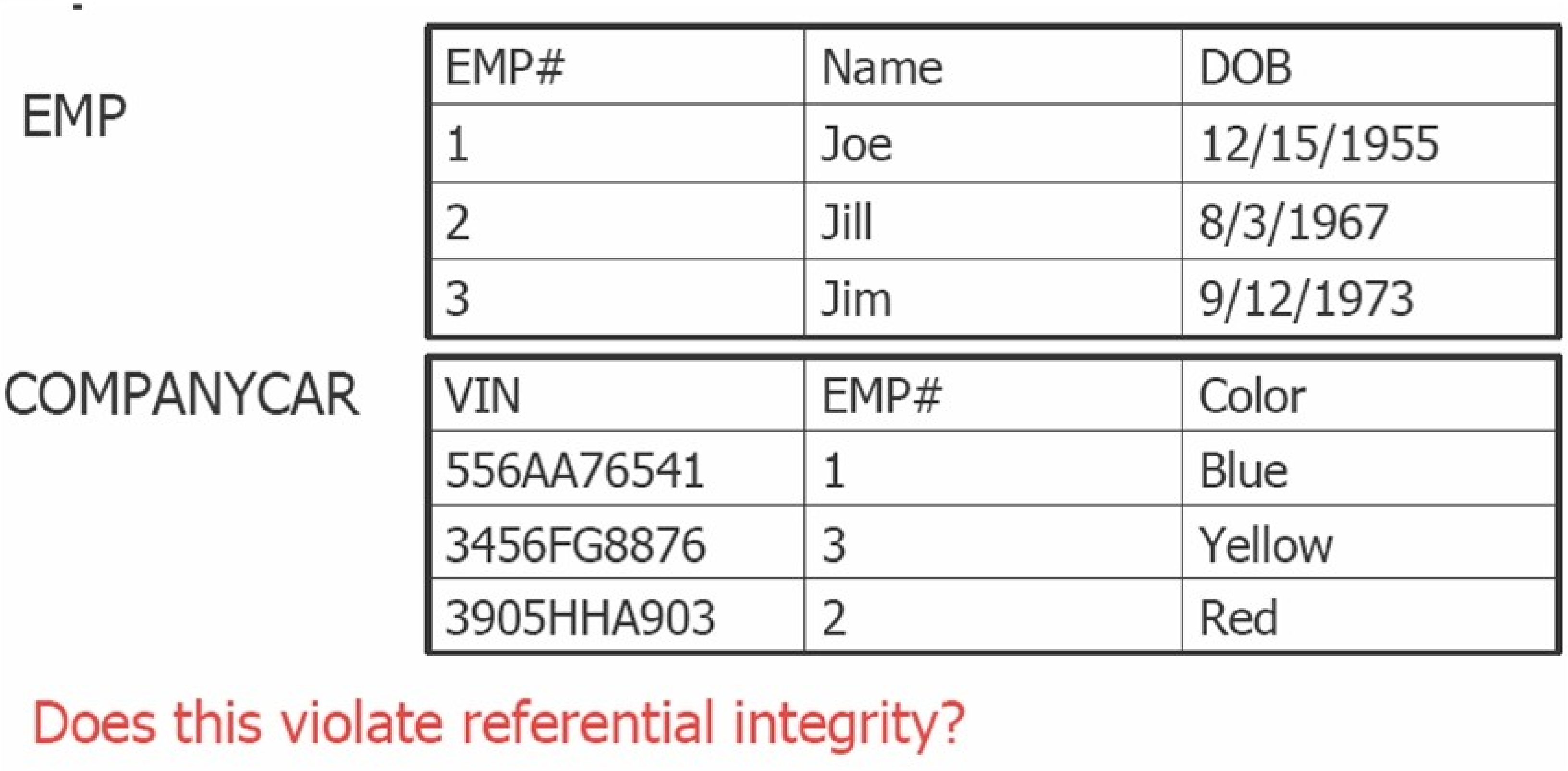
Referential Integrity Constraint (RIC)

- Def. A foreign key’s values must appear in the parent relation’s primary key! Example:
  - EMP(<u>EMP#</u>, Name, DOB, …)
  - COMPANYCAR(VIN, *EMP#*, Color, …)
- The value found in *EMP#* in COMPANYCAR, must also appear in <u>EMP#</u> in EMP

RIC

- Referential Integrity – the requirement that the value placed in a Foreign Key must already exist in the table you are linking to (parent table)
- Most DBMSs enforce this automatically

RIC Example



EMP

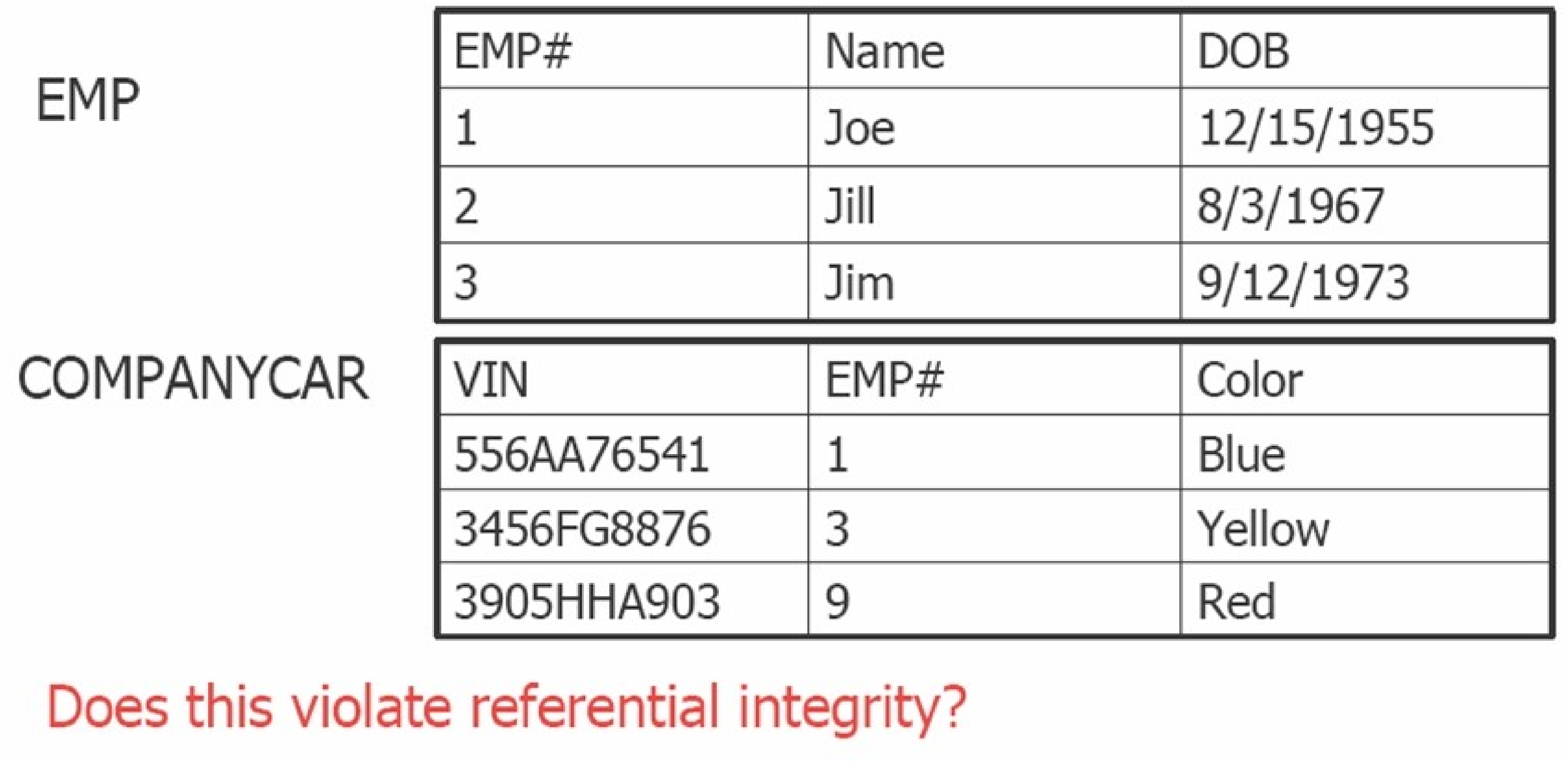
EMP#	Name	DOB
1	Joe	12/15/1955
2	Jill	8/3/1967
3	Jim	9/12/1973

COMPANYCAR

VIN	EMP#	Color
556AA76541	1	Blue
3456FG8876	3	Yellow
3905HHA903	2	Red

Does this violate referential integrity?

RIC Example



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COMPANYCAR

VIN	EMP#	Color
556AA76541	1	Blue
3456FG8876	3	Yellow
3905HHA903	9	Red

Does this violate referential integrity?

RIC Example

STUDENT(NID, Name, Major, *Building*, *Room*)

DORMROOM(Building, Room, Phone)

- In this case: the values for Building and Room must be presented in "DORMROOM" Prior to being used in "STUDENT"

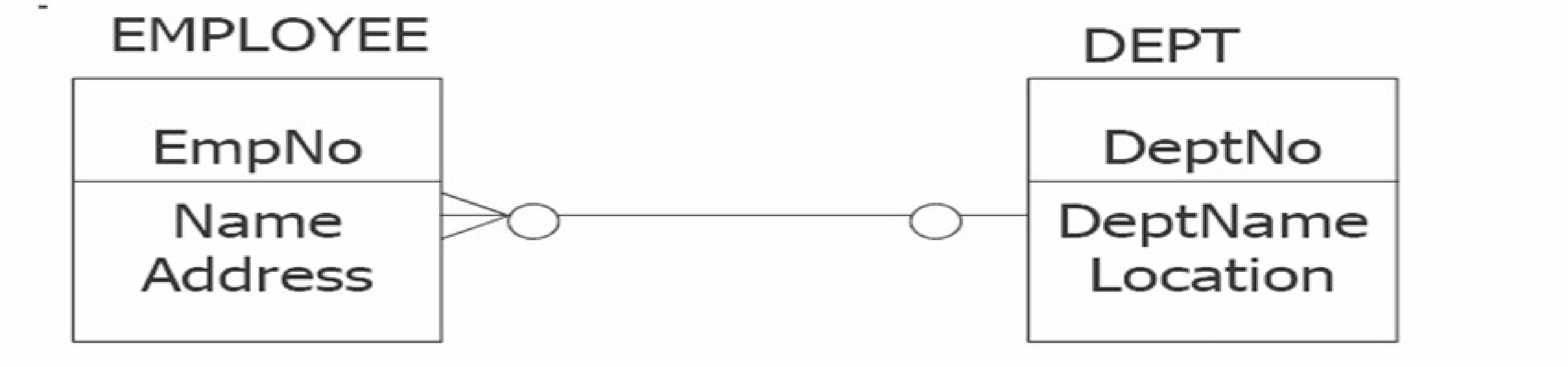
Special Cases

- Case 1: Strong entities
- Case 2: Weak entities
- Case 3: Super/Sub Class structures

Case 1: Strong Entities

- Most common case
- Create a relation for each entity that contain the entity’s attributes
- Identify the Primary key (PK)
- Add any necessary foreign keys to indicate relationships between entities

Strong Entity Example

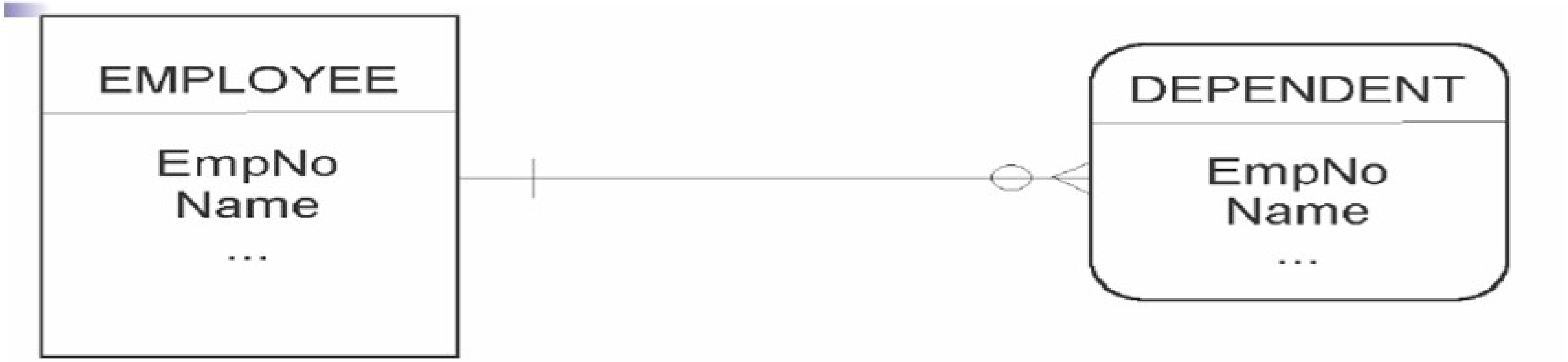


EMPLOYEE(EmpNo, Name, Address)
DEPT(DeptNo, DeptName, Location)

Case 2: Weak Entities

- An entity where an instance must be associated with another (strong) entity-instance in order to exist
  - Existence of weak entity instance depend on a strong entity instance
- Example: EMPLOYEES and DEPENDENTS
  - Dependents can not exist without a corresponding employee

Weak Entity Example

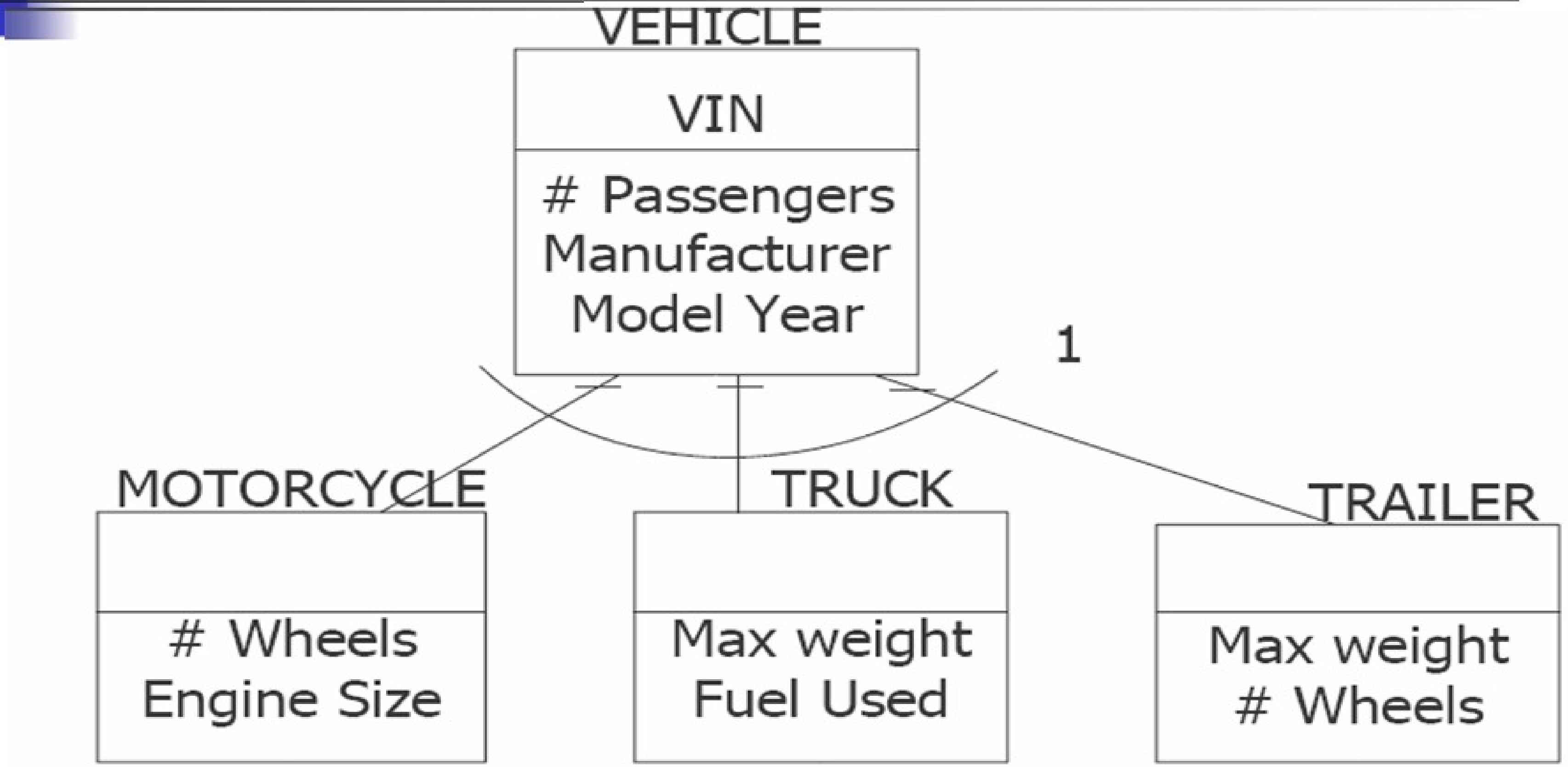


EMPLOYEE (EmpNo, Name,…)
DEPENDENT (EmpNo, Name,…)

Case 3: Super/Sub Class Structures

- Each entity becomes a relation
- All entities have the same primary key
- The primary key is shown in the parent relation (ERD)
- Child entities inherit attributes & relationships from parent entities
- Can be Top-Bottom or Bottom-Up

Super/Sub Class Structures



Super/Sub Class Structures

- VEHICLE(VIN, #Passengers, Manufacturer, Model, Year)

- MOTORCYCLE(*VIN*, #Wheels, EngineSize)
- TRUCK(*VIN*, MaxWeight, FuelUsed)
- TRAILER(*VIN*, MaxWeight, #Wheels)

Functional Dependency

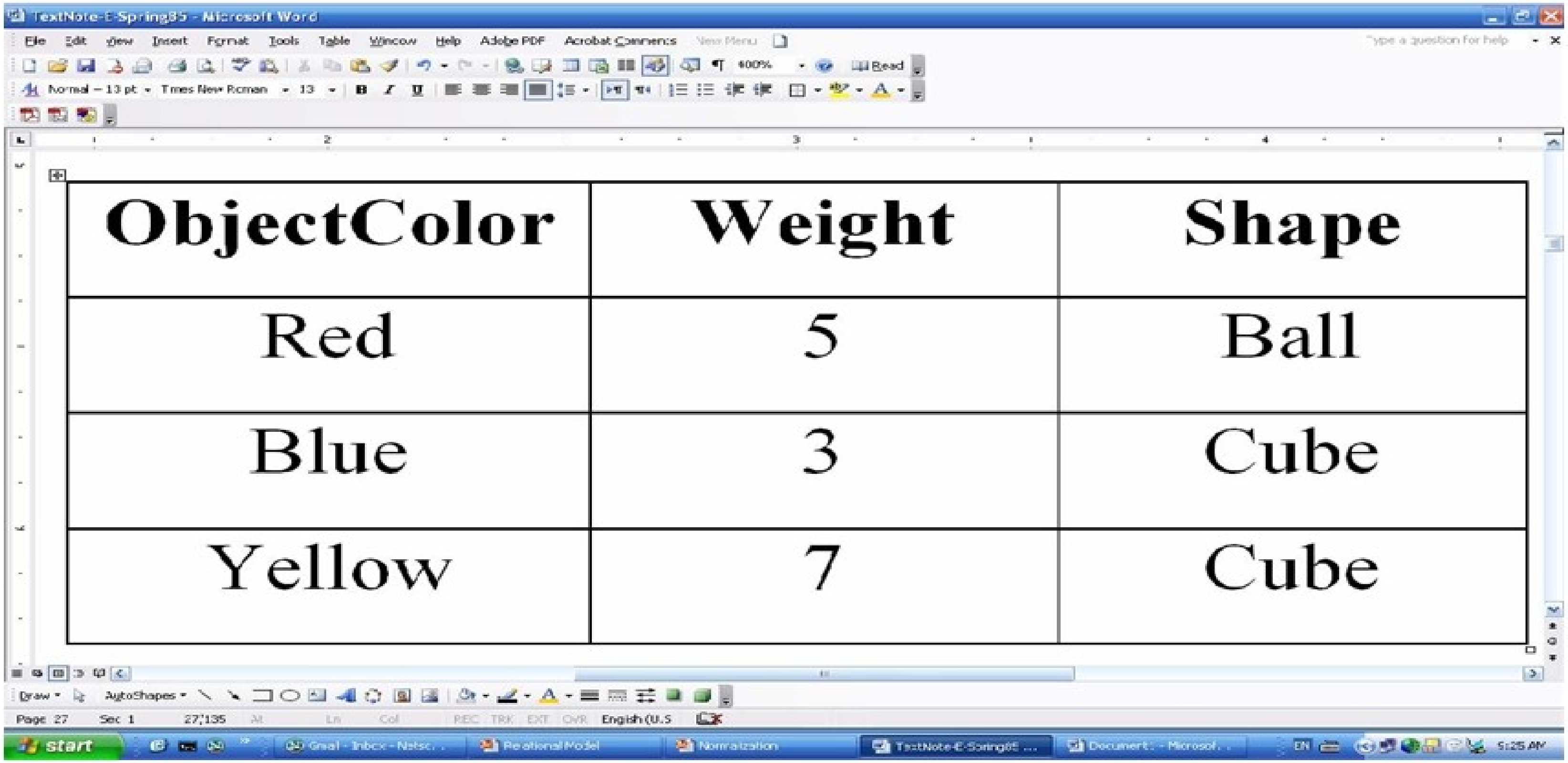
- Foreign keys are used to show the relationships between entities
- Functional dependencies are used to show the relationships between attributes within a relation

Functional Dependency

- Def: if an attribute (A) determines the value of another attribute (B), then ‘A’ functionally determines the value of ‘B’
- Notation: A → B

Determinant

Example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File Edit View Insert Format Tools Table Window Help Adobe PDF Acrobat Comments
Type a question for help
Normal + 13 pt Times New Roman 13
Draw AutoShapes
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start

ObjectColor	Weight	Shape
Red	5	Ball
Blue	3	Cube
Yellow	7	Cube

Rules for Functional Dependencies

- A set of attributes can form a functional dependency: A,B,C → D
- Dependencies like A → B, A → C, and A → D can be abbreviated as

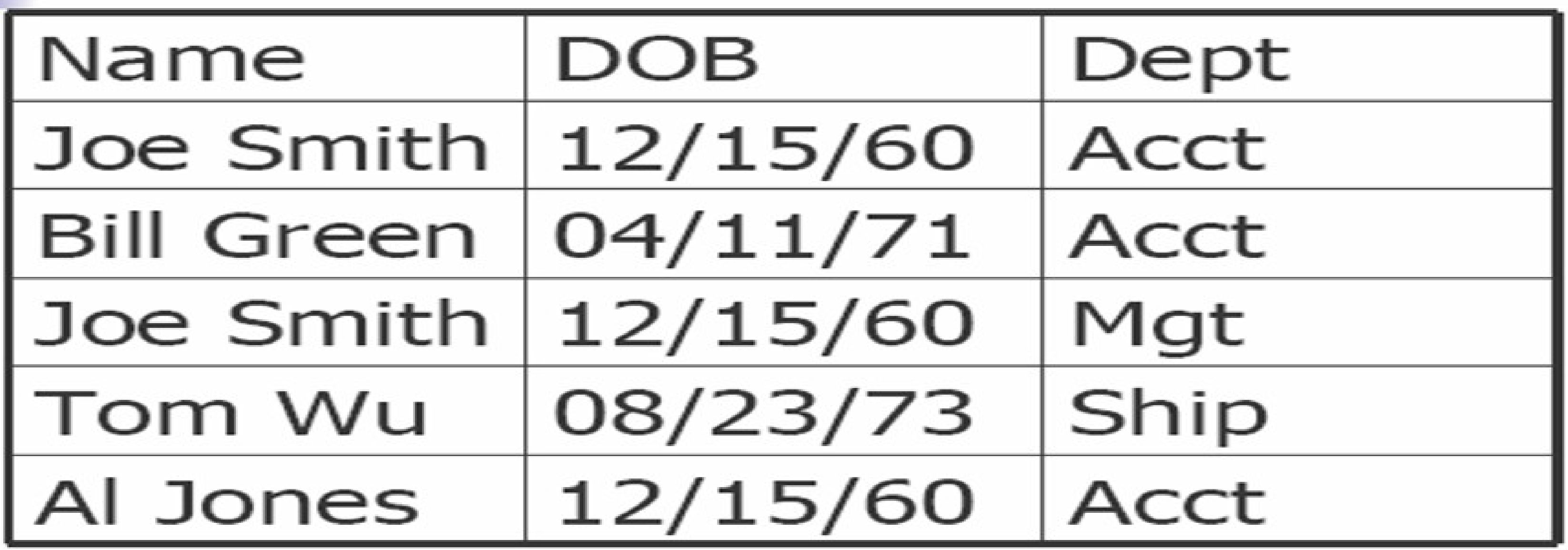
A → B C D

Rules for Functional Dependencies

Transitivity

- Given A → B and B → C in a relation, then A → C
- This rule allows you to derive new functional dependencies from the existing ones

Functional Dependency Example



Name	DOB	Dept
Joe Smith	12/15/60	Acct
Bill Green	04/11/71	Acct
Joe Smith	12/15/60	Mgt
Tom Wu	08/23/73	Ship
Al Jones	12/15/60	Acct

What functional dependencies exist in this relation?

Determining Keys

- In many cases, the primary key and candidate keys are going to be determinants
- Look for the functional dependencies
- Look for determinants or sets of determinants that cover all of the non-determinant attributes in a relation

Introduction to Database and Data Models - Normalization

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In This Chapter

- What normalization is and what role it plays in database design
- Normal forms: 1NF, 2NF, 3NF, BCNF, (4NF, 5NF, DKNF)
- How normal forms transformed from lower normal forms to higher normal forms?

In This Chapter cont…

- That normalization and E-R modeling are used concurrently to produce a good database design
- That some situations require de-normalization to generate information efficiently

Review

Relations:

- Two dimensional data (tables)
- Cells must be single value
- Column names must be unique
- Columns must have the same data type
- Order of rows and columns is not relevant

Normalization

- Def. Decomposing relations to avoid anomalies when inserting, updating or deleting data
- Normalization Steps:
  - Every determinant in a relation must be a candidate key
  - If not, split relation into two or more new relations
- Also serves to reduce redundancy of data

Normalization and Database Design

- Normalization should be part of the design process
- E-R Diagram provides macro view
- Normalization provides micro view of entities
  - Focuses on characteristics of specific entities
  - May yield additional entities

Anomalies

- Redundancy: information repeated in multiple locations
- Update: failure to change all instances of a specific value
- Delete: delete data and lose other values as a side effect problem

Anomalies cont…

- Insert:
  - need to add data about multiple “themes”
  - adding rows may force users to add information about another

General Rule of Thumb:

a table should not pertain to more than one entity type

Example

EMPLOYEE 2

Emp_ID	Name	DepN	Salary	Course	Date
100	Margaret	Marketing	48000	SPSS	6/19/200X
100	Margaret	Marketing	48000	Surveys	10/7/200X
140	Alan	Account	52000	Tax Acc	12/8/200X
110	Chris	Info Sys	43000	SPSS	1/12/200X
110	Chris	Info Sys	43000	C++	4/22/200X
190	Lone	Finance	55000	C++	
150	Susan	Marketing	42000	SPSS	6/19/200X
150	Susan	Marketing	42000	Java	8/12/200X

Example Cont…

- Question - Is this a relation?
- Answer - Yes: unique rows

- Question - What's the primary key?
- Answer - Composite:
  Emp_ID, Course_Title

Anomalies in this Table

- Insertion - can’t enter a new employee without having the employee take a class
- Deletion - if we remove employee 140, we loose information about the existence of the “Tax Acc” course
- Modification - giving a salary increase to employee 100 forces us to update multiple records

Anomalies in this Table Cont…

Why do these anomalies exist?

- Because we’ve combined two themes (entity types) into one relation
- This results in duplication, and an unnecessary dependency between the entities

Normalization

- Addresses these anomalies by removing data redundancy
- We will cover the following types of normalization:
  - First Normal Form 1NF
  - Second Normal Form 2NF
  - Third Normal Form 3NF
  - Boyce-Codd Normal Form (BCNF)

Normalization Cont…

- There are several other forms of normalization which will not cover in this course:
  - Fourth Normal Form 4NF
  - Fifth Normal Form 5NF
  - Domain Key Normal Form (DKNF)

First Normal Form – 1NF

The table must meet the definition of a relation:

- No repeating groups
- Each cell hold a single value
- An attribute's entries are all of the same kind
- No two identical rows
- Unique names for each column
- Irrelevant order of rows and columns

First Normal Form Cont...

- If a table meets the criteria of being a relation, it is directly in 1NF

1NF:

- The simplest normal form
- Does little to reduce anomalies
- Is a required precursor to other normal forms

Second Normal Form – 2NF

- A relation is in 2NF if it is in 1NF and all of its non-key attributes are dependent on all parts of the PK or PK consists of only one attribute
  - No partial-dependency
- Non-key attributes: all attributes that are not PK or part of the PK
- Dependent: Attributes appear on the right side of a functional dependency

Second Normal Form Cont…

- This form really affects composite keys

- Composite Keys: Keys that are made up of multiple attributes

Example:

- DORMROOM(Building, Room, Phone)

Third Normal Form – 3NF

- A relation is in 3NF if it is already in 2NF and contains no transitive dependencies

- Transitive Dependency: an attribute is functionally dependent on another non-key attribute

Boyce-Codd Normal Form (BCNF)

In BCNF, every determinant in a relation should be a candidate key

- Determinant is an attribute whose value determines other values in a record
- 3NF table with one candidate key is already in BCNF

Denormalization

- Sometimes, normalizing a table make more work or cause problems
- In such cases, the following problems may occur:
  - Additional processes need to access data
  - Ambiguous data appear
  - Unknown data appear
  - Data entry become difficult
  - etc

Denormalization

- In such case, we can keep a table de-normalized
- Normalization is one of many database design goals
- Normalized table requirements
  - Additional processing
  - Loss of system speed

Denormalization

- Normalization purity is difficult to sustain due to conflict in:
  - Design efficiency
  - Information requirements
  - Processing

Denormalization

- Therefore, we can keep a table in its de-normalized form
- This is shown in the following example:

STUDENT(ID, Name, Street, District, Province)

- The STUDENT table is kept de-normalized

De-normalized Table Defects

- Data updates less efficient
- Indexing more cumbersome
- No simple strategies for creating views

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