

Database Systems

Chapter # 5

The Relational Data Model and Relational Database Constraints

eman.shahid@nu.edu.pk

Chapter Outlines

- **Relational Model Concepts**
- **Relational Model Constraints**
- **Relational Database Schemas**
- **Update Operations**
- **Transactions**
- **Dealing with Constraint Violations**

Relational Model Concepts

- Relational model: represents the database as a collection of relations.
 - Relation: Table of values
 - Tuple represent facts: Row
 - Column Header: Attribute
 - Domain: Data type describing the types of values that can appear in each column.
- The model was first proposed by Dr. E.F. Codd of IBM Research in 1970 in the following paper: "A Relational Model for Large Shared Data Banks," Communications of the ACM, June 1970

STUDENT

Name	Student_number	Class	Major
Smith	17	1	CS
Brown	8	2	CS

COURSE

Course_name	Course_number	Credit_hours	Department
Intro to Computer Science	CS1310	4	CS
Data Structures	CS3320	4	CS
Discrete Mathematics	MATH2410	3	MATH
Database	CS3380	3	CS

SECTION

Section_identifier	Course_number	Semester	Year	Instructor
85	MATH2410	Fall	07	King
92	CS1310	Fall	07	Anderson
102	CS3320	Spring	08	Knuth
112	MATH2410	Fall	08	Chang
119	CS1310	Fall	08	Anderson
135	CS3380	Fall	08	Stone

GRADE_REPORT

Student_number	Section_identifier	Grade
17	112	B
17	119	C
8	85	A
8	92	A
8	102	B
8	135	A

PREREQUISITE

Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

Figure 1.2

A database that stores student and course information.

Relational Model Concepts

- **Domain:**
 - Set of atomic values
- **Represents data type, and format.**
 - For example, the PAK_phone_numbers may have a format: (ddd)-ddddddddd where each d is a decimal digit.
 - Dates have various formats such as month, date, year or yyyy-mm-dd, or dd mm,yyyy etc.
 - Names: set of character strings that represent names of persons.
 - Grade_point_averages: floating-point number between 0 and 4.
 - Employee_ages: integer value between 15 and 80.

Formal Definition of Relation

- A relation schema.
 - denoted by $R(A_1, A_2, \dots, A_n)$,
 - made up of a relation name R
 - Contains a list of attributes, A_1, A_2, \dots, A_n .
 - Each attribute A_i is the name of a role played by some domain D in the relation schema R . D is called the domain of A_i and is denoted by $\text{dom}(A_i)$.
- Degree (or arity) of a relation: number of attributes/columns
- Tuple t is a row:
 - Ordered/ unordered list of n values $t = \langle v_1, v_2, \dots, v_n \rangle$
 - each value v_i , $1 \leq i \leq n$, is an element of $\text{dom}(A_i)$ or is a special NULL value.

Example of a Relation

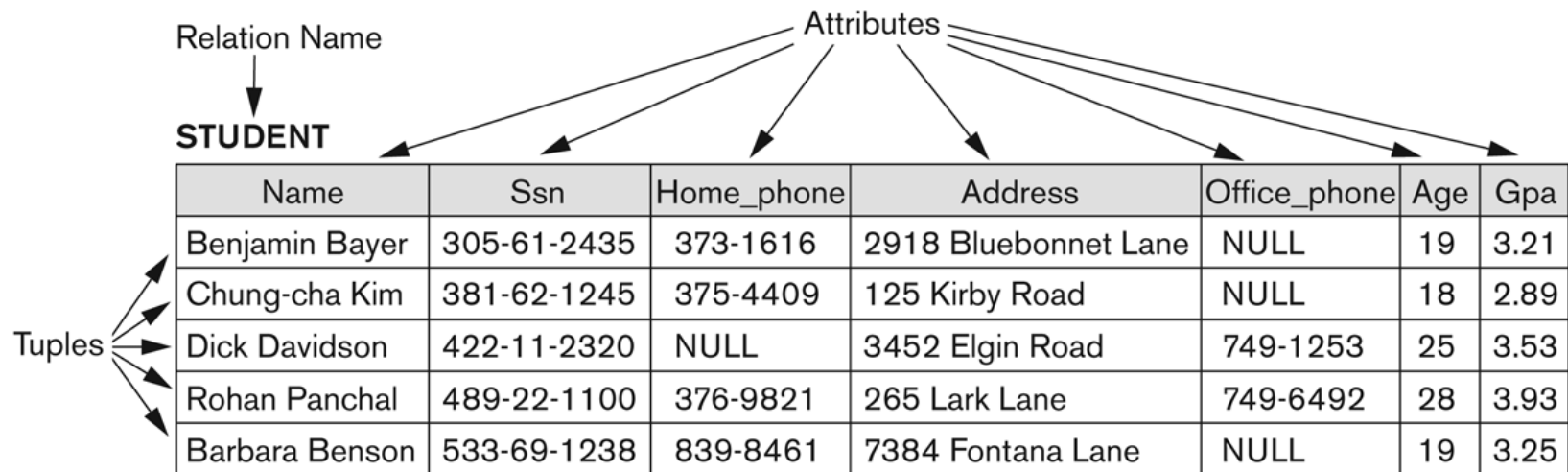


Figure 5.1

The attributes and tuples of a relation STUDENT.

Degree of Relation?

Relation Definition Using set theory

- A relation (or relation state) $r(R)$ is a mathematical relation of degree n on the domains $\text{dom}(A_1)$, $\text{dom}(A_2)$, ... , $\text{dom}(A_n)$, which is a subset of the Cartesian product (denoted by \times) of the domains that define
 - $R: r(R) \subseteq (\text{dom}(A_1) \times \text{dom}(A_2) \times \dots \times \text{dom}(A_n))$
- **Cartesian product:** All possible combinations of values from the underlying domains.
- **Total number of tuples in the Cartesian product:**
 $|\text{dom}(A_1)| \times |\text{dom}(A_2)| \times \dots \times |\text{dom}(A_n)|$

Relational Model Concepts

- Relation State: The state of the whole database will correspond to the states of all its relations at a particular point in time.

<u>Informal Terms</u>	<u>Formal Terms</u>
Table	Relation
Column	Attribute/Domain
Row	Tuple
Values in a column	Domain
Table Definition	Schema of a Relation
Populated Table	Extension

Characteristics of Relations

- Relation: set of tuples.
 - Ordering of Tuples in a Relation: tuples in a relation do not have any particular order.

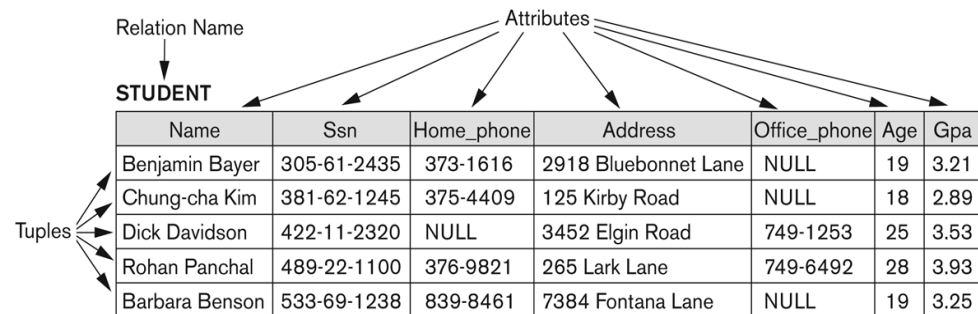


Figure 5.1

The attributes and tuples of a relation STUDENT.

Figure 5.2

The relation STUDENT from Figure 5.1 with a different order of tuples.

STUDENT						
Name	Ssn	Home_phone	Address	Office_phone	Age	Gpa
Dick Davidson	422-11-2320	NULL	3452 Elgin Road	(817)749-1253	25	3.53
Barbara Benson	533-69-1238	(817)839-8461	7384 Fontana Lane	NULL	19	3.25
Rohan Panchal	489-22-1100	(817)376-9821	265 Lark Lane	(817)749-6492	28	3.93
Chung-cha Kim	381-62-1245	(817)375-4409	125 Kirby Road	NULL	18	2.89
Benjamin Bayer	305-61-2435	(817)373-1616	2918 Bluebonnet Lane	NULL	19	3.21

- Hence, the relation displayed in Figure 5.2 is considered identical to the one shown in Figure 5.1

Characteristics of Relations

- Ordering of Attributes is not important, because the attribute name appears with its value.

$t = \langle (\text{Name}, \text{Dick Davidson}), (\text{Ssn}, 422-11-2320), (\text{Home_phone}, \text{NULL}), (\text{Address}, 3452 \text{ Elgin Road}), (\text{Office_phone}, (817) 749-1253), (\text{Age}, 25), (\text{Gpa}, 3.53) \rangle$

$t = \langle (\text{Address}, 3452 \text{ Elgin Road}), (\text{Name}, \text{Dick Davidson}), (\text{Ssn}, 422-11-2320), (\text{Age}, 25), (\text{Office_phone}, (817) 749-1253), (\text{Gpa}, 3.53), (\text{Home_phone}, \text{NULL}) \rangle$

Figure 5.3

Two identical tuples when the order of attributes and values is not part of relation definition.

- When the attribute name and value are included together in a tuple, it is known as self-describing data.

Characteristics of Relations

- **Values and NULLs in the Tuples:**
 - Each value in a tuple is an atomic value.
 - composite and multivalued attributes are not allowed
- **NULL values:** values of attributes that may be unknown or may not apply to a tuple.

Relation Name

↓

STUDENT

Attributes

↙

↙

↙

↘

↘

↘

Name	Ssn	Home_phone	Address	Office_phone	Age	Gpa
Benjamin Bayer	305-61-2435	373-1616	2918 Bluebonnet Lane	NULL	19	3.21
Chung-cha Kim	381-62-1245	375-4409	125 Kirby Road	NULL	18	2.89
Dick Davidson	422-11-2320	NULL	3452 Elgin Road	749-1253	25	3.53
Rohan Panchal	489-22-1100	376-9821	265 Lark Lane	749-6492	28	3.93
Barbara Benson	533-69-1238	839-8461	7384 Fontana Lane	NULL	19	3.25

Tuples

↗

↗

↗

↘

↘

Figure 5.1

The attributes and tuples of a relation STUDENT.

Relational Model Constraints

- **Constraints:** set of rules or restrictions. They are used to maintain the quality of data.
- Constraints ensure that the data insertion, updating, and other processes have to be performed in such a way that data integrity is not affected.
- Constraints are used to guard against accidental damage to the database.

Relational Model Constraints

- Schema Based Constraints
 - Divided into three main categories.
 - **Key** constraints
 - **Entity integrity** constraints
 - **Referential integrity** constraints
- Key Constraints: used to identify an entity within its entity set uniquely.
 - Primary Key
 - Candidate Key
 - Super Key
 - Foreign Key

Key Constraints

- **Primary key:** uniquely identifies each record in a table. It must have unique values and cannot have null values.
- **FOREIGN KEY:** Foreign keys are the columns of a table that points to the primary key of another table. They act as a cross-reference between tables.
- **Candidate Key:** A super key with no redundant attribute is known as candidate key.
- **Super Key:** A super key is a set of one or more columns (attributes) to uniquely identify rows in a table.

Primary Key Examples

STUDENT_DETAILS

Roll_no	Name	Marks
101	X	34
102	Y	46
103	Z	94

Primary Key

Candidate Key Example

Emp_Id	Emp_Number	Emp_Name
E01	2264	Steve
E22	2278	David
E23	2288	Joseph
E45	2290	Robert

The candidate keys we have selected are:

{Emp_Id}

{Emp_Number}

Super Key Example

Emp_Id	Emp_Number	Emp_Name
E01	2264	Steve
E22	2278	David
E23	2288	Joseph
E45	2290	Robert

How many super keys the above table can have?

1. {Emp_Id, Emp_Number}
2. {Emp_Id, Emp_Name}
3. {Emp_Id, Emp_Number, Emp_Name}
4. {Emp_Number, Emp_Name}

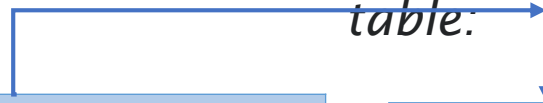
Foreign Key Example

Course_enrollment table:

Course_Id	Stu_Id
C01	101
C02	102
C03	101
C05	102
C06	103
C07	102

Student table:

<u>Stu_Id</u>	Stu_Name	Stu_Age
101	Chaitanya	22
102	Arya	26
103	Bran	25
104	Jon	21



Entity Integrity Constraint

- **Entity integrity constraint:** primary key value can't be null.
- A table can contain a null value other than the primary key field.

EMPLOYEE

EMP_ID	EMP_NAME	SALARY
123	Jack	30000
142	Harry	60000
164	John	20000
	Jackson	27000

Not allowed as primary key can't contain a NULL value

Referential integrity constraint

- **Referential integrity constraint** is specified between two tables.
 - Foreign key in Relation 1 refers to the Primary Key of Relation 2.
- Used to specify a relationship among tuples in two relations: the referencing relation and the referenced relation.
- A referential integrity constraint can be displayed in a relational database schema as a directed arc from R1.FK to R2.PK

Relational Model Constraints

- **Domain Constraints:**

- Value of each attribute must be an atomic value from the domain $\text{dom}(A)$.
- The data type of domain includes string, character, integer, time, date, currency, etc. The value of the attribute must be available in the corresponding domain.

ID	NAME	SEMENSTER	AGE
1000	Tom	1 st	17
1001	Johnson	2 nd	24
1002	Leonardo	5 th	21
1003	Kate	3 rd	19
1004	Morgan	8 th	A

Not allowed. Because AGE is an integer attribute

Relational Databases and Relational Database Schemas



- **Relational Database Schema:**
 - A set S of relation schemas that belong to the same database.
 - S is the name of the whole **database schema**
 - $S = \{R_1, R_2, \dots, R_n\}$
 - R_1, R_2, \dots, R_n are the names of the individual **relation schemas** within the database S .

Schema Diagram for the COMPANY Relational Database Schema

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
-------	----------------	---------	----------------

DEPT_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
----------------	------------------

PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------

WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
-------------	------------	-------

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
-------------	-----------------------	-----	-------	--------------

Figure 5.5
Schema diagram for
the COMPANY
relational database
schema.

Displaying a relational database schema and its constraints

- Each relation schema can be displayed as a row of attribute names
- The name of the relation is written above the attribute names
- The primary key attribute (or attributes) will be underlined
- A foreign key (referential integrity) constraints is displayed as a directed arc (arrow) from the foreign key attributes to the referenced table
 - Can also point the primary key of the referenced relation for clarity

Figure 5.7
Referential integrity constraints displayed on the COMPANY relational database schema.

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
-------	----------------	---------	----------------

DEPT_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
----------------	------------------

PROJECT

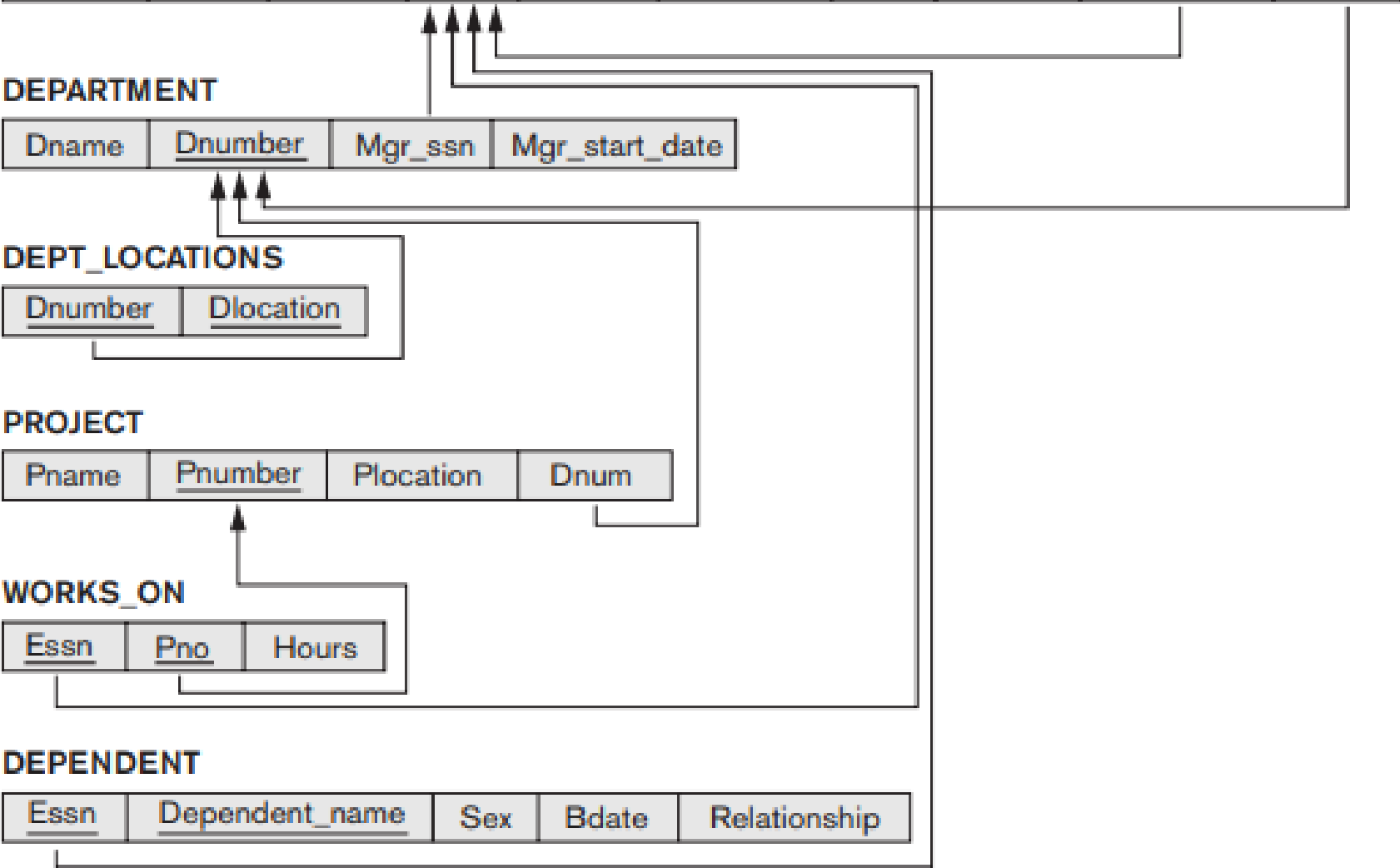
Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------

WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
-------------	------------	-------

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
-------------	-----------------------	-----	-------	--------------



Other Types of Constraints

- **Semantic integrity constraints:** specified and enforced within the application programs that update the database, or by using a general-purpose constraint specification language.
 - i.e. the salary of an employee should not exceed the salary of the employee's supervisor
 - i.e. the maximum number of hours an employee can work on all projects per week is 56.

Other Types of Constraints

- **Transition constraints:** Transition between one database state into another database state.
 - Enforced by application Program.
 - i.e., salary of an employee can only increase.

Update Operations, Transactions, and Dealing with Constraint Violations

Constraint Violation

- **Relational Model Operations:** Retrievals and updates.
- Three basic operations that can change the states of relations in the database: Insert, Delete, and Update (or Modify).
- Whenever these operations are applied, the integrity constraints specified on the relational database schema should not be violated.

Violation of Constraints: Insert Operation

- Insert can violate any of the four types of constraints.
- **Domain constraints:** can be violated if an attribute value is given that does not appear in the corresponding domain or is not of the appropriate data type.
- **Key constraints:** can be violated if a key value in the new tuple t already exists in another tuple in the relation $r(R)$.
- **Entity integrity:** can be violated if any part of the primary key of the new tuple t is NULL.
- **Referential integrity** can be violated if the value of any foreign key in table refers to a tuple that does not exist in the referenced relation.

Violation of Constraints: Insert Operation

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

■ Operation:

Insert <'Cecilia', 'F', 'Kolonsky', NULL, '1960-04-05', '6357 Windy Lane, Katy, TX', F, 28000, NULL, 4> into EMPLOYEE.

Result: This insertion violates the entity integrity constraint (NULL for the primary key Ssn), so it is rejected.

Violation of Constraints: Insert Operation

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----



EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

■ Operation:

Insert <'Alicia', 'J', 'Zelaya', '999887777', '1960-04-05', '6357 Windy Lane, Katy, TX', F, 28000, '987654321', 4> into EMPLOYEE.

Result: This insertion violates the key constraint because another tuple with the same Ssn value already exists in the EMPLOYEE relation, and so it is rejected.

Violation of Constraints: Insert Operation

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	<u>Dnumber</u>
Research	5
Administration	4
Headquarters	1

Operation:

Insert <'Cecilia', 'F', 'Kolonsky', '677678989', '1960-04-05', '6357 Windswept, Katy, TX', F, 28000, '987654321', 7> into EMPLOYEE.

Result: This insertion violates the referential integrity constraint specified on Dno in EMPLOYEE because no corresponding referenced tuple exists in DEPARTMENT with Dnumber = 7.

Insert Operations on Relations

- In case of integrity violation, several actions can be taken:
 - Cancel the operation that causes the violation (RESTRICT or REJECT option)
 - Perform the operation but inform the user of the violation
 - Trigger additional updates so the violation is corrected (CASCADE option, SET NULL option)
 - Execute a user-specified error-correction routine

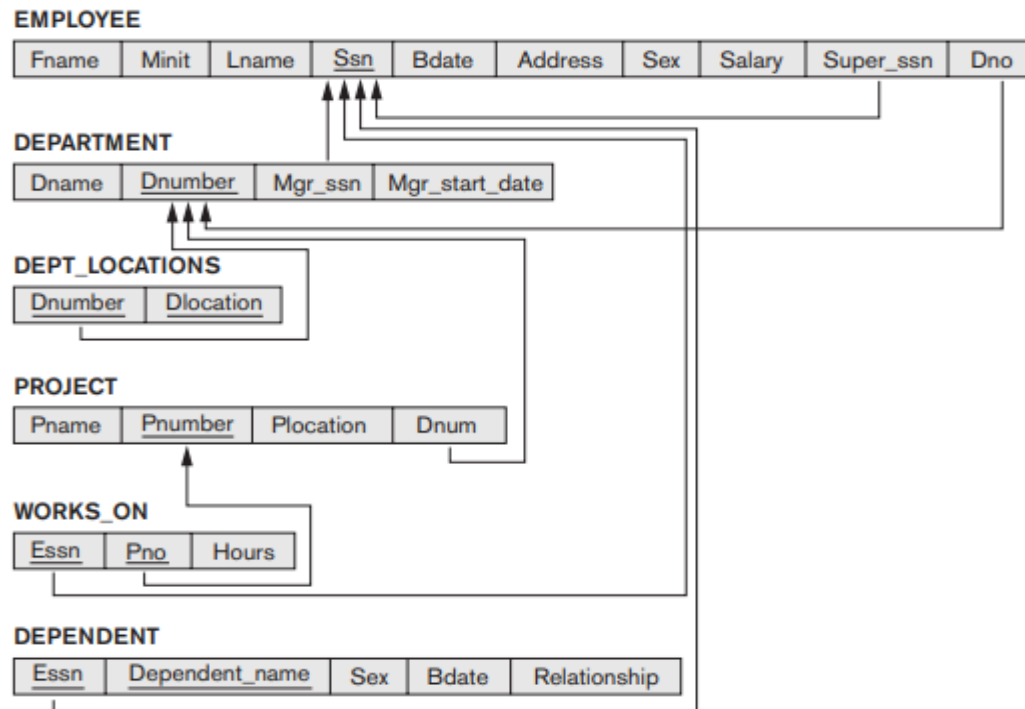
Violation of Constraints: Delete Operation

- Delete operation can violate only referential integrity.
 - This occurs if the tuple being deleted is referenced by foreign keys from other tuples in the database.

Violation of Constraints: Delete Operation

Figure 5.7

Referential integrity constraints displayed on the COMPANY relational database schema.



WORKS_ON

Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

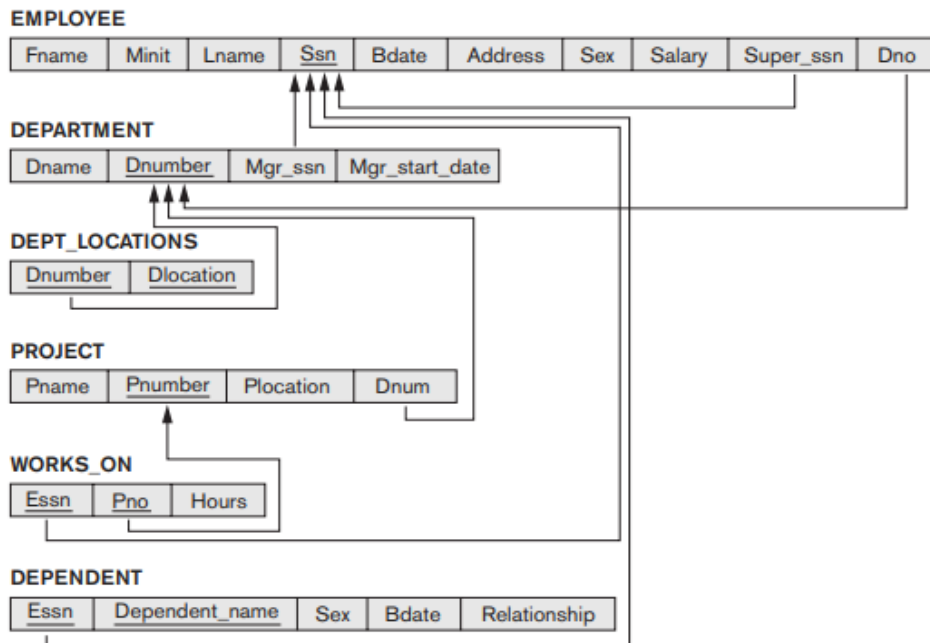
■ Operation:

Delete the WORKS_ON tuple with Essn = '999887777' and Pno = 10.

Result: This deletion is acceptable and deletes exactly one tuple.

Violation of Constraints: Delete Operation

Figure 5.7
Referential integrity constraints displayed on the COMPANY relational database schema.



WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

■ Operation:

Delete the EMPLOYEE tuple with Ssn = '999887777'.

Result: This deletion is not acceptable, because there are tuples in WORKS_ON that refer to this tuple. Hence, if the tuple in EMPLOYEE is deleted, referential integrity violations will result.

Violation of Constraints: Delete Operation

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5

Figure 5.7

Referential integrity constraints displayed on the COMPANY relation

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
-------	----------------	---------	----------------

DEPT_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
----------------	------------------

PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------

WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
-------------	------------	-------

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
-------------	-----------------------	-----	-------	--------------

DEPARTMENT

Dname	<u>Dnumber</u>
Research	5
Administration	4
Headquarters	1

WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse

Operation:

Delete the EMPLOYEE tuple with Ssn = '333445555'.

Result: This deletion will result in even worse referential integrity violations, because the tuple involved is referenced by tuples from the EMPLOYEE, DEPARTMENT, WORKS_ON, and DEPENDENT relations.

Violation of Constraints: Delete Operation

- Options to overcome violation if a deletion operation causes a violation.
 - **Restrict:** is to reject the deletion.
 - **Cascade:** to cascade (or propagate) the deletion by deleting tuples that reference the tuple that is being deleted.
 - **Set null or set default:** is to modify the referencing attribute values that cause the violation
 - each such value is either set to NULL or changed to reference another default valid tuple.
 - **Notice** that if a referencing attribute that causes a violation is part of the primary key, it cannot be set to NULL; otherwise, it would violate entity integrity. Combinations of these three options are also possible.

Violation of Constraints: Update Operation

- Updating an attribute that is neither part of a primary key nor part of a foreign key usually causes no problems.

Violation of Constraints: Update Operation

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
			↑↑↑↑						

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

- *Operation:*
Update the salary of the EMPLOYEE tuple with Ssn = '999887777' to 28000.
Result: Acceptable.
- *Operation:*
Update the Dno of the EMPLOYEE tuple with Ssn = '999887777' to 1.
Result: Acceptable.

Violation of Constraints: Update Operation

Figure 5.7

Referential integrity constraints displayed on the COMPANY relational database schema.

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
-------	-------	-------	------------	-------	---------	-----	--------	-----------	-----

DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
-------	----------------	---------	----------------

DEPT_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
----------------	------------------

PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
-------	----------------	-----------	------

WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
-------------	------------	-------

DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
-------------	-----------------------	-----	-------	--------------

DEPARTMENT

Dname	<u>Dnumber</u>
Research	5
Administration	4
Headquarters	1

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4

Operation:

Update the Dno of the EMPLOYEE tuple with Ssn = '999887777' to 7.

Result: Unacceptable, because it violates referential integrity.

Operation:

Update the Ssn of the EMPLOYEE tuple with Ssn = '999887777' to '987654321'.

Result: Unacceptable, because it violates primary key constraint by repeating a value that already exists as a primary key in another tuple; it violates referential integrity constraints because there are other relations that refer to the existing value of Ssn.

Violation of Constraints: Update Operation

- Any of the other constraints may also be violated, depending on the attribute being updated:
- **Updating the primary key (PK):**
 - Similar to a DELETE followed by an INSERT
 - Need to specify similar options to DELETE
- **Updating a foreign key (FK):**
 - May violate referential integrity
- **Updating an ordinary attribute (neither PK nor FK):**
 - Can only violate domain constraints

Transaction

- A transaction is an executing program that includes some database operations, such as reading from the database, or applying insertions, deletions, or updates to the database.
- After the transaction is completed the database must be in valid and consistent state that satisfies all the constraints.
- For example, a bank withdrawal will typically read the user account record, check if there is a sufficient balance, and then update the record by the withdrawal amount.