CS4.301 Data & Applications

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Inherent or Implicit Constraints

Constraints that exist naturally due to the meaning of data or real-world logic, not explicitly declared in the schema

Inherent constraints are enforced by logic, not the DBMS—unless we model them

Example	Explanation
A person's **date of birth cannot be in the future**	True by nature of time
A **student's age must be positive**	Logical and real-world rule
Arrival time > Departure time for the same flight	Temporal reality
A **bridge can't connect to itself**	Semantic impossibility

Schema-based or Explicit Constraints

Constraints that are formally declared in the database schema using SQL. These are explicitly stated in the schema and automatically checked by the DBMS.

Type	Example	Enforced by
Domain Constraint	`age INT CHECK (age >= 18)`	Column definition
Key Constraint	`PRIMARY KEY (student_id)`	Table-level rule
Entity Integrity	Primary key cannot be NULL	DBMS automatically
Referential Integrity	`FOREIGN KEY (dept_id) REFERENCES Department(dept_id)`	Enforced by DBMS
Unique Constraint	`UNIQUE (email)`	Ensures no duplicates

Application based or semantic constraints

Constraints that depend on business logic, process, or context — not easily enforced in schema. These constraints live in the application layer, triggers, or stored procedures — not the schema itself.

Example	Explanation
A professor cannot teach more than 3 courses per semester	Depends on institutional policy
Discount applies only if order value > ₹5000	Business rule enforced by application code
Loan approval requires credit score > 700	External data & logic-based
Employee salary increase ≤ 20% per year	Policy constraint, not structural
Two users cannot book the same seat	Controlled through transactions/application logic

Constraints summary

Type	Defined By	Example	Where Enforced
Inherent / Implicit	Nature of data, logic	Age > 0, DoB < Today	Reality / Semantics
Schema-based / Explicit	SQL schema definition	CHECK, PK, FK	DBMS
Application / Semantic	Business rules, process logic	Max 3 courses / semester	Application layer

Candidate key

Feature	Superkey	Candidate Key
Definition	Any set of attributes that uniquely identifies tuples	Minimal set of attributes that uniquely identifies tuples
Uniqueness	Must hold	Must hold
Minimality	Not required	Must hold
Count per Table	Many	Subset of superkeys
Example	`{RollNo, Name}`	`{RollNo}`, `{Email}`

Super & Primary key difference

S.NO	Super Key	Primary Key
1.	Super Key is an attribute (or set of attributes) that is used to uniquely identifies all attributes in a relation.	Primary Key is a minimal set of attribute (or set of attributes) that is used to uniquely identifies all attributes in a relation.
2.	All super keys can't be primary keys.	Primary key is a minimal super key.
3.	Various super keys together makes the criteria to select the candidate keys.	We can choose any of the minimal candidate key to be a primary key.
4.	In a relation, number of super keys are more than number of primary keys.	While in a relation, number of primary keys are less than number of super keys.
5.	Super key's attributes can contain NULL values.	Primary key's attributes cannot contain NULL values.

https://www.geeksforgeeks.org/difference-between-primary-key-and-super-key/

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

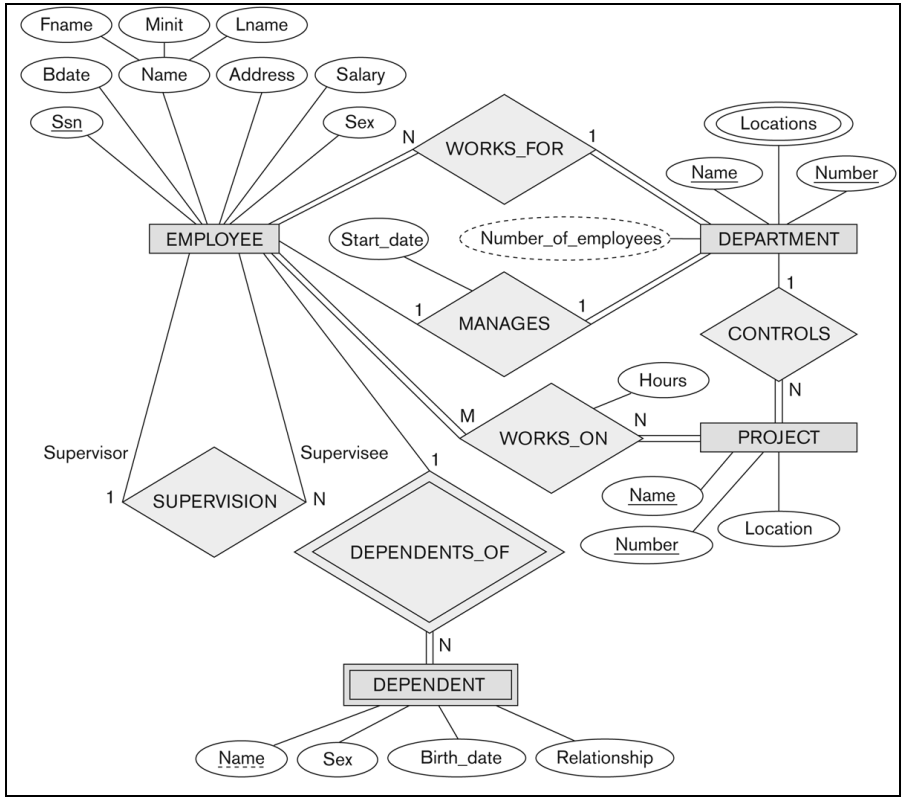
Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship



Entity Integrity

Entity Integrity:

The *primary key attributes* PK of each relation schema R in S cannot have null values in any tuple of r(R).

- This is because primary key values are used to *identify* the individual tuples.
- $t[PK] \neq null$ for any tuple t in r(R)
- If PK has several attributes, null is not allowed in any of these attributes

Note: Other attributes of R may be constrained to disallow null values, even though they are not members of the primary key.

Referential Integrity

Tuples in the **referencing relation** R1 have attributes FK (called **foreign key** attributes) that reference the primary key attributes PK of the **referenced relation** R2.

A tuple t1 in R1 is said to **reference** a tuple t2 in R2 if t1[FK] = t2[PK].

A referential integrity constraint can be displayed in a relational database schema as a directed arc from R1.FK to R2.PK

Referential Integrity (or foreign key) Constraint

Statement of the constraint

The value in the foreign key column (or columns) FK of the **referencing relation** R1 can be **either**:

(1) a value of an existing primary key value of a corresponding primary key PK in the **referenced relation** R2, or

(2) a **null**.

In case (2), the FK in R1 should **not** be a part of its own primary key.

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

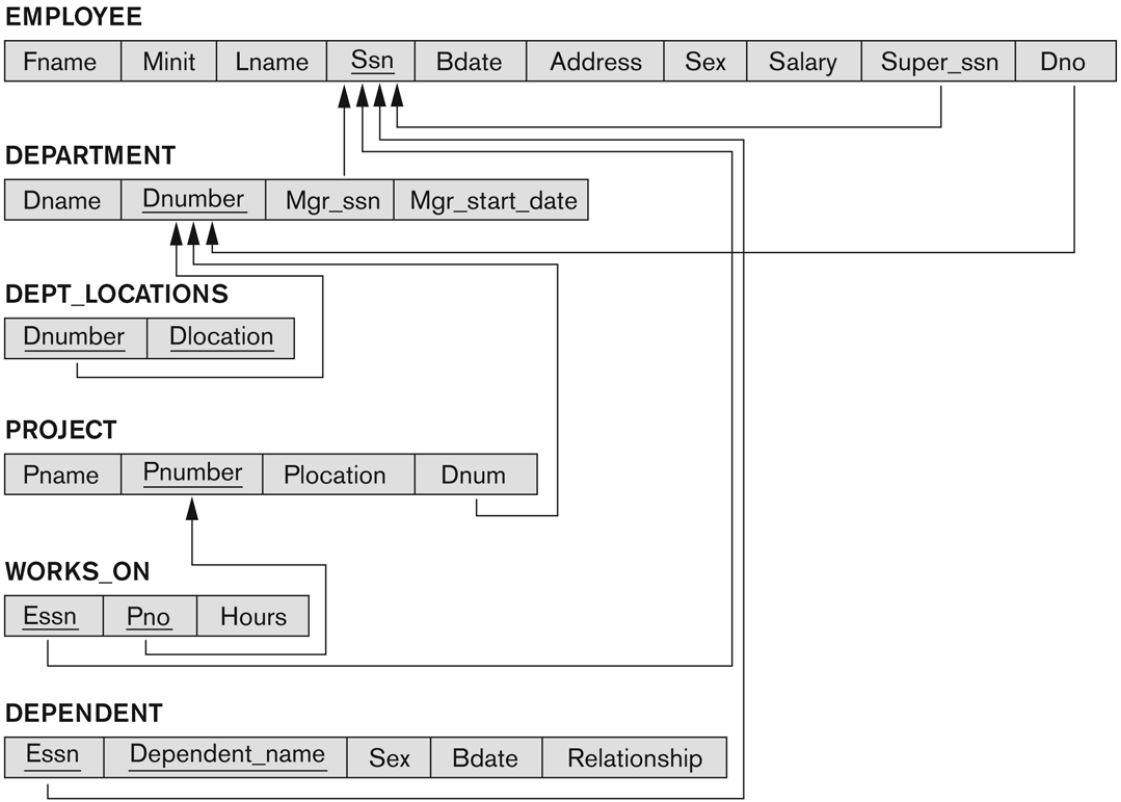
A foreign key (referential integrity) constraints is displayed as a directed arc (arrow) from the foreign key attributes to the referenced table

- Can also point the the primary key of the referenced relation for clarity

Next slide shows the COMPANY **relational schema diagram with referential integrity constraints**

Referential integrity constraints for Company

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



This Lecture

Activity: Infinium mini-world

Write down 3 examples for Inherent constraints

Write down 3 examples for Explicit constraints

Write down 3 examples for Application constraints

Generate a Relation, Super keys, Candidate keys, Primary keys

Write down a at least 2 integrity constraints, and 2 referential integrity constraints

With multiple entities show at lest 2 referential integrity constraints through relational schema

Update Operations on Relations

INSERT a tuple

DELETE a tuple

MODIFY a tuple

Integrity constraints should not be violated by the update operations

Several update operations may have to be grouped together

Updates may **propagate** to cause other updates automatically. This may be necessary to maintain integrity constraints

Update 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
- Execute a user-specified error-correction routine

Possible violations for each operation

INSERT may violate any of the constraints:

- Domain constraint:
  - if one of the attribute values provided for the new tuple is not of the specified attribute domain
- Key constraint:
  - if the value of a key attribute in the new tuple already exists in another tuple in the relation
- Referential integrity:
  - if a foreign key value in the new tuple references a primary key value that does not exist in the referenced relation
- Entity integrity:
  - if the primary key value is null in the new tuple

Figure 5.6

One possible database state for the COMPANY relational database schema.

EMPLOYEE

Fname	Minit	Lname	Ssn	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	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

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

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

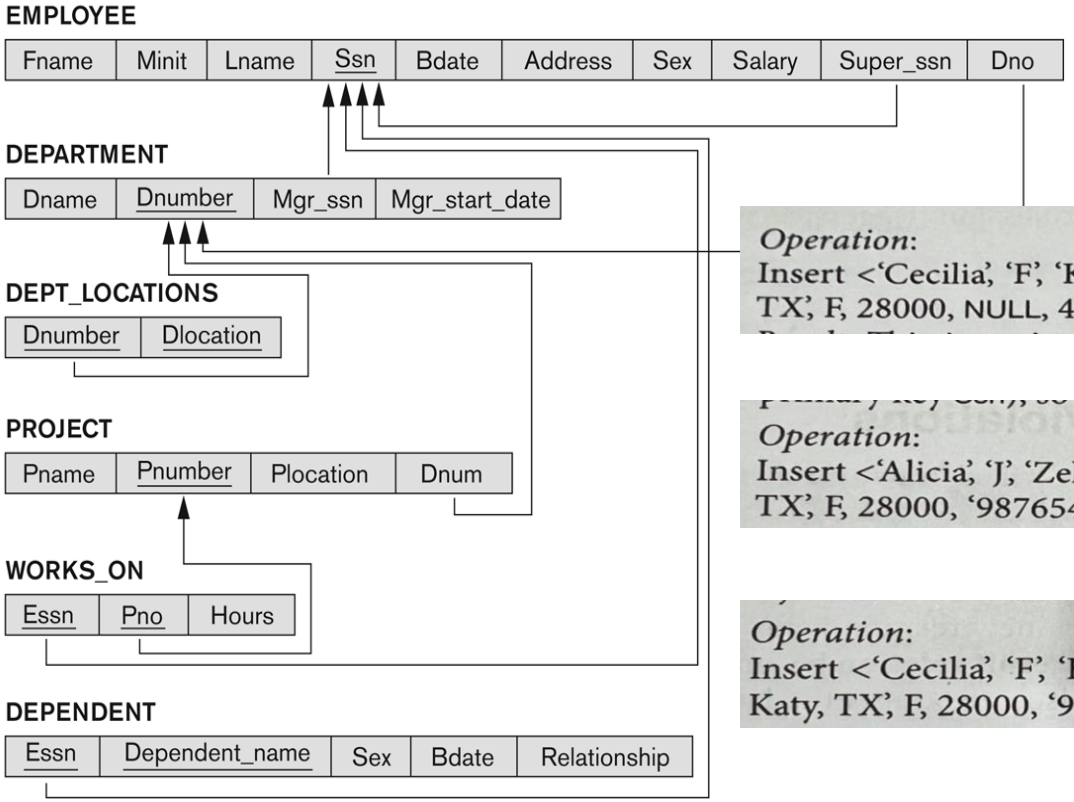
DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

Referential integrity constraints for Company

e 5.7

ential integrity constraints displayed on the COMPANY relational database schema.



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

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

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

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.

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

[redacted]

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

[redacted]

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.

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.

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

[redacted]

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.

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.

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.

Possible violations for each operation

DELETE may violate only referential integrity:

- If the primary key value of the tuple being deleted is referenced from other tuples in the database
  - Can be remedied by several actions: RESTRICT, CASCADE, SET NULL
    - RESTRICT option: reject the deletion
    - CASCADE option: by deleting tuples that reference the tuple that is being deleted
    - SET NULL option: set the foreign keys of the referencing tuples to NULL
- One of the above options must be specified during database design for each foreign key constraint

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

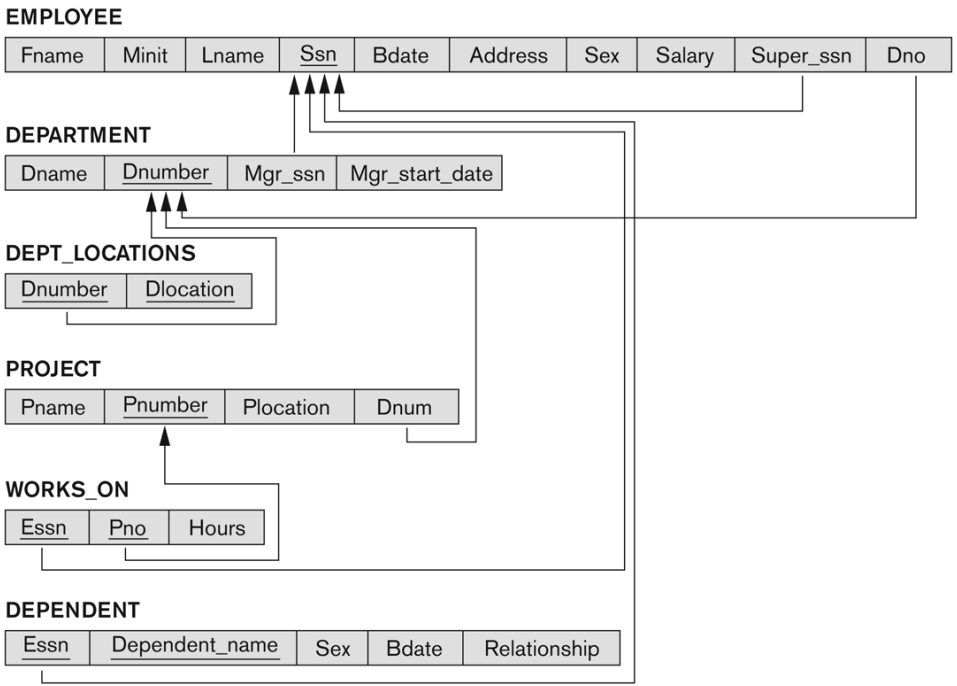


Figure 5.6
One possible database state for the COMPANY relational database schema.

EMPLOYEE

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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	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

WORKS_ON

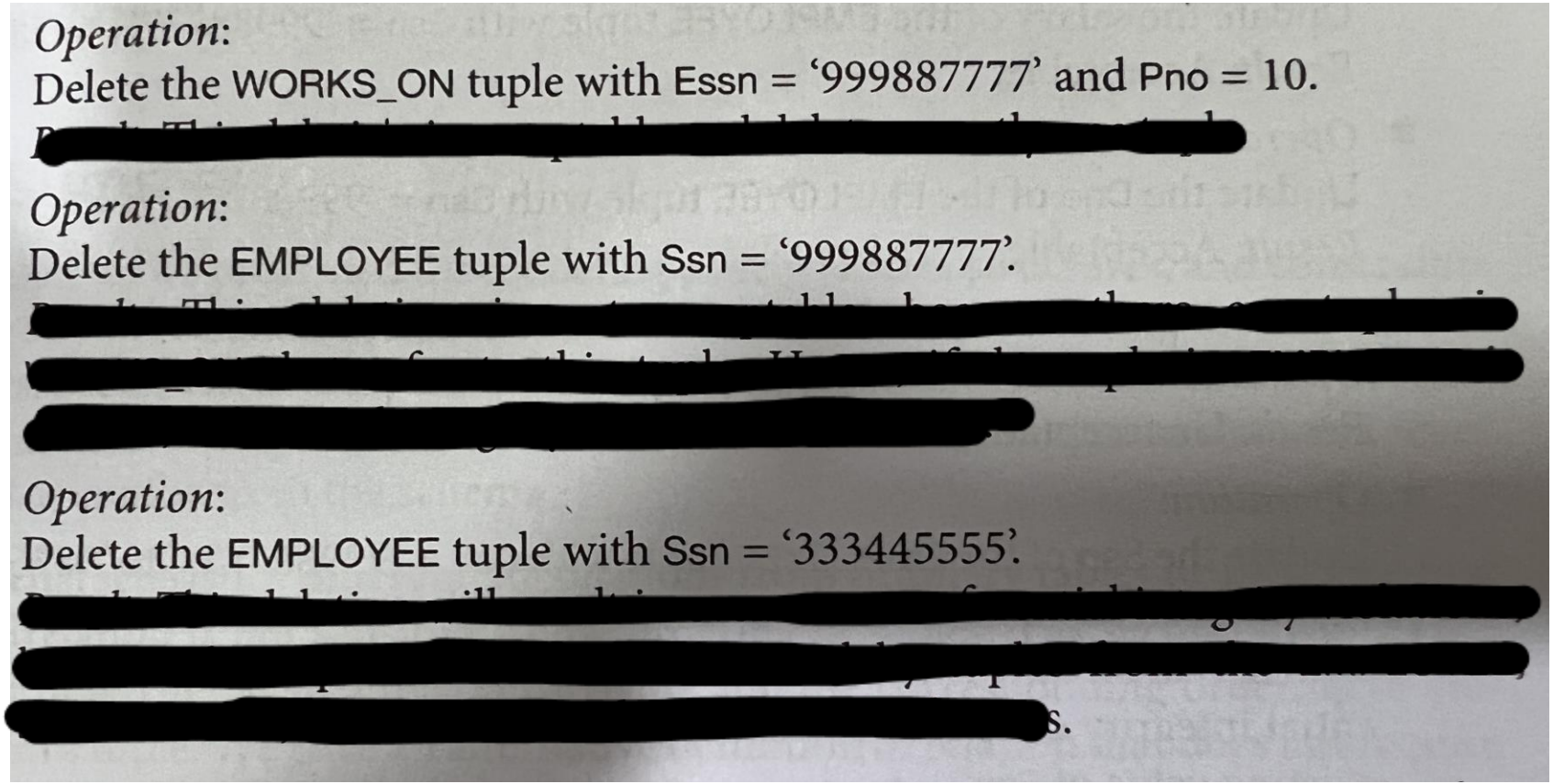
Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse



What are the results?

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
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333445555	10	10.0
333445555	20	10.0
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999887777	10	10.0
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987987987	30	5.0
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DEPENDENT

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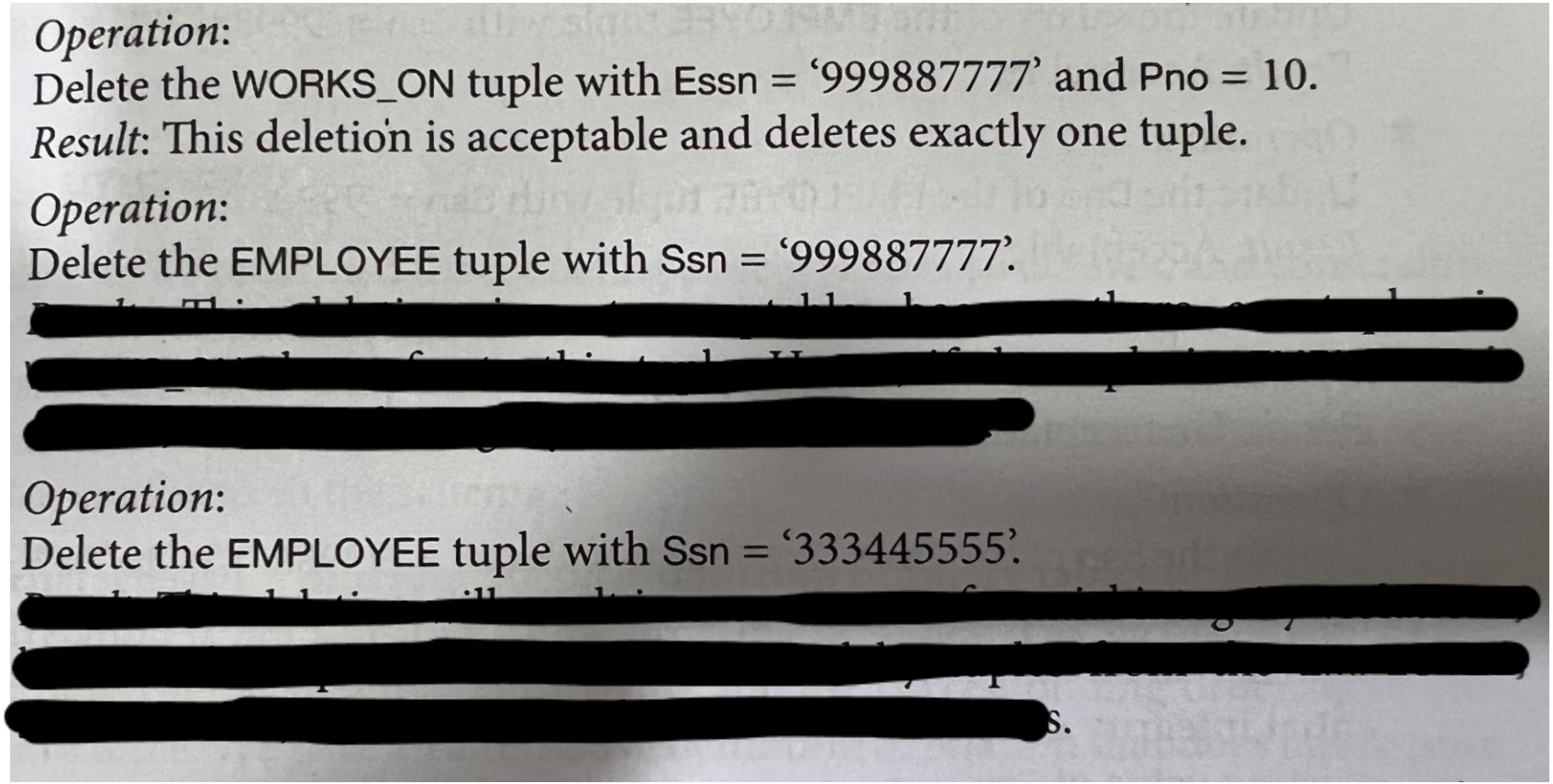

Operation:
Delete the WORKS_ON tuple with Essn = '999887777' and Pno = 10.
Result: This deletion is acceptable and deletes exactly one tuple.

Operation:
Delete the EMPLOYEE tuple with Ssn = '999887777'.

Operation:
Delete the EMPLOYEE tuple with Ssn = '333445555'.

What are the results?

Figure 5.6

One possible database state for the COMPANY relational database schema.

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
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Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
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DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
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DEPT_LOCATIONS

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WORKS_ON

Essn	Pno	Hours
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DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
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123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

Operation:
Delete the WORKS_ON tuple with Essn = '999887777' and Pno = 10.
Result: This deletion is acceptable and deletes exactly one tuple.

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.

Operation:
Delete the EMPLOYEE tuple with Ssn = '333445555'.

[redacted]

What are the results?

Figure 5.6

One possible database state for the COMPANY relational database schema.

EMPLOYEE

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999887777	10	10.0
987987987	10	35.0
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987654321	30	20.0
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DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

Operation:
Delete the WORKS_ON tuple with Essn = '999887777' and Pno = 10.
Result: This deletion is acceptable and deletes exactly one tuple.

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.

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.

What are the results?

Possible violations for each operation

UPDATE may violate domain constraint and NOT NULL constraint on an attribute being modified

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

Operation:
Update the salary of the EMPLOYEE tuple with Ssn = '999887777' to 28000.

Operation:
Update the Dno of the EMPLOYEE tuple with Ssn = '999887777' to 1.

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

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

Figure 5.6

One possible database state for the COMPANY relational database schema.

EMPLOYEE

Fname	Minit	Lname	Ssn	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	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

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

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

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.
[redacted]

Operation:
Update the Dno of the EMPLOYEE tuple with Ssn = '999887777' to 7.
[redacted]

Operation:
Update the Ssn of the EMPLOYEE tuple with Ssn = '999887777' to '987654321'.
Result: [redacted]

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.

Operation:
Update the Dno of the EMPLOYEE tuple with Ssn = '999887777' to 7.
[redacted]

Operation:
Update the Ssn of the EMPLOYEE tuple with Ssn = '999887777' to '987654321'.
Result: [redacted]

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.

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: [redacted]

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.

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.

Basic SQL

Basic SQL

SQL language

Considered one of the major reasons for the commercial success of relational databases

SQL

The origin of SQL is relational predicate calculus called tuple calculus (see Ch.8) which was proposed initially as the language SQUARE.

SQL Actually comes from the word “SEQUEL” [Structured English QUEry Language] which was the original term used in the paper: “SEQUEL TO SQUARE” by Chamberlin and Boyce. IBM could not copyright that term, so they abbreviated to SQL and copyrighted the term SQL.

Now popularly known as “Structured Query language”.

SQL is an informal or practical rendering of the relational data model with syntax

SQL Data Definition, Data Types, Standards

Terminology:

- **Table**, **row**, and **column** used for relational model terms relation, tuple, and attribute

`CREATE` statement

- Main SQL command for data definition

SQL Standards

SQL has gone through many standards: starting with SQL-86 or SQL 1.A. SQL-92 is referred to as SQL-2.

Later standards (from SQL-1999) are divided into **core** specification and specialized **extensions**. The extensions are implemented for different applications – such as data mining, data warehousing, multimedia etc.

SQL-2006 added XML features (Ch. 13); In 2008 they added Object-oriented features (Ch. 12).

SQL 2023 is the current standard

Schema and Catalog Concepts in SQL

We cover the basic standard SQL syntax – there are variations in existing RDBMS systems

SQL schema

- Identified by a **schema name**
- Includes an **authorization identifier** and **descriptors** for each element

Schema elements include

- Tables, constraints, views, domains, and other constructs

Each statement in SQL ends with a **semicolon**

In some systems, Schema is called as Database

Schema and Catalog Concepts in SQL (cont'd.)

`CREATE SCHEMA` statement

```
CREATE SCHEMA COMPANY AUTHORIZATION 'Jsmith';
```

Catalog

Named collection of schemas in an SQL environment

SQL also has the concept of a cluster of catalogs

Authorization is to make the owner of the Schema

The CREATE TABLE Command in SQL

Specifying a new relation

- Provide name of table
- Specify attributes, their types and initial constraints

Can optionally specify schema:

```
CREATE TABLE COMPANY.EMPLOYEE ...
```

or

```
CREATE TABLE EMPLOYEE ...
```

The CREATE TABLE Command in SQL (cont'd.)

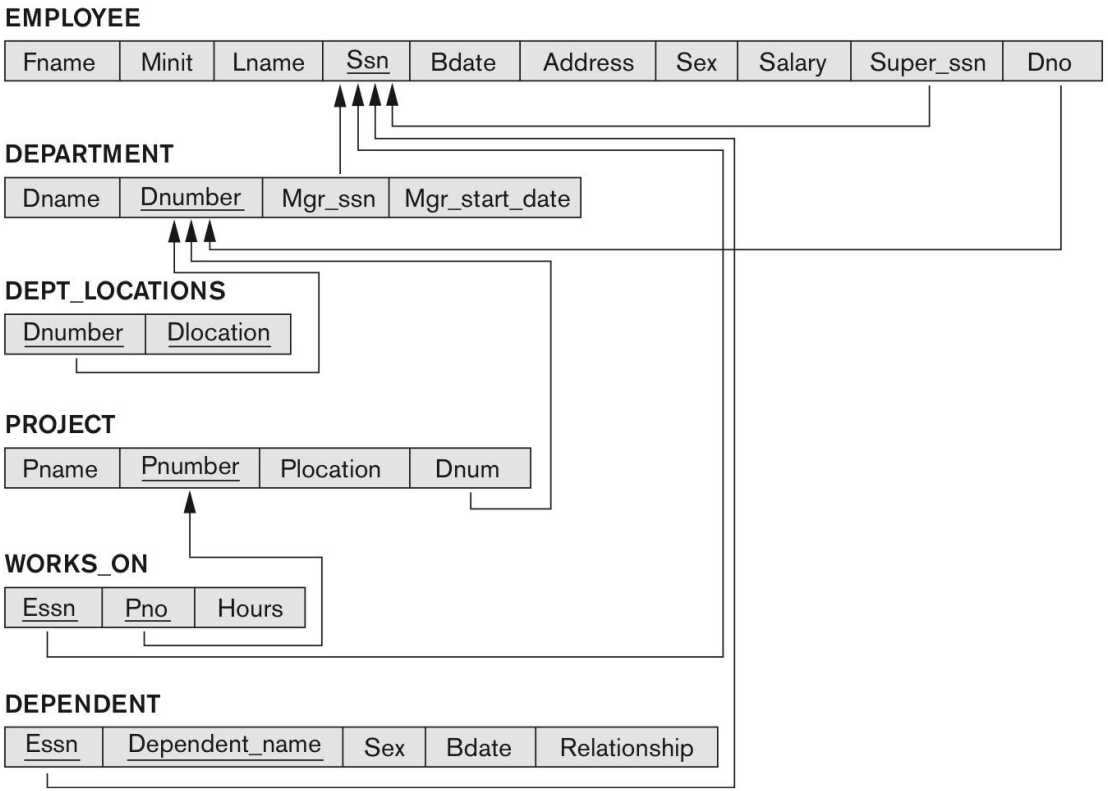
Base tables (**base relations**)

Relation and its tuples are actually created and stored as a file by the DBMS

Virtual relations (views)

Created through the `CREATE VIEW` statement. Do not correspond to any physical file.

COMPANY relational database schema (Fig. 5.7)



One possible database state for the COMPANY relational database schema (Fig. 5.6)

EMPLOYEE

Fname	Minit	Lname	Ssn	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	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

One possible database state for the COMPANY relational database schema – continued (Fig. 5.6)

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

PROJECT

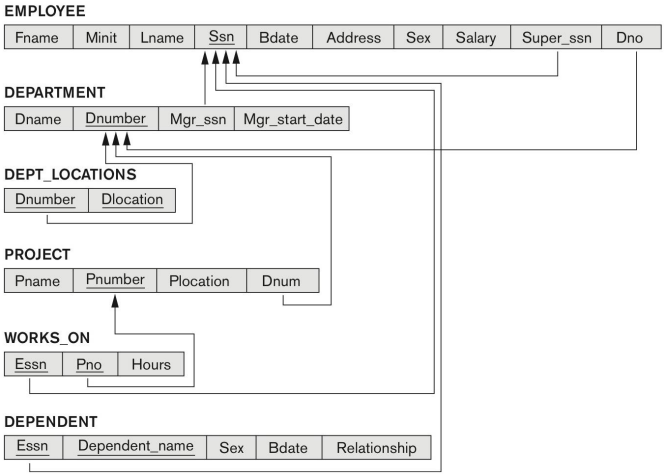
Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 5.7 (Fig. 6.1)

```
CREATE TABLE EMPLOYEE
        ( Fname                 VARCHAR(15)         NOT NULL,
          Minit                 CHAR,
          Lname                 VARCHAR(15)         NOT NULL,
          Ssn                   CHAR(9)             NOT NULL,
          Bdate                 DATE,
          Address               VARCHAR(30),
          Sex                   CHAR,
          Salary                DECIMAL(10,2),
          Super_ssn             CHAR(9),
          Dno                   INT                 NOT NULL,
        PRIMARY KEY (Ssn),
CREATE TABLE DEPARTMENT
        ( Dname                 VARCHAR(15)         NOT NULL,
          Dnumber               INT                 NOT NULL,
          Mgr_ssn               CHAR(9)             NOT NULL,
          Mgr_start_date        DATE,
        PRIMARY KEY (Dnumber),
        UNIQUE (Dname),
        FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn) );
CREATE TABLE DEPT_LOCATIONS
        ( Dnumber               INT                 NOT NULL,
          Dlocation             VARCHAR(15)         NOT NULL,
        PRIMARY KEY (Dnumber, Dlocation),
        FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber) );
```



continued on next slide

SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 5.7 (Fig. 6.1)-continued

```
CREATE TABLE PROJECT
        ( Pname                 VARCHAR(15)             NOT NULL,
          Pnumber               INT                     NOT NULL,
          Plocation             VARCHAR(15),
          Dnum                  INT                     NOT NULL,
        PRIMARY KEY (Pnumber),
        UNIQUE (Pname),
        FOREIGN KEY (Dnum) REFERENCES DEPARTMENT(Dnumber) );
CREATE TABLE WORKS_ON
        ( Essn                  CHAR(9)                 NOT NULL,
          Pno                   INT                     NOT NULL,
          Hours                 DECIMAL(3,1)            NOT NULL,
        PRIMARY KEY (Essn, Pno),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn),
        FOREIGN KEY (Pno) REFERENCES PROJECT(Pnumber) );
CREATE TABLE DEPENDENT
        ( Essn                  CHAR(9)                 NOT NULL,
          Dependent_name        VARCHAR(15)             NOT NULL,
          Sex                   CHAR,
          Bdate                 DATE,
          Relationship          VARCHAR(8),
        PRIMARY KEY (Essn, Dependent_name),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn) );
```

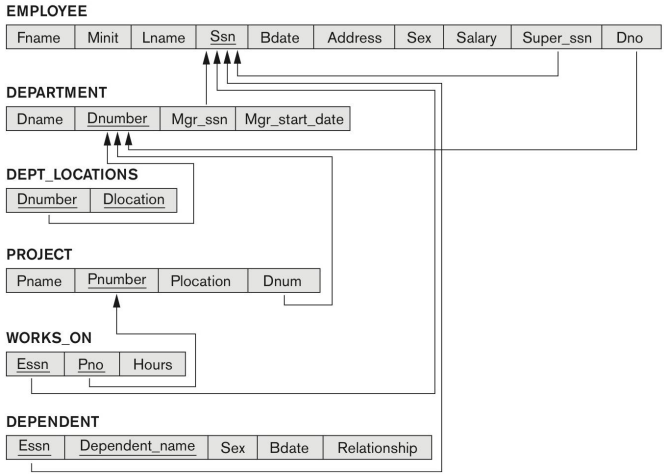
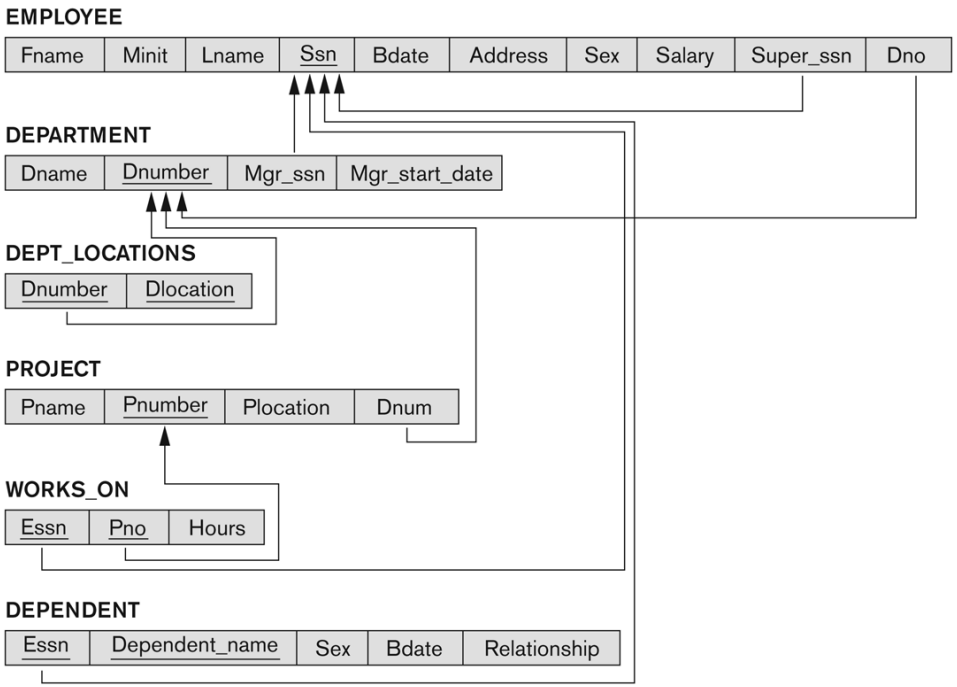


Figure 5.7
Referential integrity constraints displayed on the COMPANY relational database schema.



Activity

Figure 5.6
One possible database state for the COMPANY relational database schema.

EMPLOYEE

Fname	Minit	Lname	Ssn	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	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

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

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

One INSERT on EMPLOYEE that is acceptable

One INSERT that violates key constraint

One INSERT that violates referential integrity constraints

One DELETE on EMPLOYEE that is acceptable

One DELETE on EMPLOYEE that violates referential integrity constraints

One UPDATE on EMPLOYEE that is acceptable

One UPDATE on EMPLOYEE that violates referential integrity constraints

One UPDATE on EMPLOYEE that violates primary key constraint

One INSERT on DEPARTMENT that is acceptable

One INSERT on DEPARTMENT that is NOT acceptable

One DELETE on PROJECT that is acceptable

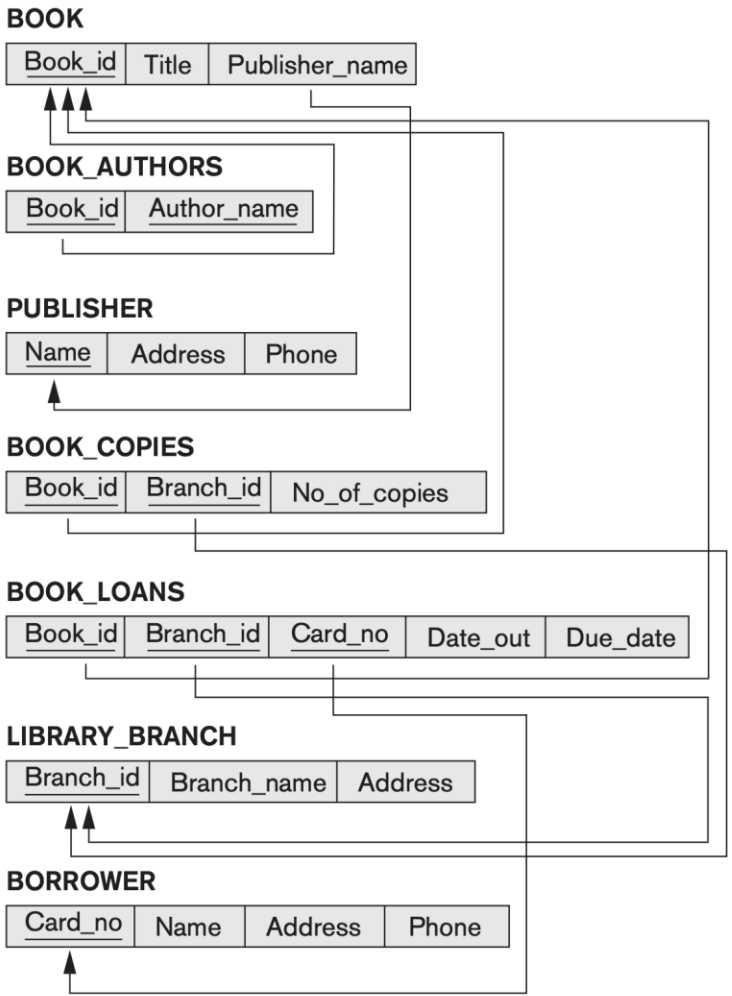
One DELETE on PROJECT that is NOT acceptable

One UPDATE on WORKS_ON that is acceptable

One UPDATE on WORKS_ON that is NOT acceptable

Activity

Create TABLE statement for this schema



Bibliography / Acknowledgements

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Ponnurangam.kumaraguru


/in/ponguru


ponguru

Thank you for attending the class!!!


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