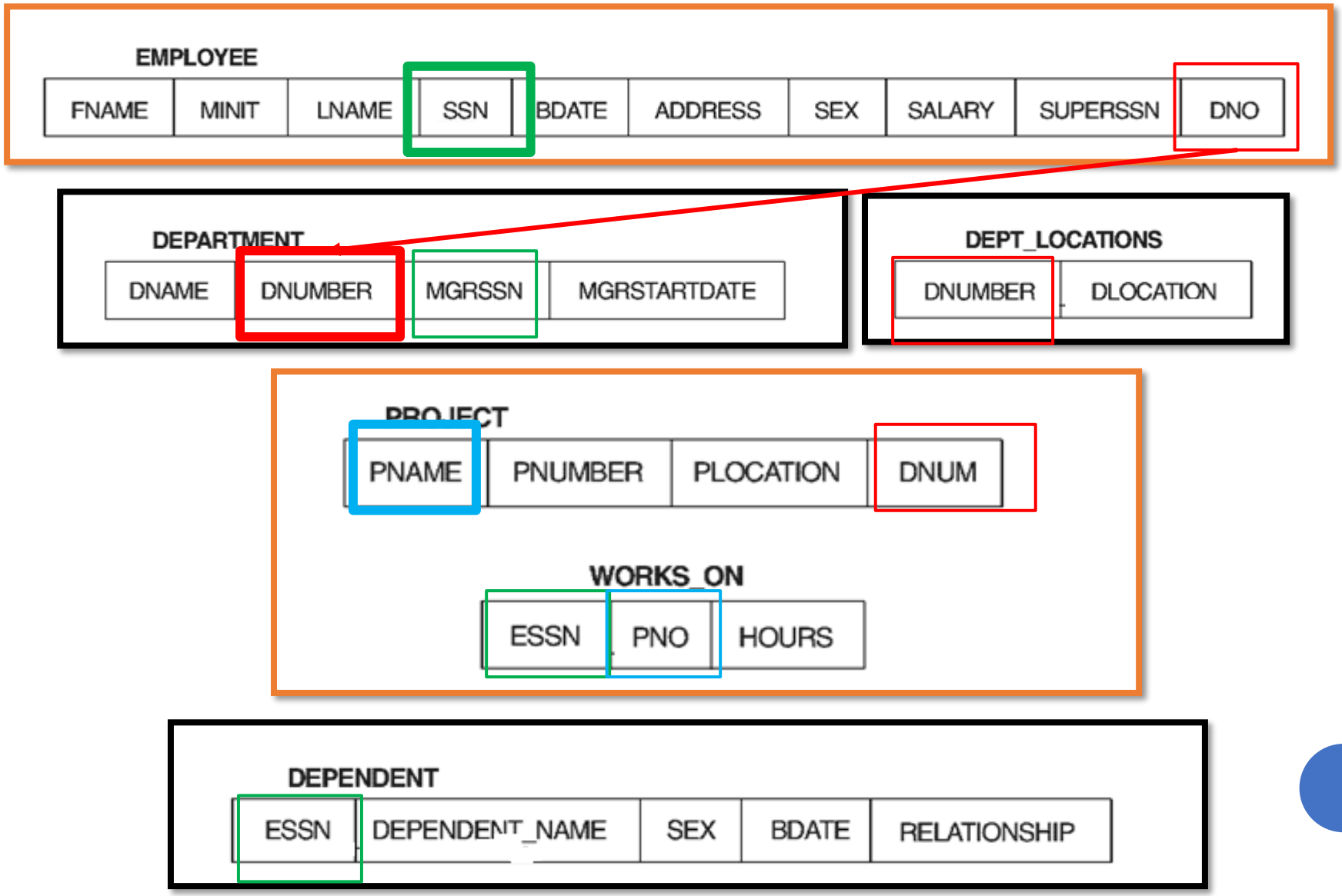
Foreign Key Constraint



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

EMPLOYEE

Fname	Minit	Lname	Ssn	Super_ssn	Dno
John	B	Smith	123456789	333445555	5
Franklin	T	Wong	333445555	888665555	5
Alicia	J	Zelaya	999887777	987654321	4
Jennifer	S	Wallace	987654321	888665555	4
Ramesh	K	Narayan	666884444	333445555	5
Joyce	A	English	453453453	333445555	5
Ahmad	V	Jabbar	987987987	987654321	4
James	E	Borg	888665555	NULL	1

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

- ***A tuple in one relation that refers to another relation must refer to an existing tuple in that relation.***

- This is specified to maintain consistency among tuples in the two relations.

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
6	Houston

Foreign Key (FK)

A foreign key FK is a field in a table that matches the primary key column of another table.

- Attributes in FK in relation R_1 must has **same domain** as the attributes in PK of R_2
- **Value of FK** must be an **existing PK value** in R_2 **or Null**.

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

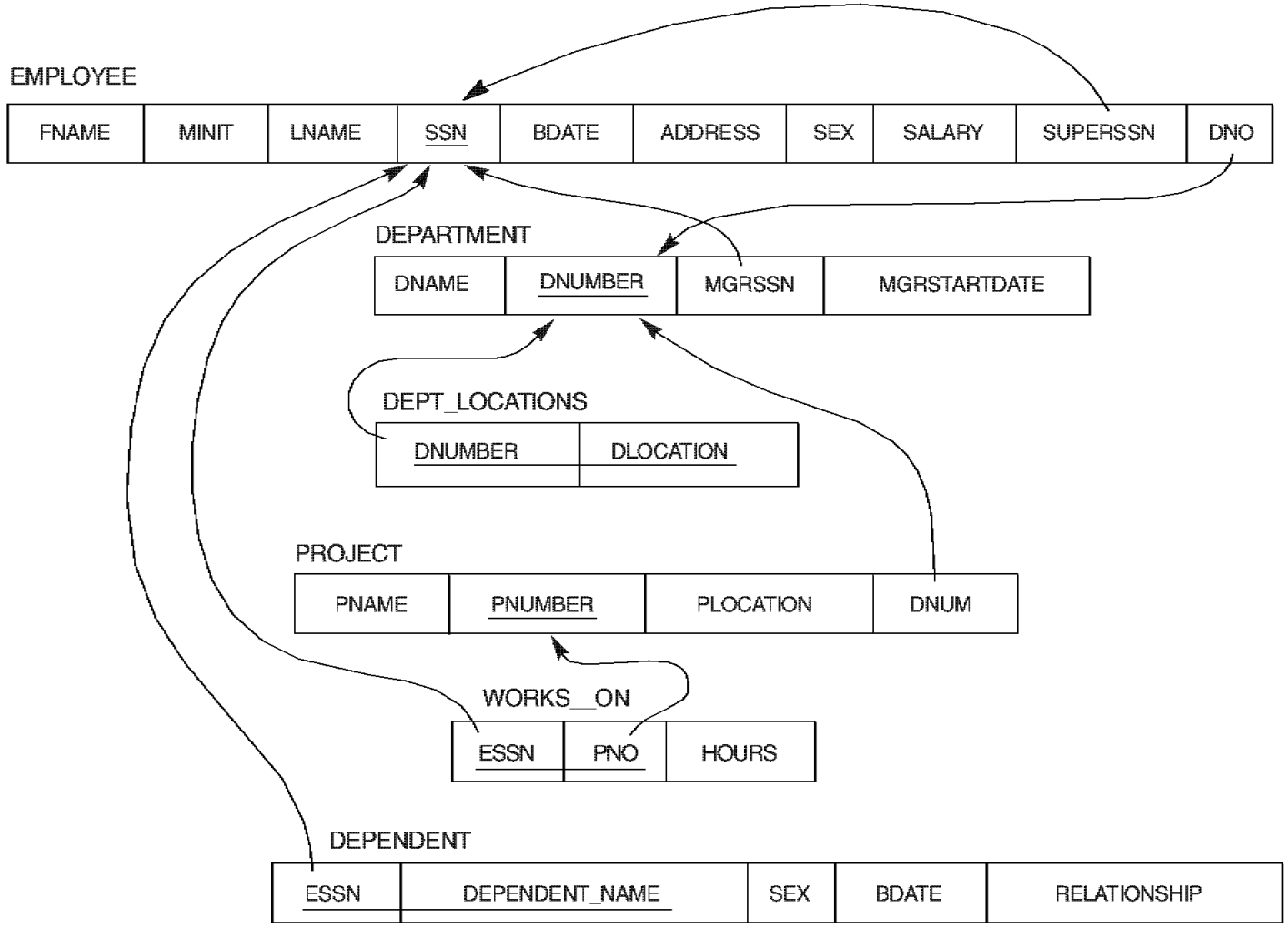
R2: Reference relation

DEPT_LOCATIONS

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

R1: Referencing relation

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



Foreign Key (FK)

- A foreign key can be a **primary key** or any of the candidate key in the referenced relation.

- FK requires that **uniqueness constraint** should hold for the column on which it is defined in referenced relation.

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

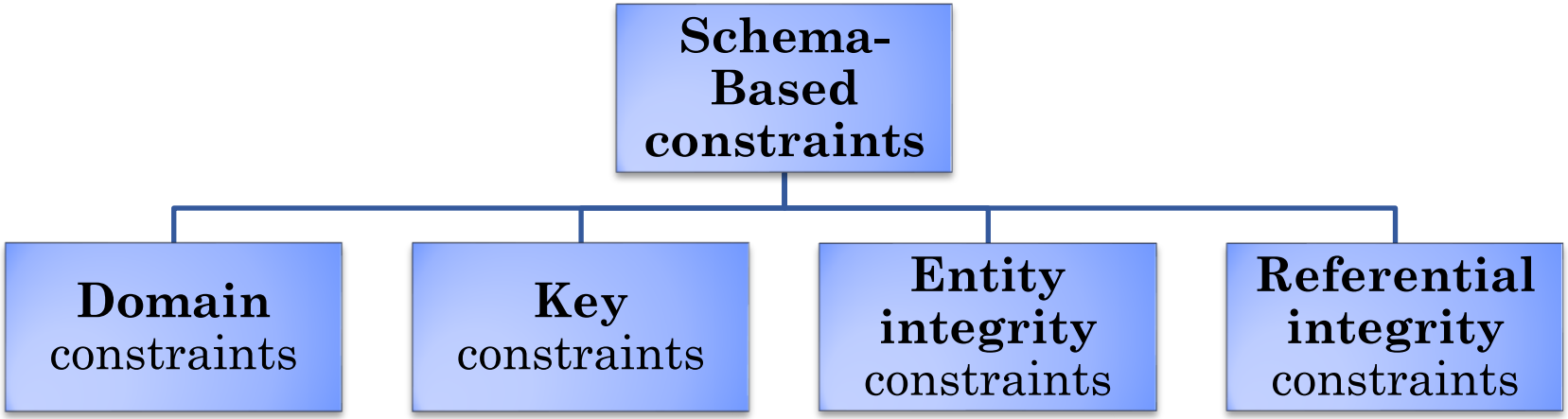
R2: Reference relation

DEPT_LOCATIONS

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

R1: Referencing relation

Schema-Based constraints



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

Relational Database Constraints

Model-based constraints or implicit constraints.

- These are inherent in data model, like no duplicate rows in table, domain is atomic.

Schema-based or explicit constraints.

- Can be expressed directly in the schema using DDL

Application based or semantic constraints or business rules.

- Can't be expressed directly in the schema
- Must be enforced by the application programs or **SQL triggers**

Semantic Integrity Constraints

- Based on application semantics and cannot be expressed by the model schema
- SQL allows triggers to specify some of these

- **Example**
  - Employee salary should not exceed supervisor salary

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

Semantic Integrity Constraints

- Based on application semantics and cannot be expressed by the model schema
- SQL triggers can specify these constraints

Example:

The max no of hours per employee for all projects he or she works on is 56 hrs per week

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

Why we need Multiple Tables

- Why not put all attributes in one relation ?

EMPLOYEE

FNAME	MINIT	LNAME	SSN	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO

DEPARTMENT

DNAME	DNUMBER	MGRSSN	MGRSTARTDATE

DEPT_LOCATIONS

DNUMBER	DLOCATION

"Relational" part -> how multiple tables relate to each other,

- Duplication
- Primary key
- Cannot insert value for employee with no assigned department … Null value in PK

Practise Questions

- Book - Fundamental of Database System
  - Chapter 1
    - 1.8 - 1.14
  - Chapter 2
    - 2.14 – 2.15
  - Chapter 5
    - 5.11
    - 5.12
    - 5.13
    - 5.14
    - 5.15
    - 5.16
    - 5.17

How the Programmer build DBMS

- Start with DDL to create tables:

```
CREATE TABLE Students (
        Name CHAR(30)
        SSN CHAR(9) PRIMARY KEY NOT NULL,
        Category CHAR(20)
)   . . .
```

- Continue with DML to populate tables:

```
INSERT INTO Students
VALUES('Charles', '123456789', 'undergraduate')
. . . .
```

Used to specify database retrievals and updates

CREATE TABLE

- Creates a new relation in the database
  - Specifies relation's attributes and their data types
  - Specifies constraints such as **NOT NULL , UNIQUE , CHECK** etc…

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

```
CREATE TABLE   DEPARTMENT(
        DNAME              VARCHAR(10)      NOT NULL ,
        DNUMBER            INTEGER  CHECK(DNUMBER >0 AND
                                          DNUMBER <25),
        MGRSSN             CHAR(9),
        MGRSTARTDATE       DATE
    );
```

Additional Data Types

DATE	• Made up of year-month-day in the format yyyy-mm-dd
TIME	• Made up of hour:minute:second in the format hh:mm:ss
TIME(i)	• Made up of hour:minute:second plus i additional digits specifying fractions of a second • format is hh:mm:ss:ii...i
TIMESTAMP	• Has both DATE and TIME components

Constraints in SQL

- CREATE TABLE command allows us to specify the primary key, secondary keys, and foreign keys.
- **Key attributes** can be specified via the PRIMARY KEY and UNIQUE phrases

```
CREATE TABLE   DEPARTMENT
(
    DNAME                   VARCHAR(10) NOT NULL,
    DNUMBER                 INTEGER NOT NULL,
    MGRSSN                  CHAR(9),
    MGRSTARTDATE            CHAR(9),
    PRIMARY KEY (DNUMBER),
    UNIQUE (DNAME),

);
```

Constraints in SQL

- CREATE TABLE command allows us to specify the primary key, secondary keys, and foreign keys.
- **Key attributes** can be specified via the PRIMARY KEY and UNIQUE phrases

```
CREATE TABLE   DEPARTMENT
(
    DNAME                   VARCHAR(10) NOT NULL,
    DNUMBER                 INTEGER NOT NULL,
    MGRSSN                  CHAR(9),
    MGRSTARTDATE            CHAR(9),
    PRIMARY KEY (DNUMBER),
    UNIQUE (DNAME),
    FOREIGN KEY (MGRSSN) REFERENCES EMPLOYEE
);
```

How to handle violation

Cancel the operation that causes the violation

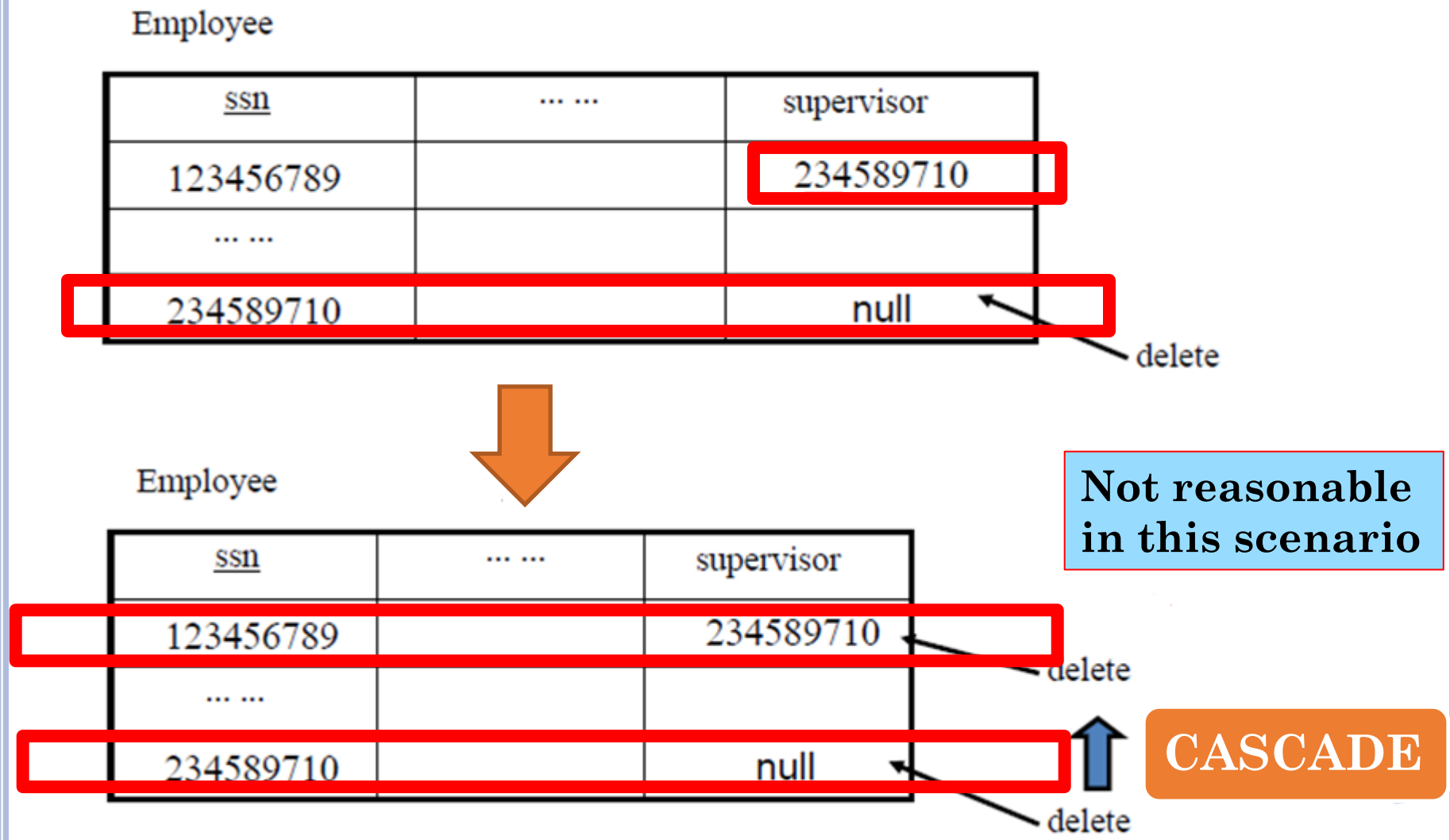
Perform the operation but inform the user of the violation

Trigger additional updates so the violation is corrected

- CASCADE option
- SET NULL option

Execute a user-specified error-correction routine

REFERENTIAL INTEGRITY OPTIONS



REFERENTIAL INTEGRITY OPTIONS

Employee

ssn	… …	supervisor
123456789		234589710
… …		
234589710		null

delete

Employee

ssn	… …	supervisor
123456789		NULL
… …		

SET NULL

REFERENTIAL INTEGRITY OPTIONS

- We can specify RESTRICT, CASCADE, SET NULL or SET DEFAULT on foreign keys.

```
CREATE TABLE   DEPARTMENT
(
    DNAME                   VARCHAR(10) NOT NULL,
    DNUMBER                 INTEGER NOT NULL,
    MGRSSN                  CHAR(9),
    MGRSTARTDATE            CHAR(9),
    PRIMARY KEY (DNUMBER),
    UNIQUE (DNAME),
    FOREIGN KEY (MGRSSN) REFERENCES EMPLOYEE
    ON DELETE SET NULL ON UPDATE  CASCADE
);
```

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
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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

REFERENTIAL INTEGRITY OPTIONS

```
CREATE TABLE   EMPLOYEE
      (
      NAME          VARCHAR(30) NOT NULL,
      SSN           CHAR(9),
      BDATE         DATE,
      DNO           INTEGER  DEFAULT 1,
      SUPERSSN      CHAR(9),
      PRIMARY KEY (ESSN),
```

```
);
```

REFERENTIAL INTEGRITY OPTIONS

```
CREATE TABLE   EMPLOYEE
      (
      ENAME          VARCHAR(30) NOT NULL,
      ESSN           CHAR(9),
      BDATE          DATE,
      DNO            INTEGER  DEFAULT 1,
      SUPERSSN       CHAR(9),
      PRIMARY KEY (ESSN),

      FOREIGN KEY (DNO) REFERENCES DEPARTMENT
      ON DELETE SET DEFAULT ON UPDATE CASCADE,

);
```

REFERENTIAL INTEGRITY OPTIONS

```
CREATE TABLE   EMPLOYEE
      (
      ENAME          VARCHAR(30) NOT NULL,
      ESSN           CHAR(9),
      BDATE          DATE,
      DNO            INTEGER  DEFAULT 1,
      SUPERSSN       CHAR(9),
      PRIMARY KEY (ESSN),
      FOREIGN KEY (DNO) REFERENCES DEPARTMENT
      ON DELETE SET DEFAULT ON UPDATE CASCADE,
      FOREIGN KEY (SUPERSSN) REFERENCES EMPLOYEE
      ON DELETE SET NULL ON UPDATE CASCADE
);
```

SQL CONSTRAINTS

- Assigning Names to Constraints

CONSTRAINT deptPK PRIMARY KEY(Dnumber)
CONSTRAINT deptSK UNIQUE(Dname)

CHECK Constraint

CHECK (Dept_create_date <= Mgr_start_date)

DROP COMMAND

- Drop Command is used to delete schema or named schema elements such as table, domains, or constraints

Example:

```
DROP TABLE  DEPENDENT;
DROP TABLE EMPLOYEE CASCADE;
DROP SCHEMA COMPANY;
```

In SQL-Server (T-SQL), DROP TABLE cannot be used to drop a table that is referenced by a FOREIGN KEY. The referencing FOREIGN KEY or the referencing table must first be dropped.

ALTER COMMAND

- The definition of table can be changed using ALTER command
- ALTER can be used to add an attribute to the relation
  - Initially, the new attribute will have NULLs in all the tuples of the relation
  - NOT NULL constraint is *not allowed* for such an attribute

Example :

ALTER TABLE EMPLOYEE ADD JOB VARCHAR(12);

The database user have to enter a value for the new attribute JOB for each EMPLOYEE tuple.

ALTER TABLE

- ALTER command can be used to add or drop constraints

- **Example:**

  - **ALTER TABLE** EMPLOYEE **add constraint** unEmp **UNIQUE(**NAME**);**

  - **ALTER TABLE** EMPLOYEE **drop constraint** unEmp **;**