CSC 261/461
Introduction to Databases

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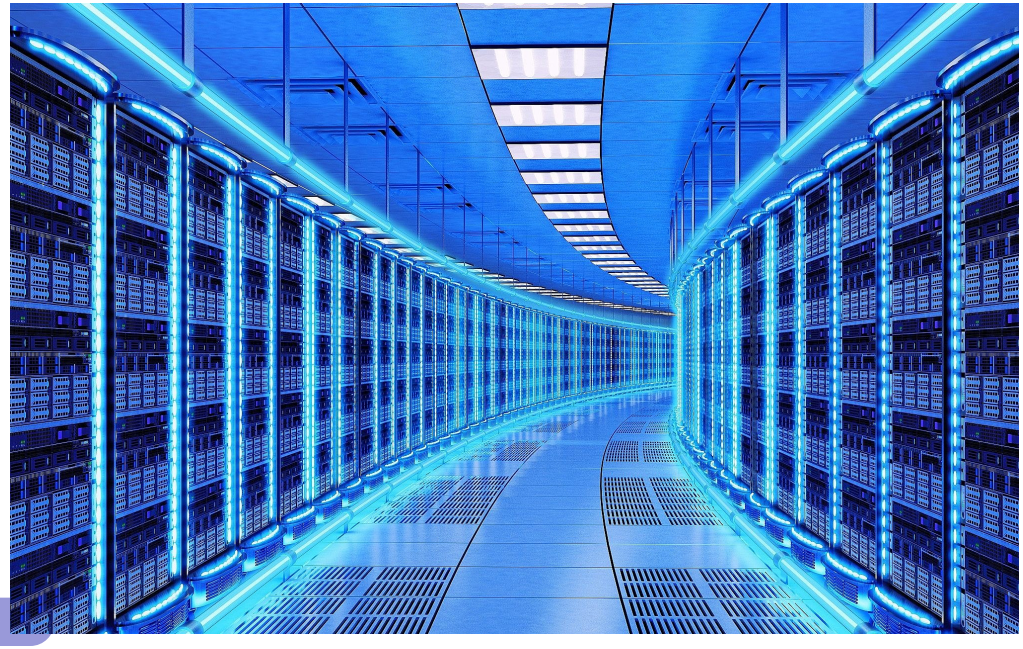

UNIVERSITY of ROCHESTER

Constraints

Constraints determine valid values in a database.

1. **Inherent** or **Implicit Constraints**: These are based on the data model itself.
2. **Schema-based** or **Explicit Constraints**: Expressed in the schema with the facilities provided by the model.
3. **Application-based** or **semantic constraints**: Beyond the expressive power of the model and must be specified and enforced by the application.

Implicit Constraints

- All values are considered **atomic** (indivisible).
  - no composite attributes
  - no multivalued attributes
- Each value in a tuple must be from the domain of the attribute for that column.

  `Mgr_ssn char(9)`
- A special `NULL` value is used to represent values that are unknown/inapplicable in certain tuples.

Explicit Constraints

The main types of constraints expressed in the relational model:

- **Domain** constraints
- **Key** constraints
- **Entity integrity** constraints
- **Referential integrity** constraints

Key Constraint

- **Superkey** of R: Is a set of attributes SK of R such that:
  - No two tuples in any valid relation state r(R) will have the same value for SK
- **Key** of R: A "minimal" superkey
  - a key is a superkey K such that removal of any attribute from K results in a set of attributes that is not a superkey

Question: Is the key a superkey? Is the superkey a key?

Example

STUDENT

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

Candidate Keys

CAR

License_number	Engine_serial_number	Make	Model	Year
Texas ABC-739	A69352	Ford	Mustang	02
Florida TVP-347	B43696	Oldsmobile	Cutlass	05
New York MPO-22	X83554	Oldsmobile	Delta	01
California 432-TFY	C43742	Mercedes	190-D	99
California RSK-629	Y82935	Toyota	Camry	04
Texas RSK-629	U028365	Jaguar	XJS	04

Entity Integrity

- The primary key attributes PK cannot have `NULL` values.
  - This is because primary key values are used to identify the individual tuples.
  - If PK has several attributes, `NULL` is not allowed in any of the attributes
- Other attributes of R may be constrained to disallow `NULL` values.

Referential Integrity

- A constraint involving two relations
- Used to specify a relationship among tuples in two relations:
  - The **referencing** relation and the **referenced** relation.
- attributes in the **foreign key** (FK) of R_1 have the same domain(s) as the attributes primary key (PK) of R_2.
- Attributes FK in R_1 reference the attributes PK in $R2$.
  - A tuple t_1 in R_1 is said to reference a tuple t_2 in R_2 if $t_1[FK] = t_2[PK]$.

Example

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

Example

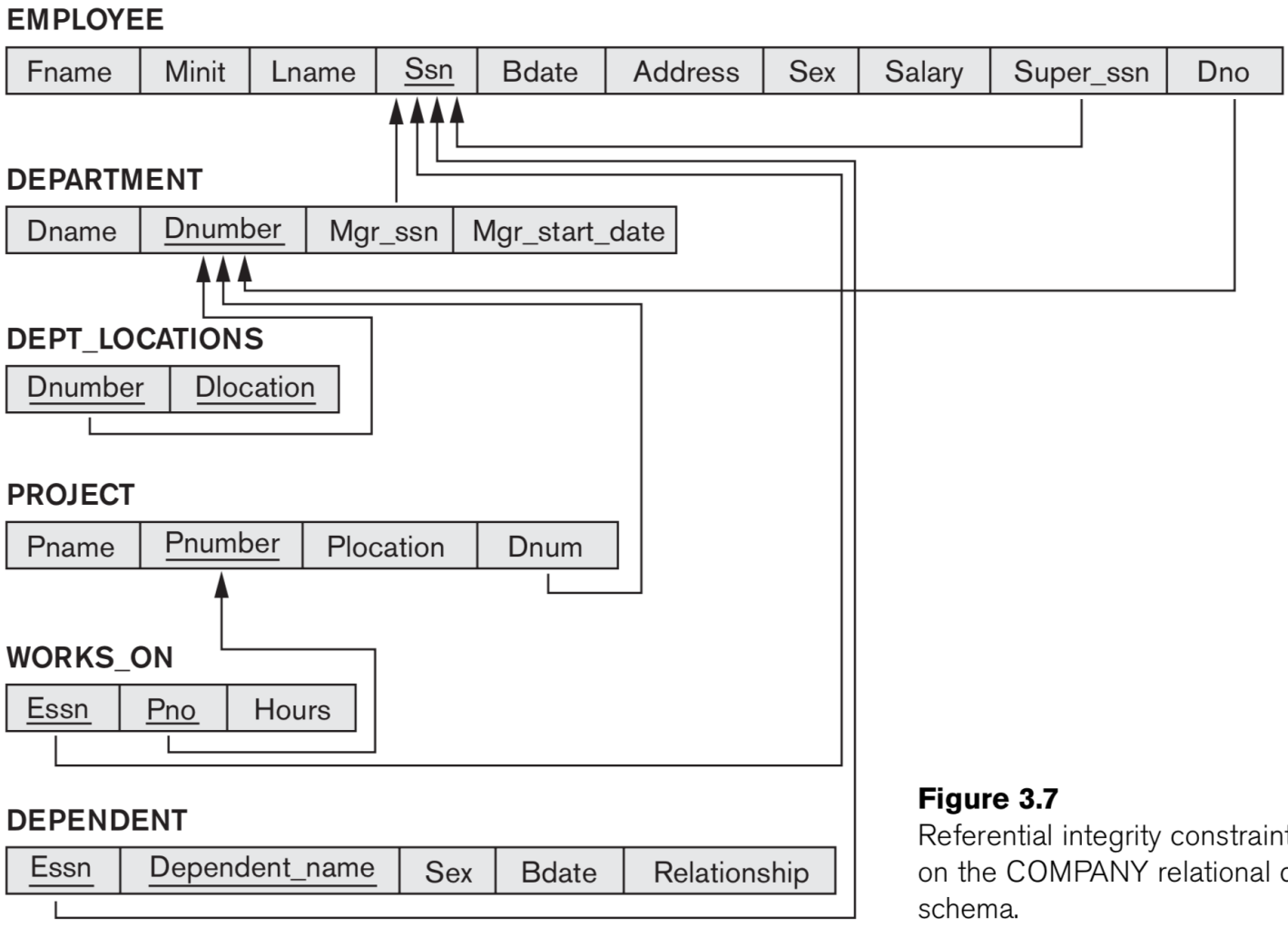

Figure 3.7
Referential integrity constraints displayed on the COMPANY relational database schema.

Atribute and Tuple Constraints

In a `CREATE TABLE` statement, we can declare two kinds of constraints:

1. A constraint on a single attribute.

   Age int CHECK (Age>=18)

2. A constraint on a tuple as a whole.

   CHECK (answer = 'F'OR name LIKE 'Mr.%')

Declaring Keys

- There are two declarations that may be used to indicate keys
  1. `PRIMARY KEY`
  2. `UNIQUE`
- the effect of declaring a set of attributes S to be a key is:
  - two tuples in R cannot agree on all of the attributes in set S, unless one of them is `NULL`.
  - any attempt to insert or update a tuple that violates this rule is rejected.
  - if `PRIMARY KEY` is used, then attributes in S do not allow `NULL` as value.

Referential Integrity

- Referential integrity is specified via `FOREIGN KEY`.
- referential integrity can be violated
  - when tuples are inserted or deleted, or
  - when a foreign key or primary key attribute value is modified.
- Default action that for an integrity violation is to reject the operation
  - this is known as the `RESTRICT` option. exa

Update Operations on Relations

- INSERT a tuple.
- DELETE a tuple.
- MODIFY a tuple.
- Integrity constraints *should not* be violated by the update operations.

Potential Violations

INSERT

- Domain constraint:
  - attribute values of new tuple 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 ▸ exa

Possible Violations

DELETE

- DELETE may violate only referential integrity:
  - If the primary key value of the tuple being deleted is referenced from other tuples in the database
  - `RESTRICT` option: reject the deletion
  - `CASCADE` option: attempt to cascade the deletion by deleting tuples that reference the deleted tuple
  - `SET NULL` option: set the foreign keys of the referencing tuples to NULL

Possible Violations

UPDATE

- UPDATE may violate domain or NOT NULL constraint
- Any of the other constraints may also be violated:
  - 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