CS4.301 Data & Applications

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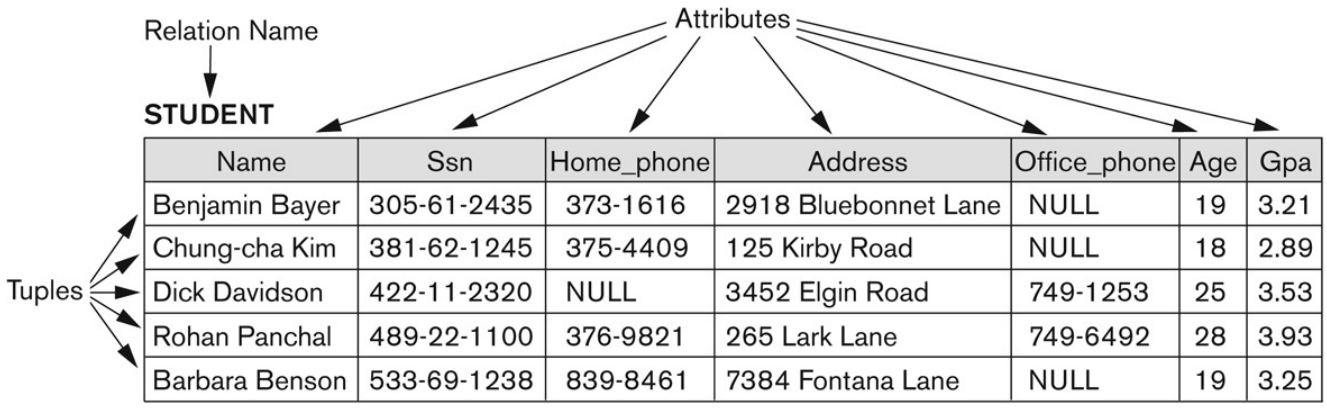
Ordering of tuples



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

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	749-1253	25	3.53
Barbara Benson	533-69-1238	839-8461	7384 Fontana Lane	NULL	19	3.25
Rohan Panchal	489-22-1100	376-9821	265 Lark Lane	749-6492	28	3.93
Chung-cha Kim	381-62-1245	375-4409	125 Kirby Road	NULL	18	2.89
Benjamin Bayer	305-61-2435	373-1616	2918 Bluebonnet Lane	NULL	19	3.21

Characteristics Of Relations

Values in a tuple:

- All values are considered atomic (indivisible).
- Each value in a tuple must be from the domain of the attribute for that column
  - If tuple t = <v1, v2, …, vn> is a tuple (row) in the relation state r of R(A1, A2, …, An)
  - Then each *vi* must be a value from *dom(Ai)*
- A special **null** value is used to represent values that are unknown or not available or inapplicable in certain tuples.

CONSTRAINTS

Constraints determine which values are permissible and which are not in the database.

They are of three main types:

1. **Inherent or Implicit Constraints**: These are based on the data model itself. (E.g., relational model does not allow a list as a value for any attribute)

2. **Schema-based or Explicit Constraints**: They are expressed in the schema by using the facilities provided by the model. (E.g., max. cardinality ratio constraint in the ER model)

3. **Application based or semantic constraints**: These are beyond the expressive power of the model and must be specified and enforced by the application programs. (E.g. Bookmytickets allowing only 4 tickets to be booked for a user at a given point in time)

Candidate key & Super key difference

Super Key	Candidate Key
Super Key is an attribute (or set of attributes) that is used to uniquely identifies all attributes in a relation.	Candidate Key is a subset of a super key.
All super keys can't be candidate keys.	But all candidate keys are super keys.
Various super keys together makes the criteria to select the candidate keys.	Various candidate keys together makes the criteria to select the primary keys.
In a relation, number of super keys is more than number of candidate keys.	While in a relation, number of candidate keys are less than number of super keys.
Super key attributes can contain NULL values.	Candidate key attributes can also contain NULL values.

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

Key Constraints (continued)

If a relation has several **candidate keys**, one is chosen arbitrarily to be the **primary key**.

- The primary key attributes are underlined.

Example: Consider the CAR relation schema:

- License_number & Enginer_serial_number
- We chose Enginer_serial_number as the primary key

The primary key value is used to *uniquely identify* each tuple in a relation

- Provides the tuple identity

Also used to *reference* the tuple from another tuple

- General rule: Choose as primary key the smallest of the candidate keys (in terms of size)
- Not always applicable – choice is sometimes subjective

CAR table with two candidate keys – LicenseNumber chosen as Primary Key

Figure 5.4
The CAR relation, with two candidate keys: License_number and Engine_serial_number.

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

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/

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.

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**:

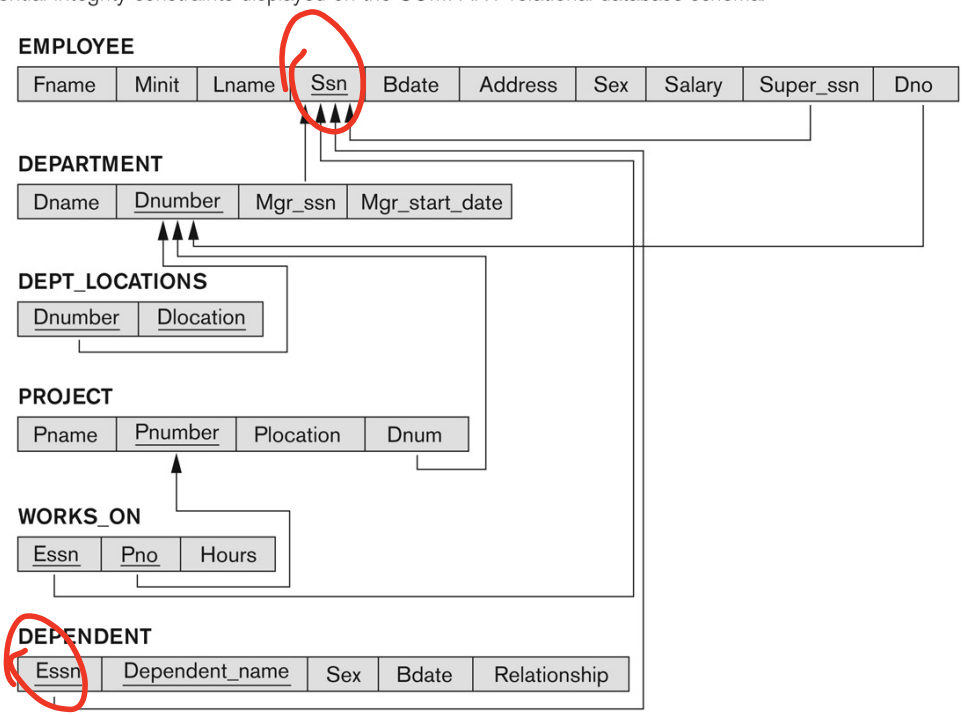
(1) a value of an existing primary key value of a corresponding primary key PK in the **referenced relation** R2, or

(2) a **null**.

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

Referential integrity constraints for Company

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

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

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.

What are the results?

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 (see Chapter 6 for more details)
    - RESTRICT option: reject the deletion
    - CASCADE option: propagate the new primary key value into the foreign keys of the referencing tuples
    - 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

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.
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.

This Lecture

Administrativia

How was Quiz 2?

Please attend the tutorial on Saturday; how many of you are not here?

Quiz 1 marks, How?

Today Quiz 2 eval.

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-3 is the current standard which started with SQL-1999

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.

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.)

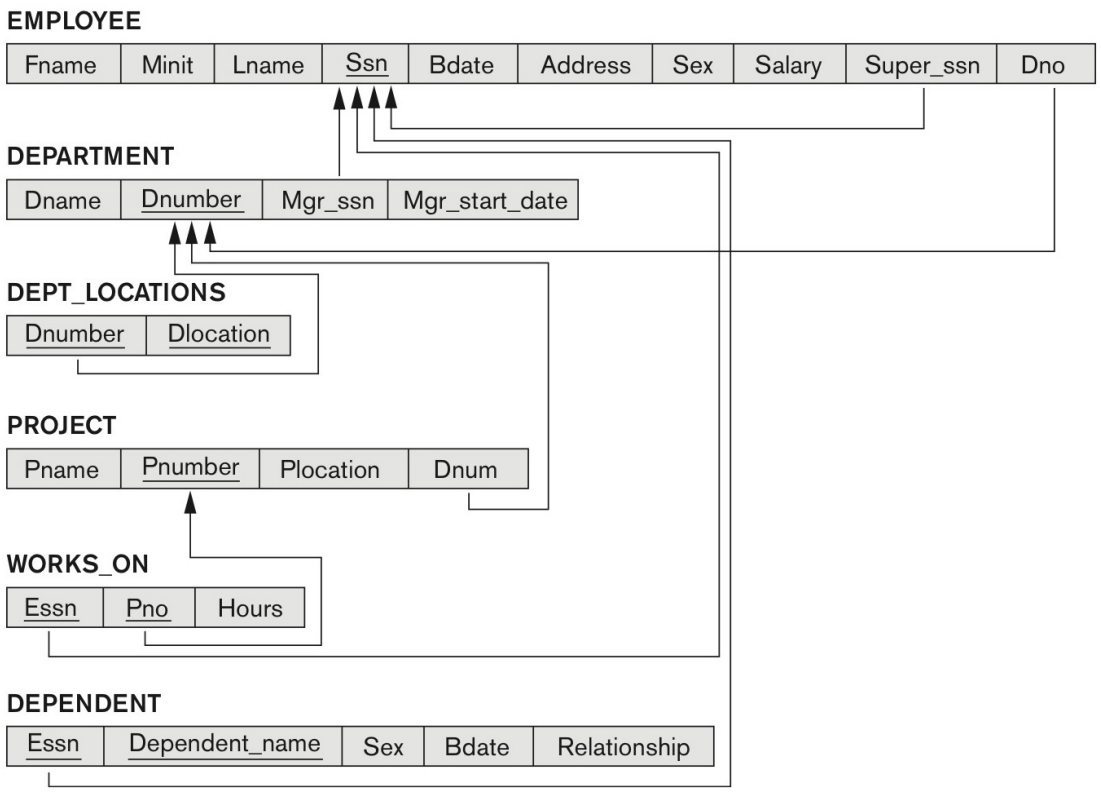
Base tables (**base relations**)

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) );
```

Attribute Data Types and Domains in SQL

Basic **data types**

- **Numeric** data types
  - Integer numbers: `INTEGER`, `INT`, and `SMALLINT`
  - Floating-point (real) numbers: `FLOAT` or `REAL`, and `DOUBLE PRECISION`
- **Character-string** data types
  - Fixed length: `CHAR(`*n*`)`, `CHARACTER(`*n*`)`
  - Varying length : `VARCHAR(`*n*`)`, `CHAR VARYING(`*n*`)`, `CHARACTER VARYING(`*n*`)`

Data type	Range	Storage
BIGINT	-2^{63} (-9,223,372,036,854,775,808) to $2^{63}-1$ (9,223,372,036,854,775,807)	8 Bytes
INT	**-2^{31} (-2,147,483,648) to $2^{31}-1$ (2,147,483,647)**	**4 Bytes**
SMALLINT	-2^{15} (-32,768) to $2^{15}-1$ (32,767)	2 Bytes
TINYINT	0 to 255	1 Byte

Attribute Data Types and Domains in SQL (cont'd.)

Bit-string data types [0s, 1s]

- Fixed length: `BIT(`*n*`)`
- Varying length: `BIT VARYING(`*n*`)`

Boolean data type

- Values of `TRUE` or `FALSE` or `NULL`

DATE data type

- Ten positions
- Components are `YEAR`, `MONTH`, and `DAY` in the form YYYY-MM-DD
- Multiple mapping functions available in RDBMSs to change date formats

Attribute Data Types and Domains in SQL (cont'd.)

Additional data types

- **Timestamp** data type
- Includes the `DATE` and `TIME` fields
  - Plus a minimum of six positions for decimal fractions of seconds
  - Optional `WITH TIME ZONE` qualifier
- **INTERVAL** data type
  - Specifies a relative value that can be used to increment or decrement an absolute value of a date, time, or timestamp
- **DATE, TIME, Timestamp, INTERVAL** data types can be **cast** or converted to string formats for comparison.

Attribute Data Types and Domains in SQL (cont'd.)

Domain

Name used with the attribute specification

Makes it easier to change the data type for a domain that is used by numerous attributes

Improves schema readability

Example:

```
CREATE DOMAIN SSN_TYPE AS CHAR(9);
```

TYPE

User Defined Types (UDTs) are supported for object-oriented applications. (See Ch.12) Uses the command: `CREATE TYPE`

```
CREATE TYPE AUDIO  AS BLOB (1M) [Binary Large OBject]
```

Specifying Constraints in SQL

Basic constraints:

Relational Model has 3 basic constraint types that are supported in SQL:

Key constraint: A primary key value cannot be duplicated

Entity Integrity Constraint: A primary key value cannot be null

Referential integrity constraints : The “foreign key “ must have a value that is already present as a primary key, or may be null.

Specifying Attribute Constraints

Other Restrictions on attribute domains:

Default value of an attribute

DEFAULT <value>

NULL is not permitted for a particular attribute (NOT NULL)

CHECK clause

```
Dnumber INT NOT NULL CHECK (Dnumber > 0 AND Dnumber < 21);
```

Specifying Key and Referential Integrity Constraints

`PRIMARY KEY` clause

Specifies one or more attributes that make up the primary key of a relation

```
Dnumber INT PRIMARY KEY;
```

`UNIQUE` clause

Specifies alternate (secondary) keys (called CANDIDATE keys in the relational model).

```
Dname VARCHAR(15) UNIQUE;
```

Specifying Key and Referential Integrity Constraints (cont'd.)

`FOREIGN KEY` clause

- Default operation: reject update on violation
- Attach **referential triggered action** clause
  - Options include `SET NULL`, `CASCADE`, and `SET DEFAULT`
  - Action taken by the DBMS for `SET NULL` or `SET DEFAULT` is the same for both `ON DELETE` and `ON UPDATE`
  - `CASCADE` option suitable for some propagation needs to be done [Manager leaving organization, or somebody stepping down as manager]

Giving Names to Constraints

Using the Keyword **`CONSTRAINT`**

- Name a constraint
- Useful for later altering

```
CREATE TABLE EMPLOYEE
    ( … ,
      Dno          INT          NOT NULL       DEFAULT 1,
    CONSTRAINT EMPPK
      PRIMARY KEY (Ssn),
    CONSTRAINT EMPSUPERFK
      FOREIGN KEY (Super_ssn) REFERENCES EMPLOYEE(Ssn)
                  ON DELETE SET NULL          ON UPDATE CASCADE,
    CONSTRAINT EMPDEPTFK
      FOREIGN KEY(Dno) REFERENCES DEPARTMENT(Dnumber)
                  ON DELETE SET DEFAULT       ON UPDATE CASCADE);
CREATE TABLE DEPARTMENT
    ( … ,
      Mgr_ssn CHAR(9)          NOT NULL       DEFAULT '888665555',
      … ,
    CONSTRAINT DEPTPK
      PRIMARY KEY(Dnumber),
    CONSTRAINT DEPTSK
      UNIQUE (Dname),
    CONSTRAINT DEPTMGRFK
      FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn)
                  ON DELETE SET DEFAULT       ON UPDATE CASCADE);
CREATE TABLE DEPT_LOCATIONS
    ( … ,
    PRIMARY KEY (Dnumber, Dlocation),
    FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber)
                  ON DELETE CASCADE           ON UPDATE CASCADE);
```

Default attribute values and referential integrity triggered action specification (Fig. 6.2)

Specifying Constraints on Tuples Using CHECK

Additional Constraints on individual tuples within a relation are also possible using CHECK

`CHECK` clauses at the end of a `CREATE TABLE` statement

Apply to each tuple individually

```
CHECK (Dept_create_date <= Mgr_start_date);
```

Basic Retrieval Queries in SQL

`SELECT` statement

- One basic statement for retrieving information from a database

SQL allows a table to have two or more tuples that are identical in all their attribute values [Results from the query]

- Unlike relational model (relational model is strictly set-theory based)
- Multiset or bag behavior
- Tuple-id may be used as a key

The SELECT-FROM-WHERE Structure of Basic SQL Queries

Basic form of the `SELECT` statement:

```
SELECT    <attribute list>
FROM      <table list>
WHERE     <condition>;
```

where

- <attribute list> is a list of attribute names whose values are to be retrieved by the query.
- <table list> is a list of the relation names required to process the query.
- <condition> is a conditional (Boolean) expression that identifies the tuples to be retrieved by the query.

The SELECT-FROM-WHERE Structure of Basic SQL Queries (cont'd.)

Logical comparison operators

=, <, <=, >, >=, and <>

Projection attributes

Attributes whose values are to be retrieved

Selection condition

Boolean condition that must be true for any retrieved tuple. Selection conditions include join conditions (see Ch.8) when multiple relations are involved.

Basic Retrieval Queries

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

Query 0. Retrieve the birth date and address of the employee(s) whose name is 'John B. Smith'.

```
Q0:   SELECT   Bdate, Address
      FROM     EMPLOYEE
      WHERE    Fname='John' AND Minit='B' AND Lname='Smith';
```

Basic Retrieval Queries

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

Query 0. Retrieve the birth date and address of the employee(s) whose name is 'John B. Smith'.

```
Q0:   SELECT   Bdate, Address
      FROM     EMPLOYEE
      WHERE    Fname='John' AND Minit='B' AND Lname='Smith';
```

Bdate	Address
1965-01-09	731 Fondren, Houston, TX

Basic Retrieval Queries

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

Query 1. Retrieve the name and address of all employees who work for the 'Research' department.

```
Q1:   SELECT   Fname, Lname, Address
      FROM     EMPLOYEE, DEPARTMENT
      WHERE    Dname='Research' AND Dnumber=Dno;
```

Basic Retrieval Queries

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

Query 1. Retrieve the name and address of all employees who work for the 'Research' department.

```
Q1:   SELECT   Fname, Lname, Address
      FROM     EMPLOYEE, DEPARTMENT
      WHERE    Dname='Research' AND Dnumber=Dno;
```

Fname	Lname	Address
John	Smith	731 Fondren, Houston, TX
Franklin	Wong	638 Voss, Houston, TX
Ramesh	Narayan	975 Fire Oak, Humble, TX
Joyce	English	5631 Rice, Houston, TX

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

Query 2. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birth date.

```
Q2:   SELECT   Pnumber, Dnum, Lname, Address, Bdate
      FROM     PROJECT, DEPARTMENT, EMPLOYEE
      WHERE    Dnum=Dnumber AND Mgr_ssn=Ssn AND
               Plocation='Stafford';
```

10, Hrw, 291, 1941

30, 4, W, - - - -

Query 2. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birth date.

```
Q2:   SELECT   Pnumber, Dnum, Lname, Address, Bdate
      FROM     PROJECT, DEPARTMENT, EMPLOYEE
      WHERE    Dnum=Dnumber AND Mgr_ssn=Ssn AND
               Plocation='Stafford';
```

(c)

Pnumber	Dnum	Lname	Address	Bdate
10	4	Wallace	291Berry, Bellaire, TX	1941-06-20
30	4	Wallace	291Berry, Bellaire, TX	1941-06-20

Ambiguous Attribute Names

Same name can be used for two (or more) attributes in different relations

- As long as the attributes are in different relations
- Must **qualify** the attribute name with the relation name to prevent ambiguity

```
Q1A:  SELECT   Fname, EMPLOYEE.Name, Address
      FROM     EMPLOYEE, DEPARTMENT
      WHERE    DEPARTMENT.Name='Research' AND
               DEPARTMENT.Dnumber=EMPLOYEE.Dnumber;
```

Aliasing, and Renaming

Aliases or **tuple variables**

Declare alternative relation names E and S to refer to the EMPLOYEE relation twice in a query:

Query 8. For each employee, retrieve the employee's first and last name and the first and last name of his or her immediate supervisor.

```
SELECT  E.Fname, E.Lname, S.Fname, S.Lname
FROM    EMPLOYEE AS E, EMPLOYEE AS S
WHERE E.Super_ssn=S.Ssn;
```

Recommended practice to abbreviate names and to prefix same or similar attribute from multiple tables.

E.Fname	E.Lname	S.Fname	S.Lname
John	Smith	Franklin	Wong
Franklin	Wong	James	Borg
Alicia	Zelaya	Jennifer	Wallace
Jennifer	Wallace	James	Borg
Ramesh	Narayan	Franklin	Wong
Joyce	English	Franklin	Wong
Ahmad	Jabbar	Jennifer	Wallace

Aliasing,Renaming and Tuple Variables (contd.)

The attribute names can also be renamed

```
EMPLOYEE AS E(Fn, Mi, Ln, Ssn, Bd, Addr, Sex,
Sal, Sssn, Dno)
```

Note that the relation EMPLOYEE now has a variable name E which corresponds to a tuple variable

The “AS” may be dropped in most SQL implementations

Unspecified WHERE Clause and Use of the Asterisk

Missing `WHERE` clause

- Indicates no condition on tuple selection

Effect is a `CROSS PRODUCT`

- Result is all possible tuple combinations (or the Algebra operation of Cartesian Product– see Ch.8) result

Queries 9 and 10. Select all EMPLOYEE Ssns (Q9) and all combinations of EMPLOYEE Ssn and DEPARTMENT Dname (Q10) in the database.

```
Q9:   SELECT   Ssn
      FROM     EMPLOYEE;

Q10:  SELECT   Ssn, Dname
      FROM     EMPLOYEE, DEPARTMENT;
```

SSn
123456789
333445555
999887777
987654321
666884444
453453453
987987987
888665555

Q9

Ssn	Dname
123456789	Research
333445555	Research
999887777	Research
987654321	Research
666884444	Research
453453453	Research
987987987	Research
888665555	Research
123456789	Administration
333445555	Administration
999887777	Administration
987654321	Administration
666884444	Administration
453453453	Administration
987987987	Administration
888665555	Administration
123456789	Headquarters
333445555	Headquarters
999887777	Headquarters
987654321	Headquarters
666884444	Headquarters
453453453	Headquarters
987987987	Headquarters
888665555	Headquarters

Q10

Unspecified WHERE Clause and Use of the Asterisk (cont'd.)

Specify an asterisk (*)

Retrieve all the attribute values of the selected tuples

The * can be prefixed by the relation name; e.g., EMPLOYEE *


```
Q1C:    SELECT    *
        FROM      EMPLOYEE
        WHERE     Dno=5;

Q1D:    SELECT    *
        FROM      EMPLOYEE, DEPARTMENT
        WHERE     Dname='Research' AND Dno=Dnumber;

Q10A:   SELECT    *
        FROM      EMPLOYEE, DEPARTMENT;
```

Bibliography / Acknowledgements

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Ponnurangam.kumaraguru

/in/ponguru

ponguru

Thank you for attending the class!!!

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