THE RELATIONAL DATA MODEL

CHAPTER 3 (6/E)

CHAPTER 5 (5/E)

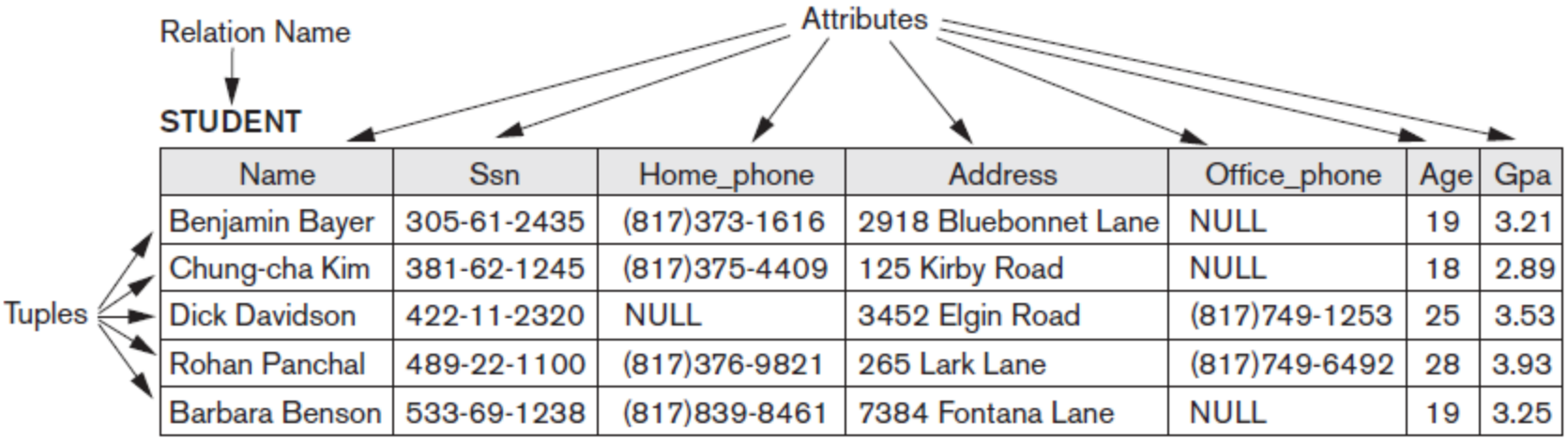
LECTURE OUTLINE

- Relational Model Concepts
- Relational Database Schemas
- Update Operations
- Brief History of Database Applications (from Section 1.7)

RELATIONAL MODEL CONCEPTS

- Represent data as a collection of relations
- **Table** of values
  - Each row (*tuple*)
    - Represents a record of related data values
    - Facts that typically correspond to a real-world entity or relationship
  - Each column (*attribute*)
    - Holds a corresponding value for each row
    - Slot for a specific interpretation for a row

RELATIONAL MODEL (CONT'D.)



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

Figure 3.1
The attributes and tuples of a relation STUDENT.

- **Schema** describes table
  - Table name, attribute names and types
- **Instance** denotes the current contents of the table
  - The **relation** (or **relation state**)

DOMAINS

- **Domain** *D*
  - Set of atomic values
    - {0,1,2,…}
    - {Jo Smith, Dana Jones, Ashley Wong, Y. K. Lee,…}
- **Atomic**
  - Each value indivisible
- Domain specified by **Data type** rather than by enumeration
  - Integer, String, Date, Real, etc.
  - Can be specified by format: (ddd)ddd-dddd

SCHEMAS AND ATTRIBUTES

- **Relation schema**
  - A relation name R and a list of attributes: A_1, A_2, ..., A_n
  - Denoted by $R(A_1, A_2, ..., A_n)$
- **Attribute** A_i
  - Name of a role in the relation schema R
  - Associated with a domain **dom(A_i)**
  - Attribute names do not repeat within relation schema, but domains can repeat.
- **Degree** (or **arity**) of a relation
  - Number of attributes n in its relation schema

FORMALIZATION

- **Relation** (or **relation state**)
  - Set of ***n*-tuples** $r = \{t_1, t_2, ..., t_m\}$
    - Unordered, no duplicates
  - Each *n*-tuple *t*
    - Ordered list of *n* values $t = <v_1, v_2, ..., v_n>$
    - Each value v_i, $1 \leq i \leq n$, is an element of dom(A_i)
  - Instance of relation schema $R(A_1, A_2, A_3, \ldots, A_n)$
  - **Finite subset** of the **Cartesian product** of the domains defining *R*:
    - rel(R) $\subseteq$ (dom(A_1) $\times$ dom(A_2) $\times$ ... $\times$ dom(A_n))
- Because of updates, relations are **time-varying**
  - rel(R) is relation state at a given time
  - Reflects only (and all) the valid tuples that represent a particular state of the real world

RELATIONAL MODEL NOTATION

- Symbolic notation
  - Uppercase letters *Q*, *R*, *S* *d*enote relation names
  - Corresponding lowercase letters *q*, *r*, *s* *d*enote corresponding relation states
  - Uppercase letters A, B, C, …, H denote attributes
    - Attribute *A* can be qualified with the relation name *R* to which it belongs using the dot notation, e.g., *R.A*
  - Lower case letters *t*, *u*, *v* *d*enote tuples

ALTERNATIVE DEFN OF RELATION

- Tuple considered as a function from attributes to values
  - $t_j : \{A_1, A_2, A_3, \ldots, A_n\} \rightarrow \text{dom}(A_1) \cup \text{dom}(A_2) \cup \ldots \cup \text{dom}(A_n)$
  - Use notation $t_j[A_i]$ or $t_j.A_i$ to refer to tuple's value v_i from dom(A_i)
  - Similarly $t_j[A_u, A_w, ..., A_z]$ and $t_j.(A_u, A_w, ..., A_z)$ refer to the subtuple of values $<v_u, v_w, ..., v_z>$ from t_j for attributes $A_u, A_w, ..., A_z$
- Therefore, tuple is a set of <attribute, value> pairs

e.g., for *attendee* (*id*, *givenName*, *surname*, *company*, *dateOfBirth*)

- t = <10483, John, Doe, IBM, 1978-11-05>
- t[id] = 10483, t[givenName] = John, t[surname] = Doe,
  t[company] = IBM, t[dateOfBirth] = 1978-11-05
- t.id = 10483, t.givenName = John, t.surname = Doe,
  t.company = IBM, t.dateOfBirth = 1978-11-05
- t = { <id, 10483>, <givenName, John>, <surname, Doe>,
  <company, IBM>, <dateOfBirth, 1978-11-05> }

VALUES IN TUPLES

- Each value in a tuple is atomic
  - **Flat** (as opposed to *nested*) **relational model**
  - Composite and multivalued attributes not allowed
  - Historically relation is said to be **in First normal form** (**1NF**)
- Composite attributes
  - Split into simple component attributes
  - e.g., *Waterloo, Ontario* treated as atomic or split into two attributes to store *Waterloo* separately from *Ontario*
- Multivalued attributes
  - Must be represented by separate relations
  - Recall: *Director* could be stored as attribute of FILM because only one director per film assumed, but multiple characters in a film implies that ROLE must have its own relation.

NULL VALUES

- Assume each domain is augmented with a special NULL value
  - Represent the values of attributes that may be unknown or may not apply to a tuple
- Interpretations for NULL values
  - *Nothing is known about the value*
  - *Value exists but is (currently) not available*
  - *Value undefined*
    - i.e., attribute does not apply to this tuple
- If an attribute for a tuple is mapped to NULL, cannot make any assumptions about the value for that attribute (for that tuple)
  - e.g., Ashley's telephone number is NULL could mean
    - Ashley doesn't have a phone
    - Ashley has a phone but we don't know the number (perhaps withheld)
    - Ashley has a phone that has no number
    - Ashley may or may not have a phone, but regardless we don't have a number for Ashley

MEANING OF A RELATION

- **Assertion**
  - Each tuple in the relation interpreted as a **fact**.
  - No other similar facts are of interest to the enterprise.
  - e.g., a relation for Classlist includes only registered students and all registered students are included in Classlist
    - presence in list ⇔ registered student
- **Predicate**
  - Values in each tuple interpreted as values that satisfy predicate
  - e.g., Name of student having ID 83201556 is Lee Wong

LECTURE SUMMARY

- Characteristics differentiate relations from ordinary tables or files
- Schemas vs. instances (states)
- Formal definitions for relations and tuples
- Null values