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M.S. Ramaiah Institute of Technology
(Autonomous Institute, Affiliated to VTU)
Department of Computer Science and Engineering

Course Name: Database Systems

Course Code: CS52

Credits: 3:1:0

UNIT 1

Term: October 2021– February 2022

Reference:
Elmasri, R., Shamkant B. Navathe, R.
Fundamentals of Database Systems

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Unit 2 – Chapter 7

- Relational Model and Relational Algebra:
- Relational Model Concepts, Relational Model Concepts
- Relational Model Constraints and Relational Database Schema
- Update Operations, Transactions and Dealing with Constraint violations
- Unary Relational operations
- Relational Algebra Operations from Set Theory
- Binary Relational Operations, JOIN and DIVISION
- Additional Relational Operations,
- Examples of Queries in Relational Algebra
- Relational Database Design Using ER- to-Relational Mapping.

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Chapter Outline

- **ER-to-Relational Mapping Algorithm**
  - Step 1: Mapping of Regular Entity Types
  - Step 2: Mapping of Weak Entity Types
  - Step 3: Mapping of Binary 1:1 Relation Types
  - Step 4: Mapping of Binary 1:N Relationship Types.
  - Step 5: Mapping of Binary M:N Relationship Types.
  - Step 6: Mapping of Multivalued attributes.
  - Step 7: Mapping of N-ary Relationship Types.

GOALS during Mapping

- Preserve all information (that includes all attributes)
- Maintain the constraints to the extent possible (Relational Model cannot preserve all constraints- e.g., max cardinality ratio such as 1:10 in ER; exhaustive classification into subtypes, e.g., STUDENTS are specialized into Domestic and Foreign)
- Minimize null values

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ER-to-Relational Mapping Algorithm

- **Step 1: Mapping of Regular Entity Types.**
  - For each regular (strong) entity type E in the ER schema, create a relation R that includes **all the simple attributes of E.**
  - Choose one of the key attributes of E as the **primary key** for R.
  - If the chosen key of E is **composite**, the **set of simple attributes that form it will together form the primary key** of R.
- Example: We create the relations EMPLOYEE, DEPARTMENT, and PROJECT in the relational schema corresponding to the regular entities in the ER diagram.
  - SSN, DNUMBER, and PNUMBER are the primary keys for the relations EMPLOYEE, DEPARTMENT, and PROJECT as shown.

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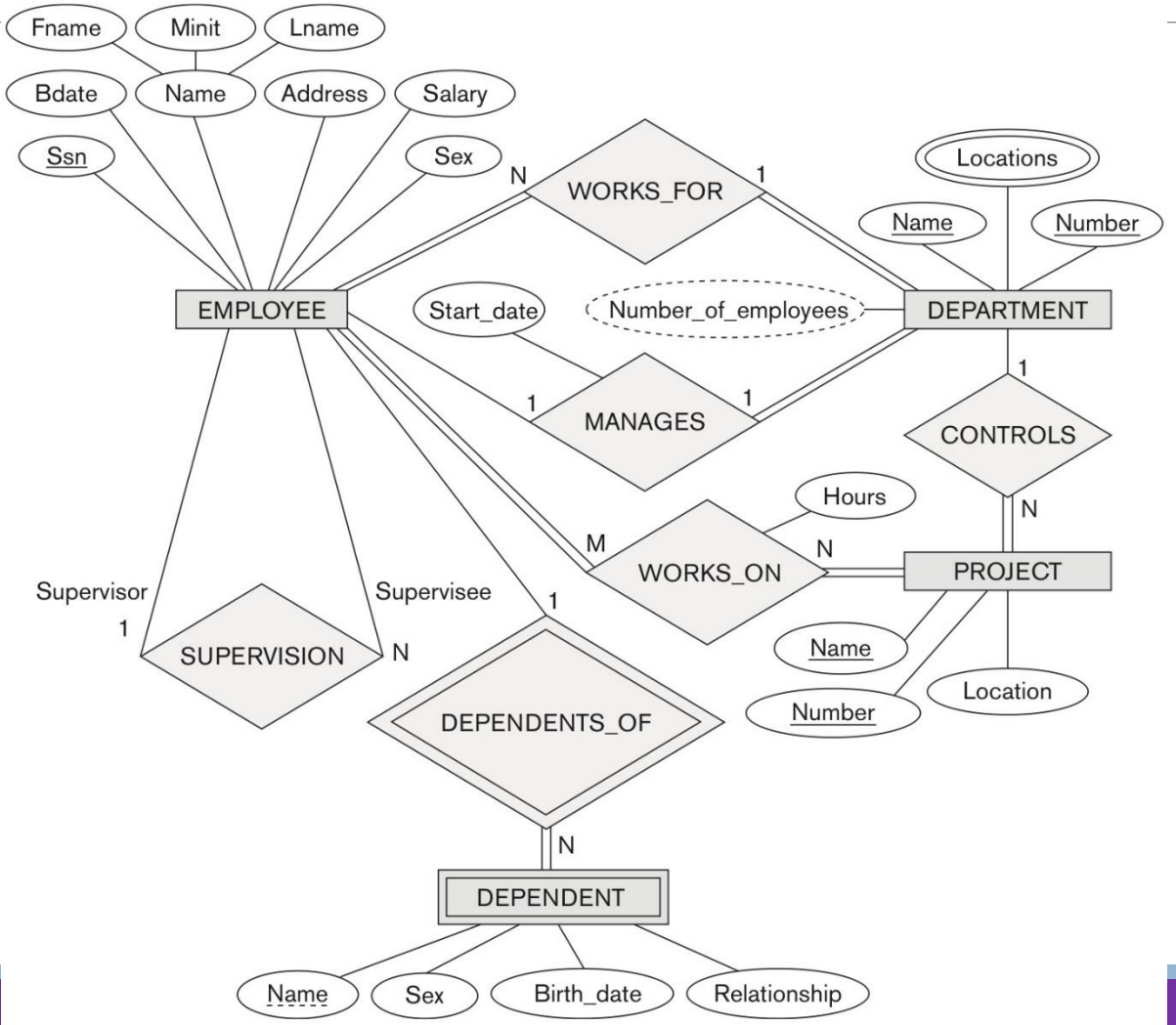
The ER conceptual schema diagram for the COMPANY database.



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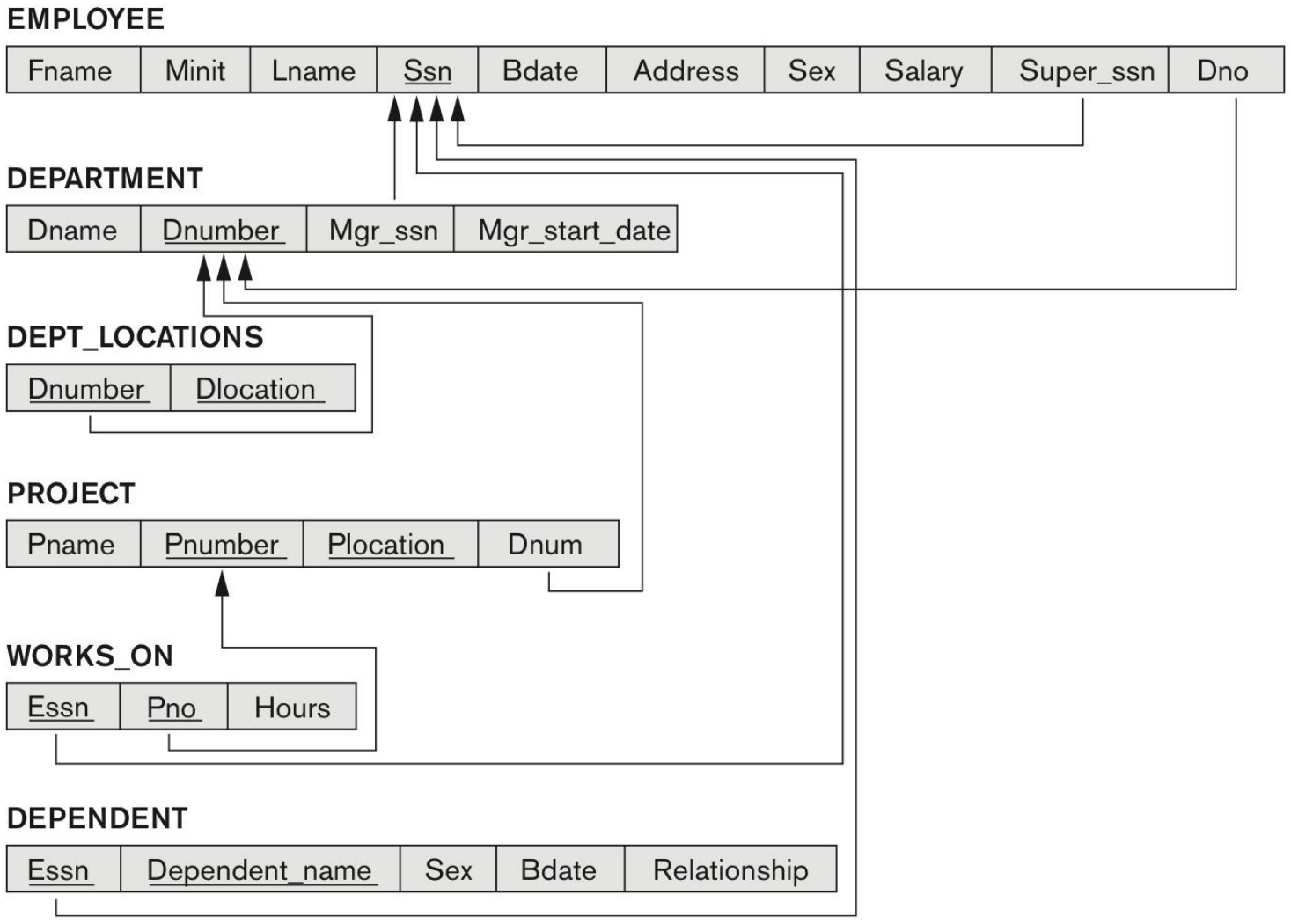
Result of mapping the COMPANY ER schema into a relational database schema.



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ER-to-Relational Mapping Algorithm

- **Step 2: Mapping of Weak Entity Types**
  - For each weak entity type W in the ER schema with owner entity type E, **create a relation R & include all simple attributes** (or simple components of composite attributes) of W as attributes of R.
  - Also, **include as foreign key attributes of R the primary key attribute(s) of the relation(s) that correspond to the owner entity type(s)**.
  - The **primary key of R is the *combination of* the primary key(s) of the owner(s) and the partial key of the weak entity type** W, if any.
- **Example:** Create the relation DEPENDENT in this step to correspond to the weak entity type DEPENDENT.
  - Include the primary key SSN of the EMPLOYEE relation as a foreign key attribute of DEPENDENT (renamed to ESSN).
  - The primary key of the DEPENDENT relation is the combination {ESSN, DEPENDENT_NAME} because DEPENDENT_NAME is the partial key of DEPENDENT.

ER-to-Relational Mapping Algorithm (contd.)

- **Step 3: Mapping of Binary 1:1 Relation Types**
  - For each binary 1:1 relationship type R in the ER schema, **identify the relations S and T** that correspond to the entity types participating in R.

- There are three possible approaches:
  1. **Foreign Key (2 relations) approach:** Choose one of the relations-say S-and **include a foreign key in S the primary key of T**. It is better to choose an entity type with total participation in R in the role of S.
     - Example: 1:1 relation MANAGES is mapped by choosing the participating entity type DEPARTMENT to serve in the role of S, because its participation in the MANAGES relationship type is total.
  2. **Merged relation (1 relation) option:** An alternate mapping of a 1:1 relationship type is possible by merging the two entity types and the relationship into a single relation. This may be appropriate when both participations are total.
  3. **Cross-reference or relationship relation (3 relations) option:** The third alternative is to set up a third relation R for the purpose of cross-referencing the primary keys of the two relations S and T representing the entity types.

ER-to-Relational Mapping Algorithm (contd.)

- **Step 4: Mapping of Binary 1:N Relationship Types.**
  - For each regular binary 1:N relationship type R, **identify the relation S** that represent the participating entity type at the **N-side of the relationship** type.
  - **Include as foreign key in S the primary key of the relation T** that represents the other entity type participating in R.
  - Include **any simple attributes of the 1:N relation type as attributes of S.**
- Example: 1:N relationship types WORKS_FOR, CONTROLS, and SUPERVISION in the figure.
  - For WORKS_FOR we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the EMPLOYEE relation and call it DNO.
- An alternative approach is to use a Relationship relation (cross referencing relation) – this is rarely done.

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ER-to-Relational Mapping Algorithm (contd.)

- **Step 5: Mapping of Binary M:N Relationship Types.**
  - For each regular binary M:N relationship type R, ***create a new relation*** **S** to represent R. This is a ***relationship relation.***
  - Include as **foreign key attributes in S the primary keys of the relations that represent the participating entity types**; *their combination will form the primary key* of S.
  - Also include any **simple attributes of the M:N relationship type** (or simple components of composite attributes) as attributes of S.
- Example: The M:N relationship type WORKS_ON from the ER diagram is mapped by creating a relation WORKS_ON in the relational database schema.
  - The primary keys of the PROJECT and EMPLOYEE relations are included as foreign keys in WORKS_ON and renamed PNO and ESSN, respectively.
  - Attribute HOURS in WORKS_ON represents the HOURS attribute of the relation type. The primary key of the WORKS_ON relation is the combination of the foreign key attributes {ESSN, PNO}.

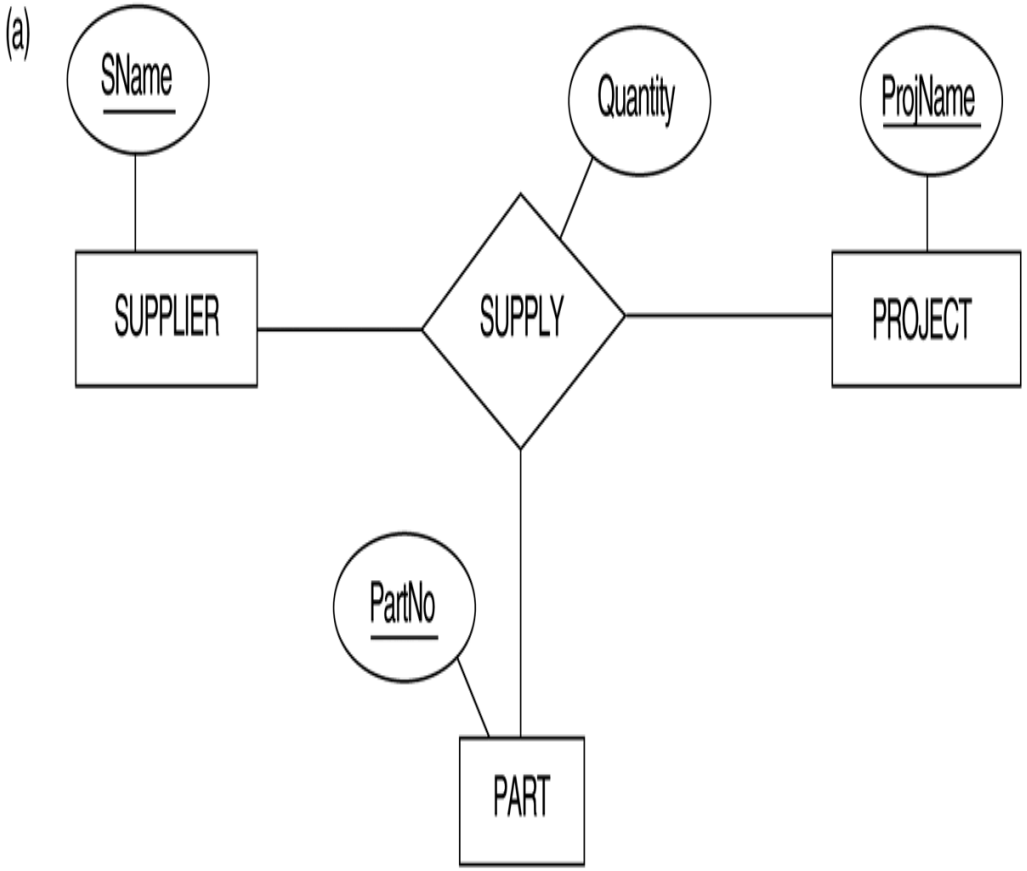
ER-to-Relational Mapping Algorithm (contd.)

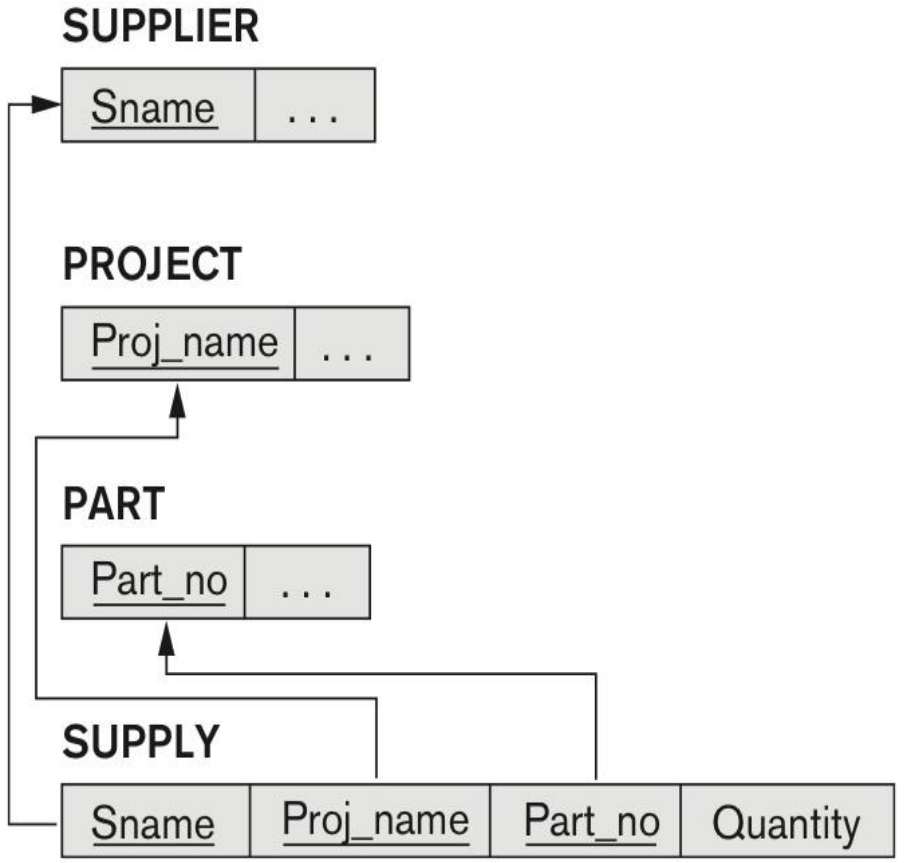
- **Step 6: Mapping of Multivalued attributes.**
  - **For each multivalued attribute A, create a new relation R.**
  - This relation R will include an **attribute** corresponding to A, plus the **primary key attribute K-as a foreign key** in R-of the relation that represents the entity type of relationship type that has A as an attribute.
  - The primary key of R is the combination of A and K. If the multivalued attribute is composite, we include its simple components.
- **Example:** The relation DEPT_LOCATIONS is created.
  - The attribute DLOCATION represents the multivalued attribute LOCATIONS of DEPARTMENT, while DNUMBER-as foreign key-represents the primary key of the DEPARTMENT relation.
  - The primary key of R is the combination of {DNUMBER, DLOCATION}.

ER-to-Relational Mapping Algorithm (contd.)

- **Step 7: Mapping of N-ary Relationship Types.**
  - For each n-ary relationship type R, where n>2, create **a new relationship** S to represent R.
  - Include as **foreign key attributes** in S the primary keys of the relations that represent the participating entity types.
  - Also **include any simple attributes of the n-ary relationship type** (or simple components of composite attributes) as attributes of S.
- **Example:** The relationship type SUPPLY in the ER on the next slide.
  - This can be mapped to the relation SUPPLY shown in the relational schema, whose primary key is the combination of the three foreign keys {SNAME, PARTNO, PROJNAME}

Mapping the *n*-ary relationship type SUPPLY

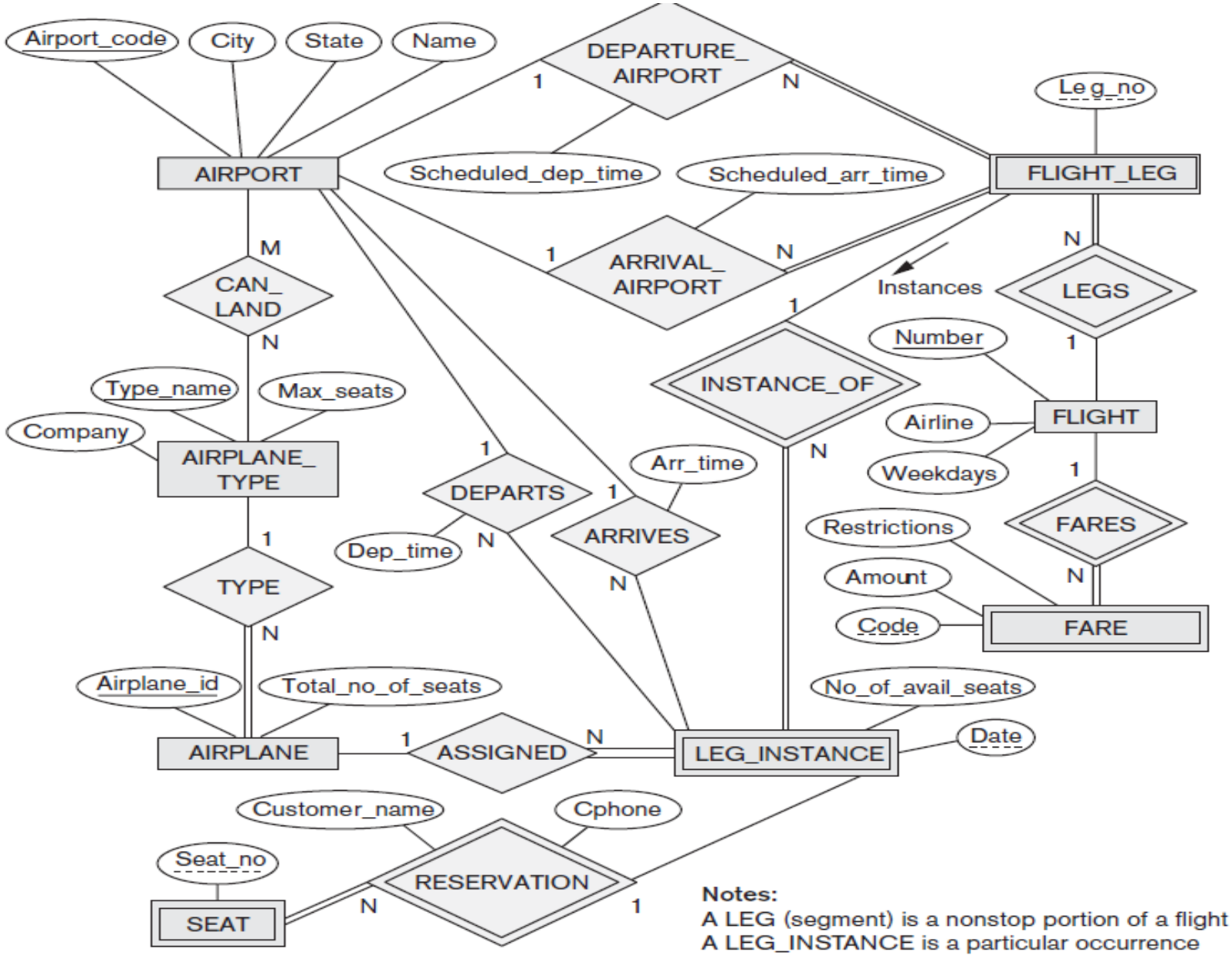




Summary of Mapping constructs and constraints

Table 9.1 Correspondence between ER and Relational Models

ER MODEL	RELATIONAL MODEL
Entity type	*Entity* relation
1:1 or 1:N relationship type	Foreign key (or *relationship* relation)
M:N relationship type	*Relationship* relation and *two* foreign keys
n-ary relationship type	*Relationship* relation and *n* foreign keys
Simple attribute	Attribute
Composite attribute	Set of simple component attributes
Multivalued attribute	Relation and foreign key
Value set	Domain
Key attribute	Primary (or secondary) key


Airport_code
City
State
Name
AIRPORT
DEPARTURE_AIRPORT
ARRIVAL_AIRPORT
Scheduled_dep_time
Scheduled_arr_time
FLIGHT_LEG
Leg_no
Instances
LEGS
CAN_LAND
Type_name
Max_seats
Company
AIRPLANE_TYPE
TYPE
DEPARTS
Dep_time
Arr_time
ARRIVES
INSTANCE_OF
Number
FLIGHT
Airline
Weekdays
FARES
Restrictions
Amount
Code
FARE
Airplane_id
Total_no_of_seats
AIRPLANE
ASSIGNED
LEG_INSTANCE
No_of_avail_seats
Date
Customer_name
Cphone
Seat_no
RESERVATION
SEAT
Notes:
A LEG (segment) is a nonstop portion of a flight
A LEG_INSTANCE is a particular occurrence of a LEG on a particular date.

AIRPORT

Airport_code	Name	City	State

FLIGHT

Flight_number	Airline	Weekdays

FLIGHT_LEG

Flight_number	Leg_number	Departure_airport_code	Scheduled_departure_time
		Arrival_airport_code	Scheduled_arrival_time

LEG_INSTANCE

Flight_number	Leg_number	Date	Number_of_available_seats	Airplane_id
		Departure_airport_code	Departure_time	Arrival_airport_code	Arrival_time

FARE

Flight_number	Fare_code	Amount	Restrictions

AIRPLANE_TYPE

Airplane_type_name	Max_seats	Company

CAN_LAND

Airplane_type_name	Airport_code

AIRPLANE

Airplane_id	Total_number_of_seats	Airplane_type

SEAT_RESERVATION

Flight_number	Leg_number	Date	Seat_number	Customer_name	Customer_phone

END of Chapter 7