Quiz will Start at 0900 hrs

CS4.301 Data & Applications

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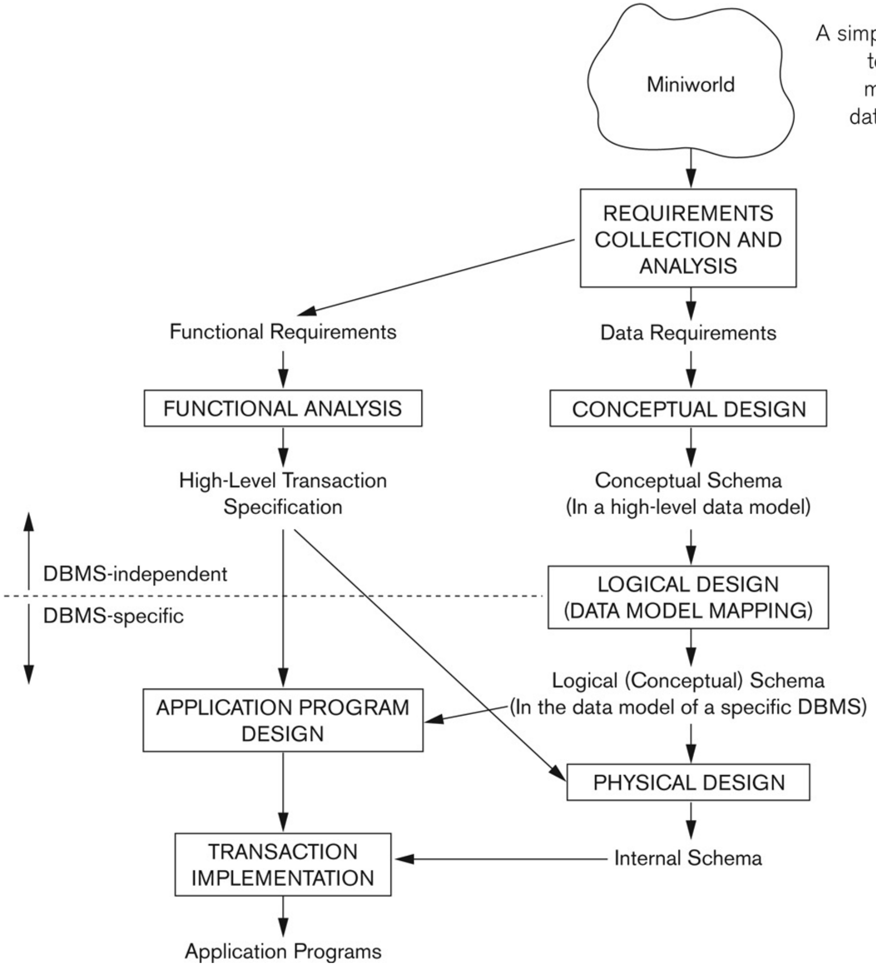

Miniworld
REQUIREMENTS COLLECTION AND ANALYSIS
Functional Requirements
Data Requirements
FUNCTIONAL ANALYSIS
CONCEPTUAL DESIGN
High-Level Transaction Specification
Conceptual Schema (In a high-level data model)
DBMS-independent
DBMS-specific
LOGICAL DESIGN (DATA MODEL MAPPING)
Logical (Conceptual) Schema (In the data model of a specific DBMS)
APPLICATION PROGRAM DESIGN
PHYSICAL DESIGN
TRANSACTION IMPLEMENTATION
Internal Schema
Application Programs

Figure 3.1
A simplified diagram to illustrate the main phases of database design.

Overview of Database Design Process

Example of a composite attribute

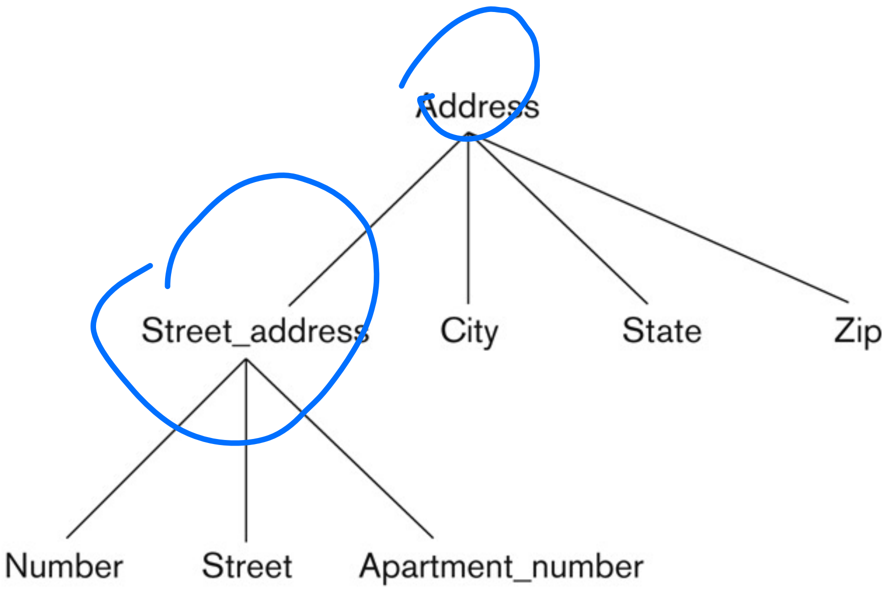


Figure 3.4
A hierarchy of
composite attributes.

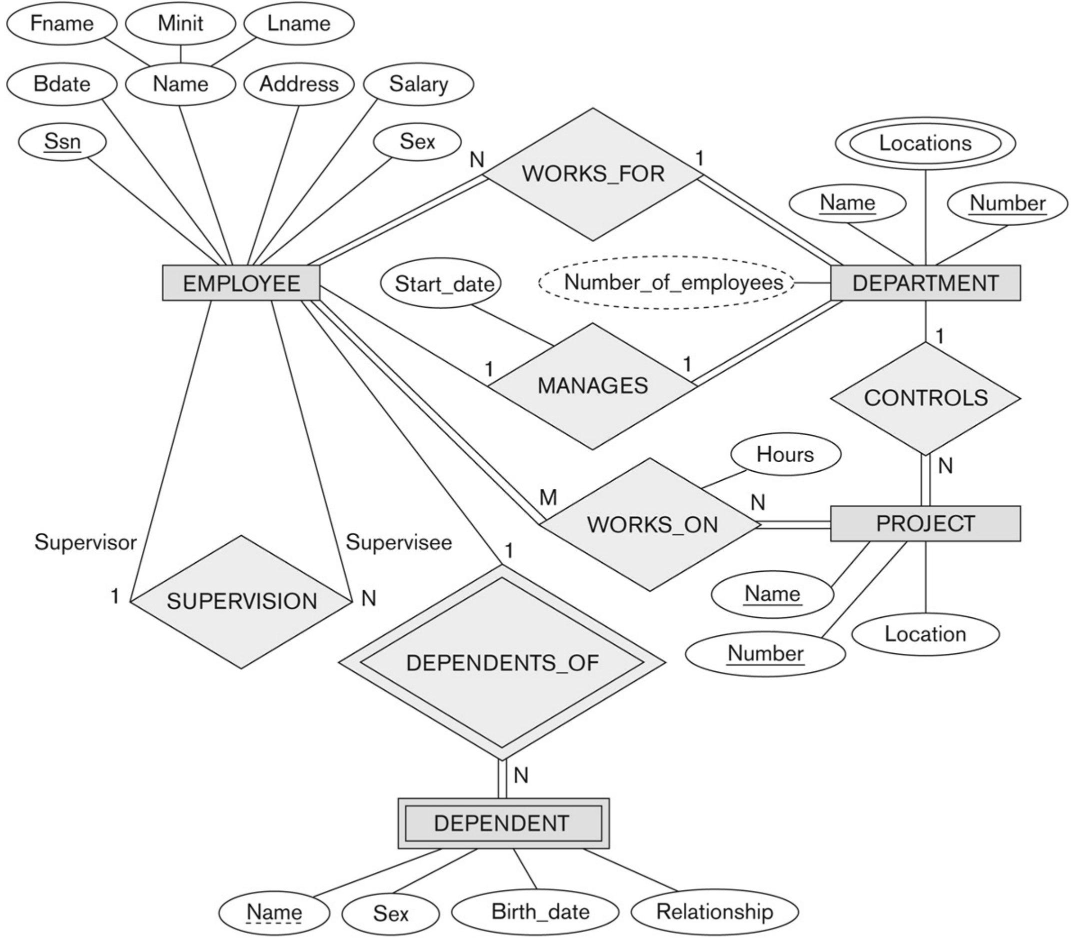


Figure 3.2
An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter.

ER DIAGRAM – Relationship Types are:

WORKS_FOR, MANAGES, WORKS_ON, CONTROLS, SUPERVISION, DEPENDENTS_OF

Many-to-one (N:1) Relationship

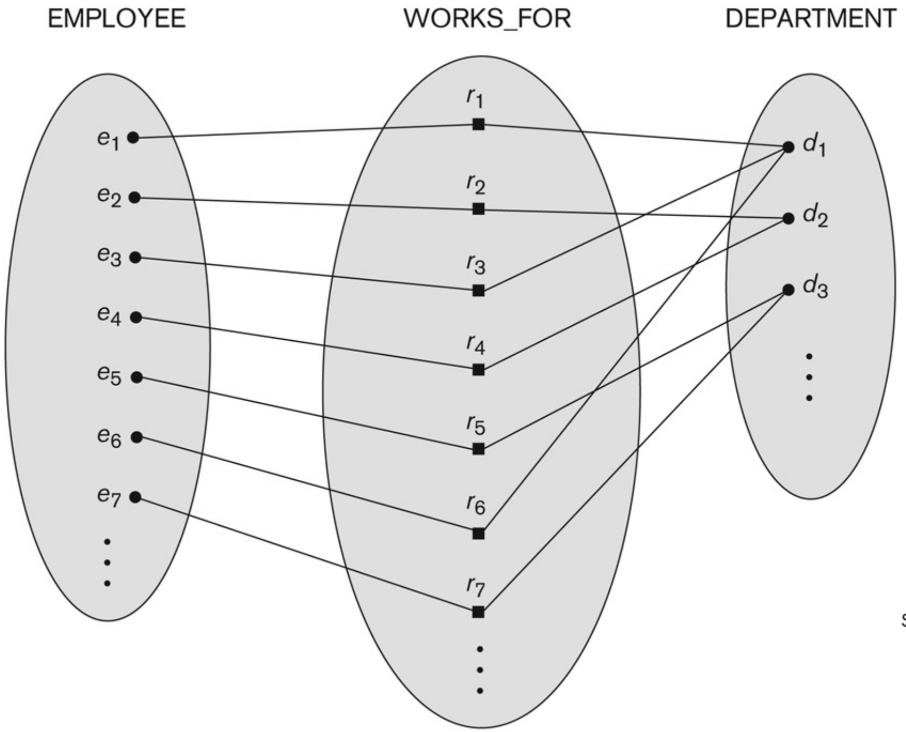


Figure 3.9
Some instances in the WORKS_FOR relationship set, which represents a relationship type WORKS_FOR between EMPLOYEE and DEPARTMENT.

Many-to-many (M:N) Relationship

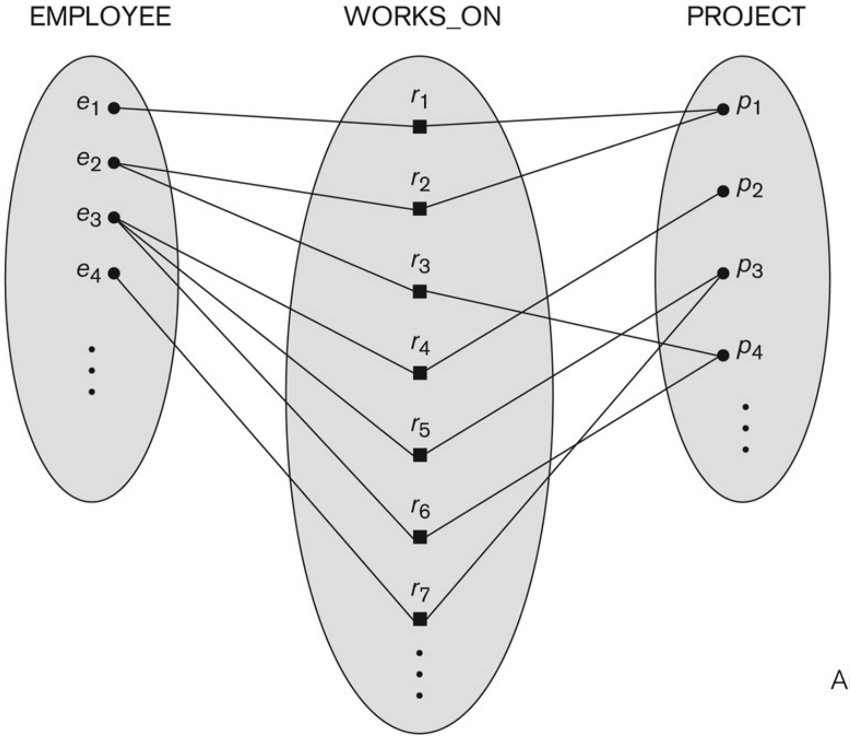


Figure 3.13
An M:N relationship, WORKS_ON.

Use a table to explain

Student_id	Student_name	Student_age	Student_gender
1	Keshav	18	M
2	Pranjali	18	F
3	Shrikara	18	M

Entity: Each row

Entity type: Details about students, so type is STUDENT

Entity set: Records with student_id 1, 2, 3

This Lecture

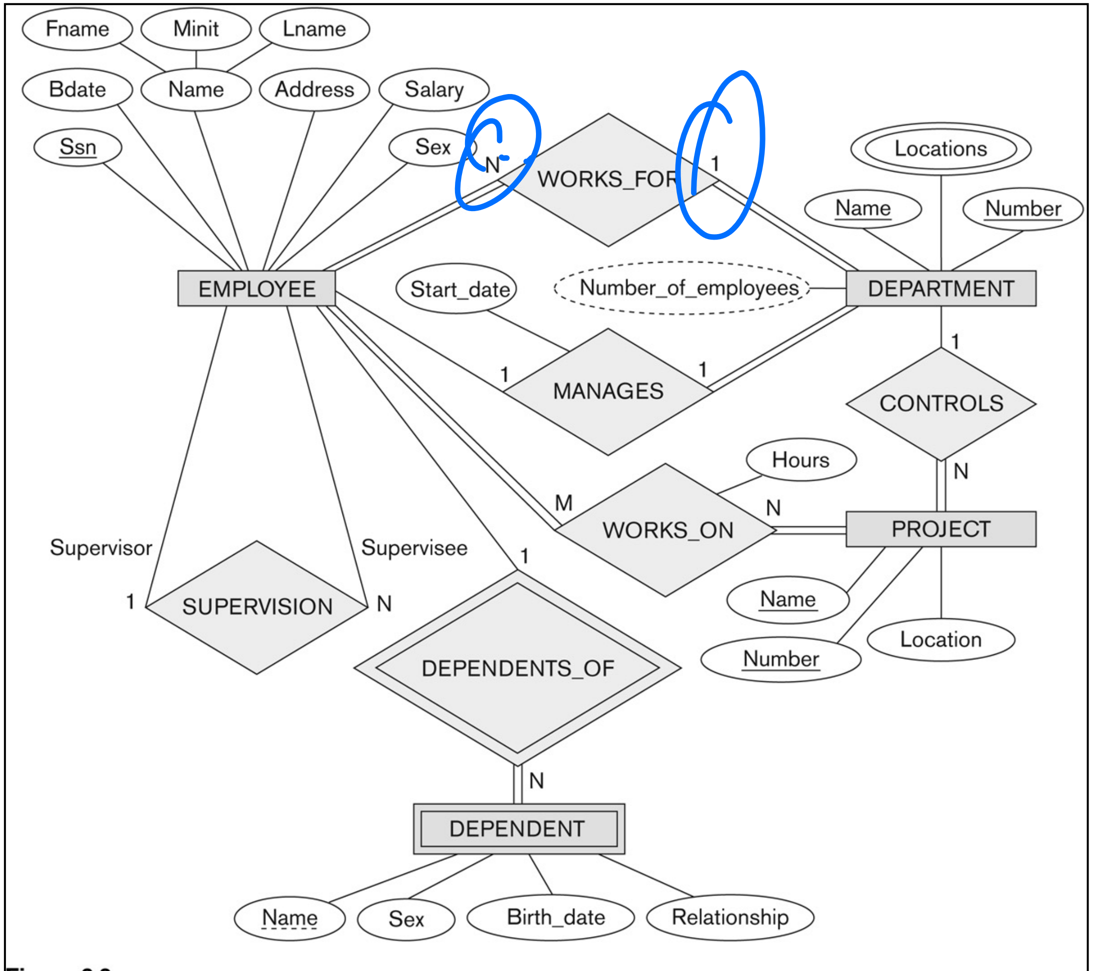


Figure 3.2
An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter.

Alternative (min, max) notation for relationship structural constraints:

Specified on each participation of an entity type E in a relationship type R

Specifies that each entity e in E participates in at least *min* and at most *max* relationship instances in R

Default(no constraint): min=0, max=n (signifying no limit)

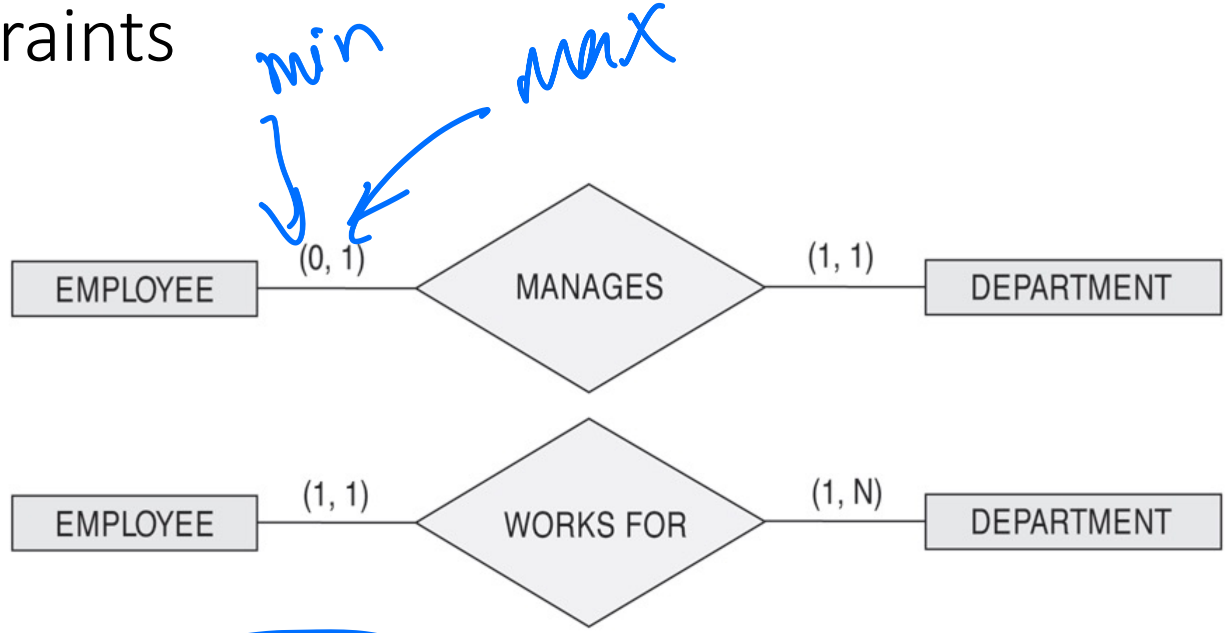
Must have min≤max, min≥0, max ≥1

Derived from the knowledge of mini-world constraints

Examples:

- A department has exactly one manager and an employee can manage at most one department.
    - Specify (1,1) for participation of DEPARTMENT in MANAGES
    - Specify (0,1) for participation of EMPLOYEE in MANAGES
- An employee can work for exactly one department but a department can have any number of employees.
    - Specify (1,1) for participation of EMPLOYEE in WORKS_FOR
    - Specify (0,n) for participation of DEPARTMENT in WORKS_FOR

The (min,max) notation for relationship constraints



Read the min,max numbers next to the entity type and looking **away from** the entity type

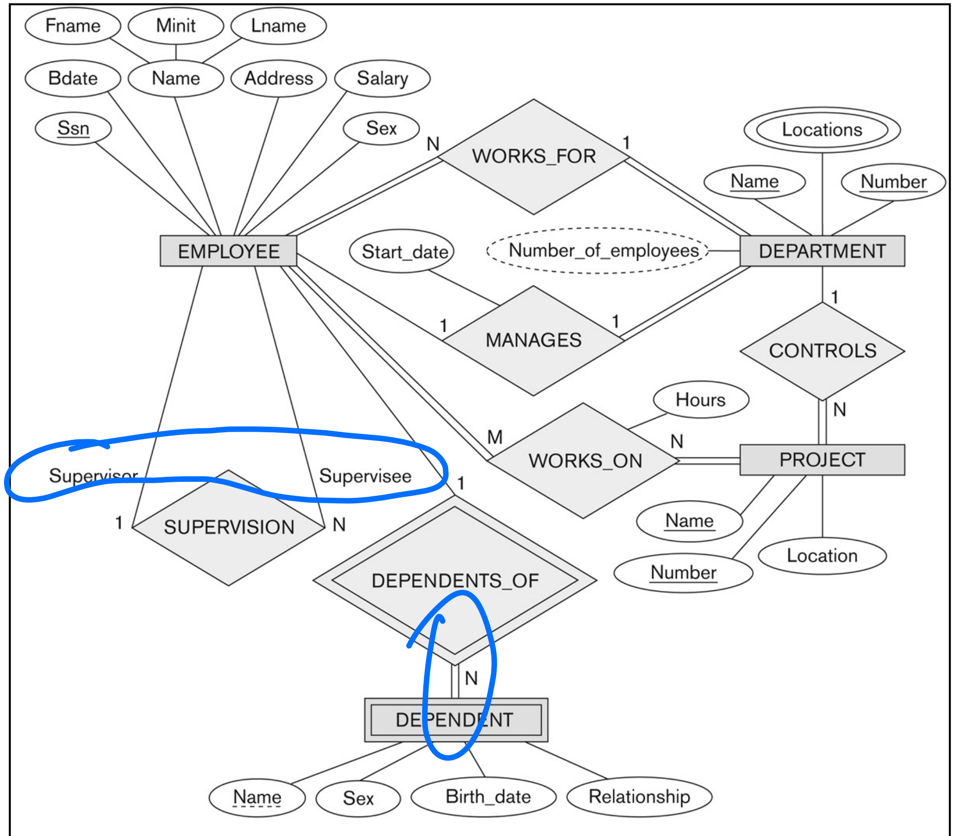
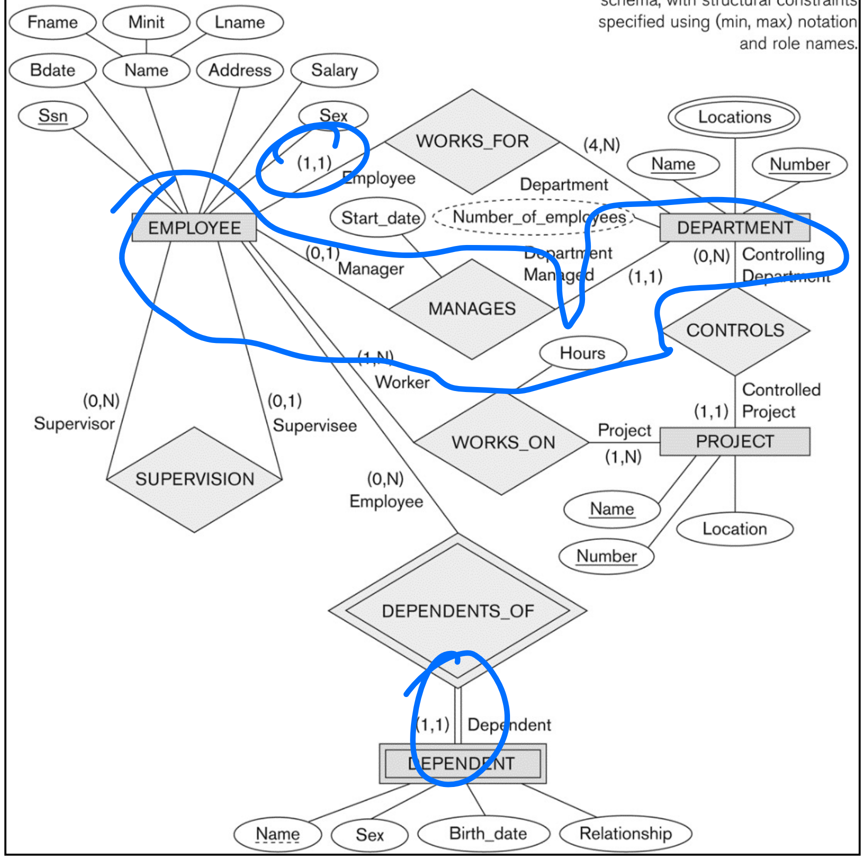


Figure 3.2
An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter.

Figure 3.15
ER diagrams for the company schema, with structural constraints specified using (min, max) notation and role names.



Alternative diagrammatic notation

ER diagrams is one popular example for displaying database schemas

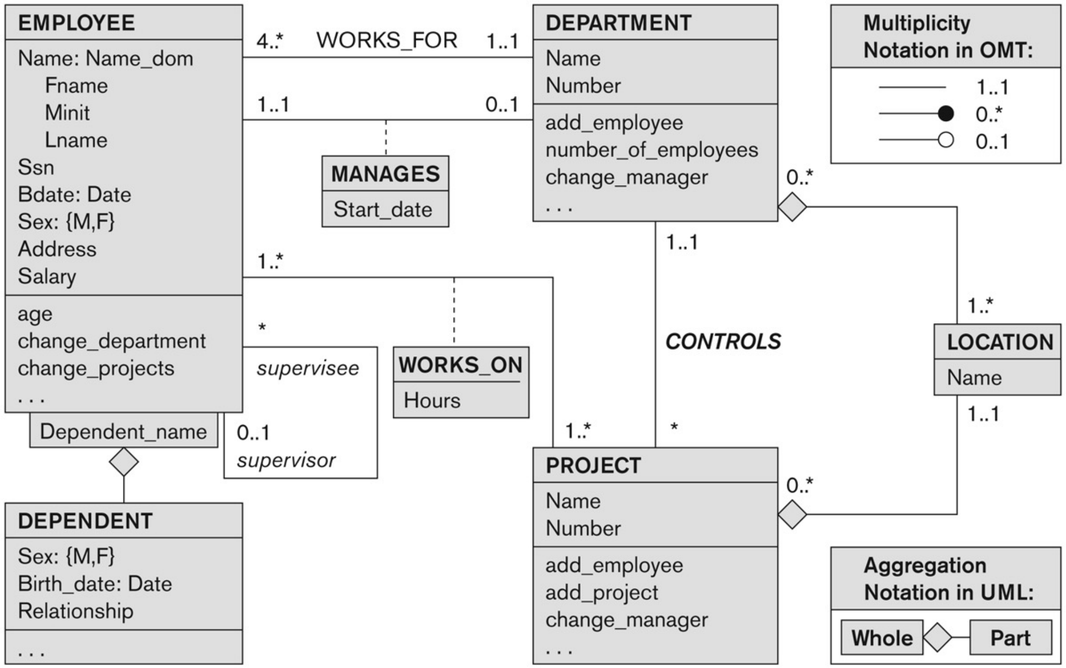
Many other notations exist in the literature and in various database design and modeling tools

UML class diagrams is representative of another way of displaying ER concepts that is used in several commercial design tools

UML class diagrams

- Represent classes (similar to entity types) as large rounded boxes with three sections:
  - Top section includes entity type (class) name
  - Second section includes attributes
  - Third section includes class operations (operations are not in basic ER model)
- Relationships (called associations) represented as lines connecting the classes
  - Other UML terminology also differs from ER terminology
- Used in database design and object-oriented software design
- UML has many other types of diagrams for software design

Figure 3.16
The COMPANY conceptual schema in UML class diagram notation.



UML class diagram for COMPANY database schema

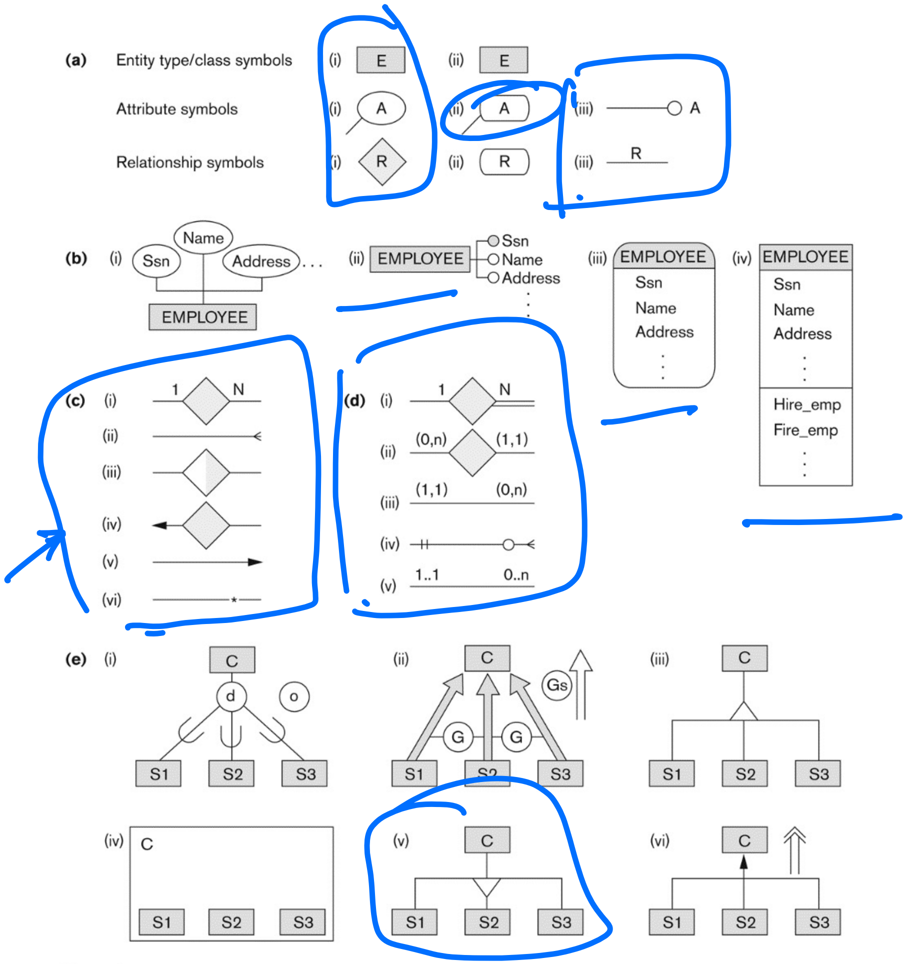


Figure A.1
Alternative notations. (a) Symbols for entity type/class, attribute, and relationship. (b) Displaying attributes. (c) Displaying cardinality ratios. (d) Various (min, max) notations. (e) Notations for displaying specialization/generalization.

Other alternative diagrammatic notations

ER Tools

COMPANY	TOOL	FUNCTIONALITY
Embarcadero Technologies	ER Studio	Database Modeling in ER and IDEF1X
	DB Artisan	Database administration, space and security management
Oracle	Developer 2000/Designer 2000	Database modeling, application development
Popkin Software	System Architect 2001	Data modeling, object modeling, process modeling, structured analysis/design
Platinum (Computer Associates)	Enterprise Modeling Suite: Erwin, BPWin, Paradigm Plus	Data, process, and business component modeling
Persistence Inc.	Pwertier	Mapping from O-O to relational model
Rational (IBM)	Rational Rose	UML Modeling & application generation in C++/JAVA
Resolution Ltd.	Xcase	Conceptual modeling up to code maintenance
Sybase	Enterprise Application Suite	Data modeling, business logic modeling
Visio	Visio Enterprise	Data modeling, design/reengineering Visual Basic/C++

The Relational Data Model and Relational Database Constraints

Relational Model Concepts

The relational Model of Data is based on the concept of a *Relation*

- The strength of the relational approach to data management comes from the formal foundation provided by the theory of relations

We review the essentials of the *formal relational model* in this chapter

In *practice*, there is a *standard model* based on SQL – We will see this as next module

Relational Model Concepts

A Relation is a mathematical concept based on the ideas of sets

The model was first proposed by Dr. E.F. Codd of IBM Research in 1970 in the following paper:

"A Relational Model for Large Shared Data Banks," Communications of the ACM, June 1970

The above paper caused a major revolution in the field of database management and earned Dr. Codd the coveted ACM Turing Award

Informal Definitions

Talib

Informally, a **relation** looks like a **table** of values.

A relation typically contains a **set of rows**.

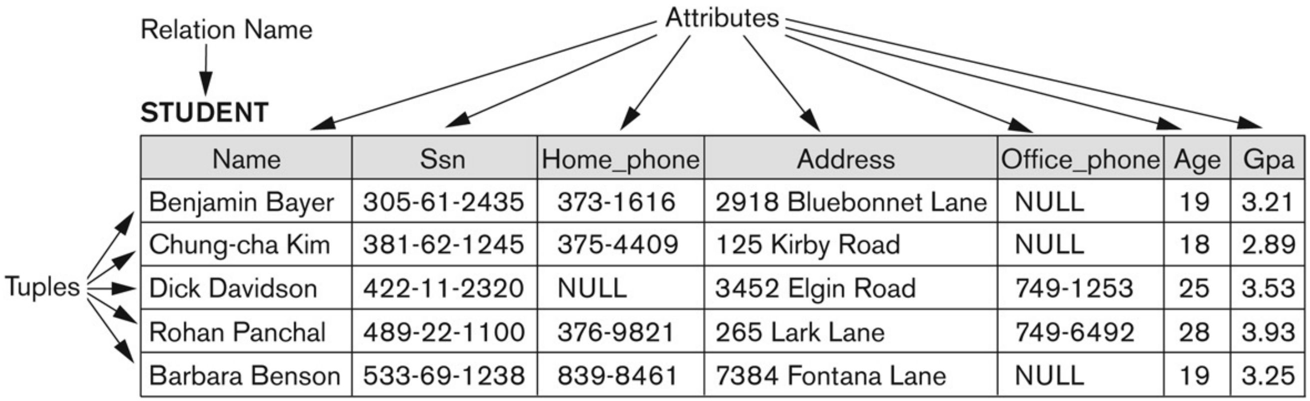
The data elements in each **row** represent certain facts that correspond to a real-world **entity** or **relationship**

In the formal model, rows are called **tuples**

Each **column** has a column header that gives an indication of the meaning of the data items in that column

In the formal model, the column header is called an **attribute name** (or just **attribute**)

Example of a Relation



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.

Informal Definitions

Key of a Relation:

- Each row has a value of a data item (or set of items) that uniquely identifies that row in the table
  - Called the *key*
- In the STUDENT table, SSN is the key

- Sometimes row-ids or sequential numbers are assigned as keys to identify the rows in a table
  - Called *artificial key* or *surrogate key*

Formal Definitions - Schema

The **Schema** (or description) of a Relation:

Denoted by R(A1, A2, ...An)

R is the **name** of the relation

The **attributes** of the relation are A1, A2, ..., An

Example:

CUSTOMER (Cust-id, Cust-name, Address, Phone#)

CUSTOMER is the relation name

Defined over the four attributes: Cust-id, Cust-name, Address, Phone#

Each attribute has a **domain** or a set of valid values.

For example, the domain of Cust-id is 6 digit numbers.

Formal Definitions - Tuple

A **tuple** is an ordered set of values (enclosed in angled brackets '< … >')

Each value is derived from an appropriate *domain*.

A row in the CUSTOMER relation is a 4-tuple and would consist of four values, for example:

- <632895, "John Smith", "101 Main St. Atlanta, GA 30332", "(404) 894-2000">
- This is called a 4-tuple as it has 4 values
- A tuple (row) in the CUSTOMER relation.

A relation is a **set** of such tuples (rows)

Formal Definitions - Domain

A **domain** has a logical definition:

- Example: “USA_phone_numbers” are the set of 10 digit phone numbers valid in the U.S.

A domain also has a data-type or a format defined for it.

- The USA_phone_numbers may have a format: (ddd)ddd-dddd where each d is a decimal digit.
- Dates have various formats such as year, month, date formatted as yyyy-mm-dd, or as dd mm,yyyy etc.

The attribute name designates the role played by a domain in a relation:

- Used to interpret the meaning of the data elements corresponding to that attribute
- Example: The domain Date may be used to define two attributes named “Invoice-date” and “Payment-date” with different meanings

Formal Definitions - State

The **relation state** is a subset of the Cartesian product of the domains of its attributes

each domain contains the set of all possible values the attribute can take.

Example: attribute Cust-name is defined over the domain of character strings of maximum length 25

dom(Cust-name) is varchar(25)

The role these strings play in the CUSTOMER relation is that of the *name of a customer*.

Formal Definitions - Summary

Formally,

Given R(A1, A2, ..., An)

r(R) $\subset$ dom (A1) X dom (A2) X ....X dom(An)

R(A1, A2, …, An) is the **schema** of the relation

R is the **name** of the relation

A1, A2, …, An are the **attributes** of the relation

r(R): a specific **state** (or "value" or “population”) of relation R – this is a *set of tuples* (rows)

r(R) = {t1, t2, …, tn} where each ti is an n-tuple [All Rows in a table]

ti = <v1, v2, …, vn> where each vj *element-of* dom(Aj) [Single Row in the table]

Bibliography / Acknowledgements

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Thank you
for attending
the class!!!