ER Modeling

• Conceptual Model in Database Design Process
• Introduced by Peter Chen in 1976
• Centered around Entities, Attributes, and Relationships

Company Example Miniworld

Company consists of departments, which have unique name and number, and are managed by one employee. We need the start date of the manager. Department might be located in several locations. Departments control projects which have unique name number, and location.

For each employee we need name, SSN, address, salary, sex, and birth date. Employee belongs to one department, but can work on multiple projects in different departments. We need to store the weekly time spent by each employee on each project. Employees have supervisors.

We need the following information on dependents: first name, sex, birth date, and relationship to employee.

Entities

• Entities are the objects (physical, or conceptual) of the model. Entity types are drawn as rectangular box.

- Project
- Movie
- Employee
- Invoice
Instances and Types

Employee is an entity type, an "abstract" employee

John D Smith 555-55-5555 is an instance of the employee entity type

Entities, and Attributes

• Entities are the objects (physical, or conceptual) of the model. Entity types are drawn as rectangular box.
• Attributes are properties of entities (or relationships). They are included in the entity box.

Attributes: Composite/Simple

Composite versus simple (atomic) attributes (depends on miniworld)
Attributes: Single/Multivalued
Multivalued attributes can hold multiple values simultaneously:
• Colors of a car
• Telephone number
Enclosed in curly braces: […] .

Attributes: Stored/Derived
The value of derived attributes can be determined from stored attributes, e.g. Age from Birth Date, or other data in the schema, e.g. Number of Employees from employee.
Derived Attributes are enclosed in square brackets: […] .

Attributes: Null Values
Possible meanings of null value:
• attribute does not apply (phone number to a person without telephone)
• attribute value is not known (missing)
• existence of attribute value is not known
Complex Attributes
Combination of multi-valued and composite attributes.

EMPLOYEE
Name (Fname, {MiddleName}, Lname)

Example: offices of an employee

Key (Identifier) Attributes
A key attribute (unique identifier) is an attribute that
• Uniquely identifies an entity
• None of its parts does
• Never contains a null value

Underline key (identifier) attributes in Entity

PROJECT
Name
Number
Location

Example: Employee

Key (Identifier) Attributes
If a key is made up of multiple attributes, introduce
composite attribute and make it key.

Example: Lot (PropertyID, CountyName, Lot#)
Company Example

Design of Department, Project, Employee and Dependent Entities (Description on slide 2).

Relationships

Relationship relates n entities (Figure 3-2, page 95)
- n=1: unary relation (relates entity to itself)
- n=2: binary relation
- n=3: ternary relation

Entities can appear in different roles in relationship

Examples:
- employee works for/manages department
- supplier supplies parts for project

Relations in Diagrams

- drawn as diamond shaped boxes (different from book)
- lines to participating entities
- roles on lines (if necessary)
- typically relationships are read from left to right, top to bottom
Multiple Roles Example

![Diagram showing supervisor and supervisee relationships]

Example: items assembled from each other

Maximum Cardinality

- **Many (crow’s feet)**: horizontal bar
- **One**: horizontal bar

![Diagram showing employee, works for, and department relationships]

Cardinality Ratios

Cardinality Ratios Examples (for binary relations):
- One to one: MANAGES
- One to many: CONTROLS
- Many to one: WORKS_FOR
- Many to many: WORKS_ON
Cardinality Constraints

Examples:
- x teaches at university y
- x has SSN y
- x supplies y to z
- x speaks language y
- x is mother of y

Find examples for one to many to many
(one to one to many is usually bad design.)

Minimum Cardinality

Mandatory (or total) participation of an entity type:
every entity must be in the relation
(depicted by a horizontal bar)

Optional (or optional) participation of an entity type:
not every entity has to be in a relation
(depicted by a 0)

Example: Every employee works for a department

Employee  \[\rightarrow\]  Works_For  \[\rightarrow\]  Department

optional  \[\rightarrow\]  mandatory

The symbols for minimum cardinality are closer to the relationship than the ones for maximum cardinality.
**Cardinality Constraints**

- [Employee](#) ➞ Optional many
- [Employee](#) ➞ Mandatory one
- [Employee](#) ➞ Optional one
- [Employee](#) ➞ Mandatory one

**Basic Notation**

See summary in Figure 3-2, page 95.

**Simple ER model**

Read Figure 3-1, page 93.
**Alternative Notations**

- **many:** M
- **one:** 1

Example: Every employee works for a department

- Employee \( \rightarrow \) Department

Example: Students enroll in at least 1 and at most 6 classes, and a class can have up to 40 students.