Topic 4:

DB Design and the Entity–Relationship Model

Review of File Schemata

- Recall: Fields $\Rightarrow$ Records ($\Rightarrow$ Blocks) $\Rightarrow$ Files

- A record represents a real–world item or concept

    Example: A student record in a grading program

- A basic DB file's records all have the same construction

    (Same fields, same types, same order)

- Identification:

    — Fields: By assigned name

    — Records: By primary key

- Together, these items define the file's schema

Date's Supplier-Part-Project Schema

Also see the SPJ Schema handout!

Used by C. J. Date in his papers and textbooks.

Consists of four files:

Supplier (S)	S#	Sname	Status	City	

Part (P)	P#	Pname	Color	Weight	City

Project (J)	J#	Jname	City

SPJ	S#	P#	J#	Qty

Three Tangents

- These are topics of importance to the creation of file schemas.

- They need to be introduced sometime; might as well be now!

- They are:

  - Nulls
  - Foreign Keys
  - A Few Types of Data Integrity

Nulls

Definition: Null

Foreign Keys

Definition: Foreign Key

A Few Types of Data Integrity

Foreign keys are essential to three types of data integrity:

1.

2.

3.

DB Design: Overview

- Very similar to software development processes

- Everyone has his/her own n step design process
  - The one we'll present is rather generic

- Some ideas to keep in mind:
  - Any design process is iterative

  - Processes can be categorized as being either . . .

    - top-down vs. bottom-up, or

    - data-driven vs. function-driven, or

    - . . .

DB Design: Phases 1 & 2

Phase 1:

Phase 2:

DB Design: Phases 3 & 4

Phase 3:

Phase 4:

DB Design: In Context

Database planning (Section 10.3)

System definition (Section 10.4)

Requirements collection and analysis (Section 10.5)

Database design (Section 10.6)

Conceptual database design

DBMS selection (optional) (Section 10.7)

Application design (Section 10.8)

Logical database design

Physical database design

Prototyping (optional) (Section 10.9)

Implementation (Section 10.10)

Data conversion and loading (Section 10.11)

Testing (Section 10.12)

Operational maintenance (Section 10.13)
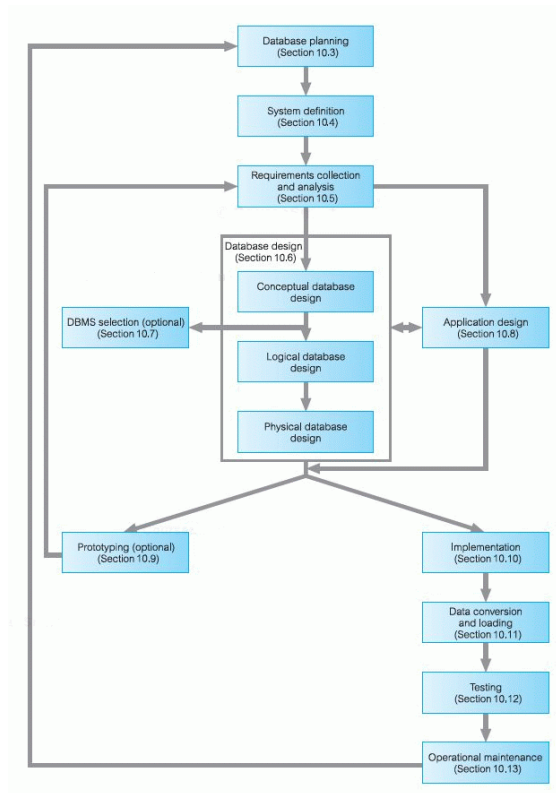
Credit: Connolly/Begg, 6/e, Figure 10.1, p. 300.

What are 'Entities'?

Definition: Entity

Example(s):

What are 'Relationships'?

Credit: "Mother Goose and Grimm" by Mike Peters, 2009– 02–12

Definition: Relationship

Example(s):

One-to-One Relationships

Definition: One-to-One Relationship

Example(s):

One-to-Many Relationships

(a.k.a. Many-to-One Relationships)

Definition: One-to-Many Relationship

Example(s):

Many-to-Many Relationships

Definition: Many-to-Many Relationship

Example(s):

Other Varieties of Relationships

This list is by no means exhaustive! Some others:

- 1:1, 1:N, M:N with Varied Multiplicities

- Ternary (a.k.a. 3-Way, Degree 3)

- Recursive (a.k.a. Cyclic)

The E-R Model: Origins

- First proposed by Pin-Shan (Peter) Chen in a 1976 paper

  — Extended many times since

    Example: Enhanced E-R (E-E-R) Model

  — Has an annual conference devoted to it

    (Int'l Conf. on Conceptual Modeling)

- Easily the most popular conceptual model in use today

- Many of its ideas appear in the Unified Modeling Language (UML)

- Diagrammatic variants abound

An E-R Example (1 / 6): A Bank Database

Description:

Consider a (very) simple database for a bank. We need to

store information about the bank's customers. Of course,

the customers have accounts with the bank, and they

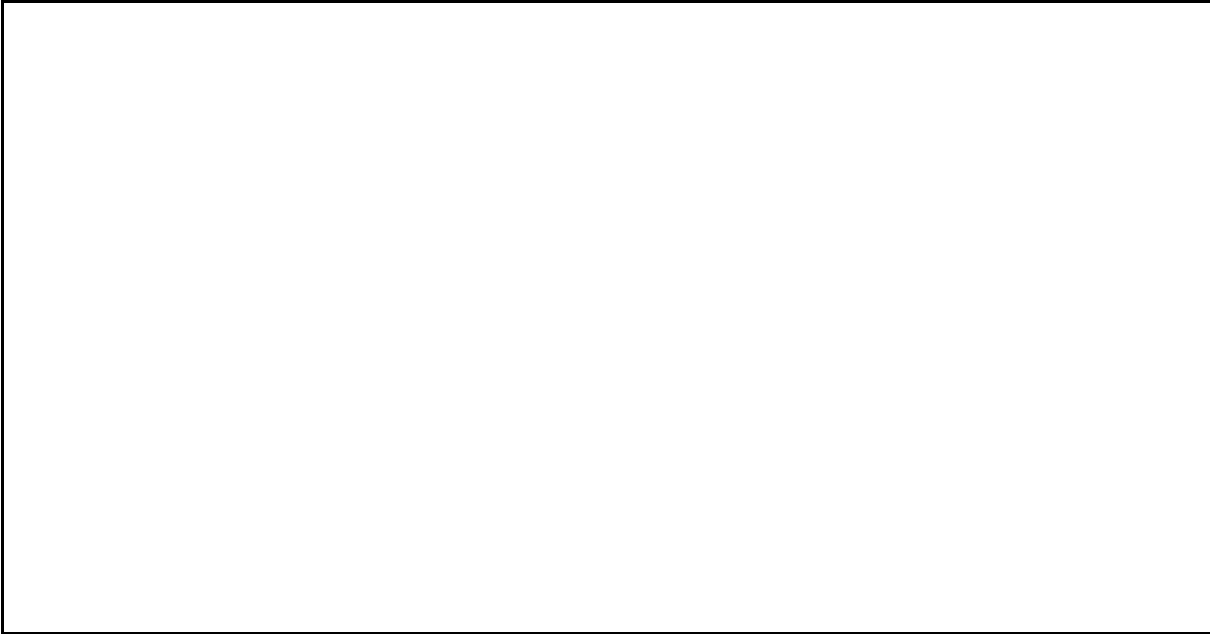perform transactions on those accounts.

Question: **What are the entity sets for our database?**

An E-R Example (2 / 6): Fields

Question: **Which pieces of information do we need for each entity set?**

An E-R Example (3 / 6): Relationships

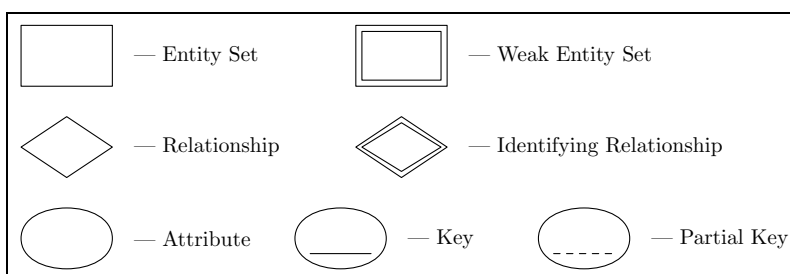**Question:** Which relationships connect these entity sets?

An E-R Example (4 / 6): Diagram (Chen's Notation)

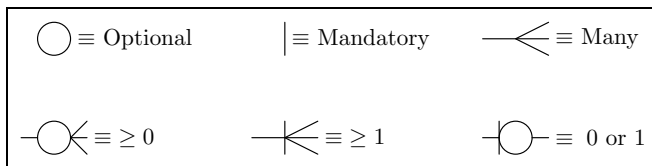**Question: Can you draw a lovely picture of all of this?**

Legend:

	— Entity Set		— Weak Entity Set
	— Relationship		— Identifying Relationship
	— Attribute	— Key	— Partial Key

An E-R Example (5 / 6): Diagram (Crow's Feet Notation)

Question: Is there another notation?

Legend (not completely standardized . . .):

○ ≡ Optional	∣ ≡ Mandatory	——< ≡ Many
—○< ≡ ≥ 0	—∣< ≡ ≥ 1	—○— ≡ 0 or 1

An E-R Example (6 / 6): Diagram (UML Notation)

Question: Doesn't UML include these concepts, too?

Another E-R Example: Faculty

<u>Description:</u>

University faculty members teach classes that are offered
by departments. Faculty are members of departments.
Each department has a chairperson.

Question: **What are the entity sets and relationships?**

E-R Modeling Rules of Thumb

- Choose singular (v. plural) names for entity sets

- Naming relationships can be a challenge; concatenation of
  the names of participating entity sets is an option

- If you can't find a candidate key, perhaps the entity set is
  weak

  ○ If so, remember that the relationship is *identifying*.

- Mixing & matching notation is common

- Make your model as informative as possible

Enhanced E-R Model: Motivation

- The basic E-R Model was designed for 'business data'

    - Basically, text and numeric fields

- Now that computers are more common, more capable, and used for a wider variety of purposes, additional representational power is required to model user concepts.

- Generally, this is called *semantic modeling*.

- Some semantic modeling suggestions have been added to E-R modeling

EER: Specialization / Generalization ("is-a")

Consider inheritance in an O-O programming language . . .

EER: Aggregation ("has-a")

Several types:

1. An entity is formed from a collection of attribute values

    Ex: A person "has-a" name, id#, . . .

2. An entity formed from other entities

    Ex: A car is engine, tires, doors, . . .

3. An entity formed from a relationship to a relationship

    Ex: A job interview (relationship between Company and Ap-
    plicant) resulting in a job offer

    Notation is often just a line between relationship diamonds.