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 field 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:

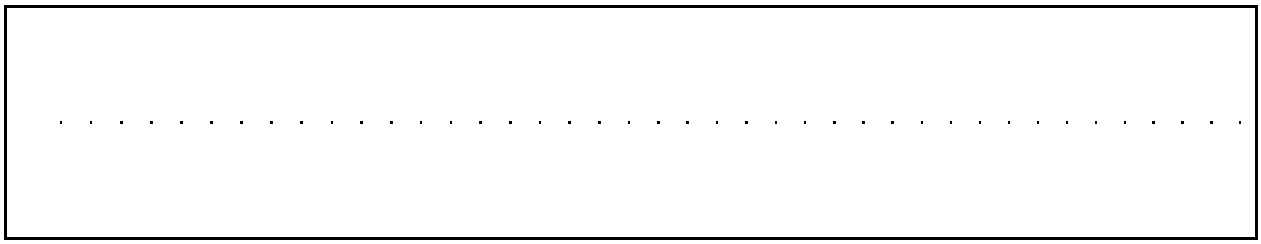
Supplier (S)	S#	Sname	Status	City	
Part (P)	P#	Pname	Color	Weight	City
Project (J)	J#	Jname	City		
SPJ	S#	P#	J#	Qty	

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

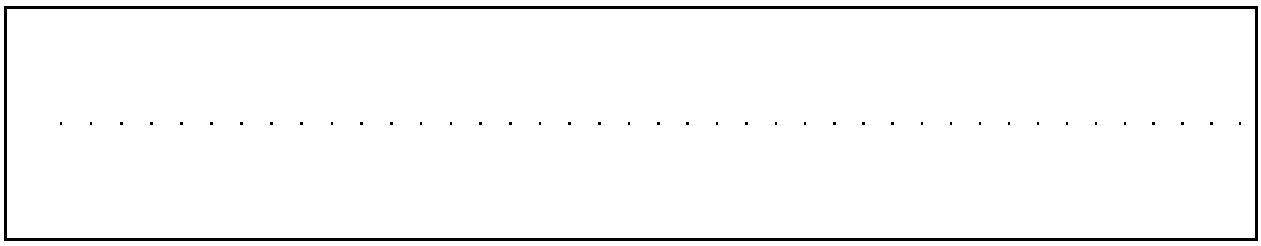
Nulls

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 their 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:

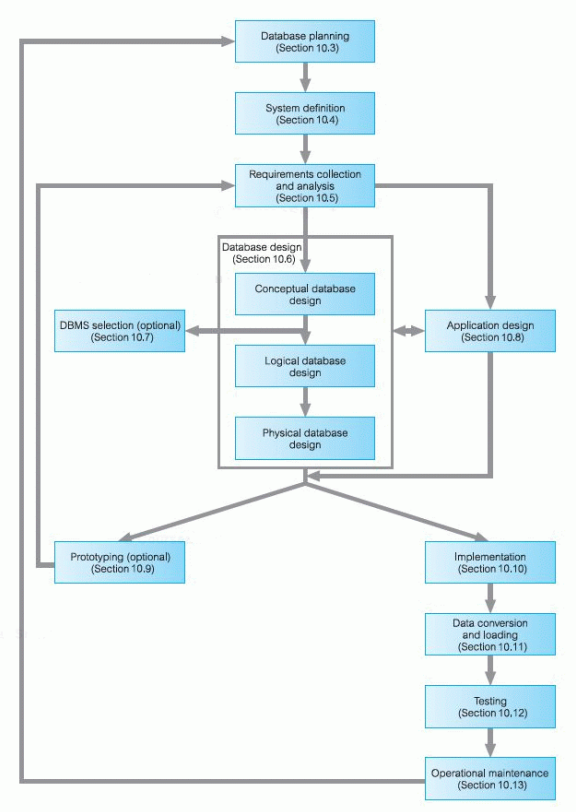
Phase 2:

DB Design: Phases 3 & 4

Phase 3:

Phase 4:

DB Design: In Context



Credit:
Connolly/Begg, 6/e,
Figure 10.1, p. 300.

What are 'Entities'?

Definition: Entity

Example(s):

Uniquely Identifying Entities

Not all entities have obvious self–contained identifiers.

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 are in 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: **What info do we need to store for each entity?**

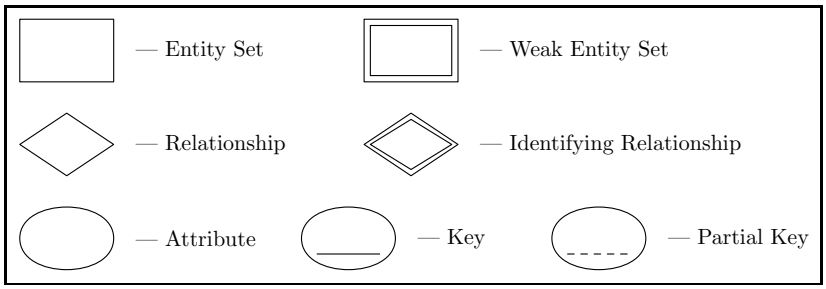
An E-R Example (3 / 6): Relationships

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?

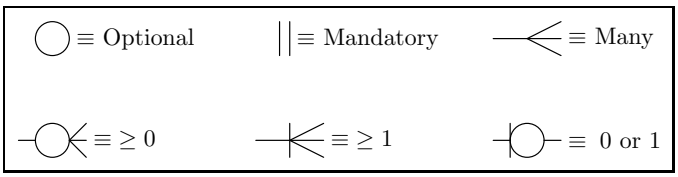
Legend:



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

Question: Is there another notation?

Legend (not completely standardized . . .):



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

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

Another E-R Example: Faculty

Description:

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; concatentation 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 Applicant) resulting in a job offer

   Notation is often just a line between relationship diamonds.