The Entity-Relationship Data Model

(Modeling Constraints & Weak Entity Sets)

Constraints

- Additional information about the data
- Often not about the structure of the data but the relationship among the data

Types of Constraints

- **Key constraint**: set of attributes that uniquely determine an entity within an entity set.
  - SSN of a person in the US
- **Single-value constraint**: uniqueness of a value in a certain context.
  - Key requires uniqueness of value
- **Referential integrity constraint**: existence of a value referred to by some other objects.
  - Movie should exist if it is owned by some studio

Types of Constraints

- **Domain constraint**: value of an attribute must be drawn from a specific set of values
  - Year in Movies should be an integer whose value is greater than or equal 1900
- **General constraint**: assertions that are required to hold in the database (customer’s need)
  - No more than 10 stars for one movie are listed in the database (Lower ranking stars are not interested)

Keys

- **Definition**: A set of attributes K is a key for an entity set E means that for every pair of two distinct entities e and f of E, e and f cannot have the same value for every attribute belonging to K.
  - Key can contain more than one attribute.
  - An entity set might have more than one key.
- For isa relation we require that
  - the root entity set has all the attributes of the key
  - the key for each entity is found from its component in the root entity set

Example

- What should be the key for Movies, Stars, and Studios?

  ![Entity-Relationship Diagram](image)
What should be a key?

• Key can be determined by the given attributes of the entity set.
• Key can be created if needed when the set of attributes of the entity set does not yield a key:
  – Student ID: not necessary SSN
  – Employee ID: not SSN

Key in E/R diagram

• only one primary key: underline all attributes belonging to this key; others?

Single-value

• Important in database design: Single value allows us to associated role with data:
  – Attributes are single-value: each attribute represents a property of the entity, e.g., for each entity m belonging to an entity set Movies, m can have only one title.
  – Attributes different than keys can have null value (also called unknown); the length of a movie can be missing
  – Many-one relationship imposes a single-value constraint: R many-one from E to F: for each entity e in E there is at most one associated entity f in F.

Referential Integrity

• Commonly used to refer to relationship among entity sets
• Requires that the referenced value must exists:
  – Owns: many-one relationship from Movies to Studios requires a movie cannot be owned by more than one studio
  – NOT: for each movie there is a studio who owns it – this is required by the referential integrity constraint on the relationship Owns
  – How to enforce referential integrity constraint?
    • Forbidden the deletion of referenced entity (do not allow a studio to be deleted) unless it does not own a movie
    • If a referenced entity is deleted then all entities that reference it will be deleted as well (delete studio implies deleting all the movies owned by that studio)

Referential Integrity in E/R

Replace the arrow with a circle (in the book: rounded arrowhead)

Others

• Domain constraints
  – place a notation described the domain next to the attribute
• General constraints
  – no specific notation for representing this type of constraints in E/R model but could be done by placing a notation on the link (of a relationship) or next to an attribute
**Weak Entity Sets**

- **Definition:** An entity set whose key is composed of attributes some or all belong to another entity set is a *weak entity set*.
- **Example:**
  - The *Cartoons* entity set in the *Movies* database: a movie is identified by its title and year, both attributes belong to the *Movies* entity set.

**Example**

- A studio has several crews, they are numbering 1, 2, 3,.
- Other studios also use the same numeral system
- Key for Crews need to include the studio's name
  - Crews is a weak entity set (below: E/R diagram)

```
Crews       Unit_of       Studios
\text{name} \quad \text{number} \quad \text{address}
```

**Representing in E/R diagram**

- A studio has several crews, they are numbering 1, 2, 3,.
- Other studios also use the same numeral system
- Key for Crews need to include the studio's name
  - In E/R diagram: double border for the Crews entity set and the Unit_of relationship

```
Crews       Unit_of       Studios
\text{name} \quad \text{number} \quad \text{address}
```

**Example**

- A database about *species* and *genus*. A species is designated by its genus and species names.
  - Key of Species is its name and the name of the Genus of which it is belonged to.

```
Species    Belongs_to    Genus
\text{name} \quad \text{Belongs_to} \quad \text{name}
```

**Sources of Weak Entity Sets**

- *isa* hierarchy: part of the key is from the 'parent' entity set.
- Connecting entity sets that are generated when a multiway relationship is converted to binary relationships: all attributes of the key belong to other entity sets.
Key of Weak Entity Set

- If E is a weak entity set then its key consists of:
  - Zero or more of its one attributes, and
  - Key attributes from entity sets that are reached by certain many-one relationship from E to other entity sets. These many-one relationships are called supporting relationships for E.

Supporting Relationship

- Conditions for R, a relationship from E to F, to be a supporting relationship of a weak entity set of E:
  - R: binary, many-one relationship from E to F
  - Referential integrity from E to F over R
  - The attributes of F that are supplied to be key attributes of E must be key attributes of F
  - If F is weak, then the supplied attributes must be the key attributes of some other entity set that were supplied to be the key of F
  - If there are several different supporting relationships from E to F, then each of these is used to supply a copy of the key attributes of F to create the key of E.

Illustrations

- What happens if Unit_of is many-many?
- What happens if no integrity constraint exists? (A crew without studio?)
- Can address help forming the key of Crews?
- What happens if Studios is 'Divisions'?

E/R Notations

- Double border for weak entity set
- Double border for supporting relationship
- Underlining key attributes

Exercise 2.1.3

- Give an E/R diagram for a database recording information about teams, players, and their fans, including
  - For each team, its name, its players, its team captain (one of its players), and the colors of its uniform.
  - For each player, his/her name.
  - For each fan, his/her name, favorite teams, favorite players, and favorite colors.

Step 1 – Entity Sets

- Entity sets:
  - Teams
  - Players
  - Fans
  - Colors
### Step 2 – Entity Sets and Attributes

- **Entity sets:**
  - Teams: name
  - Players: name
  - Fans: name
  - Colors: name

### Step 3 – … and Relationships

- **Entity sets:**
  - Teams: name
  - Players: name
  - Fans: name
  - Colors: name

- **Relationships:**
  - **Belongs_to:** (Teams, Players) (1:m)
  - **Captain_of:** (Teams, Players) (1:1)
  - **Uniform_of:** (Teams, Colors) (1:m)
  - **Favorite_of:** (Fans, Teams) (n:m)
  - **LikeP:** (Fans, Players) (n:m)
  - **LikeC:** (Fans, Colors) (n:m)

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### E/R diagram

![E/R diagram](image)

### Homework

- **Fig. 2.14** (see below) is an E/R diagram for a bank database involving customers and accounts. Since customers may have several accounts, and accounts may be held jointly by several customers, we associate with each customer an “account set”, and accounts are members of one or more account sets. Assuming the meaning of the various relationships and attributes are as expected given their names, criticize the design. What design rules are violated? Why? What modifications would you suggest?

- **2.4.4:** Draw E/R diagram for the following situations involving weak entity sets. In each case indicate keys for entity sets.
  a. Entity sets: Courses and Departments. A course is given by a unique department, but its only attribute is number. Different departments can offer courses with the same number. Each department has a unique name.
  b. Entity sets: Leagues, Teams, and Players. League names are unique. No league has two teams with the same name. No team has two players with the same number. However, there can be players with the same number on different teams, and there can be teams with the same name in different leagues.

- **2.3.2:** We can think of relationships in the E/R model as having keys, just as entity sets do. Let R be a relationship among the entity sets E₁, ..., Eₙ. Then a key for R is a set K of attributes chosen from the attributes of E₁, ..., Eₙ. A key K for R is a key for E₁ if the two tuples (e₁, ..., eₙ) and (f₁, ..., fₙ) are two entities of E₁, it is not possible for the two tuples to agree on every attribute belonging to K. Now suppose that K₁ and K₂ are keys for the entity sets E₁ and E₂, respectively. In term of K₁ and K₂, give a smallest possible key for R under the assumption that
  a. R is many-many.
  b. R is many-one from E₁ to E₂.
  c. R is many-one from E₂ to E₁.
  d. R is one-one.