Database Systems I

Entity Relationship Model

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CMPT 354 - Summer 2019
Entity Relationship Model

• The Entity Relationship Model
  • Database design
  • Entity, Entity Set, Attribute, Relationship

• E/R Design Considerations
  • Constraints: Key, Referential, Degree
  • Relationship conditions: Multiplicity of Relationships, Multiway Relationships

✓ More E/R Concepts
  • Constraints, Subclasses, Weak Entity Sets

• Conversion to SQL
Multiway to Binary

• E/R Model does not require binary relationships

• Introduce a new entity set: a **connecting entity set**
  • Entities as tuples of the relationship set for the multiway relationship
  • Many-one relationships from the connecting entity set to each of the entity sets that provide components of tuples in the original, multiway relationship
  • If an entity set plays more than one role, then it is the target of one relationship for each role
Multiway to Binary

Replacing a multiway relationship by an entity set and binary relationships

From Chapter 4, The complete book
Subclasses

• When entity set has entities that have special properties not associated with all members of the set
  
  • Special-case entity sets: subclasses
  
  • Expressed as an special kind of relationship: isa relationship
  
  • Notation: triangle
  
  • Every isa relationship is one-one
Subclasses

From Chapter 4, The complete book
Weak Entity Sets

• When the key of an entity set is composed of attributes, some or all of which belong to another entity set

• Causes
  • Falling into a hierarchy based on classifications unrelated to the isa-hierarchy
  • Connecting entity sets as a way to eliminate a multiway relationship
Weak Entity Sets

• The double-rectangle indicates a weak entity set
• The double-diamond indicates a many-one relationship that helps provide the key for the weak entity set

• Examples

From Chapter 4, The complete book
Weak Entity Sets

Contracts in (b) replaces the ternary relationship Contracts in (a)
Contracts has salary, but it does not contribute to the key

From Chapter 4, The complete book
Entity Relationship Model

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• More E/R Concepts
  • Combining, Constraints, Subclasses, Weak Entity Sets

✓ Conversion to SQL
Design Principles

• Simplicity

• Avoiding redundancy

• Choosing the right elements and relationships

• Combining Relations
Simplicity

• Avoid introducing more elements into your design than is absolutely necessary

A poor design with an unnecessary entity set

From Chapter 4, The complete book
Avoiding Redundancy

• *Wastes space* and encourages *inconsistency*
Choosing Relationships

- Entity sets can be connected in various ways by relationships

- Adding to our design every possible relationship: not a good idea
  - Redundancy
  - Update anomalies
  - Deletion anomalies

Adding a relationship between *Stars* and *Studios*
Choosing Elements

- Many choices are between using attributes and using entity set/relationship combinations.

- Attribute is simpler to implement than either an entity set or a relationship

- Cannot make everything into attribute!
From Entity Sets to Relations

- Consider entity sets that are not weak
  - For each non-weak entity set, we shall create a relation of the same name and with the same set of attributes.
  - No indication of the relationships

<table>
<thead>
<tr>
<th>name</th>
<th>address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrie Fisher</td>
<td>123 Maple St., Hollywood</td>
</tr>
<tr>
<td>Mark Hamill</td>
<td>456 Oak Rd., Brentwood</td>
</tr>
<tr>
<td>Harrison Ford</td>
<td>789 Palm Dr., Beverly Hills</td>
</tr>
</tbody>
</table>
From E/R Relationships to Relations

• Relationships in the E/R model are also represented by relations

• The relation for relationship $R$
  • Attributes
    • For each entity set involved in relationship $R$: its key attribute or attributes as part of the schema of the relation for $R$.
    • If the relationship has attributes: also attributes of relation $R$.
    • Entity set is involved several times in a relationship (in different roles): its key attributes each appear as many times as there are roles.
From E/R Relationships to Relations

Owns(title, year, studioName)

<table>
<thead>
<tr>
<th>title</th>
<th>year</th>
<th>studioName</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star Wars</td>
<td>1977</td>
<td>Fox</td>
</tr>
<tr>
<td>Gone With the Wind</td>
<td>1939</td>
<td>MGM</td>
</tr>
<tr>
<td>Wayne’s World</td>
<td>1992</td>
<td>Paramount</td>
</tr>
</tbody>
</table>

From Chapter 4, The complete book
Combining Relations

- All attributes of E
- The key attributes of F
- Any attributes belonging to relationship R

<table>
<thead>
<tr>
<th>title</th>
<th>year</th>
<th>length</th>
<th>genre</th>
<th>studioName</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star Wars</td>
<td>1977</td>
<td>124</td>
<td>sciFi</td>
<td>Fox</td>
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<tr>
<td>Gone With the Wind</td>
<td>1939</td>
<td>239</td>
<td>drama</td>
<td>MGM</td>
</tr>
<tr>
<td>Wayne’s World</td>
<td>1992</td>
<td>95</td>
<td>comedy</td>
<td>Paramount</td>
</tr>
</tbody>
</table>

Combining relation Movies with relation Owns
Handling Weak Entity Sets

• The relation for weak entity set W
  • Include not only the attributes of W but also the key attributes of the supporting entity sets.
  • The supporting entity sets reached by supporting (double-diamond) relationships from W.

• The relation for any relationship in which the weak entity set W appears
  • Must use as a key for W all of its key attributes
    • Including those of other entity sets that contribute to W’s key.

• A supporting relationship R, from the W to a supporting entity set, need not be converted to a relation at all
Example: Handling Weak Entity Sets

Studios(name, addr)
Crews(number, studioName, crewChief)
Unit-of(number, studioName, name)

The crews example of a weak entity set
Converting Subclass Structures to Relations

• Conversion Strategies
  • Follow the E/R viewpoint
    • Create a relation that includes the key attributes from the root and any attributes belonging to entity set

• Treat entities as objects belonging to a single class
  • Example
    • Movies alone.
    • Movies and Cartoons only.
    • Movies and Murder-Mysteries only.
    • All three entity sets.

• Use Null Values
  • Example
    \[ \text{Movie}(\text{title}, \text{year}, \text{length}, \text{genre}, \text{weapon}) \]
    Movies that are not murder mysteries: NULL in the weapon component of their tuple
Example: Converting Subclass Structures

- E/R View
  \[\text{Movies}(\text{title}, \text{year}, \text{length}, \text{genre})\]
  \[\text{MurderMysteries}(\text{title}, \text{year}, \text{weapon})\]
  \[\text{Cartoons}(\text{title}, \text{year})\]
  \[\text{Voices}(\text{title}, \text{year}, \text{starName})\]
Example: Converting Subclass Structures

• Object-Oriented Approach

Movies(title, year, length, genre)
MoviesC(title, year, length, genre)
MoviesMM(title, year, length, genre, weapon)
MoviesCMM(title, year, length, genre, weapon)
Voices(title, year, starName)

From Chapter 4, The complete book
Example: Converting Subclass Structures

- Using Null Values
  \[ \text{Movie}(\text{title}, \text{year}, \text{length}, \text{genre}, \text{weapon}) \]
Example: Comparison

• We would like to reduce cost of queries
  • Expensive to answer queries involving several relations

• We would like not to use too many relations

• We would like to minimize space and avoid repeating information
Summary

• Database Design Process & E/R Model

• E/R Model:
  • Entity, Entity Set, Attributes, Relationships
  • Constraints, Multiplicity of Relationships, Multiway Relationships,
  • Subclasses, Weak Entity Sets

• From E/R to relations to schemas
Acknowledgements

I have used materials from the following resources in preparation of this course:

• **Database Systems: The Complete Book**
• Database Systems (Kifer, Bernstein, Lewis)
• Database System Concepts: https://www.db-book.com
• Course offerings
  • W 4111 (Eugene Wu - Columbia): https://w4111.github.io/
  • CS 245 (Matei Zaharia - Stanford): http://web.stanford.edu/class/cs245/
  • CS 186 (Joe Hellerstein - Berkeley): https://sites.google.com/site/cs186fall17/