Entity Relationship Modeling

High Level Conceptual Design Language
ER Modeling

- method of analyzing requirements
- results in conceptual schema
- schema is E-R diagram
- data-model independent
- can translate into any data model
Uses of ERDs

• Verify designer’s understanding with customer.
• Basis for designing actual database
Uses of ERDs

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Customer’s Miniworld
Verify
Mapping
High Level ERD
Uses of ERDs

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- Customer’s Miniworld
  - Verify
  - Mapping

- Detailed ERD
- Database Design Diagrams
- High Level ERD
- Data Definition Language
E-R diagram is a DDL

- Will describe in terms of Relational Model
- But Remember: ER is Data Model Independent
- ELEMENTS of the diagram are
  1. Entity types
  2. Relationship types
  3. Attributes
DB Design Diagrams

• DB designed from
  – Table schemas
  – Foreign keys
• DB Design Diagram just represents this graphically

Arrow: Tail is FK field, Head is target relation.
Entities, Attributes, Keys

The Employee Entity
Entities, Attributes, Keys

The Employee Entity

- Addr
- Salary
- Sex
- Bdate
Entities, Attributes, Keys

The Employee Entity

Ordinary Attributes

EMPLOYEE

Addr

Sex

Bdate

Salary
Entities, Attributes, Keys

The Employee Entity

Ordinary Attributes

Nested Attributes

EMPLOYEE
The Employee Entity

Nested Attributes
- SSN
- Name
- MI
- Fname
- Lname
- Salary
- Addr
- Sex
- Bdate

The KEY. Underlined

Ordinary Attributes

Foreign Keys (DNO, SUPERSSN) not shown!
Will be represented by Relationships
Composite Keys

Key is one bubble

House Address

Street Name
Number
Address

HOUSE
Composite Keys

Key is one bubble

Street Name
Number
Address
City Area
Lot No.
City ID

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Composite Keys

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Street Name
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Two (composite) candidate keys

HOUSE
Note on ER Diagrams

- The Attribute Bubbles take up lots of space
- There is not a lot of space on one slide
- So this explanation will often omit some or all attributes.
Simple (1:N) Relationships
Simple (1:N) Relationships

DEPARTMENT
- DNUMBER
- DNAME

PROJECT
- PNUMBER
- DNUM

DB

Schema Diagram

ERD
Foreign keys should not be shown. DNUMBER is replaced by Controls relationship.
Relationship Instances

Types

Department

Controls

Project
Relationship Instances

Types
- Department
- Controls

Instances
- Research
  - Web
  - DB
  - .NET
Relationship Instances

Between one Department instance and one Project instance at most one Controls instance.
Complex (M:N) Relationships

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>PNUMBER</th>
<th>PNAME</th>
</tr>
</thead>
</table>

Complex (M:N) Relationships

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<thead>
<tr>
<th>PROJECT</th>
<th>PNUMBER</th>
<th>PNAME</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>EMPLOYEE</th>
<th>SSN</th>
<th>NAME</th>
</tr>
</thead>
</table>
Complex (M:N) Relationships

PROJECT
PNUMBER
PNAME

WORKS ON
ESSN | HRS | PNO

EMPLOYEE
SSN | NAME
Complex (M:N) Relationships

- EMPLOYEE
  - SSN
  - NAME

- PROJECT
  - PNUMBER
  - PNAME

- WORKS ON
  - ESSN
  - HRS
  - PNO
Complex (M:N) Relationships

- EMPLOYEE
  - SSN
  - NAME

- WORKS_ON
  - ESSN
  - HRS
  - PNO

- PROJECT
  - PNUMBER
  - PNAME

- EMPLOYEE
  - SSN
  - NAME

- PROJECT
  - PNUMBER
  - PNAME
Complex (M:N) Relationships

- EMPLOYEE
  - SSN
  - NAME

- WORKS_ON
  - ESSN
  - HRS
  - PNO

- PROJECT
  - PNUMBER
  - PNAME

- WORKS_ON connects EMPLOYEE and PROJECT
Complex (M:N) Relationships

Works_on has NO FOREIGN KEYS in ERD
Relationship Instances

Types

EMPLOYEE ─── WORKS_ON ─── PROJECT
Relationship Instances

Types
- EMPLOYEE
- PROJECT

Instances
- Joe
- Sally
- Cindy

Relationship: WORKS_ON
Relationship Instances

Types

EMPLOYEE

WORKS_ON

PROJECT

Instances

Joe

Sally

Cindy

Web

DB

No more than 1 connection between 1 emp and 1 proj
Reflexive Relationships

Neither SUPERSSN nor DNO appear in the ERD
Reflexive Relationships

Neither SUPERSSN nor DNO appear in the ERD
Basic Elements: Entity Types

- Represented by Rectangles
- Have own KEYS, not derived from other types in the DB.
- Instance of Entity Type is an Entity
- Foreign Keys are NOT Attributes
Basic Elements: Relationship Types

- Represented by Diamond
- Connect Two (or more) Entity Types
- May have attributes (but not FKs)
- Instance of Relationship Type is a Relationship between two entities
- Cannot connect to other relationship types
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Relationship Types (cont.)

- One Relationship Connects 2 Entities.
- Any two entities can have at most one instance of a given relationship type between them.
- That defines the relationship so there is no key.
2 entities, only one instance

• Suppose we want a history of who worked where
• Cannot use works-for relationship
• Need more complicated structure
2 entities, only one instance

- Suppose we want a history of who worked where
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Types and Instances

Types
- Emp
- Work history
- Dept

Instances
- Sally
  - Sect.
  - Director.
  - Research
Basic Elements: Attributes

- Represented by Bubbles
- Attach to both Entity and Relationship Types
- May also attach to other Attributes
Multivalued Attributes

• A Department has several Locations
• Represent with double bubble
Multivalued Attributes

• A Department has several Locations
• Represent with double bubble
Multivalued Attributes

- A Department has several Locations
- Represent with double bubble
Multivalued Attributes

- Each instance of the attribute may have attributes
- Which may be multivalued
Multivalued Attributes

- Each instance of the attribute may have attributes
- Which may be multivalued
Multivalued Attributes

- Each instance of the attribute may have attributes
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Multivalued Attributes

- Each instance of the attribute may have attributes
- Which may be multivalued
Weak Entity Types

- An Employee has several Dependents
- Represent with Double Rectangle,
- And Defining Relationship

Diagram:

- Employee entity with attributes SSN and DNO
- Dependent entity with attributes ESSN and DEP_NAME
- Relationship arrow from Employee to Dependent
Weak Entity Types

- An Employee has several Dependents
- Represent with Double Rectangle,
- And Defining Relationship

```
EMPLOYEE
  SSN  DNO

DEPENDENT
  ESSN  DEP_NAME

EMPLOYEE
  Has

DEPENDENT
  Has
```
Weak Entity Types

- An Employee has several Dependents
- Represent with Double Rectangle,
- And Defining Relationship

Diagram:

- EMPLOYEE
  - SSN
  - DNO
- DEPENDENT
  - ESSN
  - DEP_NAME

Has

Weak Entity
Weak Entity Types

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Weak Entity Types

- An Employee has several Dependents
- Represent with Double Rectangle,
- And Defining Relationship
Weak Entity Types

- Like Regular Entity Types, BUT
- Have a defining connection with some other Entity Type,
- Get KEY from other Entity (SSN) PLUS own Partial Key
  (Dependent_Name)
Multi-parented Weak Entities

- May have more than one defining relationship
- Must have partial key.
Weak Entity Types and Multivalued Attributes

- Both Represented by 1:N FKs in RDB
- Weak Entities can support relationships to other entities
- Multivalued attributes cannot

Diagram:
- DEPENDENT
- Has
- Locations
- Department
Weak Entity Types and Multivalued Attributes

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