ER-TO-RELATIONAL MAPPING

By

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Chapter Outline

• **ER-to-Relational Mapping Algorithm**
  - Step 1: Mapping of Regular Entity Types
  - Step 2: Mapping of Weak Entity Types
  - Step 3: Mapping of Binary 1:1 Relation Types
  - Step 4: Mapping of Binary 1:N Relationship Types.
  - Step 5: Mapping of Binary M:N Relationship Types.
  - Step 6: Mapping of Multivalued attributes.
  - Step 7: Mapping of N-ary Relationship Types.
The ER conceptual schema diagram for the COMPANY database
**ER-to-Relational Mapping Algorithm**

- **Step 1: Mapping of Regular Entity Types.**
  - For each regular (strong) entity type $E$ in the ER schema, create a relation $R$ that includes all the simple attributes (or simple components of composite attributes) of $E$.
  - Choose one of the key attributes of $E$ as the primary key for $R$.
  - If the chosen key of $E$ is composite, the set of simple attributes that form it will form the primary key of $R$.

- **Example:** We create the relations EMPLOYEE, DEPARTMENT, and PROJECT in the relational schema corresponding to the regular entities in the ER diagram.
  - SSN, DNUMBER, and PNUMBER are the primary keys for the relations EMPLOYEE, DEPARTMENT, and PROJECT as shown.
### Step 1: Mapping of Regular Entity Types

<table>
<thead>
<tr>
<th>EMPLOYEE</th>
<th>Fname</th>
<th>Minit</th>
<th>Lname</th>
<th>Sex</th>
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<tbody>
<tr>
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The ER conceptual schema diagram for the COMPANY database
ER-to-Relational Mapping Algorithm (contd.)

• **Step 2: Mapping of Weak Entity Types**
  o For each weak entity type W in the ER schema with owner entity type E, create a relation R & include all simple attributes (or simple components of composite attributes) of W as attributes of R.
  o Add the primary key attribute(s) of the owner entity type as foreign key attributes of R.
  o The primary key of R is the *combination of* the primary key of the owner and the partial key of the weak entity type W.

• **Example:** Create the relation DEPENDENT in this step to correspond to the weak entity type DEPENDENT.
  o Include the primary key SSN of the EMPLOYEE relation as a foreign key attribute of DEPENDENT (renamed to ESSN).
  o The primary key of the DEPENDENT relation is the combination \{ESSN, DEPENDENT_NAME\} because DEPENDENT_NAME is the partial key of DEPENDENT.
Step 2: Mapping of Weak Entity Types

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The ER conceptual schema diagram for the COMPANY database

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Step 3: Mapping of Binary 1:1 Relation Types

- For each binary 1:1 relationship type $R$ in the ER schema, identify the entity sets $S$ and $T$ participating in $R$.
- Choose one of the entity, say $S$, and the primary key of $T$ as a foreign key in $S$.
- Include any simple attributes of the 1:1 relation type as attributes of $S$.
- It is better to choose an entity type with total participation in the role of $S$.

  - Example: 1:1 relation MANAGES is mapped by choosing the participating entity type DEPARTMENT to serve in the role of $S$, because its participation in the MANAGES relationship type is total.
Step 3: Mapping of Binary 1:1 Relation Types

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<tr>
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<th>Fname</th>
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The ER conceptual schema diagram for the COMPANY database
• **Step 4: Mapping of Binary 1:N Relationship Types.**
  - For each regular binary 1:N relationship R, identify the entity S that represent the participating entity type at the N-side of the relationship.
  - Include the primary key of the entity T that represents the other entity type participating in R as a foreign key in S.
  - Include any simple attributes of the 1:N relation type as attributes of S.

• **Example: 1:N relationship types WORKS_FOR, CONTROLS, and SUPERVISION in the figure.**
  - For WORKS_FOR we include the primary key DNUMBER of the DEPARTMENT relation as foreign key in the EMPLOYEE relation and call it DNO.
Step 4: Mapping of Binary 1:N Relationship Types

**EMPLOYEE**
- Fname
- Minit
- Lname
- Sex
- Address
- Salary
- Ssn
- Bdate
- Dno

**DEPARTMENT**
- Name
- Number
- Mgr_Ssn
- Mgr_StartDate

**DEPENDENT**
- ESSN
- Name
- Sex
- Bdate
- Relationship

**PROJECT**
- Name
- Number
- Location
- Dno
The ER conceptual schema diagram for the COMPANY database

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Step 5: Mapping of Binary M:N Relationship Types.

- For each regular binary M:N relationship type R, create a new relation S to represent R.
- Add the primary keys of the participating entity types as foreign key attributes in S; their combination will form the primary key of S.
- Also include any simple attributes of the M:N relationship type (or simple components of composite attributes) as attributes of S.

Example: The M:N relationship type WORKS_ON from the ER diagram is mapped by creating a relation WORKS_ON in the relational database schema.

- The primary keys of the PROJECT and EMPLOYEE relations are included as foreign keys in WORKS_ON and renamed PNO and ESSN, respectively.
- Attribute HOURS in WORKS_ON represents the HOURS attribute of the relation type. The primary key of the WORKS_ON relation is the combination of the foreign key attributes {ESSN, PNO}.
Step 5: Mapping of Binary M:N Relationship Types

- **EMPLOYEE**
  - Fname
  - Minit
  - Lname
  - Sex
  - Address
  - Salary
  - Ssn
  - Bdate
  - Dno

- **DEPARTMENT**
  - Name
  - Number
  - Mgr_Ssn
  - Mgr_StartDate

- **DEPENDENT**
  - ESSN
  - Name
  - Sex
  - Bdate
  - Relationship

- **PROJECT**
  - Name
  - Number
  - Location
  - Dno

- **WORKS_ON**
  - Hours
  - ESSN
  - Pno
The ER conceptual schema diagram for the COMPANY database
• Step 6: Mapping of Multivalued attributes.
  o For each multivalued attribute A, create a new relation R.
  o This relation R will include an attribute corresponding to A.
  o Include the primary key attribute K of the entity that represents the entity type of relationship type that has A as an attribute, as a foreign key in R.
  o The primary key of R is the combination of A and K.

• Example: The relation DEPT_LOCATIONS is created.
  o The attribute DLOCATION represents the multivalued attribute LOCATIONS of DEPARTMENT, while DNUMBER-as foreign key-represents the primary key of the DEPARTMENT relation.
  o The primary key of R is the combination of \{DNUMBER, DLOCATION\}. 
Step 6: Mapping of Multivalued attributes

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The ER conceptual schema diagram for the COMPANY database

The diagram represents the relationships between different entities in the COMPANY database. The entities include:

- **EMPLOYEE**
  - Fname
  - Minit
  - Lname
  - Bdate
  - Name
  - Address
  - Salary
  - Ssn
  - Sex

- **SUPERVISION**
  - Supervisor
  - Supervisee

- **WORKS_FOR**
  - Number_of_employees

- **MANAGES**
  - DEPARTMENT

- **WORKS_ON**
  - PROJECT

- **DEPENDENTS_OF**
  - DEPENDENT

- **LOCATIONS**
  - Name
  - Number

- **CONTROLS**
  - Hours
  - Name
  - Location

The diagram shows the relationships and attributes for each entity, providing a clear visualization of the database schema.
Result of mapping the COMPANY ER schema into a relational database schema

EMPLOYEE
- Fname
- Minit
- Lname
- Ssn
- Bdate
- Address
- Sex
- Salary
- Super_ssn
- Dno

DEPARTMENT
- Dname
- Dnumber
- Mgr_ssn
- Mgr_start_date

DEPT_LOCATIONS
- Dnumber
- Dlocation

PROJECT
- Pname
- Pnumber
- Plocation
- Dnum

WORKS_ON
- Essn
- Pno
- Hours

DEPENDENT
- Essn
- Dependent_name
- Sex
- Bdate
- Relationship

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Step 7: Mapping of N-ary Relationship Types.
- For each n-ary relationship type $R$, where $n > 2$, create a new relationship $S$ to represent $R$.
- Include as foreign key attributes in $S$ the primary keys of the relations that represent the participating entity types.
- Also include any simple attributes of the n-ary relationship type (or simple components of composite attributes) as attributes of $S$.

Example: The relationship type SUPPY in the ER on the next slide.
- This can be mapped to the relation SUPPLY shown in the relational schema, whose primary key is the combination of the three foreign keys \{SNAME, PARTNO, PROJNAME\}
Step 7: Mapping of N-ary Relationship Types

![Diagram showing the mapping of N-ary relationships between SUPPLIER, SUPPLY, PART, PROJECT, SName, Quantity, ProjName, and PartNo.](image_url)
## Summary of Mapping constructs and constraints

<table>
<thead>
<tr>
<th>ER MODEL</th>
<th>RELATIONAL MODEL</th>
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</thead>
<tbody>
<tr>
<td>Entity type</td>
<td>Entity relation</td>
</tr>
<tr>
<td>1:1 or 1:N relationship type</td>
<td>Foreign key (or relationship relation)</td>
</tr>
<tr>
<td>M:N relationship type</td>
<td>Relationship relation and two foreign keys</td>
</tr>
<tr>
<td>n-ary relationship type</td>
<td>Relationship relation and n foreign keys</td>
</tr>
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<td>Simple attribute</td>
<td>Attribute</td>
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<td>Composite attribute</td>
<td>Set of simple component attributes</td>
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<td>Multivalued attribute</td>
<td>Relation and foreign key</td>
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<tr>
<td>Value set</td>
<td>Domain</td>
</tr>
<tr>
<td>Key attribute</td>
<td>Primary (or secondary) key</td>
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</tbody>
</table>
Mapping Exercise-1

Map this schema into a set of relations.

An ER schema for a SHIP_TRACKING database.
Reference: