DATABASE DESIGN

ER to Relational model Mapping

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Database Design

How to obtain a good relational database schema

- Deriving new relational schema from ER-diagrams
- Normal forms: use of constraints in evaluating existing relational schema
E-R Diagram to Relational Schema

General approach is straightforward

- Each entity set maps to a new table
- Each attribute maps to a new table column
- Each relationship set maps to either new table columns or to a new table

Terminology

Primary Key:
A set of attributes that uniquely identify a particular entity (or relationship).
Representing Strong Entity Sets

Entity set $E$ with attributes $a_1, \ldots, a_n$

$\rightarrow$ table $E$ with attributes $a_1, \ldots, a_n$

Entity of type $E \leftrightarrow$ row in table $E$

Primary key of entity set $\rightarrow$ primary key of table

Example:

```
Student
  ________
 /        |
/         |
  \       /  \
   \     /    \\ Major
     \   \     \\    \
      \   \     \
       \   \     \\  \\
        \   \    \\
         \   \   \
          \   \ \\
            \   \\
             \ \\
              \ \\
               \ \
               \ 
StudentNum                StudentName
```

```
Student
+--------+--------+------+
| StudentNum | StudentName | Major |
+--------+--------+------+
```
Representing Weak Entity Sets

Weak entity set $E \rightarrow$ table $E$

Columns of table $E$ should include

- Attributes of the weak entity set
- Attributes of the identifying relationship set
- Primary key attributes of entity set for dominating entities

Primary key of weak entity set $\rightarrow$ primary key of table
Representing Weak Entity Sets (cont.)

Example:

Account

<table>
<thead>
<tr>
<th>AccNum</th>
<th>Balance</th>
</tr>
</thead>
</table>

Transaction

<table>
<thead>
<tr>
<th>TransNum</th>
<th>AccNum</th>
<th>Date</th>
<th>Amount</th>
</tr>
</thead>
</table>
Representing Relationship Sets

If the relationship set is an identifying relationship set for a weak entity set then no action needed.

If we can deduce the general cardinality constraint \((1,1)\) for a component entity set \(E\) then add following columns to table \(E\):

- Attributes of the relationship set
- Primary key attributes of remaining component entity sets

Otherwise: relationship set \(R \rightarrow\) table \(R\)
Representing Relationship Sets (cont.)

Columns of table $R$ should include

- Attributes of the relationship set
- Primary key attributes of each component entity set

Primary key of table $R$ determined as follows

- If we can deduce the general cardinality constraint $(0,1)$ for a component entity set $E$, then choose the primary key attributes for $E$
- Otherwise, choose primary key attributes of each component entity
Representing Relationship Sets (cont.)

Example:

![Database Diagram]

<table>
<thead>
<tr>
<th>Team</th>
<th>TeamName</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>LocName, Address</td>
</tr>
<tr>
<td>Match</td>
<td>HomeTeamName, VisitorTeamName, LocName, Score</td>
</tr>
</tbody>
</table>

Note that the role name of a component entity set should be prepended to its primary key attributes, if supplied.
Example Translation

| Database Design: ER to Relational: 10 |

<table>
<thead>
<tr>
<th>Course</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>CourseNum</td>
<td>StudentNum</td>
</tr>
<tr>
<td>CourseName</td>
<td>StudentName</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section</th>
<th>EnrolledIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>CourseNum</td>
<td>StudentNum</td>
</tr>
<tr>
<td>SectionNum</td>
<td>Mark</td>
</tr>
<tr>
<td>ProfNum</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Professor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ProfNum</td>
</tr>
<tr>
<td>ProfName</td>
</tr>
</tbody>
</table>
Representing Aggregation

Tabular representation of aggregation of $R$

\[ = \text{tabular representation for relationship set } R \]

To represent relationship set involving aggregation of $R$, treat the aggregation like an entity set whose primary key is the \textbf{primary key} of the table for $R$. 
Representing Aggregation (cont.)

Example:

```
Student
<table>
<thead>
<tr>
<th>StudentNum</th>
</tr>
</thead>
</table>

Course
<table>
<thead>
<tr>
<th>CourseNum</th>
</tr>
</thead>
</table>

Account
<table>
<thead>
<tr>
<th>UserId</th>
</tr>
</thead>
</table>

EnrolledIn
<table>
<thead>
<tr>
<th>StudentNum</th>
<th>CourseNum</th>
</tr>
</thead>
</table>

CourseAccount
<table>
<thead>
<tr>
<th>UserId</th>
<th>StudentNum</th>
<th>CourseNum</th>
<th>ExpirationDate</th>
</tr>
</thead>
</table>
```
Representing Specialization

Create table for higher-level entity set, and treat specialized entity subsets like weak entity sets

Example:

```
<table>
<thead>
<tr>
<th>Student</th>
<th>Graduate</th>
<th>Professor</th>
</tr>
</thead>
<tbody>
<tr>
<td>StudentNumber</td>
<td>StudentName</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SupervisedBy</td>
<td>ProfessorName</td>
</tr>
<tr>
<td>Degrees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>StudentNumber</td>
<td>ProfessorName</td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>StudentNumber</td>
<td>Degree</td>
<td></td>
</tr>
</tbody>
</table>
```
Representing Generalization

Create a table for each lower-level entity set only

Columns of new tables should include

- Attributes of lower level entity set
- Attributes of the superset

The higher-level entity set can be defined as a view on the tables for the lower-level entity sets
Representing Generalization (cont.)

Example:

\begin{center}
\begin{tikzpicture}
  \node[shape=circle,draw] (1) {MakeAndModel};
  \node[shape=circle,draw] (2) at (0,-1) {Vehicle};
  \node[shape=circle,draw] (3) at (-2,-2) {LicenceNum};
  \node[shape=circle,draw] (4) at (2,-2) {Price};
  \node[shape=rectangle,draw] (5) at (0,-3) {Tonnage};
  \node[shape=rectangle,draw] (6) at (0,-4) {AxelCount};
  \node[shape=rectangle,draw] (7) at (2,-3) {MaxSpeed};
  \node[shape=rectangle,draw] (8) at (2,-4) {PassengerCount};

  \draw[->] (1) -- (2);
  \draw[->] (2) -- (3);
  \draw[->] (2) -- (4);
  \draw[->] (2) -- (5);
  \draw[->] (2) -- (6);
  \draw[->] (2) -- (7);
  \draw[->] (2) -- (8);
\end{tikzpicture}
\end{center}

\begin{tabular}{|c|c|c|c|c|}
  \hline
  LicenceNum & MakeAndModel & Price & Tonnage & AxelCount \\
  \hline
  Car        & LicenceNum   & MakeAndModel & Price & MaxSpeed & PassengerCount \\
  \hline
\end{tabular}