E/R-Modeling
UML-Modeling
An **entity–relationship model** (ER model) is composed of **entity types** and specifies **relationships** that can exist between instances of those entity types.
1:1 relationship
One student is a leader of one team.
One team is led by one student.

1:N relationship
One location is a birthplace of several persons.
The birthplace of one person is one location.

N:M relationship
One student is a member of several teams.
One team consists of several students.

(min, max)-Notation
One employee manages 0 or 1 department. One department is managed by exactly one employee.

One employee works for exactly one department. In one department work(s) from 1 to N employee(s).
One person lives at one address.
One address belongs to 0 to N persons.
Data modeling

Excerpt of the Real World

Conceptual Schema (E/R- or UML-Schema)

Relational Schema

XML Schema

Network Schema

Object-oriented Schema

Manual/intellectual Modeling

Semi-automatic Transformation
The diagram represents a relational database with entities and relationships. The main entities in this database are:

- **Students**
  - StudNr: 26120, 25403, ...
  - Name: Fichte, Jonas, ...

- **Lectures**
  - Lecture Nr: 5001, 5022, ...
  - Title: Grundzüge, Glaube und Wissen, ...

The relationship between **Students** and **Lectures** is denoted by the attribute **attend**.

The diagram illustrates the following relationships:

- **N** (Students) attends **M** (Lectures)**. This indicates that many students can attend many lectures, which is represented by the multiplicity symbols N and M.
<table>
<thead>
<tr>
<th>Name</th>
<th>Street</th>
<th>Phone#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mickey Mouse</td>
<td>Main Street</td>
<td>4711</td>
</tr>
<tr>
<td>Minnie Mouse</td>
<td>Broadway</td>
<td>94725</td>
</tr>
<tr>
<td>Donald Duck</td>
<td>Broadway</td>
<td>95672</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

- **Instance**: current state of the database
- **Candidate Key**: minimal set of attributes whose values uniquely identify a tuple
- **Primary Key**: underlined
Weak entities

### Students
<table>
<thead>
<tr>
<th>StudNr</th>
<th>Name</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>24002</td>
<td>Xenokrates</td>
<td>18</td>
</tr>
<tr>
<td>25403</td>
<td>Jonas</td>
<td>12</td>
</tr>
<tr>
<td>26120</td>
<td>Fichte</td>
<td>10</td>
</tr>
<tr>
<td>26830</td>
<td>Aristoxenos</td>
<td>8</td>
</tr>
<tr>
<td>27550</td>
<td>Schopenhauer</td>
<td>6</td>
</tr>
</tbody>
</table>

### test
<table>
<thead>
<tr>
<th>StudNr</th>
<th>LectureNr</th>
<th>PersNr</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>28106</td>
<td>5001</td>
<td>2126</td>
<td>1</td>
</tr>
<tr>
<td>25403</td>
<td>5041</td>
<td>2125</td>
<td>2</td>
</tr>
<tr>
<td>27550</td>
<td>4630</td>
<td>2137</td>
<td>2</td>
</tr>
</tbody>
</table>

### Lectures
<table>
<thead>
<tr>
<th>Lecture Nr</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>5001</td>
<td>Grundzüge</td>
</tr>
<tr>
<td>5041</td>
<td>Ethik</td>
</tr>
<tr>
<td>5043</td>
<td>Erkenntnistheorie</td>
</tr>
<tr>
<td>5049</td>
<td>Mäeutik</td>
</tr>
</tbody>
</table>

**Diagram:**
- **Students**
  - **StudNr**
  - **write**
    - **Tests**
      - **Grade**
      - **Part**
      - **consist_of**
        - **LectureNr**
        - **Lectures**
      - **give**
        - **M**
          - **Professors**
        - **PersNr**
Exercise E/R Modeling

• An employee has a name. A project has a name, a date and a budget. An employee can manage several projects but one project can only be managed by one employee.
Solution E/R Modeling

After http://datenbanken-verstehen.de/datenmodellierung/entity-relationship-modell/
Exercise UML Modeling

• There are two kinds of person (age): Student(id) and Professor (title) which can teach. Each Student can be taught by one or more professors and each professor teaches at least three students.
Solution UML Modeling

```
Person
  age : int

Student
  id : str

Professor
  title : str
teach()

Student <------------------------> Professor
  3..* 1..*
```

After https://subversion.american.edu/aisaac/notes/images/uml-class-diagram.png