Example: conceptual university schema
Extensions

- existence dependent (**weak**) entity sets
  - assumption so far: entities exist autonomously and can be uniquely identified within an entity set by their key attributes (**strong** entity set)
  - in reality there are also **weak** entities that do not have sufficient attributes to form a key. These entities are
    + dependent in their existence from another, superior entity and
    + can be uniquely identified only in combination with the key of a superior entity
  - superior entity set is called **identifying** or **owner entity set**
  - graphical notation:

- identifying relationship set
  - a weak entity set $E_1$ must be associated with an identifying entity set $E_2$ by an **identifying relationship set**, if the key of $E_1$ comprises the key of $E_2$ and if it contains one or more additional attributes of $E_1$
  - relationship from the weak entity set to the superior entity set has usually an $m:1$-cardinality and more seldom a $1:1$-cardinality
  - graphical notation:
example:

- total participation of an entity set in a relationship
  - all entities of an entity set $E_1$ are associated with another entity set $E_2$ by a relationship set $R$
  - this holds, in particular, for weak entity sets
  - example:

more precise characterization of cardinalities of relationship sets
- $(min, max)$-notation
- for each entity set participating in a relationship set
  - $min$ expresses that each entity of this set is in relationship at least $min$ times
  - $max$ expresses that each entity of this set is in relationship at most $max$ times
- special cases
  + $min = 0$: an entity does not have to be in relationship (optional)
  + $max = *$: an entity may be in relationship arbitrarily many times
- example: conceptual university schema with $(min, max)$-notations
- multivalued attributes
  - optional attribute: minimal cardinality is equal to 0
  - simple attribute: cardinality is equal to 1
  - prescribed attribute: minimal cardinality is equal to 1
  - **multivalued attribute**: maximal cardinality is equal to $n$
  - example:

```
  person
    - (1,n) first-name
    - (0,n) last-name
    - (0,1) phone-no
    - (0,1) driving-licence-no
```

- composite attributes
  - grouping of attributes of the same entity set or relationship set which are closely related
  - antonym: simple attribute
  - example:

```
  person
    - name
    - birth-date
    - address
      - street
      - number
      - zipcode
      - city
```
derived attributes
- attribute that can be derived from one or more attributes
- antonym: base/stored attribute
- graphical representation: 
- example:
  
  ![Graphical representation](image)