

In the Lecture Series Introduction to Database Systems

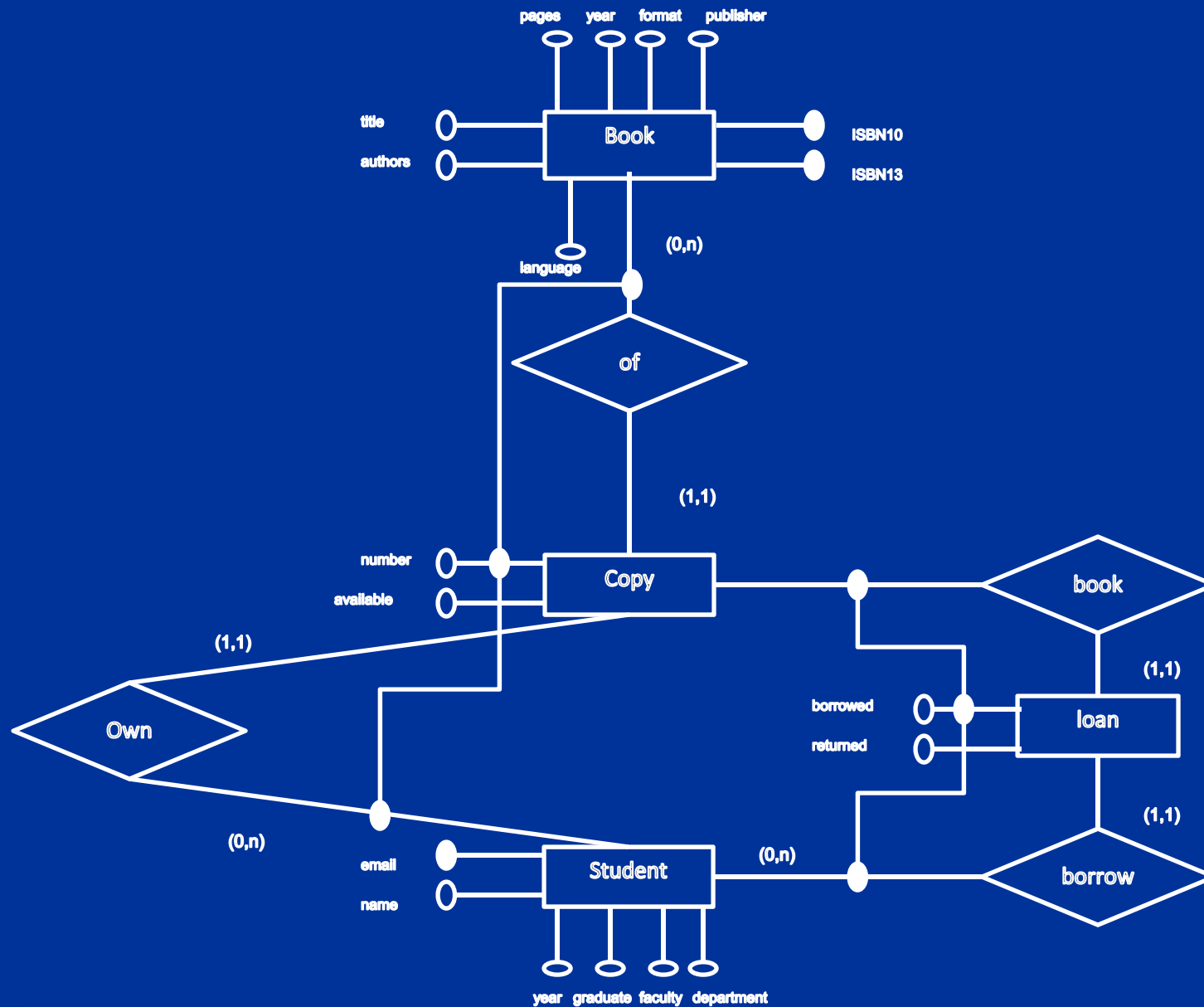


Conceptual Modeling

Presented by Stéphane Bressan

Introduction to Database Systems

Entity-relationship Diagram from the Tutorial



Entity Relationship

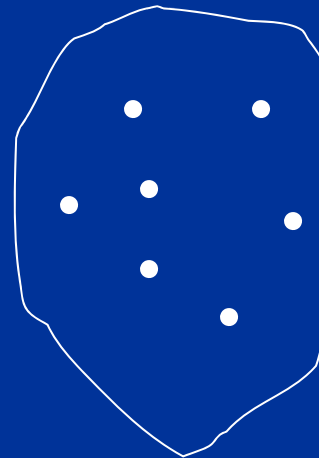
- The Entity-relationship model is a graphical model for designing data centric applications.
- The real world is represented as entity sets and their relationships
- The model can be semi-automatically translated into SQL

Conceptual Design

Entities and Relationships

Entities and Entity Sets

- Entities are identifiable “things”
- The named box represents a set of entities or entity set



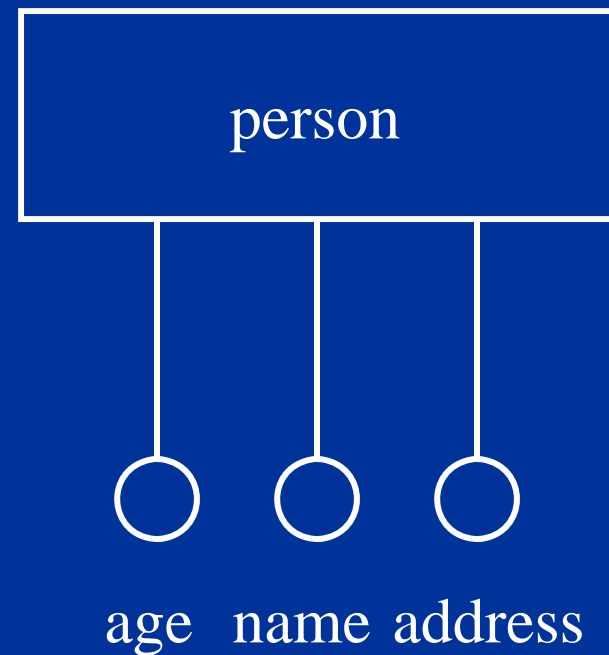
Attributes, Values and Value Sets

- The E-R model is value-oriented
- Values can be integer, strings, or atoms



Attributes of Entities

- Entities can have attributes
- All entities in one entity set have the same attributes
- However the attributes take different values for each entities



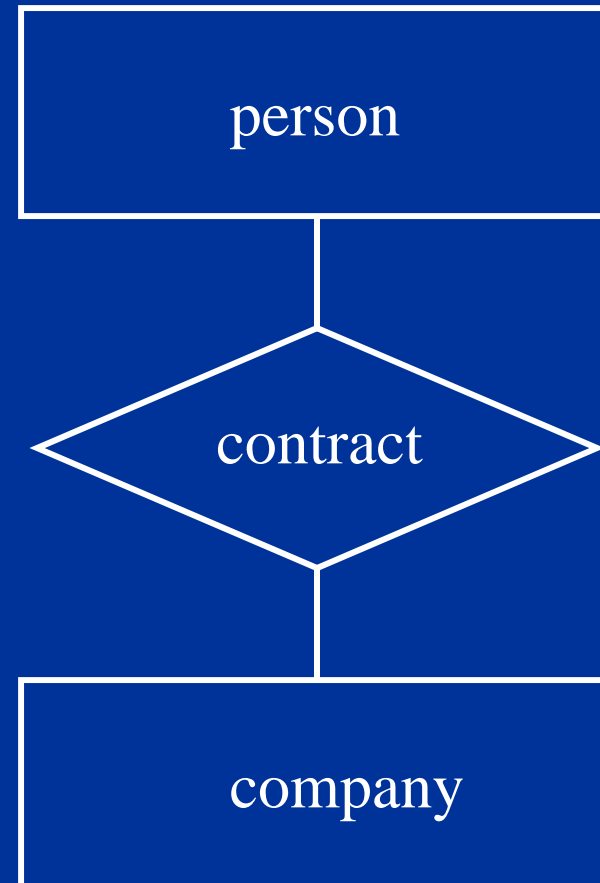
Relationships and Relationship Sets

- Relationships
- A lozenge represents a set of relationships or a relationship set



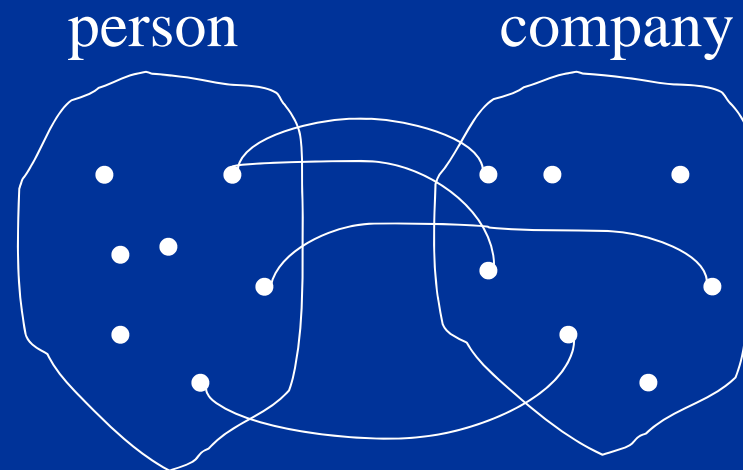
Relationships and Relationship Sets

- A relationship associates two entities (can also be 0 or more)
- A relationship set is a set of relationships associating entities from the same entity sets



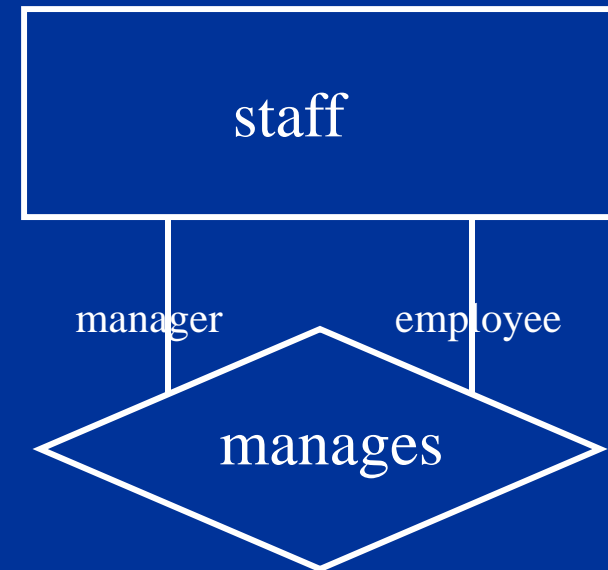
Relationships and Relationship Sets

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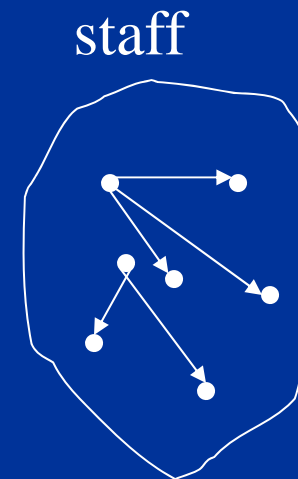
Relationships and Relationship Sets

- Relationships can associate entities from the same entity set
- In this case and in general, participation, or role, in the relationship can be named



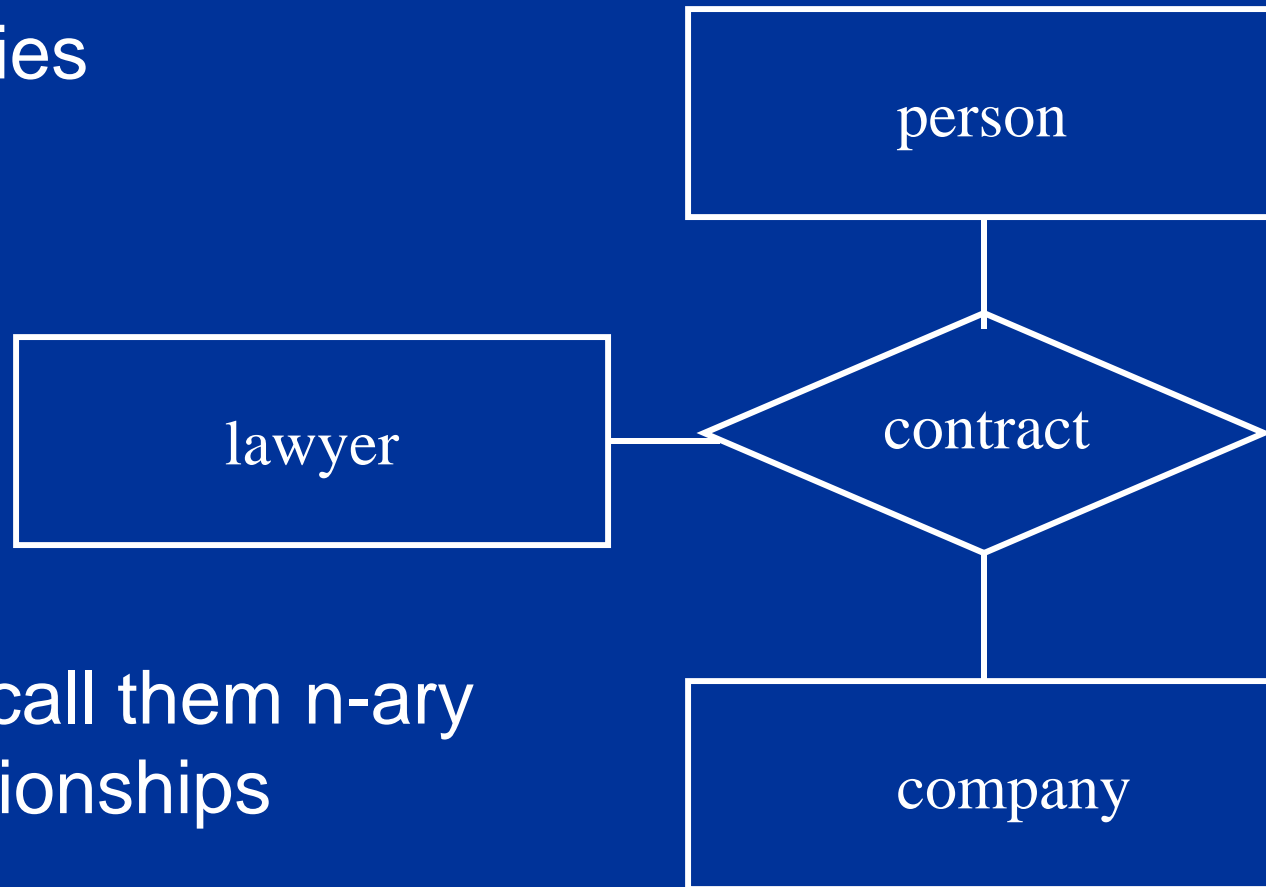
Relationships and Relationship Sets

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Relationships and Relationship Sets

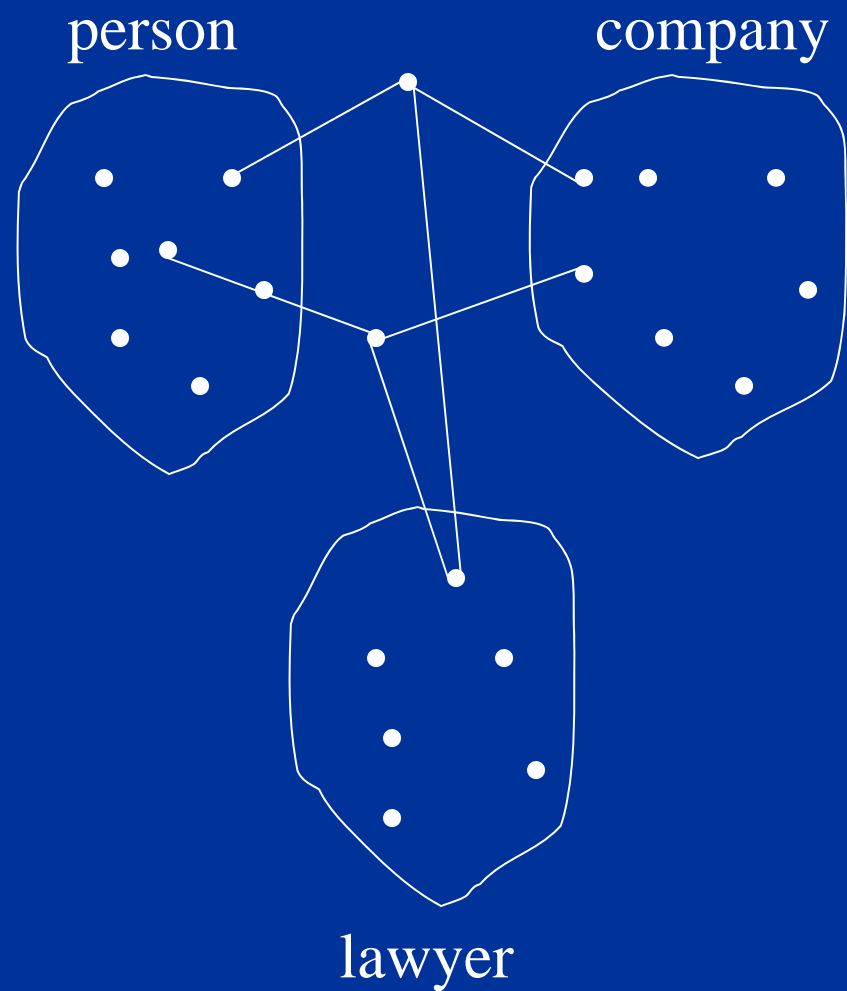
- A relationship can associate more than 2 entities



- We call them n-ary relationships

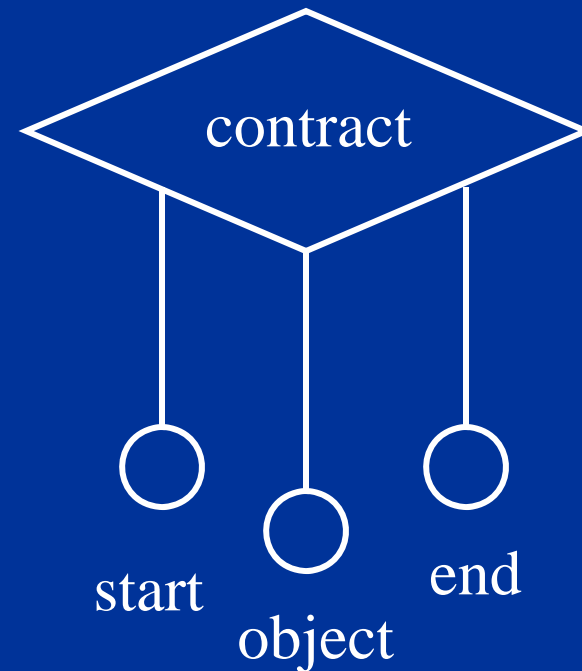
Relationships and Relationship Sets

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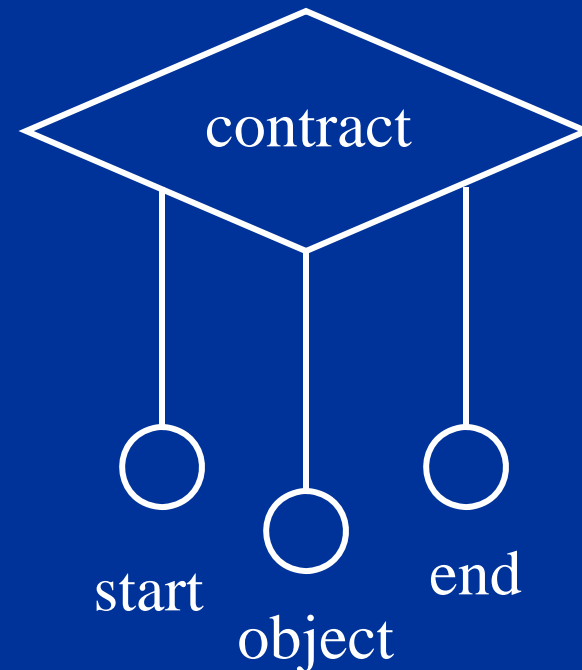
Attributes of Relationships

- Relationship can have attributes
- All relationships in one relationship set have the same attributes

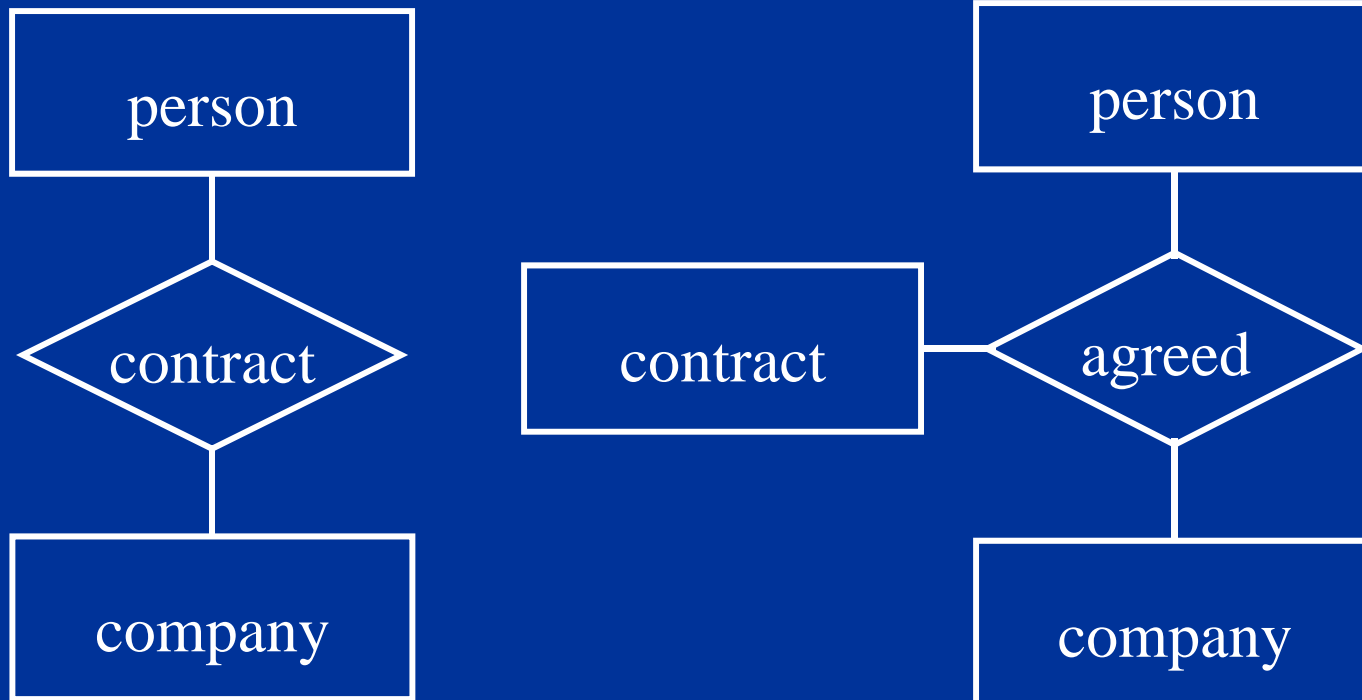


Attributes of Relationships

- Relationships are distinguished not by their attributes but by their participating entities



Entity or Relationship?

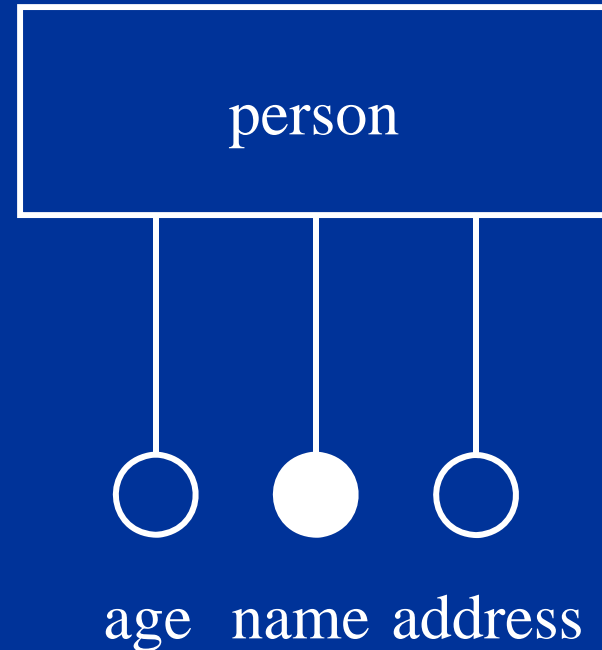


Conceptual Design

Integrity
Keys and participation Constraints

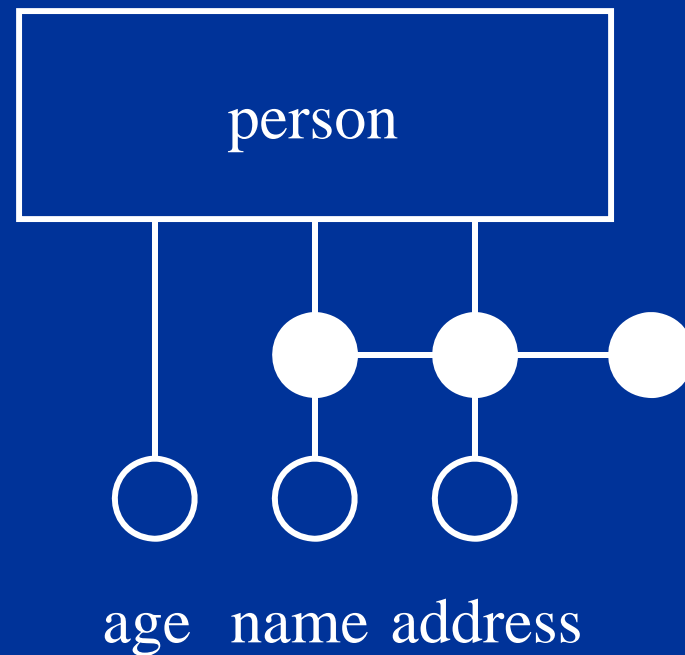
Entities' Identity

- One attribute can identify the entity
- This is a property of all entities in an entity set
- *Notice: at least all attributes identify the entity*



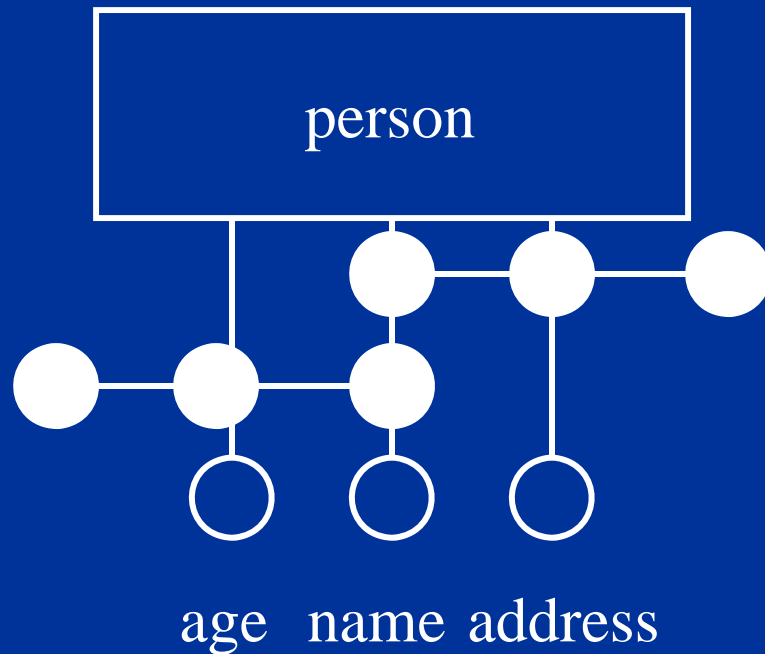
Entities' Identity

- A combination of attributes can identify the entity



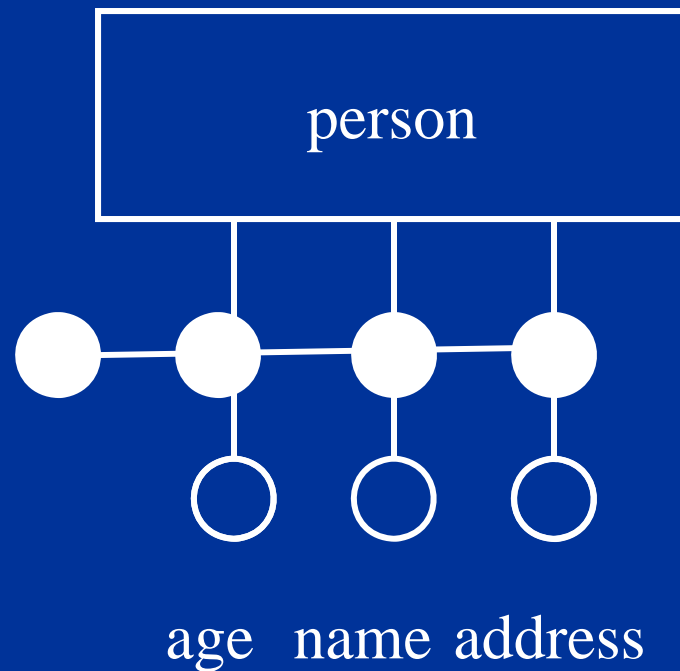
Entities' Identity

- There might be several possible combination of attributes to identify an entity



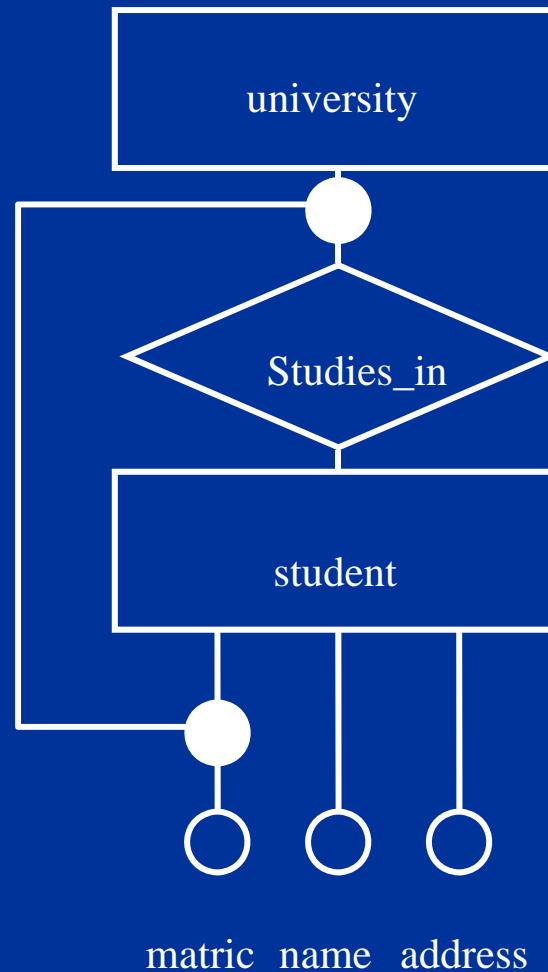
Entities' Identity

- *Notice: at least all attributes identify the entity*
- *But we might prefer a minimum set of attributes*



Weak Entities

Matric numbers are given by the universities, The same number can be used by different universities.



University is a dominant entity.
We need to know the university
In order to identify the student.

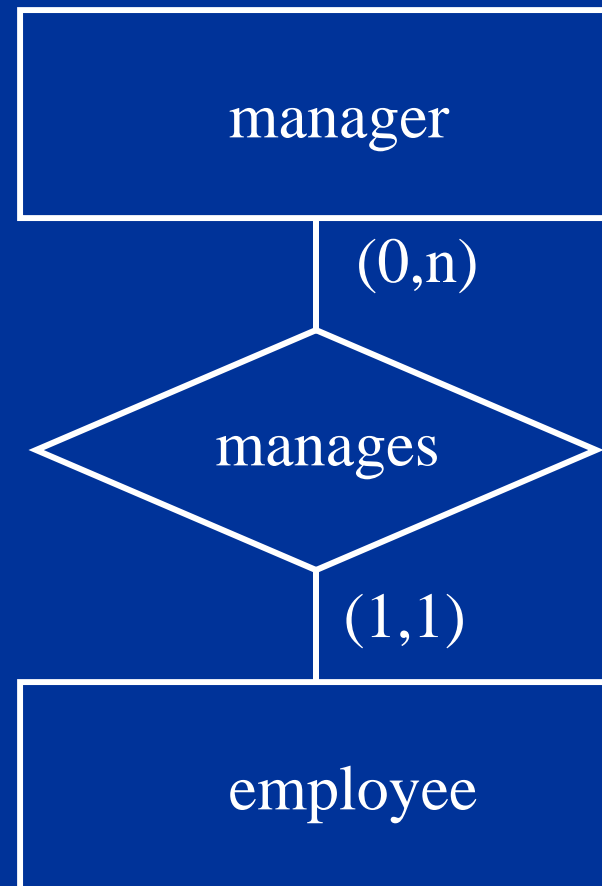
Student is a weak entity.
It can be identified
by its attributes alone.

Weak Entities

- Some entities can only be identified within the scope of a relationship with another entity set
- Notice that the relationship must exist and be unique for each entity in the set

Relationships' Cardinality

- The cardinality of the participation in a relationship can be constrained by a minimum and maximum value:
(1,1)
(0, n)
(2, 5)



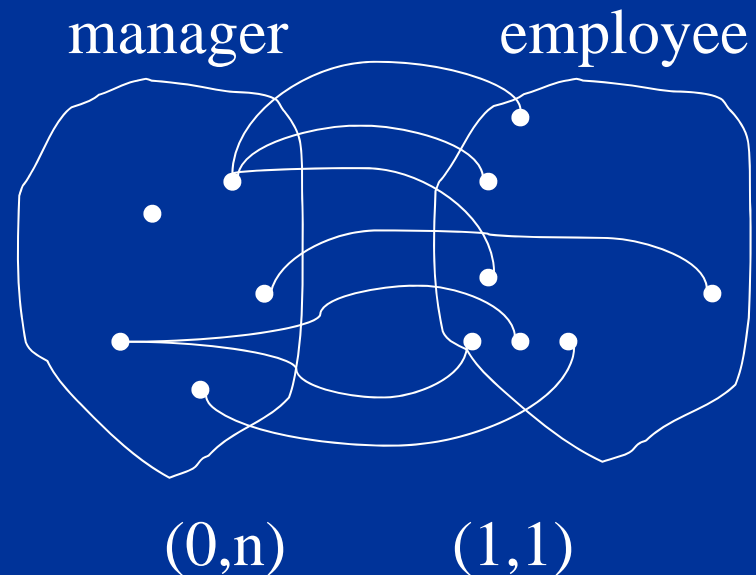
Relationships' Cardinality

- The cardinality of the participation in a relationship can be constrained by a minimum and maximum value:

(1,1)

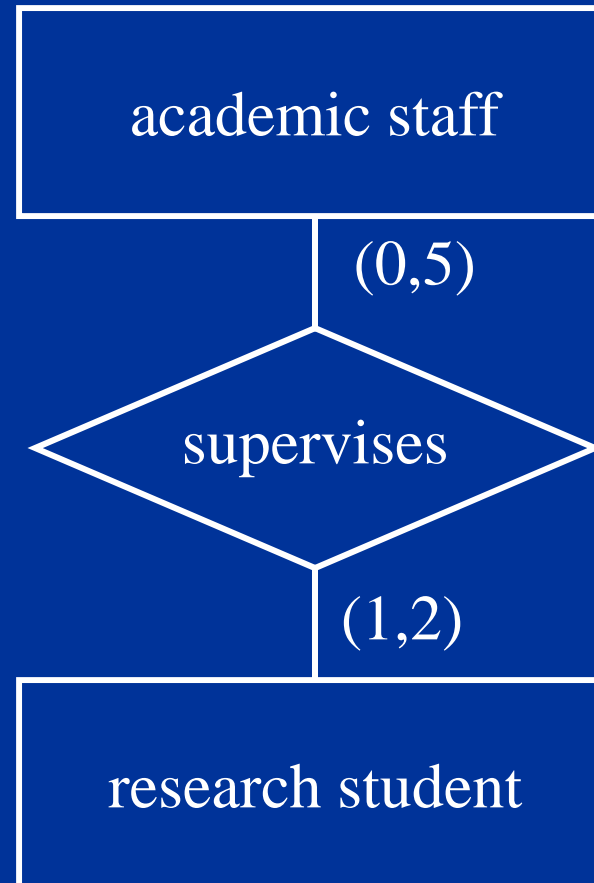
(0, n)

(2, 5)



Relationships' Cardinality

- Another example



Relationships' Cardinality

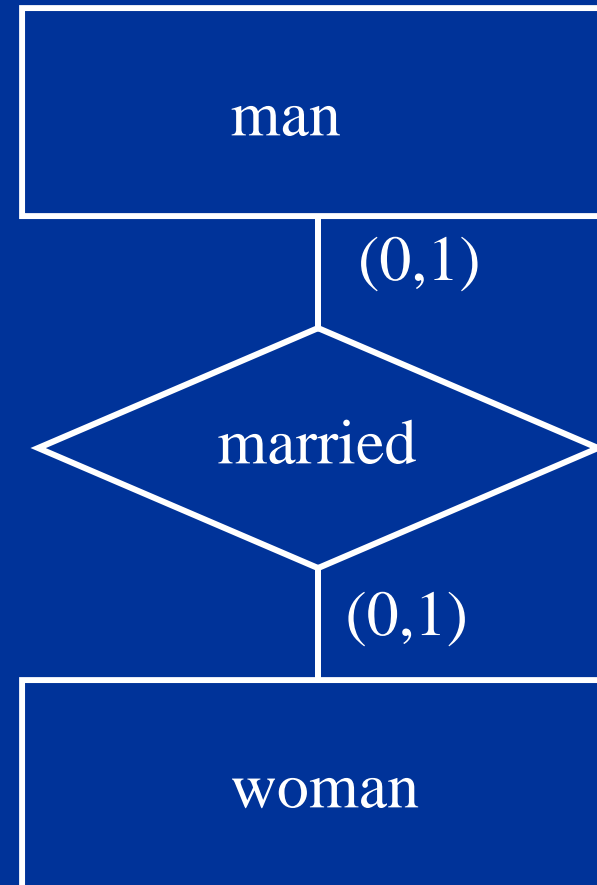
- (1, x) mandatory participation
- (0, x) optional participation

Relationships' Cardinality

- $(x, 1)$ for all entities involved characterizes a one-to-one relationship
- $(x, 1)$ for one entity involved and (x, N) or (x, y) $y > 1$ for the others characterizes a one-to-many relationship
- (x, N) or (x, y) $y > 1$ for all entities involved characterizes a many-to-many relationship

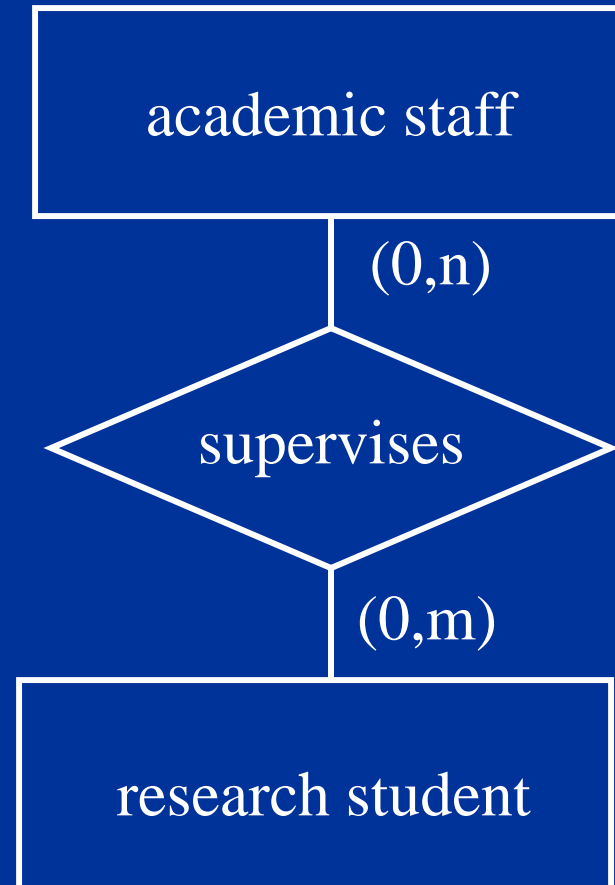
Relationships' Cardinality

- Example of a one-to-one relationship



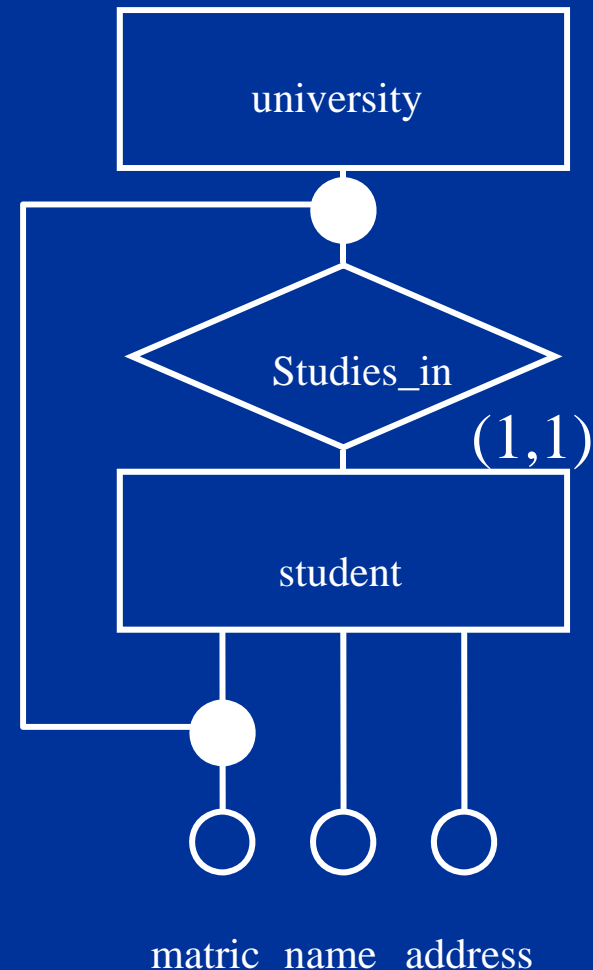
Relationships' Cardinality

- By default we have many-to-many relationships



Weak Entities

- Weak entities can only be defined for a participation constrained by (1,1) cardinalities
- Also called mandatory one-to-many relationships

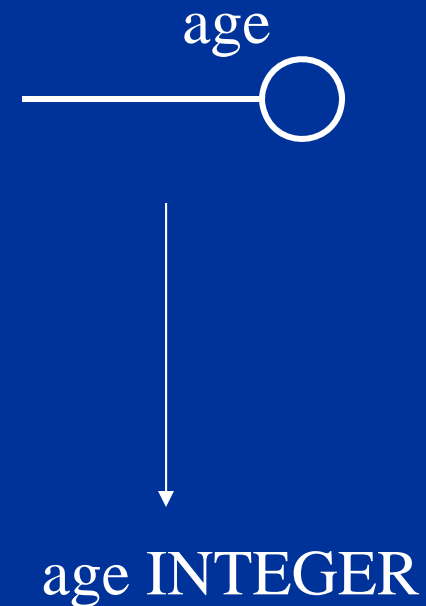


Conceptual to Logical Design

From E-R to Relational
3 Rules and 3 Exceptions

Rule 1: Value Sets

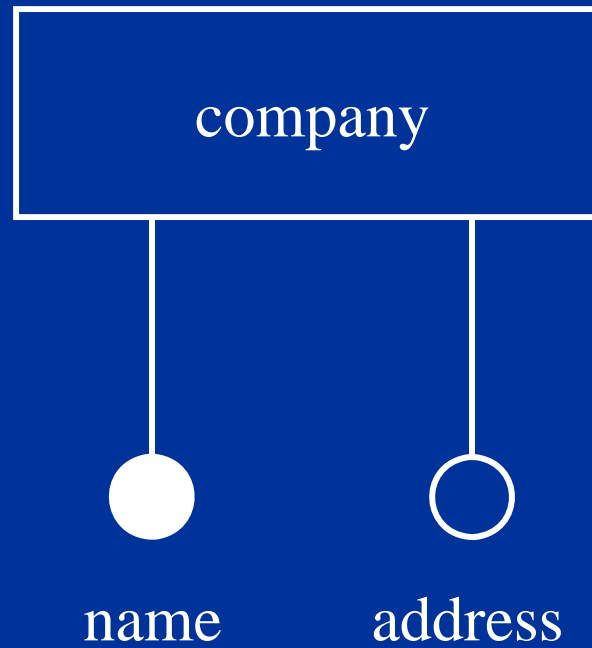
- Value sets are mapped to domains
- *In practice this is a first step towards the physical design*
- E-R attributes are mapped to attributes of relations



Rule 2: Entity Sets

- Entity sets are mapped to relations
- The entity set attributes are mapped to attributes of the relation
- The keys are mapped to primary key

Rule 2: Entity Sets



Rule 2: Entity Sets

```
CREATE TABLE company  
(  
  name VARCHAR(64) PRIMARY KEY,  
  address VARCHAR(128),  
)
```

Rule 2: Entity Sets



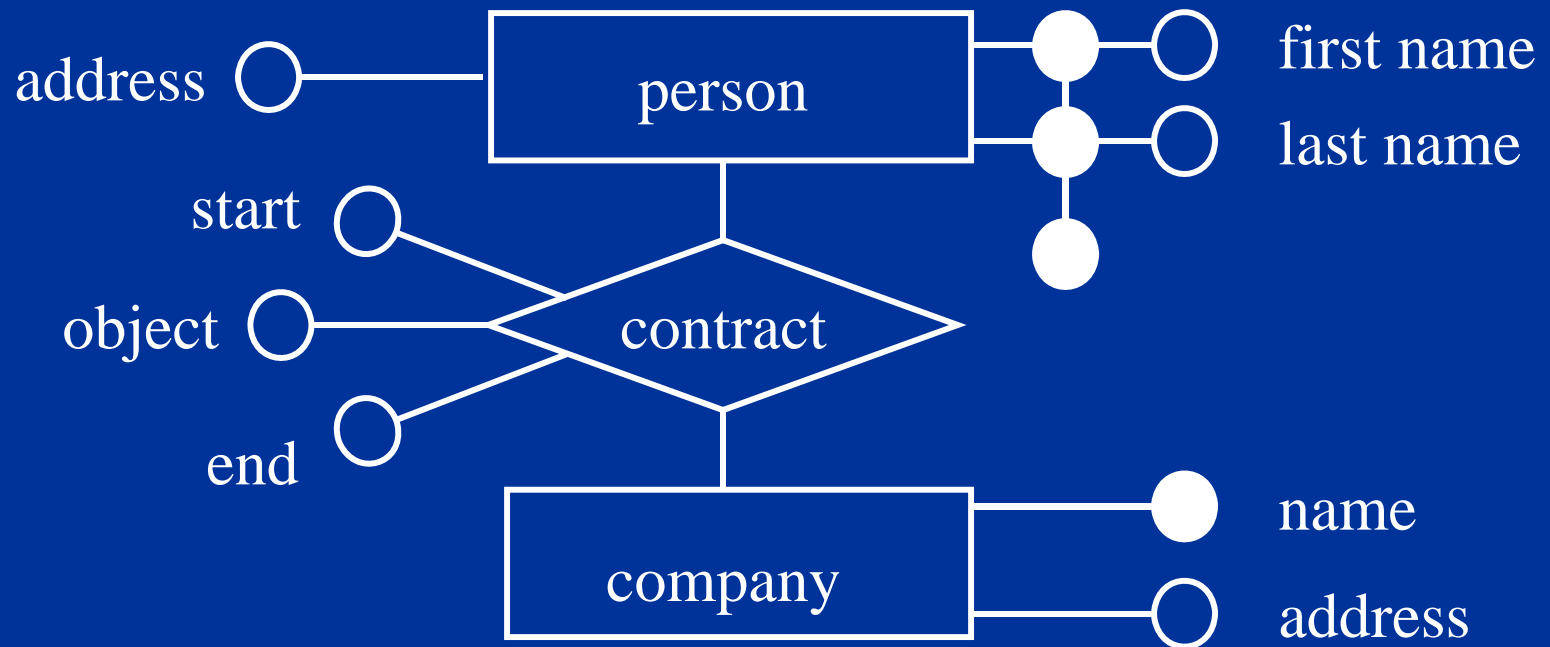
Rule 2: Entity Sets

```
CREATE TABLE person  
(  
  first_name VARCHAR(32),  
  last_name VARCHAR(32),  
  address VARCHAR(128),  
  PRIMARY KEY (first_name, last_name))
```

Rule 3: Relationship Sets

- Relationship sets are mapped to relations
- The attributes of the relation consist of the attributes of the relationship set
- As well as of the keys of the participating entities

Rule 3: Relationship Sets

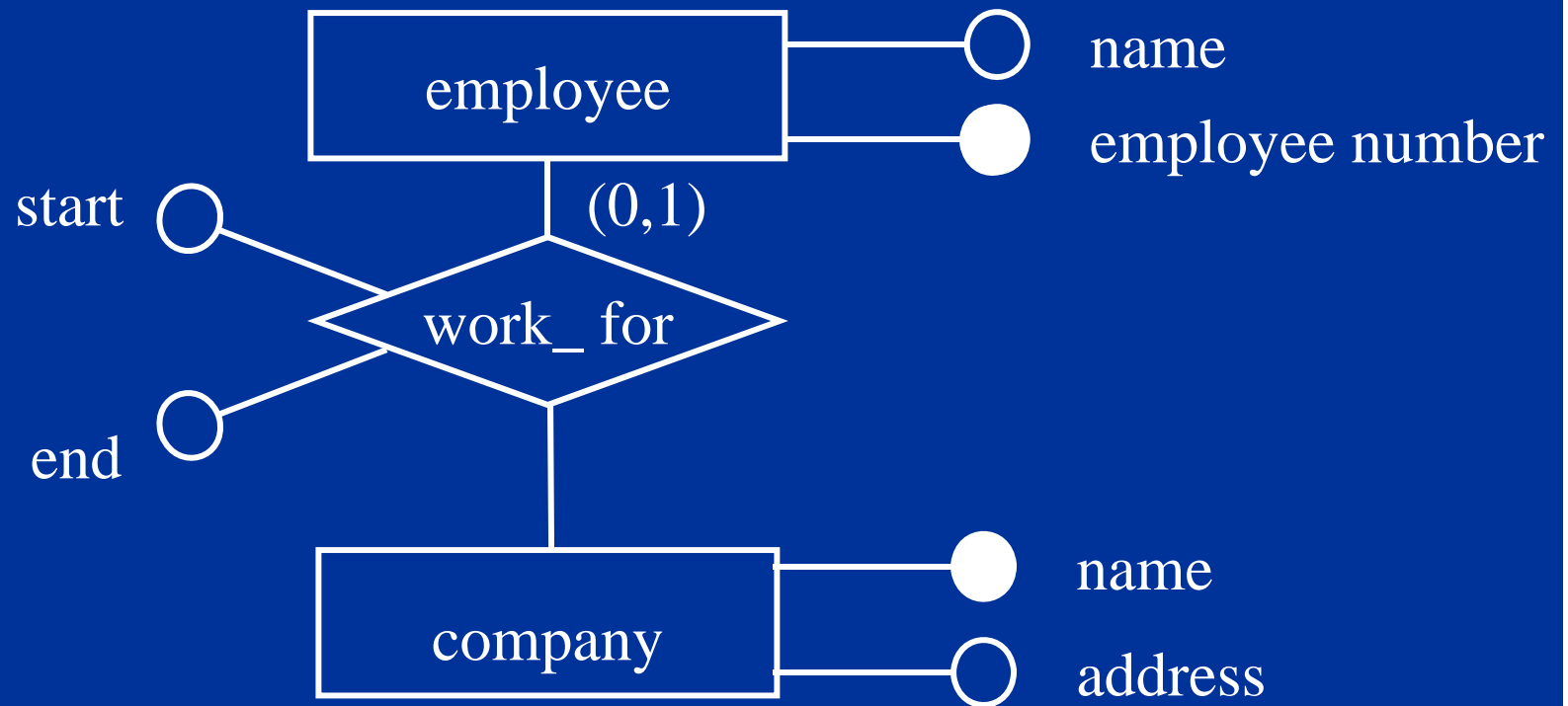


Rule 3: Relationship Sets

```
CREATE TABLE contract
(
  start DATE,
  end DATE,
  object VARCHAR(128),
  pfirst_name VARCHAR(32),
  plast_name VARCHAR(32),
  cname VARCHAR(64),
  PRIMARY KEY (pfirst_name, plast_name, cname),
  FOREIGN KEY (pfirst_name , plast_name ) REFERENCES
  person(first_name, last_name),
  FOREIGN KEY (cname ) REFERENCES company(name)
)
```

Exception 1: One-to-many Relationships

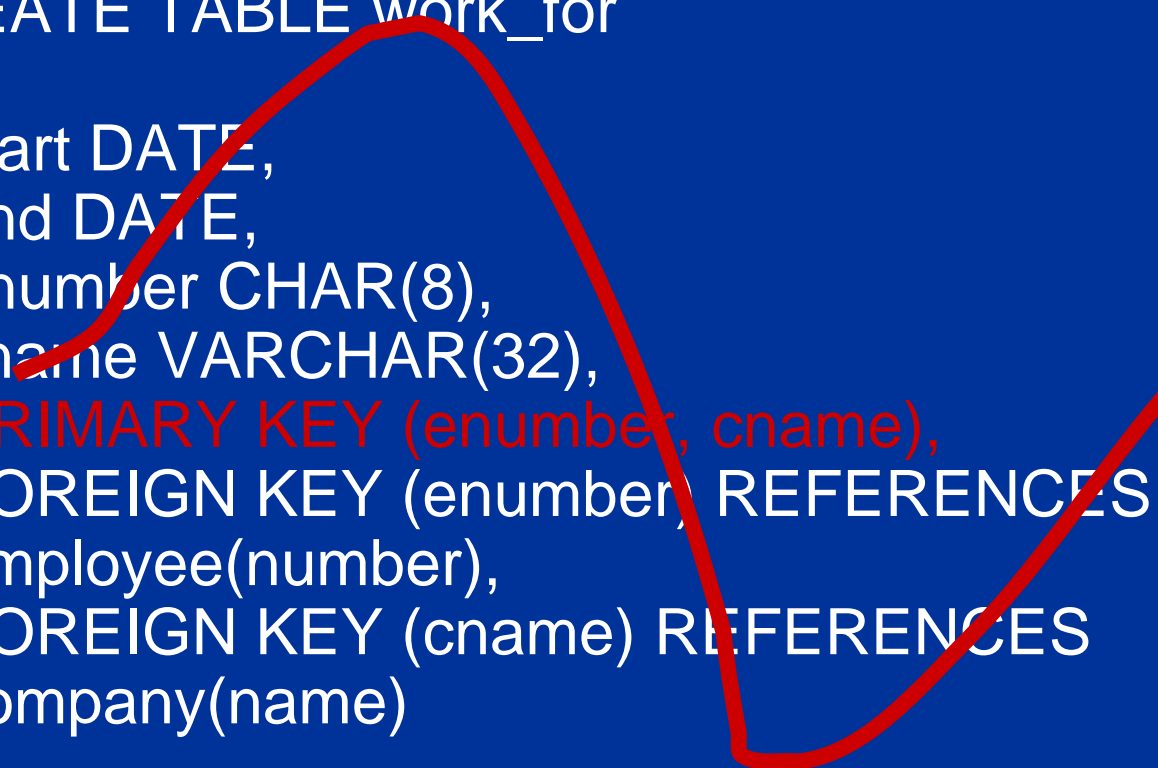
A one-to-many relationship indicate a key constraint



Exception 1: One-to-many Relationships

The primary key of the relationship table is inadequate.

```
CREATE TABLE work_for
(
  start DATE,
  end DATE,
  enumber CHAR(8),
  cname VARCHAR(32),
  PRIMARY KEY (enumber, cname),
  FOREIGN KEY (enumber) REFERENCES
  employee(number),
  FOREIGN KEY (cname) REFERENCES
  company(name)
)
```

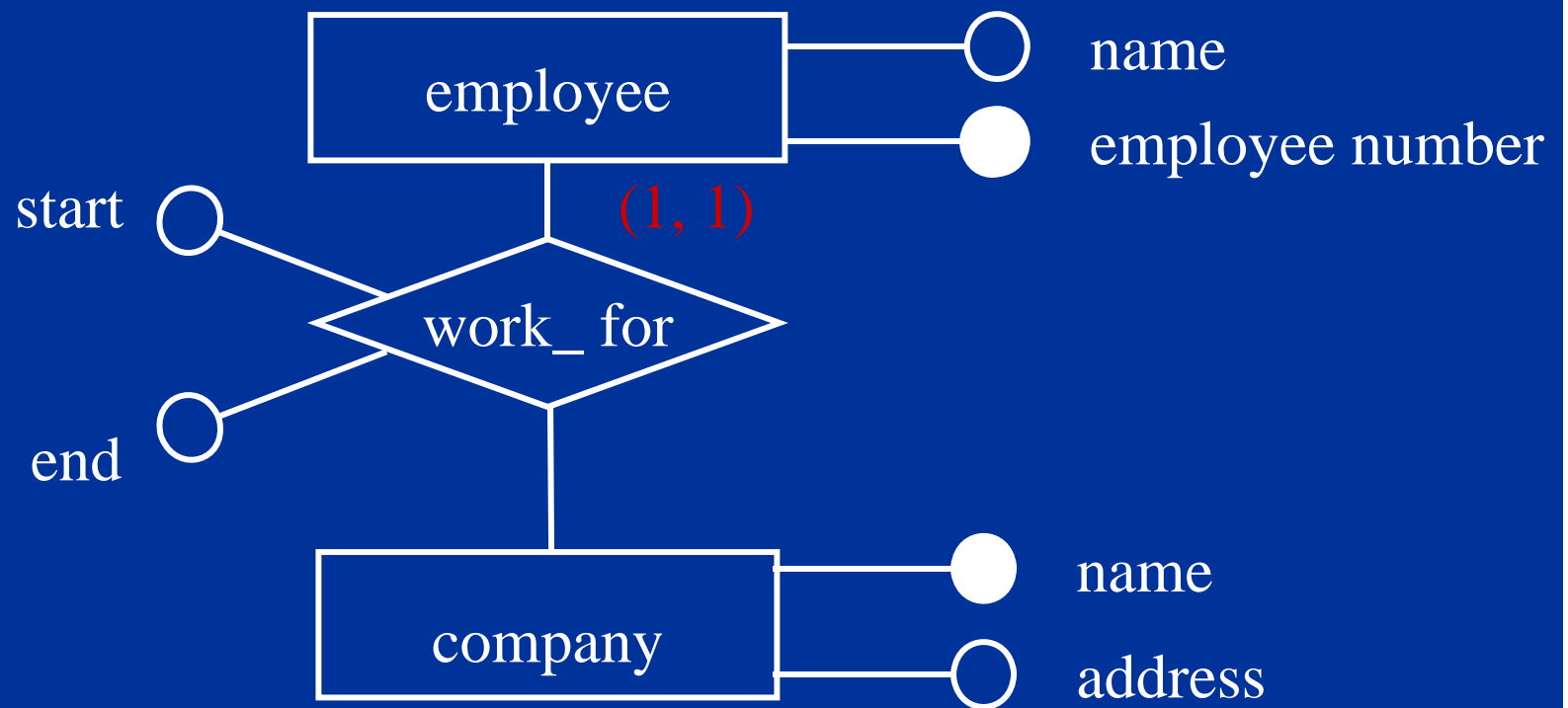


Exception 1: One-to-many Relationships

We change the primary key of the relationship table or add UNIQUE constraints.

```
CREATE TABLE work_for
(
  start DATE,
  end DATE,
  enumber CHAR(8) PRIMARY KEY,
  cname VARCHAR(32),
  FOREIGN KEY (enumber) REFERENCES
  employee(number),
  FOREIGN KEY (cname) REFERENCES
  company(name)
)
```

Exception 2: (1, 1) Participation Constraints

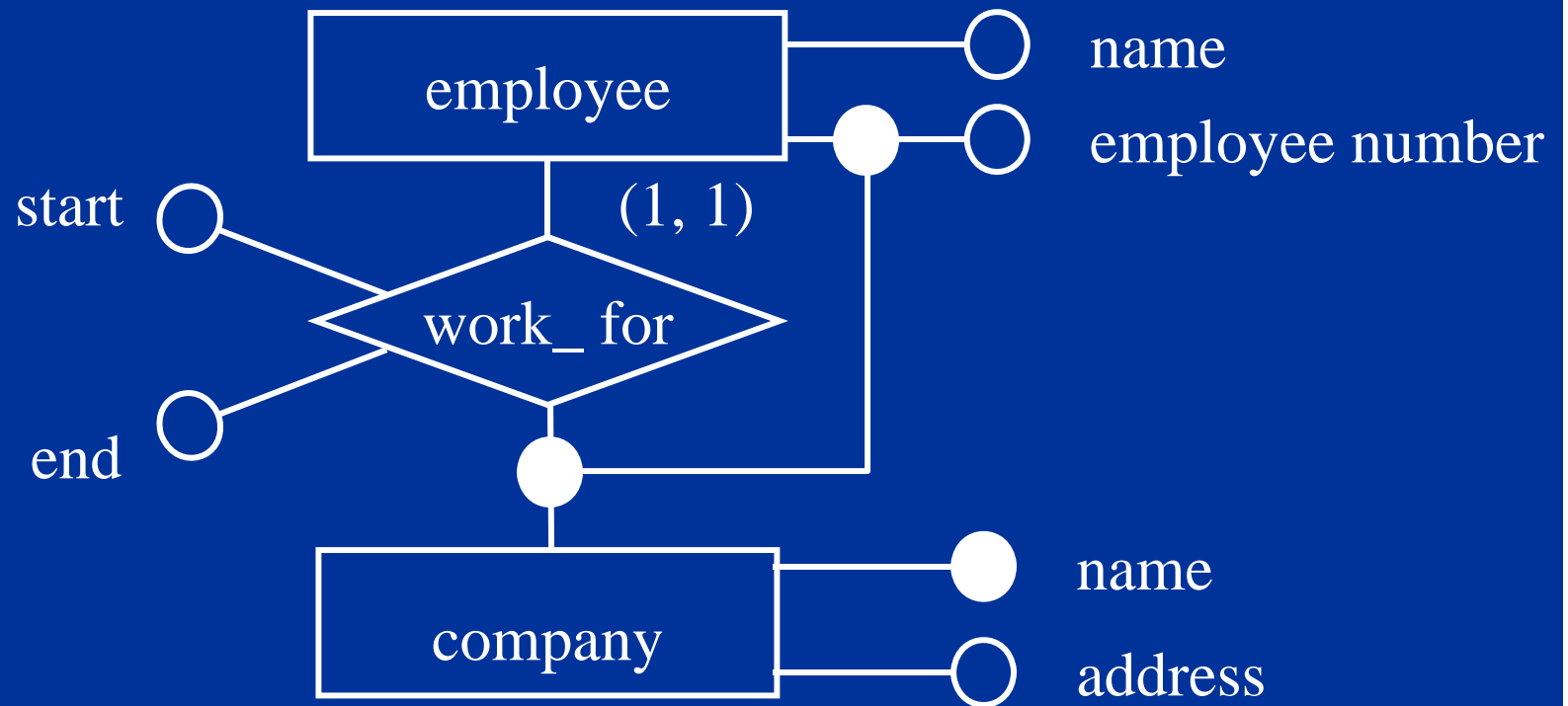


Exception 2: (1, 1) Participation Constraints

We merge the table employee and the table work_for and use the primary key of the employee table.

```
CREATE TABLE employee_work_for
(
  start DATE,
  end DATE,
  enumber CHAR(8) PRIMARY KEY,
  ename CHAR(32),
  cname VARCHAR(32),
  FOREIGN KEY (cname) REFERENCES
  company(name)
)
```

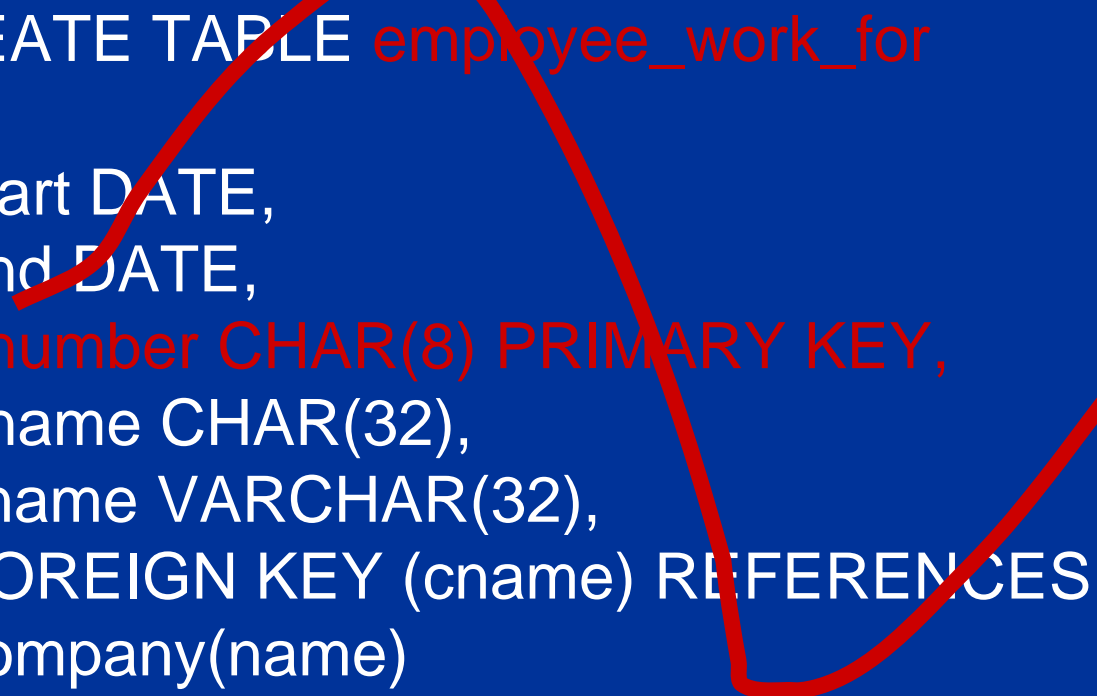
Exception 3: Weak Entity



Exception 3: Weak Entity

The primary key of the employee table is not enumber because it is a weak entity.

```
CREATE TABLE employee_work_for
(
  start DATE,
  end DATE,
  enumber CHAR(8) PRIMARY KEY,
  ename CHAR(32),
  cname VARCHAR(32),
  FOREIGN KEY (cname) REFERENCES
  company(name)
)
```

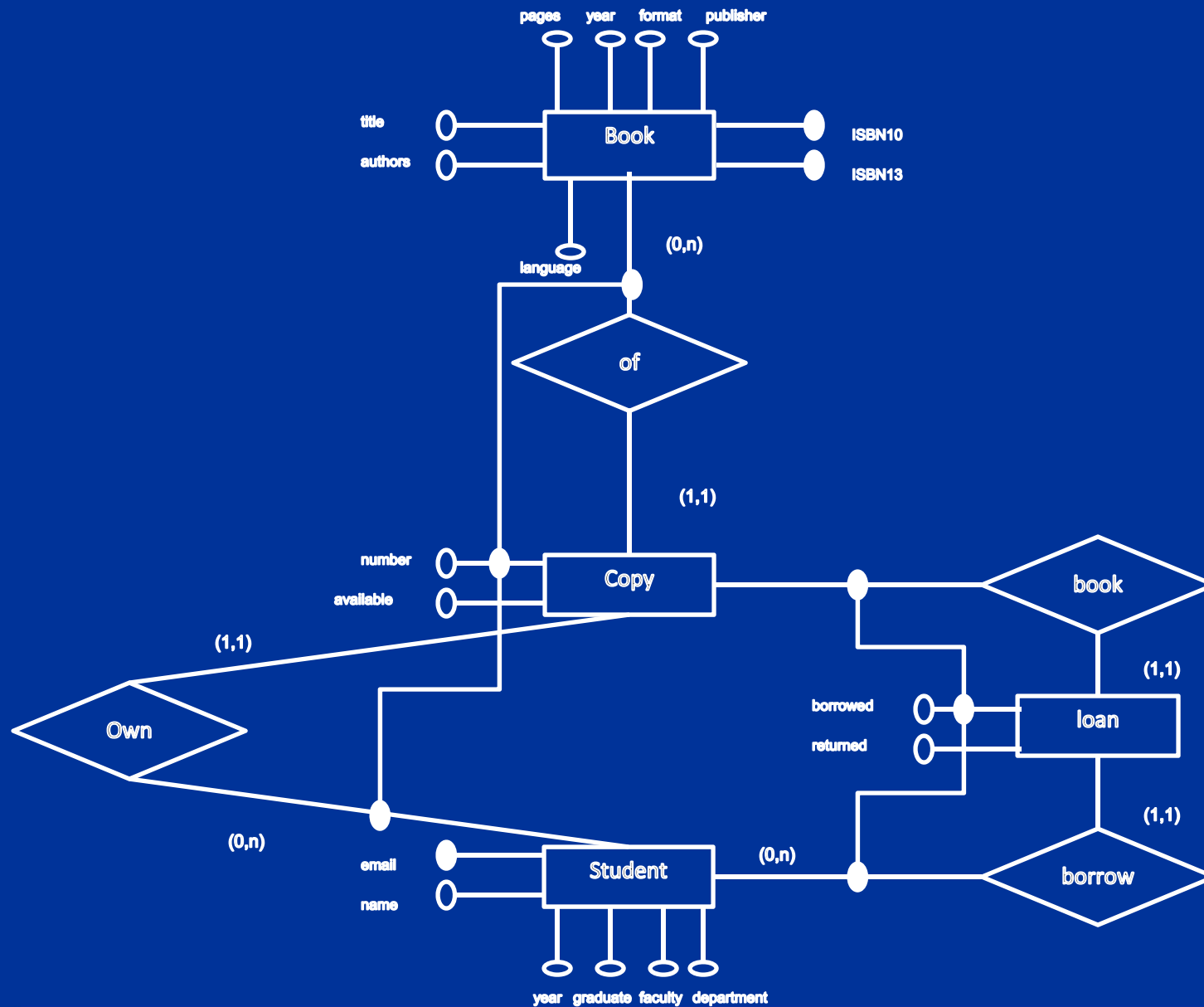


Exception 3: Weak Entity

We merge the table employee and the table work_for and use the primary key of the weak entity.

```
CREATE TABLE employee_work_for
(
  start DATE,
  end DATE,
  enumber CHAR(8),
  ename CHAR(32),
  cname VARCHAR(32),
  PRIMARY KEY (enumber, cname),
  FOREIGN KEY (cname) REFERENCES
  company(name)
)
```

Entity-relationship Diagram from the Tutorial



Credits

The content of this lecture is based
on chapter 7 of the book
“Introduction to database
Systems”

By
S. Bressan and B. Catania,
McGraw Hill publisher

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