# Sistemas de Informação e Bases de Dados
# 2020/2021

## Class 07: Translating E-A to SQL

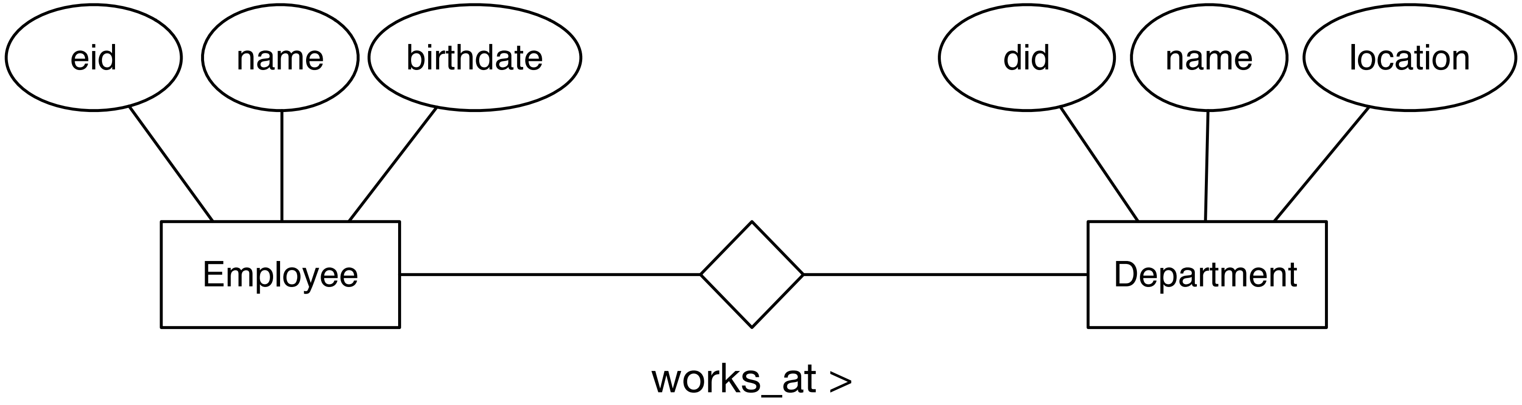
Prof. Paulo Carreira

# Class Outline

- Motivation
- Revisiting Referential Integrity
- Translating Entities and Attributes
- SQL Data Types
- Translating Column and Domain Constraints

# Motivation

# Translation Example




**Employee**

| eid | name | birthdate |
|---|---|---|
| 1 | Alice | 10/10/1995 |
| 2 | Bob | 03/02/1996 |
| 3 | Caroline | 04/04/1997 |
| 4 | Daniel | 03/04/1998 |
| 5 | Eduard | 10/03/1994 |

**works_at**

| eid | did |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 3 |
| 5 | 3 |

**Department**

| did | name | location |
|---|---|---|
| 1 | Finance | Buraca |
| 2 | Marketing | Damaia |
| 3 | Sales | Chelas |

⚠ **works_at** encodes the association of Employees to Departments

All VALUES must be coherent

# Relations and Attributes

```sql
CREATE TABLE employee(
      eid INTEGER,
      name VARCHAR(80) NOT NULL,
      bdate DATE NOT NULL,
      PRIMARY KEY (eid)
);
```

```sql
CREATE TABLE department(
      did INTEGER,
      name  VARCHAR(20) NOT NULL,
      location VARCHAR(20) NOT NULL,
      PRIMARY KEY (did)
);
```

```sql
INSERT INTO employee VALUES(1, 'Alice', '1995-10-10');
INSERT INTO employee VALUES(2, 'Bob', '1996-03-02');
```

```sql
INSERT INTO department VALUES(1, 'Finance', 'Buraca');
INSERT INTO department VALUES(2, 'Marketing', 'Damaia');
```

# Relations and Attributes

```sql
CREATE TABLE employee (
    eid INTEGER,
    name VARCHAR(80) NOT NULL,
    bdate DATE NOT NULL,
    PRIMARY KEY(eid)
);
```

```sql
CREATE TABLE department (
    did INTEGER,
    name  VARCHAR(20) NOT NULL,
    location VARCHAR(20) NOT NULL,
    PRIMARY KEY(did)
);
```

```sql
CREATE TABLE works_at(
    eid INTEGER,
    did INTEGER,
    PRIMARY KEY (eid, did)
    FOREIGN KEY(eid) REFERENCES employee(eid),
    FOREIGN KEY(did) REFERENCES department(did)
);
```

Prevents inputing invalid *eid* or *did* values

```sql
INSERT INTO works_at VALUES(1, 1);
INSERT INTO works_at VALUES(2, 1);
INSERT INTO works_at VALUES(2, 99);
```

# Referential Integrity

# Table Relationships

A foreign key connects two tables

**Foreign Key**

Employee

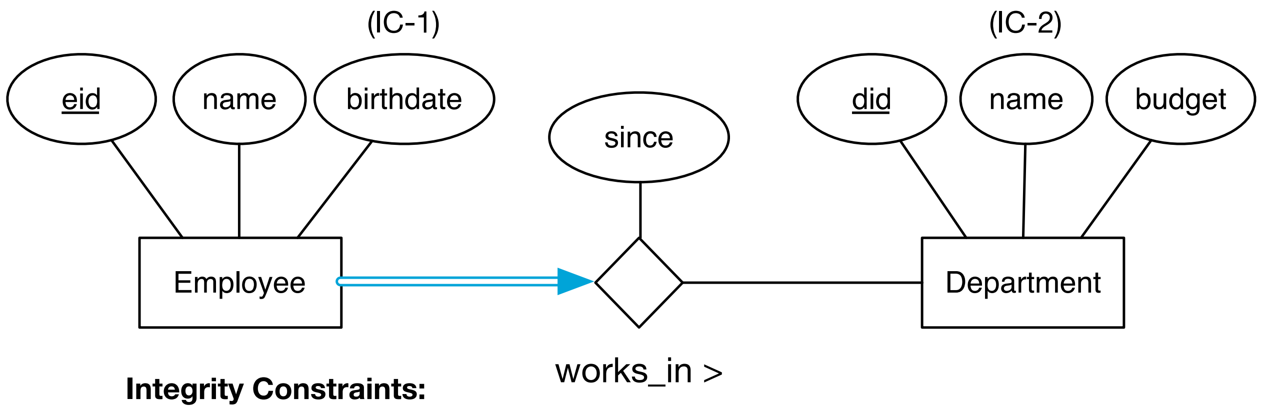
| ID | Name | Tax id | T-Shirt | DID |
|---|---|---|---|---|
| 001 | João Guilherme Silva da Cunha | 12345678 | M | EN |
| 002 | Tomás Pinto dos Santos | 91234567 | M | EN |
| 003 | David Miguel Redwanz Duque | 89012345 | L | MK |
| 004 | Pedro Daniel Diz Pinela | 67890123 | M | HR |
| 005 | Guilherme de Queiróz Rebelo Brum Gomes | 22394856 | XL | EN |
| 006 | Marta Isabel de Almeida Cardoso | 34562732 | S | HR |
| 007 | Filipe Emanuel Lourenço Ramalho Fernandes | 82533235 | L | EN |
| 008 | Gabriel Filipe Queirós Mesquita Delgado Freire | 23134539 | M | EN |
| 009 | João Gomes Vultos Freitas | 22231233 | L | EN |
| 010 | Ricardo Afonso Rodrigues da Silva Oliveira | 56372848 | L | MK |

Department

| DID | Name | Budget |
|---|---|---|
| HR | Human Resources | 50 000 |
| EN | Software Engineering | 1 200 000 |
| MK | Marketing | 150 000 |

Primary Key

# How to translate this case?




**Integrity Constraints:**
(IC-1) an employee must be at least 18 years old
(IC-2) Department names must be unique

⚠ All VALUES in Employee.dep must exist as PRIMARY KEY the Department.did

**Employee**

| eid | name | birthdat | since | dep |
|---|---|---|---|---|
| 1 | Alice | 10/10/1995 | 10/10/2015 | 1 |
| 2 | Bob | 03/02/1996 | 01/04/2014 | 2 |
| 3 | Caroline | 04/04/1997 | 15/04/2015 | 3 |
| 4 | Daniel | 03/04/1998 | 01/03/2018 | 3 |
| 5 | Eduard | 10/03/1994 | 01/01/2019 | 3 |

**Department**

| did | name | location |
|---|---|---|
| 1 | Finance | Buraca |
| 2 | Chemistry | Damaia |
| 3 | Sales | Chelas |

# Operations that violate Referential Integrity

**Employee**

| eid | name | birthdat | since | dep |
|---|---|---|---|---|
| 1 | Alice | 10/10/1995 | 10/10/2015 | 1 |
| 2 | Bob | 03/02/1996 | 01/04/2014 | 2 |
| 3 | Caroline | 04/04/1997 | 15/04/2015 | 3 |
| 4 | Daniel | 03/04/1998 | 01/03/2018 | 3 |
| 5 | Eduard | 10/03/1994 | 01/01/2019 | 3 |

**Department**

| did | name | location |
|---|---|---|
| 1 | Finance | Buraca |
| 2 | Chemistry | Damaia |
| 3 | Sales | Chelas |

- **Removing** lines from *Department*: We cannot remove *departments* to which *employees* are <u>still associated</u>
- **Updating** VALUES on *Department*: We cannot change VALUES on *department* that imply changing VALUES on *employee*
- **Inserting** lines on *Employee*: We cannot add *employees* on *departments* that do not exist

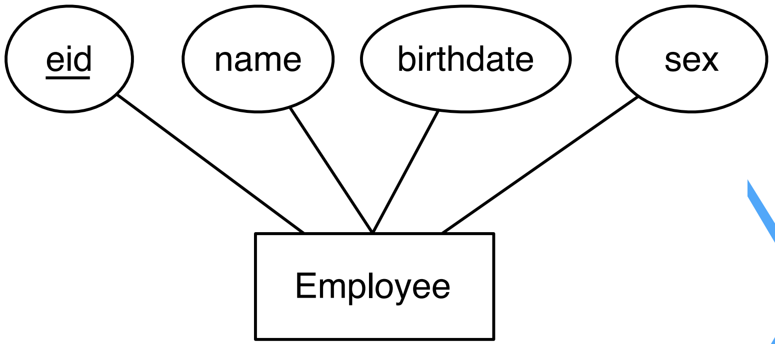
# Referential Integrity Constraints (or Foreign Keys)

- The most common constraint involving two tables is the Referential Integrity constraint

- Data in one table must be always coherent with the data of another table. A table is usually related to other tables.

# Translating Entities and Attributes

# Entities




```
CREATE TABLE employee (
      eid   INTEGER,
      name  VARCHAR(80) NOT NULL,
      bdate DATE NOT NULL,
      PRIMARY KEY(eid)
);
```

1. **Entities** result in a table with corresponding attributes
2. PRIMARY KEY is the same
3. Constraints have also to be translated (will see how later on…)

# Data Types and Values

# Basic Datatype Families

## Text Types

**Varchar** | **Char** | **Text**

```
'John Smith', 'R2D2', 'Red', ''
```

## Numeric Types

**Integer** | **Fixed Point** | **Floating Point**

```
-1, 25, +6.34, 0.5, 25e-03
```

## Date & Time

**Date** | **Time** | **Timestamp**

```
'2029-01-01', '08-JAN-2029 10:35:02'
```

# Text Types

| VARCHAR(*n*) | CHAR(*n*) | TEXT |
|---|---|---|
| Variable length character string max size *n* | Character string with fixed size *n* | Variable length text (multi-line) field (typically limited to 65535 characters) |
| $n < 4000$ | $n < 4000$ | length typically limited to 65535 characters |

# Integer Numeric Types

| INTEGER | SMALLINT | BIGINT |
| --- | --- | --- |
| An integer with up to 9 digits | An integer with up to 4 digits | An integer with up to 18 digits |
| 4 bytes | 2 bytes | 8 bytes |
| $-2^{31}$<br>-2 147 483 648<br>to<br>$+2^{31}-1$<br>2 147 483 647 | $-2^{15}$<br>-32 768<br>to<br>$+2^{15}-1$<br>32 767 | $-2^{63}$<br>-9 223 372 036 854 775 808<br>to<br>$+2^{63}-1$<br>9 223 372 036 854 775 807 |

# Fixed Point Number Types

**NUMERIC(*p*, *s*)**

A numeric value with arbitrary exact precision

≈(3+*p*/4) bytes

Up to 131072 digits before the decimal point
Up to 16383 digits after the decimal point

- Precision ***p***: total number of digits, must be positive (***p*** > 0)
- Scale ***s***: number of digits to right of the decimal point, can be zero but must always be smaller than the precision (0 < ***s*** < ***p***)

Whenever ***s*** is zero, we can write **NUMERIC(*p*)**

# Floating Point Numeric Types

| REAL | DOUBLE |
|---|---|
| variable-precision, inexact 6 digits | variable-precision, inexact 15 digits |
| 4 bytes | 8 bytes |
| 1E-37 to 1E+37 | 1E-307 to 1E+308 |

# Fixed- vs. Floating Point

| | FIXED POINT | FLOATING POINT |
|---|---|---|
| Precision | Fixed precision | Variable-precision |
| Storage | Stores numbers exactly | Stores numbers inexactly (as approximations) |
| Retrieval | Retrieved valued never show any discrepancies | Retrieved values may show discrepancies from values stored |
| Speed | Slower calculations (*) | Faster calculations |
| Money Amounts | Can be safely used for monetary values | Should never be used for monetary values |

(*) In practice, this difference is often neglectable

# Behaviour of Fixed and Float

# Behaviour of Fixed Point

```
CREATE TABLE teste(
    x NUMERIC(1,0)    -- same as NUMERIC(1)
);
```

```
INSERT INTO teste VALUES (0);
```

```
INSERT INTO teste VALUES (-1);
```

```
INSERT INTO teste VALUES (9);
```

```
INSERT INTO teste VALUES (9.1);
```

⚠ rounded

```
INSERT INTO teste VALUES (11);
```

✕ error

⚠ Inserting in a NUMERIC with a precision or scale larger than specified will result in an error or in a warning; the value is often truncated.

# Behaviour of Fixed Point

```sql
CREATE TABLE teste(
    x NUMERIC(4,2)
);
```

```sql
INSERT INTO teste VALUES (0.0);
```

```sql
INSERT INTO teste VALUES (-1.2);
```

```sql
INSERT INTO teste VALUES (12.34);
```

```sql
INSERT INTO teste VALUES (12.345);
```

⚠ Rounds to 12.35

# Behaviour of Float

```
CREATE TABLE test(
 x float,
 y float
);

INSERT INTO test VALUES(1.2, 1.2);

SELECT x+y FROM test;
```

```
2.4000000953674316
```

```
SELECT (1.0/3.0)*3.0;
```

# Date Types

| DATE | TIME | TIMESTAMP |
|---|---|---|
| Stores dates with a resolution of 1 day | Stores a time with a resolution of 1 microsecond | Stores instant timestamps with resolution of 1 microsecond |
| 4 bytes | 8 bytes | 8 bytes |
| 4713 BC to 5874897 AD | 00:00:00 to 24:00:00 | 4713 BC to 294276 AD |

# Intervals

**INTERVAL**

Enables capturing the difference between dates, times, or timestamps

4 bytes

-178 000 000 yrs
to
178 000 000 yrs

- Dates and times cannot be added (only subtracted)
- Intervals can be added to a date or to a time

| | | | | |
|---|---|---|---|---|
| DATE | - | DATE | = | INTERVAL |
| TIME | - | TIME | = | INTERVAL |
| DATE | + | INTERVAL | = | DATE |
| TIME | + | INTERVAL | = | TIME |

# Behaviour of Interval

```
CREATE TABLE test(
    a DATE,
    b TIME,
    c TIMESTAMP
);

INSERT INTO test VALUES ('2020-12-12', '09:00', '2020-12-12 10:30');
```

```
SELECT * FROM test;
```

```
     a      |    b     |          c
------------+----------+---------------------
 2020-12-12 | 09:00:00 | 2020-12-12 10:30:00
```

```
SELECT a + INTERVAL '10 days' AS a ,
       b + INTERVAL '1 hour 30 min' AS b,
       c + INTERVAL '20 days 2 hour 30 min' AS c
FROM test;
```

```
          a          |    b     |          c
---------------------+----------+---------------------
 2020-12-22 00:00:00 | 10:30:00 | 2021-01-01 13:00:00
```

# Indicative Field Sizes

# Person/Organisation

| Field | Database Type | Max Size | Min Size | Validation |
|---|---|---|---|---|
| **PERSON/ORGANIZATION DETAILS** | | | | |
| Person Full Name | VARCHAR | 80 | | |
| Company Name | VARCHAR | 200 | | |
| Street Address | VARCHAR | 255 | | |
| City | VARCHAR | 30 | | |
| Postal Code | VARCHAR | 12 | 2 | |
| Phone Number | VARCHAR | 15 | 3 | ITU E.16 |
| Phone Extension | VARCHAR | 11 | | ITU E.16 |
| Language | CHAR | 3 | | ISO 639 |
| Country Name | VARCHAR | 70 | | ISO 3166-1 |
| Latitude | NUMERIC | 9,6 | | |
| Longitude | NUMERIC | 8,6 | | |

# Finance

| Field | Database Type | Max Size | Min Size | Validation |
|---|---|---|---|---|
| **FINANCE** | | | | |
| VAT ID | VARCHAR | 20 | 1 | |
| IBAN | VARCHAR | 30 | | |
| Credit Card Number | NUMERIC | 16 | | |
| Money | NUMERIC | 16,4 | | |

# Electronic Commerce

| Field | Database Type | Max Size | Min Size | Validation |
|---|---|---|---|---|
| **ELECTRONIC** | | | | |
| E-mail Address | VARCHAR | 254 | 6 | IETF RFC 3696 Checking email addresses |
| Domain Name | VARCHAR | 253 | 4 | |
| URL | VARCHAR | 2083 | 11 | |
| IP address (incl V6) | VARCHAR | 45 | 11 | |
| GUID | char | 36 | | |

# Social Networks

| Field | Database Type | Max Size | Min Size |
|---|---|---|---|
| **SOCIAL NETWORK** | | | |
| Facebook max name length | VARCHAR | 50 | |
| Youtube channel | VARCHAR | 20 | |
| Twitter max name length | VARCHAR | 15 | |

# NULL Values

# NULL VALUES

**NULL** is a special value that means, simultaneously, unfilled / unknown / not applicable

Suppose that Daniel did not specify his birthdate, we could write the INSERT statement:

```
INSERT INTO employee VALUES(11, 'Daniel', null);
```

and then query the database for his record:

```
SELECT * FROM employee
WHERE eid=11;
```

```
eid  | name       | bdate
-----+-----------+-------
11   | Daniel     |
```

⚠ The use of NULL is ambiguous and should be avoided.

# NOT NULL Constraint

- In SQL all columns (not part of the key) by default may have null VALUES.

- To prevent columns from taking null VALUES, we must add the **NOT NULL** constraint in front of the data type:

  *<field> <type>* **NOT NULL**

```
CREATE TABLE employee(
    ssn NUMERIC(11),
    name VARCHAR(80) NOT NULL,
    birthdate DATE NOT NULL,
    PRIMARY KEY(ssn)
);
```

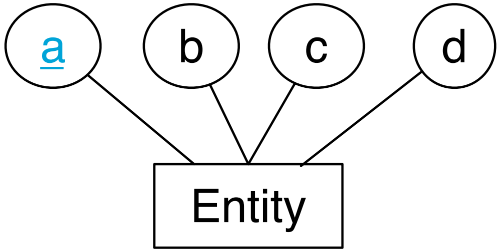
- Most columns (most often all columns) should be NOT NULL
- Any columns that participate in the PRIMARY KEY are already NOT NULL (because they null is never a valid value on a key)

# Translating Column and Domain Constraints

# Column Constraints

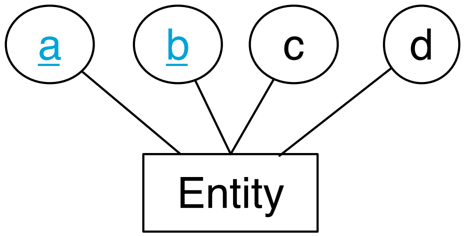
# PRIMARY KEY Constraints

## One Attribute




```
CREATE TABLE <table_name>(
        a INTEGER,
        b VARCHAR(80),
        c NUMERIC(12,4),
        d DATE,
        PRIMARY KEY(a)
);
```

## Multiple atributes



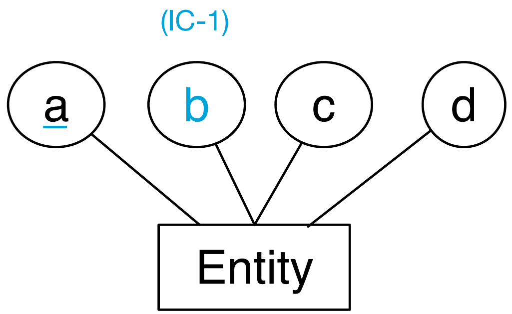

```
CREATE TABLE <table_name>(
        a INTEGER,
        b VARCHAR(80),
        c NUMERIC(12,4),
        d DATE,
        PRIMARY KEY(a, b)
);
```

A PRIMARY KEY constraint is specified as

**PRIMARY KEY**($col_1$, …, $col_n$)

# Uniqueness Constraints

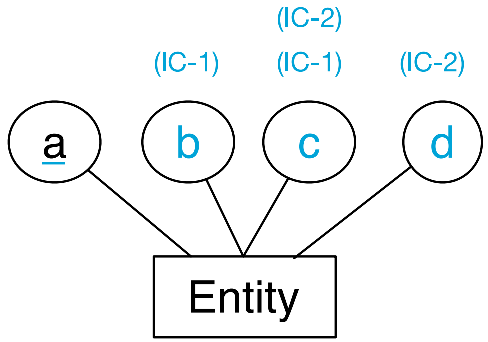
## One “unique" attribute




**Integrity Constraints:**
(IC-1) b is unique

```
CREATE TABLE table_name(
        a INTEGER,
        b VARCHAR(80),
        c NUMERIC(12,4),
        d DATE,
        PRIMARY KEY(a),
        UNIQUE(b)
);
```

## Combination of "unique"




**Integrity Constraints:**
(IC-1) (b,c) is unique
(IC-2) (c,d) is unique

```
CREATE TABLE table_name(
        a INTEGER,
        b VARCHAR(80),
        c NUMERIC(12,4),
        d DATE,
        PRIMARY KEY(a),
        UNIQUE(b, c),
        UNIQUE(c, d)
);
```

A uniqueness constraint is specified as:

**UNIQUE(*col*$_1$, …, *col*$_n$)**

# Domain Constraints

# Domain Constraint Checking

The **CHECK** clause can be used to specify the verification of the VALUES of any field of a record every time the record is inserted ou updated:

**CHECK(*condition*)**

```
CREATE TABLE products (
    product_no INTEGER,
    name VARCHAR(80),
    price NUMERIC,
    discounted_price NUMERIC,
    CHECK (price > 0),
    CHECK (discounted_price > 0),
    CHECK (price > discounted_price)
);
```

# Domain Constraints

A Domain constraint guarantees that the VALUES of a column (field VALUES) are within the intended domain

```
CREATE TABLE employee(
    ssn NUMERIC(11),
    name VARCHAR(80) NOT NULL,
    birthdate DATE NOT NULL,
    gender CHAR(1),
    PRIMARY KEY(ssn),
    CHECK (length(name) > 3),
    CHECK (birthdate > '1920-01-01'),
    CHECK (gender in ('M', 'F'))
);
```

# Domain Constraint validation using a Technical Table

Whenever the domain is too large, the valid VALUES can be validated against a technical table

```
CREATE TABLE employee
    (ssn NUMERIC(11),
     name VARCHAR(80) NOT NULL,
     birthdate DATE NOT NULL,
     birth_country CHAR(80),
     PRIMARY KEY(ssn),
     CHECK(birth_country
        IN (SELECT name FROM country))
);
```

Can be modelled as FOREIGN KEY

# Record/Line Constraints

A record (row or line) constraint is one that guarantees that the data of the record (row or line) is correct coherent

```
CREATE TABLE employee(
    eid NUMERIC(9),
    name VARCHAR(80) NOT NULL,
    birthdate DATE NOT NULL,
    graduation DATE NOT NULL,
    PRIMARY KEY(eid),
    CHECK (LENGTH(name) > 3),
    CHECK (birthdate > '1920-01-01'),
    CHECK (extract(year FROM age(birthdate)) > 18),
    CHECK graduation > birthdate
);
```

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# Sistemas de Informação e Bases de Dados 2020/2021

**Class 08: Translating E-A to SQL (cont)**

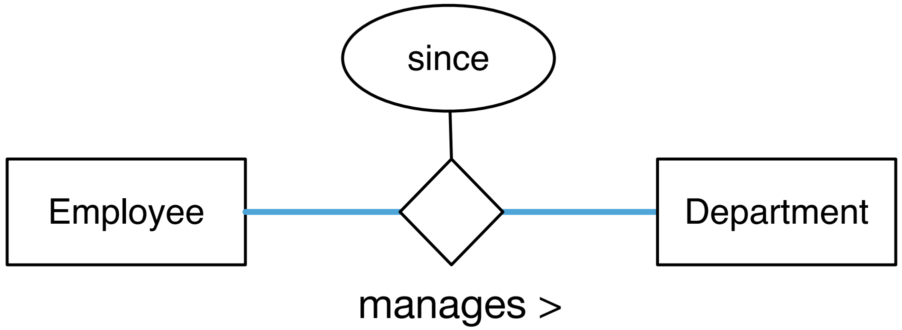
Prof. Paulo Carreira

# Class Outline

- Translating Associations
- Translating Specialisation/Generalisation
- Translating Weak Entities
- Translating Aggregations

# Translating Associations

# M:N Associations

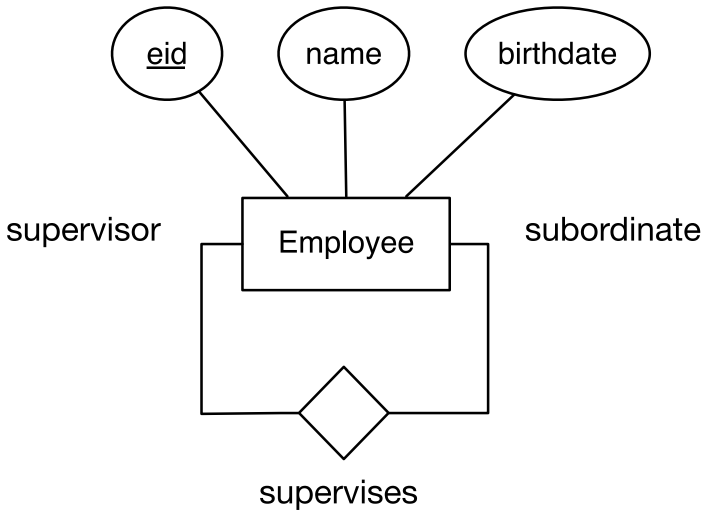



```
CREATE TABLE manages (
      eid INTEGER,
      did INTEGER,
      since DATE,
      PRIMARY KEY(eid, did),
      FOREIGN KEY (eid) REFERENCES employee(eid),
      FOREIGN KEY (did) REFERENCES department(did)
);
```

Captures any valid combination of ⟨eid, did⟩

# M:N Auto Association

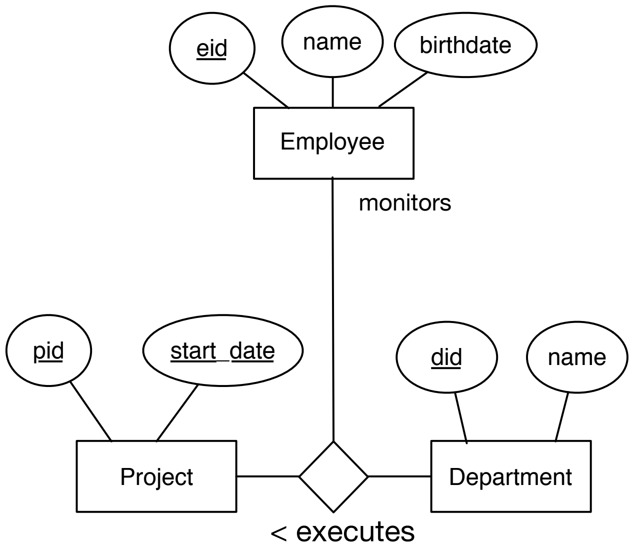
Special case of the self-association




```
CREATE TABLE supervises (
        sup_eid INTEGER,
        sub_eid INTEGER,
       PRIMARY KEY(sup_eid, sub_eid)
        FOREIGN KEY(sup_eid) REFERENCES
              Employee(eid),
        FOREIGN KEY(sub_eid) REFERENCES
              Employee(eid)
);
```

- Field names cannot repeat
- The fields sup_eid and sub_eid capture any valid combination of ⟨eid, eid⟩

# Ternary Associations

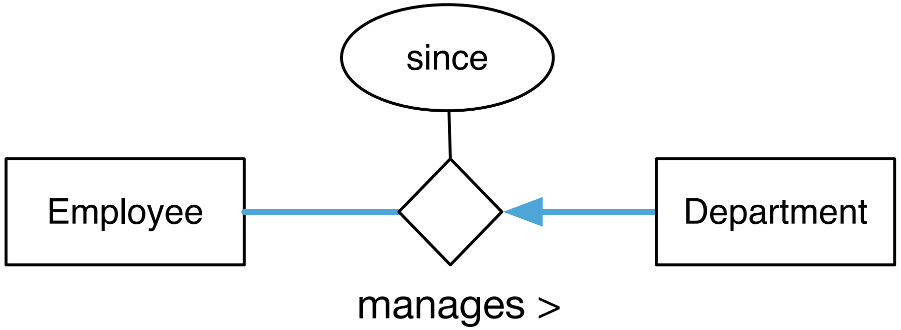



Same translation as the case for the binary but with more legs

```
CREATE TABLE executes (
      eid INTEGER,
      pid INTEGER,
      did INTEGER,
      PRIMARY KEY(eid, pid, did)
      FOREIGN KEY(eid) REFERENCES employee(eid),
      FOREIGN KEY(pid) REFERENCES project(pid),
      FOREIGN KEY(did) REFERENCES department(did)
);
```

Captures any valid combination of ⟨eid, pid, did⟩

# M:1 Associations

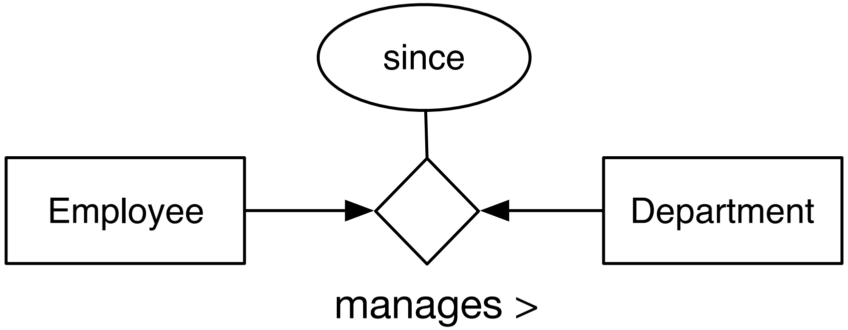



Guarantees that VALUES of *did* can never repeat!

```
CREATE TABLE manages (
     eid INTEGER,
     did INTEGER,
     since DATE,
     PRIMARY KEY(did),
     FOREIGN KEY(eid) REFERENCES employee(eid),
     FOREIGN KEY(did) REFERENCES department(did)
);
```

- Once a department is associated to an employee, it cannot be associated again (to another employee)
- We encode this by guaranteeing that each did appears only once in the table that represents the association (i.e., that did it is associated only once )

# 1:1 Associations



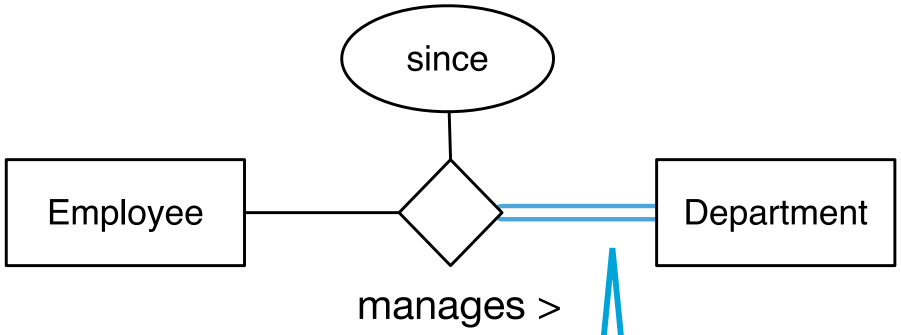

**Neither** *did* **nor** *did* **repeat**

Therefore: Once a '*department*' (or an '*employee*') exists in the table '*manages*', no other can exist

```
CREATE TABLE manages (
      eid INTEGER,
      did INTEGER,
      since DATE,
     PRIMARY KEY(eid)
      UNIQUE (did),
      NOT NULL(did),
      FOREIGN KEY(eid) REFERENCES employee(eid),
      FOREIGN KEY(did) REFERENCES department(did)
);
```

- Both a Department and a Employee can only be associated once
- We encode this by guaranteeing that both eid and did appear only once

# M:N Mandatory Participation




Every *department (did)* must participate in the '*manages*' association

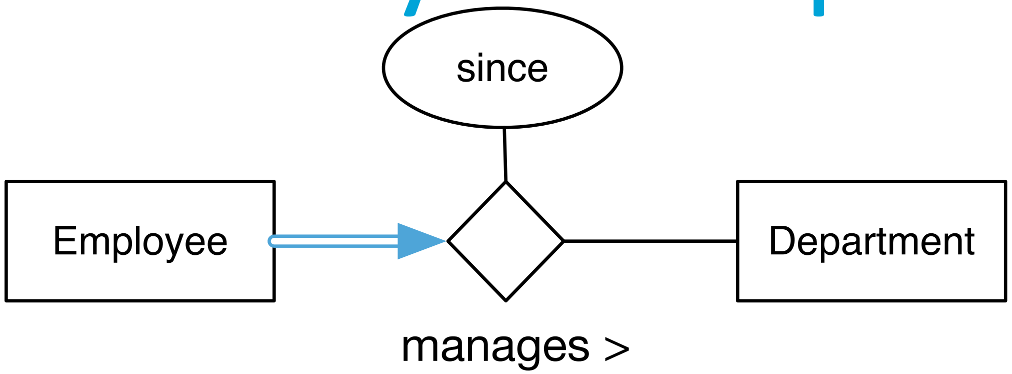
```sql
CREATE TABLE manages (
      eid INTEGER,
      did INTEGER,
      since date,
      PRIMARY KEY(eid, did),
      FOREIGN KEY(eid) REFERENCES
         employee(eid),
      FOREIGN KEY(did) REFERENCES
         department(did)
);
```

```sql
CREATE TABLE department(
      did INTEGER,
      name VARCHAR(20) NOT NULL,
      location VARCHAR(20) NOT NULL,
      PRIMARY KEY (did)
      -- Every department must exist
         in the table ‘manages’
);
```

⚠There is no simple DBMS implementation for this constraint. Must often ensured by the application code.

# M:1 Mandatory Participation

**Special Case**



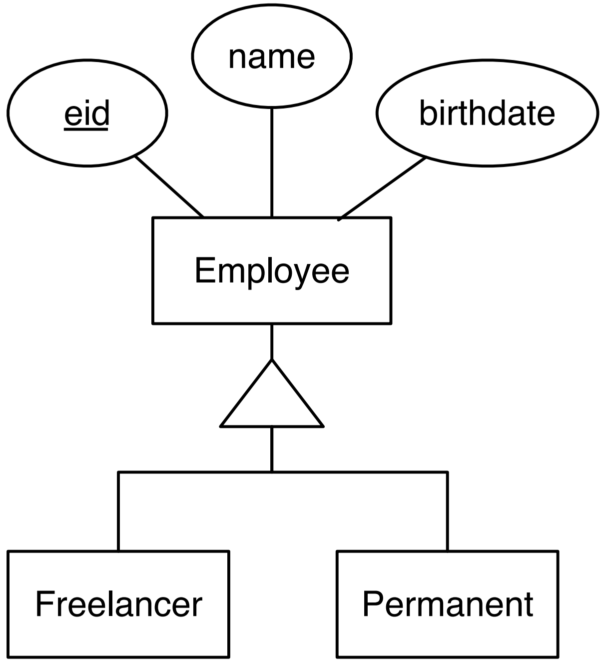

```
CREATE TABLE employee (
      eid INTEGER,
      name  VARCHAR(80) NOT NULL,
      birthdate DATE NOT NULL,
      since DATE NOT NULL,
      manages_did INTEGER NOT NULL,
      PRIMARY KEY(eid)
      FOREIGN KEY(manages_did) REFERENCES department(did)
);
```

- Instead of creating a table for the 'manages' association, we extend the table employee with the reference (a foreign key) to the department.
- Every record on employee must be connected to (in this case managing some) department

# Translating Generalisations

# Simple Specialisation

```
CREATE TABLE employee (
      eid INTEGER,
      name VARCHAR(80) NOT NULL,
      birthdate DATE NOT NULL,
      PRIMARY KEY(empid)
);
```




```
CREATE TABLE freelancer (
      eid INTEGER,
      PRIMARY KEY(eid),
      FOREIGN KEY(eid) REFERENCES
        employee(eid)
);
```

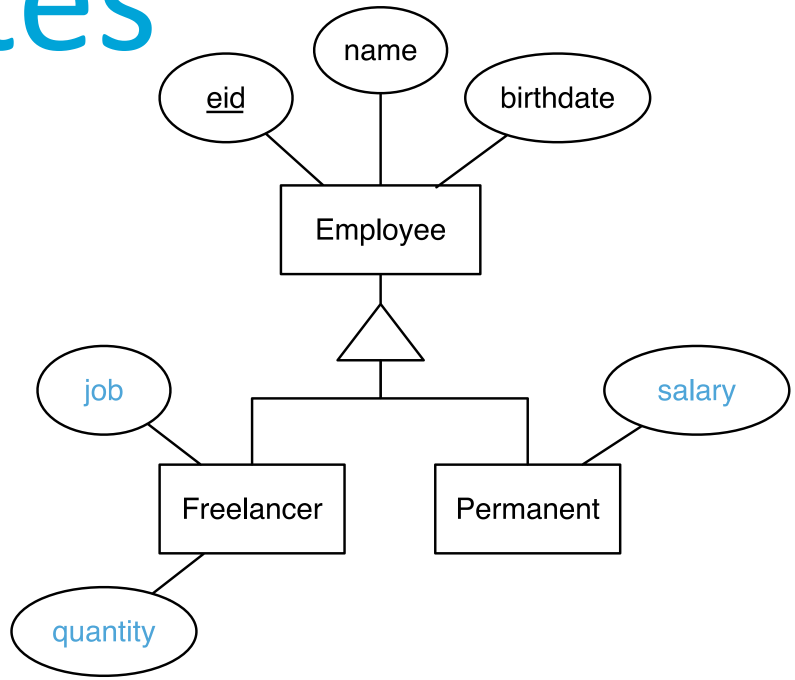
```
CREATE TABLE contracted (
      eid INTEGER,
      PRIMARY KEY(eid),
      FOREIGN KEY (eid) REFERENCES
        employee(eid)
);
```

Encodes the subset of all Freelancers

Encodes the subset of all Contracted

# Specialisation with attributes

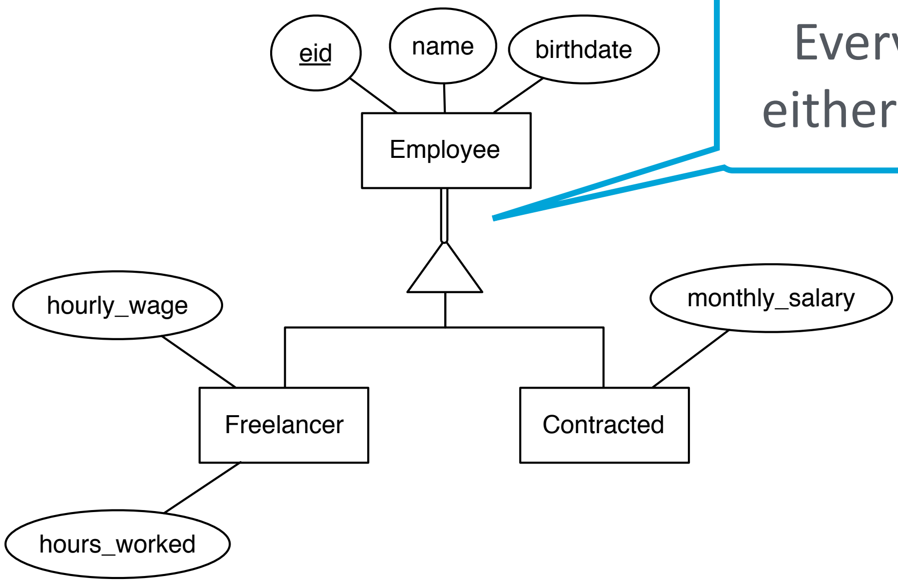
```
CREATE TABLE employee (
      eid INTEGER,
      name VARCHAR(80) NOT NULL,
      birthdate DATE NOT NULL,
      PRIMARY KEY(empid)
);
```




```
CREATE TABLE freelancer (
      eid INTEGER,
      hourly_wage NUMERIC(12,4),
      hours_worked INTEGER,
      PRIMARY KEY(eid),
      FOREIGN KEY(eid) REFERENCES
         employee(eid)
);
```

```
CREATE TABLE contracted (
      eid INTEGER,
      salary NUMERIC(12,4),
      PRIMARY KEY(eid),
      FOREIGN KEY (eid) REFERENCES
         employee(eid)
);
```

# Mandatory Specialisation



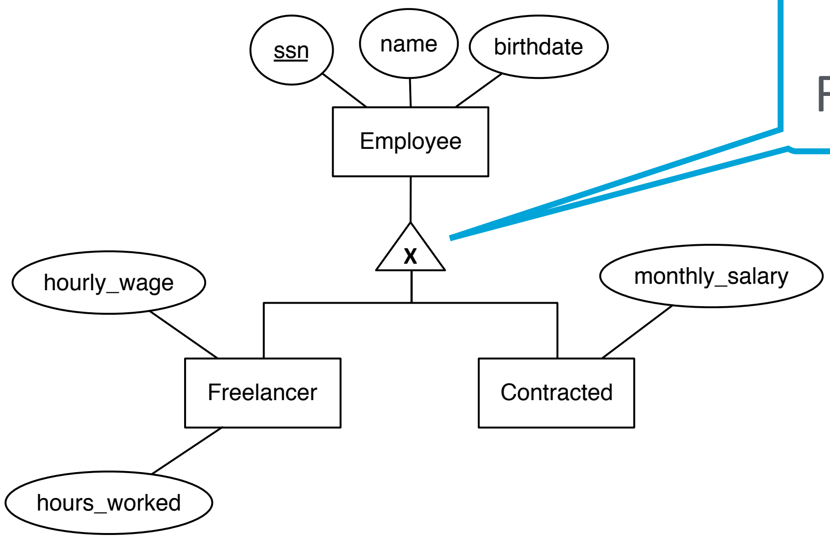

Every eid of employee must exist either in freelancer or in contracted

```
CREATE TABLE employee (
      eid INTEGER,
      name VARCHAR(80) NOT NULL,
      birthdate DATE NOT NULL,
      PRIMARY KEY(empid)
      -- Every employee must exist either
         in the table 'freelancer' or in
         the table 'permanent'
);
```

```
CREATE TABLE freelancer (
      eid INTEGER,
      hourly_wage NUMERIC(12,4),
      hours_worked INTEGER,
      PRIMARY KEY(eid),
      FOREIGN KEY(eid) REFERENCES
           employee(eid)
);
```

```
CREATE TABLE contracted (
      eid INTEGER,
      monthly_salary NUMERIC(12,4),
      PRIMARY KEY(eid),
      FOREIGN KEY (eid) REFERENCES
         employee(eid)
);
```

# Disjoint Specialisation



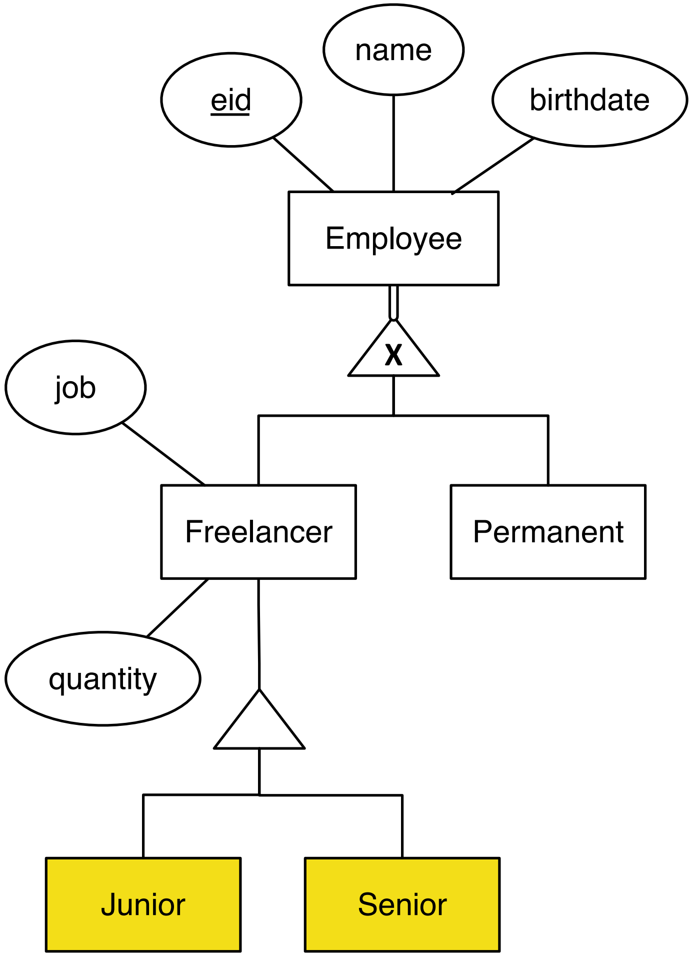

The eid of an Employee cannot exist in Freelancer and Contracted at the same time

```
CREATE TABLE employee (
    eid INTEGER,
    name VARCHAR(80) NOT NULL,
    birthdate DATE NOT NULL,
    PRIMARY KEY(empid)
    -- No employee can exist at the same
       time in the both the table
       'freelancer' or in the table
       'permanent'
);
```

```
CREATE TABLE freelancer (
    eid INTEGER,
    hourly_wage NUMERIC(12,4),
    hours_worked INTEGER,
    PRIMARY KEY(eid),
    FOREIGN KEY(eid) REFERENCES
        employee(eid)
);
```

```
CREATE TABLE contracted (
    eid INTEGER,
    monthly_salary NUMERIC(12,4),
    PRIMARY KEY(eid),
    FOREIGN KEY (eid) REFERENCES
        employee(eid)
);
```

# Nested Specialisation




```
CREATE TABLE employee (
        eid INTEGER,
        name VARCHAR(80) NOT NULL,
        bdate DATE NOT NULL,
        PRIMARY KEY(empid)
        -- <Mandatory constraint…>
        -- <Disjoint constraint…>
);
```

```
CREATE TABLE freelancer(
        eid INTEGER,
        hourly_wage money,
        hours_worked INTEGER,
        PRIMARY KEY(eid),
        FOREIGN KEY(eid) REFERENCES
            employee(eid)
);
```

```
CREATE TABLE contrated(
        eid INTEGER,
        monthly_salary money,
        PRIMARY KEY (eid),
```

```
create table junior (
        eid INTEGER,
        PRIMARY KEY (eid),
        FOREIGN KEY (eid) REFERENCES
            freelancer(eid)
);
```

```
CREATE TABLE senior (
        eid INTEGER,
        PRIMARY KEY (eid),
        FOREIGN KEY (eid) REFERENCES
            freelancer(eid)
);
```

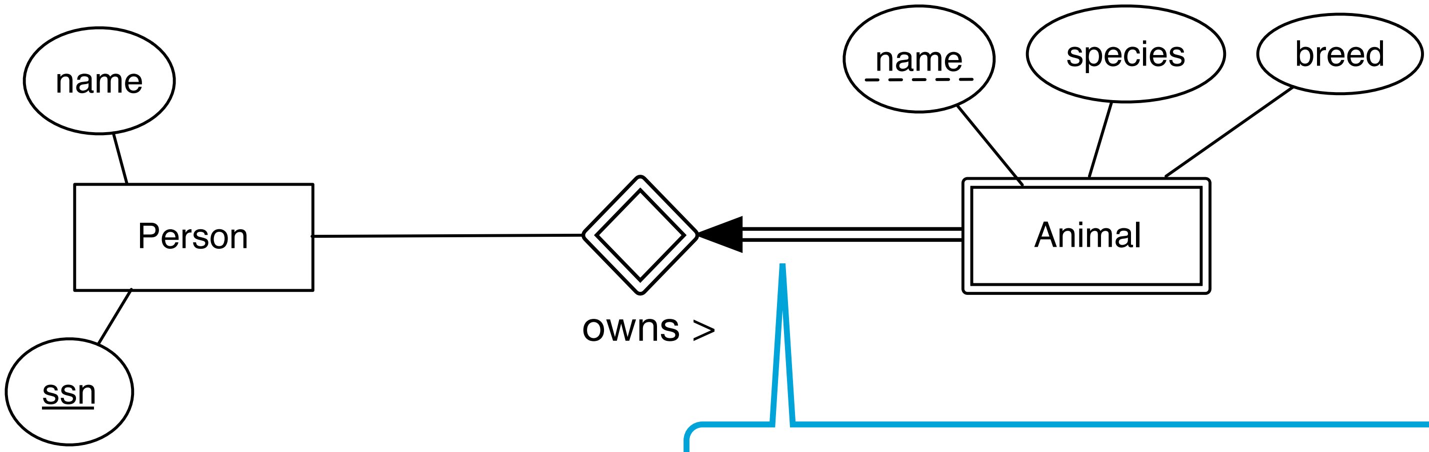
# Mapping Generalisations/ Specialisations

1. Map the super-entity in a table
2. Map sub-entities into distinct tables where:
   - The key of each table corresponding to a sub-entity is the key of the super-entity (enforced with the corresponding FK constraint)
3. Disjoint or Mandatory specialisation constraints are identified as comments (they will mapped through ICs over the super-entity using advanced database programming or application code)

⚠There is no simple DBMS implementation for **Disjoint** and **Mandatory** constraints. This will be explained later in the course.

# Translating Weak Entities

# Weak Entities




The translation is similar to the case of M:1 Mandatory Participation

```
CREATE TABLE person(
      name VARCHAR(80),
      ssn NUMERIC(9)
      PRIMARY KEY(ssn)
);
```

```
CREATE TABLE animal(
    ssn NUMERIC(9)
    name VARCHAR(80),
    species VARCHAR(20),
    breed VARCHAR(20),
    PRIMARY KEY(ssn, name),
    FOREIGN KEY(ssn) REFERENCES person(ssn)
);
```

The PRIMARY KEY is the combination of the key of the strong entity with the partial key

# Weak Entities

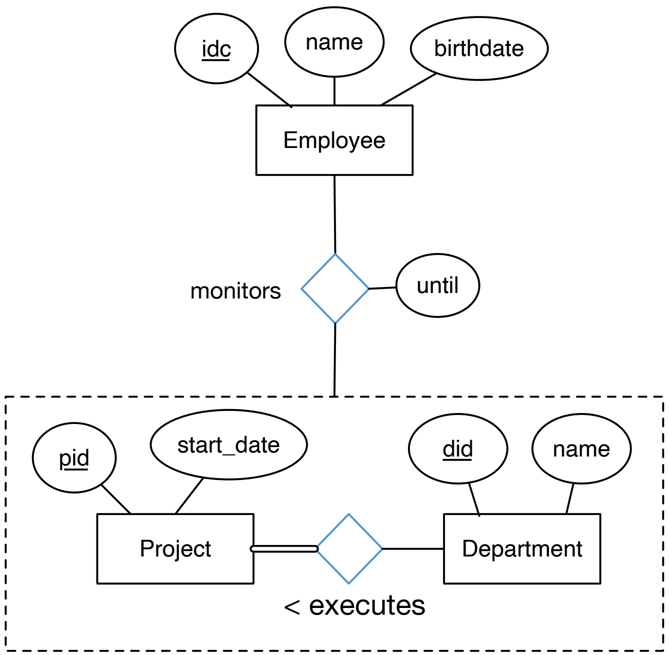
The **Weak Entities** originate a table that has a key composed by:

1. The association key that corresponds to the strong entity
2. The specified partial key
3. Any attributes of the weak entity (if they exist)

The association is not converted into a table

# Translating Aggregations

# Aggregation




```
CREATE TABLE executes(
        pid INTEGER,
        did INTEGER,
        PRIMARY KEY (pid, did)
        FOREIGN KEY (pid) REFERENCES project(pid)
        FOREIGN KEY (did) REFERENCES department(did)
);
```

```
CREATE TABLE monitors(
      eid INTEGER,
      pid INTEGER,
      did INTEGER,
      until date,
      PRIMARY KEY (eid, pid, did),
      FOREIGN KEY (pid, did) REFERENCES executes(pid, did)
      FOREIGN KEY (eid) REFERENCES employee(eid)
);
```

# Aggregation

An Aggregation is mapped as an association where:

1. <u>The interior of the aggregation</u> is mapped to a table

2. <u>The association with the</u> aggregation is mapped into a table