LAB 3 Notes

The Relational Model

In the previous lab we discussed the Conceptual Database Design Phase and the ER Diagram. Today we will mainly discuss how to convert an ER model into the Relational model of a specific database.

Outline

1) **Introduction: discuss briefly the relational model**
2) **Logical Database Design (Steps involved ER model -> Relational model)**
3) **A glance at Views**
4) **Putting it all together: An example using PostgreSQL**

1) Introduction

- **Codd** proposed the **Relational Model** in '70
- **Main advantage of Relational Model**: Simple representation: relations(row, cols)
- **DDL (Data Definition Language)** – language for creating, manipulating and querying data in a relational DBMS
- **Domain, Primary key, Foreign Key constraints are fundamental part of the relational model**

2) Logical Database Design [ER schema -> relational database schema]

- ER schema is convenient for initial high-level description of the database design
- There is a standardized procedure to translate the ER diagram -> Relational schema (in fact software does it automatically)

A **relation schema** can be thought of as the **basic information describing a table** or relation. This includes a **set of column names**, the **data types** associated with each column, and the name associated with the entire table

Formally: $\{ < f_1 : d_1, \ldots , f_n : d_n > \mid d_1 \in DOM_1 , \ldots , d_n \in DOM_n \}$

For **example**, a relation schema for the relation called Students could be expressed using the following representation:

Students(sid: *string*, name: *string*, login: *string*, age: *integer*, gpa: *real*)

There are five fields or columns, with names and types as shown above **Domain is synonymous with data type**. **Attributes** can be thought of as **columns in a table**. Therefore, an attribute domain refers to the data type associated with a column

A relation instance is a set of tuples (also known as rows or records) that each conform to the schema of the relation

The relation **cardinality** is the number of tuples in the relation
The relation **degree** is the number of fields (or columns) in the relation

Relational Schema: Product(Name, Price, Category, Manufacturer)

Instance:

Name	Price	Category	Manufacturer
Gizmo	19.99	gadgets	Gizmo Works
Power gizmo	29.99	gadgets	Gizmo Works
Single Touch	149.99	photography	Canon
Multi Touch	203.99	household	Hitachi

Entity Example:
Employee(ssn, name, age);

Employee

ssn	name	age

We use the **Data Definition Language** of a DBMS to describe the generated Tables

```
// create a relation
CREATE TABLE Employee (ssn CHAR(11) NOT NULL,
                       name CHAR(30) NOT NULL,
                       age INTEGER,
                       PRIMARY KEY(ssn));

// Altering a relation to add a constraint
ALTER TABLE Employee ADD Column surname CHAR(40) NOT NULL;

// Adding to a relation
INSERT INTO Employee(ssn, name, surname, age)
VALUES (“34342”, “Smith”, “Heiss”, 18);

// Update tuple
UPDATE Employee SET name=”John” WHERE name=”Smith”;

// delete tuples
DELETE Employee WHERE name=”John”;

// Drop Table
DROP TABLE Employees;
```

Relationships

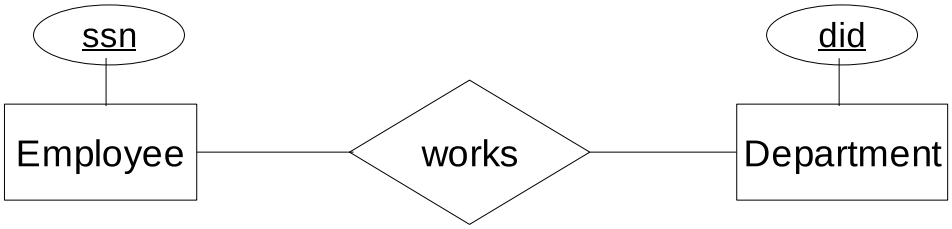
Constraints found in a relationship
Key Constraint: determined by the “At-Most” question
Participation Constraint: determined by the “At-Least” question

a) WITHOUT PARTICIPATION CONSTRAINT

M:N Relationships

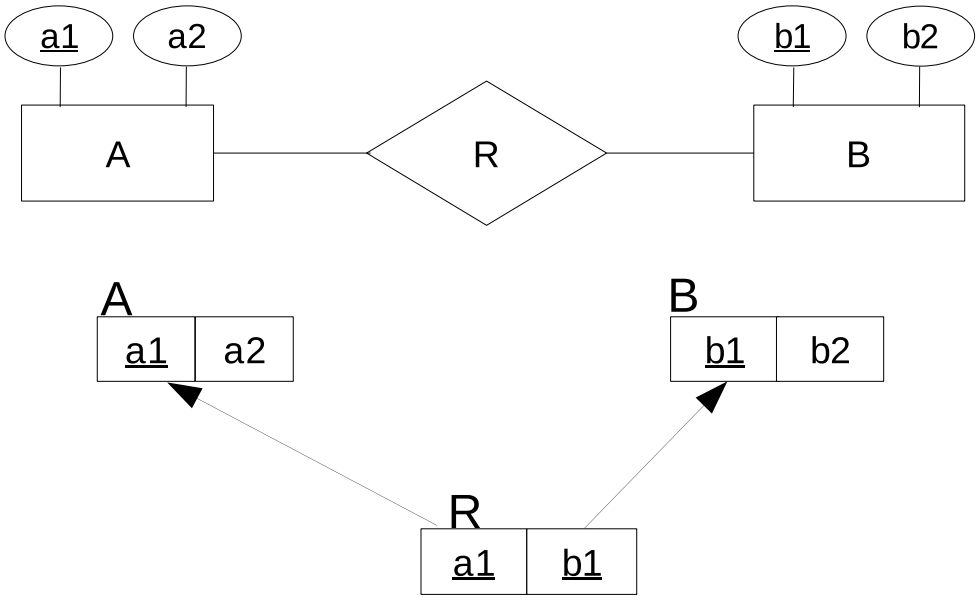
- The relationship becomes a relation itself: Works(ssn,did)

- Also called an Entity-Relationship




```
CREATE TABLE Employee (ssn CHAR(11) NOT NULL,
                       PRIMARY KEY(ssn));

CREATE TABLE Department (did INTEGER NOT NULL,
                         PRIMARY KEY(did));

CREATE TABLE Works (ssn CHAR(11) NOT NULL,
                    did INTEGER NOT NULL,
                    PRIMARY KEY(ssn, did),
                    FOREIGN KEY (ssn) REFERENCES Employee(ssn),
                    FOREIGN KEY (did) REFERENCES Department(did));
```

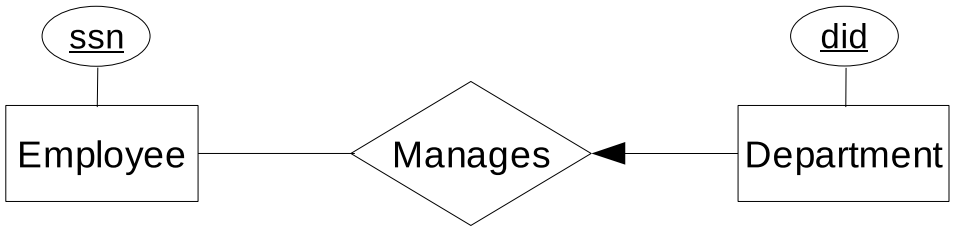
Generally:



1:M Relationships

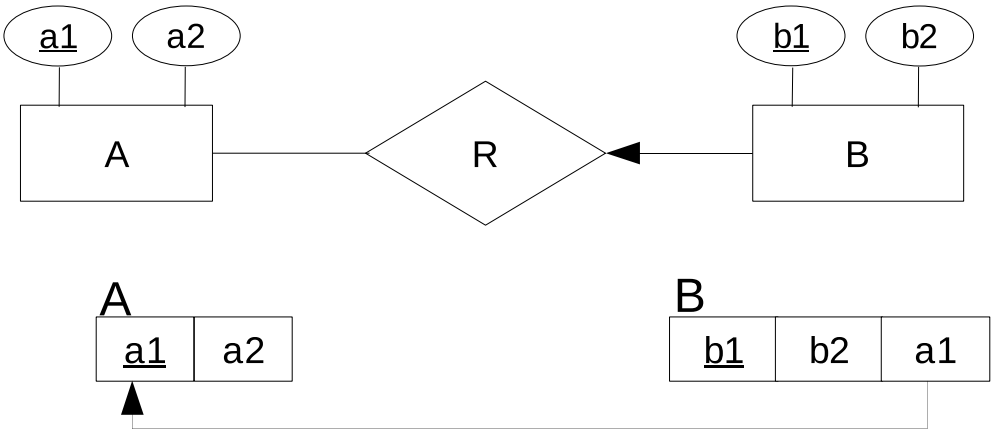
- Suppose that an Employee manages *N* Departments but *ANY* department is managed only by at-most 1 person
- The key of the Employee entity moves to the direction of Department.

- Employee(ssn), Department(did, ssn) where did -> primary key, ssn -> foreign key



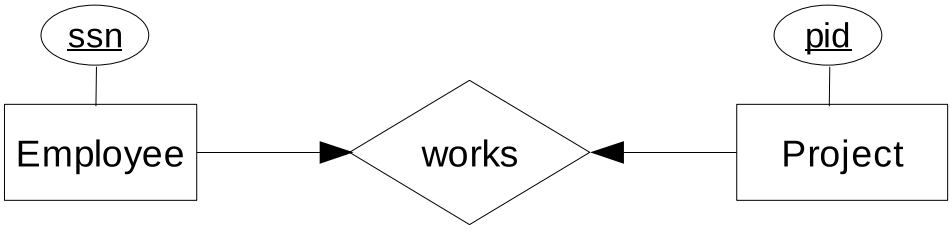

```
CREATE TABLE Employee (ssn CHAR(11) NOT NULL,
                       PRIMARY KEY(ssn));

CREATE TABLE Department (did INTEGER NOT NULL,
                         ssn CHAR(11)
                         PRIMARY KEY(did),
                         FOREIGN KEY (ssn) REFERENCES Employee(ssn));
```

Generally:



1:1 Relationships

- Suppose an employee works on at-most 1 single-person project



- Move the key to either direction BUT remember that you want to avoid nulls
- E.g. Employee(ssn, pid) Project(pid)

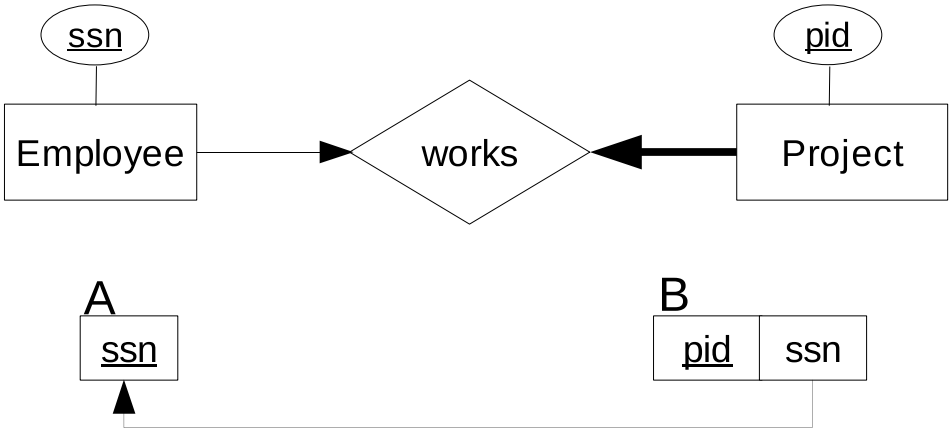
May create too many **nulls** because each employee is not said to be working on **At-least 1 project**
The **participation constraint** that will be described in a while will make it clear to which direction we

should move the key

- **Employee(<u>ssn</u>) Project(<u>pid</u>, ssn) on the other hand has no nulls since every project belongs to some employee**

b) WITH PARTICIPATION Constraints

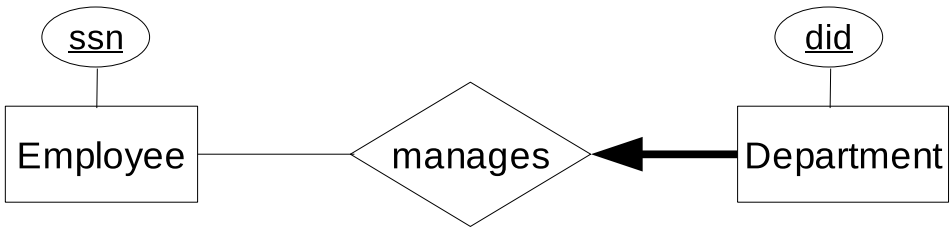
- Participation Constraint: The At-Least question (bold line)
- This will give you the complete picture since any ER should capture key and participation constraints
  - FIRST of all the participation constraint makes it clear in which direction to move the key in the case of a 1:1 relationship
  - Suppose an employee works on 0:1 projects and each project is worked on by 1:1 employees



- Now we automatically know that the key moves to the direction of the bold line. (so we avoid nulls)
- What would happen if the participation constraint was from both sides -> the key goes to either direction

ii) Enforcing referential integrity

- Suppose you are given the following example
- We already know what is happening with the keys. (Dept gets the ssn)



ON [DELETE|UPDATE] "of the refereed tuple the DBMS should"{ CASCADE, SET NULL, RESTRICT=NO ACTION=default, SET DEFAULT} "with the current relation"

a) RESTRICT=No ACTION=default

```
CREATE TABLE Department (did INTEGER,
                         ssn CHAR(11) NOT NULL
```

```
                        PRIMARY KEY(did)
                        FOREIGN KEY (ssn) REFERENCES Employee(ssn)
                        ON DELETE NO ACTION;
```

Means:
ON DELETE of the refereed tuple in relation EMPLOYEE the DBMS should prohibit the delete of the given employee

Employee

ssn
1
2
3

Department

did	ssn
1	1
2	2
3	3

If we want to delete employee 1 i.e.

```
Delete FROM Employee where ssn=”1”;
```

-> **System gives “Illegal Action – Violates Referential Integrity Constraint”**
We can change the manager did=1 to did=2 and then try again
e.g.

```
UPDATE Department D SET D.ssn=2 WHERE D.ssn=1;
```

b) CASCADE

```
CREATE TABLE Department (did INTEGER,
                         ssn CHAR(11) NOT NULL
                         PRIMARY KEY(ssnv
                         FOREIGN KEY (ssn) REFERENCES Employee(ssn)
                         ON DELETE CASCADE;
```

Means:
ON DELETE of the refereed tuple in relation EMPLOYEE the DBMS should cascade the delete. That means that the Department record should be deleted as well.!!!!

c) SET NULL

```
CREATE TABLE Department (did INTEGER,
                         ssn CHAR(11) NOT NULL
                         PRIMARY KEY(did)
                         FOREIGN KEY (ssn) REFERENCES Employee(ssn)
                         ON DELETE SET NULL;
```

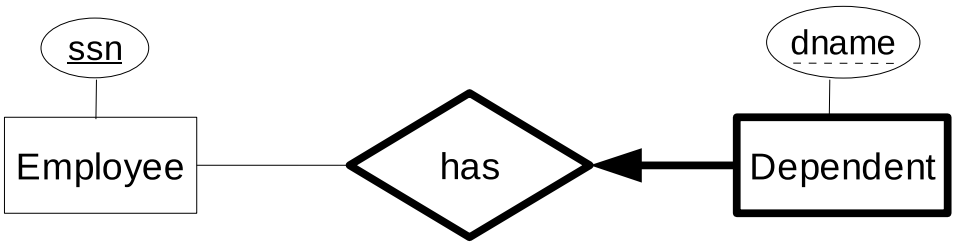
ILLEGAL since ssn cannot be NULL
MIGHT violate PARTICIPATION constraint

d) SET DEFAULT

```
CREATE TABLE Department (did INTEGER,
                         ssn CHAR(11) NOT NULL DEFAULT “0”;
                         PRIMARY KEY(did)
                         FOREIGN KEY (ssn) REFERENCES Employee(ssn)
                         ON DELETE SET DEFAULT;
```

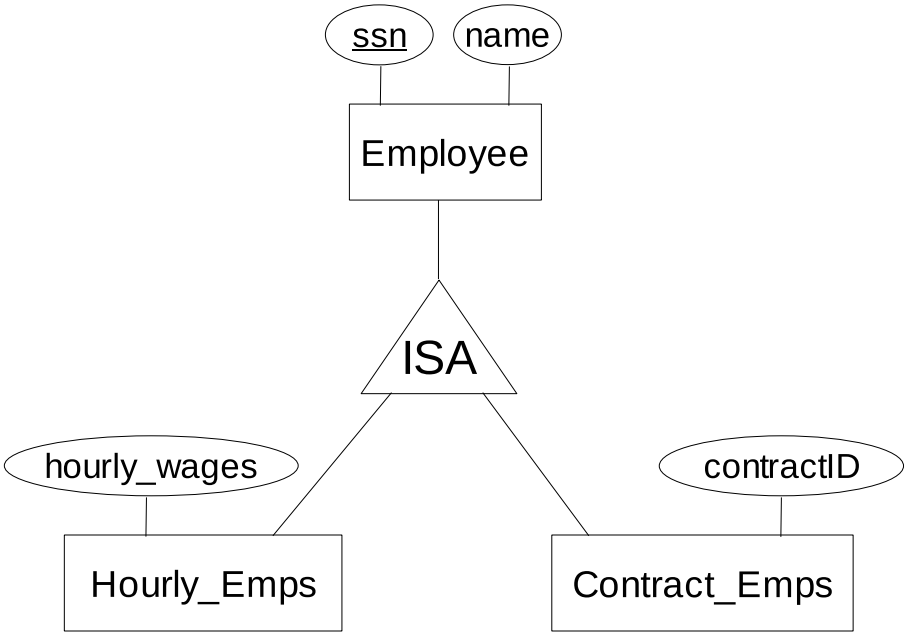
Means:
ON DELETE of the refereed tuple in relation EMPLOYEE the DBMS should set ssn in Department to the default value (i.e. 0) !!!!

Step 3: Weak Entities




```
CREATE TABLE Dependent (dname CHAR(11) NOT NULL,
                        ssn CHAR(11) NOT NULL,
                        age Integer,
                        PRIMARY KEY(ssn, dname)
                        FOREIGN KEY (ssn) REFERENCES Employee(ssn)
                        ON DELETE CASCADE; // deletes dependent
```

Step 4 : ISA Hierarchies



Inherit the key & create 3 relations. -> In order to find e.g. name of hourly_employees we need to combine EMPLOYEE, HOURLY_EMPS