LAB 3 Notes

The Relational Model – Chapter 3
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 Postgres**

1) Introduction

- **Codd** proposed the **relational model** in '70
- **Main advantage of Relational Model** : Simple representation (relations-tables(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:$\{ < f_1 : d_1, \ldots , f_n : d_n > | d_1 \in DOM_1 , \ldots , d_n \in DOM_n \}$

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	GizmoWorks
Power gizmo	$29.99	gadgets	GizmoWorks
SingleTouch	$149.99	photography	Canon
MultiTouch	$203.99	household	Hitachi

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

Employee

ssn	name	age

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

// notation used in book, (ingres, ansi)
- CREATE TABLE Employee (ssn CHAR(11) NOT NULL,
name CHAR(30) NOT NULL,
age Integer,
Primary Key(ssn));

- ALTER TABLE Employee ADD Column surname:CHAR(40) NOT NULL;

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

//Update tuple
- UPDATE Employee SET name=”John” where name=”smith”;

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

//Drop Table
- DROP TABLE Employees;

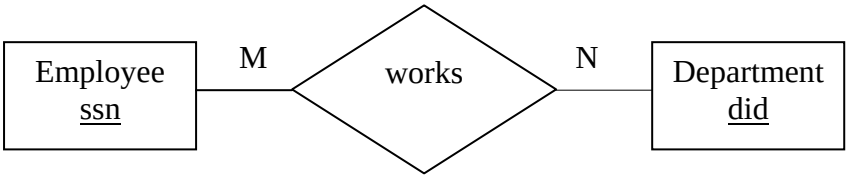
Step 2: Relationships

Constraints found in a relationship
Key Constraint → determined by the "At-Most" question
Participation Constraint → determined by the "At-Least" question

2a) WITHOUT PARTICIPATION CONSTRAINT

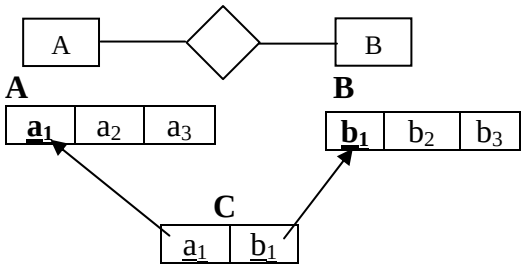
M:N Relationships

- The relationship becomes a relation itself EMP_DEPT(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 Emp_Dept (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));
```

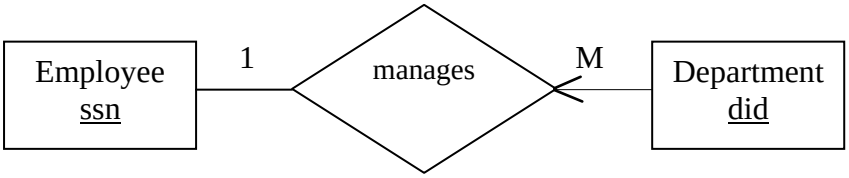
Generally:



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 one Entity moves to the direction of M.
- → Employee(ssn), Department(did, ssn)

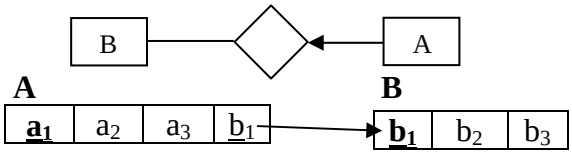
primary key foreign key



CREATE TABLE Employee (ssn CHAR(11) NOT NULL,
Primary Key(ssn));

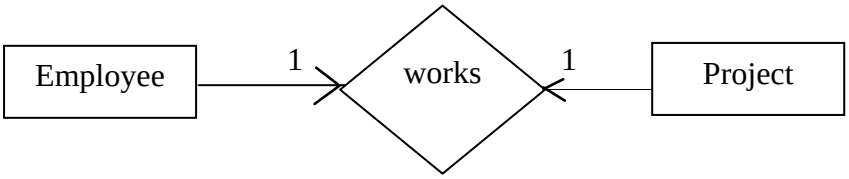
CREATE TABLE Department (did INTEGER NOT NULL,
ssn CHAR(11)
Primary Key(did),
FOREIGN KEY (ssn) REFERENCES Employee(ssn));

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(ssn) Project(pid, ssn) on the other hand has no nulls since every project belongs to some employee.**

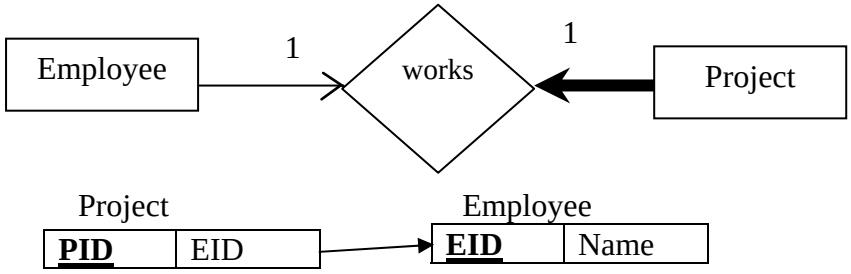
2b) WITH PARTICIPATION Constraints

- Participation Constraint → The At-Least question (bold line)
- This will give you the complete picture since any ER should capture key and participation constraints

i) FIRST of all the participation constraint makes it clear in which direction to move the key in the case of a 1:1 relationship

Again 1:1 Relationships

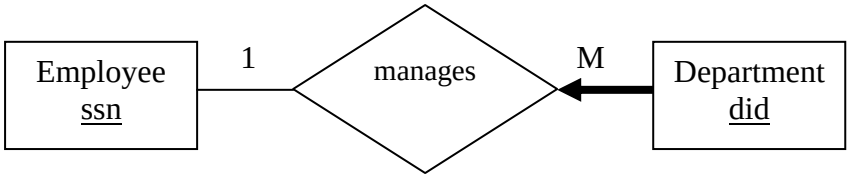
- Suppose an employee works on 0:1 projects and each project is worked on by 1:1 employees



- 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 key)



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(ssn)
                       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(ssn)
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(ssn)
FOREIGN KEY (ssn) REFERENCES Employee(ssn)
ON DELETE SET NULL;

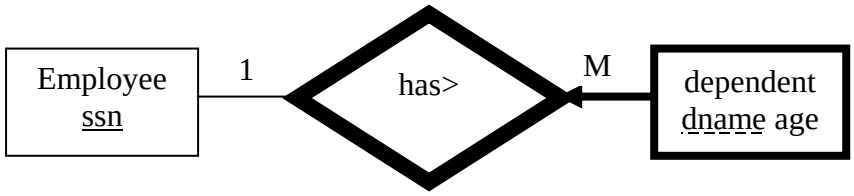
ILLEGAL since ssn can't be NULL
MIGHT violate PARTICIPATION constraint

d) SET DEFAULT

CREATE TABLE Department (did INTEGER,
ssn CHAR(11) NOT NULL DEFAULT "0";
Primary Key(ssn)
FOREIGN KEY (ssn) REFERENCES Employee(ssn)
ON DELETE SET DEFAULT;

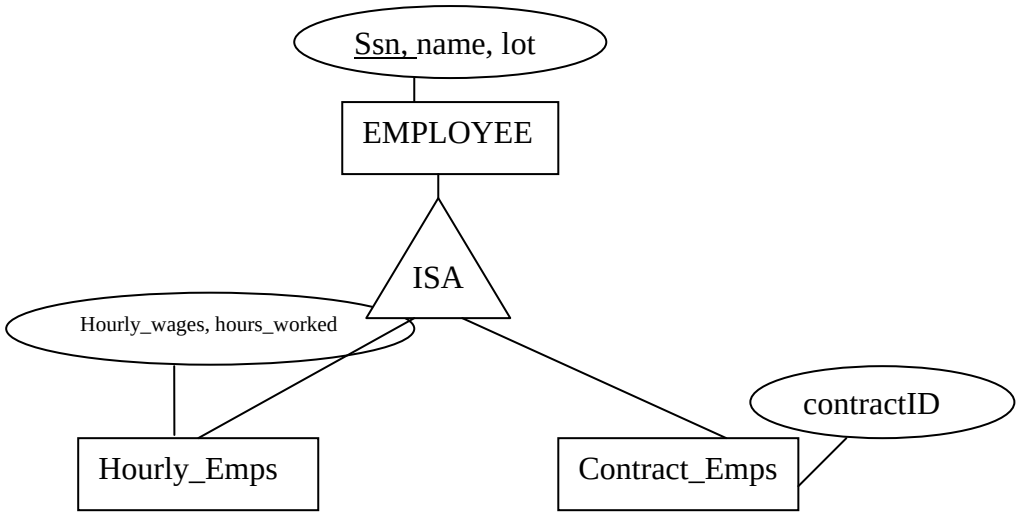
Means:
ON DELETE of the refereed tuple in relation EMPLOYEE the DBMS should set ssn in Department to the default value (i.e. 0) !!!!

Step 3: Weak Entities

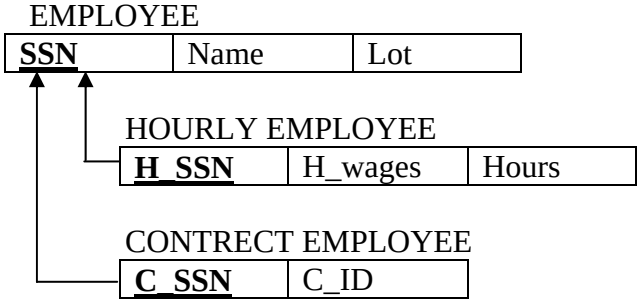



```
CREATE TABLE Dependent ( dname CHAR(11) NOT NULL,
                         ssn  CHAR(11) NOT NULL,
                         age Integer,
                         Primary Key(ssn, dname)
                         FOREIGN KEY (ssn) REFERENCES Employee(ssn)
                        ON DELETE CASCADE;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



3) VIEWS

1) Useful for hiding information – reducing degree

```
CREATE TABLE Employee (ssn  CHAR(11) NOT NULL,
                       Name CHAR(30) NOT NULL,
                       PIN INTEGER NOT NULL,
                       Primary Key(ssn));
```

```
CREATE VIEW Secure_Employee(ssn, name)
        AS SELECT E.ssn, E.name
            FROM Employee E;
```

2) Useful for shrinking information – reducing cardinality

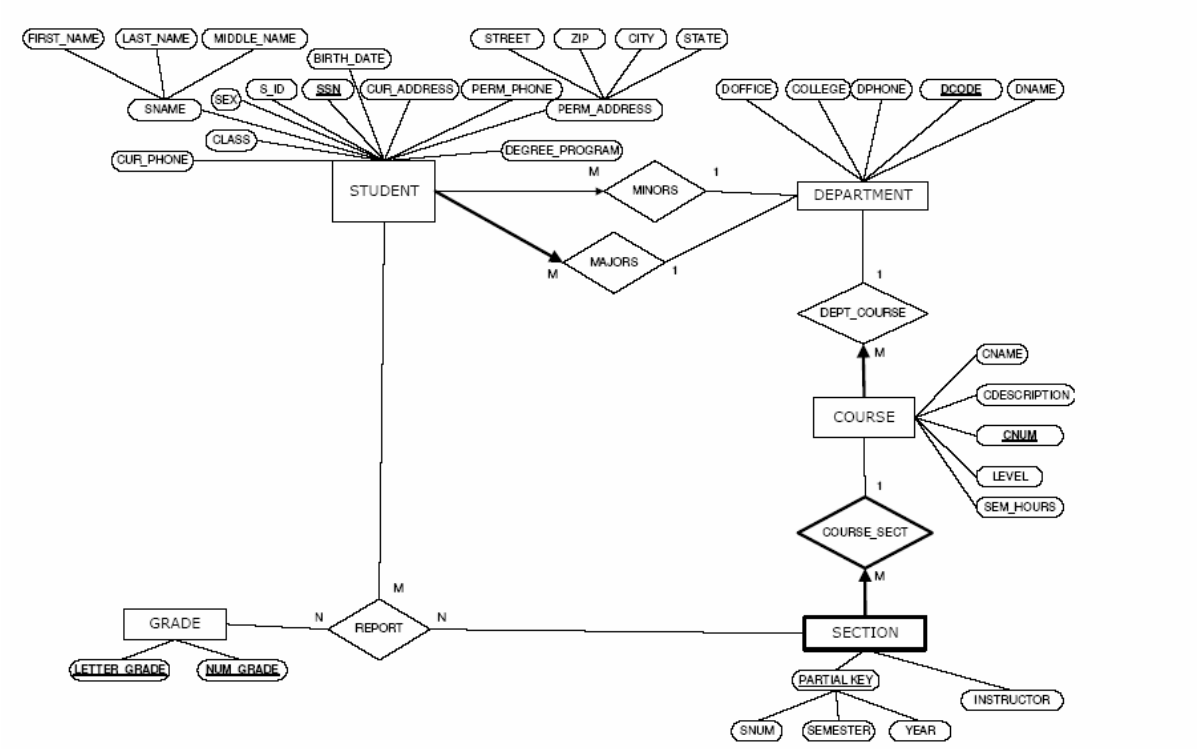
```
CREATE TABLE Employee (ssn  CHAR(11) NOT NULL,
                       Name CHAR(30) NOT NULL,
                       BIRTHCITY char(30) NOT NULL,
                       Primary Key(ssn));

CREATE VIEW Chicago_Employees(ssn, name)
        AS SELECT E.ssn, E.name
            FROM Employee E
            WHERE E. BIRTHCITY= "Chicago";
```

Attention needs to be given on updating VIEWS, It is generally a bad idea but you can still do it (updatable views)

MORE EXAMPLES GIVEN IN LAB AND OFFICE HOURS

Putting it all together

Consider the following ER diagram from last week:



Assumptions:

1) A student minors at most in one department.
2) A student has exactly one major.
3) A course may have many sections but each section belongs to one course.
4) A course is offered by only one department, while a department may offer many courses.
5) A student receives many grade reports and a section issues many grade reports but for a specific section a student may receive only one grade report.

Construct a corresponding relational schema and database in Postgres. In additional, create a view of reports with letter grades equal to A.