Course: Database management
Unit: Database Design. E-R model to relational model
Material: E-R to relational exercises
Teamwork: Groups of two or three

In the previous lesson you crated ER diagrams for the following cases. Now convert those ER diagrams to relational.

1.- Hierarchical Organisation Structure.
a) A group (ID, name) has several companies (ID, name), whereas a company belongs to group.
b) Companies are connected by a hierarchical structure; each subsidiary is assigned to exactly one company of the next higher hierarchy level, the parent company.
c) Each company has several plants (ID, name, address); a plant belongs to one company only.
d) A plant produces many items (ItemNo, Description, ProductionCost). An item is only produced in one of the plants.

2.- Customer Discounts.
a) Customers (ID, name, surname) get discounts (discountNo, description, amount) on items (ItemNo, description, price). Each item can have many discount rates and a discount rate is only for a single item. A customer can have many discounts on the same item.
b) Items belong to a single category (ID, name).

3.- Products, parts and materials.
a) We have products (ID, description) formed by several parts (PartNo, description).
b) Every part is used only in a single product.
c) Products belong to a single category.

4.- Web shop.
We want to design a database for a web shop. We want to keep information about customers. We want to keep their name (composed by a first name, middle name, and last name), their date of birth, and their address. Customers will place orders of the products that we sell. Obviously, an order can contain many products (or only one). Regarding the products, we want to keep its code, its name, a description, and its price.

5.- Person in organization.
a) A person (SSN, name, address, phone_number, email) is either an employee or a manager. We want to keep relatives of a person. Employees have a salary and managers have only a commission.
b) A manager manages one department (ID, name, address) and a department may have several managers. Departments are assigned to one company (ID, name, address), while companies have several departments.
c) Employees work for one department (and a department can have many employees working in it).

6.- Webcourses.
We want to build a website to sell webcourses. Students (id_card, name, surname, e-mail, address, cell_phone) will enroll in the courses (code, name, description). The same course can be done in different dates in which students will be enrolled in it. Obviously, there are also teachers (id_card, name, surname, e-mail, address, cell_phone). Students enrolled in courses will have a single teacher assigned to it (but there can be courses without teachers).

7.- Census (=register of inhabitants).
We want to save the data of towns/villages in Spain and its inhabitants. We must consider:

- Each person can only be registered in a dwelling house (=residence).
- Each person can own more than one house and one house can have more than one owner.
- You want to store of each person his/her NIF, name, surname, and date of birth. Of the house you want to store cadastral reference and the address (street, number, floor, and door).
- Each person can depend on another person, who will be the head of the family.
- Each house is located in a town. You want to store of each town its name.
- The towns are located in regions and the regions in states. You want to store of regions/states their name.

8.- Project management.
A company wants to keep information about the departments in which it is divided and about the heads of those departments. Moreover, it must be kept data about the projects that are carried out currently, employees that participate in them and who coordinates them.
You must consider:

- Each department can only have a head and an employee can only be head of a single department.
- Each project is coordinated by a single employee who can be coordinator of several projects.
- Each employee can work in a single department.
- Each employee can work on several projects at once.
- You must select the attributes that you consider.

9.- Project management 2.
We want to design a data model of a company that is dedicated to the development of projects. These projects are ordered to the company by external customers. Each of the projects are composed of phases (with information to store).Employees working within the company will be assigned to a single phase of a project in a specific moment in time. However, throughout their professional lives each employee has worked on many phases of many projects that we want to keep information about them. The employees are college graduates with different certificates and we want to keep this information. The company is divided into departments where the employees work. Each department has a head (only one). It is considered that the heads are also employees of the company. An employee can't belong simultaneously to more than one department. You must select the attributes that you consider appropriate.

10.- Classical music concerts.

We want to collect information in a database about the classical music concert program of the Teatre Principal of Palma de Mallorca, according to the following considerations:

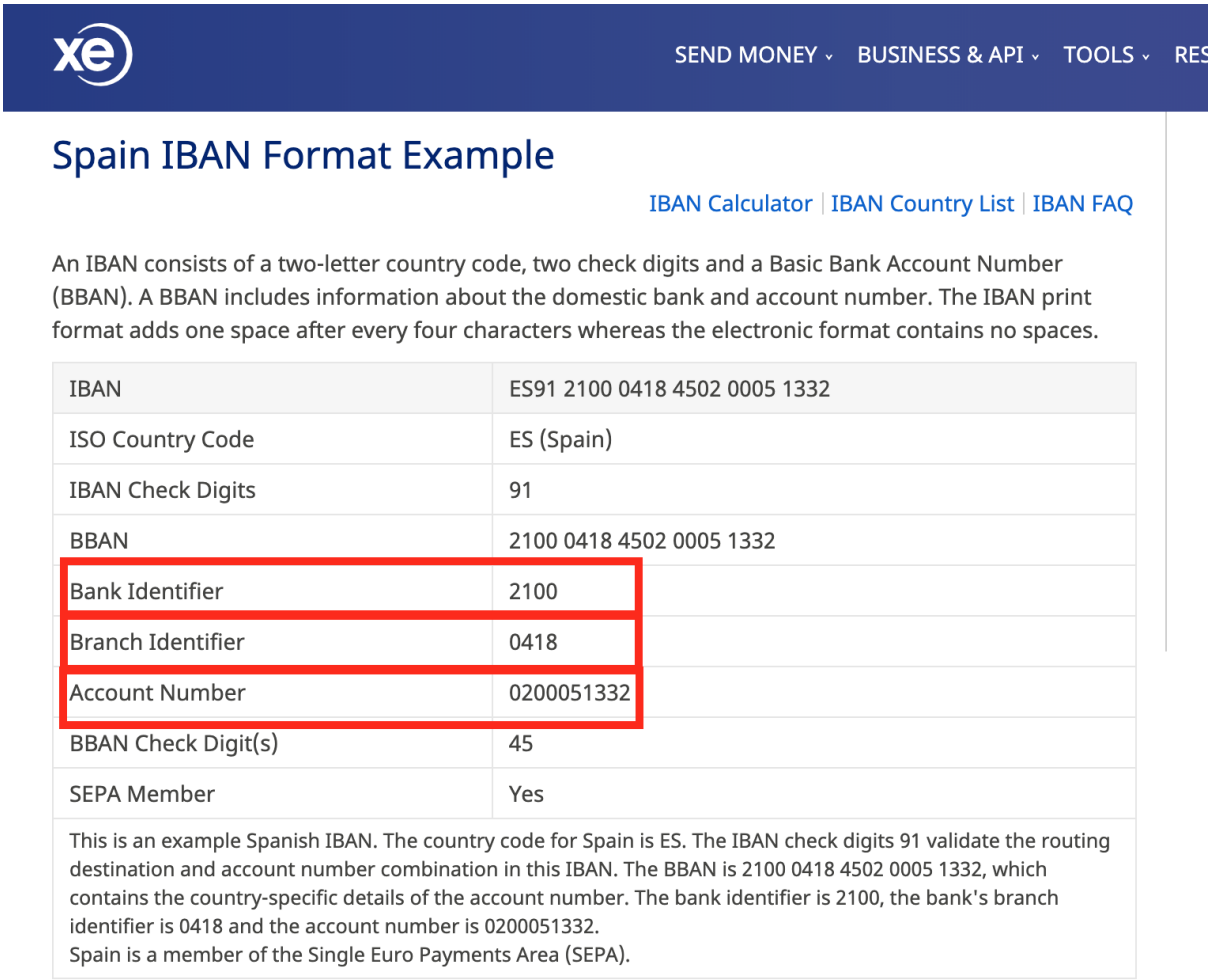
- An orchestra can perform several concerts. Only a single orchestra will perform in each concert.
- The orchestra conductor is single person (there is only a main conductor for every orchestra), but an orchestra could have several guest conductors, who could be invited in several orchestras. In the same concert several compositions can be played. Moreover, a composition can be performed in several concerts.
- In the same concert several soloists may participate.
- Each composition is written by a single composer. But we can have compositions without author...
- Obviously, the orchestra has musicians who are specialist only in a specific instrument. A musician belongs only to an orchestra. Musicians were born in different countries.
- You must select the attributes that you consider appropriate.

11.- Saving accounts.

We want to computerize the managing of savings accounts that its customers open in its branches of different banks, as well as the management of their employees. It should be considered:

- Each savings account has a number and a creation date. It is interesting to know the movements with their amount. A movement is a transfer of an amount of money from a savings account to other savings account. There will be different types of movements.
- The customer's NIF, name, surname, address and telephone number are stored.
- An account in a branch has a single owner, that is, it is opened by a single owner. Shared accounts are not allowed.
- Each branch is known by its branch identifier, its address and its telephone number.
- The employees are exclusively assigned to a branch. They want to know their NIF, name, surname, address and salary of the employees.
- Each branch has a branch director and they want to know their name, surname, address and salary.
- Employees (and directors) may change the branch where they work (we want to know the start and end date in every branch).
- Banks: We need to know their identifier and their name.

Clue, bank account format:



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Spain IBAN Format Example

IBAN Calculator | IBAN Country List | IBAN FAQ

An IBAN consists of a two-letter country code, two check digits and a Basic Bank Account Number (BBAN). A BBAN includes information about the domestic bank and account number. The IBAN print format adds one space after every four characters whereas the electronic format contains no spaces.

IBAN	ES91 2100 0418 4502 0005 1332
ISO Country Code	ES (Spain)
IBAN Check Digits	91
BBAN	2100 0418 4502 0005 1332
Bank Identifier	2100
Branch Identifier	0418
Account Number	0200051332
BBAN Check Digit(s)	45
SEPA Member	Yes

This is an example Spanish IBAN. The country code for Spain is ES. The IBAN check digits 91 validate the routing destination and account number combination in this IBAN. The BBAN is 2100 0418 4502 0005 1332, which contains the country-specific details of the account number. The bank identifier is 2100, the bank's branch identifier is 0418 and the account number is 0200051332.
Spain is a member of the Single Euro Payments Area (SEPA).

12.- Real estate agency.

A real estate agency, with several branches, wants to computerize the sales of parcels of land. The information needed:

- The owners transfer their parcels to a branch (only to one) of the agency. An owner can have several parcels of land transferred to different branches.
- The parcels transferred to the estate agency are sold to customers through a certain salesman. The owners want a minimum price for the parcel.
- There are two types of salesman in the company: those who work permanently in a certain branch of the company (with a fixed salary) and those who do so sporadically in one or more branches and who only earn a commission based on sales. The sellers who work permanently in a branch have commission for sales also.

The data we must store is the following:

- Owners: NIF, name, surname, address and telephone number.
- Parcels: Cadastral_number, location.
- Customers: NIF, name, surname, date of birth, address and telephone number.
- Salesmen: NIF, name, surnames and telephone.
- Branches: Address, telephone.

Finally, they want to keep information on the amount and date of sales that are made.
VERY IMPORTANT: A parcel can be sold or transferred **only one time** (that means that if we sell the parcel for a second time it will be introduced in the system as a new one).

13.- Crusades in the Middle Age.
A professor of medieval history wants a database. The specifications are:

- Knights: It is interesting to keep their name, their date of birth, and their father (according to the social rules of their time, knights can only be children of another knight). It is also interesting to know in what province they were born, in what province they governed and in what crusades they participated under the king's orders. Finally, we want to keep —if any— a quote claimed by the knight in combat (e.g. “For God’s glory!”).
- Provinces: It is interesting to know their name. In addition, we want to know the knights who have governed them and those who were born there. A province can be governed by several knights on different dates and a knight can govern in several provinces (on different dates). It is interesting to know the date of beginning and end of government of each knight on the province. Provinces are part of a kingdom.
- Crusades: It is interesting to know its name, start date, end date, against whom was the crusade (a kingdom) and its result, as well as the kings and knights participating in it. Keep in mind that more than one king can participate in each crusade.
- Kings: You want to store data corresponding to their names, their date of birth, start and end dates of their reign and the kingdoms over which they reigned. Finally, we want to know the main color of their dynasty.

14.- Project management 3.
A company wants to design a database to store in it all the information generated in the projects that carries out.
For each projects carried out, it is important to store the code, description, total cost of the project, estimated cost of the project, start date and end date. The projects are developed for customers that they wish to keep the code, telephone, address and company name. A customer can have several projects, but a single project is only for a single customer.
There are also collaborators involved in projects. Regarding collaborators, we want to keep: nif, name, address, telephone and account number. A collaborator can participate in several projects. The projects are developed by one or more collaborators.
Collaborators of the projects receive payments. Regarding the payments made, they want to keep the payment number, concept, amount and date of payment. It is also interesting to store the different types of payments that the company can make. For each of the types of payments they want to keep code and description. A type of payment can belong to several payments.

15.- Travel agency.
A travel agency wants to computerize all the management of travelers who come to the agency and the trips they make.The agency gave us with the following information:

- The agency wants to keep the following travellers’ data: ID, name, address and telephone number.
- For each trip handled by the agency, it is important to keep the trip code, maximum number of travelers, start date of the trip is made and for how many days. A traveler can make as many trips as she/he wants with the agency.

- Each trip made has a destination and a place of origin. From each of them, they want to store the code, name and other information that may be of interest. A trip has a unique place of destination and a unique place of origin.

16.- Booking a hotel.

The aim is to design a database in the E -R model for a hotel company:

- Each hotel (you want to keep: name, address, telephone number, year of construction, etc.) is necessarily classified in one category (for example, three stars) and can be downgraded or upgraded in a concrete date.
- Each category has various information associated with it, such as, for example, the type of VAT that corresponds to it and the description.
- Hotels have different kinds of rooms (suites, doubles, singles, etc.), they define the number of hosts in the room (you also want to keep a code, a name, and a description). The rooms are numbered and you want to know the floor where the rooms are located. For each room you want to save their code and the type of room. Every room has a price.
- Customers can book hotel rooms. The id_card (passport or country id card), name, address and telephone number will appear in their private booking information. Date_of_birth, Obviously, a booking has a check-in date and a check-out date.
- Travel agencies can also book rooms. In case a booking is made by a travel agency, the same data as for private customers will be needed, in addition to the name of the person of the travel agency who is making the reservation.

17.- Accidents and fines.

Imagine that an insurance company in your town asks you for a database to keep track of accidents and fines. After some interviews with your new customer, you have the following information:

- You must store information of all the people who have a vehicle. It is necessary to keep the personal data of each person (name, surname, address, town, telephone and ID).
- For each vehicle you want to store the license plate (or number plate), the brand, model, and color. A person may have several vehicles, and it may be possible that a vehicle belongs to several persons at the same time.
- It is also desired to keep information to manage the traffic accidents of the province. Each traffic accident has a correlative reference number according to the order of entry to the database. You want to know the date, place and time that each accident took place. It could be possible that an accident may involve several people and several vehicles.
- You also want to keep a record of the fines of your customers. Each fine will be assigned a correlative reference number. In addition, the date, time, place, description and amount there must be stored. A fine will only apply to a driver and involves only one vehicle.

18.- Drugstore.

A drugstore (chemist's or pharmacy) wants a computer system to manage the stock, location, sales and orderings of drugs (=medications).

The queries planned are:

- Stock, location (shelf), and price of a drug.
- Drugs of a certain drug company (provider). We will suppose that we buy drugs directly to the drug company that produces them.
- List of drugs that are below the stock (that has been set to minimum number of units).
- Pre-order list, with date: for each drug company, the list of drugs that must be ordered together with their number of units because they are below the minimum stock.

Keep in mind that:

- The client sometimes don't know the name of the drug, but they know the applications of the drug. For example, headache, stomach pain, toothache, ear pain, antivirals, etc. Obviously, the same drug may have several applications. The client sometimes also knows the drug company that distributes the medication.
- A drug is only distributed by a drug company.
- A drug is never stored on several shelves.
- The cash registers have a barcode reader.

In a short time, they will want to expand the system with new features such as:

- Statistics on drugs sold, sales per day, profitability by medication, profitability by laboratory,

It would be advisable that appropriate data will be stored to offer these outputs in the future.

19.- Airline company.

An airline company wants to build a database that can be accessed through terminals from the stands opened to the public in different airports. Reservations can only be done from the stands and reservations are only for a single flight. In particular, you want to keep information about what they call "generic flights" (flight number, departure airport and destination airport, departure and arrival dates, and departure and arrival times) and the state of the reservations of seats (number of free seats) for a certain flight of a certain day. All flights are daily and direct (without scales). There may be more than one daily flight between the same cities, at different times (but only one at the same time). The most typical queries will be:

- Given cities of origin and destination, list all flights between each other (flight number and time).
- Given a flight number and a date, list the number of free seats.

20.- Products and commissions.

A database for a small business must contain information about customers, items and orders. So far, the following data is stored in several documents:

- For each customer: Customer number (unique), shipping addresses (many per customer), balance (="*saldo*"), credit limit (depends on the customer, but it can't exceed 3000€), discount.
- For each item: Item number (unique), factories that distribute it, stock of that item in each factory, description of the item.
- For each order: Each order has a header and the body of the order. The header is formed by the customer number, shipping address and date of the order. The body of

the order is divided in several lines, in each line the number of line, units of the product and price.

In addition, it has been determined that data about the factories should be stored: Factory number and telephone number. And you want to see how many items (in total) the factory provides.

Note: An address will be understood as number, street, city and province. A date includes time.

21.- Olympics.

The Olympic host cities are divided into sports complexes. The sports complexes are subdivided into those in which a single sport is developed. The sports complexes have areas for each sport with a location indicator (example: center, cornerNE, etc.). A complex has a location, a head of organization and a total occupied area. Each complex holds a series of events (example: the stadium running track can hold many different races). For each event there is a date, hour, duration, number of participants, number of commissioners. A list of all commissioners will be kept together with the list of events in which each commissioner is involved (with the task of judge or observer). Finally, for each event and for maintenance, some equipment will be needed (example: arcs, poles, parallel bars, etc).

Sources of the exercises:

- https://www.wu.ac.at/erp/webtrainer/erm-webtrainer/exercise
- Apunts de la UIB del professor Miquel Manresa (1996).