Entity Relationship Diagram

Exercise 1 – Plant wholesaler

You are requested to design a database for the management of the wholesale sale of plants, taking into account the following information:

- Different species of plants are available for sale. For each species both the Latin name and the common name are known, as well as a unique code through which the species is identified. For each species it is also known whether it is typically suited for indoor (apartment) or outdoors (garden) and whether it is an exotic species or not. Plants can be non-flowering or flowering. In the case of flowering plant species, all the colors in which the plant is available are known.

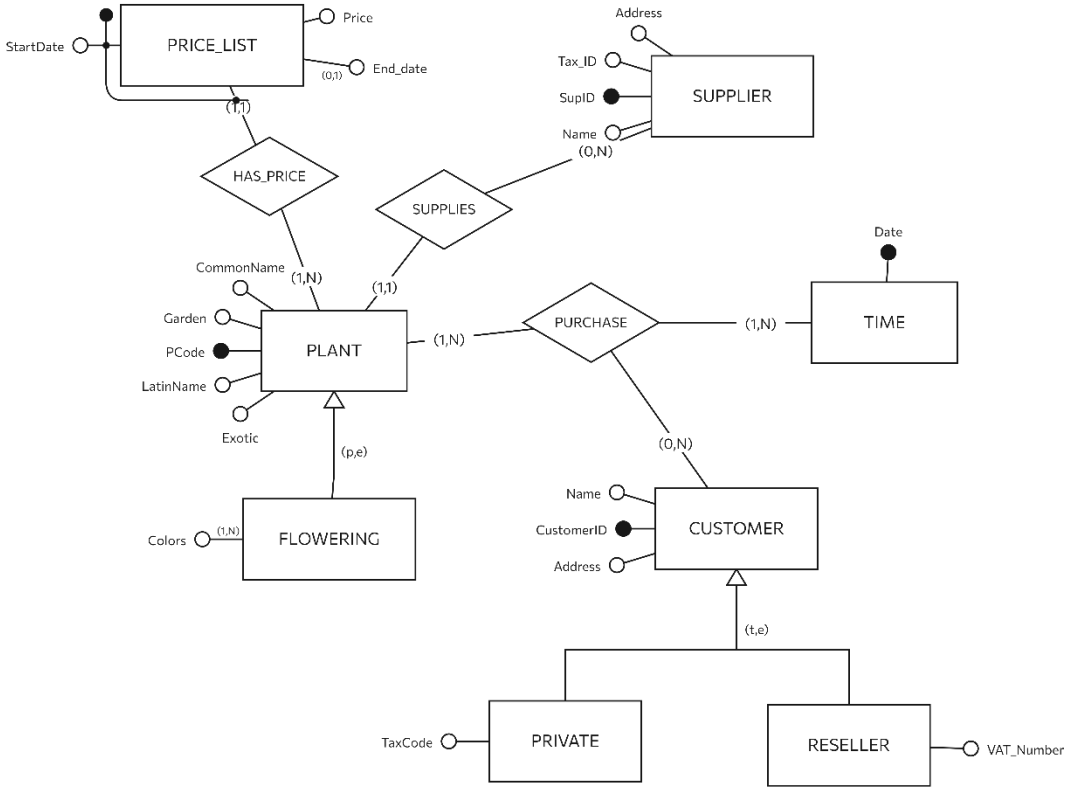
- Customers are identified by a customer code and can be both private customer and resellers. For each private customer, the tax code, name and address of the person are known, while for each reseller the VAT number, name and address are known.

- Suppliers are identified through a supplier code; for each supplier, the name, tax code and address are also known. A supplier can supply different plant species. However, plants of the same species are always purchased from the same supplier.

- We want to keep track of all purchases made by each customer. A purchase, made on a specific date, relates to a certain quantity of plants belonging to a specific species.

- The price list keeps track of the prices assumed over time by each species of plants.

a) Describe the Entity-Relationship diagram addressing the above requirements.
b) Provide a normalized relational logical schema for the same database



SUPPLIER(SupID,Tax_ID,Name,Address)

Generalization about plants can be translated by eliminating the entity FLOWERING. The "Type" attribute is introduced to discriminate between flowering and non-flowering plants.

PLANT(PCode,Type, LatinName, CommonName, Garden, Exotic, SupID)
COLORS(PCode, Colour)
PRICE_LIST(Pcode,StartDate,EndDate*,Price)

Generalization about customers can be translated by eliminating the entities PRIVATE and RESELLER. The "Type" attribute is introduced to discriminate between private customers and resellers

CUSTOMER(CustomerID,Type,Name,Address,TaxCode*,VAT_Number*)
TIME(Date)
PURCHASE (PCode, CustomerID, Date, Quantity)

Other possible translations

The generalization on plants can be translated by maintaining the entity FLOWERING

PLANT(Pcode ,LatinName,CommonName,Garden,Exotic,SupID)
FLOWERING(Fcode)
COLORS(Fcode,Colour)

Generalization about customers can be translated by maintaining the entities CUSTOMER, PRIVATE AND RESELLER

CUSTOMER(CustomerID,Type,Name,Address)
PRIVATE(PrivateCode,TAX_ID)
RESELLER(CodeReseller,VAT_Number)
TIME(Date)
PURCHASE (Pcode,CustomerID,Date,Quantity)

Generalization about customers can be translated by eliminating the entity CUSTOMER

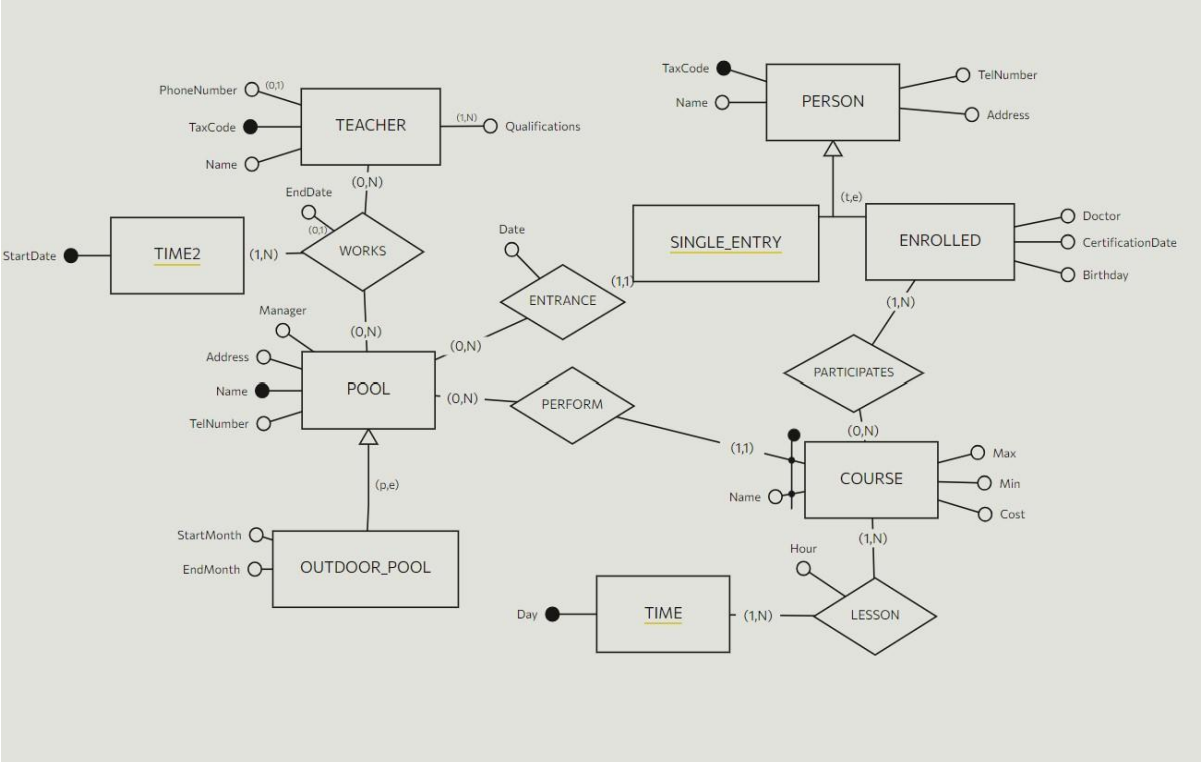
PRIVATE(PrivateCode,TAX_ID,Name,Address)
RESELLER(CodeReseller,VAT_Number,Name,Address)
TIME(Date)
PRIVATEPURCHASE(CodeP,PrivateCode,Date,Quantity)
RESELLERPURCHASE(CodeP,CodeReseller,Date,Quantity)

Exercise 2 – Municipal swimming pools

You are requested to design a database containing information relating to the swimming pools managed by the municipality of Turin, taking into account the following information:

- The pools are uniquely identified by the name (for example Vigone, Comunale, Trecate, etc.). For each pool, the address, a telephone number and the name of a manager are also known. If the swimming pool also has an outdoor pool, the database contains information on when this pool can be used (for example from March to September, from July to August, etc.)
- Courses are organized at the pools; the same type of course can be offered by different swimming pools in different modalities. Each course is therefore identified by the name of the activity carried out (e.g., Aerobics, Acquagym, Synchronized swimming, or course for pregnant women), and by the name of the swimming pool where this course takes place. For each course, available at a certain swimming pool, available information include the cost, the maximum and minimum number of participants, on which days of the week it takes place and at what time. At each swimming pool each course is held only once per day, but several times during the week.
- The teaching staff rotates among the various pools. Each teacher is identified by the tax code and is characterized by the name, surname, mobile phone number, if available, and the teacher's list of qualifications (for example diving instructor, aerobics instructor, etc.). Within the database we want to keep track of all the time intervals in which a teacher worked at each swimming pool. It is possible that the same teacher works at the same swimming pool in different time intervals.
- The swimming pools can be attended either by people who are enrolled in courses, or according to the "single entry" method for free swimming (note that only people who have never attended courses are registered for single entry). All people who access the municipal swimming pools are identified by their tax code and also known by their name, address and telephone number.
- Persons who are enrolled in courses must present a medical certificate. Therefore, if the person is enrolled in a course, the database contains information about the doctor who issued the certificate, the date on which the person presented the certificate, the person's age, and the list of courses to which the person is enrolled. For people with “single entry” registration, only the date on which the last entry was made and at which swimming pool are known.

a) Describe the Entity-Relationship diagram addressing the above requirements.
b) Provide a normalized relational logical schema for the same database



POOL(Name,Address,TelNumber,Manager,Type,StarthMonth*,EndMonth*)
COURSE(PoolName,Name,Min,Max,Cost)
~~TIME(Day)~~
LESSON(PoolName,Name,Day,Hour)

The generalization about people has been translated by keeping both the parent entity PERSON and the two child entities ENROLLED and SINGLE_ENTRY:

PERSON(TaxCode,Name,Address,TelNumber)
ENROLLED(TaxCodeEnrolled,Doctor,CertificationDate,Birthday)
SINGLE_ENTRY(TaxCodeSingle, PoolName, Date)
PARTICIPATES(TaxCodeEnrolled,PoolName,CourseName)
TEACHER(TaxCode,Name,PhoneNumber*)
QUALIFICATIONS(TaxCode,Qualification)
~~TIME2(StartDate)~~
WORKS(TaxCode,StartDate,PoolName,EndDate*)

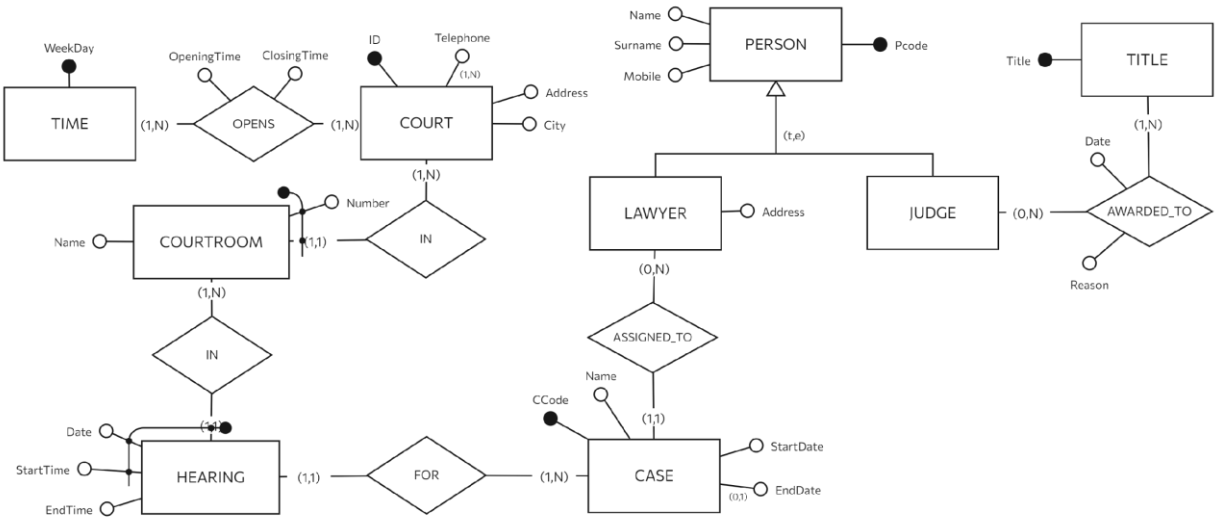
Exercise 3 – Court and courtrooms

You are requested to design a database containing information for the management of some activities of the Italian courts.

- The courts are characterized by a unique numeric code, by the city and address where they are located and a list of telephone numbers. Each court is characterized by the hours of operation (opening time and closing time) which varies according to the day of the week. For each court it is requested to store the opening hours on each day. Each court has several courtrooms used for hearings. Each courtroom is identified by a unique code within the court in which it is located and is characterized by a name.
- Various cases are being disputed in the courts. The people involved in the lawsuits are identified by a unique code and are characterized by their name and a mobile phone number. People are divided into judges and lawyers. For each judge, the list of honorary titles acquired is known. In particular, for each title, the date on which the title was awarded to the judge and a brief description of the reason for which the title was awarded are known. Consider that the same title may have been assigned to several judges, but only once to each judge. For lawyers, the address of the office where they work is known.
- The cases are identified by a unique numeric code. Each case is characterized by a name, a start date and an end date (consider that the end date is known only after the case is finished). The lawyer assigned to follow the case is known.
- Different hearings may be held for each case. Each hearing is characterized by the case to which it refers, the courtroom in which it takes place, and the date, start time and end time in which it takes place. It should be noted that several hearings cannot be held simultaneously in the same courtroom for the same cause or for different causes.

a) Describe the Entity-Relationship diagram addressing the above requirements.

b) Provide a normalized relational logical schema for the same database



Logical Model

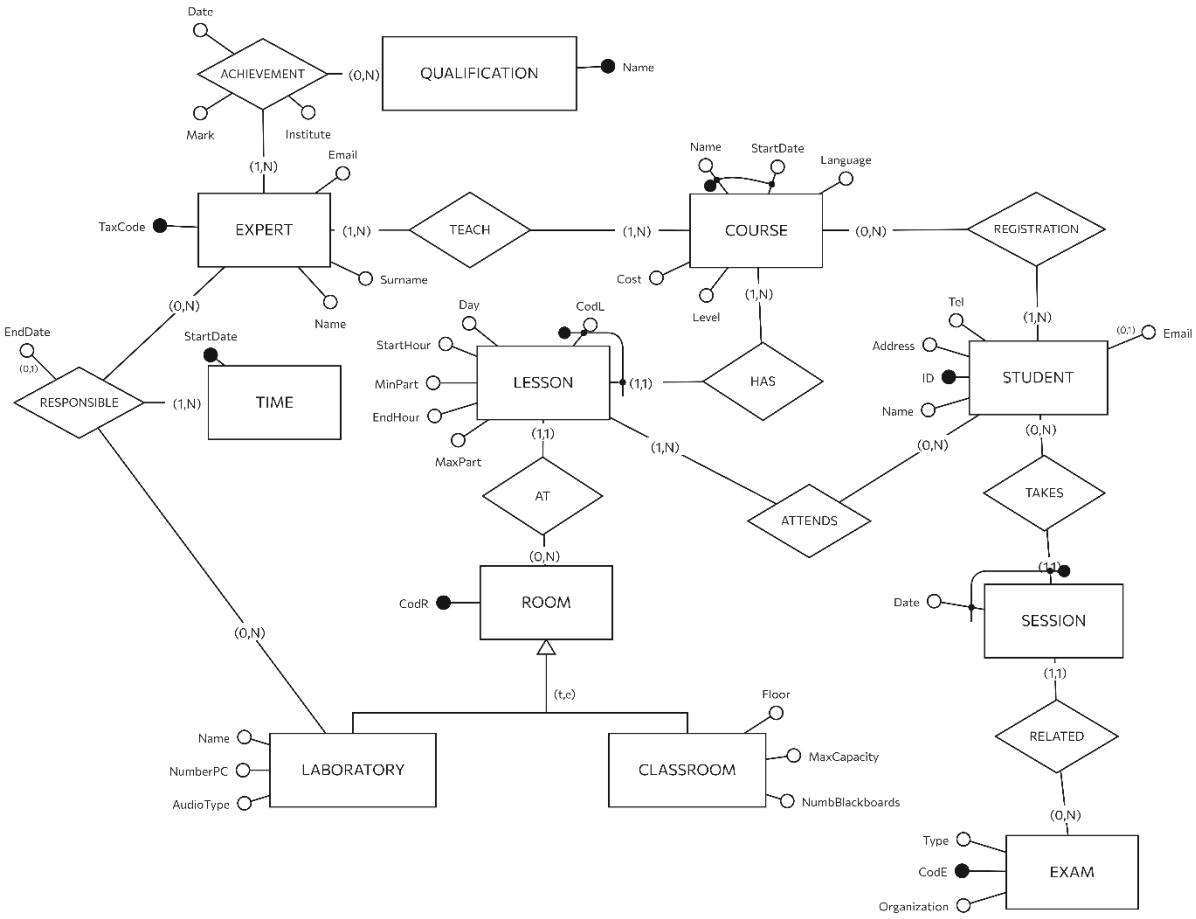
COURT(ID, City, Address)
TELEPHONE(Telephone, ID)
COURTROOM(ID, Number, Name)
OPENING_TIME(ID, WeekDay, OpeningTime, ClosingTime)
TIME(WeekDay)
JUDGE(Pcode, Name, Surname, Mobile)
LAWYER(Pcode, Name, Surname, Mobile, Address)
TITLE(Title)
TITLE_AWARDED(Pcode, Title, Reason, Date)
CASE(CCode, Name, StartDate, EndDate*, PcodeLawyer)
HEARING(ID, Number, Date, StartDate, EndDate, CCode)

Exercise 4 – Foreign language courses

You are requested to design a database containing information the management of a school that provides language courses.

- Language courses are uniquely identified by a code and the start date of the course. The language taught, cost and level (e.g. beginner, intermediate, advanced) are also known for each course.
- The language courses are organized in lessons. Each lesson is identified by a unique code within the course and is characterized by the day on which it is held, start time and end time, minimum and maximum number of participants.
- Lessons are held on the school premises. For each lesson it is necessary to memorize the room where it takes place. The rooms, identified by an alphanumeric code, are classified into classrooms and laboratories. The classrooms are characterized by the maximum capacity, the floor on which they are located and the number of blackboards present. The laboratories, on the other hand, are characterized by the name, the number of personal computers present and the type of audio system they have.
- The language experts who work at the school are characterized by their tax code, name, surname, e-mail address, telephone number and list of qualifications acquired with the date of achievement and the mark obtained. For each qualification, the language institute that issued it is also known. Each linguistic expert teaches at least one course, while the same course can be taught by more than one linguistic expert.
- The language experts are in charge of the laboratories. The database shall store all the time periods in which the language experts have been responsible for the different laboratories. A laboratory can have several managers in the same period of time, and a language expert can be responsible for several laboratories in the same period of time.
- Students enrolled in the school are identified by a registration number and characterized by name, address, telephone number and e-mail address if available. For each student, the list of courses in which they are enrolled and the list of lessons they have attended is also known. A lesson can be attended by several students.
- The school organizes language exams for students who want to get a certificate. Each exam is identified by a unique code and is characterized by the type of certificate issued and by the organization that organizes it (for example, Cambridge, Oxford, etc.). The database stores all the registrations for exams made by people who attend courses at the school. Each registration is characterized by the student who signs up, the exam they want to take, and the day on which the exam will be held. A person can take at most one exam per day, while for the same exam the same person can register several times to take the exam on different days.

a) Describe the Entity-Relationship diagram addressing the above requirements..
b) Provide a normalized relational logical schema for the same database



Logical model

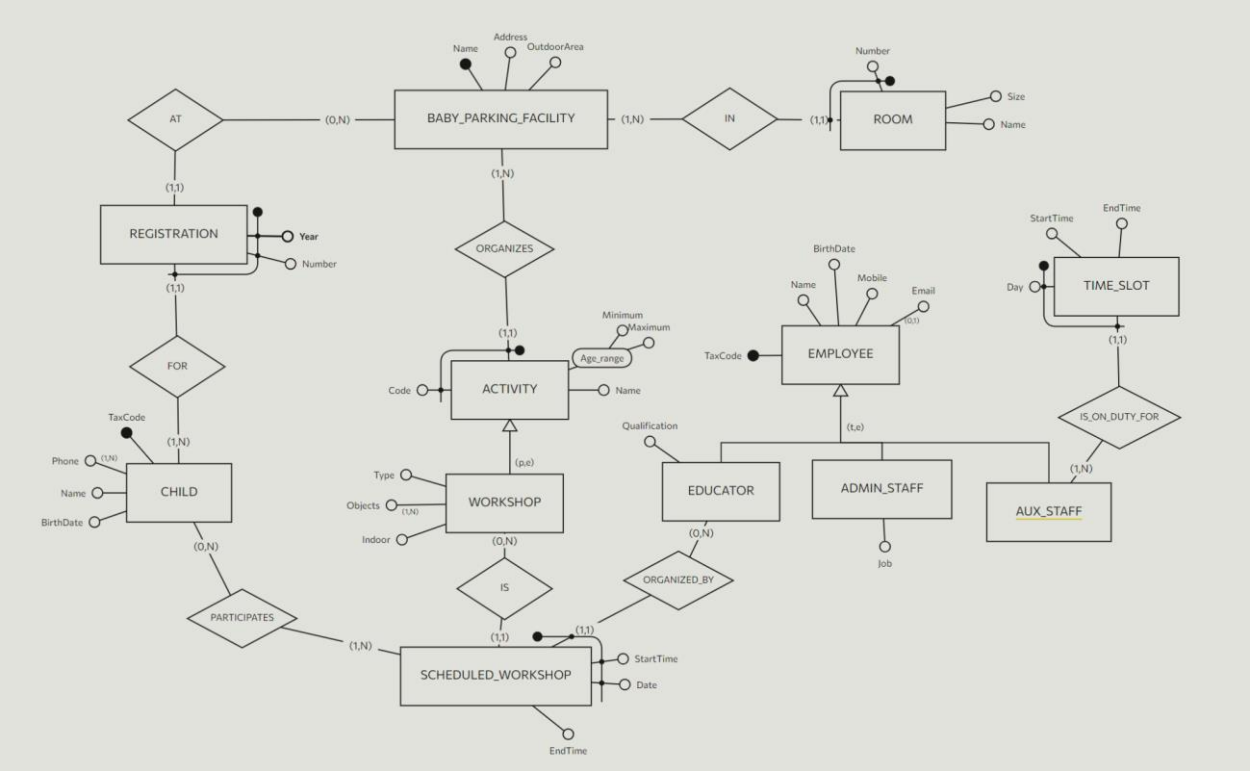
COURSE(<u>Name,StartDate</u>,Cost,Level)
EXPERT(<u>TaxCode</u>,Name,Surname,Email)
QUALIFICATION(<u>Qualification</u>)
ACHIEVEMENT(<u>TaxCode,Achievement</u>,Date,Mark,Institute)
ROOM(<u>CodR</u>,Type,Name*,NumberPC*,AudioType*,Floor*,MaxCapacity*,NumBlackboards*)
LESSON(<u>CodL,Name,StartDate</u>,Day,StartHour,EndHour,MinPart,MaxPart,CodR)
TIME(<u>StartDate</u>)
RESPONSIBLE(<u>TaxCode,CodR,StartDate</u>,EndDate*)
STUDENT(<u>ID</u>,Name,Address,Tel,Email*)
ATTENDS(<u>ID,CodL,Name,StartDate</u>)
EXAM(<u>CodE</u>,Organization,Type)
SESSION(<u>Date,ID</u>,CodE)

Exercise 5 – Baby parking

The non-profit organization BimbiGioco manages several baby parking facilities in the city of Turin and wants to create a database for the management of its activities.

- Each baby parking facility managed by the BimbiGioco non-profit is identified by its name and is characterized by the address and the presence of an equipped outdoor area. Several rooms are available at each baby parking facility. Each room is identified by a unique code within the baby parking facility where it is available and is characterized by the name and size of the room.
- In each baby parking facilities several activities are organized to entertain children. Each activity is characterized by a unique code within the baby parking where it is organised. For each activity, the name of the activity and the age range (minimum and maximum age) of the children who can participate in it are also known. Among the possible activities there are thematic workshops. For each thematic workshop, the type is known (for example body expression, theater or animated story), the list of objects used during the workshop (for example musical instruments, paper and colours) and the information on where the workshop is held (i.e., whether inside the baby parking or outdoors).
- Employees of the BimbiGioco non-profit are identified by their tax code. For each employee, the name, date of birth, mobile phone number and e-mail address (if available) are known. Employees are classified into educators, auxiliary and administrative staff. For administrative staff, the job is known, while for educators the educational qualification is known. For auxiliary staff, the database memorizes the days of the week in which they are on duty with the indication of the working time range (start time and end time). Consider that the same person can work on several days of the week, but at most in one time slot on each day.
- Children who attend the baby parking facilities of the BimbiGioco non-profit are characterized by their tax code, name, date of birth and list of parents' telephone numbers. The database stores the annual registrations made for children in each facility. Each enrollment is identified by the reference school year and by a progressive code within the reference school year. For each registration, the child and the baby parking facility it refers to are also known. Each child can enroll in multiple facilities in different school years.
- It is requested to keep track of the program of thematic workshops organized at the various baby parking facilities. For each scheduled workshop, the database stores the date, the start and end time, the educator who coordinates the workshop and the list of children participating in the workshop. It should be noted that the same workshop can be carried out on different dates and several times on the same date. An educator cannot coordinate two or more thematic workshops at the same time.

a) Describe the Entity-Relationship diagram addressing the above requirements.
b) Provide a normalized relational logical schema for the same database



Logical model

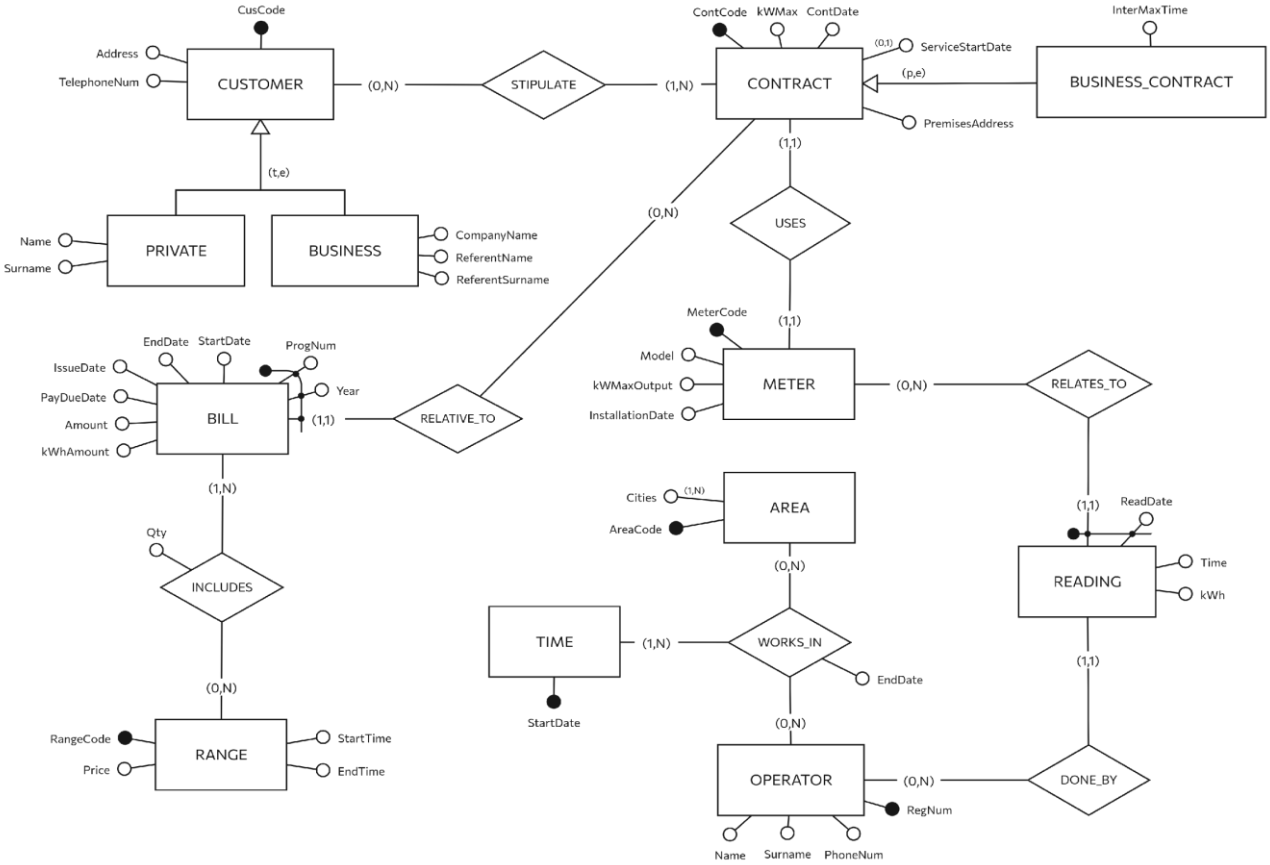
Baby_Parking_Facility (Name, Address, OutdoorArea)
Room(Name,Number,Size,Name)
Activity(Name,Code,MaxAge,MinAge,Name)
Workshop(Name,Code,Type,Indoor)
WorkshopObject(Object)
UseObjects(Name, Code, ObjectName)
Child(TaxCode, Name, BirthDate)
Phone(Number)
Phone(Number, TaxCode)
Registration(ChildTaxCode, Year, Number, BabyParkingName)
Employee(TaxCode, Name, BirthDate, Mobile, Email*, Type, Qualification*, Job*)
Time_slot (Tax Code, Day, StartTime, EndTime)
Scheduled_workshop (EducatorTaxCode, Date, StartTime, EndTime, Name, ActivityCode)
Participate(EducatorTaxCode, Date, StartTime, ChildTaxCode)

Exercise 6 – Electric company

We want to create a database for the management of some activities of a company that supplies electricity.

- The company's customers are uniquely identified by a customer code. Private customers are characterized by their name, surname, address and a telephone number. Business customers are characterized by the company name, address, telephone number, name and surname of the contact person.
- Contracts are uniquely identified by a contract code and are characterized by the address of the premises for which the contract is stipulated, the date of the contract, the start date of service (if already known), the customers of the contract and the maximum kW available. For business contracts, the maximum intervention time following a breakdown is known.
- Company operators are characterized by a unique registration number and by name, surname and mobile phone number.
- The meters are uniquely identified by an alphanumeric code and are characterized by model, maximum kW output, date of installation and contract to which they refer. The meter readings are stored. Each reading is characterized by the meter to which it refers, by the operator who carried out the reading, by the value in kWh read on the meter, by the date and time it was carried out. It should be noted that during the same date a maximum of one reading is made for each meter.
- Each bill is uniquely identified by a progressive number within the year and the contract for which it is issued, and is characterized by the time period to which it refers, the issue date, the payment due date, the amount to be to pay and the total amount of electricity consumed expressed in kWh.
- The price per kWh of electricity depends on the time slot during which the electricity is supplied. The time slots are uniquely identified by an alphanumeric code and are characterized by a valid start time, a valid end time and the price per kWh. For each bill, memorize the total amount of electricity supplied, expressed in kWh, in relation to each time slot.
- The geographical areas where the company supplies electricity are uniquely identified by an alphanumeric code and are characterized by a list of cities. Each city belongs to at most one geographical area. The periods of time (start date, end date) in which an operator works in an area are stored. In particular, each operator can work at different times in the same geographical areas, but also in different geographical areas in the same period of time.

a) Describe the Entity-Relationship diagram addressing the above requirements.
b) Provide a normalized relational logical schema for the same database



Logical model

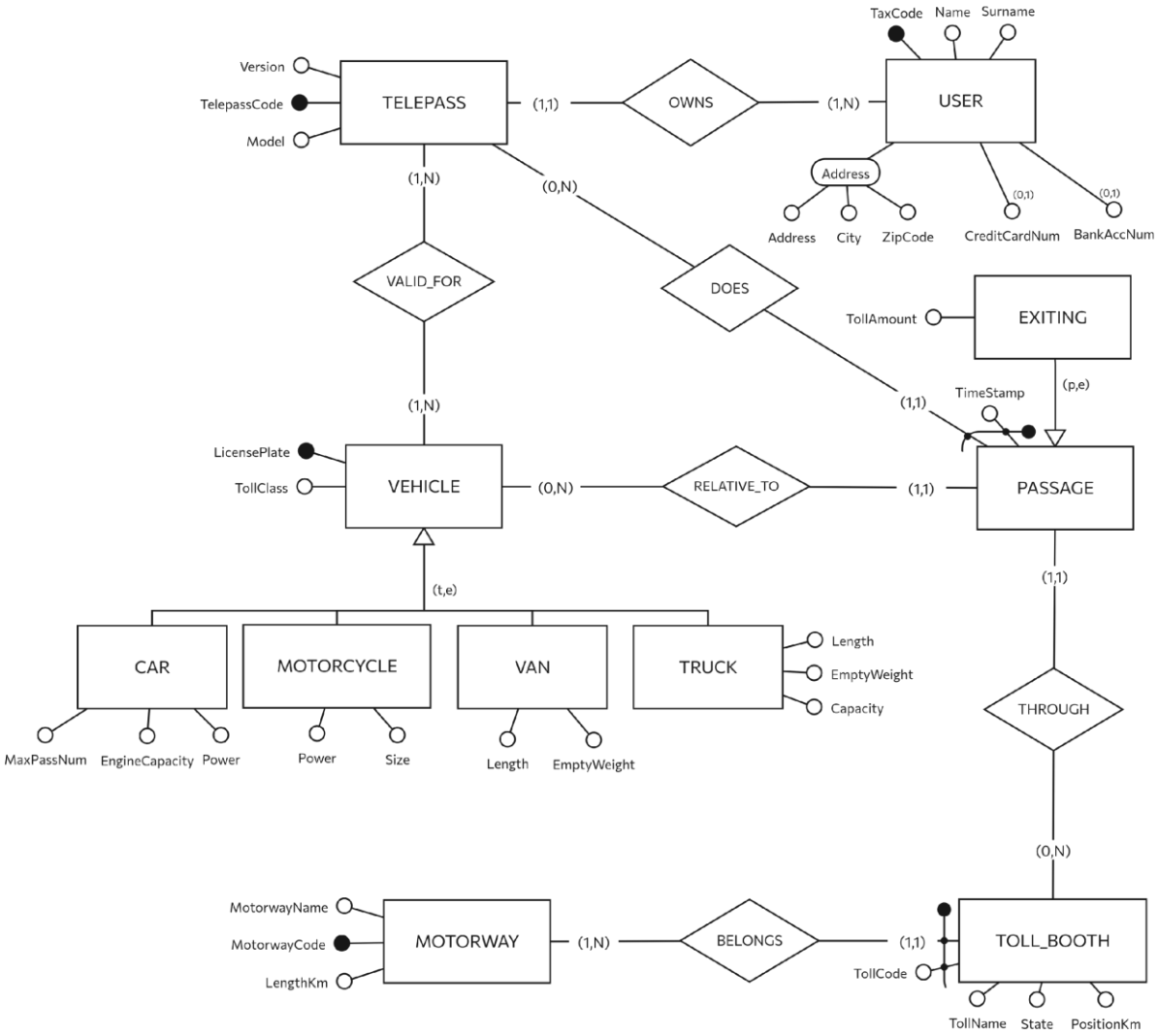
CUSTOMER(<u>CusCode</u>, Address, TelephoneNum, Type, Name*, Surname*, CompanyName*, ReferentName*, ReferentSurname*)
CONTRACT(<u>ContCode</u>, kWMax, ContDate, ServiceStartDate*, PremisesAddress, Type, InterMaxTime*)
METER(<u>MeterCode</u>, Model, kWMaxOutput, InstallationDate, ContCode)
OPERATOR(<u>RegNum</u>, Name, Surname, PhoneNum)
~~AREA(AreaCode)~~
CITIES_AREA(<u>City</u>, AreaCode)
WORKS_IN(<u>RegNum</u>, <u>StartDate</u>, <u>AreaCode</u>, EndDate)
READING(<u>ReadDate</u>, <u>MeterCode</u>, Time, kWh, RegNum)
BILL(<u>ContCode</u>, <u>Year</u>, <u>ProgNum</u>, StartDate, EndDate, IssueDate, PayDueDate, Account, kWhAmount)
RANGE(<u>RangeCode</u>, Price, StartTime, EndTime)
INCLUDES(<u>Year</u>, <u>ContCode</u>, <u>ProgNum</u>, <u>RangeCode</u>, Qty)

Exercise 7 – Remote toll collection

It is requested to create the database for the management of remote toll collection devices (Telepass) on the Italian motorways.

- Motorways are identified by a unique code at European level and are characterized by a name and total length in km. The toll booths of the motorway network are identified by a unique code within the motorway to which they belong and are characterized by the name and the position along the motorway (in km) where they are located. Furthermore, the current state (open, closed, work in progress, etc.) is known.
- Each Telepass is identified by a unique alphanumeric code. The version and model are known for each Telepass. Each Telepass has a user who owns it, who is identified by the tax code and his name, surname, address, city and zip code are known. In addition, we want to store the user's bank account number or credit card number to which tolls will be charged. A user can be the owner of several Telepasses.
- A Telepass is valid for one or more vehicles. Each vehicle is identified by its license plate and is characterized by toll class and type. Vehicles can be of four types: cars, motorcycles, vans and trucks. Cars are characterized by the maximum number of passengers they can carry, by the engine capacity and power. Motorcycles are characterized by engine power and size. Vans are characterized by their length and empty weight. Trucks are characterized by their length, empty weight and capacity in cubic metres.
- It is requested to record Telepass passages at toll booths on the motorway network. Each Telepass pass at the same toll booth at different times, but cannot pass through different toll booths at the same time. Each passage can be an entrance to or exit from the highway. The toll amount is also known for exit passes. Each pass is associated with the vehicle that carried it out.

a) Describe the Entity-Relationship diagram addressing the above requirements.
b) Provide a normalized relational logical schema for the same database



Logical Model

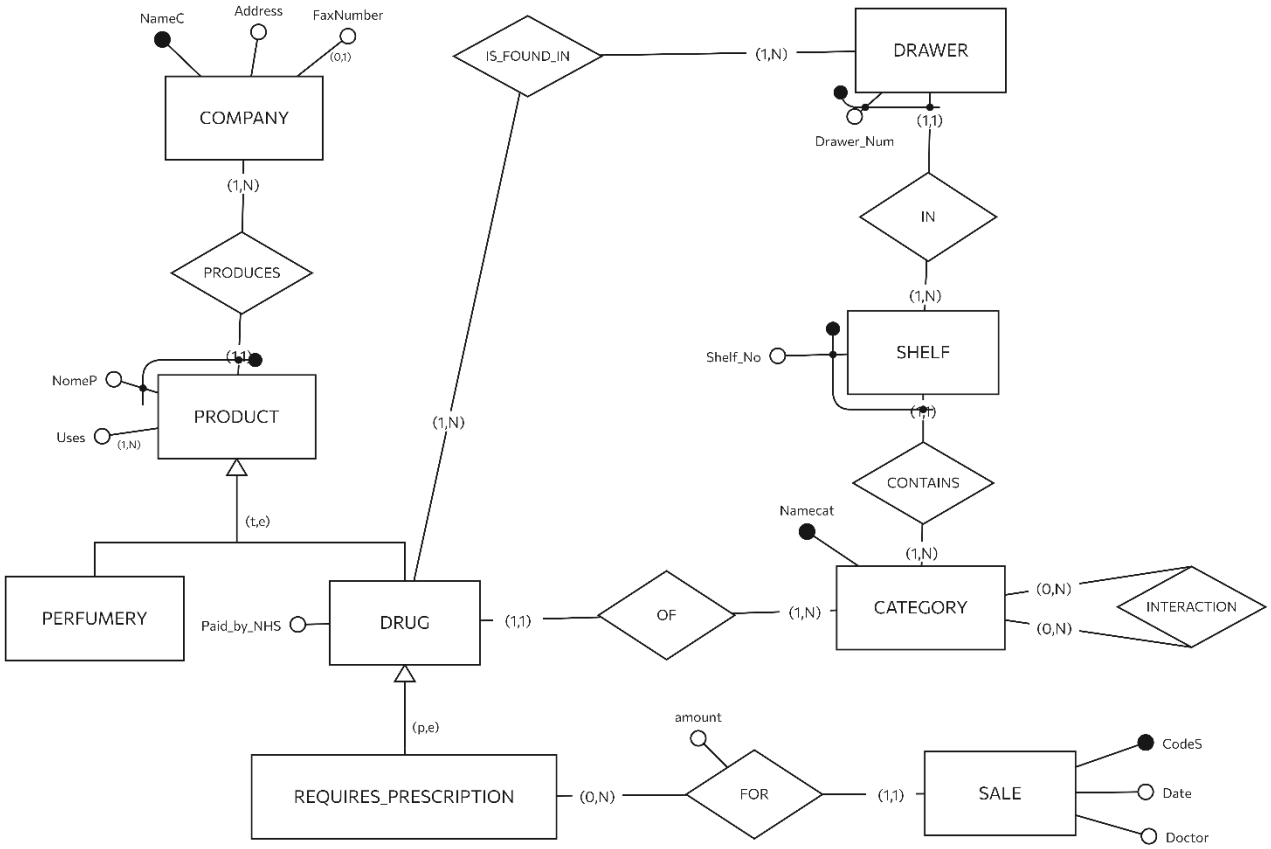
USER(<u>TaxCode</u>, Name, Surname, CreditCardNum*, BankAccNum*, Address, City, ZipCode)
TELEPASS(<u>TelepassCode</u>, Model, Version, TaxCode)
VEHICLE(<u>LicensePlate</u>, TollClass, Type, MaxPassNum*, EngineCapacity*, Power*, Size*, Length*, EmptyWeight*, Capacity)
PASSAGE(<u>TelepassCode</u>, <u>TimeStamp</u>, Type, Amount*, LicensePlate, MotorwayCode, TollCode)
MOTORWAY(<u>MotorwayCode</u>, MotorwayName, LengthKm)
TOLL_BOOTH(<u>TollCode</u>, <u>MotorwayCode</u>, TollName, State, PositionKm)
VALID_FOR(<u>LicensePlate</u>, <u>TelepassCode</u>)

Exercise 8 – Pharmacy management

It is requested to design a database for the management of the products available at a pharmacy taking into account the following information:

- Each product is uniquely characterized by the name of the product itself and by the information related to the company supplying the product. The products present in the pharmacy can be medicines or perfumery products. For each product, however, the list of possible uses of the product itself is known (for example, colds, bone ache, or a cleanser for the face or body). The supplying company, on the other hand, has a contact address, the name used to identify the company itself, and possibly the fax number if available.
- In the case of medicinal products, the database contains information relating to whether a medicinal product can be paid by the National Health Service or not, and whether it can be sold only upon presentation of a medical prescription. Furthermore, the pharmacotherapeutic category to which the medicinal product belongs is known (for example antibiotic or anti-inflammatory), and whether there are interactions between that pharmacotherapeutic category and other pharmacotherapeutic categories.
- Medicines are contained in drawers, which are themselves contained in shelves. The shelves are identified by a unique numerical code for each pharmacotherapeutic category and the drawers by a unique numerical code for each shelf.
- Finally, in the case of medicines that require a medical prescription, we want to keep track of each sale made, indicating the day, quantity and name of the doctor who made the prescription.

a) Describe the Entity-Relationship diagram addressing the above requirements.
b) Provide a normalized relational logical schema for the same database



Logical model

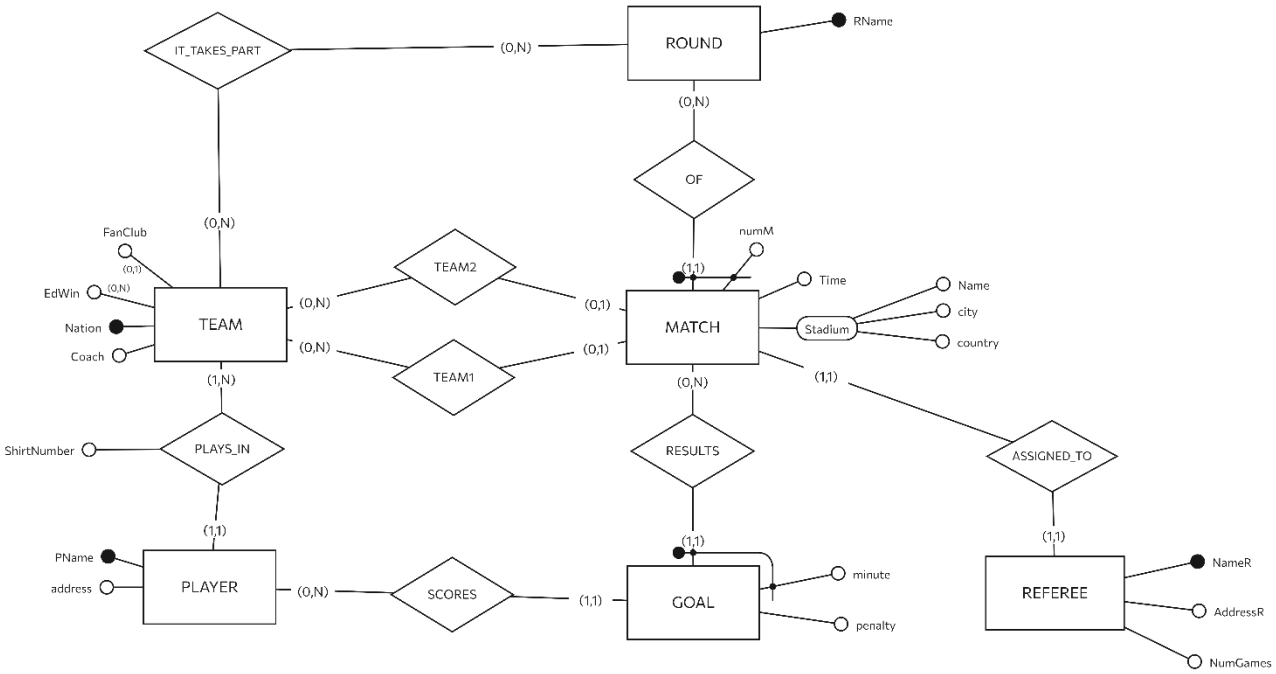
COMPANY (NameC, Address, Fax*)
PRODUCT (NameC, NameP, ProductType)
~~USES (Usage)~~
PRODUCT_USES (NameC, NameP, Use)
DRUG_PRODUCT (NameC, NameP, Paid_by_NHS, NameCategory, DrugType)
SALE (CodeS, Date, Doctor, NameC, NameP, amount)
~~CATEGORY (NameC)~~
INTERACTION (NameCat, InteractNameCat)
SHELF (NameCat, Shelf_No)
DRAWER (NameCat, Shelf_No, Drawer_Num)
IS_FOUND_IN (NameC, NameP, NameCat, Rack_Num, Drawer_Num)

Exercise 9 – European Football (soccer) League

We want to represent a database for the management of football matches held in the context of the European Championship, taking into account the following information:

- The teams participating in the European football championships are uniquely identified by the name of the nation they belong to (Italy, Romania, England, etc.). For each team, the name of the current coach is known and the list of previous editions of the European Championships won by the team itself. In addition, the name of a fan club is known for each team if available.
- The European Championships are organized in rounds. Each round is uniquely identified by the name of the round itself (example: "qualification", "quarters", "semifinal" and "final"). The database contains the list of teams that take part in each round of the championship.
- Football matches are identified by a unique order number within each round. For each match, you are requested to store the names of the two teams involved, the stadium in which the match is being played (stadium name, city, country) and at what time.
- Players are uniquely identified by the name. For each player, it is also known which team he plays for in the European Championships, and with which shirt number. A contact address is known for each player. For each of the players who scored, we want to memorize in the database, for each game played, the minute of the game in which that player scored a goal, and whether it was a penalty.
- Finally, the database contains information about which referee has been assigned to each match. For each referee, the name is known, which uniquely identifies him, a contact address, and the total number of games refereed at the European Championships.

a) Describe the Entity-Relationship diagram addressing the above requirements.
b) Provide a normalized relational logical schema for the same database



Logical model

TEAM (Nation, Coach, Fanclub*)
EDWIN (Year Edition, Nation)
ROUND (RName)
IT_TAKES_PART (RName, Nation)
PLAYER (PName, Address, Nation, ShirtNumber)
REFEREE (NameR, AddressR, NumGames)
MATCH (DName, NumM, Stadium_Name, Stadium_city, Stadium_Country, Time, Team1, Team2, NameR)
GOAL (RName, NumM, Minute, PName, Penalty)