Universidad Autónoma de Madrid

Computer Science Department

EDAT

Exercises

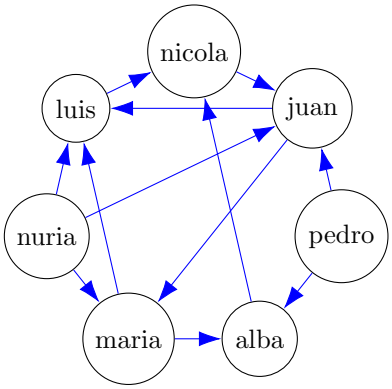
Roberto Marabini Ruiz

Exercise 1

a. Write the SQL operations needed to create a database that stores information of an asymmetric social network ("follow" type) in which users have a *nick*, *name* and *email*.

b. Define the primary keys and constraints for each table.

c. Insert the data that stores the following social network. Since the graph only shows nicknames you may choose any string as *names* and *emails*.



Exercise 2

Using the tables defined in the previous exercise, write the SQL operation needed to obtain the following information:

a. People that follow both luis AND maria.

b. People that follow people that follow nicola.

c. Rewrite queries (a) and (b) assuming that the follower relationship is symmetric. That is, if A follows B then B follows A

Exercise 3

Write the SQL operations needed to store information on flights including the following information:

- Airports: store them as a three letter code (unique) and city (a city can have several airports)
- Flights: flight numbers (single), origin and destination (airport codes), time of departure, number of places (assuming it was always the same model airplane), and airline operating them.
- Airlines: name and abbreviation (unique).
- Passengers: with ID and name.
- Plane bookings: for passengers at a given date, with its price, for a given flight.

Populate the tables with some data.

Exercise 4

Write the SQL operations needed to:

- Cancel all flight with origin=$Madrid$
- Reassign all $BritishAirways$ flights with origin=$Madrid$ to $Iberia$
- Increase by a factor of 2 all $EasyJet$ bookings

Exercise 5

Using the database defined in exercise 3, write the SQL queries needed to obtain the following information:

- Flights that depart from Paris.
- Flights from Madrid to Paris departing at 12:00.
- Name of passengers traveling from London to Paris. Include departing date.
- Name of passengers traveling from London to Paris and *vice versa*.
- Name of passengers making a round trip on the same day. That is they fly from A to B and from B to A.

Exercise 6

Using the database defined in exercise 3, write the SQL queries needed to obtain the following information:

- Airlines with no departures from London.
- Fully booked flights including date.
- Empty flights (no ticket sold) in 2011.
- Airlines that only have flights that either depart from or land in Madrid.

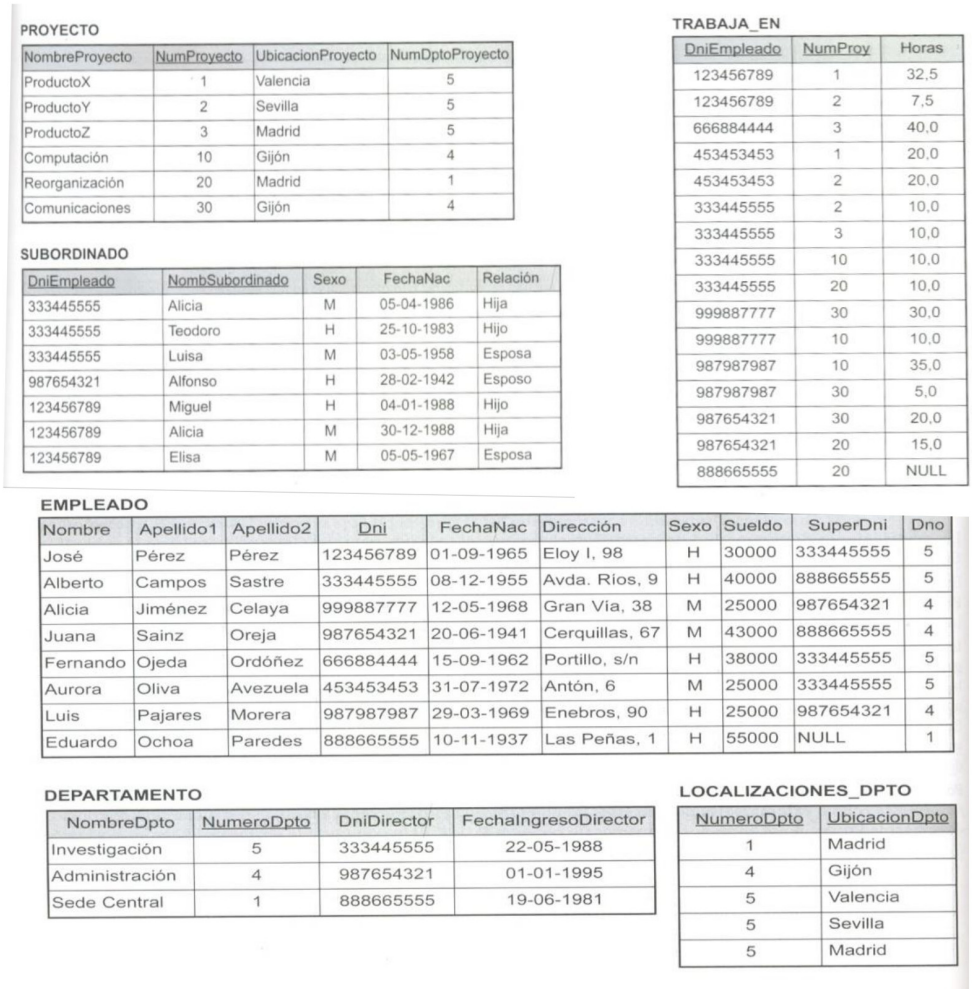
Exercise 7

Using the database defined in exercise 3, write the SQL queries needed to obtain the following information:

- Busier airport (count both departures and landings).
- Airlines sorted by the number of reservation.
- For each day, city from which the first flight departs.
- Average expenditure per passenger.
- Turn over per airline and departure airport.

Exercise 8

Given the following Database



PROYECTO

NombreProyecto	NumProyecto	UbicacionProyecto	NumDptoProyecto
ProductoX	1	Valencia	5
ProductoY	2	Sevilla	5
ProductoZ	3	Madrid	5
Computación	10	Gijón	4
Reorganización	20	Madrid	1
Comunicaciones	30	Gijón	4

TRABAJA_EN

DniEmpleado	NumProy	Horas
123456789	1	32,5
123456789	2	7,5
666884444	3	40,0
453453453	1	20,0
453453453	2	20,0
333445555	2	10,0
333445555	3	10,0
333445555	10	10,0
333445555	20	10,0
999887777	30	30,0
999887777	10	10,0
987987987	10	35,0
987987987	30	5,0
987654321	30	20,0
987654321	20	15,0
888665555	20	NULL

SUBORDINADO

DniEmpleado	NombSubordinado	Sexo	FechaNac	Relación
333445555	Alicia	M	05-04-1986	Hija
333445555	Teodoro	H	25-10-1983	Hijo
333445555	Luisa	M	03-05-1958	Esposa
987654321	Alfonso	H	28-02-1942	Esposo
123456789	Miguel	H	04-01-1988	Hijo
123456789	Alicia	M	30-12-1988	Hija
123456789	Elisa	M	05-05-1967	Esposa

EMPLEADO

Nombre	Apellido1	Apellido2	Dni	FechaNac	Dirección	Sexo	Sueldo	SuperDni	Dno
José	Pérez	Pérez	123456789	01-09-1965	Eloy I, 98	H	30000	333445555	5
Alberto	Campos	Sastre	333445555	08-12-1955	Avda. Ríos, 9	H	40000	888665555	5
Alicia	Jiménez	Celaya	999887777	12-05-1968	Gran Vía, 38	M	25000	987654321	4
Juana	Sainz	Oreja	987654321	20-06-1941	Cerquillas, 67	M	43000	888665555	4
Fernando	Ojeda	Ordóñez	666884444	15-09-1962	Portillo, s/n	H	38000	333445555	5
Aurora	Oliva	Avezuela	453453453	31-07-1972	Antón, 6	M	25000	333445555	5
Luis	Pajares	Morera	987987987	29-03-1969	Enebros, 90	H	25000	987654321	4
Eduardo	Ochoa	Paredes	888665555	10-11-1937	Las Peñas, 1	H	55000	NULL	1

DEPARTAMENTO

NombreDpto	NumeroDpto	DniDirector	FechaIngresoDirector
Investigación	5	333445555	22-05-1988
Administración	4	987654321	01-01-1995
Sede Central	1	888665555	19-06-1981

LOCALIZACIONES_DPTO

NumeroDpto	UbicacionDpto
1	Madrid
4	Gijón
5	Valencia
5	Sevilla
5	Madrid

Show the result of the following SQL operation and (if modified) the state of the different tables. All SQL operations are applied to the original database.

a. DELETE FROM EMPLEADO WHERE dni='123456789';

b. DELETE FROM EMPLEADO WHERE Apellido1='Cabrera';

c. ALTER TABLE EMPLEADO ADD COLUMN Trabajo VARCHAR (12);

d. ALTER TABLE EMPLEADO DROP COLUMN dirección CASCADE;

e. INSERT INTO EMPLEADO VALUES ('Ricardo', 'Roca', 'Flores', '653298653', '1962-12-30', 'Los Jarales, 47', 'H', 37000, '653298653', 4);

f. INSERT INTO EMPLEADO (Nombre, Apellido1, Dno, Dni) VALUES ('Ricardo', 'Roca', 4, '653298653');

g. UPDATE PROYECTO SET UbicaciónProyecto='Valencia', NumDptoProyecto = 5 WHERE NumProyecto=10;

h. SELECT FechaNac, Dirección FROM EMPLEADO WHERE Nombre='José' AND Apellido1='Pérez' AND Apellido2='Pérez';

i. SELECT Nombre, Apellido1, Dirección FROM EMPLEADO, DEPARTAMENTO WHERE NombreDpto='Investigación' AND NumeroDpto=Dno;

j. SELECT NumProyecto, NumDptoProyecto, Apellido1, Dirección, FechaNac FROM PROYECTO, DEPARTAMENTO, EMPLEADO WHERE NumDptoProyecto='NumeroDpto' AND DniDirector=Dni AND UbicacionProyecto='Gijon';

k. SELECT Nombre, Apellido1, Dirección FROM (EMPLEADO JOIN DEPARTAMENTO ON Dno=NumeroDpto) WHERE NombreDpto='Investigación';

Exercise 13

A bookstore chain requires a management application that handles: catalog, stocks, sales and human resources. Model the problem creating a ER diagram. The system must be able to store the following information.

a. Books: title, author(s), editorial, ISBN and price.

b. Editorials: name, VAT number, phone.

c. Authors: name

d. Employees: name, SSN (social security number), salary , bookshop (in which they work).

e. Bookshop: address, manager (one of the employees), stock (number of copies of each book)

f. Sales: book, date, bookstore and employee (that sold the book).

Exercise 14

Convert the ER Diagram created in the exercise-13 into a Relational Schema.

Exercise 21

In the database of an investment company the following attributes has been defined:

b: broker	a: share
o: broker company	o: broker company
c: client	d: dividend per share

We know that the following functional relationships are held:

$a \to d \quad \{c, a\} \to q$
$c \to b \quad b \to o$

Given de relational schema $R(b, o, a, q, c, d)$:

a. Which is the best key for for R.

b. Does R satisfy the second normal form.

c. Decompose R so that satisfies the third normal form

   If we decompose R in
   $R1(c, a, q, d)$
   $R2(c, b, o)$

d. Do R1 and R2 satisfy the third normal form?

Exercise 22

Given the following relations:
$RESERVATION(pasangerName, SSN, flightID,$
$departureAirport, arrivalAirport, time, date, cost)$
$FLIGHT(flightID, time, departureAirport, arrivalAirport, departureCity, arrivalCity)$
and assuming the requirements:

a. two people cannot have the same SSN (social security number).

b. some cities have more than one airport.

c. fares may not be constant for a given flight. That is, different reservations may have different prices

d. for a given day the flight number is unique. That is, it is not possible to have two flight with the same flight number the same sday.

e. two planes cannot take off simultaneously. That is, for a given day, departure hours are different for all flights

f. A passenger may take two different flights the same day form the same airport.

perform the following tasks:

a. find all candidate keys and suggest a primary key.

b. indicate all NON REDUNDANT functional dependences

c. what normal forms are satisfied by each relation? Why?

d. convert each relation so that they satisfy BCNF. Indicate the primary keys. Do we lost any functional dependence after normalization?

Exercise 23

Probe that the relation schema $R(a, b)$ always satisfies BCNF form.

Exercise 24

Repeat exercises 2, 5 y 6 (except 6b) using relational calculus instead of SQL.

Exercise 25

Repeat exercises 2, 5 y 6 using relational algebra instead of SQL.

Exercise 26

Given the following relations
$FLIGTH(\underline{Number}, Depart, Arrive, dateF)$
$AIRPORT(\underline{Code}, City)$
$PASSENGER(\underline{SSN}, Name)$
$RESERVATION(\underline{SSN, Number}, dateR, Price)$

write the following queries using relational calculus:

a. Flights from Charles de Gaulle (CDG) to Heathrow (LHR).

b. departure time for all flights from Charles de Gaulle (CDG) to Heathrow (LHR).

c. Flights BETWEEN Charles de Gaulle (CDG) and Heathrow (LHR).

d. Flights from Paris to London.

e. Name, date and destination for all passengers traveling from Madrid Barajas (MAD).

f. empty flights (no reservations).

Exercise 27

Apply the queries created in the previous exercise to the following data:

Number1	Depart	Arrive	dateF
345	MAD	CDG	12:30
321	MAD	ORY	19:05
165	LHR	CDG	09:55
903	CDG	LHR	14:40
447	CDG	LHR	17:00

table: FLIGHT.

Code	City
MAD	Madrid
LGW	Londres
LHR	Londres
ORY	Paris
CDG	Paris

table: AIRPORT.

SSN	Name
123	Maria
789	Pedro
LHR	Isabel

table: PASSENGER.

SSN	Number	dateR	Price
789	165	07-01-11	210
123	345	20-12-10	170
789	321	15-12-10	250
456	345	03-11-10	190

table: RESERVATION.

Exercise 28

Given a database in the state described in the previous exercise give the output of the following queries.

a. $\{p, r \mid PASSENGER(p)\ and\ RESERVATION(r)\ and\ r.PRICE < 200\}$

b. $\{p, r \mid PASSENGER(p)\ and\ RESERVATION(r)\ and\ (r.SSN = p.SSN\ OR\ r.Price < 200)\}$

c. $\{p, r.number \mid PASSENGER(p)\ and\ RESERVATION(r)\ and\ (r.SSN = p.SSN\ OR\ r.Price < 200)\}$

d. $\{p.name \mid PASSENGER(p)\ and\ \exists r(RESERVATION(r) and\ (r.SSN = p.SSN\ AND\ r.Price$ 200)$\}$

e. $\{p.name \mid PASSENGER(p)\ and\ NOT\exists r(RESERVATION(r) and\ (r.SSN = p.SSN\ AND\ r.Price < 200)\}$

Exercise 29

Repeat exercises 26 and 28 using relational algebra.

Exercise 30

Repeat exercises 26 and 28 using SQL.

Exercise 31

Show the result of the following queries when executed using the databse described in exercise 27

a. $\Pi_{SSN}(\sigma_{price>200}(RESERVATION)$

b. $\sigma_{name=Maria}(PASSENGER \times RESERVATION)$

c. $\sigma_{name=Maria}(PASSENGER \bowtie RESERVATION)$

d. $\sigma_{SSN=123}(PASSENGER \bowtie RESERVATION)$

e. $R1 \leftarrow \Pi_{name,price,ssn}(\sigma_{name=pedro}(PASSENGER \bowtie RESERVATION))$
$R1 \leftarrow \Pi_{name,price,ssn}(\sigma_{price>100}(PASSENGER \bowtie RESERVATION))$
$R1 \cap R2$

f. $R1 \leftarrow \Pi_{city,depart}(\sigma_{city=madrid}(FLIGTH \bowtie_{depart,code} AIRPORT))$
$R1 \leftarrow \Pi_{city,arrive}(\sigma_{city=london}(FLIGTH \bowtie_{arrive,code} AIRPORT))$
$\Pi_{Number} R1 \bowtie R2$

Exercise 42

Given the relation $RESERVATION$ (see exercise 27)

a. Does it make sense to store the relation data using fixed-length records?

b. Assuming that $RESERVATION$ data is stored using fixed-length records,

- Cancel Maria's reservation
- Cancel Pedros reservation
- Book a ticket for Maria in the flight 321 on 23th-Oct-2010, price=200.

After each operation, show the state of the register table including a list with all the deleted registers.

Exercise 43

In a given file, that contains a collection of registers, the list of deleted registers looks like (the number inside each register indicate its length):

Assuming that the allocation of free space is done using the worst-fit strategy, show the state of the list after the following operations on the table:
i. insert a 300 byte register;
ii. delete a 250 byte register;
iii. insert a 400 byte register.

Note: apply each operation to the result of the previous one.

Exercise 45

We want to read a file containing 5,000,000 records of 400 Bytes each on a disk with the following characteristics:

average seek time: 8ms;
rotation speed: 15,000 r.p.m.;
sector size: 1,000 Bytes;
sector per track: 500;
cluster size (minimum amount of Bytes that the operation system is able to read-/write in a single access to the hard disk): 4 sectors.

Estimate the reading time in the following three scenarios:

a. the registers are read using a function in the program that reads one record (after each record is read, it is necessary to place the head again);

b. the registers are read in blocks, reading them in a 400,000 Byte buffer;

c. the file is read in memory all at the same time using a single program instruction.

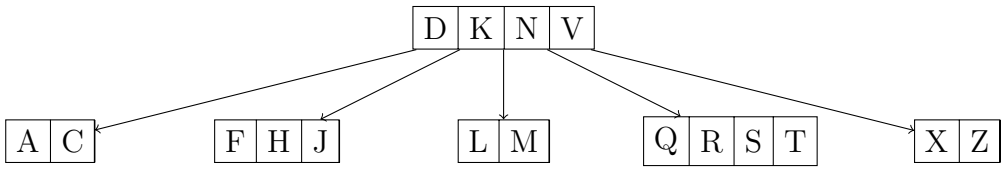
For each scenario, calculate the read time under the following hypotheses:

a. the file is stored in contiguous clusters;

b. the file is completely fragmented in clusters stored randomly on the disk.

Exercise 52

Given the following B tree with space for 4 keys per node



a. insert the key P;

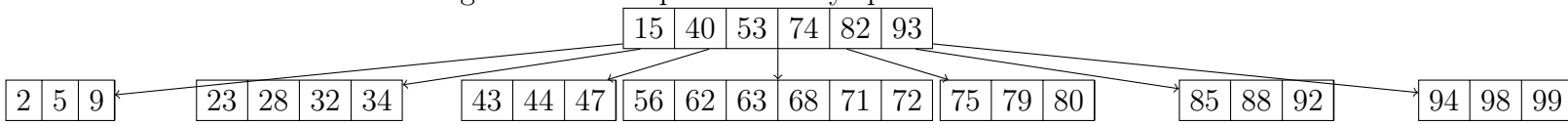
b. in the resulting tree, erase the key L;

c. in the resulting tree, erase the key J.

Draw the tree after each operation.

Exercise 53

Given the following B tree with space for 6 keys per node



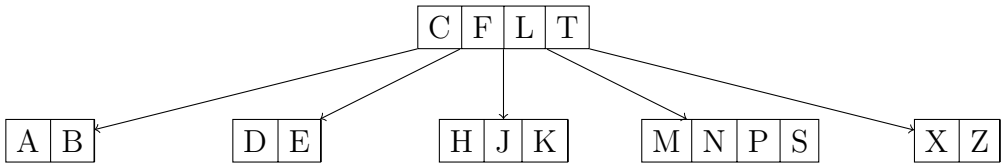
a. insert the key 60

b. in the resulting tree, erase the key 2 and 63;

Draw the resulting tree after each operation.

Exercise 54

Given the following B tree with space for 4 keys per node



a. insert the key R

b. in the resulting tree, erase the key B

c. show how the initial tree can be stored in a file

Show the resulting tree after each operation.

Exercise 58

Show how to store the following btree (with space for 5 keys per node)