Pablo Cuesta Sierra. Group 125.

22. The following attributes are defined in a database for an investment services company:
b: broker
a: asset
o: broker office
q: number of shares of a client
c: client
d: dividends paid for a share

We know that the following functional dependencies should hold:
$a \to d, \{c, a\} \to q, c \to b, b \to o$

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

a) As we have $a \to d$, d is not part of any key. Also, as $c \to b$ and $b \to o \Rightarrow c \to o$, so neither b nor o are part of any key (minimal superkey). Same goes for q.

Therefore the candidate key would be $\{a, c\}$.

b) No, R is not BCNF, because there is a dependancy: $c \to b$, where $\{c\}$ is not a key of R - but part of the key.

c) No, R is not 3NF, because there is a dependancy: $b \to o$, where $\{b\}$ is not part of any key of R.

23. Consider the following relational schemas:

```
Ticket(pname, pid, fnumber, from_airport, to_airport,
       departure_time, date, price)

Flight(fnumber, departure_time, from_airport, to_airport,
       from_city, to_city)
```

In addition to natural constraints (e.g. two people cannot have the same ID cardnumber), we consider the following conditions apply:

- Some cities have more than one airport.
- The same flight can have different prices in different tickets.
- Two flights cannot cover a different air route and/or depart at a different time and have a different flight number.

- Two flights cannot depart at the same time from the same airport (this is not a constraint in real airports, we just consider it here for the sake of the exercise).
- A passenger cannot fly twice on the same flight on the same date, though we do not discard that someone might fly twice from the same airport on different flights within a day (difficult but not impossible).

Given these conditions:

a. Identify all the keys of the schemas, and propose primary keys.

For Ticket:

{pid, fnumer, date}, this could be a PK, {pid, departure_time, from_airport, date}

For Flight:

{fnumber} (most natural PK), {departure_time, from_airport}

b. Find all functional dependencies between the attributes of the relations, avoiding redundancy(that is, if a dependency can be inferred from others, it should not be included in your answer).

`Ticket:`

pid → pname, {departure_time, from_airport}→fnumber, fnumber→{from_airport, to_airport, departure_time}, {pid, date, fnumber}→{price}

`Flight:`

fnumber→{departure_date, from_airport, to_airport}, from_airport→from_city, to_airport→to_city, {departure_date, from_airport}→fnumber

c. Determine the normal form of the schemas, justifying your answer.

The normal form of Ticket is 3NF, because for example: pid → pname, and pid is not a key of the relation, but part of one.

Flight, however, is 2NF, because for example, there is the functional dep.: to_airport→to_city, and to_airport is not part of a key.

24.Prove that a schema with two attributes is always BCNF.

We have a schema with two attributes: $R(a, b)$. There are two options: {a,b} is a key. {a,b} is not a key.

Option 1: {a,b} is a key, therefore, the non-trivial functional dependancies are: $\emptyset$. Then it is BCNF.

Option 2: {a,b} is not a key, There are two subcases:

a) Either a or (exclusive) b is a key. WLG, let's assume a is a key, so the only non-trivial dependancy there is, is a→b. And this fulfills the definition of BCNF

b) Both a and b are keys, so there are two non-trivial dependancies: a$\rightarrow$b, b$\rightarrow$a, where both a and b are keys, so still, R is BCNF.