

Databases

TDA357/DIT621/DIT620 (4.5 hec)

Responsible: Ana Bove

Thursday 26th of August 2021, 14:00–18:00

Total: 60 points	
CTH: ≥ 24 : 3, ≥ 36 : 4, ≥ 48 : 5	GU: ≥ 24 : G, ≥ 42 : VG

General notes:

- You can use any help material but you CANNOT communicate with other people other than the teacher of the course in any way.
- There will be one assignment for each of the questions in the exam.
- You need to upload the solution to each question in the corresponding assignment in canvas. You have 30 min (45 if you have extra time) for this so it should be more than enough to get it right!
- We would prefer if you use a computer to type all your answers instead of writing them by hand since handwritten solutions are not always easy to read. In addition, pictures are sometimes not too sharp and clear. Think that what we cannot read we cannot correct!
- If you take pictures of your handwritten solutions please make sure your handwriting is clearly visible and readable in the picture.
- The file extensions allowed are pdf, jpg, jpeg, png, and and txt.
- We advice you to really start working on the uploading of your solution at 18:00 since at 18:30 sharp the system will close for submissions (unless you have extra time) and we will NOT accept submissions by mail.

Good luck!

1 SQL and Constraints (10.5 pts)

Upload your solution to this question into assignment 1 in canvas.

If possible use a computer to type your answer instead of writing it by hand.

File extensions allowed are pdf, jpg, jpeg, png, and and txt.

A veterinary clinic has the following information about their clients, the pets of the clients and the veterinarians that work there. The clinic only takes care of dogs, cats or rabbits.

Clients (name, email, phonenr)

Pets (chipnr, name, owner, type, born)

owner \rightarrow Client.name

type \in {dog, cat, rabbit}

Vets (id, name, phonenr, specialisation)

specialisation \in {dog, cat, rabbit}

where chipnr and id are numbers that identify the pets and the employees respectively, and born is the year on which the pet was born. Assume name is enough to identify a client.

a) (3.5 pts) Define SQL tables for the relational schema above.

Make sure to add reasonable constraints to your data, for example no pet should have been born in the future! :-)

b) (3.5 pts) Define a table to keep track of the bookings. The table needs to contain information about the veterinarian that is booked, which animal the consultation is about, which day and time the consultation will take place, and the length of the consultation which can be 30 or 60 minutes long, with 30 minutes as default. Consultations can only be booked at 9, 10, 11, 13, 14 or 15 hours.

Observe that it might be possible that the same pet has 2 appointments the same day (on different hours) but of course, neither pets nor veterinarians can have two different appointments at the same day and time.

c) (3.5 pts) Write an SQL query that gives the total amount of money that needs to be billed to each costumer for all the bookings taking place this month. Every 30 min of consultation costs 500 kr. Each customer that needs to be billed should only appear once and those with no bill this month should not be part of the result.

Note: In order to obtain the current year one can use the following PostgreSQL expression: `date_part('year', CURRENT_DATE)`. Similar with month.

2 Views and Triggers (11 pts)

Upload your solution to this question into assignment 2 in canvas.

If possible use a computer to type your answer instead of writing it by hand.

File extensions allowed are pdf, jpg, jpeg, png, and and txt.

Recall the relational schema from question 1 on SQL:

Clients (name, email, phonenr)

Pets (chipnr, name, owner, type, born)

owner → Client.name

type ∈ {dog, cat, rabbit}

Vets (id, name, phonenr, specialisation)

specialisation ∈ {dog, cat, rabbit}

extended with the table that was added for the bookings.

After running the clinic for a few years, the owners would like to make some improvements in their database. Propose a solution (meaning, the corresponding full SQL code) to each of the changes the company wants to make.

Recall that as a general rule, constraints, views and triggers should be applied in the appropriate order: if a constraint is enough just add it, and if a constraint or a view can adequately do the job, do not use a trigger!

- a) (3 pts) Keep track of the name and phone number of all clients with at least 2 pets in the clinic.
- b) (5 pts) If a pet is older than 5 years, one can only book 60 minutes consultation with a veterinarian that is specialised in that kind of animal.
- c) (3 pts) Keep track of the name and specialisation of all veterinarians who had more than 1000 hours consultation in the clinic.

Note than only consultations that already took place (meaning those with date today or earlier) should be counted, not the consultations that will take place in the future.

3 Relational Algebra (8.5 pts)

Upload your solution to this question into assignment 3 in canvas.

If possible use a computer to type your answer instead of writing it by hand.

File extensions allowed are pdf, jpg, jpeg, png, and and txt.

Recall the relation schema from question 1 on SQL:

Clients (name, email, phonenr)

Pets (chipnr, name, owner, type, born)

owner \rightarrow Client.name

type \in {dog, cat, rabbit}

Vets (id, name, phonenr, specialisation)

specialisation \in {dog, cat, rabbit}

extended with the table that was added for the bookings.

Note: For this question, it is fine to use the same expression in relational algebra as in SQL to work with dates, so for example use CURRENT_DATE even in relational algebra to get today's date.

- a) (2.5 pts) Write a relational algebra expression that gives all the pets' names and their owners that had a booking during the last year (the last 365 days). The result cannot contain repetition.

Note: the result should only contain the bookings that took place the last year, not future bookings!

Hint: CURRENT_DATE - 1 gives yesterday's date.

- b) (3 pts) Write a relation algebra expression that gives the ids of all cat specialists that have no bookings today at 13.
- c) (3 pts) Write a relational algebra expression that gives the name and phone number of all clients with at least 2 pets in the clinic.

4 ER Modelling (11 pts)

Upload your solution to this question into assignment 4 in canvas.

If you write your diagram by hand, please make sure the picture you upload is legible.

If possible use a computer to type your relational schema instead of writing it by hand.

File extensions allowed are pdf, jpg, jpeg, png, and and txt.

- a) (6 pts) Make an ER-diagram for parts of an online book repository, where users can write their own stories and read stories written by others.

The text of each book is divided into chapters, each chapter has its own title in addition to the text. Book titles are unique across the whole repository but chapters in different books may have the same title.

All users have an email and a name. The users adding books to the repository are designated authors. Each author has a short biography text for their presentation page.

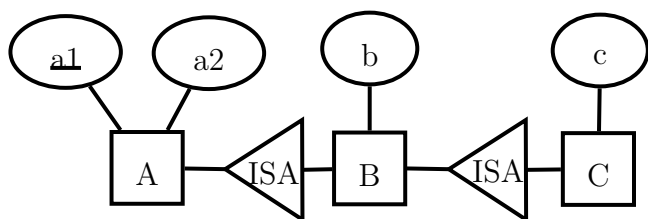
Every book has an owner (must be an author) and may have any number of additional co-authors.

Users (including authors) can rate books; rates consist of 1-5 stars.

- b) (2 pts) Translate the part of the diagram related to books and their chapters into a schema.

Note: no other part of the diagram should be translated into a schema! This applies also to any relationship between books and their chapters, and the rest of the domain.

- c) (3 pts) Translate the ER-diagram below into a schema. For full points the NULL-approach for ISA-relationships should be used whenever possible.



Note: Mark nullable attributes in your schema by writing (or null) after their names.

Hint: “possible” means that the translation preserves the properties we expect when using inheritance, meaning every B is an A and every C is a B.

5 Functional and Multivalued Dependencies (11 pts)

Upload your solution to this question into assignment 5 in canvas.

If possible use a computer to type your answer instead of writing it by hand.

File extensions allowed are pdf, jpg, jpeg, png, and txt.

Consider the domain of books with authors and reviews from question 4.

- a) (1.5 pts) Write a “domain relation” containing all the attributes (and no duplicate attributes or such). This attribute set will be used in the other parts of this question. The solution should be on the form D (list, of, attributes, here). Name the attributes so their intention is self-explanatory.
- b) (3x(1+1) pts) Write three functional dependencies, using the attributes from the domain relation above:
- A sensible FD (based on the domain description) where the right hand side attribute represents author biography text.
 - A sensible FD (based on the domain description) where the right hand side attribute represents chapter text.
 - A sensible FD (based on the domain description) where the right hand side attribute represents the number of stars given in a book review.

For each functional dependency, explain why they make sense in the domain. All FDs should be non-trivial and minimal (no unnecessary attributes on the left hand side).

- c) (2 pts) A fellow database designer claims that `bookTitle` \rightarrow `chapterText` is a sensible multivalued dependency to express the fact that a book contains multiple chapter texts. Explain why this is incorrect.
- d) (1.5 pts) Give a counterexample of the MVD in the previous question in the form of a small table (a header row with attribute names and at least two rows of contents). The table should contain possible valid data for the database that violates the MVD. There is no need to include all the attributes of the domain, only those that are relevant to the example.

6 JSON (8 pts)

Upload your solution to this question into assignment 6 in canvas.

If possible use a computer to type your answer instead of writing it by hand.

File extensions allowed are pdf, jpg, jpeg, png, and txt.

Consider the domain of books with authors and reviews from question 4.

The JSON Schema below describes a JSON format for parts of this domain.

```
{ "type": "array",
  "description": "Every item is a book",
  "items": {
    "type": "object",
    "description": "A single book",
    "required": ["bookTitle", "authors", "reviews" ],
    "properties": {
      "bookTitle": { "type": "string" },
      "authors": {
        "type": "array",
        "description": "All authors, the first one is the owner.",
        "minItems":1,
        "items": {
          "type": "object",
          "required": [ "email", "name" ],
          "properties": {
            "email": { "type": "string" },
            "name": { "type": "string" }
          }
        }
      }
    }
  },
  "reviews": {
    "type": "array",
    "description": "Every item is a review left by a user",
    "items": {
      "type": "object",
      "required": ["email", "stars" ],
      "properties": {
        "email": { "type": "string" },
        "stars": { "type": "integer" }
      }
    }
  }
}
```

- a) (3 pts) Make an example document that validates against the schema (and uses it the way it is intended). The example should contain a single book with two authors and one review.
- b) (2.5 pts) Show how the schema can be modified to make sure that there is always between 1 and 5 stars in a review. No need to include the whole modified schema, just enough to make it clear where the addition/modification is placed.
- c) (2.5 pts) Write a JSON path that finds the name of the owner of the book “JSON Tutorial”.