

Examination

Database Technology

2016–03–15, 14.00–19.00

No aids are allowed during the exam. Assessment (preliminary): the questions give $13 + 13 + 13 + 5 + 3 + 3 = 50$ points. For a passing grade you need at least 27 points (3/27, 4/35, 5/43).

1. The Swedish air sport federation will develop a database for storing national records. The sport activities is divided into classes, for example *gliding* or *parachuting*. Each class is divided into subclasses, for example *single place glider*, *wing span 15m* or *formation skydiving (4-way)*. Each class have unique subclasses. There are different types of records, for example *speed over a triangular course, 500 km*, and a type of record may appear in several classes, for example *straight distance* is used in both *gliding* and *hang gliding and paragliding*.

Air sport follows the regulation of the national sport association. An athlete must be member of a club and represent that club in all sort activities. For each record an athlete represent a club. The athlete may change club over time and the system should keep track of which club the athlete represent at the time of the record as well as its current club. A record is set by one or several athletes. For the record types that have more than one athlete, you should be able to store a team name. The athletes of a record may represent different clubs.

The process for to get a record approved starts when an athlete files a record claim. The claim contains all documentation, i.e. track logs and signed statements from observers. The claim is reviewed by an expert who gives a recommendation. The board of the Swedish air sport association then decides if the claim should be approved or rejected.

- a) Develop an E/R model that describes the database.
 - b) Translate the E/R model into a relational model. All relations should be in BCNF. Show that they are in BCNF or motivate why you have chosen a lower normalization level. Indicate primary keys and foreign keys in all relations.
 - c) Using your relations in question b, write an SQL statement that gives a list of all athletes that have set records in more than one subclass.
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2. The security system a building uses a database to keep track of users and their access rights to different rooms. The system uses the database both for checking access rights as well as logging which rooms a person enters. Note that doors are one-way passages, going from one room to another. You may assume the person opening a door is the only one passing through it. The database has this schema:

Users(userId, name, phone, email)
 Rooms(roomNbr, description)
 Doors(doorId, exitRoom, enterRoom, blocked, lastMaintenanceDate)
 AccessRights(userId, roomNbr, mayEnter)
 Events(userId, doorId, logt)

Draw a diagram in assignment a, write SQL queries for assignments b–g (you may define views):

- Draw an ER diagram which describes the database.
 - Create the AccessRights table. Set reasonable integrity conditions. Boet that *outside* can be modeled as a special room, or *null* – choose your preference.
 - List all rooms (in temporal order) that the user with ID “myrslok” has passed. Room ID and timestamps of the entry time should be listed.
 - List the ID of all people that have access rights to room number “5”, but have never visited the room.
 - Find the number of people that are inside the building the 5th of Februari 2016, at 16.00.
 - All doors that has been used more than 1000 times during February¹ need maintenance and will be blocked. Update the database to reflect this.
 - List all rooms with at least one in door and one out door that is not blocked. (You may not use intersect since it is not implemented in MySQL)
3. The relation R(A, B, C, D, E) has the following functional dependencies:

FD1. $AB \rightarrow D$
 FD2. $D \rightarrow E$
 FD3. $E \rightarrow AC$
 FD4. $C \rightarrow B$

- Determine all keys of the relation.
 - Show that the relation is in 3NF but not in BCNF.
 - Decompose the relation into BCNF relations.
4. In assignment has not implemented any routine for checking the correctness of the event logg. Specifically, there is no way to find events that implies that a person has jumped from one room to another without passing a door. For example if a person walks from room A to B using a door, the same person should not use a door from C to D without first passing a door between B and C.
- Your task is to write a java method that does this check. The method takes four parameters. The first is a string with a user ID, the second and third are object from the Timestamp class² that dictates the period in the event logg that should be investigated. The fourth parameter is an object with an open connection to a database³. The method should print all events that deviate from the expected and return true if no deviating events occurred, else false.

Is it possible to implement the method in SQL? Why?

¹ DATE(datetime), TIME(datetime) och MONTH(date) are functions to extract the date, time and month from a timestamp.

² java.sql.Timestamp

³ java.sql.Connection

5. We have the following DTD and XML document.

```

<!DOCTYPE Star [
  <!ELEMENT Star (Name, Address+, Movies)>
  <!ELEMENT Name (#PCDATA)>
  <!ELEMENT Address (#PCDATA | (Street, City))>
  <!ELEMENT Street (#PCDATA)>
  <!ELEMENT City (#PCDATA)>
  <!ELEMENT Movies (Movie*)>
  <!ELEMENT Movie (Title, Year)>
  <!ELEMENT Title (#PCDATA)>
  <!ELEMENT Year (#PCDATA)>
]>

<?xml version = "1.0" standalone = "no" ?>
<!DOCTYPE Stars SYSTEM "star.dtd"
<Star> <Name>Carrie Fisher</Name>
  <Address> <Street>123 Maple St.</Street><City>Hollywood</City></Address>
  <Address>5 Locust Ln. Malibu</Address>
  <Movies>
    <Movie><Title>Star Wars</Title><Year>1977</Year></Movie>
    <Movie><Title>Empire Strikes Back</Title><Year>1980</Year> </Movie>
  </Movies>
</Star>
<Star> <Name>Harrison Ford</Name>
  <Movies>
    <Movie><Title>Star Wars</Title><Year>1977</Year></Movie>
  </Movies>
</Star>
<Movie><Title>Star Wars</Title><Year>1977</Movie></Year>

```

- a) What does it mean that a XML document is “valid” and “well-formed”?
 - b) Is the XML document above a “valid” XML document? Motivate by listing any errors in the document.
 - c) Is the XML document above a “well-formed” XML document? Motivate by listing any errors in the document.
6. Describe the difference between relational and graph databases. Which are the benefits and drawbacks of respective database model?