Databases and Web Services

Final Exam, Fall 2021

Instructor: Peter Baumann

Logistics: • Don't forget to enter your name below, we cannot grade if it is not present or illegible! • *Different problems test different knowledge, so do not get stuck on one problem.*
Name:

Task	1.1	1.2	1,3	2.1	2.2	2.3	3.1	4.1	3.2	5.1	5.2	6.1	6.2	7.1	8.1	8.2	9.1	10.1	Total
Pts	4.5	4	6	3	6	4	4	3	2.5	6	7	4	3	3	3	4	3	4	74
Score																			

1. Data modeling

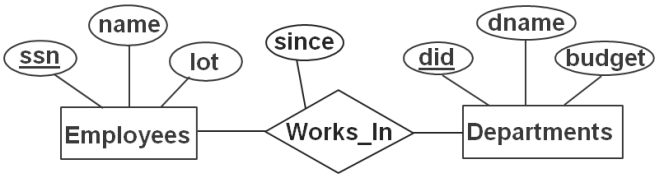
Task 1.1 (4.5 pts):

Draw the ER diagram for the following "music store" miniworld, based on the following information:

- The stores sell only music and video CD's and each CD has a title, duration.
- In addition, each music CD has a genre, number of tracks, while each video CD has a box office rating and date it was premiered.
- Each video CD must feature at least one artist, and an artist can feature in any number video of CD's
- Each artist has a name, and date of birth.
- The shop also keeps the list of its customers (with name and address) and the CD's they buy.

Task 1.2 (4 pts): In ER modeling, IS-A hierarchies have two important constraints: their *overlap* and *complete-coverage* properties. Explain both (if you want with the help of an example).

Task 1.3 (6 pts): Write SQL statements to create the relations corresponding to the ER diagram below. Assume cardinalities are m:n. Remember to introduce your own primary key attributes.



2. SQL

Task 2.1 (1+2 pts): You have a database that contains the following 3 tables:

Student
sid
firstname
lastname
matriculation#

StudyProgram
pid
pname
dept

MajorsIn
sid
pid
inscribedSinceYear

Task is to write the following queries in SQL:

(a) Matriculation# of all students inscribed since 2019.
(b) For each study program: program name and the number of students majoring in it.

Task 2.2 (6 pts): In class three different techniques have been explained for mapping entities engaged in an IS-A hierarchy to table schemas. Explain two of them in detail showing the concrete table definitions, based on the following scenario:

A(b,c) and D(e,f) are subclasses of class X(y,z)

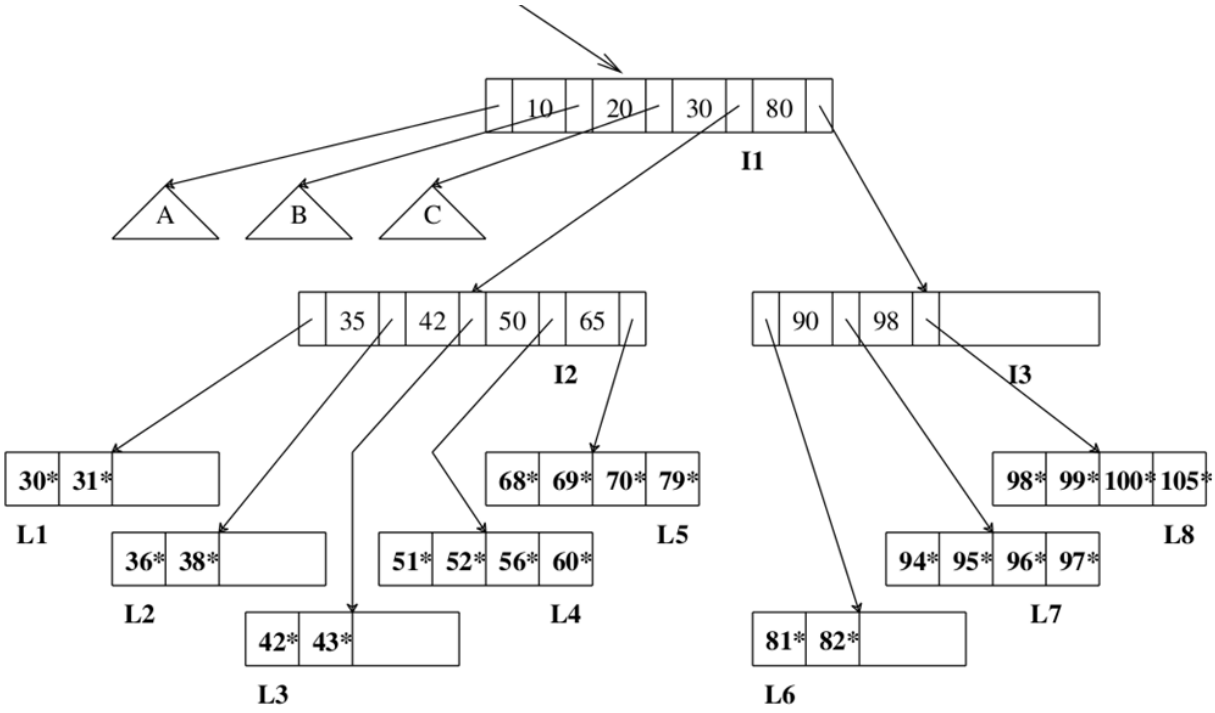
For both schemas formulate the queries “All y of X” and “All b of A”.

Task 2.3 (4 pts): Draw a logical query plan for the query “last name and inscription year of all students majoring in Computer Science”, based on the schema of Task 2.1 above:

3. Indexing

Task 3.1 (4 pts): Explain the B+-Tree database index concept. (Hint: 4 properties)

Task 3.2 (2.5 pts): In the B+-Tree below, list the nodes (pages) fetched for answering the range query “value between 43 and 73” in proper sequence.



4. Normal Forms

Task 4.1 (3 pts): Assume a relation schema ABCDEF with Functional Dependencies B→C and D→EF. Transform this schema into an equivalent one (ie, where all information can be recovered in full) where each table is at least in 3NF.

5. Database Application Programming

Task 5.1 (6 pts): Keeping state information about a user session is a task that regularly has to be solved in implementing Web Services, as http itself is stateless. Name two techniques for maintaining state information and give a short characterization plus a limitation.

Task 5.2 (7 pts): Given table *Tickets* as below, write server-side code that, when invoked through the URL provided below, obtains the flight to be searched from the database and returns the number of seats occupied on flight "LH400". This consists of:

> CREATE TABLE Tickets(id INT, flight CHAR(20) UNIQUE, seat CHAR(3), paxid INT)
> https://www.amadeus.com/handleRequest?flight=LH400

Hints:
no CSS or other styling required, no security checks, no login etc. – just plain HTML.
Where you need names just invent some.
Pick your favorite language for server-side execution (such as PHP, python, etc.). Syntactic correctness is not a criterion as long as concepts and methods get across clearly.

6. Transactions

Task 6.1 (4 pts): What are the four core properties the (classic) transaction concept offers to database users? Explain them briefly.

Task 6.2 (3 pts): Consider a database with objects (i.e., tuples) X and Y and assume that there are two transactions T1 and T2. Transaction T 1 reads objects X and Y and then writes object X. Transaction T2 reads objects X and Y and then writes objects X and Y.

- Give an example schedule with actions of transactions T1 and T2 on objects X and Y that results in a write-read conflict through "dirty reads". Show where (=when) exactly the conflict happens.
- Explain how Strict 2-Phase Locking (2PL) disallows this dirty-read schedule.

7. Web protocols

Task 7.1 (1+2 pts): Why is AJAX an improvement of users' Web experience over classical form-based HTML pages? Name two such improvements in the behavior of an AJAX-enabled Web page.

8. Security

Task 8.1 (3 pts): You are joining LostSouls Inc. and get instructed to use their standard email disclaimer. Explain to the team why email disclaimers are just wishful thinking and name methods to really achieve secrecy and trust.

Task 8.2 (4 pts): Describe how an SQL injection attack works.
Hint: the attack string has 3 components.

9. NoSQL

Task 9.1 (3 pts): Explain the term NoSQL. Name two NoSQL technologies (use concrete systems, if you prefer) and describe how they differ from classical relational technology.

10. Big Data

Task 10.1 (4 pts): Define the term Big Data by naming each of the four "V" words and explaining them with the help of examples.

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