

Database Systems

Problem Set 1

Due: September 26, 2025 at 11:59 PM

1 Schema Refinement

You work at a record store called *The Data-Bass*. To increase profits, the store manager has decided to hold a sales competition for the employees. The winner of the competition will receive a commemorative fish statue known as the Data Bass. Since you have taken CS 115, the manager asks you to make a schema to store information for the competition, which includes personal and sales data from all store employees. The information collected from each employee included employee ID number, employee name, employee role, sold record price, sold record ID, sold record name, and sold record artist. For the given table, answer the questions below.

EMP_ID	REC_NAME	REC_ID	PRICE	REC_ARTIST	ROLE	EMP_NAME
1	Rocky Mountain High	1	\$10	John Denver	Cashier	Bob
2	Back to the Country	5	\$15	Loretta Lynn	Manager	Lupe
3	Jolene	3	\$12	Dolly Parton	Asst. Manager	Sara
4	Rocky Mountain High	2	\$10	John Denver	Security	Geoff
5	22	4	\$10	Taylor Swift	Cashier	Dakota

- Is the schema for this table in Boyce-Codd Normal Form? Explain why or why not. (1 pt)
- Decompose the schema into BCNF, if necessary. Show your work, including the functional dependency you use at each step of the decomposition. (2 pts)

2 Schema Design

You are designing a database for TicketBlaster, a service for selling tickets to concerts and other performances. This system will be a catalog of showtimes and their corresponding ticket prices. The company has the following design requirements:

- You keep track of *performances*, where each performance is described by an ID, artist, and show date for the event. Performances take place in exactly one venue.
 - The company maintains a list of *venues*, including an identifier, name, and address for each one.
 - Each venue has one or more *sections* of seating. Each section has a unique ID, capacity, and name such as “orchestra pit” or “mezzanine”. A section must always be associated with a venue.
 - A performance has ticket prices associated with each section in its venue.
- Design a schema for this database. Be sure to note the primary keys, data types, and at least one constraint per relation. For each relation, write the corresponding SQL CREATE TABLE statement and justify your design in a sentence. (3 pts)
 - Describe a situation that would not be compatible with how you store relations in your schema. Example: If you have a performance table like Performance (ID, artist, date, venue), then you would not be able to handle a performance that takes place at multiple venues at the same time. (1 pt)

3 Relational Algebra and SQL

Consider the following schema from an elven toy factory:

Customer(cid: integer, cname: string, address: string)

Worker(wid: integer, wname:string)

Catalog(iid: integer, wid: integer, iname: string, category: string)

SalesRecord(cid: integer, iid: integer, unit_price: real, quantity: integer)

The Customer relation describes customers who has made a purchase in the past. The Worker relation describes workers who produced toys. The Catalog relation contains information about which worker specialize in making which toys. The SalesRecord relation lists the quantities and the unit prices of certain toys sold to a customer. (The keys are underlined: cid is a key for Customer, wid for Worker, iid is a key for Catalog, and (cid,iid) is a key for SalesRecord)

Write the following queries in relational algebra (if possible) without using aggregate operators such as MAX, COUNT, or AVG, but a single self join is allowed per query. In addition, write the SQL versions for each query (aggregate operators CAN be used for SQL).

1. Find the wids of workers who made one or more type of toys in category 'LEGO'. (1 pt)
2. Find the wids of workers who produced only 'LEGO'. Write this query without using the division operator. (1 pt)
3. Find the names of workers and the customers their toys are sold to. (1 pt)
4. Find each customer that bought at least 10 different toys; print customers' names. (1 pt)
5. Find the name(s) of the most expensive toy(s) (in terms of unit price) bought by a customer named 'Mrs Claus'. (1 pt)