Name

CWID

# Homework Assignment 1

# September 12th, 2016

# CS425 - Database Organization Results

---

*Please leave this empty!*

1.1 1.2 1.3 1.4 1.5 1.6

1.7 1.8 1.9 1.10 1.11 1.12 1.13 Sum

# Instructions

- Try to answer all the questions using what you have learned in class
- **When writing a query, write the query in a way that it would work over all possible database instances and not just for the given example instance!**
- Some questions are marked as bonus. You do not have to answer these questions to get full points for the assignment. However, you can get bonus points for these questions!

Consider the following database schema and example instance:

### buyer

| name | age | gender |
|---|---|---|
| Alice | 20 | Female |
| Bob | 21 | Male |
| Carol | 18 | Female |

### card

| cardNum | owner | limit |
|---|---|---|
| 1111 | Alice | 50 |
| 1234 | Bob | 10 |
| 4321 | Bob | 30 |
| 9999 | Carol | 1000 |

### product

| pname | type | price | weight |
|---|---|---|---|
| Pen | Office | 3 | 5 |
| Pencil | Office | 2 | 3 |
| Notebook | Office | 10 | 400 |
| Camera | Electronic | 300 | 600 |
| Bike | Transport | 100 | 15000 |
| Skateboard | Transport | 50 | 1500 |
| Pan | Kichen | 25 | 700 |

### order

| buyer | product | count |
|---|---|---|
| Alice | Pen | 4 |
| Alice | Notebook | 2 |
| Bob | Bike | 1 |
| Alice | Pan | 1 |
| Carol | Camera | 1 |
| Carol | Skateboard | 1 |

**Hints:**

- Underlined attribute form the primary key of a relation
- The attribute *buyer* of relation *order* is a foreign key to relation *buyer*. The attribute *product* of relation *order* is a foreign key to relation *product*.
- The attribute *owner* of relation *card* is a foreign key to relation *buyer*.

## Part 1.1 Relational Algebra (Total: 100 Points)

### Question 1.1.1 (6 Points)

Write a relational algebra expression that returns all products brought by "Alice". For each such product return the product name paired with the number of items (Attribute `count`) brought by the buyer.

### Solution

$$\pi_{product,count}(\sigma_{buyer='Alice'}(order))$$

### Question 1.1.2 (6 Points)

Write a relational algebra expression that returns products that are of type "Office" and their price.

### Solution

$$\pi_{pname,price}(\sigma_{type='Office'}(product))$$

### Question 1.1.3 (6 Points)

Write a relational algebra expression that returns products (their names) that are of type "Electronic" or of type "Transport" and have at most 100 dollars unit price (attribute `price`).

### Solution

$$\pi_{pname}(\sigma_{(type='Electronic' \vee type='Transport') \wedge price \leq 100}(product))$$

### Question 1.1.4 (9 Points)

Write a relational algebra expression that returns the product name and price for all products of type "Transport" brought by "Bob" or "Carol".

### Solution

$$\pi_{pname,price}(\sigma_{(buyer='Bob' \vee buyer='Carol') \wedge type='Transport'}(product \bowtie \rho_{pname \leftarrow product}(order)))$$

### Question 1.1.5 (9 Points)

Write a relational algebra expression that returns the ages of all buyers that brought products of type "Kitchen".

### Solution

$$\pi_{age}(\sigma_{type='Kitchen'}(order \bowtie_{product=pname} product \bowtie_{buyer=name} buyer))$$

### Question 1.1.6 (10 Points)

Write a relational algebra expression that returns the names of all buyer that brought products of both "Office" and "Kitchen" type.

### Solution

$$\pi_{buyer}(\sigma_{type='Office'}(product \bowtie_{pname=product} order)) \cap \pi_{buyer}(\sigma_{type='Kitchen'}(product \bowtie_{pname=product} order))$$

### Question 1.1.7 (10 Points)

Write a relational algebra expression that returns the names of products that are type of "Transport" but were not brought by "Carol".

### Solution

$$\pi_{pname}(\sigma_{type='Transpoet'}(product)) - \pi_{pname}(\sigma_{buyer='Alice'}(\rho_{pname \leftarrow product}(order)))$$

### Question 1.1.8 (7 Points)

Write a relational algebra expression that returns the total number of products brought by each buyer.

### Solution

$${}_{buyer}\mathcal{G}_{sum(count)}(order)$$

### Question 1.1.9 (10 Points)

Write a relational algebra expression that returns the number of credit cards owned for each gender.

### Solution

$$buyercard \leftarrow buyer \bowtie_{name=owner} card$$
$$q \leftarrow_{gender} \mathcal{G}_{count(*)}(buyercard)$$

## Question 1.1.10 (14 Points)

Write a relational algebra expression that returns the number of product types for which the average weight for all products of this type is lower than 500.

## Solution

$$avgW \leftarrow_{type} \mathcal{G}_{avg(weight)}(product)$$
$$q \leftarrow \mathcal{G}_{count(*)}(\sigma_{avg(weight)<500}(avgW))$$

## Question 1.1.11 (13 Points)

Write a relational algebra expression that returns the total credit limit (attribute `limit`) for each buyer with the amount of remaining limit after purchasing all the orders of this buyer. Do not return buyers whos limit is not enough to purchase all orders under his/her name.

## Solution

$$oPrice \leftarrow \pi_{buyer,price*count \text{ AS } orderPrice}(product \bowtie_{pname=product} order)$$
$$tPrice \leftarrow_{buyer} \mathcal{G}_{sum(orderPrice) \text{ AS } ttlPrice}(oPrice)$$
$$tLimit \leftarrow_{owner} \mathcal{G}_{sum(limit) \text{ AS } ttlLimit}(card)$$
$$q \leftarrow \sigma_{resLimit \geq 0}(\pi_{buyer,ttlLimit-ttlPrice \text{ AS } resLimit}(tLimit \bowtie_{owner=buyer} tPrice))$$

## Question 1.1.12 (BONUS QUESTION) (5 Points)

Write a relational algebra expression that returns the name of the buyer that paid the highest total price for all her/his orders.

## Solution

$$oPrice \leftarrow \pi_{buyer,price*count \text{ AS } orderPrice}(product \bowtie_{pname=product} order)$$
$$tPrice \leftarrow_{buyer} \mathcal{G}_{sum(orderPrice) \text{ AS } ttlPrice}(oPrice)$$
$$q \leftarrow \pi_{buyer}(\mathcal{G}_{max(ttlPricce) \text{ AS } ttlPrice}(tPrice) \bowtie tPrice)$$

### Question 1.1.13 (BONUS QUESTION) (5 Points)

Write a relational algebra expression that returns all buyers who brought all products from at least one single type. For example, if a buyer did buy all "Office" products, then he/she should be in the result.

### Solution

$$buyerCt \leftarrow_{buyer,type} \mathcal{G}_{count(*) \text{ AS } n}(order \bowtie_{product=pname} product)$$
$$prodCt \leftarrow_{type} \mathcal{G}_{count(*) \text{ AS } n}(product)$$
$$q \leftarrow \pi_{buyer}(buyerCt \bowtie prodCt)$$