

Name

CWID

Homework Assignment 1

September 10th, 2013

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

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:

beer

<u>bName</u>	alcohol	type
Schmecks	5.9	wheat
Lecker	3.5	ale
Bass	4.6	IPA

wine

<u>wName</u>	alcohol	type	dryness
Enttaler	12.0	white	semi-dry
HippiHope	18.05	red	sweet

producesBeer

<u>bName</u>	<u>cName</u>
Schmecks	Beer Inc.
Lecker	Moselwine
Bass	Beer Inc.

producesWine

<u>wName</u>	<u>cName</u>
Enttaler	Moselwine
HippiHope	Caliwine

company

<u>cName</u>	country	numEmpl
Beer Inc.	USA	10,000
Caliwine	USA	5,500
Moselwine	Germany	3,000

Hints:

- Underlined attribute form the primary key of a relation
- The attribute *bName* of relation *producesBeer* is a foreign key to *bName* in relation *beer*. The attribute *cName* of relation *producesBeer* is a foreign key to *cName* in relation *company*.
- The attribute *wName* of relation *producesWine* is a foreign key to *wName* in relation *wine*. The attribute *cName* of relation *producesWine* is a foreign key to *cName* in relation *company*.

Part 1.1 Relational Algebra (Total: 100 Points)

Question 1.1.1 (7 Points)

Write a relational algebra expression that returns the names of all wheat beers.

Solution

$$\pi_{bName}(\sigma_{type='wheat'}(beer))$$

Question 1.1.2 (7 Points)

Write a relational algebra expression that returns companies (their name and number of employees) from the USA.

Solution

$$\pi_{cName,numEmpl}(\sigma_{country='USA'}(company))$$

Question 1.1.3 (7 Points)

Write a relational algebra expression that returns the names of wines that are red and sweet.

Solution

$$\pi_{wName}(\sigma_{type='red' \wedge dryness='sweet'}(wine))$$

Question 1.1.4 (7 Points)

Write a relational algebra expression that returns the names of all red and white wines.

Solution

$$\pi_{wName}(\sigma_{type='red'\vee type='white'}(wine))$$

Question 1.1.5 (8 Points)

Write a relational algebra expression that returns the names of all beers produced by companies from Germany.

Solution

$$\pi_{bName}(\sigma_{country='Germany'}(beer \bowtie producesBeer \bowtie company))$$

Alternatively, people may use cross-product + renaming and selection or theta-join. The natural join with beer can be avoided.

Question 1.1.6 (12 Points)

Write a relational algebra expression that returns the countries of all companies that produce both wine and beer.

Solution

$$\pi_{country}(\pi_{cName,country}(company \bowtie producesBeer) \cap \pi_{cName,country}(company \bowtie producesWine))$$

Alternatively, this can be done through joining company with both beer and wine through the produces relations

Question 1.1.7 (8 Points)

Write a relational algebra expression that returns the names of all wines and beers.

Solution

$$(\pi_{wName}(wine)) \cup (\pi_{bName}(beer))$$

Question 1.1.8 (7 Points)

Write a relational algebra expression that returns the number of beers per type (e.g., wheat or ale)

Solution

$$type \mathcal{G}_{count(*)}(beer)$$

Question 1.1.9 (15 Points)

Write a relational algebra expression that returns the average alcohol content of all drinks sold by each company. For example, this expression should return tuples like (*BeerInc.*, 5.25).

Solution

$$\begin{aligned}
beerSold &\leftarrow \pi_{cName,bName,alcohol,'wine'}(beer \bowtie producesBeer \bowtie company) \\
wineSold &\leftarrow \pi_{cName,wName,alcohol,'beer'}(wine \bowtie producesWine \bowtie company) \\
drinksSold &\leftarrow beerSold \cup wineSold \\
q &\leftarrow_{cName} \mathcal{G}_{avg}(alcohol)(drinksSold)
\end{aligned}$$

There are several ways how to express this query. For example, first computing average wine and beer alcohol content and number per company and then join the results and compute by adding the averages times numbers, divided by the total count.

Question 1.1.10 (10 Points)

Write a relational algebra expression that returns the number of companies that produce wine.

Solution

$$\mathcal{G}_{count(*)}(\pi_{cName}(producesWine))$$

Many students will likely join with company which is not incorrect ;-)

Question 1.1.11 (12 Points)

Write a relational algebra expression that returns the name of the company(ies) with the largest number of employees.

Solution

$$\pi_{cName}(\mathcal{G}_{max(numEmpl)} \text{ AS } numEmpl(company) \bowtie company)$$

Since we need max, the students may use the trick using set difference instead of aggregation here.

Question 1.1.12 (BONUS QUESTION) (10 Points)

Write a relational algebra expression that returns all companies that are producing less than 3 types of IPA beers.

Solution

$$\begin{aligned} numIPA &\leftarrow_{cName} \mathcal{G}_{count(*)} AS n(\sigma_{type='IPA'}(beer) \bowtie producesBeer) \\ moreThan &\leftarrow \pi_{cName}(\sigma_{n \geq 3}(numIPA)) \\ q &\leftarrow \pi_{cName}(company) - moreThan \end{aligned}$$