Name

CWID

Homework Assignment 1

September 16th, 2014

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:

recipe

name	inventor	kitchen
Pasta and Meatballs	Le cook	Italian
Cheese Soup	The french	French
Burger	Cowboys	American

ingredient

recipe	foodItem	ounces
Pasta and Meatballs	Pasta	50
Pasta and Meatballs	Meatballs	10
Pasta and Meatballs	Tomato Sauce	5
Pasta and Meatballs	Onions	1
Cheese Soup	Onions	4
Cheese Soup	Cheese	15
Cheese Soup	Bread	20
Burger	Bread	10
Burger	Ground Beef	20

foodItem

item	type	calories
Pasta	Wheat product	20
Meatballs	Meat	40
Tomato Sauce	Sauce	5
Onions	Vegetables	1
Cheese	Diary	30
Bread	Wheat product	25
Ground Beef	Meat	45

stock

foodItem	shop	price
Pasta	Aldi	5
Meatballs	Aldi	10
Tomato Sauce	Aldi	3
Tomato Sauce	Walmart	3
Cheese	Treasury Island	15

Hints:

- Underlined attribute form the primary key of a relation
- The attribute *recipe* of relation *ingredient* is a foreign key to relation *recipe*. The attribute *foodItem* of relation *ingredient* is a foreign key to relation *foodItem*.
- The attribute *foodItem* of relation *stock* is a foreign key to relation *foodItem*.

Part 1.1 Relational Algebra (Total: 100 Points)

Question 1.1.1 (6 Points)

Write a relational algebra expression that returns the food items required to cook the recipe "Pasta and Meatballs". For each such food item return the item paired with the number of ounces required by the recipe.

Solution

$$\pi_{foodItem,ounces}(\sigma_{recipe='\text{Pasta and Meatballs}'}(ingredient))$$

Question 1.1.2 (6 Points)

Write a relational algebra expression that returns food items that are sold at "Aldi" and their price.

Solution

$$\pi_{foodItem,price}(\sigma_{shop='Aldi'}(stock))$$

Question 1.1.3 (6 Points)

Write a relational algebra expression that returns food items (item) that are of type "Wheat product" or of type "Meat" and have at least 20 calories per ounce (attribute calories).

Solution

$$\pi_{item}(\sigma_{(type='\text{Wheat product}'\vee type='Meat')\wedge calories\geq 20}(foodItem))$$

Question 1.1.4 (9 Points)

Write a relational algebra expression that returns the items and their price for all items of type "Wheat product" sold at Aldi.

Solution

$$\pi_{item,price}(\sigma_{shop='Aldi' \wedge type='Wheatproduct'}(foodItem \bowtie \rho_{item \leftarrow foodItem}(stock)))$$

Question 1.1.5 (9 Points)

Write a relational algebra expression that returns the names of all recipes that contain meat products (food items of type "Meat").

Solution

$$\pi_{recipe}(\sigma_{type='Meat'}(ingredient \bowtie_{foodItem=item} foodItem))$$

Question 1.1.6 (10 Points)

Write a relational algebra expression that returns all recipes that contain both "Onions" and "Cheese".

Solution

$$\pi_{recipe}(\sigma_{foodItem='Onions'}(ingredient)) \cap \pi_{recipe}(\sigma_{foodItem='Cheese'}(ingredient))$$

Question 1.1.7 (10 Points)

Write a relational algebra expression that returns the food items that are ingredients for "Cheese Soup" but not for "Burgers".

Solution

$$\pi_{foodItem}(\sigma_{recipe='\text{Cheese Soup}'}(ingredient)) - \pi_{foodItem}(\sigma_{recipe='Burger'}(ingredient))$$

Question 1.1.8 (7 Points)

Write a relational algebra expression that returns the total number of ounces for all ingredients per recipe.

Solution

$$_{recipe}\mathcal{G}_{sum(ounces)}(ingredient)$$

Question 1.1.9 (10 Points)

Write a relational algebra expression that returns the average price of food items per type. For example, this expression should return tuples like (Wheat product, 34.5).

Solution

$$typePrice \leftarrow foodItem \bowtie_{item=foodItem} stock$$
$$q \leftarrow_{type} \mathcal{G}_{avg(price)}(typePrice)$$

Question 1.1.10 (14 Points)

Write a relational algebra expression that returns the number of food item types for which the average calories for all food items of this type is higher than 40.

Solution

$$avgCal \leftarrow_{type} \mathcal{G}_{avg(calories)}(foodItem)$$
$$q \leftarrow \mathcal{G}_{count(*)}(\sigma_{avg(calories)>40}(avgCal))$$

Question 1.1.11 (13 Points)

Write a relational algebra expression that returns the total calories per recipe (assume that calories in the foodItem table are given per ounce).

Solution

$$tCal \leftarrow \pi_{recipe,ounces*calories \rightarrow ttlCal}(ingredient \bowtie_{foodItem=item} foodItem)$$
$$q \leftarrow_{recipe} \mathcal{G}_{sum(ttlCal)}(tCal)$$

Question 1.1.12 (BONUS QUESTION) (5 Points)

Write a relational algebra expression that returns the cheapest price for making the recipe "Burger". Assume that the price in the stock table is given per ounce. Also assume that there might be more than one entry for each food item (e.g., bread and ground Beef) in the stock table, i.e., a food item may be sold by different shops.

Solution

$$burgerPrice \leftarrow \pi_{foodItem, ounces*price \rightarrow ttlPrice}(\sigma_{recipe='Burger'}(ingredient \bowtie stock))$$
$$minPrice \leftarrow_{foodItem} \mathcal{G}_{min(ttlPrice) \text{ AS } t}(burgerPrice)$$
$$q \leftarrow \mathcal{G}_{sum(t)}(minPrice)$$

Question 1.1.13 (BONUS QUESTION) (5 Points)

Write a relational algebra expression that returns all recipes that can be cooked from ingredients bought from a single shop.

Solution

$$shopIng \leftarrow_{recipe, shop} \mathcal{G}_{count(*) \text{ AS } n}(ingredients \bowtie stock)$$
$$recIng \leftarrow_{recipe} \mathcal{G}_{count(*) \text{ AS } n}(ingredients)$$
$$q \leftarrow \pi_{recipe}(shopIng \bowtie recIng)$$