

# CS 440 – Databases

Homework 1 (20 points)  
Due: Friday Feb. 5, 2021

- P. 36, Ex. 2.3.1 (in SQL)
- P. 37, Ex. 2.3.2 (in SQL)
- P. 52–55, Ex. 2.4.1 a–g
- P. 55, Ex. 2.4.3

# Solutions

## 2.3.1

- a) CREATE TABLE Product (  
    model INT PRIMARY KEY,  
    maker VARCHAR(50),  
    type VARCHAR(50));
- b) CREATE TABLE PC (  
    model INT PRIMARY KEY,  
    speed FLOAT,  
    ram INT,  
    hd INT,  
    price FLOAT);
- c) CREATE TABLE Laptop (  
    model INT PRIMARY KEY,  
    speed FLOAT,  
    ram INT,  
    hd INT,  
    screen FLOAT,  
    price FLOAT);
- d) CREATE TABLE Printer (  
    model INT PRIMARY KEY,  
    color BOOLEAN,  
    type VARCHAR(10),  
    price FLOAT);
- e) ALTER TABLE Printer DROP color;
- f) ALTER TABLE Laptop ADD od VARCHAR(10) DEFAULT 'none';

## 2.3.2

- a) CREATE TABLE Classes (  
    class VARCHAR(50) PRIMARY KEY,  
    type VARCHAR(10),  
    country VARCHAR(50),  
    numGuns INTEGER,  
    bore FLOAT,  
    displacement INTEGER);
- b) CREATE TABLE Ships (  
    name VARCHAR(50) PRIMARY KEY,  
    class VARCHAR(50),  
    launched INT);
- c) CREATE TABLE Battles (  
    name VARCHAR(50) PRIMARY KEY,  
    date DATE);

- d) CREATE TABLE Outcomes (  
 ship VARCHAR(50),  
 battle VARCHAR(50),  
 result VARCHAR(10),  
 PRIMARY KEY (ship, battle));
- e) ALTER TABLE Classes DROP bore;
- f) ALTER TABLE Ships ADD yard VARCHAR(50);

## 2.4.1

a)

$$A(\text{model}, \text{speed}, \text{ram}, \text{hd}, \text{price}) := \sigma_{\text{speed} \geq 3.00}(PC)$$

$$\text{Answer}(\text{model}) := \pi_{\text{model}}(A)$$

model
1005
1006
1013

b)

$$A(\text{maker}, \text{model}, \text{type}, \text{speed}, \text{ram}, \text{hd}, \text{screen}, \text{price}) := \text{Product} \bowtie \text{Laptop}$$

$$B(\text{maker}, \text{model}, \text{type}, \text{speed}, \text{ram}, \text{hd}, \text{screen}, \text{price}) := \sigma_{\text{hd} \geq 100}(A)$$

$$\text{Answer}(\text{maker}) := \pi_{\text{maker}}(B)$$

Maker
E
A
B
F
G

c)

$$A(\text{model}, \text{price}) := \pi_{\text{model}, \text{price}}(PC) \cup \pi_{\text{model}, \text{price}}(\text{Laptop}) \cup \pi_{\text{model}, \text{price}}(\text{Printer})$$

$$B(\text{maker}, \text{model}, \text{type}) := \sigma_{\text{maker} = 'B'}(\text{Product})$$

$$C(\text{maker}, \text{model}, \text{type}, \text{price}) := A \bowtie B$$

$$\text{Answer}(\text{model}, \text{price}) := \pi_{\text{model}}(C)$$

model	price
1004	649
1005	630
1006	1049
2007	1429

d)  $\pi_{model}(\sigma_{color \wedge type = "laser"}(Printer))$

model
3003
3007

e)

$$\begin{aligned}
 A(maker, model, type) &:= \sigma_{type = "pc"}(Product) \\
 B(maker, model, type) &:= \sigma_{type = "laptop"}(Product) \\
 Answer(maker) &:= \pi_{maker}(B) - \pi_{maker}(A)
 \end{aligned}$$

maker
F
G

f)

$$\begin{aligned}
 PC2 &:= \rho_{PC2}(PC) \\
 A(model, speed, ram, hd, price) &:= PC \bowtie_{(PC.hd = PC2.hd \wedge PC.model \neq PC2.model)} PC2 \\
 Answer(hd) &:= \pi_{hd}(A)
 \end{aligned}$$

hd
250
80
160

g)

$$\begin{aligned}
 PC2 &:= \rho_{PC2}(PC) \\
 A(model, speed, ram, hd, price) &:= PC \bowtie_{(PC.hd = PC2.hd \wedge PC.model < PC2.model)} PC2 \\
 Answer(PC.model, PC2.model) &:= \pi_{PC.model, PC2.model}(A)
 \end{aligned}$$

PC.model	PC2.model
1004	1012

### 2.4.3

a)  $Answer(class, country) := \pi_{class, country}(\sigma_{bore \geq 16}(Classes))$

b)  $Answer(name) := \pi_{name}(\sigma_{launched < 1921}(Ships))$

c)  $Answer(name) := \pi_{name}(\sigma_{battle = 'DenmarkStrait'}(Outcomes))$

d)  $Answer(name) := \pi_{name}(\sigma_{launched > 1921 \wedge displacement > 35000}(Classes \bowtie Ships))$

e)

$$\begin{aligned} \text{Ships}'(\text{ship}, \text{class}, \text{launched}) &:= \rho_{\text{Ships}'(\text{ship}, \text{class}, \text{launched})}(\text{Ships}) \\ \text{Battles}'(\text{battle}, \text{date}) &:= \rho_{\text{Battles}'(\text{battle}, \text{date})}(\text{Battles}) \\ \text{Answer}(\text{ship}, \text{displacement}, \text{numGuns}) &:= \pi_{\text{ship}, \text{displacement}, \text{numGuns}}(\sigma_{\text{battle}='Guadalcanal'}(\text{Ships}' \times \text{Battles}' \times \text{Outcomes})) \end{aligned}$$

f)  $\pi_{\text{ship}}(\text{Outcomes}) \cup \pi_{\text{ship}}(\rho_{\text{ship}, \text{class}, \text{launched}}(\text{Ships}))$

g)

$$\begin{aligned} \text{Ships}'(\text{name}, \text{class}, \text{launched}) &:= \rho_{\text{Ships}'(\text{name}, \text{class}, \text{launched})}(\text{Ships}) \\ \text{MultiShipClasses}(\text{class}) &:= \pi_{\text{Ships.class}}(\text{Ships} \bowtie_{\text{Ships.class}=\text{Ships'.class} \wedge \text{Ships.name} \neq \text{Ships'.name}} \text{Ships}') \\ \text{Answer}(\text{class}) &:= \pi_{\text{class}}(\text{Ships}) - \text{MultiShipClasses}(\text{class}) \end{aligned}$$

h)

$$\begin{aligned} \text{BBs}(\text{country}) &:= \pi_{\text{country}}(\sigma_{\text{type}='bb'}(\text{Classes})) \\ \text{BCs}(\text{country}) &:= \pi_{\text{country}}(\sigma_{\text{type}='bc'}(\text{Classes})) \\ \text{Answer}(\text{country}) &:= \text{BBs} \cap \text{BCs} \end{aligned}$$

i)

$$\begin{aligned} \text{Lived}(\text{ship}, \text{battle}) &:= \pi_{\text{ship}, \text{battle}}(\sigma_{\text{result}='ok'}(\text{Outcomes})) \\ \text{Answer}(\text{ship}) &:= \pi_{\text{ship}}(\text{Lived} \bowtie_{\text{Lived.name}=\text{Outcomes.name} \wedge \text{Lived.battle} \neq \text{Outcomes.battle}} \text{Outcomes}) \end{aligned}$$