CS 440 – Databases

Homework 2 (20 points)
Due: Friday February 1, 2019

- P. 62–63, Ex. 2.5.1, 2.5.2, 2.5.3
- P. 71–72, Ex. 3.1.1, 3.1.2
- P. 83, Ex. 3.2.1, 3.2.2

Solutions

2.5.1

a) $\sigma_{speed<2.00 \wedge price>500}(PC) = \emptyset$

b) $\sigma_{screen<15.4}(Laptop) \cap (\sigma_{hd<100}(Laptop) \cup \sigma_{price>1000}(Laptop)) = \emptyset$

c) $\pi_{maker}(Product \bowtie PC) \cap \pi maker(Product \bowtie Laptop) = \emptyset$

d)

$$A(maker, speed) := \pi_{maker,speed}(Product \bowtie PC)$$
$$B(maker, speed) := \pi_{maker,speed}(Product \bowtie Laptop)$$
$$FasterLaptops(maker) := \pi_{maker}(A \bowtie_{A.maker=B.maker \wedge B.speed \geq A.speed} B)$$
$$\pi_{maker}(A) - FasterLaptops = \emptyset$$

e) $\sigma_{Laptop.ram>PC.ram}(Laptop \times PC) - \sigma_{Laptop.price \leq PC.price}(Laptop \times PC) = \emptyset$

2.5.2

a) $sigma_{bore>16}(Classes) = \emptyset$

b) $\sigma_{bore>14}(\sigma_{numGuns>9}(Classes)) = \emptyset$

c)

$$S1(name) := \pi_{name}(\rho_A(Ships) \bowtie_{A.class=B.class \wedge A.name<B.name} \rho_B(Ships))$$
$$S2(name) := \pi_{name}(\rho_A(Ships) \bowtie_{A.class=B.class \wedge A.name>B.name} \rho_B(Ships))$$
$$\pi_{name}(Ships) - S1 - S2 = \emptyset$$

d) $\pi_{country}(\sigma_{type=bb}(Classes)) \cap \pi_{country}(\sigma_{type=bc}(Classes)) = \emptyset$

e)

$$M9(name) := \pi_{name}(\sigma_{numGuns>9}(Ships \bowtie Classes))$$
$$L9(name) := \pi_{name}(\sigma_{numGuns<9}(Ships \bowtie Classes))$$
$$\rho_A(Outcomes \bowtie M9) \bowtie_{A.battle=B.battle \wedge B.result='sunk'} \rho_B(Outcomes \bowtie L9) = \emptyset$$

2.5.3

$\pi_{A_1 \ldots A_n}(R) - \pi_{B_1 \ldots B_n}(S) = \emptyset$

3.1.4

There's a lot of things that should be true, but aren't. For example, SSNs are supposed to be unique to people, but aren't. I'm going to assume they are...

Functional Dependencies:

$$SSN \rightarrow name$$
$$areaCode \rightarrow state$$
$$streetAddress \quad city \quad state \rightarrow zipCode$$

Based on the above, the key is: $\{SSN, streetAddress, city, areaCode, phoneNumber\}$

3.1.2

Functional Dependencies:
$x \quad y \quad z \rightarrow vx \quad vy \quad vz$ We are assuming that only one molecule can be in exactly a given location. So the key is: $\{x, y, z\}$

3.2.1

a)

$$C \rightarrow A$$
$$AB \rightarrow D$$
$$AC \rightarrow D$$
$$BC \rightarrow D$$
$$BC \rightarrow A$$
$$BD \rightarrow A$$
$$CD \rightarrow A$$
$$ABC \rightarrow D$$
$$BCD \rightarrow A$$

b) The keys are: $\{A, B\}\{B, C\}\{B, D\}$

c) The non-key superkeys are: $\{A, B, C\}, \{B, C, D\}, and \{A, B, C, D\}$

3.2.2

i. a)

$$A \rightarrow C$$
$$A \rightarrow D$$
$$AB \rightarrow C$$
$$AB \rightarrow D$$
$$AC \rightarrow D$$
$$BC \rightarrow D$$
$$BD \rightarrow C$$

i. b) The keys are: $\{A\}$

i. c) The non-key superkeys are subsets of $\{A, B, C, D\}$ that include A.

ii. a)

$$
\begin{aligned}
AB &\rightarrow D \\
AD &\rightarrow C \\
BC &\rightarrow A \\
CD &\rightarrow B \\
ABC &\rightarrow D \\
BCD &\rightarrow A
\end{aligned}
$$

ii. b) The keys are $\{A, B\}, \{B, C\}, \{C, D\}, \{A, D\}$

ii. c) Left as an exercise.

iii. a)

$$
\begin{aligned}
A &\rightarrow C \\
A &\rightarrow D \\
B &\rightarrow D \\
B &\rightarrow A \\
C &\rightarrow A \\
C &\rightarrow B \\
D &\rightarrow B \\
D &\rightarrow C \\
AB &\rightarrow C \\
AB &\rightarrow D \\
AC &\rightarrow B \\
AC &\rightarrow D \\
AD &\rightarrow B \\
AD &\rightarrow C \\
BC &\rightarrow D \\
BC &\rightarrow A \\
BD &\rightarrow C \\
BD &\rightarrow A \\
CD &\rightarrow A \\
CD &\rightarrow B \\
ABC &\rightarrow D \\
ABD &\rightarrow C \\
ACD &\rightarrow B \\
BCD &\rightarrow A
\end{aligned}
$$

iii. b) The key is any single attribute.

iii. c) All the subsets that have more than 1 element in them.