Homework 4 Solutions

3.7.3b

(a) [5 points]

A →→ B and B →→ CD are given. Since we aren't given any FD's, we can't assume A or B is a superkey, so both MVD's are 4NF violations.

From the complementation rule for MVD's, we also have
A →→ CD and B →→ A, also 4NF violations.

We can decompose into AB, ACD, ***or*** into AB, BCD. None of the resulting relations has non-trivial MVD's, so both would be 4NF decompositions.

3.7.4

The moral of this problem seems to be that different ways of stating assumptions about MVD's can nonetheless lead to the same MVD's overall.

We are asked to identify MVD's *other than* FD's. Abbreviate attributes as follows:

B = Baby
M = Mother
D = Doctor
N = Nurse

Base assumption: [5 points]
"If there is more than one nurse and/or doctor attending, then there will be several tuples with the same baby and mother, one for each combination of nurse and doctor."

This says that BM →→ D and BM →→ N.

(a) [5 points]
"For every baby there is a unique mother." This gives us B →→ M in addition to the above. Thus we would also have by the complementation rule:

B →→ DN

But it seems that we can also combine B→ M with the baseline BM →→ D to get
B →→ D
and with the baseline BM →→ N to get
B →→ N
That is, we don't need the mothers to determine the set of doctors independent of nurses, because the babies are enough to do it, as they determine the mothers.

(b) [5 points]

"For every combination of a baby, nurse, and doctor, there is a unique mother." This gives us BDN $\rightarrow\rightarrow$ M, which is automatic if BDMN are the only attributes. So nothing new is added over the baseline.

(c) [5 points]
"For every combination of a baby and mother, there is a unique doctor." This gives us BM $\rightarrow\rightarrow$ D, which is the same as the baseline assumptions.

3.3.7 b [10 points]

Show that $X \rightarrow\rightarrow Y$ and $X \rightarrow\rightarrow Z$ together imply $X \rightarrow\rightarrow Y \cap Z$.

I am assuming that $X \cap Y = \emptyset$ and $X \cap Z = \emptyset$, which I believe to be the cases of interest. If these are not true, then I assert without proof that the result can be obtained from the argument I am giving.

Let W be the set of all attributes, and define

$A = Y - Z$

$B = Y \cap Z$

$C = Z - Y$

$D = W - (X \cup Y \cup Z)$

so that X, A, B, C, D are pairwise disjoint and have W as their union.

Restated, the problem is to show that $X \rightarrow\rightarrow (A \cup B)$ and $X \rightarrow\rightarrow (B \cup C)$ together imply $X \rightarrow\rightarrow B$.

Assume that $X \rightarrow\rightarrow (A \cup B)$ and $X \rightarrow\rightarrow (B \cup C)$.

We must then show that for any two tuples t and t' such that t(X) = t'(X), there is a tuple w such that

w(B) = t(B), and
w(A∪C∪D) = t'(A∪C∪D).

Let t and t' be tuples such that t(X) = t'(X). We can express these as:

t = t(x) t(a) t(b) t(c) t(d)
t' = t(x) t'(a) t'(b) t'(c) t'(d)

Our goal is to derive the existence of a tuple w such that

$w = t(x)\ \ t'(a)\ \ t(b)\ t'(c)\ t'(d)$

From $X \rightarrow\rightarrow (A \cup B)$, we know that there is a tuple u in the relation, due to t and t', such that

$u = t(x)\ \ t(a)\ \ t(b)\ \ t'(c)\ \ t'(d)$

From $X \rightarrow\rightarrow (B \cup C)$, we know that there is a tuple v in the relation, due to t and t', such that

$v = t(x)\ \ t'(a)\ \ t(b)\ t(c)\ t'(d)$

But then from $X \rightarrow\rightarrow (A \cup B)$ again, we know that there is a tuple w in the relation, due to u and v, such that

$w = t(x)\ \ t'(a)\ \ t(b)\ t'(c)\ t'(d)$

This is exactly the form of tuple we were trying to derive.

5.2.1

(c) [5 points]

Find the model number and price of all products of any type made by manufacturer B.

$\pi_{model,\ price}\ (\sigma_{maker='B'}(Product)\ join\ (PC \cup Laptop \cup Printer))$

result =

model	price
1004	999
1005	1499
1006	2119
2001	1448
2002	2584
2003	2738

(e) [5 points]

Find the manufacturers (i.e. makers) that sell laptops but not PC's.

$\pi_{maker}\ (\sigma_{type='laptop'}(Product) - \sigma_{type='PC'}(Product))$

result = $\varnothing$