

1. Some students only did parts a,b,c – which is ok. For those that also did exercise 7.1 in the text, $R1 \cap R2 = A$; $A^+ = \{A,B,C,D,E\} \geq R1$. Therefore the given decomposition is lossless.
 - a) $R1 \cap R2 = C$. $C^+ = \{C\} \neq R1$ nor $R2$. Therefore the given decomposition is lossy.
 - b) Based on the BCNF violation $B \rightarrow D$, we get: (B,D) and (A,B,C,E) .
 - c) R is trivially valid. Also valid: (A,B,C) , (C,D,E) , (B,D) , (A,E) .
2. $A \rightarrow B$, $C \rightarrow B$, $AC \rightarrow B$. Plus all trivial dependencies: $\alpha\beta \rightarrow \alpha$, where β can be empty.
3. We will just list the relevant closures for candidate key identification:
 $A^+ = \{A,B,C,D,E\}$, $B^+ = \{B,D\}$, $C^+ = \{C\}$, $D^+ = \{D\}$, $E^+ = \{A,B,C,D,E\}$
 $BC^+ = \{A,B,C,D,E\}$, $CD^+ = \{A,B,C,D,E\}$. Therefore the candidate keys are: A , E , BC , CD .
4. There are some variations, but here is one solution:

UNION: prove $\alpha \rightarrow \beta$ and $\alpha \rightarrow \gamma$ gives $\alpha \rightarrow \beta\gamma$

1. $\alpha \rightarrow \alpha\beta$ (augmentation on $\alpha \rightarrow \beta$)
2. $\alpha\beta \rightarrow \beta\gamma$ (augmentation on $\alpha \rightarrow \gamma$)
3. $\alpha \rightarrow \beta\gamma$ (transitivity on 1 & 2). QED

PSEUDOTRANSITIVITY: prove $\alpha \rightarrow \beta$ and $\beta\gamma \rightarrow \delta$ gives $\alpha\gamma \rightarrow \delta$

1. $\alpha\gamma \rightarrow \beta\gamma$ (augmentation on $\alpha \rightarrow \beta$)
2. $\alpha\gamma \rightarrow \delta$ (transitivity on 1 & $\beta\gamma \rightarrow \delta$). QED

5. a) The relation does not satisfy 3NF because book_type is neither trivial, nor contained in any candidate key. The candidate key is (title, author).

b) book_type \rightarrow price causes our first decomposition into:

(book_type, price) and (title, author, book_type, author_affiliation, publisher)

author \rightarrow author_affiliation causes another decomposition into:

(author, author_affiliation) and (title, author, book_type, publisher)

title \rightarrow book_type, publisher causes the final one:

(title, book_type, publisher) and **(title, author)**

Therefore **(book_type, price)**, **(author, author_affiliation)**, **(title, book_type, publisher)** and **(title, author)** is one BCNF decomposition.

6. ZDB_ID is not in 1NF. There are many reasons why something like this can happen – even the non-ideal reason is possible: “Well, the person who first designed the schema it never took CIS 451 and that's just how they always did it and we just work around it.” Sometimes it is also hard to generate and lock a unique ID in some DBMS systems (like MySQL). GetZDBID generates a new unique ID based on the given type. The third field is a date-stamp, a common practice in older methods for assisting in generating a guaranteed unique ID. Think about it: 2 people request a new ID at exactly the same time – how do you **guarantee** they get unique ones? It is not as easy as it sounds to implement without a good lock manager. GetType and GetDate are possible functions.