

Homework 3 Solutions

Problem 1:

(a)

First, we split $BC \rightarrow AD$ into $BC \rightarrow A$ and $BC \rightarrow D$.

We start with $\{A, B\}$. We look for right sides of FDs contained in this set. There is only $AB \rightarrow C$, which gives $\{A, B, C\}$. Now we can use $BC \rightarrow D$. This adds D and our set is now $\{A, B, C, D\}$. Finally, we can use $D \rightarrow E$ to give $\{A, B, C, D, E\}$.

(b)

Using $A, B, C \rightarrow EF$, we can add E and F to the set and obtain $\{A, B, C, D, E, F\}$. Finally, $E \rightarrow G$ gives $\{A, B, C, D, E, F, G\}$.

(c)

We start out with $\{A, B\}$ and can use $B \rightarrow DE$ to add both attributes on the right, obtaining $\{A, B, D, E\}$. The only FD we can now apply is $E \rightarrow FG$, giving us now the set $\{A, B, D, E, F, G\}$. The only other FDs involve C on the left side and cannot be applied.

Problem 2:

We need to find all closures. We have

$$\{A\}^+ = \{A, D, E, F, G\}$$

$$\{D\}^+ = \{D, E, F, G\},$$

$$\{F\}^+ = \{F\},$$

$$\{G\}^+ = \{G\}.$$

Since $\{A\}^+$ contains all the attributes in the projection, there is no need to calculate the closure of sets containing A .

$$\{D, F\}^+ = \{D, E, F, G\}^+ = \{D, E, F, G\} \text{ (reusing a previous calculation),}$$

$$\{D, G\}^+ = \{D, E, F, G\},$$

$$\{F, G\}^+ = \{F, G\}, \text{ and}$$

$$\{D, F, G\}^+ = \{D, E, F, G\}.$$

This allows us to read off the FDs in the projection, leaving out the ones that easily follow:

$$A \rightarrow D, A \rightarrow F, A \rightarrow G, D \rightarrow F, D \rightarrow G.$$

Problem 3:

Author-ID → Author name is a functional dependency, because the Author-ID has to be an artificial key used by the web site in order to find books by the same author. If you want to argue against it, you can point to the frequent use of pen names, e.g. among authors of political tracks in past centuries.

Author-name → Author ID is not true as two authors can share the same name. For example, Author *Anonymous* wrote many works, often in the Erotica genre.

ISBN (by definition) determines all other attributes with the exception of the price, as used books could have different prices, and of author-name and author Id, as the same book can have more than one author. (If you create a new edition or translate a book, the ISBN number has to be changed.

Each chess player in the database has to have a FIDE number, which determines First, middle, and last name as well as birth date. Players can change country, gain additional titles, and while active have different rankings. Good players will have more than one tournament.

Problem 4:

Battleships can change name and service (e.g. after WW1, some German men-of-war changed ownership while most were scuttled), and they can arguably change speed, armament, and crew by a refit. It is very difficult to change the geometry of a ship (unless you run it into another ship, or quay, or cliff, but that does not count). However, by adding weight, the displacement can be changed. They cannot change their history, so we get:

name → class, shipyard, type, length, beam, fate

Adding the service will not help, since capital ships are regularly refitted. Since we can have the same capital ship copied exactly, no other functional dependencies can exist.