

MODEL ANSWERS :: EXAMPLES CLINIC 04

Normalising Relational Schemas

T1.

1. The relation is in 1NF, but not in 2NF as none of the attributes is fully functionally dependent on the key (e.g., Publisher is functionally dependent on only part of the key, and Author_affil is also functionally dependent on only part of the key). The relations is also not in 3NF, since it is not in 2NF.
2. The 2NF decomposition is as follows:

```
Book0(Book_title, Authorname)
Book1(Book_title, Publisher, Book_type, Listprice)
Book2(Authorname, Author_affil)
```

This decomposition eliminates the partial dependencies.

The 3NF decomposition is as follows:

```
Book0(Book_title, Authorname)
Book1-1(Book_title, Publisher, Book_type)
Book1-2(Book_type, Listprice)
Book2(Authorname, Author_affil)
```

This decomposition eliminates the transitive dependency of Listprice.

T2.

A minimal set of attributes whose closure includes all the attributes in R is a key.

Since the closure of {A, B}

$$\{A, B\}^+ = R$$

one key of R is {A, B} (in this case, it is the only key).

To normalise R into 2NF then 3NF, we take the following steps.

First, we identify partial dependencies that violate 2NF. These are attributes that are functionally dependent on either parts of the key, {A} or {B}, alone.

We can calculate the closures $\{A\}^+$ and $\{B\}^+$ to determine partially dependent attributes:

$$\{A\}^+ = \{A, D, E, I, J\}$$

Hence

$$\{A\} \rightarrow \{D, E, I, J\}$$

($\{A\} \rightarrow \{A\}$ is a trivial dependency)

$$\{B\}^+ = \{B, F, G, H\}$$

Hence $\{B\} \rightarrow \{F, G, H\}$

($\{B\} \rightarrow \{B\}$ is a trivial dependency)

To normalize into 2NF, we remove the attributes that are functionally dependent on part of the key (A or B) from R and place them in separate relations R1 and R2, along with the part of the key they depend on (A or B), which are copied into each of these relations but also remains in the original relation, which we call R3 below:

$$\begin{aligned} R1 &= \{\underline{A}, D, E, I, J\} \\ R2 &= \{\underline{B}, F, G, H\} \\ R3 &= \{\underline{A}, \underline{B}, C\} \end{aligned}$$

The new keys for R1, R2, R3 are underlined.

Next, we look for transitive dependencies in R1, R2, R3. The relation R1 has the transitive dependency

$$\{A\} \rightarrow \{D\} \rightarrow \{I, J\}$$

so we remove the transitively dependent attributes {I, J} from R1 into a relation R11 and copy the attribute D they are dependent on into R11. The remaining attributes are kept in a relation R12.

Hence, R1 is decomposed into R11 and R12 as follows:

$$\begin{aligned} R11 &= \{\underline{D}, I, J\} \\ R12 &= \{\underline{A}, D, E\} \end{aligned}$$

The relation R2 is similarly decomposed into R21 and R22 based on the transitive dependency

$$\{B\} \rightarrow \{F\} \rightarrow \{G, H\}$$

So

$$\begin{aligned} R21 &= \{\underline{F}, G, H\} \\ R22 &= \{\underline{B}, F\} \end{aligned}$$

The final set of relations in 3NF are

$$\{R11, R12, R21, R22, R3\}$$