Normalization exercises

Try the exercises below to test your knowledge of normalization. Although the answers are included, you are encouraged to try yourself before looking.

Given relation r(ABCDEFGH) and the functional dependencies F={A→CGH, AD→C, DE→F, G→H}, test whether or not it is in 3NF. If not, propose a 3NF decomposition.

In A→CGH, A is not a superkey since the closure is ACGH, so the relation is not in 3NF. First, find the canonical cover of F.

AD→C contains an extraneous attribute.
C is not a subset of $(AD - A)^+ = D^+$ since D^+ is {D}. We don't need D to infer C.

The canonical cover is F_c = {A→CG, DE→F, G→H}.

Using the functional dependencies, we decompose r into

> R_1(ACG)
> R_2(DEF)
> R_3(GH)

None of these relations contain candidate keys, so we must create one. Looking at our attributes, we divide them into the following sets:

1. B (never appears in a functional dependency)
2. CFH (only on the right and never on the left) G (on both sides)
3. ADE (only on the left and never on the right)

1 + 3 = ABDE is the core and CFGH is the exterior. Starting with the core, its closure is (ABDE)+ = ABCDEFGH, so ABDE is a candidate key and we create R_4(ABDE). Our final decomposition is R_1, R_2, R_3, R_4.

Given relation r(ABCDE) and the functional dependencies F={A→BC, CD→E, E→A, B→D}, test whether or not it is in 3NF. If not, propose a 3NF decomposition.

None of our functional dependencies are trivial, so we must check if the left-hand side of each functional dependency is a superkey.

A^+ = (ABCDE) so A is a superkey
CD^+ = (ABCDE) so CD is a superkey
E^+ = (ABCDE) so E is a superkey
B^+ = (BD) so B is not a superkey

Since B is not a superkey, which must check if (D - B) is contained in some candidate key. We already identified CD as a superkey above. Since C and D alone are not superkeys, CD is a minimal superkey, making it a candidate key. SInce D is contained in this candidate key, the relation is in 3NF.

Find the candidate keys for r(ABCDEGHK) given F={ABH→C, A→DE, BGH→K, K→ADH, BH→GE}.

First, we find the canonical cover of this set of dependencies. In this case, there are no extraneous attributes, so F_c = F.

We then partition all of the attributes

1. No attributes are absent from all functional dependencies
2. CDE (only on the right and never on the left) and AGHK (on both sides)
3. B (only on the left and never on the right)

1 + 3 = B is the core and 2 = ACDEGHK is the exterior. We start by combining the core with one attribute from the exterior and checking the closure.

We find BA, BG, BH, and BK as candidate keys. Considering the remaining attributes from the exterior, if we try adding two at a time, three at a time, etc. we find there are no other candidate keys. (To confirm this, see that BCDE is not a superkey, so no subset can be a candidate key.)