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Assignment 4

CMPT354

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Question 1

1. *isrc* **->** *mln*

   this cannot be implied from F, because mln is only in two functional dependencies which are kind of isolated from others and there isn't any attribute in those two to/from other FDs.

2. *isrc*, *rep* **->** *end*

It can be implied from F:

a. we know rep -> label using augmentation we have:
   end, rep -> end, label
b. we also know that artist, label -> end, rep
c. transitivity on a and b, we have:
   artist, label -> end, label
d. augmentation on c we get:
   artist->end
e. from isrc -> artist, genre and decomposition
   isrc-> artist
f. transitivity on e and d:
   isrc -> end
g. from reflexivity we know:
   isrc, rep -> isrc
h. transitivity on f and g:
   isrc, rep -> end

3. *label*, *msin*, *artist* **->** *inst*, *mfn*, *rep*

It can be implied from F:

a. we know:
   msin-> mln, inst
b. Decomposition on a:
   Msin -> inst
   Msin -> mln
c. We know:
   Msin, mln -> msin, mfn
d. Augmentation on c:
   Mln -> mfn
e. Transitivity on b and d:
   Msin -> mfn
f. Union on b and e:
   Msin -> inst, mfn

g. We know:
   Artist, label -> end, rep
h. Decomposition on g:
   Artist, label -> rep
i. From reflexivity we have:
   Artist, label, msin -> msin
   Artist, label, msin -> artist, label
j. Transitivity on f and i:
   Artist, label, msin -> inst, mfn
k. Transitivity on h and i:
   Artist, label, msin -> rep
l. Union on j and k:
   Artist, label, msin -> inst mfn, rep

4. *wsin*, *artist* **->** *genre*, *royalty*

   this cannot be implied from F, we have these FDs

   - *isrc*, *wsin*, *title* **->** *royalty*, *title*, *album*
- *isrc*, *wsin* **->** *royalty*, *album*
- *isrc*, *wsin* **->** *royalty*
- artist **->** genre

   there's no way to get the required FD from these ones, so it cannot be implied**.**

Question 2

1. attribute closure of (msin, wsin):
   {msin, wsin, mln, inst, mfn, wfn, wln}
2. attribute closure of (isrc, label):
   {isrc, label, icity, icountry, artist, genre, member, title, album, syear, end, rep}
3. minimal super key:
   {msin, isrc, wsin}

Question 3

In order to get canonical cover of F, we'll follow these three steps:

1. apply decomposition rule to the ones possible
2. remove extraneous attributes
3. remove redundant FDs

step 1:

artist $\rightarrow$ member
artist $\rightarrow$ genre
msin $\rightarrow$ mln
msin $\rightarrow$ inst

msin, mln → msin (will be discard for step 2, because we can always conclude X.Y → X)
msin, mln → mfn
isrc, title, album, artist → syear
isrc, artist → title
isrc, artist → album
artist, label → end
artist, label → rep
rep → label
label → icity
label → icountry
isrc, wsin, title → royalty
isrc, wsin, title → title (will be discard for step 2, because we can always conclude X.Y → X)
isrc, wsin, title → album
wsin → wfn
wsin → wln
isrc → artist
isrc → genre

step 2: remove extraneous attributes
artist → member
artist → genre
msin → mln
msin → inst
msin → mfn (mln extraneous)
isrc → syear (title, album, artist extraneous)
isrc → title (artist extraneous)
isrc → album (artist extraneous)
artist, label → end
artist, label → rep
rep → label
label → icity
label → icountry
isrc, wsin → royalty (title extraneous)
isrc → album (wsin, title extraneous)
wsin → wfn
wsin → wln
isrc → artist
isrc → genre
step 3:
artist* = {artist, member, genre}

Fc = {artist → member}
Fc = {artist → member, artist → genre}

Msin* = {Msin, mln, inst, mfn}
Fc = {artist → member, artist → genre, msin → mln, msin → inst, msin → mfn}

Isrc* = {isrc, syear, title, album, artist, genre, member}
Fc = {artist → member, artist → genre, msin → mln, msin → inst, msin → mfn, isrc → syear, isrc → title, isrc → album, isrc→artist}

Label* = {label, icity, icountry}
Fc = {artist → member, artist → genre, msin → mln, msin → inst, msin → mfn, isrc → syear, isrc → title, isrc → album, isrc→artist, label → icity, label → icountry}

(Artist, label) * = {artist, member, genre, label, icity, icountry, end, rep}
Fc = {artist → member, artist → genre, msin → mln, msin → inst, msin → mfn, isrc → syear, isrc → title, isrc → album, isrc→artist, label → icity, label → icountry, artist, label → end, artist, label → rep}

Rep* = {rep, label, icity, icountry}
Fc = {artist → member, artist → genre, msin → mln, msin → inst, msin → mfn, isrc → syear, isrc → title, isrc → album, isrc→artist, label → icity, label → icountry, artist, label → end, artist, label → rep, rep→ label}

Wsin* = {wsin, wfn, wln}
Fc = {artist → member, artist → genre, msin → mln, msin → inst, msin → mfn, isrc → syear, isrc → title, isrc → album, isrc→artist, label → icity, label → icountry, (artist, label) → end, (artist, label) → rep, rep→ label, wsin → wfn, wsin → wln, (isrc, wsin) → royalty}

Question 4

Lossless join decomposition:

First, we check and make sure that we have all attributes of F if we get the union of the sub relations which is true in this case.

Artist (artist, member, genre)
Plays (artist, msin)

Artist is the common attribute and Artist → member, genre

So, artist is a candidate Key for Artist.

Musician (msin, mfn, mln, inst)
Plays (artist, msin)

msin is the common attribute and msin→ mln, inst & msin, mln →msin, mfn

So, msin is a candidate Key for Musician.
Publishes (artist, rep, end)
Reps (label, rep)
rep is the common attribute and Rep → label
So, rep is a candidate Key for Reps.
Label (label, icity, icountry)
Reps (label, rep)
rep is the common attribute and Label → icity, icountry
So, label is a candidate Key for Label.
Writes (isrc, wsin, royalty)
Song (isrc, title, album, syear, artist)
rep is the common attribute and Isrc, title, album, artist → syear & Isrc, artist → title, album & isrc → artist
So, isrc is a candidate Key for Song.
Writer (wsin, wln, wfn)
Writes (isrc, wsin, royalty)
rep is the common attribute and Wsin → wfn, wln
So, wsin is a candidate Key for Writer.

So, as we can see they're all connected together and the common attributes is key for either X or Y. so, this is lossless.

Dependency preservation:
Artist (artist, member, genre)
Artist → member, genre
Musician (msin, mfn, mln, inst)
msin→ mln, inst
msin, mln →msin, mfn
Song (isrc, title, album, syear, artist)
Isrc, title, album, artist → syear
Isrc, artist → title, album
Plays (artist, msin)
Label (label, icity, icountry)
Label → icity, icountry
Publishes (artist, rep, end)
Reps (label, rep)
Rep → label
Writer (wsin, wln, wfn)
Wsin → wfn, wln
Writes (isrc, wsin, royalty)
NONE?
artist, label→ end, rep
isrc, wsin, title → royalty, title, album

isrc → artist, genre
based on this schema F is not dependency preservation because as we can see there are 3 FD that can't be fit into anything.

BCNF
Artist (artist, member, genre)
Key: artist
Prime: artist
Non-prime: member, genre
Musician (msin, mfn, mln, inst)
Key: msin
Prime: msin
Non-prime: mfn, mln, inst
Song (isrc, title, album, syear, artist)
Key: isrc
Prime: isrc
Non-prime: title, album, syear, artist
Plays (artist, msin)
N/A
Label (label, icity, icountry)
Key: label
Prime: label
Non-prime: icity, icountry
Publishes (artist, rep, end)
Key: artist
Prime: artist
Non-prime: end, rep
Reps (label, rep)
Key: rep
Prime: rep
Non-prime: label
Writer (wsin, wln, wfn)
Key: wsin
Prime: wsin
Non-prime: wln, wfn
Writes (isrc, wsin, royalty)
Key: isrc, wsin
Prime: isrc, wsin
Non-prime: royalty

- *artist* -> *members*, *genre* ***Superkey***
- *msin* -> *mln*, *inst* ***Superkey***

- *msin*, *mln* -> *msin*, *mfn* ***Superkey***
- *isrc*, *title*, *album*, *artist* -> *syear* ***Superkey***
- *isrc*, *artist* -> *title*, *album* ***Superkey***
- *artist*, *label* -> *end*, *rep* ***Superkey***
- *rep* -> *label* ***Superkey***
- *label* -> *lcity*, *lcountry* ***Superkey***
- *isrc*, *wsin*, *title* -> *royalty*, *title*, *album* ***Superkey***
- *wsin* -> *wfn*, *wln* ***Superkey***
- *isrc* -> *artist*, *genre* ***Superkey***

it is BCNF because the RHS of all are superkey.

3NF

Every BCNF FD is also 3NF, because it satisfies the 3NF requirements too. So it is also 3NF

Question 5

Lossless join decomposition:

Artist (artist, members, genre, msin, mfn, mln, inst)

Song (isrc, title, album, syear, wsin, wln, wfn, royalty, artist)

artist is the common attribute but it's not key in any of them.

So, it's not lossless join decomposition.

Dependency preservation:

Artist (artist, members, genre, msin, mfn, mln, inst)

Artist → member, genre

msin→ mln, inst

msin, mln →msin, mfn

Song (isrc, title, album, syear, wsin, wln, wfn, royalty, artist)

Isrc, title, album, artist → syear

Isrc, artist → title, album

isrc, wsin, title → royalty, title, album

Wsin → wfn, wln

Label (label, icity, icountry)

Label → icity, icountry

Publishes (label, artist, rep, end)

artist, label→ end, rep

Rep → label

NONE?

isrc → artist, genre

this is the only one which is not fitting we can decompose this as

isrc → artist

isrc → genre

we also know that

artist → genre

so instead of isrc → genre

if we write

isrc → artist

artist → genre

we can fit these two in Song and Artist respectively.

In this case we can say this is dependency preservation.

BCNF

Artist (artist, members, genre, msin, mfn, mln, inst)

Key: artist, msin

Prime: artist, msin

Non-prime: member, genre, mfn, mln, inst

In a lot of FDs, super key is not in LHS, like:

- *artist* -> *members*, *genre*
- *msin* -> *mln*, *inst*
- *msin*, *mln* -> *msin*, *mfn*

So it is not BCNF.

3NF

Artist (artist, members, genre, msin, mfn, mln, inst)

Key: artist, msin

Prime: artist, msin

Non-prime: member, genre, mfn, mln, inst

Song (isrc, title, album, syear, wsin, wln, wfn, royalty, artist)

Key: isrc, wsin

Prime: isrc, wsin

Non-prime: title, album, syear, wsin, wln, wfn, royalty, artist

Label (label, icity, icountry)

Key: label

Prime: label

Non-prime: icity, icountry

Publishes (label, artist, rep, end)
Key: label, artist
Prime: label, artist
Non-prime: rep, end

- *artist* -> *members*, *genre* ***Not satisfied***
- *msin* -> *mln*, *inst* ***Not satisfied***
- *msin*, *mln* -> *msin*, *mfn* ***Not satisfied***
- *isrc*, *title*, *album*, *artist* -> *syear* ***satisfied***
- *isrc*, *artist* -> *title*, *album* ***satisfied***
- *artist*, *label* -> *end*, *rep* ***satisfied***
- *rep* -> *label* ***satisfied***
- *label* -> *lcity*, *lcountry* ***satisfied***
- *isrc*, *wsin*, *title* -> *royalty*, *title*, *album* ***satisfied***
- *wsin* -> *wfn*, *wln* ***Not satisfied***
- *isrc* -> *artist*, *genre* ***Not satisfied***

so, this is not 3NF, as we see.

Question 6
Lossless join decomposition:
Artist (artist, member, genre)
Song (isrc, title, album, syear, artist)
artist is the common attribute and Artist → member, genre
So, artist is a candidate Key for Artist.
Label (label, icity, icountry)
Publishes (label, artist, rep, end)
label is the common attribute and Label → icity, icountry
So, label is a candidate Key for Label.
Writer (wsin, wln, wfn)
Writes (isrc, wsin, royalty)
wsin is the common attribute and Wsin → wfn, wln
So, wsin is a candidate Key for Writes.
It's lossless decomposition.

Dependency preservation:
Artist (artist, member, genre)
Artist → member, genre

Musician (msin, mfn, mln, inst)
msin→ mln, inst
msin, mln →msin, mfn

Song (isrc, title, album, syear, artist)
Isrc, title, album, artist → syear
Isrc, artist → title, album

Label (label, icity, icountry)
Label → icity, icountry
Publishes (label, artist, rep, end)
artist, label→ end, rep
Rep → label

Writer (wsin, wln, wfn)
Wsin → wfn, wln

Writes (isrc, wsin, royalty)
NONE
isrc, wsin, title → royalty, title, album
isrc → artist, genre

there's two FD that won't fit in any, for the second one we can apply what we discussed in Q5 and have it in Song and Artist which works,
we can rewrite isrc, wsin, title → royalty, title, album
as isrc, wsin → royalty, album using augmentation
using these two relations from Songs:
isrc, artist → album
and
isrc → artist.
we can say
isrc → album
Now, we have these two:
isrc → album
isrc, wsin → royalty, album
which can be written as
isrc, wsin → royalty
and this can be fit in Writes
doing these calculations, we can say there's dependency preservation.

BCNF
Artist (artist, member, genre)
Key: artist

Prime: artist
Non-prime: member, genre
Musician (msin, mfn, mln, inst)
Key: msin
Prime: msin
Non-prime: mfn, mln, inst
Song (isrc, title, album, syear, artist)
Key: isrc
Prime: isrc
Non-prime: title, album, syear, artist
Label (label, icity, icountry)
Key: label
Prime: label
Non-prime: icity, icountry
Publishes (label, artist, rep, end)
Key: artist, label
Prime: artist, label
Non-prime: end, rep
Writer (wsin, wln, wfn)
Key: wsin
Prime: wsin
Non-prime: wln, wfn
Writes (isrc, wsin, royalty)
Key: isrc, wsin
Prime: isrc, wsin
Non-prime: royalty

- *artist* -> *members*, *genre* ***satisfied***
- *msin* -> *mln*, *inst* ***satisfied***
- *msin*, *mln* -> *msin*, *mfn* ***satisfied***
- *isrc*, *title*, *album*, *artist* -> *syear* ***satisfied***
- *isrc*, *artist* -> *title*, *album* ***satisfied***
- *artist*, *label* -> *end*, *rep* ***satisfied***
- *rep* -> *label* ***not satisfied***
- *label* -> *lcity*, *lcountry* ***satisfied***
- *isrc*, *wsin*, *title* -> *royalty*, *title*, *album* ***satisfied***
- *wsin* -> *wfn*, *wln* ***satisfied***
- *isrc* -> *artist*, *genre* ***satisfied***

only because of *rep* -> *label* this is not BCNF.

3NF

- *artist* -> *members*, *genre* ***satisfied***
- *msin* -> *mln*, *inst* ***satisfied***
- *msin*, *mln* -> *msin*, *mfn* ***satisfied***
- *isrc*, *title*, *album*, *artist* -> *syear* ***satisfied***
- *isrc*, *artist* -> *title*, *album* ***satisfied***
- *artist*, *label* -> *end*, *rep* ***satisfied***
- *rep* -> *label* ***satisfied***
- *label* -> *lcity*, *lcountry* ***satisfied***
- *isrc*, *wsin*, *title* -> *royalty*, *title*, *album* ***satisfied***
- *wsin* -> *wfn*, *wln* ***satisfied***
- *isrc* -> *artist*, *genre* ***satisfied***

3NF requirement is satisfied in all of them, and because on the RHS of *rep* -> *label* there is prime attribute this FD is also satisfied, and it is 3NF