# CMPT 354 Assignment 4a Solution: Normalization

## Music Database Attributes and Functional Dependencies

The set of attributes, *R*, for a music database is as follows. Note that it is similar to, but not identical to, the database from assignments 1 and 2.

```
artist name (artist) - the name of a band
number of members (members)
music genre (genre)
musician SIN (msin)
musician first name (mfn)
musician last name (mln)
primary instrument of a musician (inst)
international standard recording code (isrc) - uniquely identifies a song
song title (title)
song's album name (album)
year of release of song (syear)
record label name (label) - publishing company for an artist
home city of record label (lcity)
home country of record label (lcountry)
end date of association of artist with record label (enddate) - if there is no end date
then that is the artist's current label
record label representative associated with an artist (rep)
writer SIN (wsin)
writer first name (wfn)
writer last name (wln)
royalty due to a writer for a song (royalty)
```

The set of functional dependencies (F) that hold over these attributes has been identified as follows.

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

## Question 1

Show whether or not the following functional dependencies are implied by *F*. Explain how the functional dependency is implied by using Armstrong's inference rules, including the additional rules if you wish. If the functional dependency is not implied by *F*, briefly explain why.

2 marks each, 1 mark for the answer (is or is not implied) and one mark for the explanation, there are other possible correct solutions for (b) and (c) in terms of applying Armstrong's axioms.

a. `isrc -> mln` – is not implied: `isrc+ = {isrc,artist,genre,members,title,album,syear}` which does not include `mln`

b. `isrc, rep -> enddate` – is implied: `rep->label`$^{A}$ and `artist,label->enddate,rep`$^{B}$ and `isrc->artist,genre`$^{C}$ (assumptions)
`artist,label->enddate`$^{D}$ (decomposition of B)
`isrc->artist`$^{E}$ (decomposition of C)
`artist,rep->enddate`$^{F}$ (pseudo-transitivity of A and D)
`isrc,rep->enddate` (pseudo-transitivity of E and F)

c. `label, msin, artist -> inst, mfn, rep` – is implied:
`artist,label->enddate,rep`$^{A}$ and `msin->mln,inst`$^{B}$ and `msin,mln->msin,mfn`$^{C}$

(assumptions),
`artist,label->rep`[D] (decomposition of A)
`msin,mln->mfn`[E] (decomposition of C)
`msin->mln`[F] (decomposition of B)
`msin->inst`[G] (decomposition of B)
`msin->msin,mln`[H] (augmentation of G)
`msin->mfn`[I] (transitivity of E and H)
`msin->inst,mfn`[J] (union of G and I)
`artist,label,inst,mfn->inst,mfn,rep`[K] (augmentation of D)
`artist,label,msin->rep` (pseudo-transitivity of J and K)

d. `wsin, artist -> genre, royalty` – is not implied: `{wsin,artis}+ =` `{wsin,artist,members,genre,wfn,wln}` which does not include `royalty`

## Question 2

a. What is the attribute closure of (`msin, wsin`)? – `{msin,wsin,mln,inst,mfn,wfn,wln}`: -½ mark for each missing attribute, maximum of -2
b. What is the attribute closure of (`isrc, label`)? – `{isrc,label,lcity,lcountry,artist,genre,members,title,album,syear,enddate,rep}`: -½ mark for each missing attribute, maximum of -2
c. Identify a minimal superkey for the entire set of attributes, *R* – `{isrc,msin,label,wsin}`: -½ mark for each missing attribute, maximum of -2
`{isrc,msin,rep,wsin}` is also acceptable

## Question 3

Compute $F_c$ (the canonical cover of *F*) -1 mark for each incorrect FD, maximum of -8

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

–
results in:
–

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

## Question 4

Consider the relational database schema shown below

```
Artist = {artist, members, genre}
Musician = {msin, mfn, mln, inst}
Song = {isrc, title, album, syear, artist}
Plays = {artist, msin}
Label = {label, lcity, lcountry}
Publishes = {artist, rep, enddate}
```

```
Reps = {label, rep}
Writer = {wsin, wln, wfn}
Writes = {isrc, wsin, royalty}
```

State whether or not the following properties with respect to *F* are satisfied by the schema. If the property is not satisfied, briefly explain why.

1 mark each, if the answer is no there must be an explanation for why, if there is not then 0 marks. Yes answers do not require explanation.

a. lossless join decomposition – yes
b. dependency preservation – no ({artist, label -> enddate, rep} not preserved)
c. BCNF – yes
d. 3NF – yes

### Question 5

Consider the relational database schema shown below

```
Artist = {artist, members, genre, msin, mfn, mln, inst}
Song = {isrc, title, album, syear, wsin, wln, wfn, royalty, artist}
Label = {label, lcity, lcountry}
Publishes = {label, artist, rep, enddate}
```

State whether or not the following properties with respect to *F* are satisfied by the schema. If the property is not satisfied, briefly explain why.

1 mark each, if the answer is no there must be an explanation for why, if there is not then 0 marks. Yes answers do not require explanation.

a. lossless join decomposition – no (no join between A and S, LP and A or LP and S)
b. dependency preservation – yes
c. BCNF – no (Artist and Song not in BCNF)
d. 3NF – no (Artist and Song not in 3NF)

### Question 6

Consider the relational database schema shown below

```
Artist = {artist, members, genre}
Musician = {msin, mfn, mln, inst}
Song = {isrc, title, album, syear, artist}
Label = {label, lcity, lcountry}
Publishes = {label, artist, rep, enddate}
Writer = {wsin, wln, wfn}
Writes = {isrc, wsin, royalty}
```

State whether or not the following properties with respect to *F* are satisfied by the schema. If the property is not satisfied, briefly explain why.

1 mark each, if the answer is no there must be an explanation for why, if there is not then 0 marks. Yes answers do not require explanation.

a. lossless join decomposition – no (missing Plays, M does not join to anything)
b. dependency preservation – yes
c. BCNF – no (Publishes must be further decomposed)
d. 3NF – yes

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