

# CSCI 403 - Database Management

## Project 7 - Normalize

### Instructions

This project is worth 50 points.

For this project, you are given an unnormalized relation schema, and asked to normalize it (with respect to Boyce-Code Normal Form only, although an optional extra credit asks you to normalize further). I will provide you with the attributes and a set of functional dependencies, which together form a cover of the possible functional dependencies (you may need to infer additional dependencies using the inference rules we learned). I will also provide you with a key for the initial relation schema; you will need to infer keys for any new relation schemas you create from the functional dependencies.

Your job is to decompose the relation schema(s) until all relation schemas are in BCNF. To document your work, for each decomposition you do, please note the following:

1. The starting relation schema (a variable name)
2. The functional dependency which violates BCNF which you choose to use to decompose the relation schema
3. The two decomposition products (two lists of attributes, labeled with variable names, e.g., “R1” and “R2”)

At the end of your work, please list the set of final relation schemas (discard schemas which were decomposed), along with the functional dependencies for each final relation schema.

An example of what your solution should look like is on the next page.

### Details

The relation schema you need to decompose concerns composers and their compositions (sorry for the pun, I couldn't resist). The attributes for the relation are: {composer, era, era\_dates, birthplace, continent, work, setting}. The choice of attributes is somewhat contrived, and also abbreviated for instructional purposes - try to imagine a much larger set of attributes for each “entity”. If it helps make sense of things, some example tuples compatible with the unnormalized relation schema can be found in figure 1.

The only key for the unnormalized relation is: {composer, era, work}.

You are given the following functional dependencies:

- {composer}  $\rightarrow$  {birthplace}
- {composer, work}  $\rightarrow$  {setting}
- {era}  $\rightarrow$  {era\_dates}
- {birthplace}  $\rightarrow$  {continent}

## Extra Credit

You may notice (by looking at the example data) that one relation in your final result still has some remaining redundancy. For 5 points extra credit, identify the relation and the violating multi-valued dependency (MVD), and show the decomposition needed to bring it into fourth normal form (4NF).

## Example

In case the instructions are not clear, here is an artificial example, showing what I am looking for in your solution.

Given some set of attributes  $R = \{a, b, c, d, e\}$  where the only key is the set  $\{a\}$ , and functional dependencies

- $\{b\} \rightarrow \{c\}$
- $\{d\} \rightarrow \{e\}$ ,

your solution would look something like this:

### Solution

#### Step 1

1. Starting schema:  $R$
2. Decompose on  $\{b\} \rightarrow \{c\}$
3. Results:  
 $R1 = \{a, b, d, e\}$   
 $R2 = \{b, c\}$

#### Step 2

1. Starting schema:  $R1$
2. Decompose on  $\{d\} \rightarrow \{e\}$
3. Results:  
 $R3 = \{a, b, d\}$   
 $R4 = \{d, e\}$

#### Final database:

- $R3 = \{a, b, d\}$ , only FD is  $\{a\} \rightarrow \{b, d\}$
- $R2 = \{b, c\}$ , only FD is  $\{b\} \rightarrow \{c\}$
- $R4 = \{d, e\}$ , only FD is  $\{d\} \rightarrow \{e\}$

Note that your solution doesn't need to show the resulting relations (i.e., the example data), just the resulting relation schemas (the list of attributes will do).

composer	era	era_dates	birthplace	continent	work	setting
J.S. Bach	Baroque	c. 1600 - 1750	Germany	Europe	Fugue in G minor	organ
J.S. Bach	Baroque	c. 1600 - 1750	Germany	Europe	St Matthew Passion	choir and orchestra
J.S. Bach	Baroque	c. 1600 - 1750	Germany	Europe	Mass in F major	choir and orchestra
Henry Purcell	Baroque	c. 1600 - 1750	England	Europe	Dido and Aeneas	opera
Joseph Haydn	Classical	c. 1730 - 1820	Austria	Europe	Mass in F major	choir and orchestra
Ludwig van Beethoven	Classical	c. 1730 - 1820	Germany	Europe	Symphony No. 1	orchestra
Ludwig van Beethoven	Classical	c. 1730 - 1820	Germany	Europe	Symphony No. 2	orchestra
Ludwig van Beethoven	Romantic	c. 1780 - 1910	Germany	Europe	Symphony No. 1	orchestra
Ludwig van Beethoven	Romantic	c. 1780 - 1910	Germany	Europe	Symphony No. 2	orchestra
Frédéric Chopin	Romantic	c. 1780 - 1910	Poland	Europe	Three Polonaises	piano
Charles Ives	20th Century	c. 1880 - 2010	United States	North America	String Quartet No. 1	string quartet
Alberto Ginastera	20th Century	c. 1880 - 2010	Argentina	South America	Don Rodrigo	opera

Figure 1: Some example tuples for the unnormalized relation schema