Normalization exercises

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Note: For each of the following exercises complete the following tasks:

1. (Complete after lesson 1) Find what normal form each of the following tables satisfies.Motivate the answer according the definition of normal forms seen in class.
2. (Complete after lesson 2) Apply the normalization algorithms seen in class to each table. Use intermediate refinements, i.e. if the table is in 1NF first normalize in 2NF and, if necessary, in BCNF.

Exercise 1 - Lockers The table is in no normal form, since it contains a multi-value attribute.

teacher		
teacher_id	name	surname

locker			
id	teacher_id	key_num	size

In `locker` the attribute `teacher_id` is a foreign key to `teacher`. The table is already in BCNF since all dependencies have the left argument which is a superkey.

Exercise 2 - Library The table is in no normal form since it contains a multi-value attribute.

1NF:

library		
card_num	name	surname

borrowed_books				
author	car_num	title	date	return_date

In `member` the attribute card_num is a foreign key to `library`.

2NF:

BCNF:
The tables rreated at the previous step are in 2NF because no functional dependencies exist. All the tables at this point are in BCNF because all the dependencies have a superkey as left argument.

Exercise 3 - Books 1NF:
The table is already in 1NF because all the attributes are atomic.

2NF:
Both dependencies have the left argument that is part of a key and the right argument that is a non-key attribute, thus they break 2NF

book	
author	title

book_author	
author	author_bdate

description			
title	genre	page	section

In the table `book` the attribute _author is a foreign key to `book_author` and `title` is a foreign key to `description`.

BCNF:
All the tables are already in BCNF since the left argument of all the dependencies are superkeys.

Exercise 4 - Houses The table is in no normal form because it contains a multi-value attribute.

1NF:

houses				
owner	postal_code	price	size	account

owner_address				
owner	postal_code	city	street	number

In `owner_address` the attribute `postal_code` is a foreign key to `houses`

2NF:
Using the decomposition rule on `postal_code` → `price, size` we get the functional dependencies `postal_code` → `price` and `postal_code` → `size`. Both break the 2NF because they are partially dependent on the primary key. Also the dependency `owner` → `account` breaks 2NF.

account	
owner	account

property		
postal_code	price	size

owner_address				
owner	postal_code	city	street	number

In `houses` the attribute `owner` is a foreign key to `account` and `postal_code` is a foreign key to `property`

BCNF:
All tables are already in BCNF because the left argument of all the dependencies is a superkey.

Exercise 5 - Port 1NF:
The table is already in 1NF because all attributes are atomic

2NF:
The dependencies `ship_name` → `docked_at,country,weight,class` and `captain` → `cpt_license` break the 2NF because the left argument is part of a key and the right argument is a non-key attribute (again use the decomposition rule). Note that the dependency `docked_at` → `country` does not break 2NF because the left argument is not part of any key (the 2NF only considers dependencies where the left side is part of a key)

ship_captain	
ship_name	captain

ship				
ship_name	weight	class	docked_at	country

license	
captain	cpt_license

In `ship_captain` the attribute `ship_name` is foreign key to `ship` and `captain` is a foreign key to `license`.

BCNF:
The dependency `docked_at` → `country` breaks BCNF because the left argument is not a superkey. The table `ship` must be decomposed in BCNF.
In the table `ship` the attribute `docked_at` is a foreign key to `docking`.

ship			
ship_name	weight	class	docked_at

docking	
docked_at	country

Exercise 6 - Cellar 1NF:
The table is in 1NF because it contains only atomic attributes

2NF:
The dependencies `producer` → `country,location` and `wine` → `bottling_date,price/l,grape_variety` break the 2NF since the left side is part of a key and the right side is a non-key attribute. The other dependencies do not break 2NF because they do not have a left argument that is part of a key

cellar	
producer	wine

producer		
producer	country	location

wine			
wine	bottling_date	price/l	grape_variety

In cellar the attribute producer is a foreign key to the table producer and the attribute wine is a foreign key to the table wine.

BCNF:
The dependencies location → country grape_variety → price/l break BCNF because their left argument is not a superkey. The tables wine and producer must be normalized in BCNF.

producer	
producer	location

location	
location	country

wine		
wine	bottling_date	grape_variety

grape	
grape_variety	price/l

In the table wine the attribute grape_variety is foreign key to grape and in the table producer the attribute location is foreign key to the table location.

Note: The following exercises are analogous to the previous exercises so only the final solution can be found

Exercise 7 - Courses In `teaching` the attribute `employee_code` is a foreign key to `employee` and the attribute `course_code` is a foreign key to `course`. In the table `course` the attribute study_points is a foreign key to `hours`.

teaching	
employee_code	course_code

employee		
employee_code	name	surname

course		
course_code	course_name	study_points

hours	
study_points	hours

Exercise 8 - Flights In the table `flying` the attribute `flight_code` is a foreign key to `flight`, and the attribute `captain_code` is a foreign key to `captain`. In the table `flight` the attributes { `departure,arrival` } are a foreign key to `duration`.

fying	
flight_code	captain_code

flight			
flight_code	plane_model	departure	arrival

captain	
captain_code	captain_name

duration		
departure	arrival	flight_time

Exercise 9 - Buildings In materials the attribute building_type_code is a foreign key to building and material is a foreign key to the table material. In the table building the attributes { length,width,height } are a foreign key to taxes.

building_materials		
building_code	component_type	material

material		
material	aximum_pressure	specific_weight

building			
building_code	building_length	building_width	building_height

taxes			
building_length	building_width	building_height	tax_rate