Algorithms and datastructures
Exercises

Kristoffer Klokker

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6.1 Indicate the following according to figure 1.

acctNo	*type*	*balance*
12345	savings	12000
23456	checking	1000
34567	savings	25

The relation **Accounts**

firstName	*lastName*	*idNo*	*account*
Robbie	Banks	901-222	12345
Lena	Hand	805-333	12345
Lena	Hand	805-333	23456

The relation **Customers**

Figure 1: Two relations of a banking database

6.1.a The attributes of each realtion

Accounts: $acctNo$, $type$, $balance$
Customers: $firstName$, $lastName$, $idNo$, $account$

6.1.b The tuples of each realtion

- $12345, savings, 12000$
- $23456, checking, 1000$
- $34567, savings, 25$

- $Robbie$, $Banks$, $901 - 222$, 12345
- $Lena$, $Hand$, $805 - 333$, 12345
- $Lena$, $Hand$, $805 - 333$, 23456

6.1.c The components of one tuble of each realtion

12000
$Banks$

6.1.d The relation schema of each realtion

$Accounts(acctNo, type, balance)$
$Customers(firstName, lastName, idNo, account)$

6.1.e The database schema

$Accounts, Customers$

6.1.f A suitable domain of each attribute

- $acctNo$ - INT
- $type$ - $VARCHAR[20]$
- $balance$ - INT
- $firstName$ - $VARCHAR[20]$
- $lastName$ - $VARCHAR[20]$
- $idNo$ - $CHAR[7]$
- $account$ - INT

6.1.g Another equivalent way to present each relation.

The attributes could simply just be in a different order.

6.2 In a table with the following attributes which are valid example of keys

$$title, year, length, genre, studioName, producerC\#$$

- title, year
- title, year, studioName
- title, length
- length, genre, studioName, year

6.3 How many ways can relation be represented if it has:

6.3.a Four attributes and five tuples

$4! \cdot 5! = 2880$

6.3.b n attributes and m tuples

$n! \cdot m!$

6.4 Write a database schema of the following relations

The datasbase schema includes
$Product(make, model, type)$
$PC(model, speed, ramhd, price)$
$Laptop(model, speed, ram, hd, screen, price)$
$Printer(model, color, type, price)$

6.4.a Write a schema for $Product$

CREATE TABLE Product(VARCHAR[20] maker, INT model, INT type)
The type is here an int where 0 is PC, 1 is laptop and 2 is printer. There is no foreign keys due to it being the lookup table for the other relations

6.4.b Write a schema for PC

CREATE TABLE PC(INT model, FLOAT speed, INT ram, BOOLEAN hd, FLOAT prize, FOREIGN KEY(Products) REFERENCES Products(model))
Here the model is a reference to products, speed is gigahertz of CPU

6.4.c Write a schema for *Printer*

CREATE TABLE Printer(INT model, BOOLEAN color, VARCHAR[20] type, FLOAT price, FOREIGN KEY(Products) REFERENCES Products(model))

6.4.d Write an alternation for Printer and delete the attribute color

ALTER TABKE Printer DROP color

6.4.e Add an *od* attribute for PC, which defaults to none an otherwise can be cd or dvd

ALTER TABLE PC ADD VARCHAR[20] od DEFAULT 'none'

7 Uge

7.1 Working with linear notation

The following exercises uses the following schema:
$Product(maker, model, type)$
$PC(model, speed, ram, hd, price)$
$Laptop(model, speed, ram, hd, screen, price)$
$Printer(model, color, type, price)$

7.1.a PC models which have speed of at least 3.00?

$\pi_{model}(\sigma_{speed>3.00}(PC))$

7.1.b PC manufacturers which makes PC with a hdd with at leat 100GB

$\pi_{maker}(Product \bowtie \sigma_{hd>=100}(PC))$

7.1.c Find model and price of all products made by manufacturer B

$$
\begin{aligned}
man &:= \sigma_{maker=B}(Product)\\
PCModelPrice &:= \pi_{model,price}(man \bowtie PC)\\
LaptopModelPrice &:= \pi_{model,price}(man \bowtie Laptop)\\
PrinterModelPrice &:= \pi_{model,price}(man \bowtie Printer)\\
modPrice &:= PCModelPrice \cup LaptopModelPrice \cup PrinterModelPrice
\end{aligned}
$$

7.1.d Find model numbers of all color laster printers

$\pi_{model}(Product \bowtie \sigma_{color=1ANDtype=laser}(Printer))$

7.1.e Find manufactures that sell Laptops but not PC

Due to algebra not including a method for group by I have answered in form of SQL queries.
SELECT (SELECT maker FROM LAPTOP NATURAL JOIN Product GROUP BY maker) - (SELECT maker FROM PC NATURAL JOIN Product GROUP BY maker)

7.1.f Find hd size which accour in two or more PC's

$$
\begin{aligned}
PC &= \pi_{model,hd}(PC)\\
PC2(model2, hd) &= \pi_{model,hd}(PC)\\
hd = \pi_{hd}(\sigma_{model!=model}&(PC \bowtie PC2)
\end{aligned}
$$

7.2 In the following data, what is the result of $\pi_{speed}(PC)$ when treated as a bag and set

model	speed	ram	hd	price
1001	2.66	1024	250	2114
1002	2.10	512	250	995
1003	1.42	512	80	478
1004	2.80	1024	250	649
1005	3.20	512	250	630
1006	3.20	1024	320	1049
1007	2.20	1024	200	510
1008	2.20	2048	250	770
1009	2.00	1024	250	650
1010	2.80	2048	300	770
1011	1.86	2048	160	959
1012	2.80	1024	160	649
1013	3.06	512	80	529

Bag

speed
2.66
2.10
1.42
2.80
3.20
3.20
2.20
2.20
2.00
2.80
1.86
2.80
3.06

Set

speed
2.66
2.10
1.42
2.80
3.20
2.20
2.00
2.80
1.86
3.06

8 Week

8.1 What are the expexted FD's in the following database and what key would it have

- name
- Social Security number
- street address
- city
- state
- ZIP code
- area code
- phone number

Social Security number $\rightarrow$ name,street address, city, state, ZIP code, area code
phone number $\rightarrow$ name key: Social security number, phone number

8.2 Consider the relation with schema $R(A, B, C, D)$ and FD's $AB \rightarrow C, C \rightarrow D, D \rightarrow A$

8.2.a What are all the nontrivial FD's that follow from the given FD's? You should restrict yourself to FD's with single attributes on the rigth side

$AB \rightarrow C$
$C \rightarrow D$
$D \rightarrow A$
ABD
$C \rightarrow A$

8.2.b What are all the keys of R

$AB^+ = \{C, D\}$
$C^+ = \{A, D\}$
$D^+ = \{A\}$
$BC^+ = \{D, A\}$

$BD^+ = \{A, C\}$
AB, BC, DC

8.2.c What are all the superkeys for R that is not keys?

BC, BD

8.3 Find BCNF violations and decompose the schema

8.3.a $R(A, B, C, D)$ with $AB \to C$, $C \to D$, and $D \to A$

$AB^+ = \{C, D, A\}$ - violation.
$R1 = R - AB^+ + AB = R(A, B)$
$R2 = AB^+ = R2(A, C, D)$

8.3.b $R(A, B, C, D, E)$ and $AB \to C, DE \to C, B \to D$

Starts wit the original relation
$R(A, B, C, D, E)$
The table violates ABC
$AB^+ = \{C, D\}$
$R1 = R - AB^+ = R(A, B, E)$
$R2 = AB^+ + AB = R(A, B, C, D)$
But $R2$ violates $B \to D$
$B^+ = \{D\}$
$R3 = R2 - B^+ = R(A, B, C)$
$R4 = B^+ + B = R(B, D)$
Therefore the new realtions are $R1, R3, R4$, since none now violates BCNF.

8.4 Perform the chase method on the relations $R(A, B, C), R(B, C, D), R$ using the given FD's

8.4.a $B \to E$ and $CE \to A$

A, B, C, D_1, E_1
A_2, B, C, D, E_2
A, B_3, C, D_3, E
$E_1 = E_2$ - $B \to E$
$A_2 = A$ - $CE_1 \to A$
$E_1 = E$ - $CE \to A$
Therfore on line two is now
A, B, C, D, E

8.4.b $A \to D, D \to E$ and $B \to D$

A, B, C, D_1, E_1
A_2, B, C, D, E_2
A, B_3, C, D_3, E
$D_1 = D$ - $B \to D$
$A_2 = A$ - $A \to D$
$D_3 = D$ - $A \to D$
$E_1 = E$ - $D \to E$

8.5 The following exercise is on the relation $Courses(C, T, H, R, S, G)$

The relation has the following FD's
$C \to T$
$HR \to C$
$HT \to R$
$HS \to R$
$CS \to G$

8.5.a What are all the keys for $Courses$

The candidate keys are:
$CSH^+ = \{T, G, R\}$
$SHR^+ = \{C, T, G\}$

8.5.b Verify that the given FD's are their own minimal basis

$C^+ = \{T\}$
$HR^+ = \{C, T\}$
$HT^+ = \{R, C\}$
$HS^+ = \{R, C, T\}$
$CS^+ = \{G, T\}$
As it can be seen no one of the FD's closure result in another FD, therefore making it minimal.

8.5.c Make the relation into a 3NF and check if any BCNF violation accour

$R1(C, T)$
$R2(H, R, C, T)$
$R3(H, T, R, C)$
$R4(H, S, R, C, T)$

$R5(C, S, G, T)$
$R2$ violates BCNF due to $HT \to R$, the same with $R3$ due to HR FD.