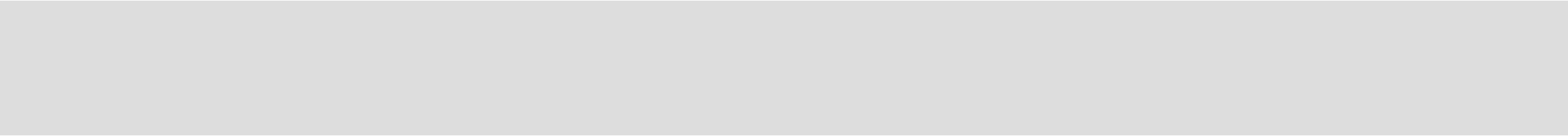# Database Normalization

Rhine-Waal University of Applied Sciences

R. Becker

2021-12-13
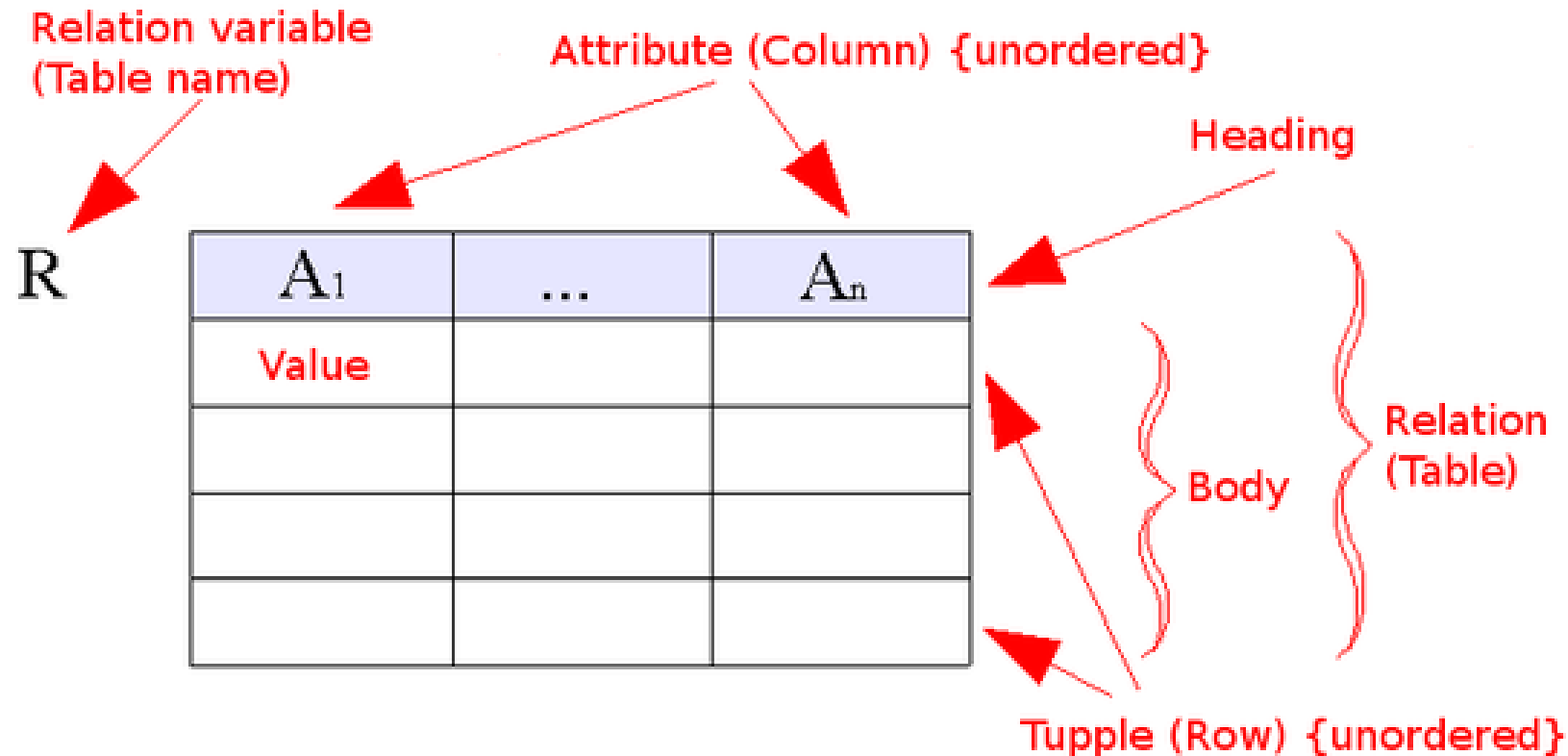
Relational Data Model
and
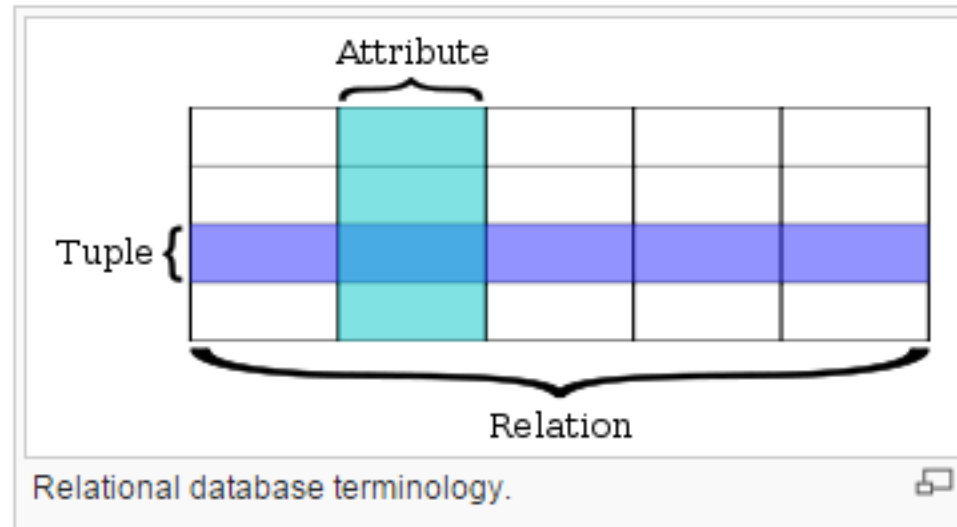# Relational Databases

Relation „Overview“

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Relation

A relation is a data structure which consists of an unordered set of tuples which share the same unordered set of attributes (heading).

Relational database terminology.

SQL term	Relational database term	Description
Row	*Tuple* or *record*	A data set representing a single item
Column	*Attribute* or *field*	A labeled element of a tuple, e.g. "Address" or "Date of birth"
Table	*Relation* or *Base relvar*	A set of tuples sharing the same attributes; a set of columns and rows
View or *result set*	*Derived relvar*	Any set of tuples; a data report from the RDBMS in response to a query

Relation

Relation Schema: R = (A1,…,An)
e.g. R1 = (ID, Name, Address)

Attribute name : Domain name
ID : Integer
Name : String
Address : String

Relation: r(R) = r(A1,…,An)

ID : Integer	Name : String	Address : String
102	"YONEZAWA Akinori"	"Naha, Okinawa"
202	"MURATA Makoto"	"Sendai, Miyagi"
104	"SAKAMURA Ken"	"Kumamoto, Kumamoto"
152	"MATSUMOTO Yukihiro"	"Okinawa, Okinawa"

Distinguish:

- relation schema (= relation type)

- relation

- attribute
- attribute type
- domain

Attributes

Sample Attributes

- **Attribute:** Date (= attribute name)
  - **attribute type:** date
  - **domain:** all valid dates,
    (e.g. not 2009-02-29, not BC(?))

- **Attribute:** Price
  - **attribute type:** numeric(10,2)
  - **domain:** Price >= 0

Relation „Overview“

Overview (Date, Customer, City, Sales Rep., Product, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Relation Schemata and Relations: Which are equal?

r1(Product, Price)

Product	Price
FU-Book	1200
Lady's Phone green	230
T-shirt for Cosies	20

r2(Product, Price)

Product	Price
T-shirt for Cosies	20
Lady's Phone green	230
FU-Book	1200

r3(Price, Product)

Price	Product
1200	FU-Book
230	Lady's Phone green
20	T-shirt for Cosies

r4(Product, Price)

Product	Price
FU-Book	1200
Lady's Phone green	230
Skirt for Cosies	40
T-shirt for Cosies	20

Functional Dependency (FD)

Definition FD : $\forall t_i, t_k \in r : t_i[\alpha] = t_k[\alpha] \Rightarrow t_i[\beta] = t_k[\beta]$

Example : $\tau = \{A, B, C\}$, $\alpha = \{A, B\}$, $\beta = \{C\}$

	A	B	C
r(A,B,C)			
t1	1	1	3
t2	1	1	3
t3	1	2	4

$t_1[\tau] = (1,1,3) \qquad t_2[\tau] = (1,1,3)$

$t_1[\alpha] = (1,1) \qquad t_2[\alpha] = (1,1)$

$t_1[\beta] = (3) \qquad t_2[\beta] = (3)$

Inversion : $\forall t_i, t_k \in r : t_i[\beta] \neq t_k[\beta] \Rightarrow t_i[\alpha] \neq t_k[\alpha]$

$t_3[C] \neq t_2[C] \Rightarrow t_3[A, B] \neq t_2[A, B]$

Functional Dependency (FD)

In simple words:

FD X→Y means:
If I give you an X
you will know the Y.

r(A,B,C)

	A	B	C
t1	1	1	3
t2	1	1	3
t3	1	2	4

FD or not? Check!

$A, B \rightarrow C$

$A, B \rightarrow B, C$

$A, B \rightarrow A, B, C$

$B \rightarrow A$

$B \rightarrow C$

$B \rightarrow A, B, C$

$C \rightarrow A, B, C$

$A \rightarrow C$

Functional Dependency (FD)

In simple words:

FD X→Y means:
If I give you an X
you will know the Y.

r(A,B,C)	A	B	C
t1	1	1	3
t2	1	1	3
t3	1	2	4

Example FDs:

$A, B \rightarrow C$

$A, B \rightarrow B, C$

$A, B \rightarrow A, B, C$

$B \rightarrow A$

$B \rightarrow C$

$B \rightarrow A, B, C$

$C \rightarrow A, B, C$

$~~A \rightarrow C$

Full Functional Dependency

In simple words

**Full FD means:
left side is minimal**

Examples of FDs:

r(A,B,C)		
A	**B**	**C**
t1	1	1	3
t2	1	1	3
t3	1	2	4

$$A, B \rightarrow C$$

$$A, B \xrightarrow{\quad\text{Full FD}\quad} C$$

$$B \xrightarrow{\quad\text{Full FD}\quad} C$$

$$B \xrightarrow{\quad\text{Full FD}\quad} A, C$$

$$B \xrightarrow{\quad\text{Full FD}\quad} A, B, C$$

Candidate Key (CK)

A candidate key is a <u>minimal set of attributes</u> uniquely identifying the (whole) <u>tuples</u> of a relation.

A CK is not necessarily FFD.

r(A,B,C)	A	B	C
t1	1	1	3
t2	1	1	3
t3	1	2	4

Examples of CKs:

$$B \xrightarrow{\textit{Full FD}} A, B, C$$

$$C \xrightarrow{\textit{Full FD}} A, B, C$$

Functional Dependency

Overview (Date, Customer, City, Sales Rep., Product, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Functional Dependency X→Y

Overview (Date, Customer, City, Sales Rep., Product, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Functional Dependency X→Y

Overview (Date, Customer, City, Sales Rep., Product, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Functional Dependency X→Y

Overview (Date, Customer, City, Sales Rep., Product, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Functional Dependency X→Y

Overview (Date, Customer, City, Sales Rep., Product, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Candidate Key

Overview (Date, Customer, City, Sales Rep., Product, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Improvement: Order ID

Overview (Order ID, Date, Customer, City, Sales Rep, Product, Price, Quantity)

FFD?

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Improvement: Order ID

Overview (Order ID, Date, Customer, City, Sales Rep, Product, Price, Quantity)

Order ID	Date	Customer	City	Sales Rep	Product	Price	Quantity
1	2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2	2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
3	2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
4	2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
4	2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
4	2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
5	2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
6	2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
7	2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
7	2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
8	2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Update (Change) Anomaly

Many records (tuple) affected

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarcosy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarcosy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarcosy	Paris	Julia	Lady's Phone green	230	1

Deletion Anomaly

**Cancelation of an order leads
to loss of customer contact**

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Insertion Anomaly

You cannot insert (customer, city) without an order (or you loose candidate key)

Date	Customer	City	Sales Rep	Product	Price	Quantity
2009-11-05	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
2009-11-05	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
2009-11-07	Berlusconi	Rom	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	FU-Book	1200	1
2009-11-07	Merkel	Berlin	Olga	Lady's Phone orange	200	4
2009-11-07	Merkel	Berlin	Olga	T-shirt for Cosies	20	12
2009-11-07	Merkel	Berlin	Bari	Skirt for Cosies	40	12
2009-11-08	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
2009-11-09	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
2009-11-10	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Database Normalization

- Normal Forms (NF)
- 1. NF: Attributes are atomic
  - e.g. not „Johnny Depp" but „Johnny", „Depp"
- 2. NF: Relation R is in 1. NF and
  each attribute A of relation R is fully functional dependent on
  every candidate key CK or is attribute of CK.
- 3. NF: Relation R is in 2. NF and there is no
  functional dependency between non-key-attributes.

Example from wikipedia (de)

http://de.wikipedia.org/wiki/Normalisierung_(Datenbank)

CD_Lieder

CD_ID	Album	Jahr der Gründung	Titelliste
4711	Anastacia - Not That Kind	1999	{1. Not That Kind, 2. I'm Outta Love, 3. Cowboys & Kisses}
4712	Pink Floyd - Wish You Were Here	1964	{1. Shine On You Crazy Diamond}
4713	Anastacia - Freak of Nature	1999	{1. Paid my Dues}

No NF → 1. NF

CD_Lieder

CD_ID	Album	Jahr der Gründung	Titelliste
4711	Anastacia - Not That Kind	1999	{1. Not That Kind, 2. I'm Outta Love, 3. Cowboys & Kisses}
4712	Pink Floyd - Wish You Were Here	1964	{1. Shine On You Crazy Diamond}
4713	Anastacia - Freak of Nature	1999	{1. Paid my Dues}

↓

CD_Lieder

CD_ID	Albumtitel	Interpret	Jahr der Gründung	Track	Titel
4711	Not That Kind	Anastacia	1999	1	Not That Kind
4711	Not That Kind	Anastacia	1999	2	I'm Outta Love
4711	Not That Kind	Anastacia	1999	3	Cowboys & Kisses
4712	Wish You Were Here	Pink Floyd	1964	1	Shine On You Crazy Diamond
4713	Freak of Nature	Anastacia	1999	1	Paid my Dues

1. NF, not 2. NF

CD_Lieder

CD_ID	Albumtitel	Interpret	Jahr der Gründung	Track	Titel
4711	Not That Kind	Anastacia	1999	1	Not That Kind
4711	Not That Kind	Anastacia	1999	2	I'm Outta Love
4711	Not That Kind	Anastacia	1999	3	Cowboys & Kisses
4712	Wish You Were Here	Pink Floyd	1964	1	Shine On You Crazy Diamond
4713	Freak of Nature	Anastacia	1999	1	Paid my Dues

Not fully functional dependent:
Part of key sufficient to yield Albumtitel

1. NF → 2. NF

CD_Lieder

CD_ID	Albumtitel	Interpret	Jahr der Gründung	Track	Titel
4711	Not That Kind	Anastacia	1999	1	Not That Kind
4711	Not That Kind	Anastacia	1999	2	I'm Outta Love
4711	Not That Kind	Anastacia	1999	3	Cowboys & Kisses
4712	Wish You Were Here	Pink Floyd	1964	1	Shine On You Crazy Diamond
4713	Freak of Nature	Anastacia	1999	1	Paid my Dues

CD

CD_ID	Albumtitel	Interpret	Jahr der Gründung
4711	Not That Kind	Anastacia	1999
4712	Wish You Were Here	Pink Floyd	1964
4713	Freak of Nature	Anastacia	1999

Lieder

CD_ID	Track	Titel
4711	1	Not That Kind
4711	2	I'm Outta Love
4711	3	Cowboys & Kisses
4712	1	Shine On You Crazy Diamond
4713	1	Paid my Dues

2. NF, not 3. NF

CD

CD_ID	Albumtitel	Interpret	Jahr der Gründung
4711	Not That Kind	Anastacia	1999
4712	Wish You Were Here	Pink Floyd	1964
4713	Freak of Nature	Anastacia	1999

**Functional Dependency
among non key attributes:**

FD: Interpret → Jahr der Gründung

2. NF → 3. NF

CD

CD_ID	Albumtitel	Interpret	Jahr der Gründung
4711	Not That Kind	Anastacia	1999
4712	Wish You Were Here	Pink Floyd	1964
4713	Freak of Nature	Anastacia	1999

Lieder

CD_ID	Track	Titel
4711	1	Not That Kind
4711	2	I'm Outta Love
4711	3	Cowboys & Kisses
4712	1	Shine On You Crazy Diamond
4713	1	Paid my Dues

CD

CD_ID	Albumtitel	Interpret
4711	Not That Kind	Anastacia
4713	Freak of Nature	Anastacia
4712	Wish You Were Here	Pink Floyd

Künstler

Interpret	Jahr der Gründung
Anastacia	1999
Pink Floyd	1964

3. NF

CD_Lieder

CD_ID	Album	Jahr der Gründung	Titelliste
4711	Anastacia - Not That Kind	1999	{1. Not That Kind, 2. I'm Outta Love, 3. Cowboys & Kisses}
4712	Pink Floyd - Wish You Were Here	1964	{1. Shine On You Crazy Diamond}
4713	Anastacia - Freak of Nature	1999	{1. Paid my Dues}

CD

CD_ID	Albumtitel	Interpret
4711	Not That Kind	Anastacia
4713	Freak of Nature	Anastacia
4712	Wish You Were Here	Pink Floyd

Künstler

Interpret	Jahr der Gründung
Anastacia	1999
Pink Floyd	1964

Lieder

CD_ID	Track	Titel
4711	1	Not That Kind
4711	2	I'm Outta Love
4711	3	Cowboys & Kisses
4712	1	Shine On You Crazy Diamond
4713	1	Paid my Dues

Candidate Key

Overview (<u>Date</u>, <u>Customer</u>, City, <u>Sales Rep.</u>, <u>Product</u>, Price, Quantity)

Date	Customer	City	Sales Rep	Product	Price	Quantity
05.11.2009	Berlusconi	Rom	Sidney	Lady's Phone pink	230	5
05.11.2009	Berlusconi	Rom	Julia	Lady's Phone pink	230	1
07.11.2009	Berlusconi	Rom	Olga	FU-Book	1200	1
07.11.2009	al-Gaddafi	Tripolis	Olga	FU-Book	1200	1
07.11.2009	al-Gaddafi	Tripolis	Olga	Lady's Phone orange	200	4
07.11.2009	al-Gaddafi	Tripolis	Olga	T-shirt for Cosies	20	12
07.11.2009	al-Gaddafi	Tripolis	Bari	Skirt for Cosies	40	12
08.11.2009	Depp	Los Angeles	Pascal	Lady's Phone green	230	1
09.11.2009	Sarkozy	Paris	Julia	Lady's Phone orange	200	2
09.11.2009	Sarkozy	Paris	Julia	Lady's Phone pink	230	1
10.11.2009	Sarkozy	Paris	Julia	Lady's Phone green	230	1

Entity-Relationship Model

data given

↓

decomposition/normalisation

↓

conceptual schema

↑

transition

↑

entity-relationship model