IT 775
Database Technology

SQL

Functional Dependencies

FUNCTIONAL DEPENDENCIES

Functional dependency - occurs when the value of one (or more) column(s) in each record of a relation uniquely determines the value of another column in that same record of the relation

For example

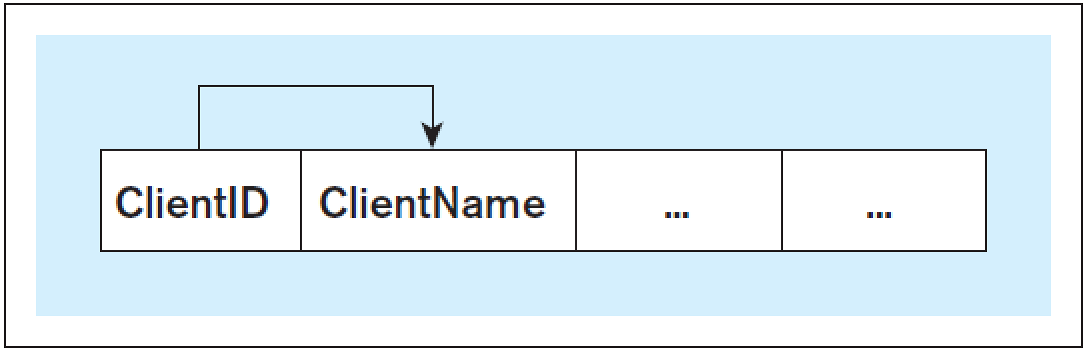
A → B

ClientID → ClientName

FUNCTIONAL DEPENDENCIES

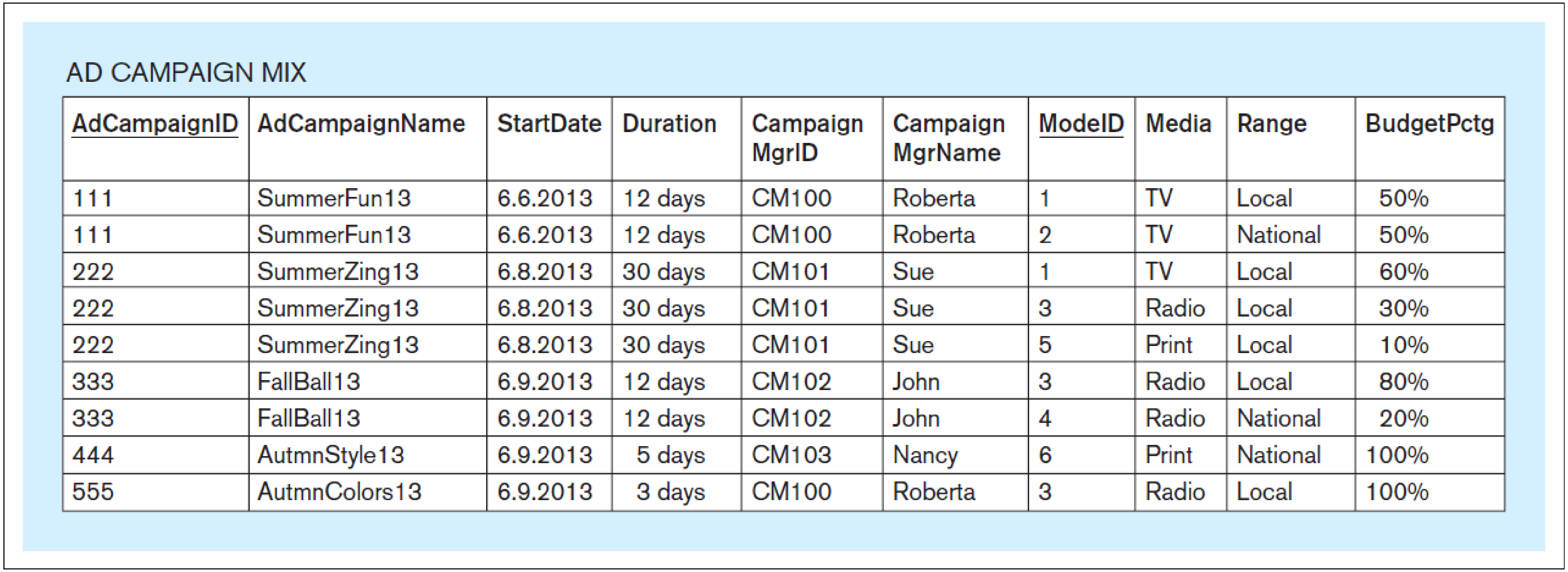
Two functional dependency notations

ClientID → ClientName



ClientID	ClientName	...	...

Example relation AD CAMPAIGN MIX

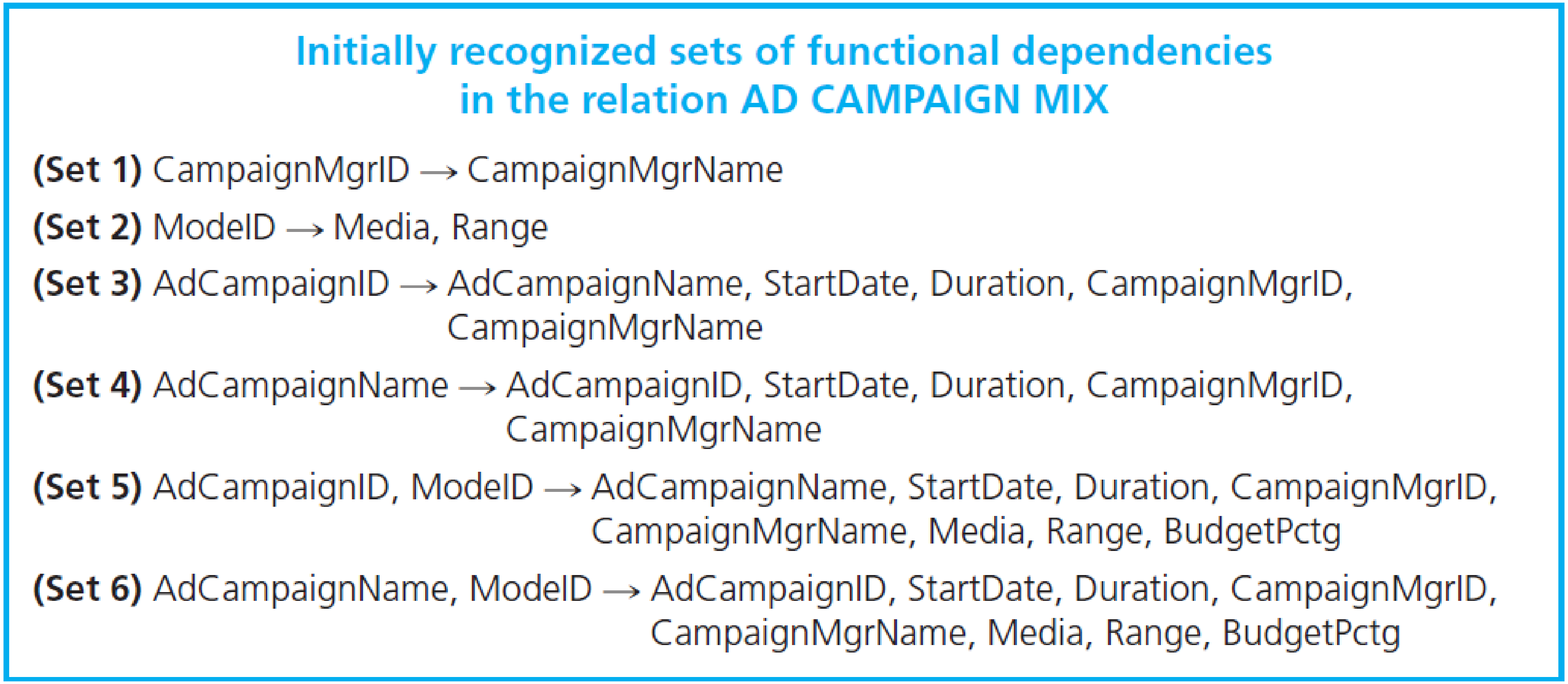


AD CAMPAIGN MIX

AdCampaignID	AdCampaignName	StartDate	Duration	Campaign MgrID	Campaign MgrName	ModelID	Media	Range	BudgetPctg
111	SummerFun13	6.6.2013	12 days	CM100	Roberta	1	TV	Local	50%
111	SummerFun13	6.6.2013	12 days	CM100	Roberta	2	TV	National	50%
222	SummerZing13	6.8.2013	30 days	CM101	Sue	1	TV	Local	60%
222	SummerZing13	6.8.2013	30 days	CM101	Sue	3	Radio	Local	30%
222	SummerZing13	6.8.2013	30 days	CM101	Sue	5	Print	Local	10%
333	FallBall13	6.9.2013	12 days	CM102	John	3	Radio	Local	80%
333	FallBall13	6.9.2013	12 days	CM102	John	4	Radio	National	20%
444	AutmnStyle13	6.9.2013	5 days	CM103	Nancy	6	Print	National	100%
555	AutmnColors13	6.9.2013	3 days	CM100	Roberta	3	Radio	Local	100%

FUNCTIONAL DEPENDENCIES

Example



Initially recognized sets of functional dependencies in the relation AD CAMPAIGN MIX

(Set 1) CampaignMgrID → CampaignMgrName

(Set 2) ModelD → Media, Range

(Set 3) AdCampaignID → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName

(Set 4) AdCampaignName → AdCampaignID, StartDate, Duration, CampaignMgrID, CampaignMgrName

(Set 5) AdCampaignID, ModelD → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName, Media, Range, BudgetPctg

(Set 6) AdCampaignName, ModelD → AdCampaignID, StartDate, Duration, CampaignMgrID, CampaignMgrName, Media, Range, BudgetPctg

FUNCTIONAL DEPENDENCIES

Streamlining functional dependencies

Not all functional dependencies need to be depicted

The following types of functional dependencies can be omitted:

- **Trivial functional dependencies**
- **Augmented functional dependencies**
- **Equivalent functional dependencies**

FUNCTIONAL DEPENDENCIES

Trivial functional dependency - *occurs when an attribute (or a set of attributes) functionally determines itself or its subset*

For example:

A → A

A, B → A, B

A, B → A

CampaignMgrID, CampaignMgrName → CampaignMgrName

Trivial functional dependencies are not depicted

FUNCTIONAL DEPENDENCIES

Augmented functional dependency - *functional dependency that contains an existing functional dependency*

For example if a functional dependency :

A → B

exists in a relation, then :

A, C → B

is an *augmented functional dependency*

Does not add new information to what is already described by the existing functional dependency

It can be omitted

FUNCTIONAL DEPENDENCIES

AD CAMPAIGN MIX example

- Functional dependencies (Set 3):

AdCampaignID → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName

- Augmented functional dependencies (in Set 5) due to Set 3:

AdCampaignID, ModelID → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName

can be omitted

FUNCTIONAL DEPENDENCIES

AD CAMPAIGN MIX example

- Functional dependencies (Set 2):

  ModelID → Media, Range

- Augmented functional dependencies (in Set 5) due to Set 2:

  AdCampaignID, ModelID → Media, Range

  can be omitted

FUNCTIONAL DEPENDENCIES

Equivalent functional dependency - *occurs when two columns (or sets of columns) that functionally determine each other determine other columns*

If one of the equivalent functional dependencies is depicted, the other equivalent functional dependency can be omitted

For example if functional dependencies :

A → B
B → A

exists in a relation, then :

A → B
B → A

are equivalent functional dependencies, and:

A → B, X
B → A, X

are equivalent functional dependencies, and:

Y,A → B, X
Y,B → A, X

are equivalent functional dependencies

FUNCTIONAL DEPENDENCIES

AD CAMPAIGN MIX example

Because the functional dependency:

AdCampaignID → AdCampaignName

and the functional dependency:

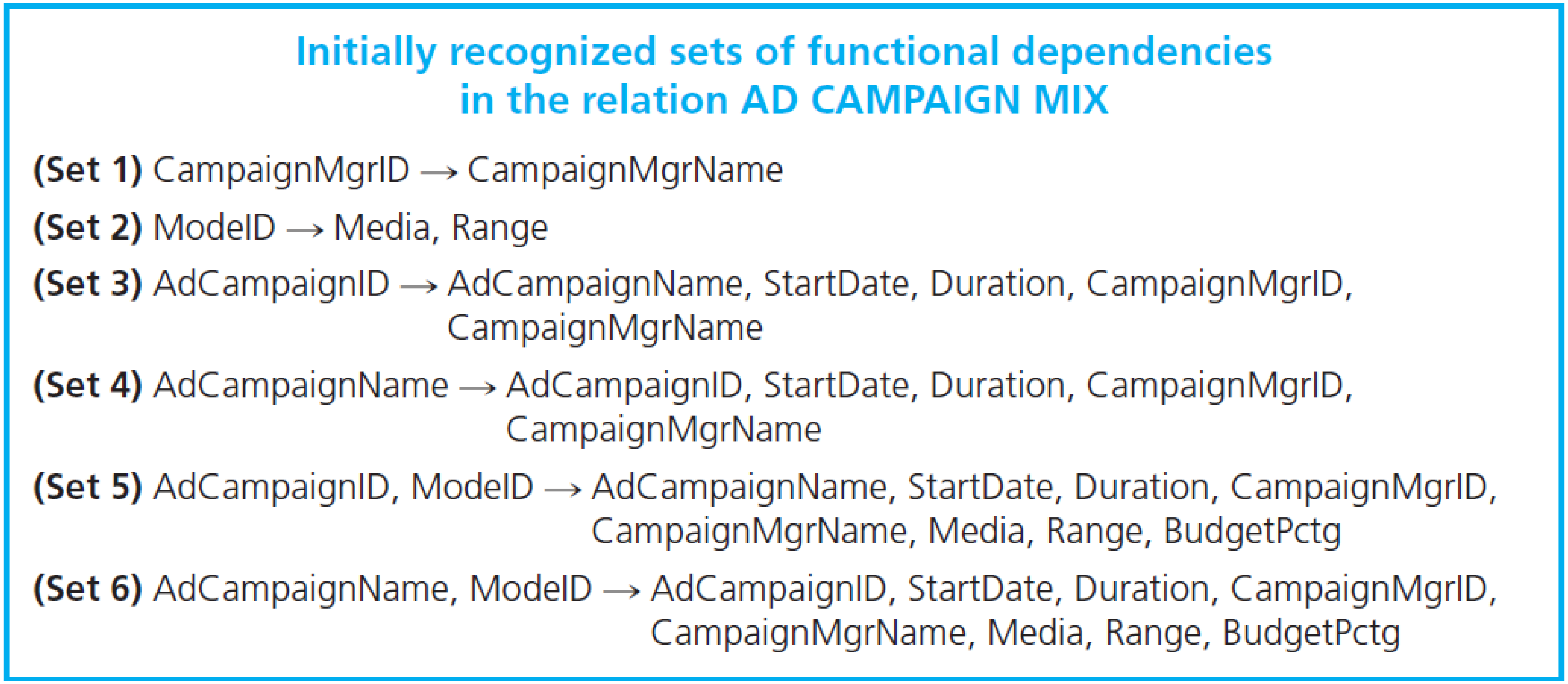
AdCampaignName → AdCampaignID

are equivalent,
Set 3 and Set 4 are *equivalent sets* and
Set 5 and Set 6 are also *equivalent sets*

Set 4 can be omitted from depiction because it is equivalent to Set 3
Set 6 can be omitted from depiction because it is equivalent to Set 5

FUNCTIONAL DEPENDENCIES

Example - streamlining functional dependencies



Initially recognized sets of functional dependencies in the relation AD CAMPAIGN MIX

(Set 1) CampaignMgrID → CampaignMgrName

(Set 2) ModelD → Media, Range

(Set 3) AdCampaignID → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName

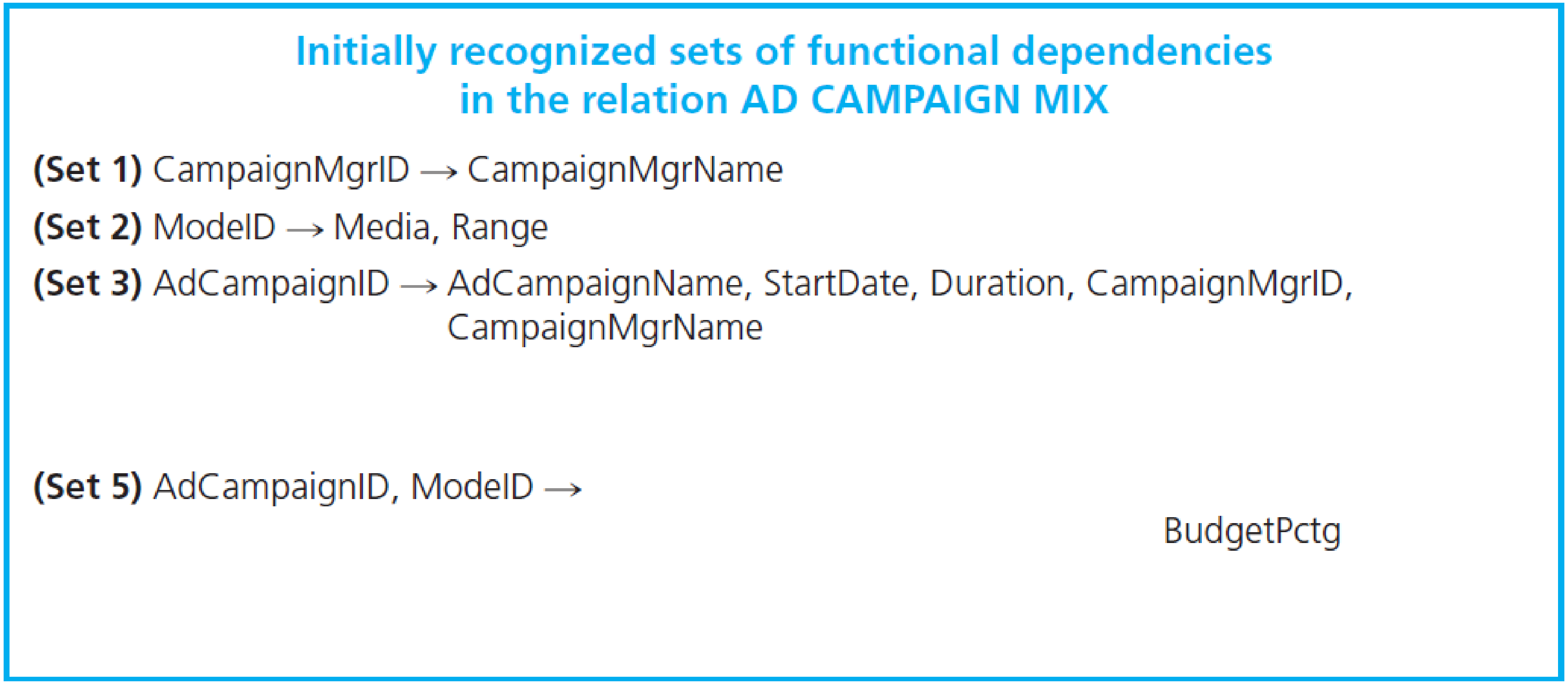
(Set 4) AdCampaignName → AdCampaignID, StartDate, Duration, CampaignMgrID, CampaignMgrName

(Set 5) AdCampaignID, ModelD → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName, Media, Range, BudgetPctg

(Set 6) AdCampaignName, ModelD → AdCampaignID, StartDate, Duration, CampaignMgrID, CampaignMgrName, Media, Range, BudgetPctg

FUNCTIONAL DEPENDENCIES

Example - streamlining functional dependencies



Initially recognized sets of functional dependencies in the relation AD CAMPAIGN MIX

(Set 1) CampaignMgrID → CampaignMgrName

(Set 2) ModelD → Media, Range

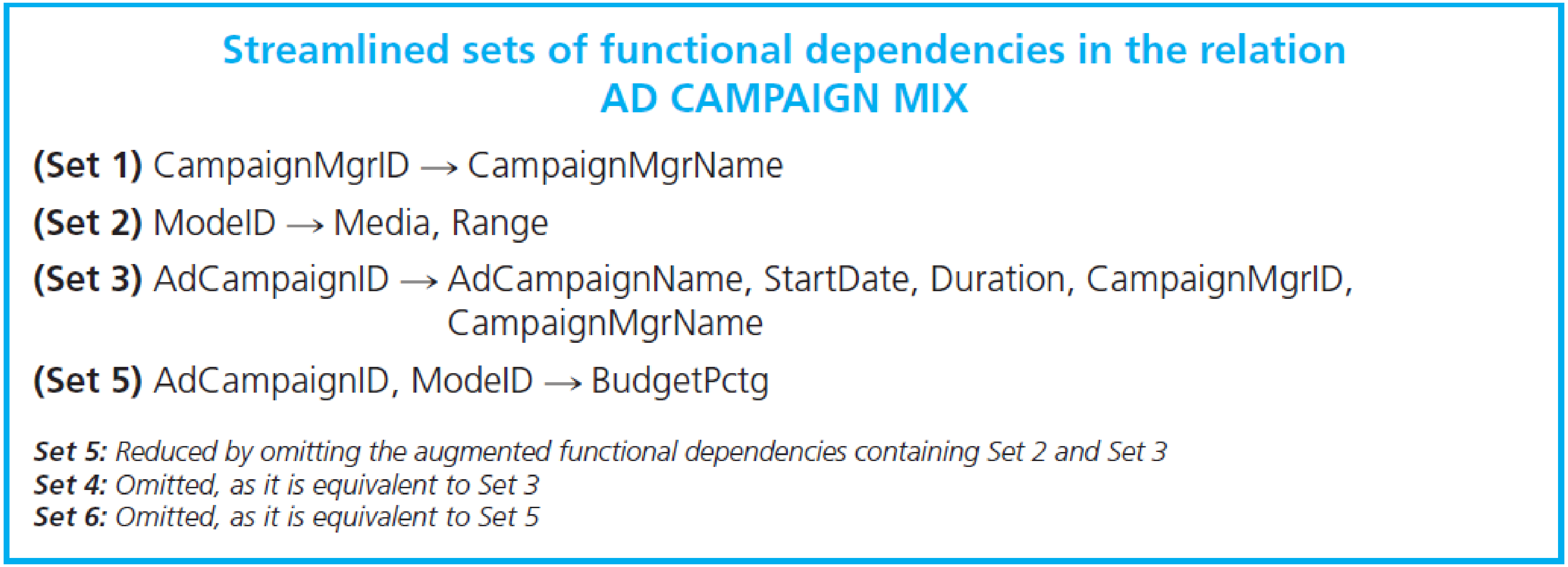
(Set 3) AdCampaignID → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName

(Set 5) AdCampaignID, ModelD →

BudgetPctg

FUNCTIONAL DEPENDENCIES

Example – streamlined functional dependencies



Streamlined sets of functional dependencies in the relation AD CAMPAIGN MIX

(Set 1) CampaignMgrID → CampaignMgrName

(Set 2) ModelD → Media, Range

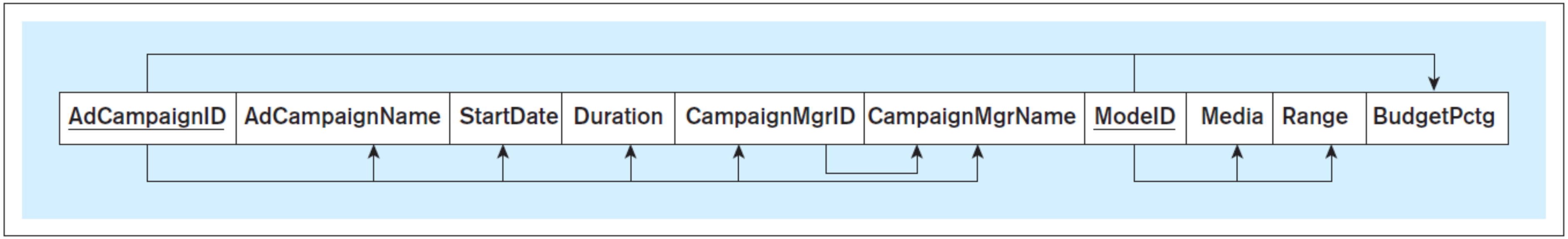
(Set 3) AdCampaignID → AdCampaignName, StartDate, Duration, CampaignMgrID, CampaignMgrName

(Set 5) AdCampaignID, ModelD → BudgetPctg

Set 5: *Reduced by omitting the augmented functional dependencies containing Set 2 and Set 3*
Set 4: *Omitted, as it is equivalent to Set 3*
Set 6: *Omitted, as it is equivalent to Set 5*

FUNCTIONAL DEPENDENCIES

Example – streamlined functional dependencies (another notation)



AdCampaignID	AdCampaignName	StartDate	Duration	CampaignMgrID	CampaignMgrName	ModelID	Media	Range	BudgetPctg

FUNCTIONAL DEPENDENCIES

Types of functional dependencies

The functional dependencies that are used as a basis for the typical normalization process can be classified in one of the three categories:

- **Partial functional dependency**
- **Full key functional dependency**
- **Transitive functional dependency**

FUNCTIONAL DEPENDENCIES

Partial functional dependency - *occurs when a column of a relation is functionally dependent on a component of a composite primary key*

Only composite primary keys have separate components, while single-column primary keys do not have separate components

Hence, partial functional dependency can occur only in cases when a relation has a composite primary key

FUNCTIONAL DEPENDENCIES

Partial functional dependencies (in **AD CAMPAIGN MIX** example)

AdCampaignID → AdCampaignName, StartDate, Duration,
CampaignMgrID, CampaignMgrName

ModelD → Media, Range

FUNCTIONAL DEPENDENCIES

Full key functional dependency - *occurs when a primary key functionally determines the column of a relation and no separate component of the primary key partially determines the same column*

- If a relation has a single component (non-composite) primary key, the primary key fully functionally determines all the other columns of a relation
- If a relation has a composite key, and portions of the key partially determine columns of a relation, then the primary key does not fully functionally determine the partially determined columns

FUNCTIONAL DEPENDENCIES

Full key functional dependency (in **AD CAMPAIGN MIX** example)

AdCampaignID, ModelID → BudgetPctg

FUNCTIONAL DEPENDENCIES

Transitive functional dependency - *occurs when nonkey columns functionally determine other nonkey columns of a relation*

Nonkey column is a column in a relation that is neither a primary nor a candidate key column.

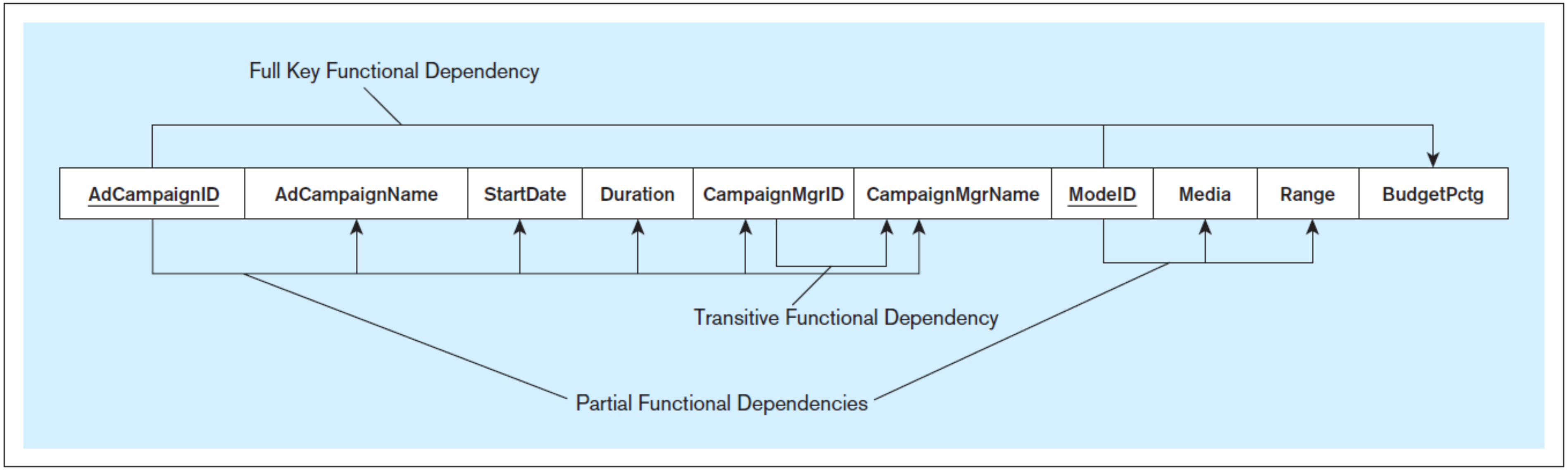
FUNCTIONAL DEPENDENCIES

Transitive functional dependency (in **AD CAMPAIGN MIX** example)

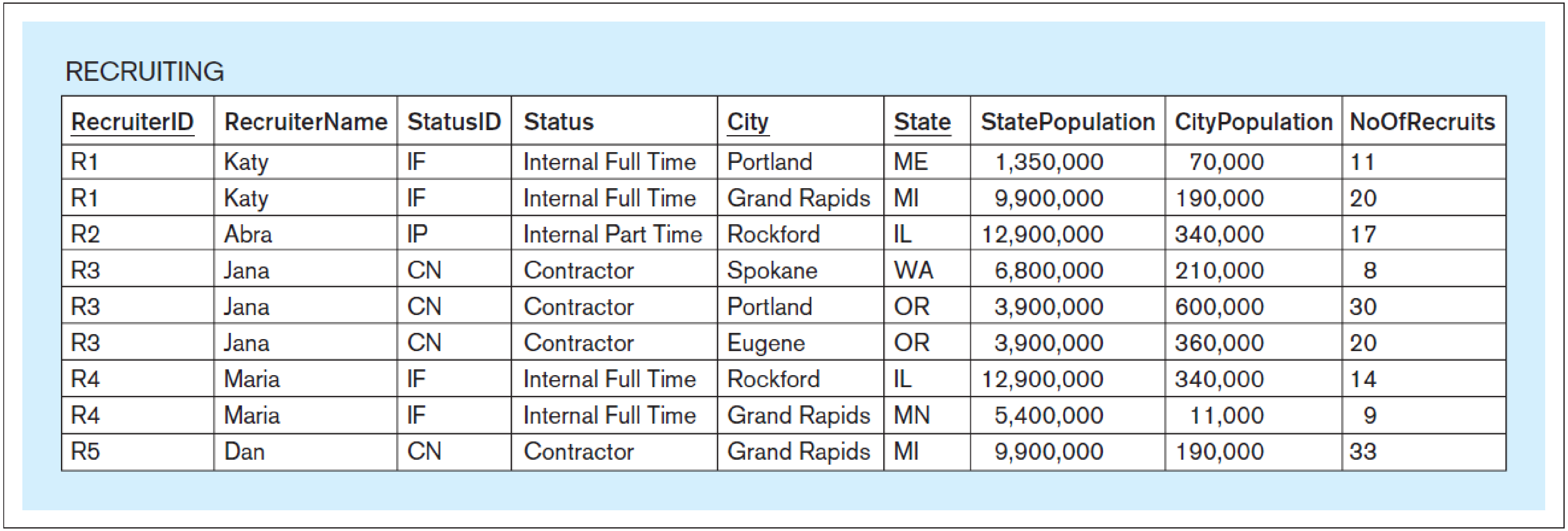
CampaignMgrID → **CampaignMgrName**

FUNCTIONAL DEPENDENCIES

Functional dependencies in the relation AD CAMPAIGN MIX (types indicated)



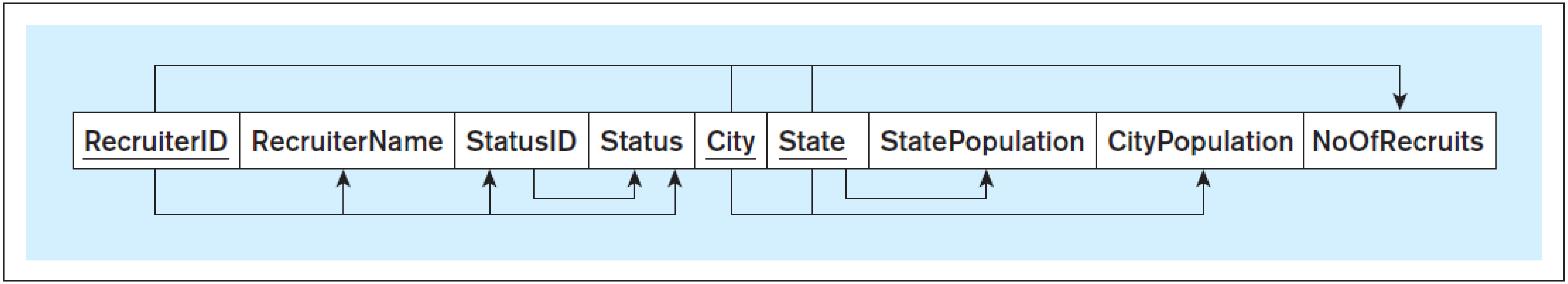
Example relation RECRUITING



RECRUITING

RecruiterID	RecruiterName	StatusID	Status	City	State	StatePopulation	CityPopulation	NoOfRecruits
R1	Katy	IF	Internal Full Time	Portland	ME	1,350,000	70,000	11
R1	Katy	IF	Internal Full Time	Grand Rapids	MI	9,900,000	190,000	20
R2	Abra	IP	Internal Part Time	Rockford	IL	12,900,000	340,000	17
R3	Jana	CN	Contractor	Spokane	WA	6,800,000	210,000	8
R3	Jana	CN	Contractor	Portland	OR	3,900,000	600,000	30
R3	Jana	CN	Contractor	Eugene	OR	3,900,000	360,000	20
R4	Maria	IF	Internal Full Time	Rockford	IL	12,900,000	340,000	14
R4	Maria	IF	Internal Full Time	Grand Rapids	MN	5,400,000	11,000	9
R5	Dan	CN	Contractor	Grand Rapids	MI	9,900,000	190,000	33

Example relation RECRUITING (functional dependencies shown)



RecruiterID | RecruiterName | StatusID | Status | City | State | StatePopulation | CityPopulation | NoOfRecruits