Relational Model

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Introduction

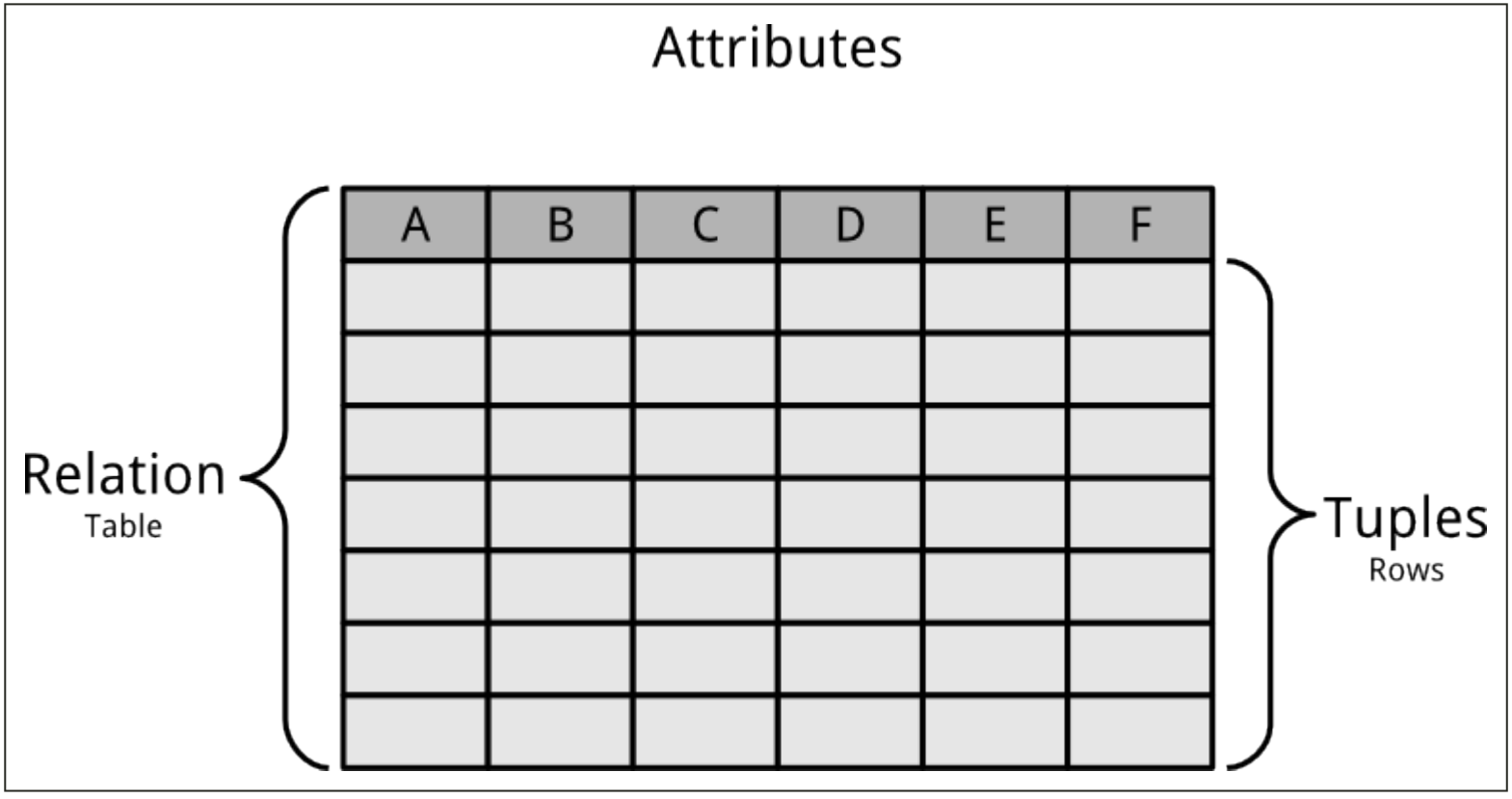
Relational Model

- A simple **Database model** based on first-order predicate logic.
- First formulated and proposed in **1969** by Edgar F. **Codd**.
- But still the most used model for databases.

Principles

- Relational Model:
  - Set of **relations** (tables)
  - Composed by **tuples** and **attributes** (rows and columns)
- Subject to **constraints**
- Relation:
  - Relation name
  - Attributes
  - Constraints

Relation



Tuples

- The lines of a relation.
- Ordered sequence of values.
- Tuples do not have a specific order between them.
- Tuple values are atomic (no composite or multi-value).

Notation

The notation used to represent a basic relation is the following:

Relation Name	attribute_1	attribute_2	...	attribute_n

Example for an employee:

Employee	id	name	address	telephone

Values

Domain

- The set of possible values for a given attribute.
- Can be considered a **constraint** on the value of the attribute.
- Examples:
  - integer values
  - email addresses
  - text
- For certain attributes, **null** can be a possible value. Others don't allow the null value (not null constraint).

Notation

Notation for **not null** attributes:

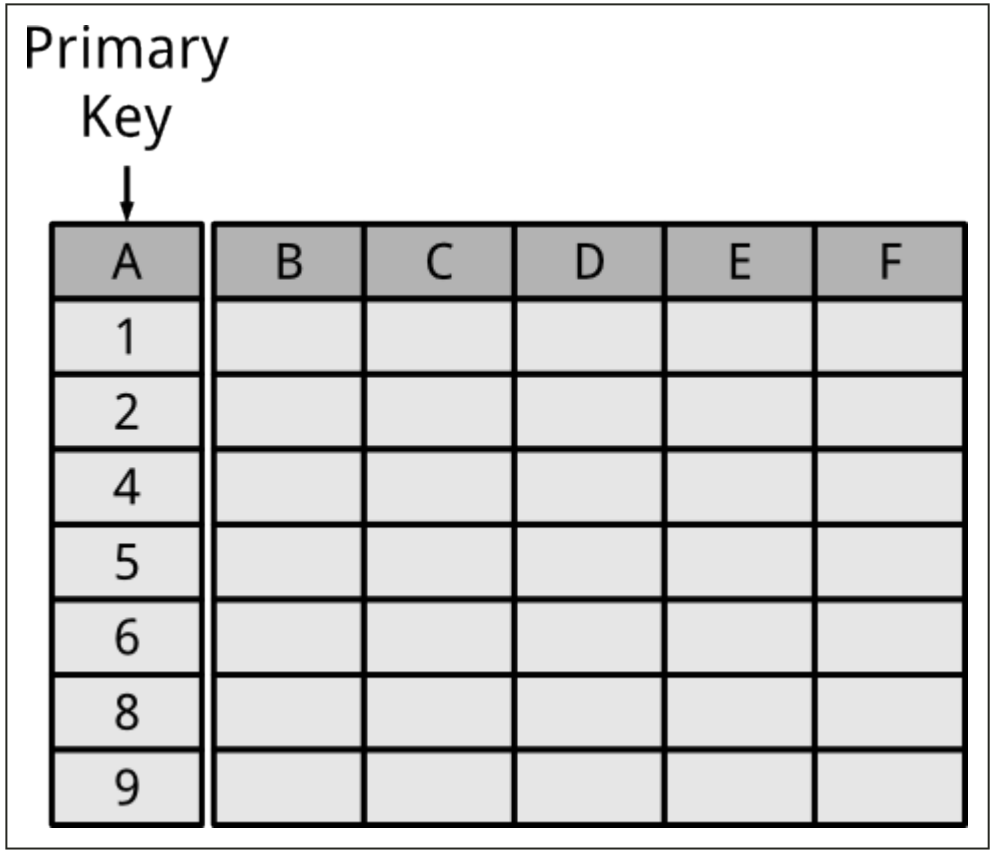
Relation Name	attribute_1	attribute_2 (NN)	...	attribute_n

Primary Keys

Definition

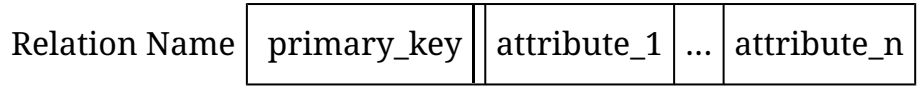
- Primary keys are a set of **one or more** attributes that uniquely define a tuple within a relation.
- They **cannot have repeated** values.
- They **cannot have null** values.
- There can **only** be **one** primary key in each relation.

Table with a Primary Key

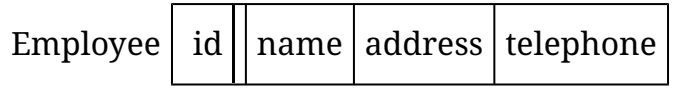


Notation

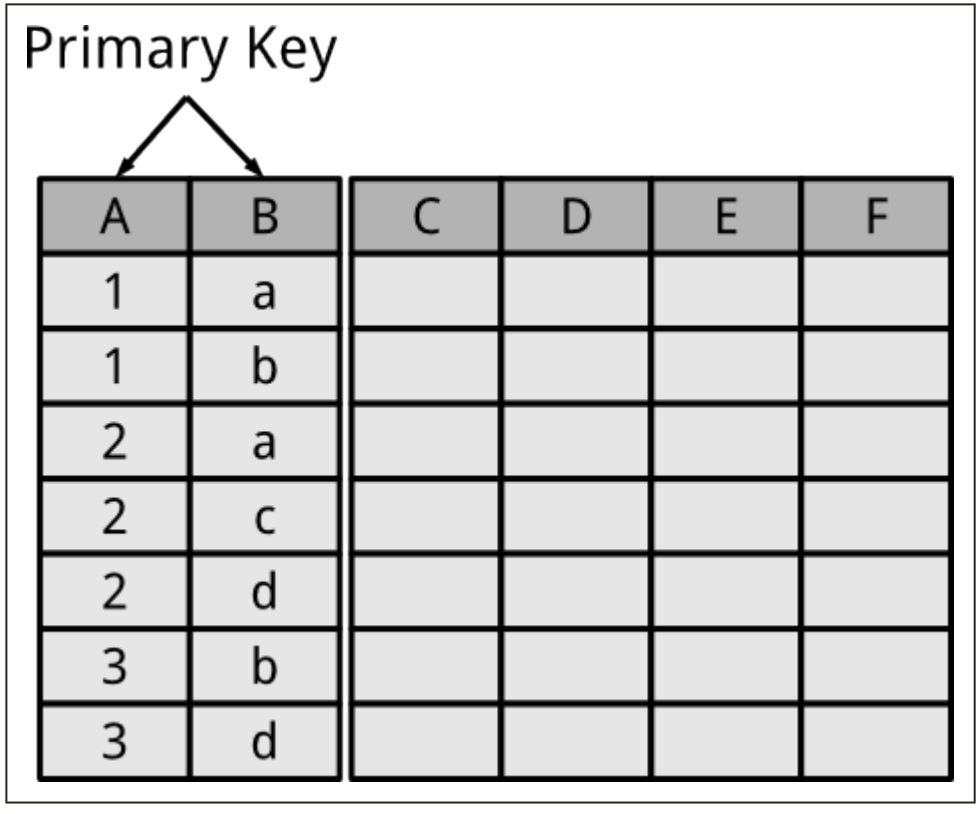
Notation for primary keys:



Example for an employee:



Double Primary Key



A	B	C	D	E	F
1	a				
1	b				
2	a				
2	c				
2	d				
3	b				
3	d				

Notation

Notation for double primary keys:

Relation Name	primary_key_1	primary_key_2	attribute_1	...	attribute_n

Example for a phone list:

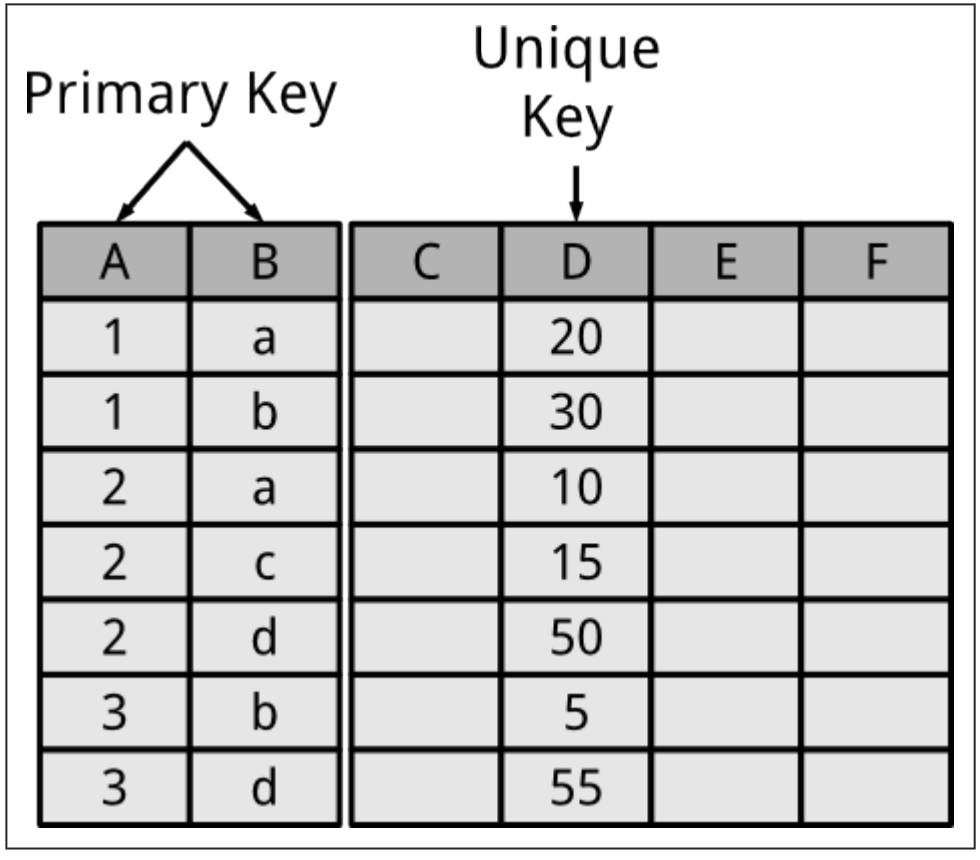
Phone	person	number	type

Unique Keys

Definition

- Unique keys are **similar to primary keys** but **allow null** values.
- A relation can have several unique keys.

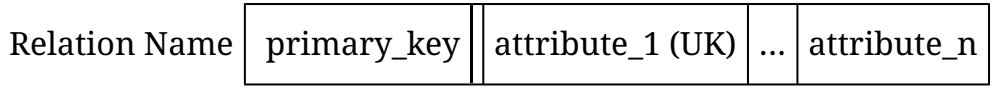
Table with an Unique Key



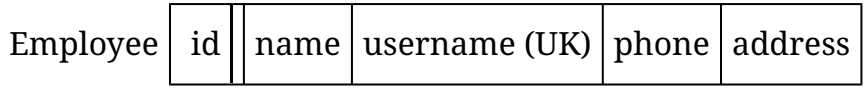
A	B	C	D	E	F
1	a		20		
1	b		30		
2	a		10		
2	c		15		
2	d		50		
3	b		5		
3	d		55		

Notation

Notation for unique keys:



Example for an employee:

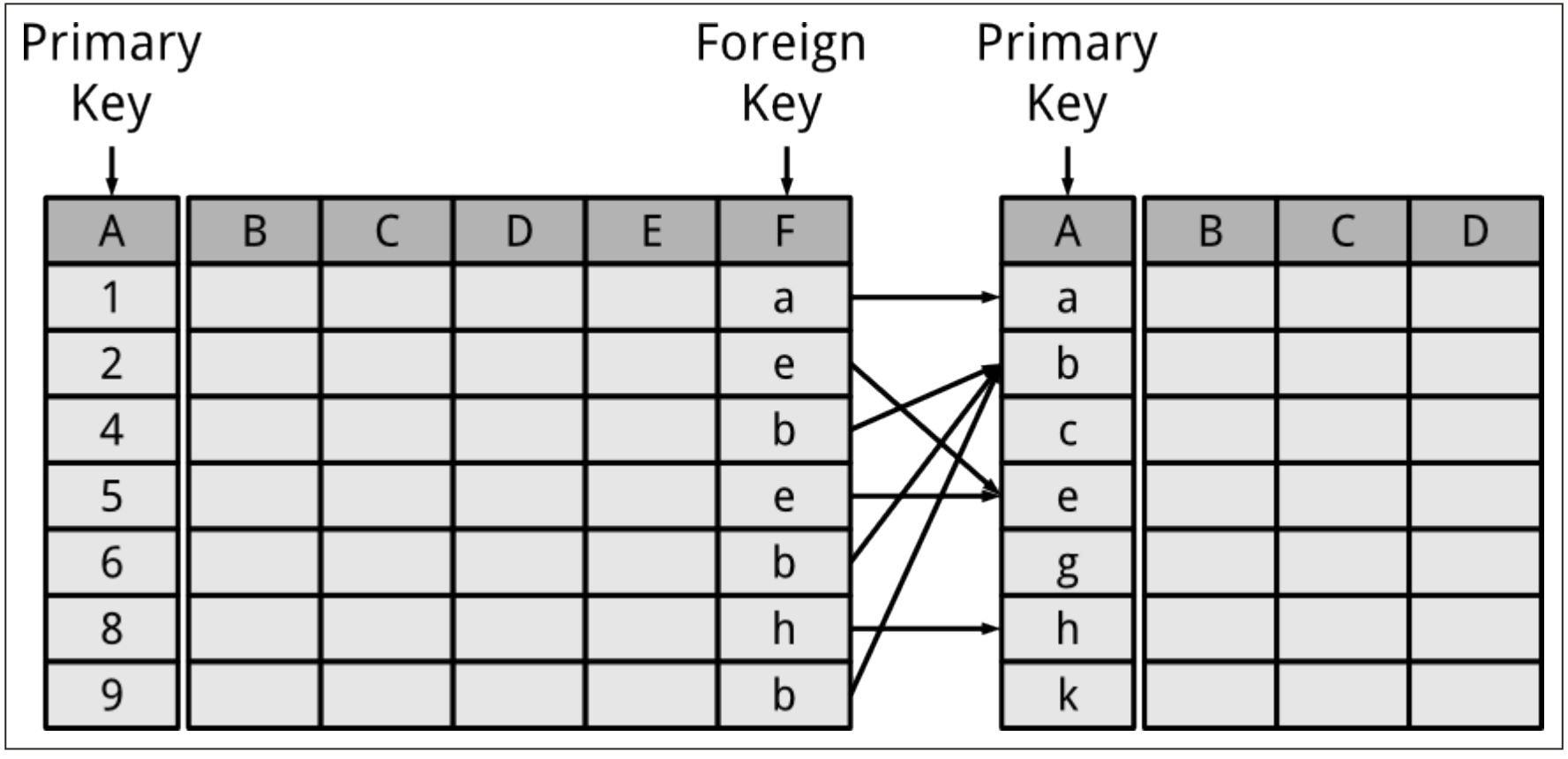


Foreign Keys

Definition

- An **attribute** (or set of attributes) that **always matches a key** attribute in **another** relation.
- Can be used to **cross-reference** relations.
- Possible to use the values of attributes in the referenced relation to restrict the domain of one or more attributes in the referencing relation.

Table with a Foreign Key



Notation

Notation for foreign keys:

Relation Name	primary_key	attribute_1	attribute_2	#foreign_key → referenced_relation

Example for an employee and a department:

Employee	id	name	address	phone	#dep_id → Department

Department	id	name (UK)

Constraints

Summary of Constraints

- **Primary key** values **cannot be null**.
- **Key values** (primary and unique) **cannot have repeated** values.
- **Values** have to belong to the attribute **domain**.
- Attributes with a **not null** constraint **cannot have null** values.
- **Foreign key** attributes can only have values that **exist in the referenced relation**.

Operations

List of Operations

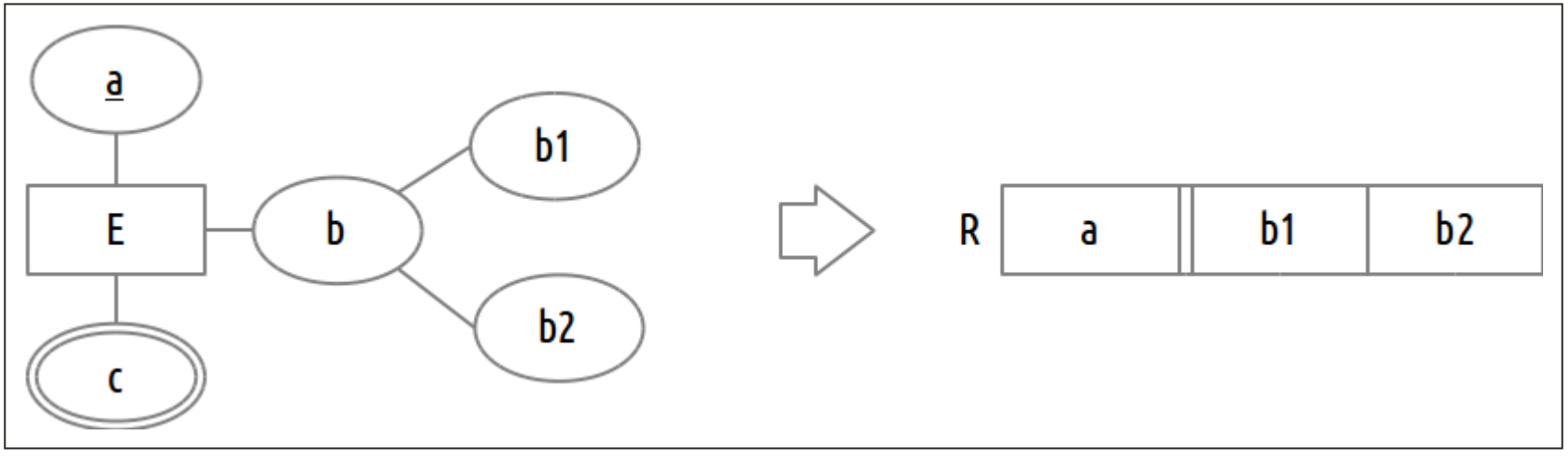
- **Insertion**: Inserts a new tuple into a relation.
- **Deletion**: Deletes one or more tuples from a relation.
- **Update**: Updates one or more tuples.

Entity Relationship to Relational

Step 1. Entity to Relation

- **Every entity** in the entity-relationship model **becomes a relation** in the relational model.
- **Composite attributes** are **separated** into several attributes.
- **Key attributes** become **primary keys**.
- Multi-valued attributes (see step 5).

Step 1. Entity to Relation

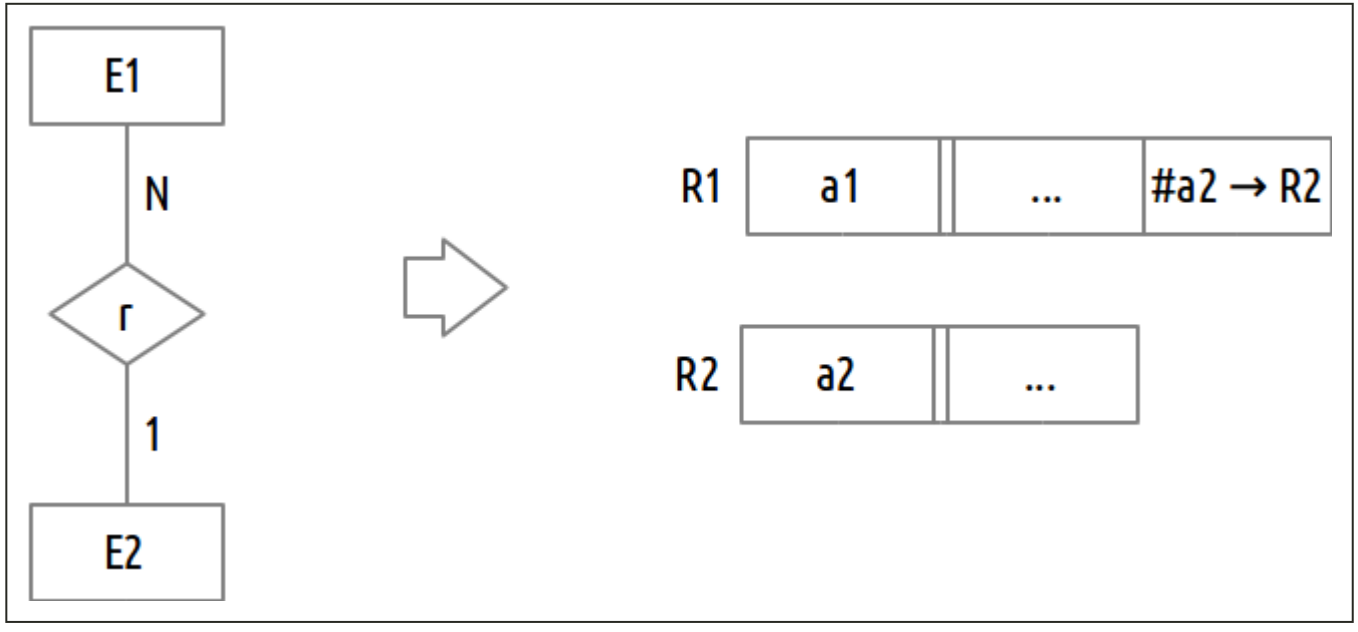


Step 2. Many-to-one relationships

- Add a foreign key **from** the relation in the **many side** of the relationship **to the** relation in the **one side**.
- If the participation of the entity on the **many side** of the relationship is **total**, add a **not null** constraint to the **foreign key**.

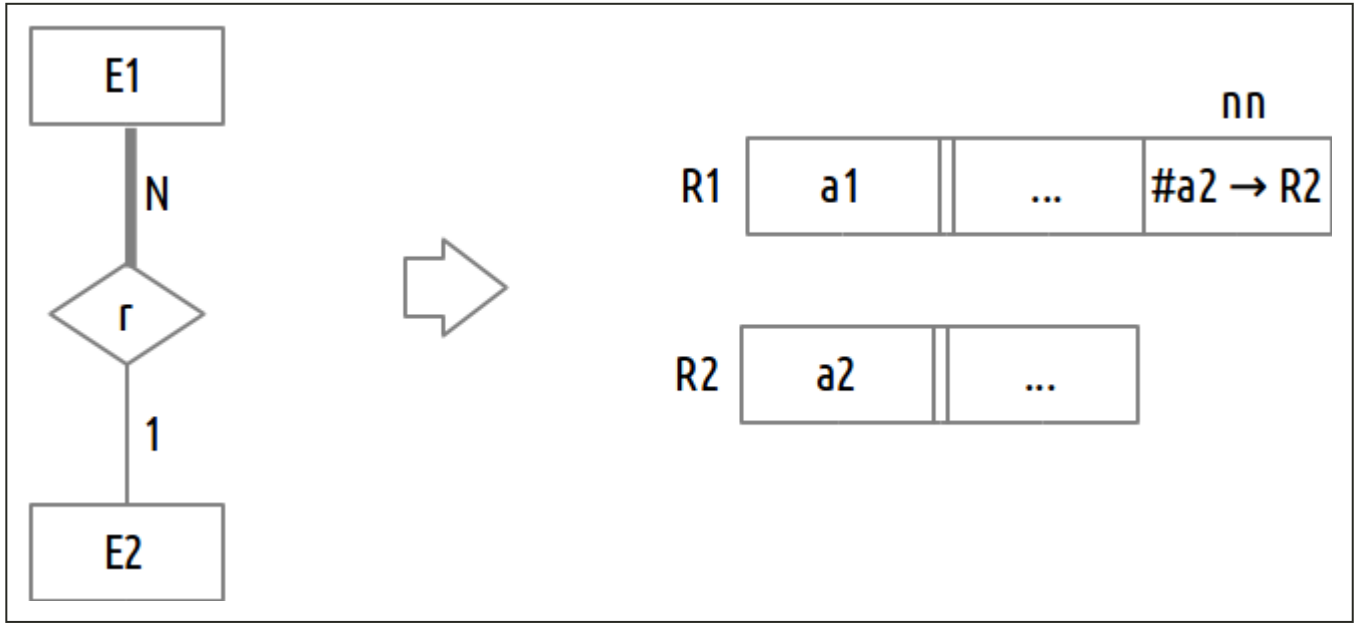
Step 2. Many-to-one relationships

Foreign key always in the **many** side



Step 2. Many-to-one relationships

If the **many** side has **total participation** in the relationship

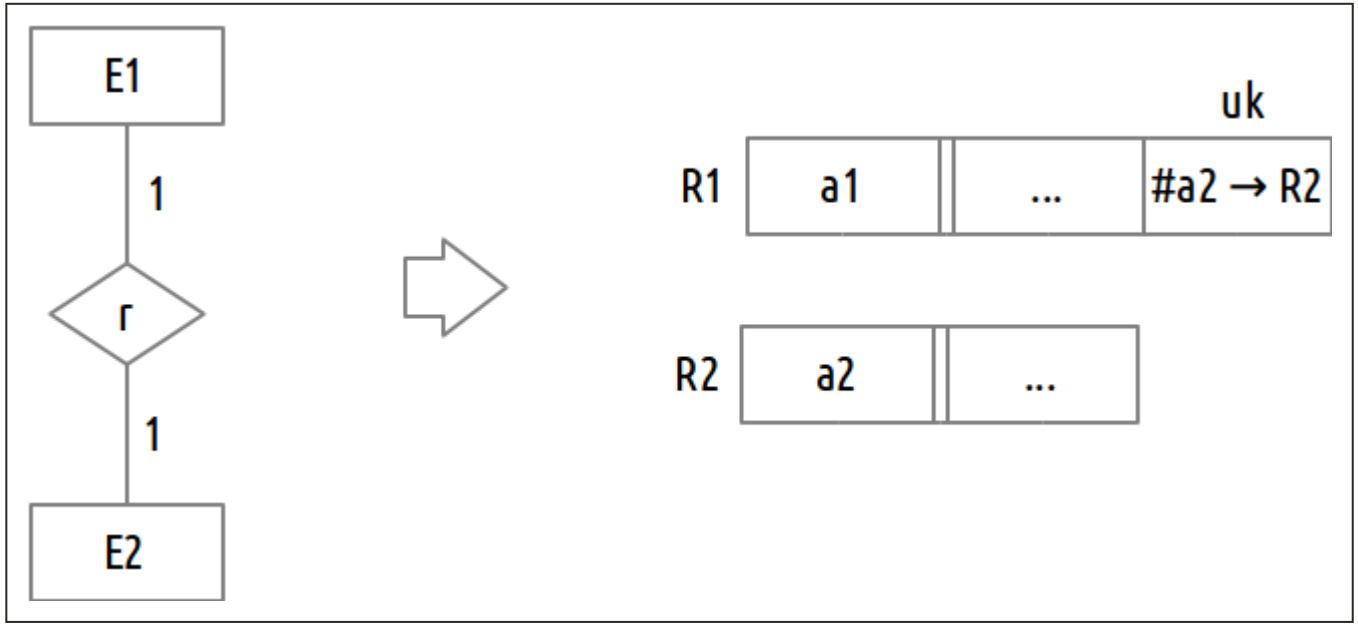


Step 3. One-to-one relationships

- Add a foreign key **from one** of the relations **to the other**.
  - If one of the entities has total participation in the relationship, add the foreign key to that relation and add a not null constraint to it.
  - If none of the entities has a total participation, pick the one expected to have less tuples.
- **Add a unique key** constraint to the **foreign key**.

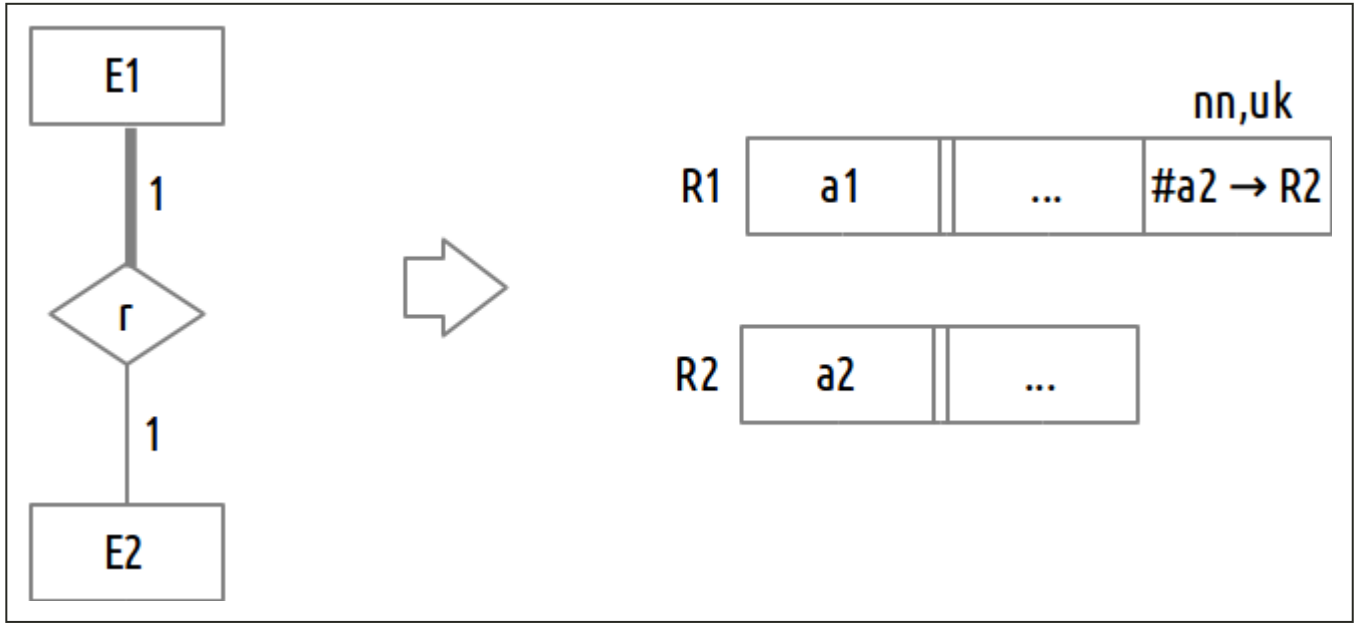
Step 3. One-to-one relationships

When **none** of the entities has a total participation in the relationship choose.



Step 3. One-to-one relationships

When **one** of the entities has a total participation in the relationship choose that one.

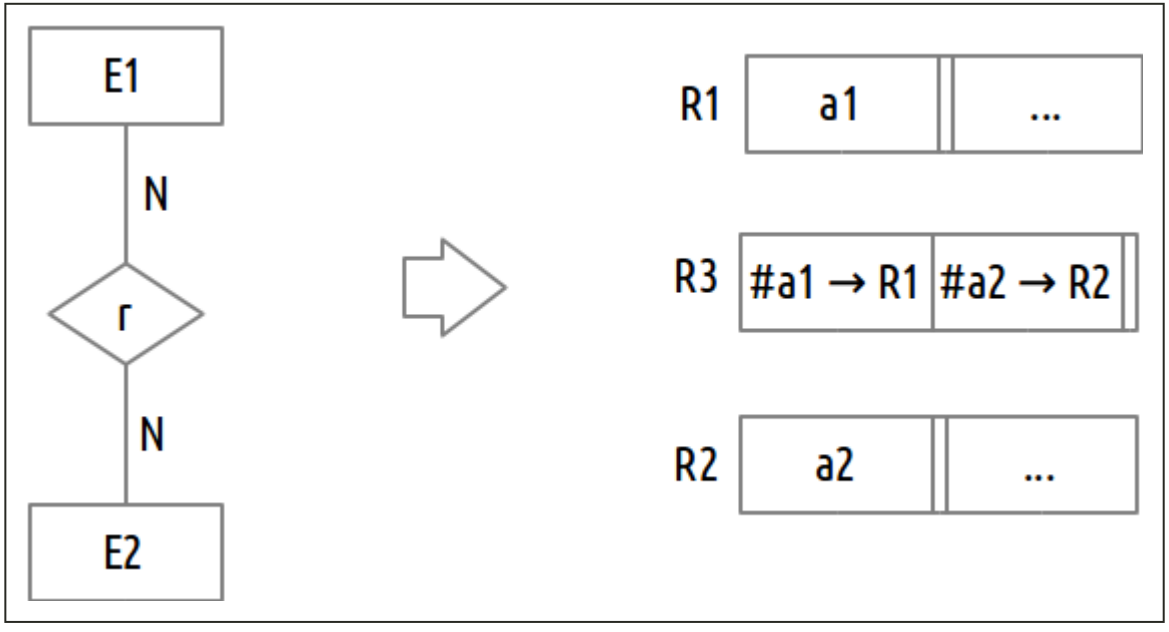


Step 4. Many-to-many relationships

- Add a **new relation** to the model.
- Add **foreign keys** to the new relation **referencing both relations**.
- Select **both foreign keys** as the (double) **primary key** of the new relation.

Step 4. Many-to-many relationships

Always create a new relation with a double foreign key

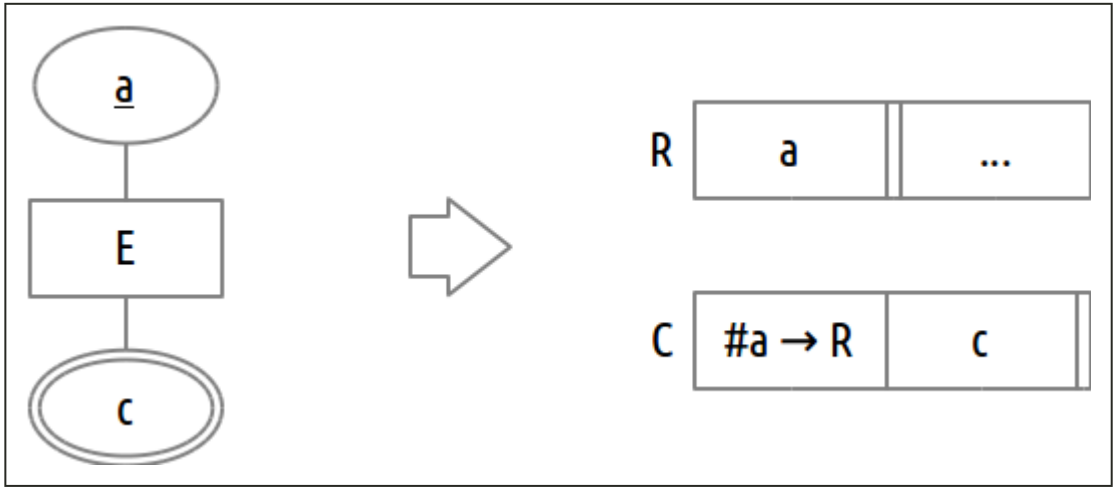


Step 5. Multi-valued attributes

- For each multi-valued attribute create **a new relation**.
- Add the multi-valued **attribute** and a **foreign key**, referencing the relation containing the attribute, to the new relation.
- **Both attributes** (foreign key and attribute) become the **primary key** of the new relation.

Step 5. Multi-values attributes

Always create a new relation with a double foreign key



Example

Example

Employee (id, name, address (city, street, number, appartment))
Department (number, name)
Project (number, name)
Car (plate)
Model (make, model)

manages (Employee, Department) 1:1 p/p
uses (Employee, Car) 1:1 p/t
belongsTo (Employee, Department) N:1 t/p
controls (Employee, Project) 1:N p/p
itsA (Car, Model) N:1 t/p
worksAt (Employee, Project, hours) N:N p/p

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Employee	id	name	city	street	number	apartment

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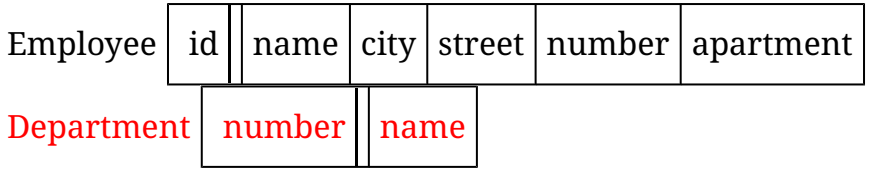

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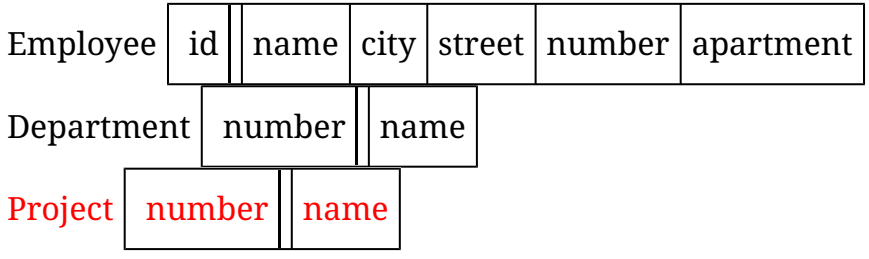

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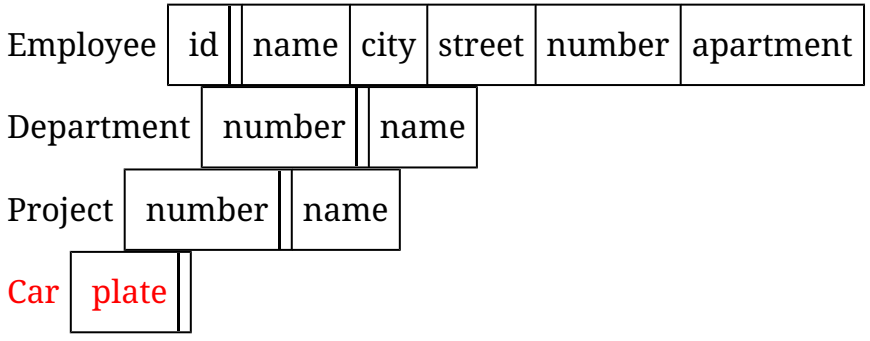

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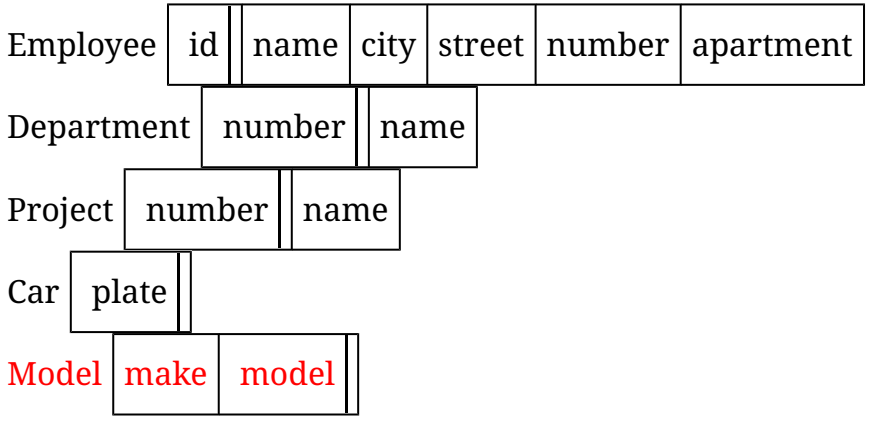

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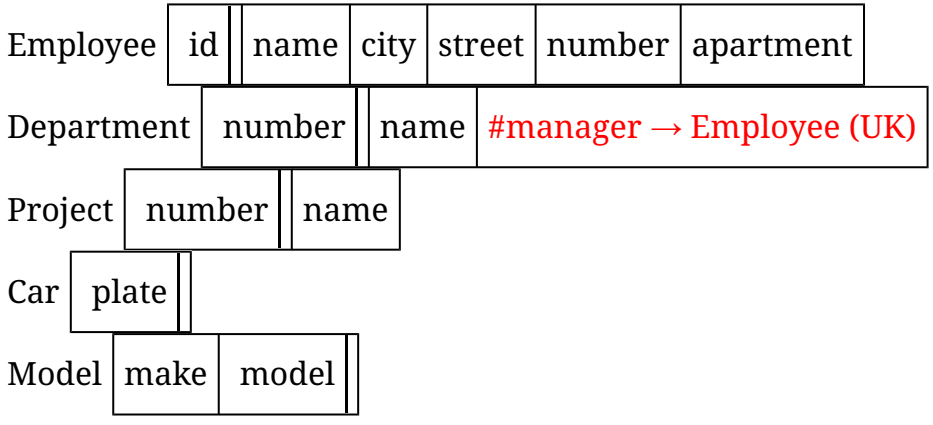

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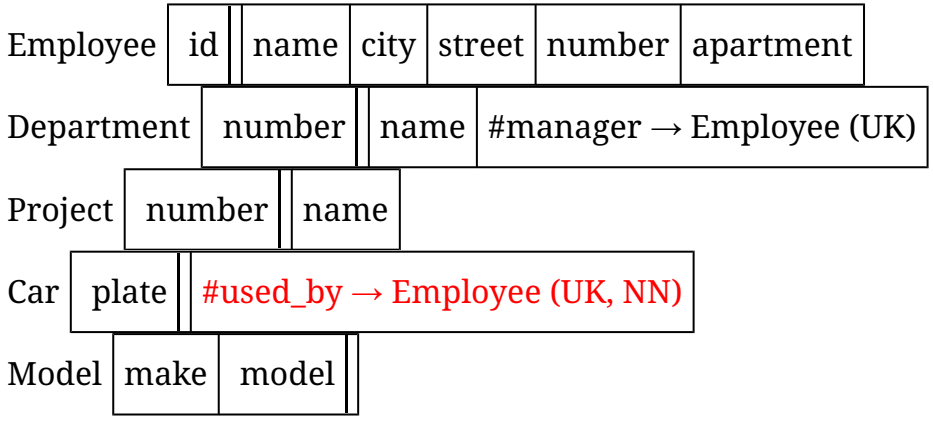

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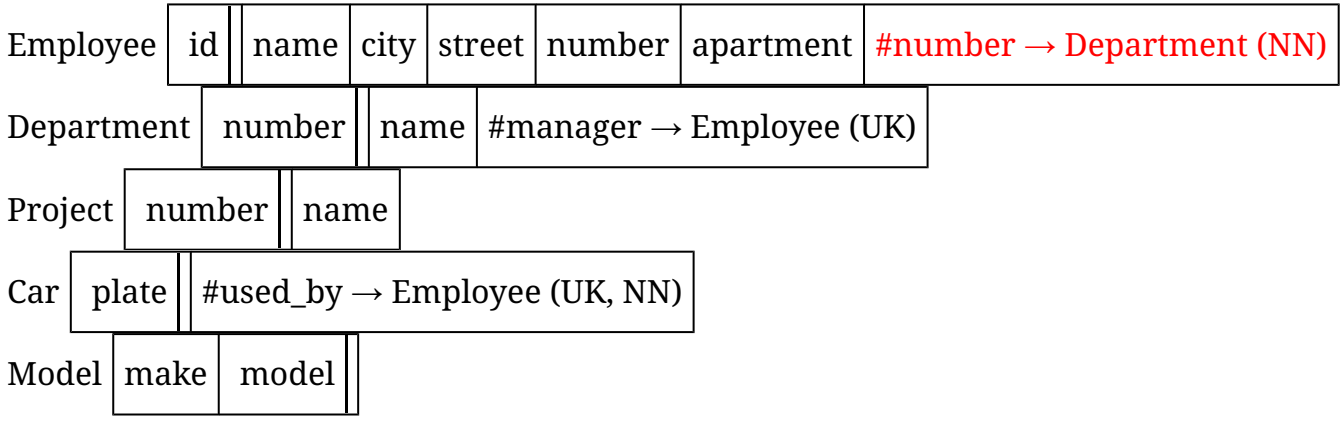

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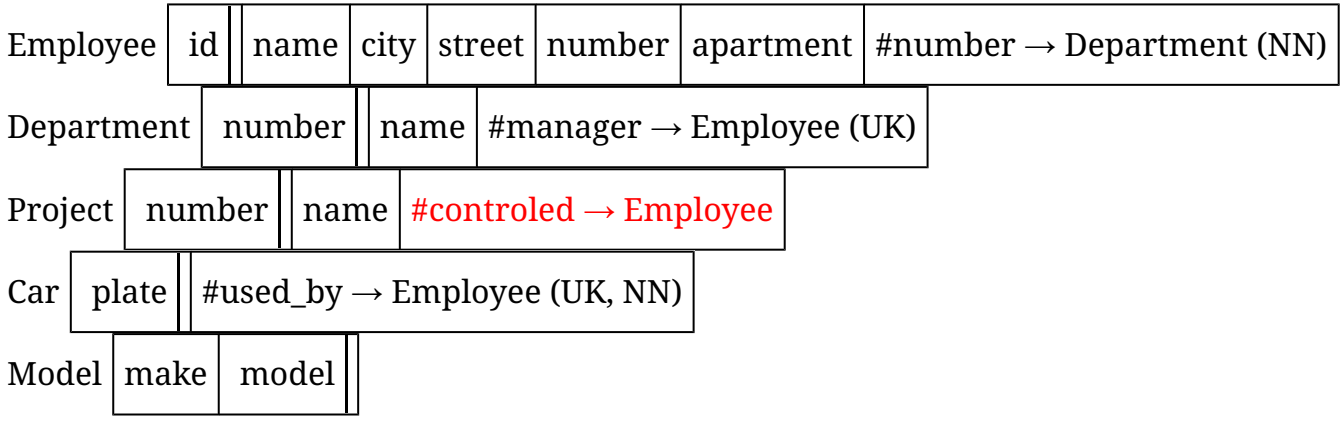

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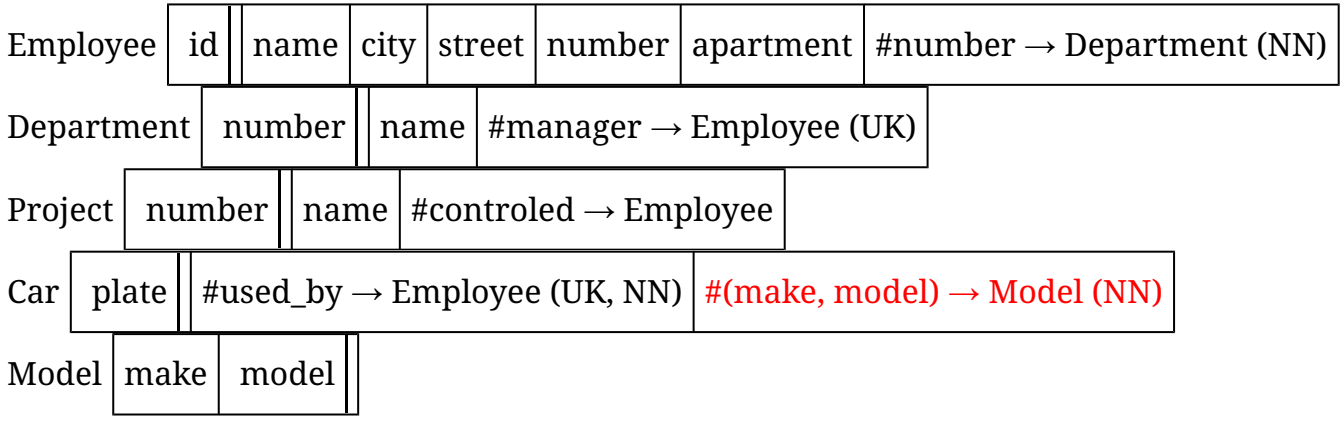

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