



Universität Hamburg

DER FORSCHUNG | DER LEHRE | DER BILDUNG



CHAI

Humanities-Centered AI

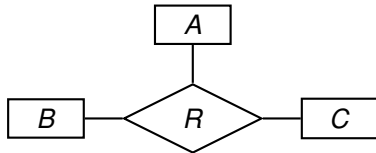
Databases

**Malte Luttermann – Institute for Humanities-Centered
Artificial Intelligence (CHAI)**

October 23, 2025

Topics for Today

- Relational schema
- Refinement of a relational schema
- Functional dependencies



Exercise 1: Relational Schema Specification

Specify the relational schema for the given database.

Table »Employee«:

EmployeeID	Name	Email	HireDate
1	Alice	alice@example.com	01.10.2025
2	Bob	bob@example.com	01.01.2023
3	Carol	carol@example.com	01.01.2024

Table »Project«:

ProjectID	Title	Budget
1	Project A	300.000
2	Project B	200.000
3	Project C	200.000

Table »Department«:

DepartmentID	Name
1	Sales
2	Production

Table »Works_On«:

EmployeeID	ProjectID
1	2
1	3
2	1
3	2

Table »Belongs_To«:

EmployeeID	DepartmentID
1	1
2	2
3	2

Exercise 1: Possible Solution

- Employee: {[EmployeeID, Name, Email, HireDate]}
- Project: {[ProjectID, Title, Budget]}
- Department: {[DepartmentID, Name]}
- Works_On: {[EmployeeID, ProjectID]}
- Belongs_To: {[EmployeeID, DepartmentID]}

Exercise 1: Possible Solution

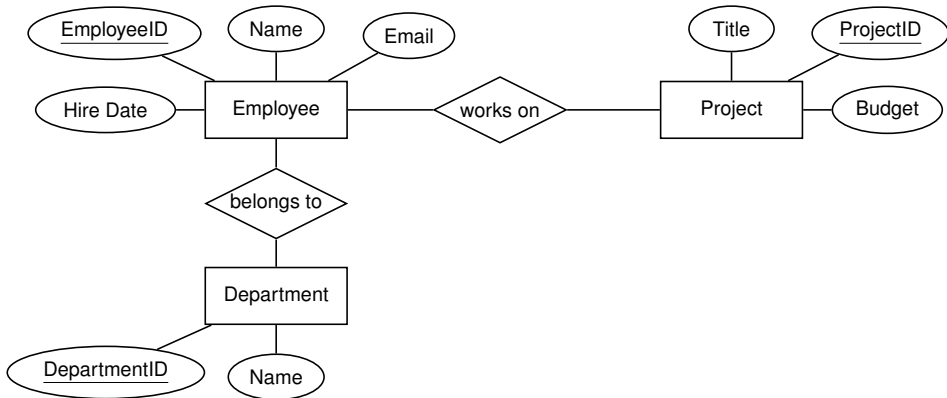
- Employee: {[EmployeeID, Name, Email, HireDate]}
- Project: {[ProjectID, Title, Budget]}
- Department: {[DepartmentID, Name]}
- Works_On: {[EmployeeID, ProjectID]}
- Belongs_To: {[EmployeeID, DepartmentID]}

With types:

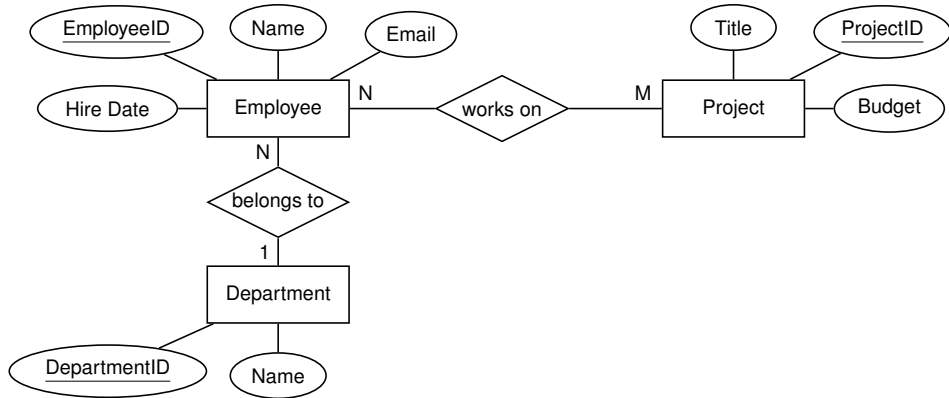
- Employee: {[EmployeeID:integer, Name:string, Email:string, HireDate:date]}
- Project: {[ProjectID:integer, Title:string, Budget:integer]}
- Department: {[DepartmentID:integer, Name:string]}
- Works_On: {[EmployeeID:integer, ProjectID:integer]}
- Belongs_To: {[EmployeeID:integer, DepartmentID:integer]}

Exercise 2: Functionality Specifications (Recap)

Add functionality specifications to the relations in the following ER diagram.

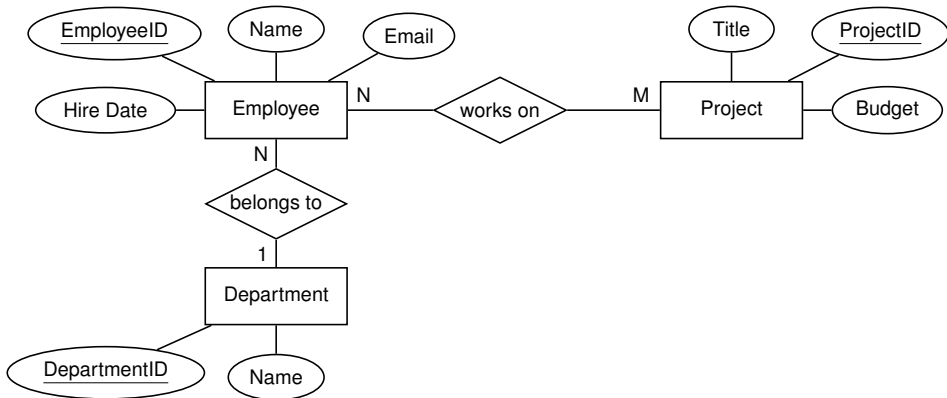


Exercise 2: Possible Solution



Exercise 3: Relational Schema Specification from ER Diagram

Translate the given ER diagram into a relational schema.



Exercise 3: Possible Solution

- Project: {[ProjectID, Title, Budget]}
- Employee: {[EmployeeID, Name, Email, Hire Date]}
- Department: {[DepartmentID, Name]}
- Works_On: {[EmployeeID, ProjectID]}
- Belongs_To: {[EmployeeID, DepartmentID]}

Exercise 3: Possible Solution

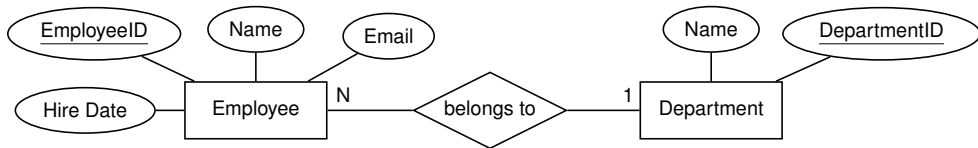
- Project: {[ProjectID, Title, Budget]}
- Employee: {[EmployeeID, Name, Email, Hire Date]}
- Department: {[DepartmentID, Name]}
- Works_On: {[EmployeeID, ProjectID]}
- Belongs_To: {[EmployeeID, DepartmentID]}

With types:

- Employee: {[EmployeeID:integer, Name:string, Email:string, HireDate:date]}
- Project: {[ProjectID:integer, Title:string, Budget:integer]}
- Department: {[DepartmentID:integer, Name:string]}
- Works_On: {[EmployeeID:integer, ProjectID:integer]}
- Belongs_To: {[EmployeeID:integer, DepartmentID:integer]}

Exercise 4: Refinement of a Relational Schema

Translate the given ER diagram into a relational schema and then refine the schema by combining relations.



Exercise 4: Possible Solution

Initial draft:

- Employee: {[EmployeeID, Name, Email, HireDate]}
- Department: {[DepartmentID, Name]}
- Belongs_To: {[EmployeeID, DepartmentID]}

Exercise 4: Possible Solution

Initial draft:

- Employee: {[EmployeeID, Name, Email, HireDate]}
- Department: {[DepartmentID, Name]}
- Belongs_To: {[EmployeeID, DepartmentID]}

Refinement (combine Employee and Belongs_To):

- Employee: {[EmployeeID, Name, Email, HireDate, Belongs_To]}
 - Belongs_To is a foreign key to Department
- Department: {[DepartmentID, Name]}

Exercise 4: Example

Initial relations:

Table »Employee«:

EmployeeID	Name	Email	HireDate
1	Alice	alice@example.com	01.10.2025
2	Bob	bob@example.com	01.01.2023
3	Carol	carol@example.com	01.01.2024

Table »Belongs_To«:

EmployeeID	DepartmentID
1	1
2	2
3	2

Table »Department«:

DepartmentID	Name
1	Sales
2	Production

Exercise 4: Example

Refinement of relations:

Table »Employee«:

EmployeeID	Name	Email	HireDate	Belongs_To
1	Alice	alice@example.com	01.10.2025	1
2	Bob	bob@example.com	01.01.2023	2
3	Carol	carol@example.com	01.01.2024	2

Table »Department«:

DepartmentID	Name
1	Sales
2	Production

Exercise 4: Example

Is it also possible to combine Department and Belongs_To?

Table »Employee«:

EmployeeID	Name	Email	HireDate
1	Alice	alice@example.com	01.10.2025
2	Bob	bob@example.com	01.01.2023
3	Carol	carol@example.com	01.01.2024

Table »Department«:

DepartmentID	Name	Contains
1	Sales	1
2	Production	2
2	Production	3

Exercise 4: Example

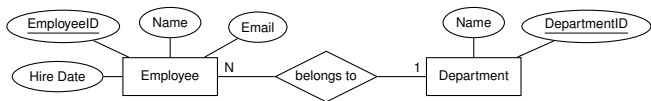
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3	Carol	carol@example.com	01.01.2024

Table »Department«:

DepartmentID	Name	Contains
1	Sales	1
2	Production	2
2	Production	3



No, combining Department and Belongs_To does not work!

Exercise 5: Functional Dependencies

- Schema: $\mathcal{R} = \{A, B, C, D\}$
- Instance R :

A	B	C	D
a_4	b_2	c_4	d_3
a_1	b_1	c_1	d_1
a_1	b_1	c_1	d_2
a_2	b_2	c_3	d_2
a_3	b_2	c_4	d_3

Let $\alpha \subseteq \mathcal{R}$, $\beta \subseteq \mathcal{R}$. It holds that $\alpha \rightarrow \beta$ if and only if $\forall r, s \in R: r.\alpha = s.\alpha \Rightarrow r.\beta = s.\beta$.

Which of the following functional dependencies hold?

- $\{A\} \rightarrow \{B\}$
- $\{C, D\} \rightarrow \{A\}$
- $\{C, D\} \rightarrow \{B\}$
- $\{B\} \rightarrow \{C\}$
- $\{B\} \rightarrow \{A\}$

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