TÉCNICO LISBOA

Data Analysis and Integration

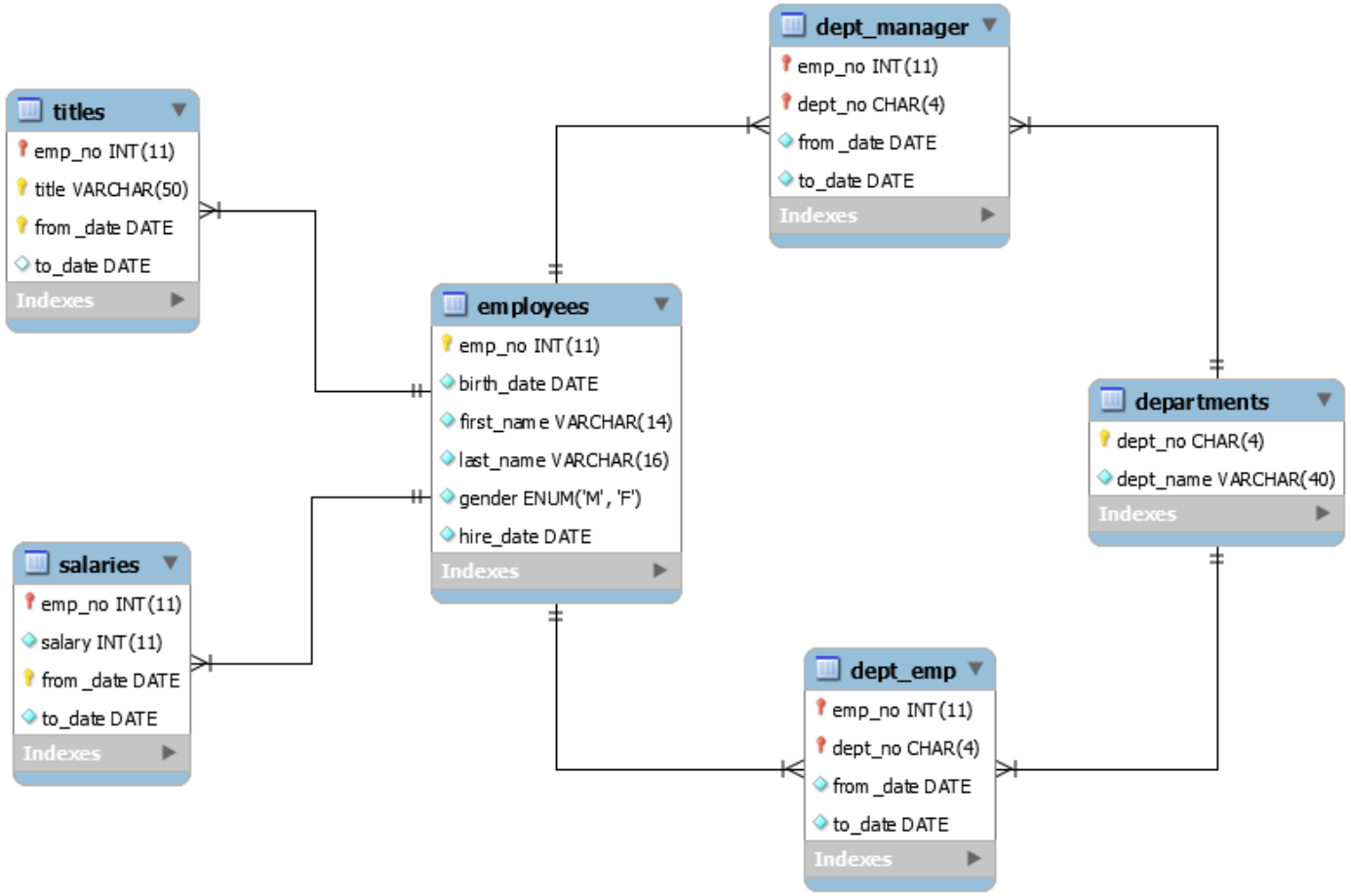
Concepts of data integration

Introduction

- The need for data integration
  - company A merges with company B
  - A is a company with the **employees** database
  - B is a company with the **company** database
  - provide an integrated view of data from both companies
    - e.g. employees, departments, salaries, job titles

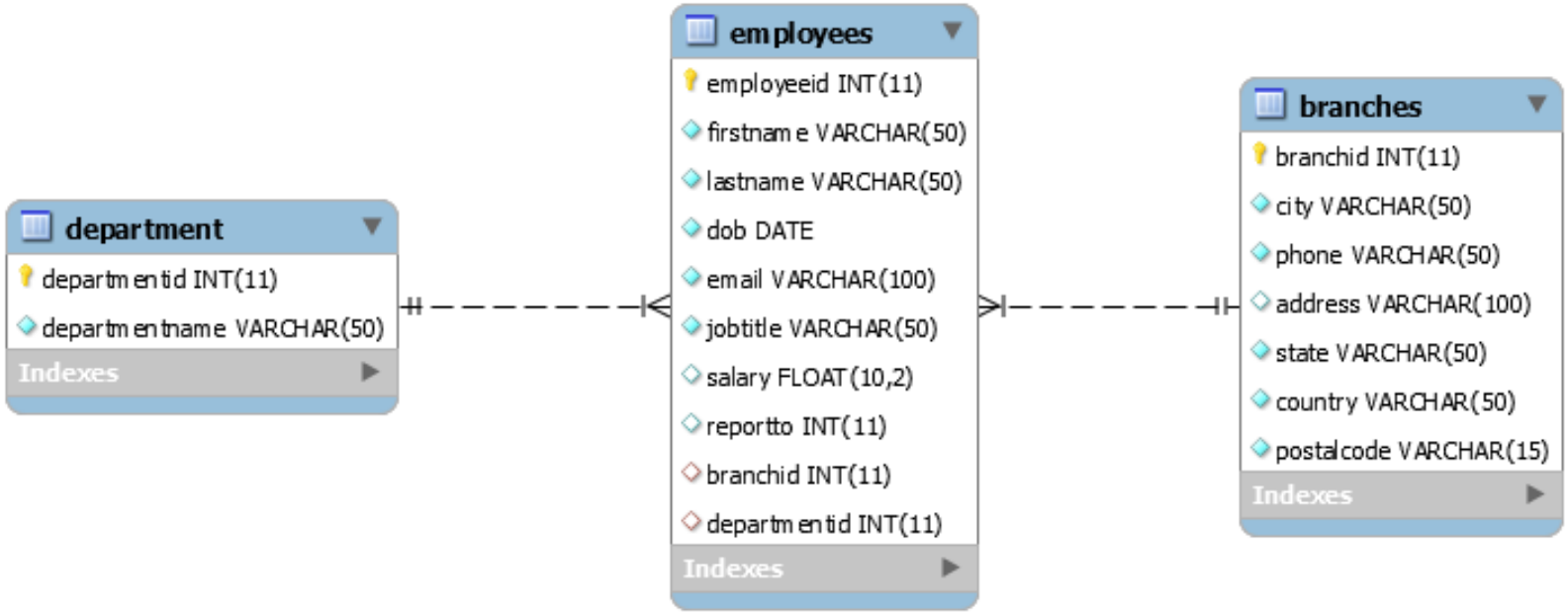
Company A

- The employees database



Company B

- The company database

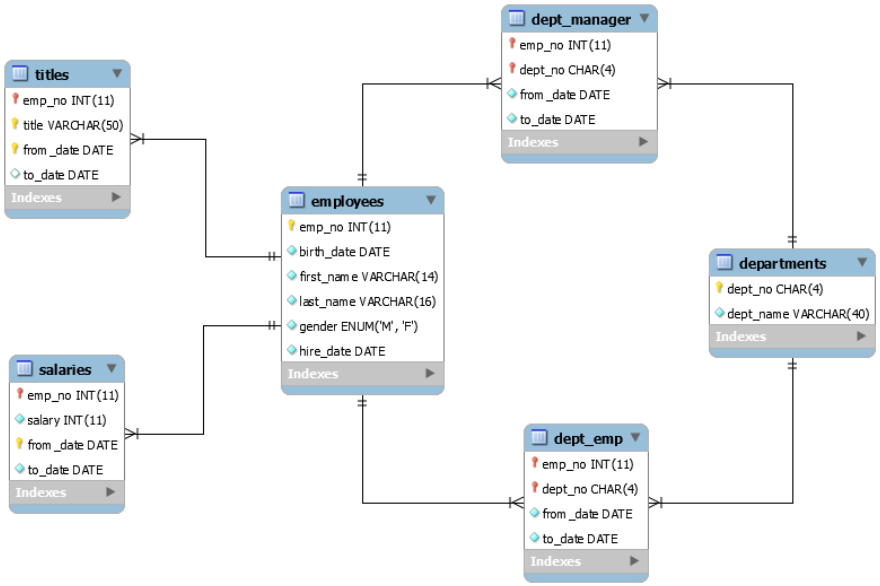


Schema Matching

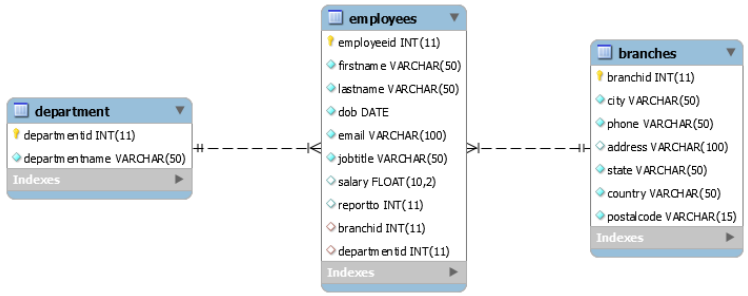
Data sources

- Comparing the two **data sources** (schema)

Data source A (**employees** database)

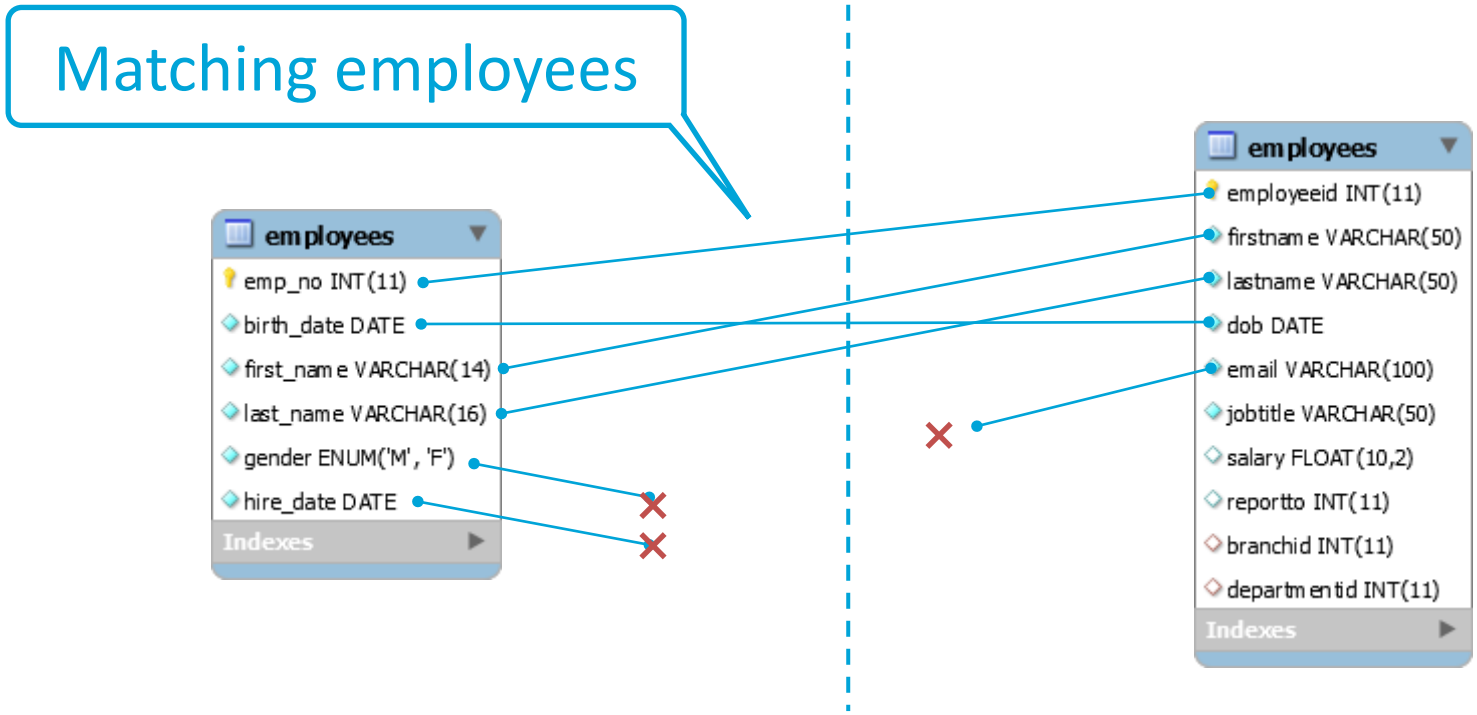


Data source B (**company** database)



Schema matching (employees)

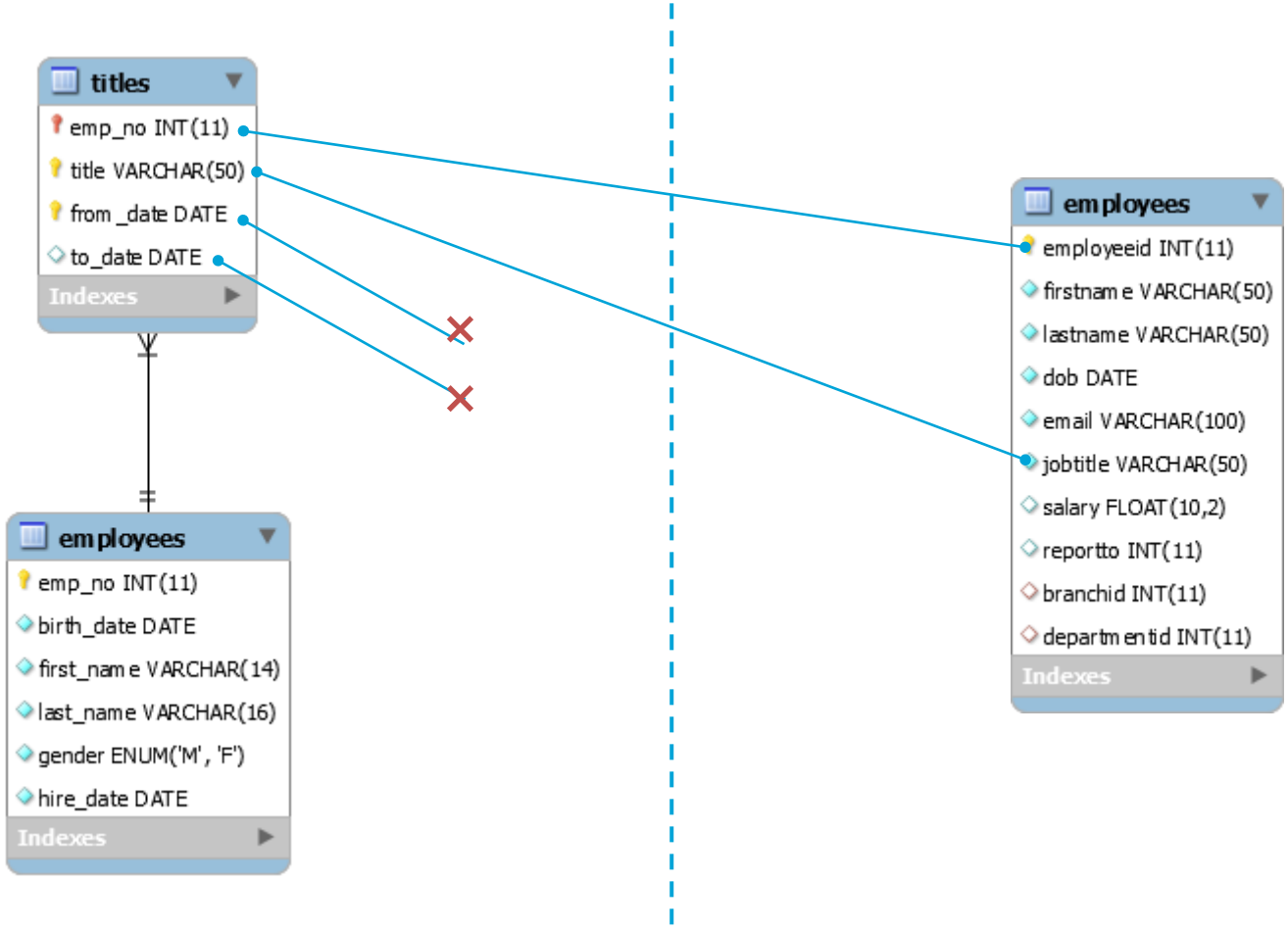
- Comparing the two data sources (**schema matching**)



We are only specifying the "*what*"; not the "*how*"!

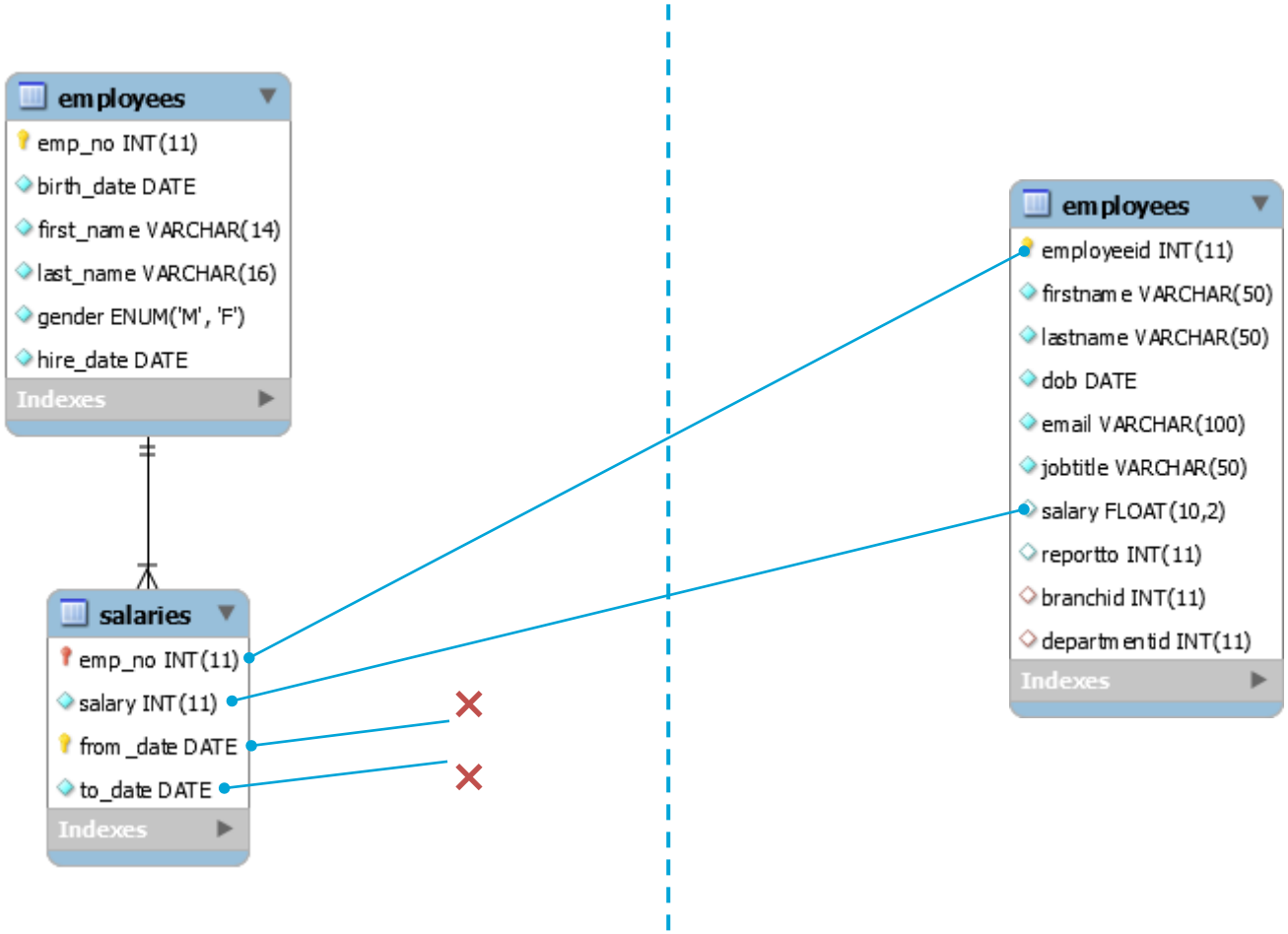
Schema matching (titles)

- Comparing the two data sources (**schema matching**)



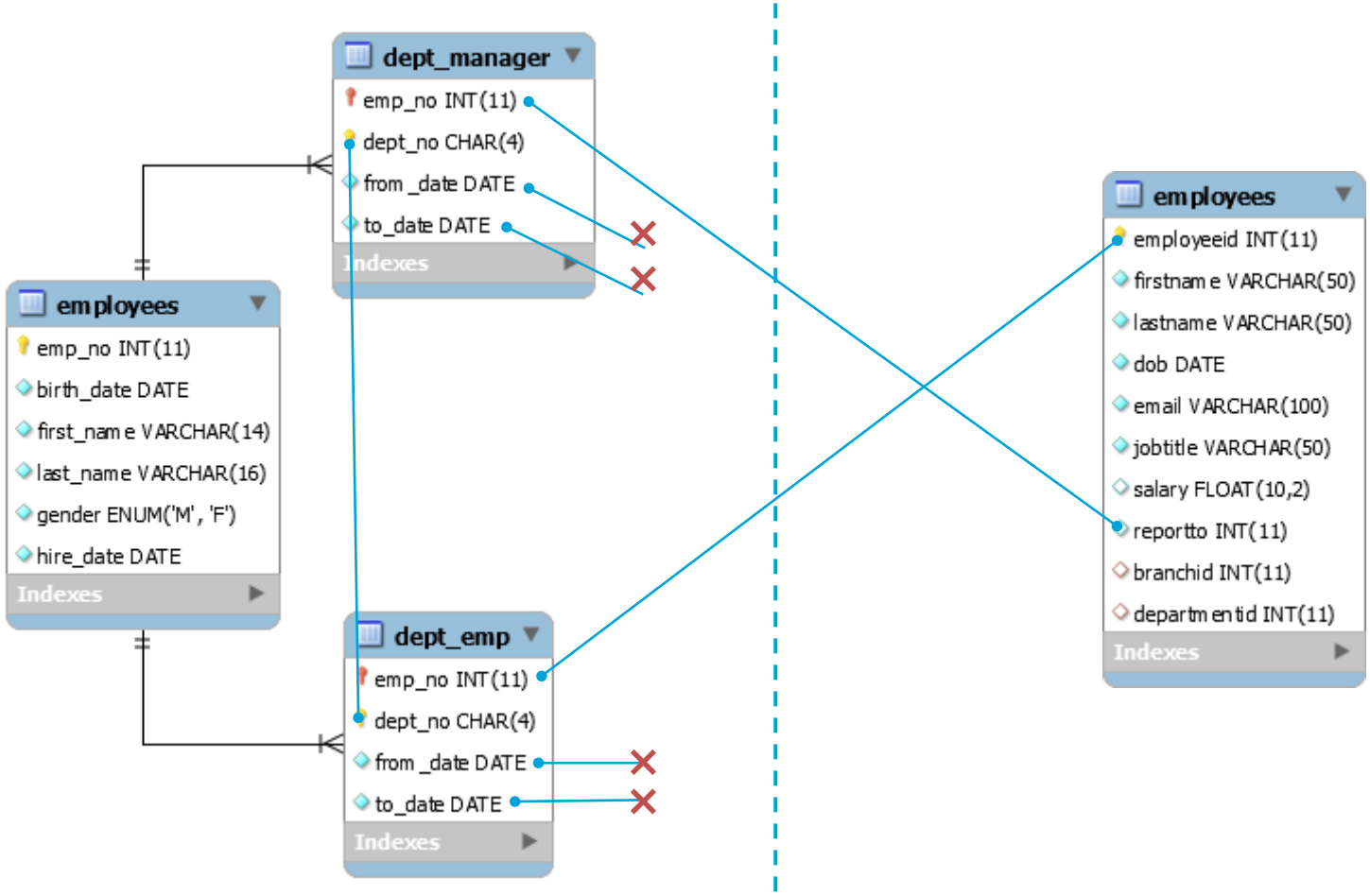
Schema matching (salaries)

- Comparing the two data sources (**schema matching**)



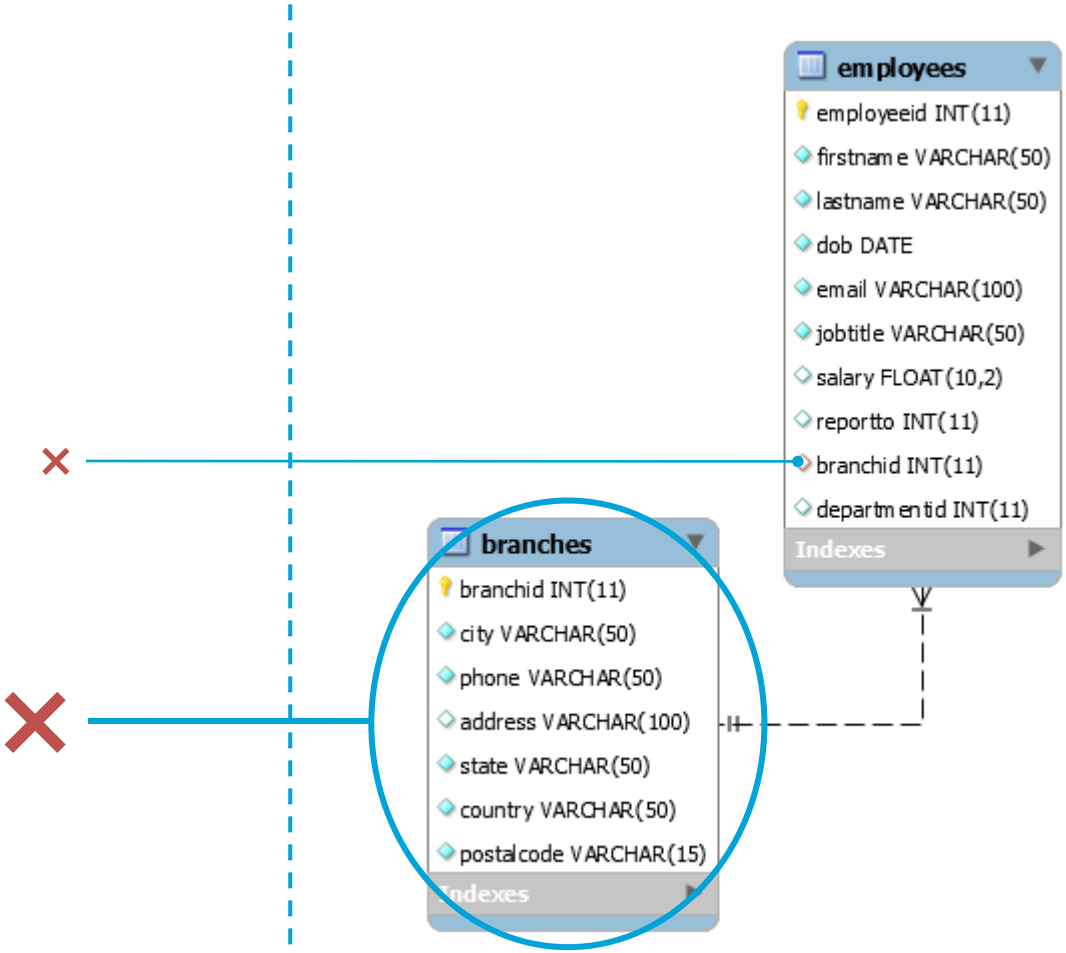
Schema matching (managers)

- Comparing the two data sources (**schema matching**)



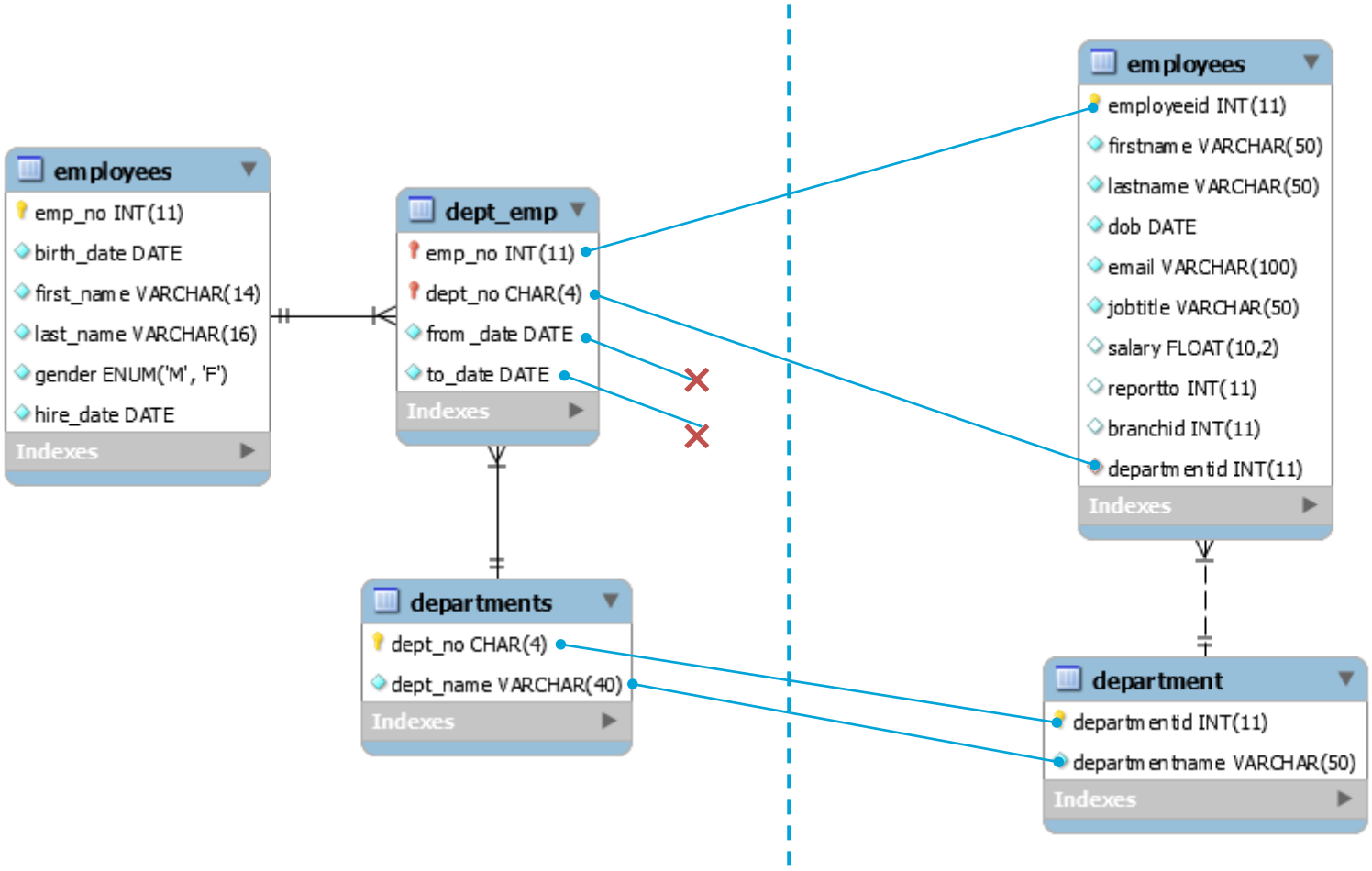
Schema matching (branches)

- Comparing the two data sources (**schema matching**)



Schema matching (departments)

- Comparing the two data sources (**schema matching**)



Schema Matching: The mediated schema

Mediated schema

- Once company A merges with company B
  - We need to access data through a single/uniform access point

- Example of a common schema (**mediated schema**)

  all_employees(emp_no, first_name, last_name, birth_date, report_to)

  all_departments(dept_no, dept_name)

  all_dept_emp(emp_no, dept_no)

  all_salaries(emp_no, salary)

  all_titles(emp_no, title)

Mediated schema

- Common schema (**mediated schema**)

  all_employees(emp_no, first_name, last_name, birth_date, report_to)

  all_departments(dept_no, dept_name)

  all_dept_emp(emp_no, dept_no)

  all_salaries(emp_no, salary)

  all_titles(emp_no, title(

Absence of **from_date** and **to_date** attributes means that data retrieved from the employees database will always refer to current date

Wrappers for data sources

- We already have a set of views to retrieve data for the current date

  employees(emp_no, birth_date, first_name, last_name, gender, hire_date)

  departments(dept_no, dept_name)

  curr_dept_emp(emp_no, dept_no)

  curr_dept_manager(emp_no, dept_no)

  curr_salaries(emp_no, salary)

  curr_titles(emp_no, title)

We will use these views as a **wrapper** for the employees database

i.e. a layer through which we access the employees database

Schema mapping

Schema mapping (all_employees)

- Mapping to common schema (**schema mapping**)
  - transformations/queries that populate common schema

all_employees(emp_no, first_name, last_name, birth_date, report_to**)**

  - from **employees** database

```
select a.emp_no, a.first_name, a.last_name, a.birth_date, c.emp_no
from employees.employees as a,
        employees.curr_dept_emp as b,
        employees.curr_dept_manager as c
where a.emp_no = b.emp_no and b.dept_no = c.dept_no;
```

  - from **company** database

```
select employeeid, firstname, lastname, dob, reportto
from company.employees;
```

Schema mapping (all_employees)

- Mapping to common schema (**schema mapping**)

  all_employees(emp_no, first_name, last_name, birth_date, report_to)

```
(select a.emp_no, a.first_name, a.last_name, a.birth_date, c.emp_no
 from employees.employees as a,
          employees.curr_dept_emp as b,
          employees.curr_dept_manager as c
 where a.emp_no = b.emp_no and b.dept_no = c.dept_no)
union
(select employeeid, firstname, lastname, dob, reportto
 from company.employees);
```

```
+--------+------------+-----------+------------+--------+
| emp_no | first_name | last_name | birth_date | emp_no |
+--------+------------+-----------+------------+--------+
|  21637 | Yefim      | Luby      | 1964-04-28 | 110039 |
|  25949 | Owen       | Matheson  | 1959-08-08 | 110039 |
|    ... | ...        | ...       | ...        |    ... |
|   1001 | Ravi       | Gupta     | 1969-12-03 |   1001 |
|   1002 | Ram        | charan    | 1985-02-20 |   1001 |
|    ... | ...        | ...       | ...        |    ... |
+--------+------------+-----------+------------+--------+
```

Schema mapping (all_employees)

- Mapping to common schema (**schema mapping**)

  all_employees(emp_no, first_name, last_name, birth_date, report_to)

```
create view all_employees(
      emp_no, first_name, last_name, birth_date, report_to)
as
     (select a.emp_no, a.first_name, a.last_name, a.birth_date, c.emp_no
      from employees.employees as a,
                employees.curr_dept_emp as b,
                employees.curr_dept_manager as c
      where a.emp_no = b.emp_no and b.dept_no = c.dept_no)
     union
     (select employeeid, firstname, lastname, dob, reportto
      from company.employees);
```

Schema mapping (all_departments)

- Mapping to common schema (**schema mapping**)

  all_departments(dept_no, dept_name)

  – from **employees** database

  ```
  select dept_no, dept_name
  from employees.departments
  ```

  – from **company** database

  ```
  select departmentid, departmentname
  from company.department
  ```

Schema mapping (all_departments)

- Mapping to common schema (**schema mapping**)

  all_departments(dept_no, dept_name)

```
(select dept_no, dept_name
 from employees.departments)
union
(select departmentid, departmentname
 from company.department);
```

```
+---------+--------------------+
| dept_no | dept_name          |
+---------+--------------------+
| d009    | Customer Service   |
| d005    | Development        |
| d002    | Finance            |
| d003    | Human Resources    |
| d001    | Marketing          |
| d004    | Production         |
| d006    | Quality Management |
| d008    | Research           |
| d007    | Sales              |
| 101     | IT                 |
| 102     | HR                 |
| 103     | Finance            |
| 104     | Sales              |
| 105     | marketing          |
+---------+--------------------+
14 rows in set (0.00 sec)
```

Schema mapping (all_departments)

- Mapping to common schema (**schema mapping**)

  all_departments(dept_no, dept_name)

```
create view all_departments(dept_no, dept_name)
as
    (select dept_no, dept_name
     from employees.departments)
    union
    (select departmentid, departmentname
     from company.department);
```

Schema mapping (all_dept_emp)

- Mapping to common schema (**schema mapping**)

  all_dept_emp(emp_no, dept_no)

  – from **employees** database

  ```
  select emp_no, dept_no
  from
  employees.curr_dept_emp
  ```

  – from **company** database

  ```
  select employeeid,
  departmentid
  from company.employees
  ```

Schema mapping (all_dept_emp)

- Mapping to common schema (**schema mapping**)

  all_dept_emp(emp_no, dept_no)

```
(select emp_no, dept_no
 from employees.curr_dept_emp)
union
(select employeeid, departmentid
 from company.employees);
```

```
+--------+---------+
| emp_no | dept_no |
+--------+---------+
|  10721 | d009    |
|  11260 | d009    |
|    ... | ...     |
|   1008 | 101     |
|   1014 | 101     |
|    ... | ...     |
+--------+---------+
```

Schema mapping (all_dept_emp)

- Mapping to common schema (**schema mapping**)

  all_dept_emp(emp_no, dept_no)

```
create view all_dept_emp(emp_no, dept_no)
as
    (select emp_no, dept_no
     from employees.curr_dept_emp)
    union
    (select employeeid, departmentid
     from company.employees);
```

Schema mapping (all_salaries)

- Mapping to common schema (**schema mapping**)

  all_salaries(emp_no, salary)

  – from **employees** database

  ```
  select emp_no, salary
  from employees.curr_salaries
  ```

  – from **company** database

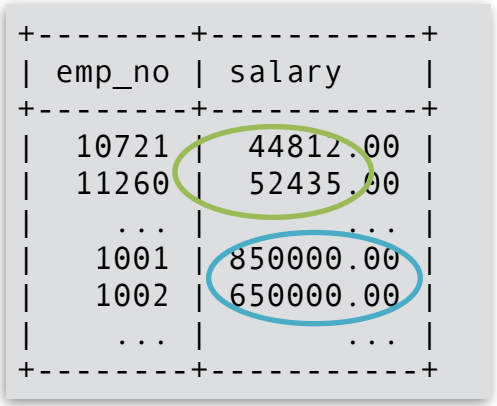
  ```
  select employeeid, salary
  from company.employees
  ```

Schema mapping (all_salaries)

- Mapping to common schema (**schema mapping**)

  all_salaries(emp_no, salary)

```
(select emp_no, salary
from employees.curr_salaries)
union
(select employeeid, salary
from company.employees);
```



emp_no	salary
10721	44812.00
11260	52435.00
...	...
1001	850000.00
1002	650000.00
...	...

Schema mapping (all_salaries)

- Mapping to common schema (**schema mapping**)

  all_salaries(emp_no, salary)

```
create view all_salaries(emp_no, salary)
as
    (select emp_no, salary
    from employees.curr_salaries)
    union
    (select employeeid, salary
    from company.employees);
```

Schema mapping (all_titles)

- Mapping to common schema (**schema mapping**)

  all_titles(emp_no, title)

  – from **employees** database

  ```
  select emp_no, title
  from employees.curr_titles
  ```

  – from **company** database

  ```
  select employeeid, jobtitle
  from company.employees
  ```

Schema mapping (all_titles)

- Mapping to common schema (**schema mapping**)

  all_titles(emp_no, title)

```
(select emp_no, title
from employees.curr_titles)
union
(select employeeid, jobtitle
 from company.employees);
```

```
+--------+--------------------+
| emp_no | title              |
+--------+--------------------+
|  11371 | Senior Engineer    |
|  41548 | Staff              |
|  62635 | Engineer           |
|  64387 | Senior Staff       |
| 110039 | Manager            |
| 204631 | Assistant Engineer |
| 207968 | Technique Leader   |
|    ... | ...                |
|   1001 | CEO                |
|   1002 | Director           |
|   1003 | President          |
|   1004 | Vice President     |
|   1005 | Sr. Manager        |
|   1007 | Sales Manager      |
|   1008 | Reporting Manager  |
|   1009 | Team Leader        |
|   1010 | Sales Rep          |
|   1014 | Software Engineer  |
|   1023 | Admin              |
|   1024 | Network Engineer   |
|    ... | ...                |
+--------+--------------------+
```

Schema mapping (all_titles)

- Mapping to common schema (**schema mapping**)

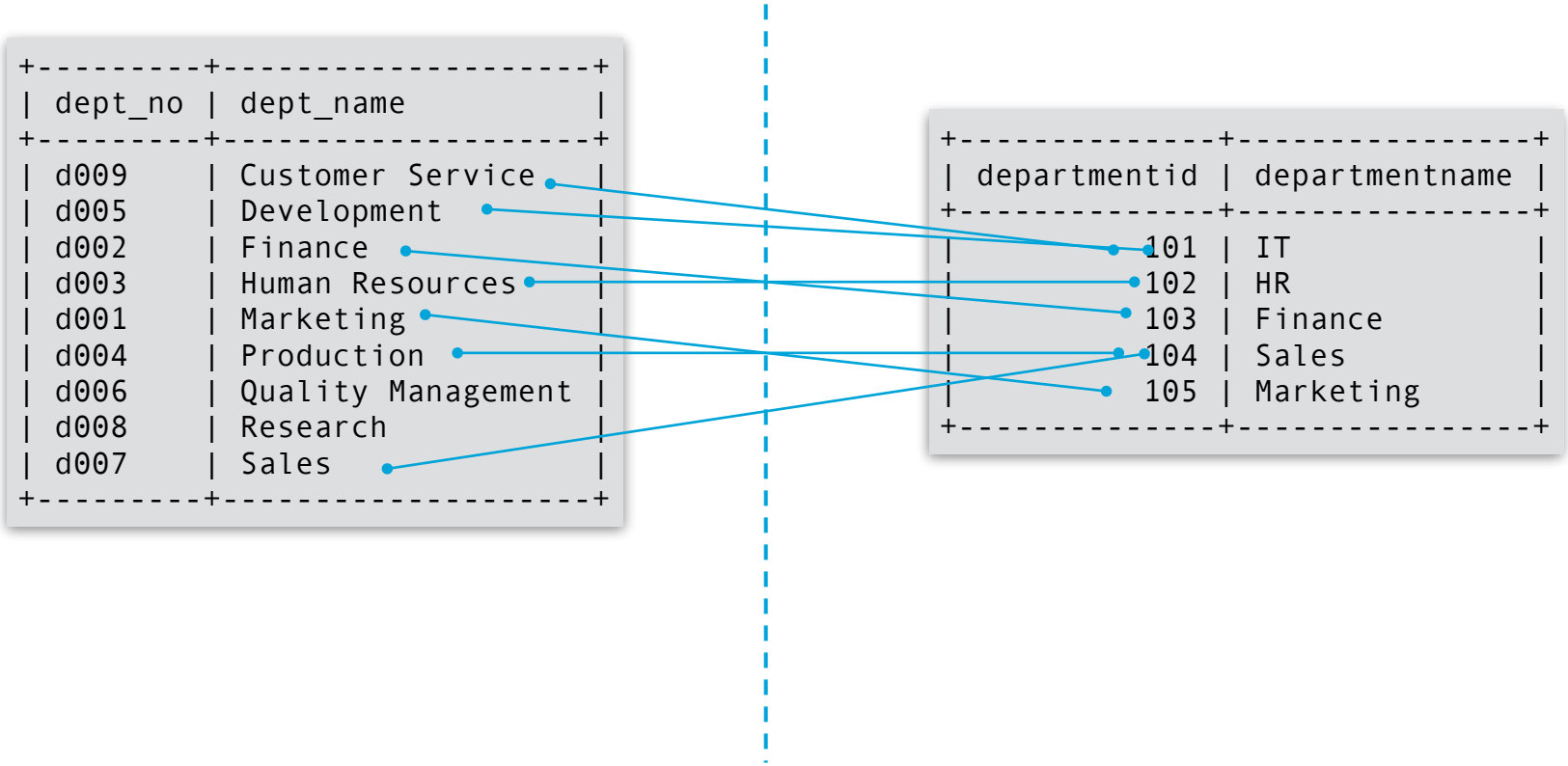
  all_titles(emp_no, title)

```
create view all_titles(emp_no, title)
as
    (select emp_no, title
    from employees.curr_titles)
    union
    (select employeeid, jobtitle
     from company.employees);
```

Data mapping

Data matching – Duplicates

- When comparing data instances from distinct data source



dept_no	dept_name
d009	Customer Service
d005	Development
d002	Finance
d003	Human Resources
d001	Marketing
d004	Production
d006	Quality Management
d008	Research
d007	Sales

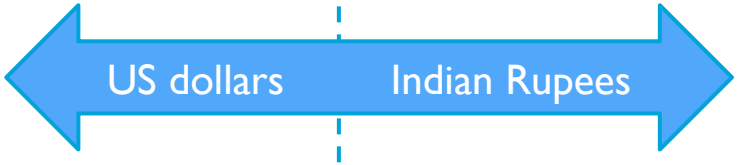
departmentid	departmentname
101	IT
102	HR
103	Finance
104	Sales
105	Marketing

Duplicate department names need to be merged

Data matching – Conversion

- When comparing data instances from distinct data sources

salary
44812
52435
81461
101179
76104
105453
71350
49249
91443
91836
80046
67677
70313
66406
56851
57499
...

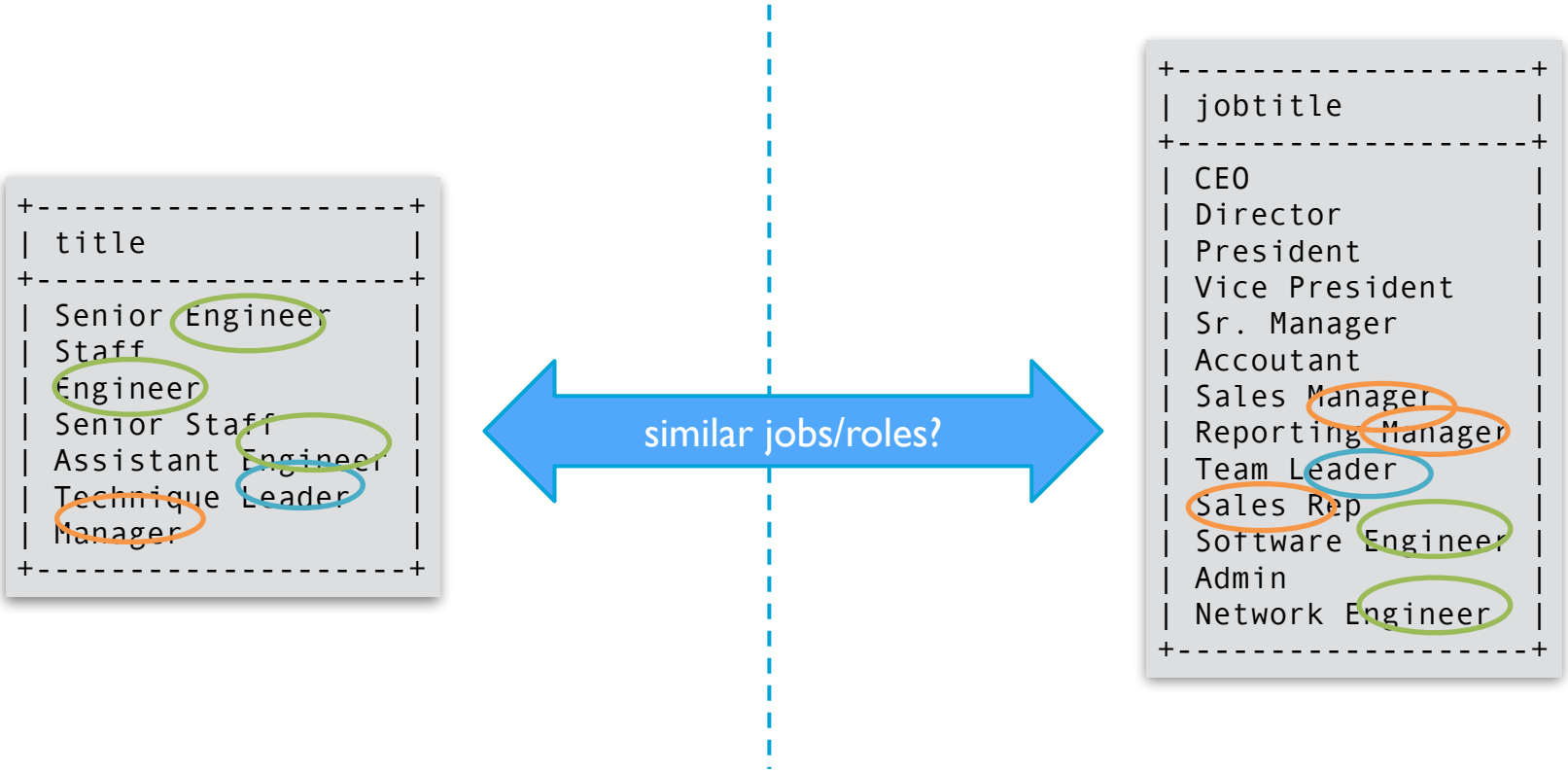


salary
850000.00
650000.00
625000.00
215000.00
115000.00
38000.00
65000.00
75000.00
45000.00
15000.00
15000.00
15000.00
15000.00
35000.00
35000.00
25000.00
...

Salaries need to be converted

Data matching – approximate duplicates

- When comparing data instances from distinct data sources



Similar job titles need to be found and merged/ consolidated

Summary of concepts

- Multiple **data sources** with different schemas
  - Relational databases, but could be other data sources as well
- **Schema matching** between data sources
  - How attributes in one data source correspond to attributes in another data source
- Design of a common **mediated schema**
  - Subset of attributes from data source schemas
- **Wrappers** for data sources
  - Facilitate and simplify access to data sources
- **Schema mapping** from data sources to mediated schema
  - Queries to bring data from local schema to global mediated schema
- **Data matching** between data sources
  - Find exact/approximate duplicates from different sources that may need to be merged, converted or consolidated