Model 1:N relationships with foreign keys

INTRODUCTION TO RELATIONAL DATABASES IN SQL

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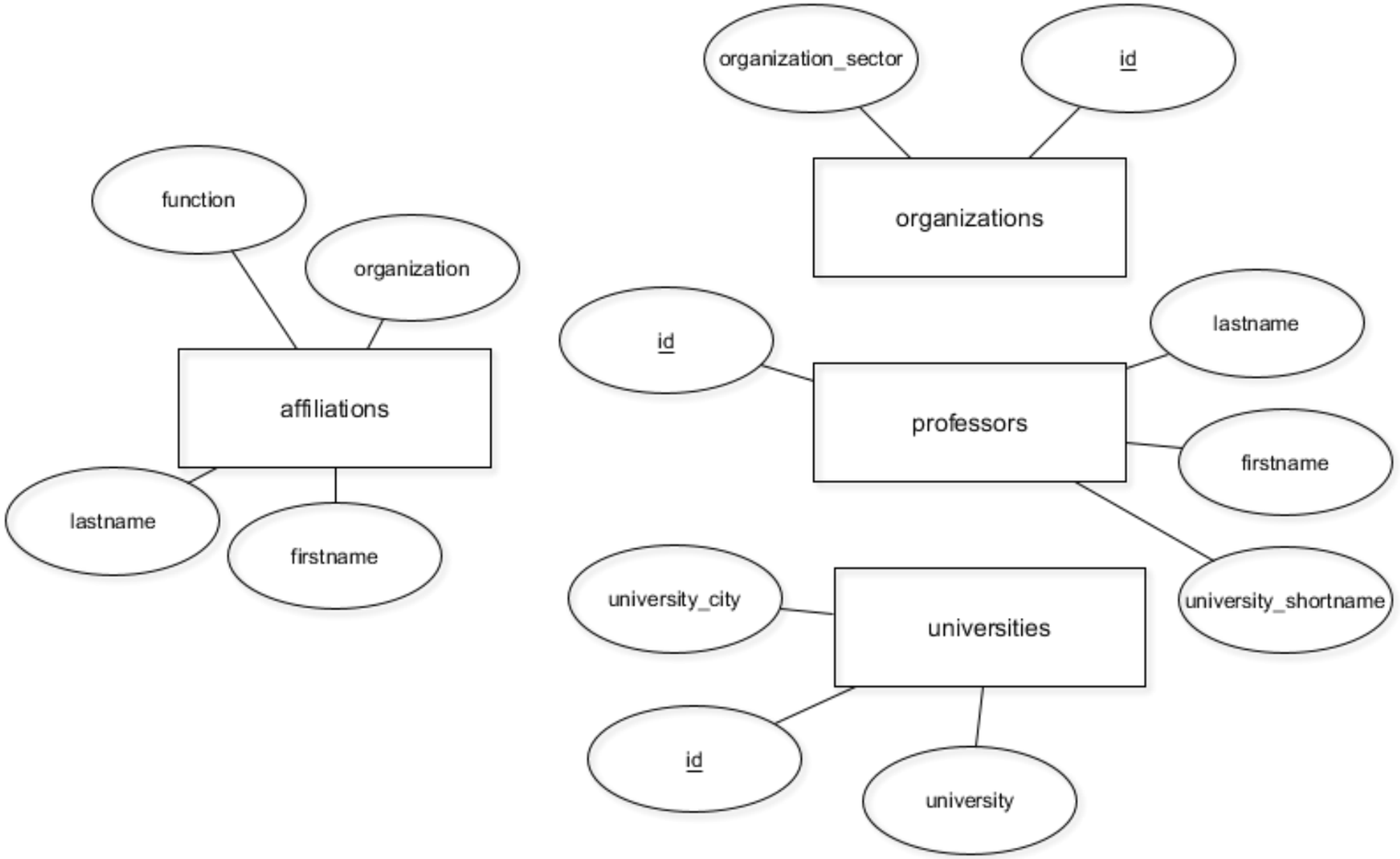
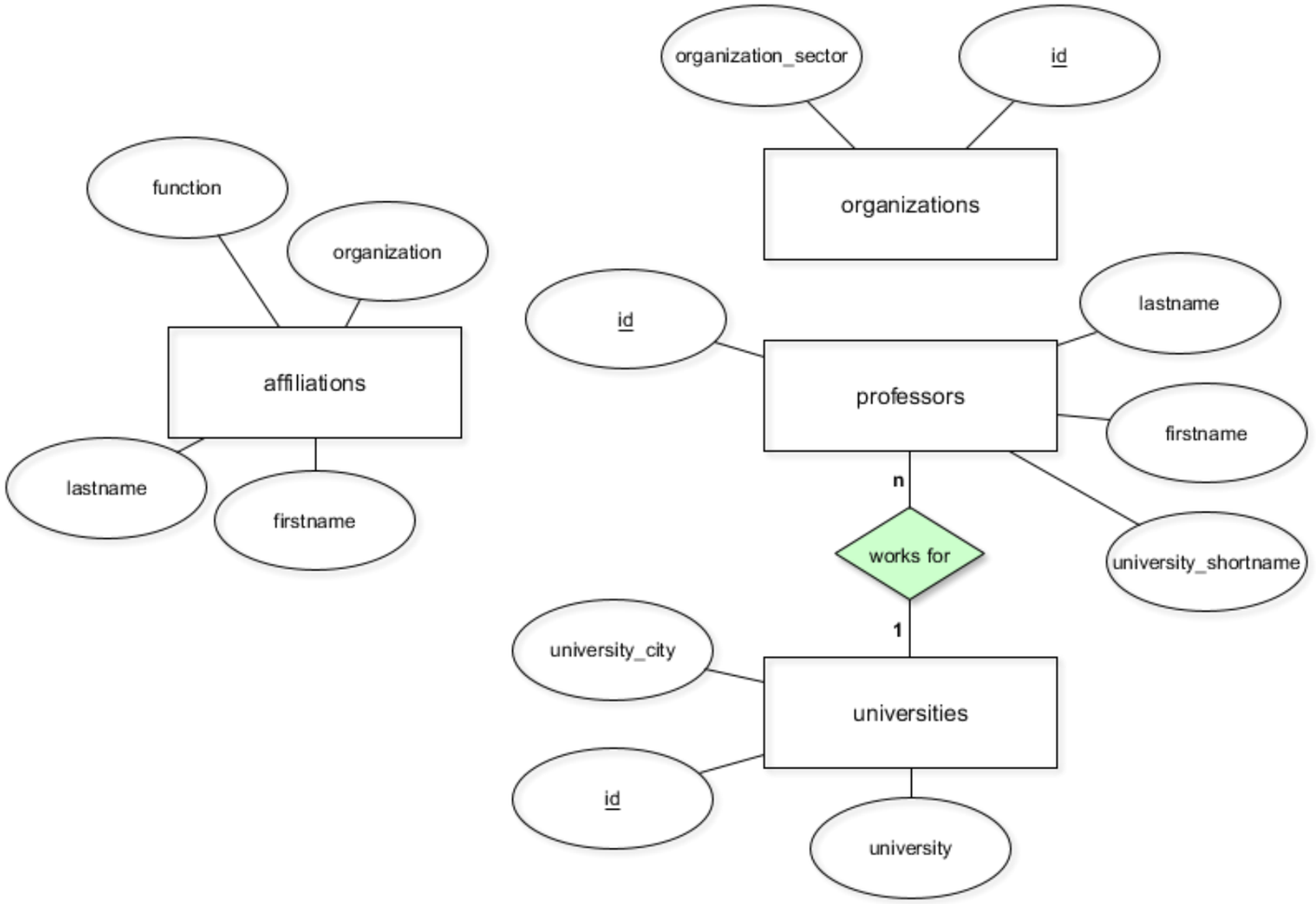
The current database model



The next database model



Implementing relationships with foreign keys

- A foreign key (FK) points to the primary key (PK) of another table
- Domain of FK must be equal to domain of PK
- Each value of FK must exist in PK of the other table (FK constraint or "referential integrity")
- FKs are not actual *keys*

A query

```
SELECT * FROM professors LIMIT 8;
```

```
id |    firstname    |  lastname   | university_s..
 --+-----------------+-------------+------------
 1 | Karl            | Aberer      | EPF
 2 | Reza Shokrollah | Abhari      | ETH
 3 | Georges         | Abou Jaoudé | EPF
 4 | Hugues          | Abriel      | UBE
 5 | Daniel          | Aebersold   | UBE
 6 | Marcelo         | Aebi        | ULA
 7 | Christoph       | Aebi        | UBE
 8 | Patrick         | Aebischer   | EPF
```

```
SELECT * FROM universities;
```

```
 id  |   university   | university_city
<hr />--+----------------+----------------
 EPF | ETH Lausanne   | Lausanne
 ETH | ETH Zürich     | Zurich
 UBA | Uni Basel      | Basel
 UBE | Uni Bern       | Bern
 UFR | Uni Freiburg   | Fribourg
 UGE | Uni Genf       | Geneva
 ULA | Uni Lausanne   | Lausanne
 UNE | Uni Neuenburg  | Neuchâtel
 USG | Uni St. Gallen | Saint Gallen
 USI | USI Lugano     | Lugano
 UZH | Uni Zürich     | Zurich
```

Specifying foreign keys

```
CREATE TABLE manufacturers (
 name varchar(255) PRIMARY KEY);

INSERT INTO manufacturers
VALUES ('Ford'), ('VW'), ('GM');
CREATE TABLE cars (
 model varchar(255) PRIMARY KEY,
 manufacturer_name varchar(255) REFERENCES manufacturers (name));

INSERT INTO cars
VALUES ('Ranger', 'Ford'), ('Beetle', 'VW');
```

```
-- Throws an error!
INSERT INTO cars
VALUES ('Tundra', 'Toyota');
```

Specifying foreign keys to existing tables

```
ALTER TABLE a
ADD CONSTRAINT a_fkey FOREIGN KEY (b_id) REFERENCES b (id);
```

Let's implement this!

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Model more complex relationships

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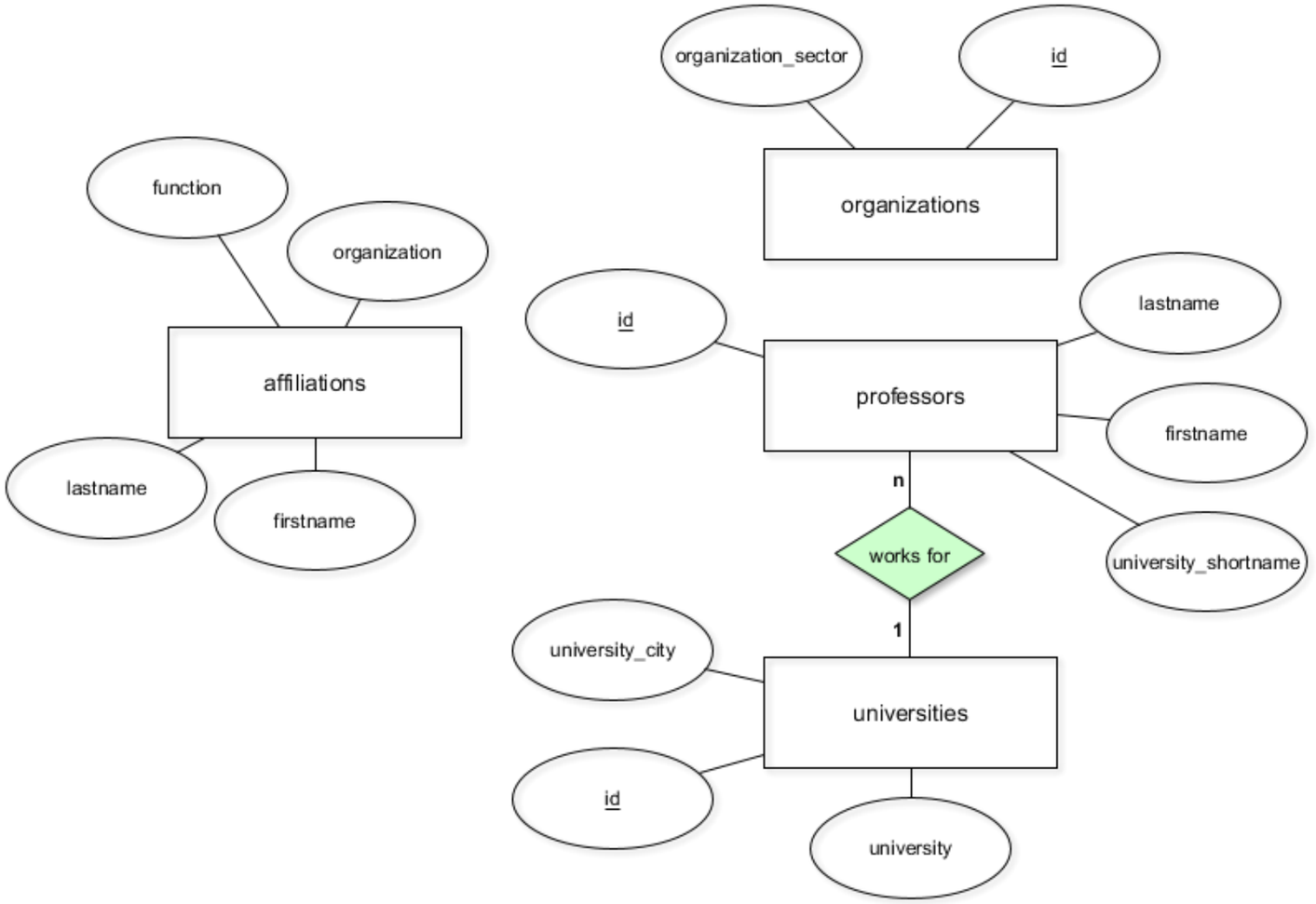
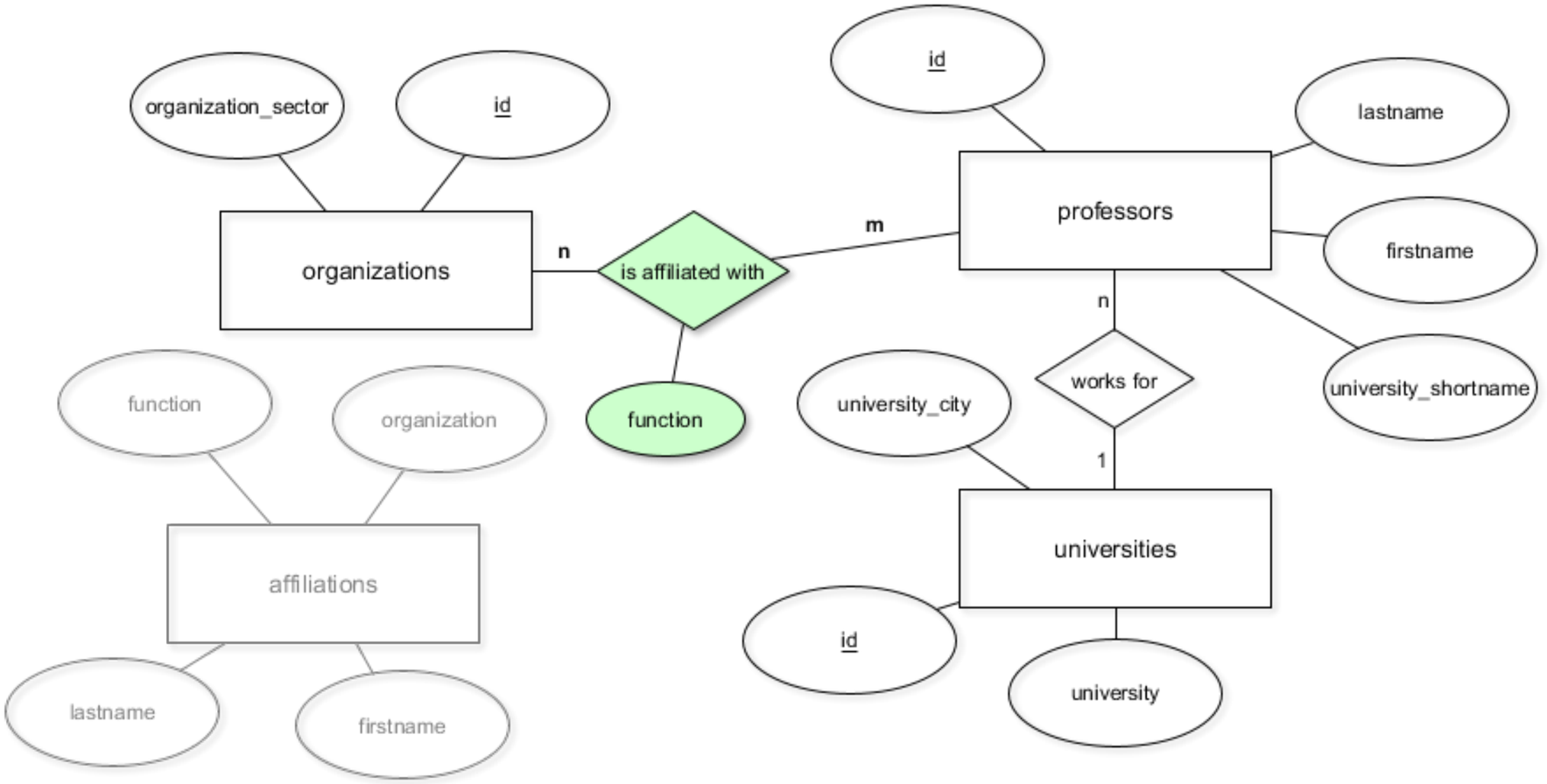
The current database model



The final database model



How to implement N:M-relationships

- Create a table
- Add foreign keys for every connected table
- Add additional attributes

```
CREATE TABLE affiliations (
 professor_id integer REFERENCES professors (id),
 organization_id varchar(256) REFERENCES organizations (id),
 function varchar(256)
);
```

- No primary key!
- Possible PK = {professor_id, organization_id, function}

Time to implement this!

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Referential integrity

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Referential integrity

- *A record referencing another table must refer to an existing record in that table*
- Specified between two tables
- Enforced through foreign keys

Referential integrity violations

Referential integrity from table A to table B is violated...

- ...if a record in table B that is referenced from a record in table A is deleted.
- ...if a record in table A referencing a non-existing record from table B is inserted.
- Foreign keys prevent violations!

Dealing with violations

```
CREATE TABLE a (
 id integer PRIMARY KEY,
 column_a varchar(64),
 ...,
 b_id integer REFERENCES b (id) ON DELETE NO ACTION
);
```

```
CREATE TABLE a (
 id integer PRIMARY KEY,
 column_a varchar(64),
 ...,
 b_id integer REFERENCES b (id) ON DELETE CASCADE
);
```

Dealing with violations, contd.

ON DELETE...

- ...NO ACTION: Throw an error
- ...CASCADE: Delete all referencing records
- ...RESTRICT: Throw an error
- ...SET NULL: Set the referencing column to NULL
- ...SET DEFAULT: Set the referencing column to its default value

Let's look at some examples!

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Roundup

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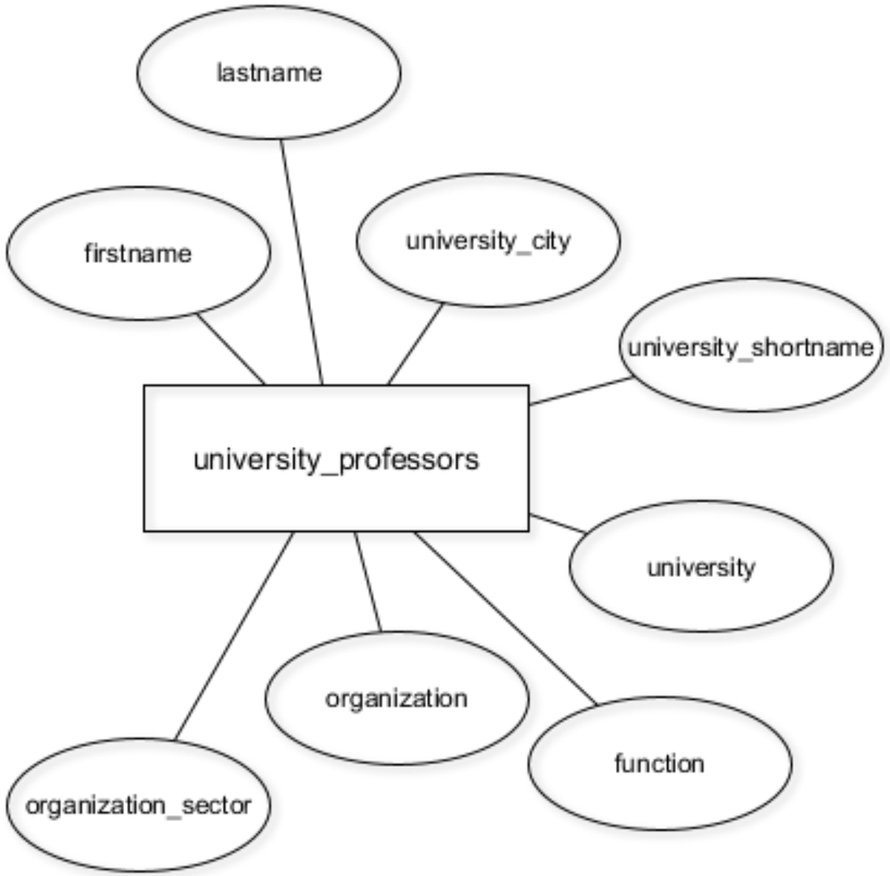
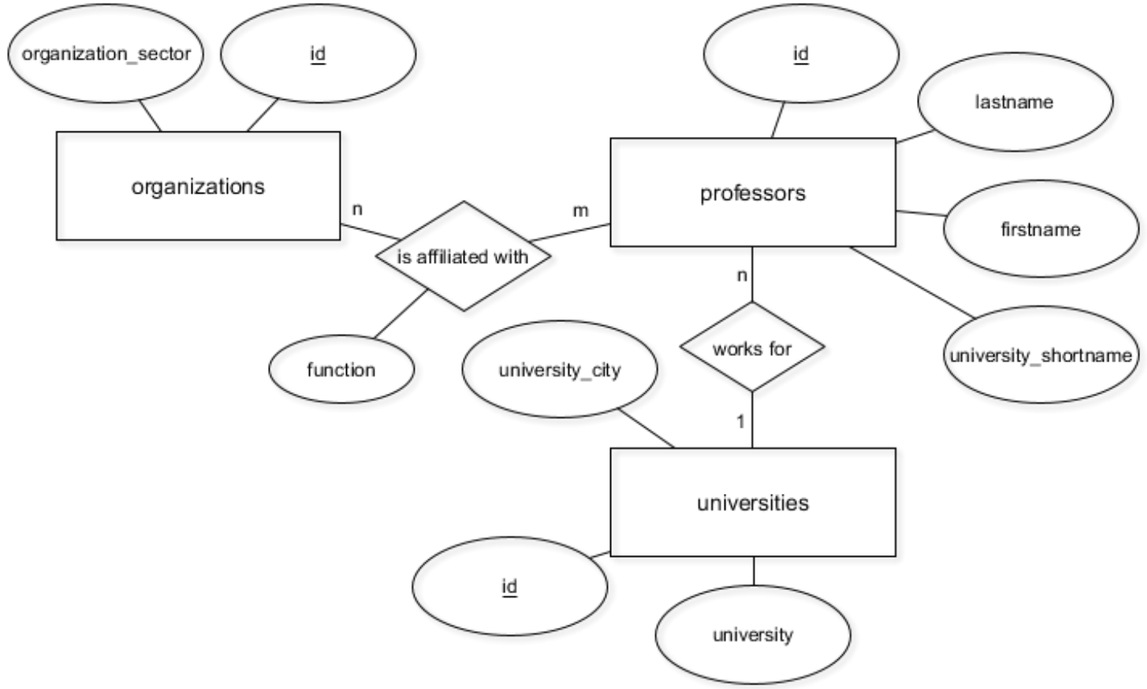
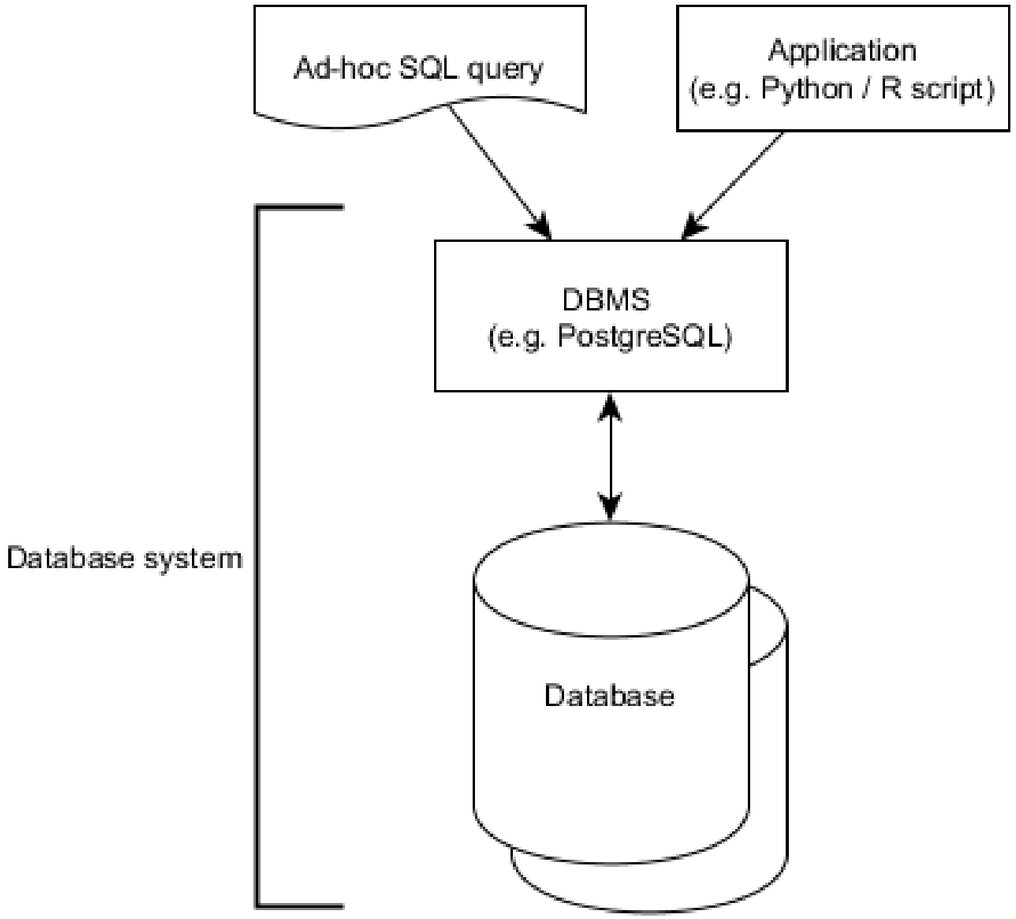
How you've transformed the database



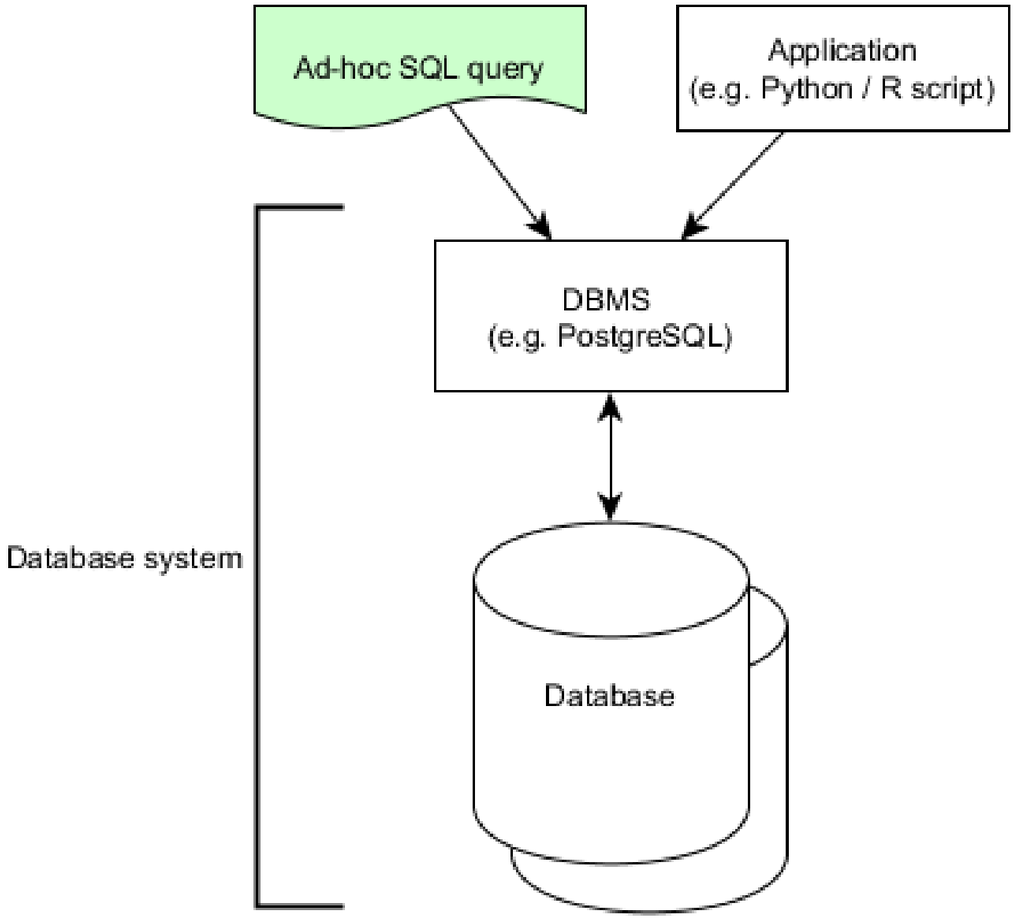


- Column data types
- Key constraints
- Relationships between tables

The database ecosystem



The database ecosystem



Thank you!

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