ORMs and ERDs, OMG! Forward and Reverse Engineering Databases ERDs vs Django's ORM and Migration Tools

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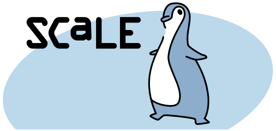

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Outline

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- I saw parallels between forward and reverse engineering features in entity relationship diagram (ERD) tools and Django's object relational mapper (ORM)
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- Entity-Relationship Diagrams (ERDs) are diagrams that help to visualize a database's structure or "schema"
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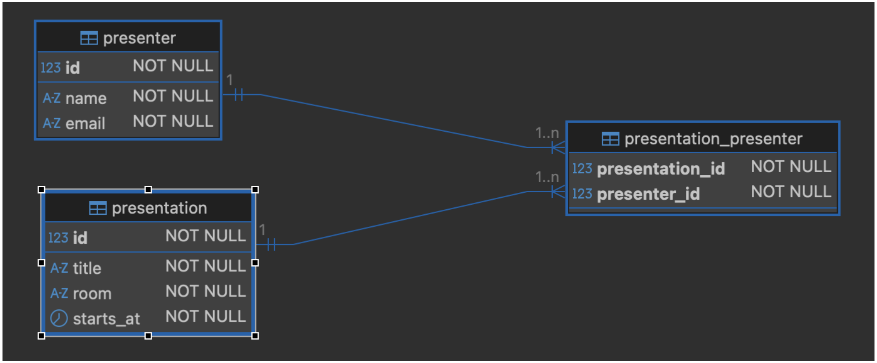
DBeaver ER Diagram Example



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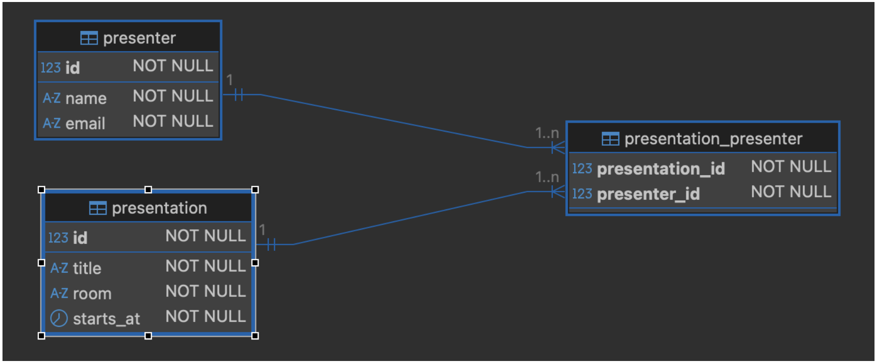

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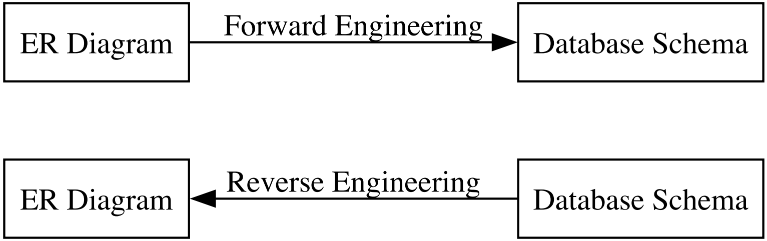

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  - Objects can have all sorts of data in them, but *relational* databases like to have tables that are dedicated to just one specific type of information ("normalization")
  - The difference in behavior between objects in a programming language and data in a relational database is called "object-relational impedance mismatch"
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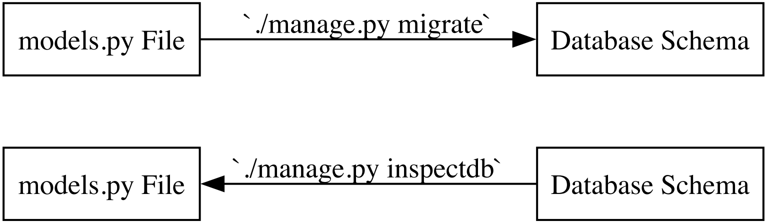
Django InspectDB and Migration



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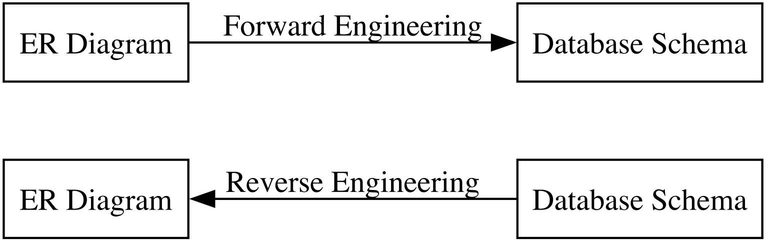

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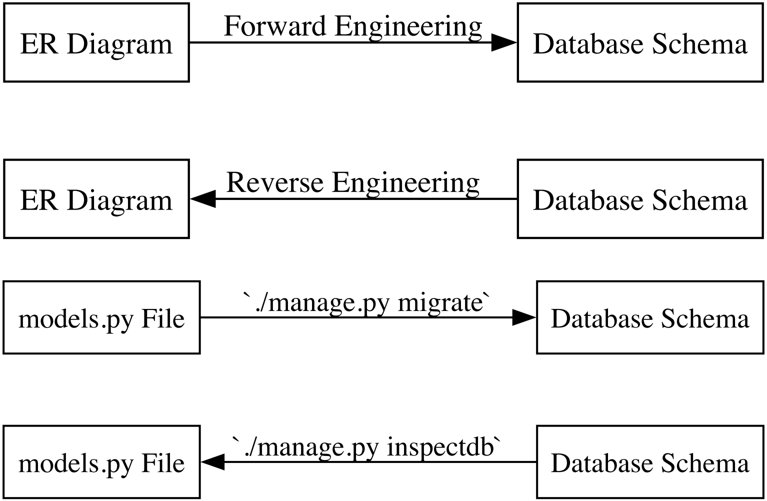

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- SQL: Structured Query Language, how to talk to databases
  - DDL: data definition language (creating table structure)
  - DML: data manpulation language (select/insert/update/delete)
- ER diagram: visualize databases, node ≡ table a.k.a. entity, edge≡foreign key relationship between tables
- Logical design vs relational design: is a many-to-many relationship shown as an edge or as an intersection/association table
- Forward engineering: convert/export an ER diagram into a database schema (CREATE TABLE statements), a.k.a. database modeler, SQL generation (DDL)
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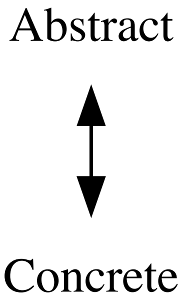

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- Logical design/schema:
- Physical design/schema:

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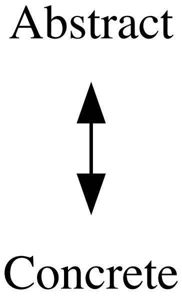

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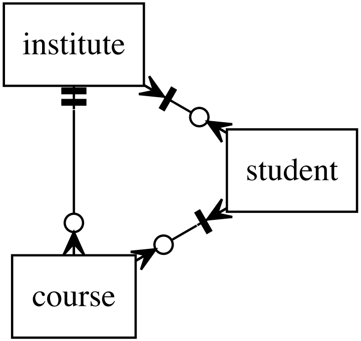
Crow's Foot: Conceptual



Crow's Foot Diagram
drawn by GraphViz/Circo

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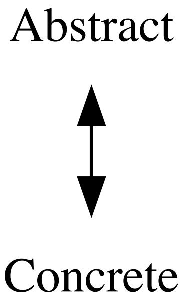
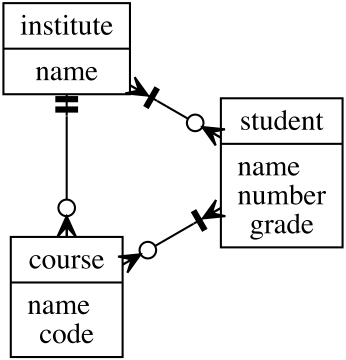


- Conceptual design/schema: only entities and relations
- Logical design/schema: entities/relations plus attributes
- Physical design/schema:

ER Logical



Crow's Foot Diagram
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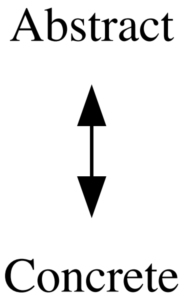
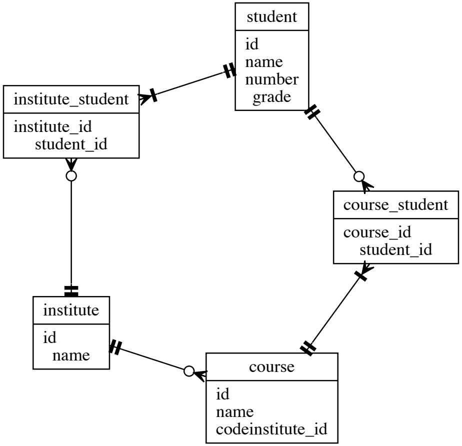


- Conceptual design/schema: only entities and relations
- Logical design/schema: entities/relations plus attributes
- Physical design/schema: entities/relations/attributes plus keys, types, and many-to-many "join" tables (a.k.a. associative entities)

ER Physical



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Terminology

- SQL: Structured Query Language, how to talk to databases
  - DDL: data definition language (creating table structure)
  - DML: data manpulation language (select/insert/update/delete)
- ER diagram: visualize databases, node ≡ table a.k.a. entity, edge≡foreign key relationship between tables
- Logical design vs relational design: is a many-to-many relationship shown as an edge or as an intersection/association table
- Forward engineering: convert/export an ER diagram into a database schema (CREATE TABLE statements), a.k.a. database modeler, SQL generation (DDL)
- Reverse engineering: convert/import a database schema (existing database) to an ER diagram. A.k.a. db metadata analysis, after-the-fact visualization

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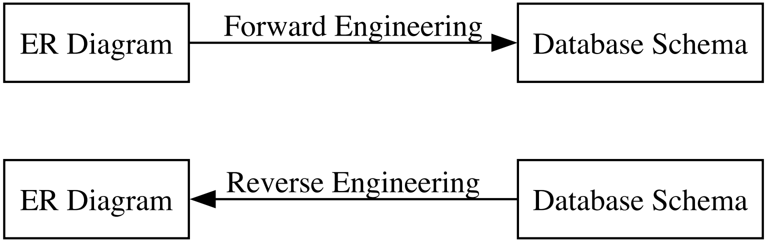
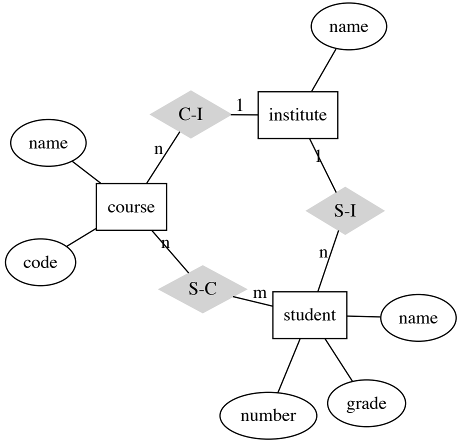
Forward and Reverse Engineering



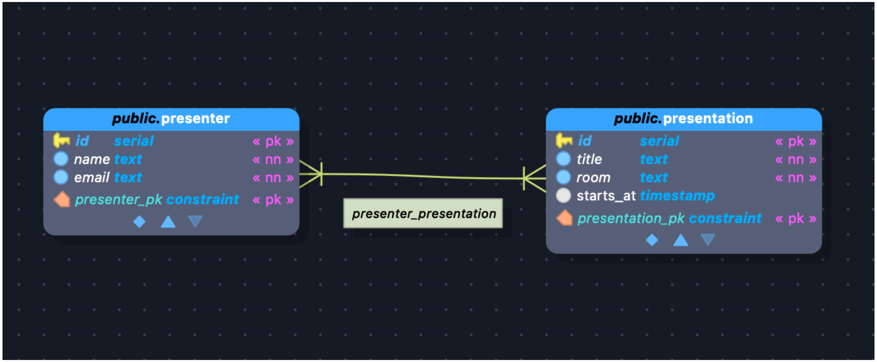
$$\begin{tikzcd}
\boxed{\text{ER Diagram}} \arrow[r, "\text{Forward Engineering}"] & \boxed{\text{Database Schema}} \\
\boxed{\text{ER Diagram}} & \boxed{\text{Database Schema}} \arrow[l, "\text{Reverse Engineering}"']
\end{tikzcd}$$

Older Peter Chen-Style ER Diagram

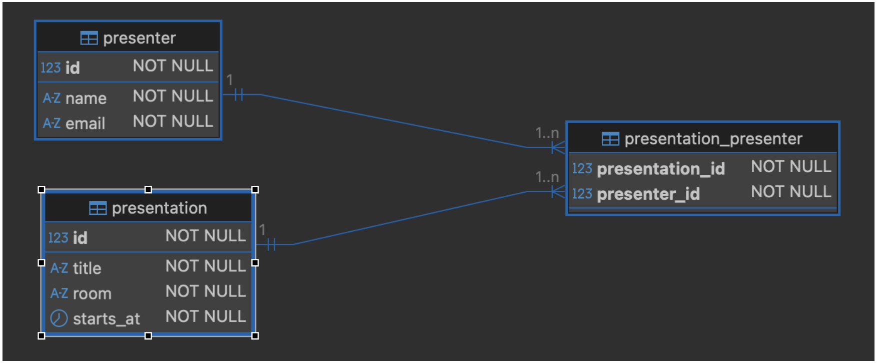


Entity Relation Diagram
drawn by GraphViz/NEATO

pgModeler ER Diagram (Many-to-Many/Conceptual Design)



DBeaver ER Diagram Example (Many-to-Many Relationship Converted to an Intersection/Association/Bridge/Junction/Join Table)



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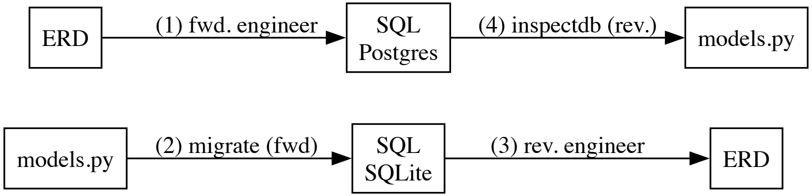

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4. Django inspectdb (ORM equivalent of reverse engineering)
   - DBeaver-generated database design in Postgres converted to Python classes

Forward Engineering: ERD to SQL

- Create a presenter table
  - id, name, and email columns
- Create a presentation table
  - id, title, room, and starts_at columns
- Create a presentation_presenter table (many-to-many mapping)
  - presentation_id and presenter_id columns
- See the generated SQL code

Plan

1. Forward engineering: convert an ERD to SQL CREATE TABLE statements
   - We will show DBeaver ERD converted to PostgreSQL
2. **Django sqlmigrate/migrate (ORM equivalent of forward engineering)**
   - **Classes in Python code converted to SQL CREATE TABLE STATEMENTS in SQLite**
3. Reverse engineering
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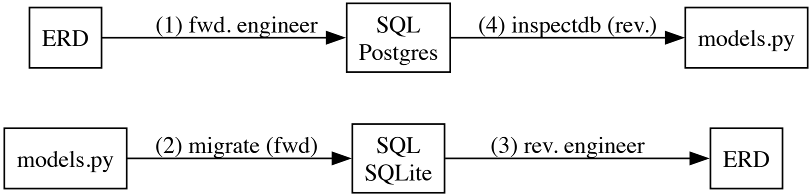
Demo Diagram



Django Migrate

- Install django into a virtual environment
- Create a project called "scale" and an app called "talks"
- Create classes for presenter and presentation in `talks/models.py`
  - presentation will have a many-to-many field
- Add the "talks" app to the INSTALLED_APPS in `scale/settings.py`
- Make migrations, view SQL, then migrate
- Optional (if time): register the models in the admin panel

Django Setup

```
uv pip install django # install django

# start project
django-admin  startproject scale

# start app
cd edu
django-admin startapp talks

# create models by editing registration/models.py

# add 'talks' to INSTALLED_APPS in scale/settings.py

# make migrations (writes to app/migrations/0001_initial.py)
./manage.py makemigrations

# optionally, view sql
./manage.py sqlmigrate talks 0001

# migrate the DB
./manage.py migrate
```

Models.py

```
from django.db import models
# Create your models here.

class Presenter(models.Model):
    name = models.CharField(max_length=256)
    email = models.CharField(max_length=256)

class Presentations(models.Model):
    title = models.CharField(max_length=50)
    room = models.CharField(max_length=256)
    starts_at = models.DateTimeField()
    presenters = models.ManyToManyField(Presenter)
```

(Optional, If Time) Register the Models with the Django Admin Panel

```
# registration/admin.py
from django.contrib import admin
from registration.models import Presenter, Presentation
# or from .models import Presenter, Presentation
# Register your models here.
admin.site.register(Presenter)
admin.site.register(Presentation)
```

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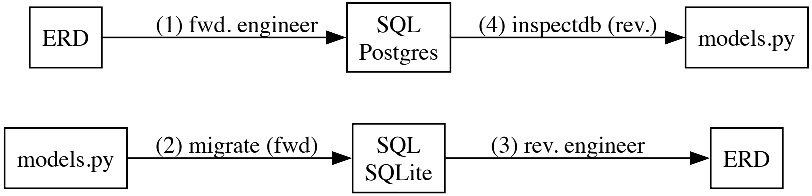

Reverse Engineering: View Django-Generated Tables in DBeaver

- In DBeaver, connect to the Django-generated SQLite database and view the ERD
- Notice: there are many tables created, not just our model classes, but lots of other ones
  - Django is "batteries included": it includes users, access permissions, content-types, etc
  - The tables have automatically generated ids, and the many-to-many table is automatically generated (and has an id)
  - Names are converted from Python class naming conventions to SQL naming conventions

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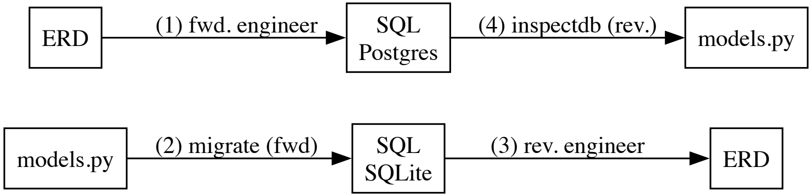


Django's InspectDB: Generating Python Classes from SQL Tables

```
uv pip install psycopg2 # install postgres triver

# in registration/admin.py,  connect to Postgres instead of SQLite
DATABASES = {
    "default": {
        "ENGINE": "django.db.backends.postgresql",
       "NAME": "postgres",
       "USER": "kaze7539",
#     "PASSWORD": "mypassword",
       "HOST": "127.0.0.1",
       "PORT": "5432",     } }

# in commmand line,  run
./manage.py inspectdb
```

Bonus: Pyreverse

- Pyreverse is a part of PyLint
- Instead of reverse engineering from SQL to ERD, pyreverse generates UML diagrams from Python code
    - Another type of "reverse engineering"
    - This is very useful for visualizing large projects with complex object-oriented inheritance

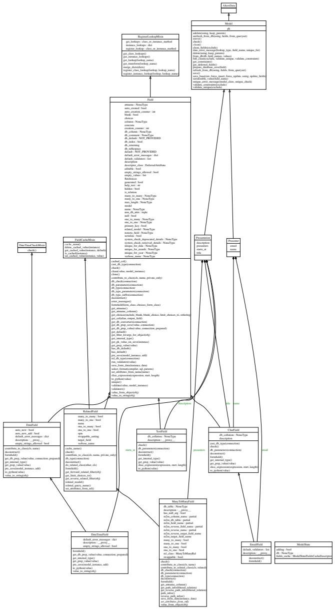
Pyreverse

```
uv pip install pylint  # install pylint module

# in command line,  run
pyreverse --all-ancestors --show-associated 1 talks/models.py

# convert dot to svg
dot -T svg -O classes.dot
```

Pyreverse Generated UML Diagram



Outline

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- We discussed the similarities and differences between Django's migration features and ER diagrams forward and reverse engineering features
  - Think of forward and reverse engineering more broadly
- We discussed different ERD software
- We saw how we can use Django to convert between SQL and Python code
- We also saw pyreverse
- AI statement:

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Questions

- Any questions or comments?