Models Inheritance and Customization

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#python-db

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Model Inheritance

Inheritance of Models

- **Model inheritance** allows you to create a **new model based** on an **existing** one
- The **new model** (**child**)
  - has **all** the **fields** and **methods** of the **original** model (**parent**)
  - can also **define** its **own additional fields** and **methods**

Types of Model Inheritance

- There are **three types** of **model inheritance** in Django
  - **Multi-table Inheritance**
    - **Both parent** and **child** models **generate** database tables
  - **Abstract Base Classes**
    - The **abstract** model (**parent**) does **not generate** a database table
  - **Proxy Models**
    - The **proxy** model (**child**) does **not generate** a database table

Multi-table Inheritance

- **Multi-table inheritance** creates
  - a **separate** database **table** for **each model** in the **inheritance chain**
- **Each table** includes
  - **fields** from **all** the **parent** **models** in the **hierarchy**
- Django **automatically** generates
  - a **`OneToOneField`** **field** for the **relationship** in the **child's** model to its **parent**

Multi-table Inheritance

```
from django.db import models

class ParentModel(models.Model):
    parent_field = models.CharField(max_length=50)

class ChildModel(ParentModel):
    child_field = models.IntegerField()
```

A field that a child will inherit from its parent

Own field that only child has

Problem: Zoo Animals

- You are given an empty **ORM project skeleton** (you can download it from **here**) needed to **create a Zoo Management System**
- First, in the **`main_app`** create 4 models called **`"Animal"`**, **`"Mammal"`**, **`"Bird"`**, and **`"Reptile"`**
- A full description of the problem can be found in the Lab document **here**

Solution: Zoo Animals

```
class Animal(models.Model):
    name = models.CharField(max_length=100)
    species = models.CharField(max_length=100)
    birth_date = models.DateField()
    sound = models.CharField(max_length=100)

class Mammal(Animal):
    fur_color = models.CharField(max_length=50)

class Bird(Animal):
    wing_span = models.DecimalField(max_digits=5, decimal_places=2)

class Reptile(Animal):
    scale_type = models.CharField(max_length=50)
```

Abstract Base Classes

- **Abstract models**
  - are **base classes**
  - allow **other models** to **inherit** **fields** and **methods** from them
  - do **not** **create** their **own** database **tables**
  - act as **templates** for **other models** to **reuse** **common fields** and **behavior**

Abstract Base Classes

```
from django.db import models

class AbstractBaseModel(models.Model):
    common_field = models.CharField(max_length=100)

    class Meta:
        abstract = True

class ChildModel(AbstractBaseModel):
    additional_field = models.IntegerField()
```

A field that a child will inherit from its abstract parent

No database table will be created

Own field that only child has

Class Meta

- Use the **inner class Meta**
  - to **insert metadata** into the model
- Adding **Meta** inner class is **optional**

```
class PersonBaseClass(models.Model):
    ...
    age = models.IntegerField()

    class Meta:
        abstract = True
```

Turns the model into an Abstract Base Class

Meta option

*Note: **Meta options** will be the subject of an article in the next presentation

Problem: Zoo Employees

- In the `main_app` create an **additional model** called **`"Employee"`**
  - It is a **base class** for any **type of employee** in the zoo
  - It is **NOT** meant to **create a database table** on its own
- Then, **create 2 more models: `"ZooKeeper"`** and **`"Veterinarian"`**
  - They are **types of employees**
- A full description of the problem can be found in the Lab document **here**

Solution: Zoo Employees

```
class Employee(models.Model):
    first_name = models.CharField(max_length=50)
    last_name = models.CharField(max_length=50)
    phone_number = models.CharField(max_length=10)

    class Meta:
        abstract = True

class ZooKeeper(Employee):
    # Add the predefined choices in the SPECIALITIES variable
    specialty = models.CharField(max_length=10, choices=SPECIALITIES)
    managed_animals = models.ManyToManyField('Animal')

class Veterinarian(Employee):
    license_number = models.CharField(max_length=10)
```

Proxy Models

- **Proxy models** allow you to create a **new model**
  - that **behaves exactly like** an existing **model**
  - with some **customizations added**
- The **proxy model** uses the **same** database **table** as the **original model**
- Useful when adding
  - **extra methods**, **managers**, or **custom behavior** to an **existing** model **without modifying** the **original** model

Proxy Models

```
from django.db import models

class OriginalModel(models.Model):
    ...
    field = models.CharField(max_length=50)

class ProxyModel(OriginalModel):
    ...
    class Meta:
        proxy = True
```

Original model fields

Some extra methods

No new table will be created

Problem: Animal Display System

- In the **`main_app`** create one **additional model** called **`"ZooDisplayAnimal"`**
  - It inherits from the **`"Animal"`** model but does **NOT** have its **own database table**
  - Its primary purpose is to **extend** the **`"Animal"`** model **behavior**
  - Currently, it is **NOT needed to add additional logic** to the model

Solution: Animal Display System

```
class ZooDisplayAnimal(Animal):
    class Meta:
        proxy = True
```

Model Methods

Built-in Methods, Custom Methods

Model Methods

- **Model methods** are **functions** defined **within** a Django **model**
- They allow you to **perform**
  - **operations** on **model instances**
  - **other tasks related** to the model
- Types of **model methods**
  - **Built-in** methods
  - **Custom** methods

Built-in Model Methods

- **Built-in Methods** are **standard** methods **provided** by
  - Django's `models.Model` **class**
- Main **built-in methods**
  - `save()`
    - Called **when saving** an **instance to** the **database**
  - `clean()`
    - Used for **data validation before saving**

More at: *https://docs.djangoproject.com/en/5.0/topics/db/models/#model-methods*

Overriding Predefined Model Methods

- **Override built-in methods** to **add**
  - **custom behavior** or **validation** to a model

```
from django.db import models

class MyModel(models.Model):
    field = models.CharField(max_length=100)

    def save(self, *args, **kwargs):
        ...
        super().save(*args, **kwargs) # Call the original save method

    def clean(self):
        ...
```

Custom logic before saving

Custom validation logic

Problem: Zookeeper's Specialty

- In the `"ZooKeeper"` **model add a custom validation logic before** each zookeeper object **is saved**
  - Create a **validation** to ensure that the object **is checked against the given list of valid choices** (`"SPECIALITIES"`)
  - If the **specialty** is **not a valid choice**, a `ValidationError` should be raised with the message: **`"Specialty must be a valid choice."`**

Solution: Zookeeper's Specialty

```
from django.core.exceptions import ValidationError

class ZooKeeper(Employee):
    ...

    def clean(self):
        super().clean()

        choices = [choice[0] for choice in self.SPECIALITIES]
        if self.specialty not in choices:
            raise ValidationError(
                "Specialty must be a valid choice."
            )
```

Custom Model Methods

- **Custom Model Methods**
  - **Additional methods defined** in a **model**
  - Performing **specific tasks** or **calculations related** to the **model**
  - Acting on a particular **model instance**
  - Keeping **business logic** in **one place**

Custom Model Methods

```
from django.db import models

class MyModel(models.Model):
    field = models.CharField(max_length=100)

    def custom_method(self):

        ...
```

Custom model method

Custom logic

Problem: Animal Display System Logic

- It is time to add logic to the **`"ZooDisplayAnimal"`** model
  - It is designed to create a **customized** view of **animal data** exclusively for visitors
- Your task is to **implement two custom methods** **`"display_info"`**, and **`"is_endangered"`**
- A full description of the problem can be found in the Lab document **here**

Solution: Animal Display System Logic

```
class ZooDisplayAnimal(Animal):

    class Meta:
        proxy = True

    def display_info(self):
        return f"Meet {self.name}! Species: {self.species}, 
born {self.birth_date}." \
               f" It makes a noise like '{self.sound}'."
```

Solution: Animal Display System Logic

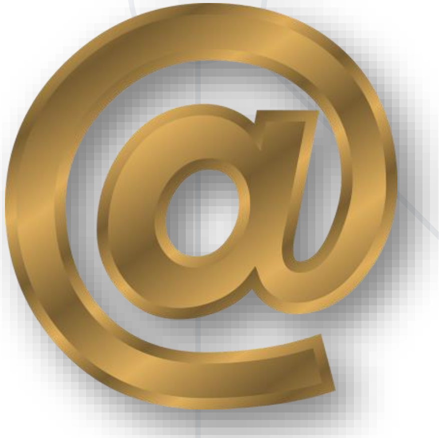
```
class ZooDisplayAnimal(Animal):
    ...

    SPECIES_AT_RISK = ["Cross River Gorilla", "Orangutan", 
"Green Turtle"]

    def is_endangered(self):
        danger = self.species in self.SPECIES_AT_RISK
        return f"{self.species} is at risk!" if danger \
            else f"{self.species} is not at risk."
```

Custom Model Properties

- **Custom model properties** allow you to
  - define **new attributes** for a **model** that are
    - **not stored** in the **database**
    - **calculated** or **derived** from **existing model fields**
- They are similar to **regular** model **fields**
  - but **do not correspond** to **database columns**
  - defined as **Python class properties**



Custom Model Properties

- To create a **custom model property**
  - use the **@property** decorator in Python
- The decorator allows you to **define** a **method** that
  - acts as a **property**
  - does **not require** a **database column**

```
class Employee(models.Model):
    birth_date = models.DateField()
    ...

    @property
    def age(self):
        ...  # Returns the
calculated age
```

Problem: Animal's Age

- In the **`"Animal"`** model implement **one property** that **calculates and returns the age** of an animal based on its birth date
- The age is **dynamically** calculated each time, ensuring that it remains accurate over time

Solution: Animal's Age

```
class Animal(models.Model):
    ...

    @property
    def age(self):
        today = date.today()
        age = today.year - self.birth_date.year - (
                (today.month, today.day) <
                (self.birth_date.month, self.birth_date.day))
        return age
```

Custom Fields

Custom Fields

- Django allows you to create **custom fields** by **subclassing**
  - `django.db.models.Field`
  - or one of the **existing field classes**
    - `models.CharField`, `models.IntegerField`, etc.
- **Custom fields** can be **helpful** when using
  - **custom data type**
  - **validation**
  - **serialization** for your model fields

Custom Fields Built-in Methods

- Django provides **several built-in** custom **field methods** that you can **override** to
  - **customize** the **behavior** of the custom model field
- Some of the most useful **built-in custom** field **methods**
  - `from_db_value()`
    - Converts the field's **value** as retrieved **from** the **database** into its **Python representation**
  - `to_python()`
    - Converts the field's **value** from the **serialized format** (usually as a string) into its **Python representation**

Custom Fields Built-in Methods

- `get_prep_value()`
  - **Prepares** the field's **value before saving** it to the database
- `validate()`
  - Performs **custom validation** on the field's **value**
- `deconstruct()`
  - Used when serializing the **field** to store its constructor **arguments as a tuple**, allowing Django to **recreate** the **field** when migrating or serializing models

***Note:** you do **not need** to override all of these methods for every custom field

Custom Field Example

```python
from django.db import models

class CustomField(models.Field):
    def to_python(self, value):
        # Custom data conversion logic
        ...

    def get_prep_value(self, value):
        # Custom value preparation for database storage
        ...

class MyModel(models.Model):
    custom_field = CustomField()
```

Overriding some built-in methods

An instance of the custom field

Custom Phone Field - Example

```
from django.db import models

class PhoneNumberField(models.CharField):
    def __init__(self, *args, **kwargs):
        kwargs['max_length'] = 15
        super().__init__(*args, **kwargs)

    def get_prep_value(self, value):
        if value is None:
            return value
        return ''.join(filter(str.isdigit, value))

class Employee(models.Model):
    ...
    phone_number = PhoneNumberField(default='111-111-111')
```

Defining a max-length

Preparing value for saving in DB

Filtering only the digits to be saved in DB

A default value can be set

Using the custom phone field

Saved value will be '111111111'

Problem: Veterinarian Availability

- In the **`"Veterinarian"`** model implement a new **field** called **`"availability"` with a custom model field type called `"BooleanChoiceField"`**
  - It should **behave like a Boolean field** but has **custom choices** and a **default value**
- A full description of the problem can be found in the Lab document **here**

Solution: Veterinarian Availability

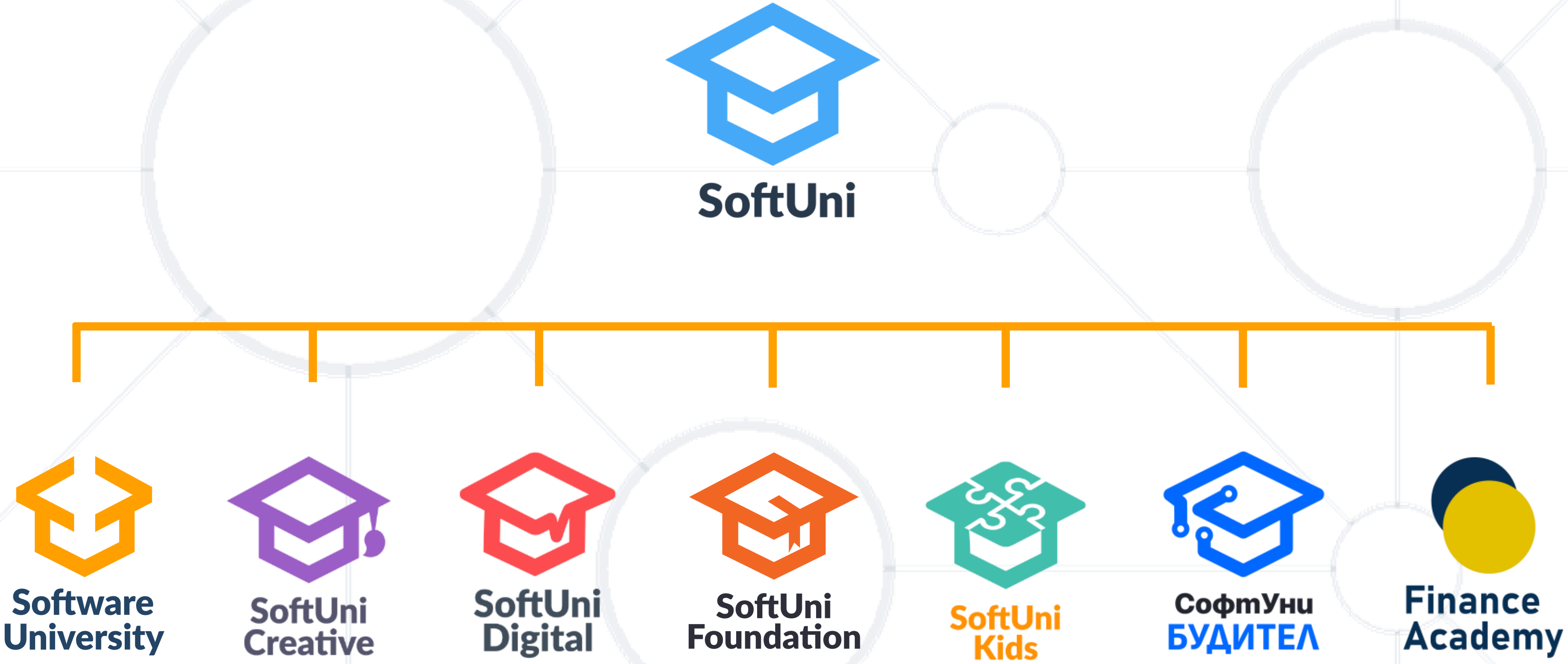
```
class BooleanChoiceField(models.BooleanField):
    def __init__(self, *args, **kwargs):
        kwargs['choices'] = ((True, 'Available'),
                             (False, 'Not Available'))
        kwargs['default'] = True
        super().__init__(*args, **kwargs)

class Veterinarian(Employee):
    ...
    availability = BooleanChoiceField()
```

Summary

- Model inheritance
  - Multi-table Inheritance
  - Abstract Base Classes
  - Proxy Models
- Model Methods
  - Built-in Methods, Custom Methods
- Custom Fields
  - Custom Field Built-in Methods

Questions?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