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Databases with MongoDB & PyMongo

WEB 1.1

Agenda

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- Learning Outcomes
- Code Review
- APIs Bonus Topics - virtual environments, environment variables
- Document-based Databases
- **BREAK**
- MongoDB in Python
- Wrap-Up

Learning Outcomes

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By the end of today, you should be able to...

1. **Describe** the structure of a Document-based Database.
2. **Identify** the operations used to create, read, update, & delete objects from a MongoDB database using Flask-PyMongo.

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Code Review

Warm-Up: Code Review (20 minutes)

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Break out into pairs and choose who will be the **reviewer** and **reviewee** for your finished Homework 3 (More Forms) assignment.

- **Reviewee**: Share your screen and explain what your code does from top to bottom.
- **Reviewer**: Listen, ask questions, and make suggestions for improvement.

After 7 minutes, switch roles.

** You may choose to do a code review of a different assignment, if you prefer.

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Virtual Environments

What is a virtual environment?

A **virtual environment** allows us to manage Python packages for different projects. Think of it like a **sandbox or container** where we can install packages and they won't affect the rest of your file system or projects.

For example, for **Project A** you may need **Version 1** of a package, but for **Project B** you may need **Version 2**. Since those versions are incompatible, you'll need a separate virtual environment for each project.

How do I use one?

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Navigate to your project directory, then:

- `python3 -m venv env` - create a folder called `env` that will hold all installed packages
- `source env/bin/activate` - activate your virtual environment; do this before you run your code or install packages
- `deactivate` - deactivate your virtual environment; do this when switching to work on a different project

What is requirements.txt?

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In Python projects, we use a file called `requirements.txt` to list all of the project's required packages.

- `pip3 install -r requirements.txt` - install all packages listed in the requirements
- `pip3 freeze > requirements.txt` - populate the requirements.txt file with all packages that are currently installed in the environment

Activity (10 minutes)

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Navigate to your Homework 3 directory. Use the steps on the previous slides to create a virtual environment, activate it, install Flask, & "freeze" to a requirements file.

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Environment Variables

What are Environment Variables?

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Sometimes, there are pieces of information (e.g. API keys) that you want to keep secret from the public. (Why?)

We call these pieces of information **secrets**.

It is very important to hide your secrets!!!

We can do this by saving each "secret" as an **environment variable**.

What are Environment Variables?

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An **environment variable** is a key-value pair that is saved to your operating system's environment.

We can read in environment variables using the **dotenv** Python package.

How do we use it?

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1. Install the dotenv package: `pip3 install python-dotenv`
2. Create a file called `.env` and enter your key-value pairs (do not use quotes):

```
# .env
SECRET_KEY=ilikebananas
```

3. In your Python code, enter the following:

```
import os
from dotenv import load_dotenv
load_dotenv()

secret_key = os.getenv('SECRET_KEY')
print(secret_key) # 'ilikebananas'
```

Activity (10 minutes)

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In your Homework 3 directory, create a `.env` file.

Follow the steps on the previous slide to create a key-value pair for the **GIF Search API key** instead of hard-coding it.

The `datetime` Library

datetime

The `datetime` library is built into Python, so you don't need to install it.

This library provides us access to `datetime` objects - which represent a specific date and time in object form.

```
from datetime import datetime

now_date_obj = datetime.now()

print(now_date_obj)

# 2020-09-02 21:17:19.511047
```

datetime

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The datetime object has many useful fields:

```
print(now_date_obj.day) # 2

print(now_date_obj.month) # 9

print(now_date_obj.year) # 2020

print(now_date_obj.hour) # 21

print(now_date_obj.minute) # 20
```

Check out the datetime documentation for more info.

Converting datetime

We can convert a datetime to a string using `strftime`:

```
print(now_date_obj.strftime('%Y-%m-%d'))
# '2020-09-02'
```

format codes

And we can convert a string to a datetime using `strptime`:

```
another_date = datetime.strptime('2020-09-03', '%Y-%m-%d')
print(another_date) # 2020-09-03 00:00:00
```

Time since epoch

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The "**epoch time**" of any datetime object is the number of seconds that have elapsed since January 1st, 1970 (considered to be the "epoch" of the Internet).

```
print(now_date_obj.strftime('%s'))
# 1599082605
```

Activity

Read over this Format Code List for a complete list of codes. Try using some to convert a datetime to a string, or vice versa!

What is **one question** you still have about date objects?

- Time durations
- Timezones
- UTC vs. local time

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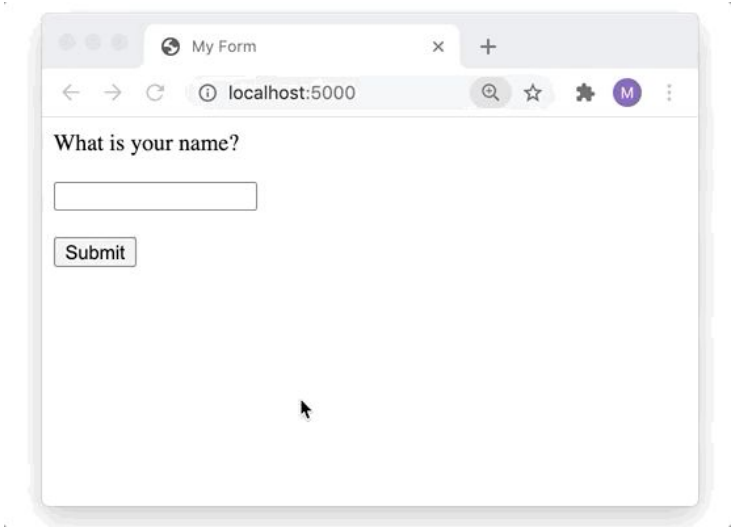
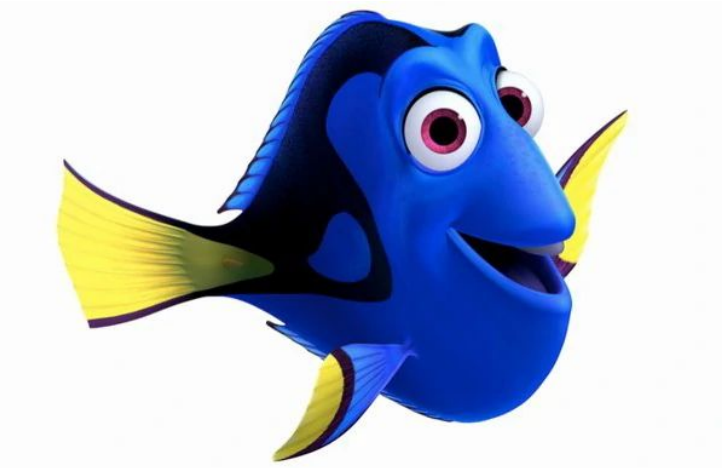
Why Databases?

Databases

We can collect information about a user, and save it to a variable. But what happens when we restart the server?

All of that information is forgotten!



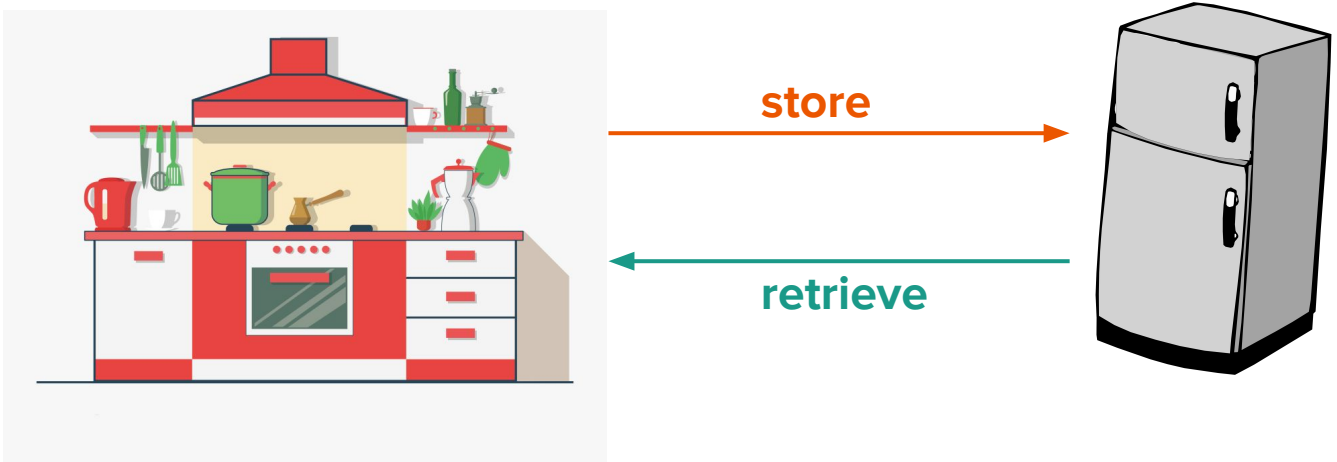


Databases

Think about a site that requires user login, like Facebook.

What would happen if it didn't have a database?

If our web application is like a kitchen, then the database is like a refrigerator that keeps our data safe until we need to use it again.



What is MongoDB?

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In this class, we'll be using **MongoDB** as our database, and **PyMongo** as the Python library to connect to it.

MongoDB is called a **NoSQL**, or **Document-based** database, because we don't have to specify ahead of time what our data will look like. Instead, we can store **any key-value pairs** in a database item.

Activity (10 minutes)

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With a partner, follow the steps in the MongoDB Setup Tutorial to install MongoDB and run a local server on your computer.

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So... What is a Document-based Database?

MongoDB Vocabulary

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A **resource** refers to **one type of data** that can be saved to a database. For example, in a Music application, we may have the resources of **Song**, **Artist**, **Album**, and **Playlist**.

A resource usually has **attributes** (sometimes called **fields**). For example, the **Song** resource may have attributes of: song name, artist id, rating, and publish date.

What **resources** might we have for an **Online Store** application? Name at least 3.

MongoDB Vocabulary

A **document** is a JSON object containing data related to **one single object** of a resource. E.g. we may have a document for the song “Single Ladies” by Beyonce.

```
{
    'name': 'Can\'t Buy Me Love',
    'artistId': ObjectId('12345'),
    'avgRating': 4.7
}
```

```
{
    'name': 'Single Ladies',
    'artistId': ObjectId('12347'),
    'avgRating': 4.7
}
```

```
{
    'name': 'Teardrops on My Guitar',
    'artistId': ObjectId('12342'),
    'avgRating': 4.7
}
```

```
{
    'name': 'Roar',
    'artistId': ObjectId('12343'),
    'avgRating': 4.7
}
```

MongoDB Vocabulary

A **collection** is a container for documents specific to a certain type of object, or resource. E.g. we may have one collection for **songs**, another for **albums**, another for **artists**, another for **playlists**, etc. A collection contains many **documents**.

MongoDB Vocabulary

A **database** is a container for many collections. Typically, we will use one database for one project.

Songs Database

Songs

```
{
    'name': 'Can\'t Buy Me Love',
    'artistId': ObjectId('12345'),
    'avgRating': 4.7
}
```

```
{
    'name': 'Single Ladies',
    'artistId': ObjectId('12347'),
    'avgRating': 4.7
}
```

...

Albums

```
{
    'title': 'Hey Jude',
    'artistId': ObjectId('12347'),
    'published': '2/26/1970'
}
```

```
{
    'title': 'Lemonade',
    'artistId': ObjectId('12347'),
    'published': '4/23/2016'
}
```

...

Artists

```
{
    'name': 'The Beatles',
    'members': [ 'John Lennon',
        'Paul McCartney',
        'George Harrison',
        'Ringo Starr' ]
}
```

```
{
    'name': 'Beyonce',
    'born': '9/4/1981'
}
```

...

Activity (10 minutes)

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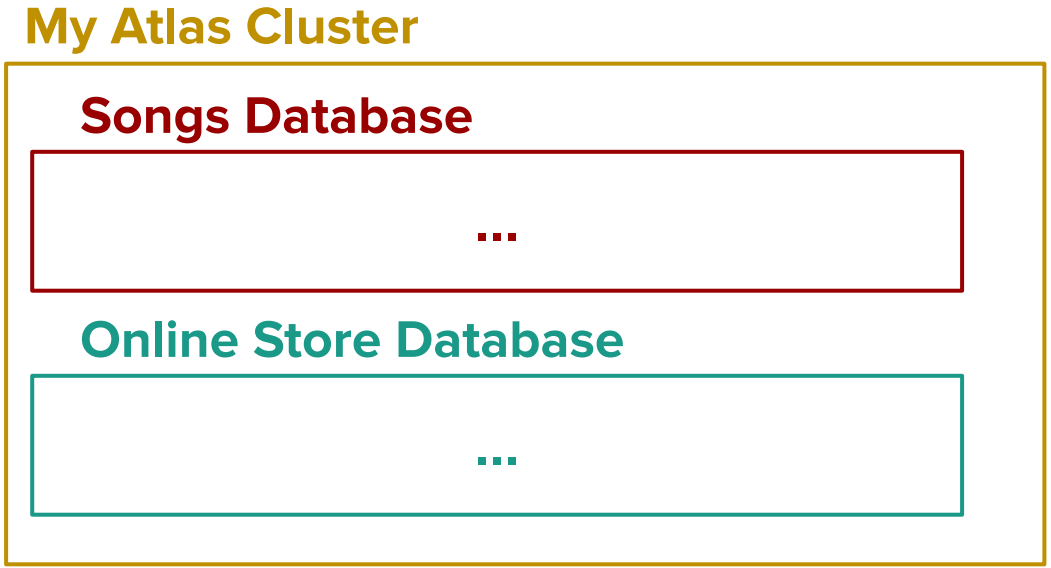
In a group of 3, discuss which collections you would use to create an online store where users can sign up, view items, add items to a shopping cart, and purchase items. Write down 3 possible collections and give an example document for each collection.

Use this worksheet to organize your thoughts.

MongoDB Vocabulary

A **cluster** is specific to MongoDB Atlas, and gives computing power to hosting your data. A cluster can contain many **databases** (but doesn't have to).



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Break - 10 min

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How do I use it in Python?

Set Up

We can import the PyMongo module in our code:

```
from flask import Flask
from flask_pymongo import PyMongo

app = Flask(__name__)
app.config["MONGO_URI"] = "mongodb://localhost:27017/myDatabase"

mongo = PyMongo(app)
```

Then, we can use the **mongo.db** object directly in our routes:

```
@app.route("/")
def home_page():
    online_users = mongo.db.users.find({"online": True})
    return render_template("index.html",
        online_users=online_users)
```

MongoDB Operations

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There are **four operations** we can do on a database document. You can remember them with the acronym **C.R.U.D.**

C reate

R ead

U pdate

D elete

MongoDB Operations - Insert One

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We can **create a new document** using the operation `insert_one`.

```
new_user = {
    'first_name': 'Meredith',
    'role': 'instructor',
    'num_pets': 1
}

result = mongo.db.users.insert_one(new_user)
```

This means that we are creating a new document in the **users** collection of the **db** database.

What is an ObjectId?

All new objects in the database are automatically given a field **_id** which is an randomly-generated 24-digit hexadecimal string.

However, this field is stored as type **bson.objectid.ObjectId**, not as a string.

```
{
    'name': 'Meredith',
    'role': 'instructor',
    'num_pets': 1,
}
```

```
{
    'name': 'Meredith',
    'role': 'instructor',
    'num_pets': 1,
    '_id': ObjectId('5f5f871c9bca94a49d6e8956')
}
```

MongoDB Operations - Find

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We can get all objects in a collection by using **find**:

```
all_users = mongo.db.users.find()
for user in all_users:
   print(user['name'])
```

We can also get all objects matching some constraint(s):

```
all_instructors = mongo.db.users.find({'role': 'instructor'})
for user in all_instructors:
   print(user['name'])
```

Activity (5 minutes)

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Use the MongoDB Playground to experiment with using the **find** operation:

- What happens if you create two identical objects? How can you tell them apart?
- What happens if you include nested data (lists/objects) inside of a document? How could you retrieve that information?

MongoDB Operations - Find One

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We can get one single object using **find_one**:

```
user1 = mongo.db.users.find_one({'first_name': 'Meredith'})
print(user1)

>>> {'name': 'Meredith', 'role': 'instructor', 'num_pets': 1,
'_id': ObjectId('5f5f871c9bca94a49d6e8956')}
```

MongoDB Operations - Update One

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We can update an existing entry using **update_one** and setting a field called **$set** in the second parameter.

```
user1 = mongo.db.users.update_one({
   'first_name': 'Meredith'
},
{
   '$set': { 'num_pets': 2 }
})
print(user1)

>>> {'name': 'Meredith', 'role': 'instructor', 'num_pets': 2,
'_id': ObjectId('5f5f871c9bca94a49d6e8956')}
```

Activity

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Run the code for the Fruits Database Repl. Notice what happens after each database operation is run.

MongoDB Operations - Delete One

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We can delete an entry by using **delete_one**.

```
result = mongo.db.users.delete_one({
    'first_name': 'Meredith'
})
print(result.deleted_count)


>>> 1
```

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Lab Time

Homework

Homework 4: Databases will require you to use a MongoDB database to create, read, update, & delete objects.