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# 🐍 Python Interview Notes – Concurrency, Asyncio, Threading, Multiprocessing

## 🧠 Python Basics Summary

### 🔹 ****1. Python Data Types****

* **int** – Integer numbers: 1, -5
* **float** – Decimal numbers: 3.14, -2.5
* **str** – Strings: "hello", 'world'
* **bool** – Boolean: True, False
* **list** – Ordered, mutable: [1, 2, "a"]
* **tuple** – Ordered, immutable: (1, 2, "a")
* **set** – Unordered, unique items: {1, 2, 3}
* **dict** – Key-value pairs: {"name": "Alice", "age": 25}
* **None** – Null type: None

### 🔹 ****2. Conditional Statements****

python

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x = 10

if x > 5:

print("Greater")

elif x == 5:

print("Equal")

else:

print("Smaller")

### 🔹 ****3. Loops****

**For loop**:

python

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for i in range(5):

print(i)

**While loop**:

python

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count = 0

while count < 5:

print(count)

count += 1

### 🔹 ****4. List Comprehension****

python

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# Square of even numbers from 0 to 9

squares = [x\*\*2 for x in range(10) if x % 2 == 0]

### 🔹 ****5. Scope in Python****

* **Local**: Inside a function
* **Enclosing**: In the outer function (closure context)
* **Global**: Defined at the top level of the script
* **Built-in**: Names pre-defined by Python (e.g., len, sum)

👉 Known as **LEGB Rule** (Local → Enclosing → Global → Built-in)

### 🔹 ****6. Closures****

A closure is when an inner function remembers variables from its enclosing scope even after the outer function has finished executing.

python

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def outer():

x = 5

def inner():

print(x) # x is remembered

return inner

func = outer()

func() # Output: 5

## 🐍 Python Interview Summary Notes

### ✅ 1. Object-Oriented Programming (OOPs) in Python

| Concept | Description |
| --- | --- |
| **Class** | Blueprint for creating objects. |
| **Object** | Instance of a class. |
| **Encapsulation** | Hiding internal state using private variables (\_var, \_\_var). |
| **Abstraction** | Hiding complex logic using simple interfaces. Achieved via classes or ABCs. |
| **Inheritance** | One class inherits properties from another (class B(A):). |
| **Polymorphism** | Same function behaves differently in different classes. |

python

CopyEdit

class Animal:

def speak(self): print("Animal sound")

class Dog(Animal):

def speak(self): print("Bark")

### ⚠️ 2. Exception Handling in Python

| Concept | Syntax & Notes |
| --- | --- |
| Try/Except | Catches exceptions |
| Else | Runs if no exception |
| Finally | Always runs (cleanup etc.) |
| Custom Exception | class MyError(Exception): pass |

python

CopyEdit

try:

result = 10 / 0

except ZeroDivisionError:

print("Cannot divide by zero")

finally:

print("Cleanup")

## 🔄 What is Concurrency?

**Concurrency** means multiple tasks are in progress at the same time (but not necessarily running simultaneously).

Python supports concurrency via:

| Method | Best For | True Parallelism? | GIL Aware? |
| --- | --- | --- | --- |
| threading | I/O-bound tasks | ❌ No | ❌ Yes |
| multiprocessing | CPU-bound tasks | ✅ Yes | ✅ Avoids GIL |
| asyncio | I/O-bound tasks | ❌ No | ✅ Single-threaded |

## 🧵 1. threading – For I/O-bound Tasks

python

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import threading

import time

def send\_email():

time.sleep(2)

print("Email sent!")

def log\_response():

print("Response sent!")

t1 = threading.Thread(target=send\_email)

t1.start()

log\_response()

### ✅ Key Points:

* Threads share memory.
* Great for I/O-bound tasks (e.g., file I/O, APIs).
* Blocked by GIL for CPU tasks.
* Good for **parallel waiting**, not **parallel computing**.

## 💥 2. multiprocessing – For CPU-bound Tasks

python

CopyEdit

from multiprocessing import Process

def square(n):

print(n \* n)

p = Process(target=square, args=(5,))

p.start()

p.join()

### ✅ Key Points:

* Separate memory space, runs on multiple CPU cores.
* Not blocked by GIL.
* Ideal for CPU-heavy tasks (math, image processing).
* Slower communication between processes than threads.

## ⚡ 3. asyncio – For Async I/O

python

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import asyncio

async def say\_hello():

await asyncio.sleep(1)

print("Hello")

asyncio.run(say\_hello())

### ✅ Key Points:

* Uses async and await.
* Cooperative multitasking using an event loop.
* Efficient for **many** I/O-bound tasks (like calling 100 APIs).
* Not parallel, just fast-switching via event loop.

## 🔁 JavaScript-style Event Loop in Python

### Similarities to JS:

* Uses **event loop** to handle tasks.
* Handles I/O operations **without blocking**.
* await releases control back to the event loop.

### Event Loop Flow:

1. Synchronous code runs first.
2. await pauses the coroutine.
3. Event loop runs next task (like a microtask).
4. Completed async task resumes later.

## ⚙️ I/O-bound vs CPU-bound

| Task Type | CPU-bound | I/O-bound |
| --- | --- | --- |
| Definition | Slowed by CPU | Slowed by Input/Output (e.g. network, disk) |
| Uses CPU? | ✅ Yes | ❌ No |
| Examples | Math, image processing | API calls, DB reads, file write |
| Best Tool | multiprocessing | asyncio / threading |

## 🔍 When to Use What?

| Scenario | Tool |
| --- | --- |
| Heavy computation (math, image) | multiprocessing |
| Fetching data from APIs | asyncio |
| Sending email in background | asyncio / threading |
| Reading large file | asyncio |
| Simulating background job | threading |

## 🔄 Quick Analogy Summary:

| Feature | Threading | Asyncio | Multiprocessing |
| --- | --- | --- | --- |
| Type | OS-level threads | Coroutines (green threads) | Independent processes |
| Parallel? | ❌ Not for CPU-heavy | ❌ No (cooperative) | ✅ Yes |
| GIL safe? | ❌ No | ✅ Yes | ✅ Yes |
| Memory Shared? | ✅ Yes | ✅ Yes | ❌ No (isolated) |
| Use Case | I/O-bound | I/O-bound | CPU-bound |

## 🧠 Final Core Difference Between asyncio and threading

| Feature | asyncio | threading |
| --- | --- | --- |
| **Concurrency Model** | **Cooperative multitasking** | **Preemptive multitasking** (OS-controlled) |
| **Underlying Mechanism** | Single-threaded **event loop** | Multiple **OS-level threads** |
| **Switching Control** | You **manually yield** with await | OS **automatically switches** between threads |
| **Runs in Parallel?** | ❌ No true parallelism | ✅ Threads may run in parallel on I/O waits |
| **Memory** | Shared (single thread) | Shared memory across threads |
| **Code Complexity** | Needs async/await syntax everywhere | Can use regular functions |
| **Best Use Case** | High I/O tasks with **many lightweight jobs** | Blocking I/O like file reading or API calls |
| **CPU Usage** | Low CPU load (ideal for 10,000 I/O tasks) | Slightly more CPU usage due to threads |
| **Error Risk** | Fewer race conditions | Prone to **race conditions**, needs locking |

### 🔍 What does this really mean?

* **Asyncio** is like one person doing many small tasks and saying “I'll wait, do something else for now.”
* **Threading** is like having multiple people doing tasks at the same time — the OS manages who works when.

### 🧪 Practical Difference Example:

If you want to **download 1000 URLs**:

* asyncio scales better with fewer resources.
* threading may hit system limits (thread pool limits, memory).

## ✅ Final Verdict

| If you need to: | Use: |
| --- | --- |
| Handle 1000+ network/API requests | asyncio |
| Read/write files or handle 10-100 tasks | threading |
| Avoid async/await syntax | threading |
| Avoid race conditions | asyncio |

## 🧵 Multithreading vs 🔥 Multiprocessing in Python

| Feature | threading (Multithreading) | multiprocessing |
| --- | --- | --- |
| **Concurrency Model** | Multiple threads **within a single process** | Multiple **independent processes** |
| **Parallelism** | ❌ No true parallelism due to the GIL | ✅ True parallelism (each process has its own Python interpreter) |
| **GIL Affected?** | ✅ Yes – only one thread runs Python bytecode at a time | ❌ No – each process has its own GIL |
| **Memory Sharing** | ✅ Yes (shared memory space) | ❌ No (separate memory space) |
| **Communication** | Easy (same memory) but needs **thread locks** | Harder (need Queues, Pipes, or Managers) |
| **Setup Cost** | Low overhead | High overhead (process creation is expensive) |
| **Best For** | I/O-bound tasks | CPU-bound tasks (e.g., computation-heavy) |
| **Risk of Bugs** | High – race conditions, deadlocks | Lower (isolated memory avoids data clashes) |
| **Crash Effect** | One thread crashing may affect others | One process crashing doesn’t affect others |

### 🧠 Global Interpreter Lock (GIL)

* A mutex that allows **only one thread** to execute Python bytecode at a time.
* Makes multithreading inefficient for **CPU-bound** tasks in CPython.
* Multiprocessing avoids the GIL by creating separate memory and interpreter spaces.

### 📌 Example: Same Task with Both

#### 1. Using Threads (I/O-bound)

python

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import threading

import time

def task():

time.sleep(2)

print("Done")

for \_ in range(3):

t = threading.Thread(target=task)

t.start()

#### 2. Using Processes (CPU-bound)

python

CopyEdit

from multiprocessing import Process

import time

def compute():

# heavy CPU task

total = 0

for \_ in range(10\*\*7):

total += 1

print("Done")

for \_ in range(3):

p = Process(target=compute)

p.start()

### 🧪 Summary Decision Table

| Situation | Use This |
| --- | --- |
| API calls, file I/O, network latency | threading |
| Image processing, ML computation | multiprocessing |
| Need shared memory or object states | threading |
| Want true CPU parallelism | multiprocessing |

🔹 **7. Lambda Functions (Anonymous Functions)**

**Syntax**:

python

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lambda arguments: expression

**Examples**:

python

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add = lambda a, b: a + b

print(add(3, 4)) # Output: 7

# With map

nums = [1, 2, 3]

doubled = list(map(lambda x: x \* 2, nums)) # [2, 4, 6]

# With filter

evens = list(filter(lambda x: x % 2 == 0, nums)) # [2]

**Use Cases**: Use in places where you need a quick, short function for map(), filter(), sorted(), etc.

## 🎁 Decorators in Python

### 🔸 What is a Decorator?

A **decorator** is a function that **takes another function as input**, adds some functionality, and **returns a new function** — without modifying the original one.

In simple terms, it **wraps** a function to extend its behavior.

### 🧱 Syntax

python

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def decorator\_func(original\_func):

def wrapper\_func():

print("Before the function runs")

original\_func()

print("After the function runs")

return wrapper\_func

Usage:

python

CopyEdit

@decorator\_func

def say\_hello():

print("Hello!")

say\_hello()

**Output:**

pgsql

CopyEdit

Before the function runs

Hello!

After the function runs

The @decorator\_func is **syntactic sugar** for:

python

CopyEdit

say\_hello = decorator\_func(say\_hello)

### 🧩 Decorator with Arguments

python

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def decorator\_func(func):

def wrapper(\*args, \*\*kwargs):

print(f"Running {func.\_\_name\_\_}")

return func(\*args, \*\*kwargs)

return wrapper

@decorator\_func

def greet(name):

print(f"Hello, {name}!")

greet("Alice")

Output:

sql

CopyEdit

Running greet

Hello, Alice!

### 🔁 Use Cases

* Logging
* Access control (permissions)
* Measuring execution time
* Caching
* Rate limiting in APIs

### ✅ Built-in Decorators

* @staticmethod – Define a static method in a class.
* @classmethod – Define a class method (gets cls instead of self).
* @property – Make a method behave like an attribute.

Example:

python

CopyEdit

class Circle:

def \_\_init\_\_(self, radius):

self.\_radius = radius

@property

def area(self):

return 3.14 \* self.\_radius \*\* 2

c = Circle(5)

print(c.area) # No parentheses!

### 🚀 Bonus: Timer Decorator Example

python

CopyEdit

import time

def timer(func):

def wrapper(\*args, \*\*kwargs):

start = time.time()

result = func(\*args, \*\*kwargs)

end = time.time()

print(f"{func.\_\_name\_\_} ran in {end - start:.2f}s")

return result

return wrapper

@timer

def slow\_function():

time.sleep(2)

print("Done")

slow\_function()

🧠 **Python's "spread-like" behavior (e.g. unpacking with** \* **or** \*\***) creates a** shallow copy — **not a deep copy**.

## 🧯 Examples of "Spread Operator" in Python

### 🔹 For Lists (\* operator)

python

CopyEdit

original = [[1, 2], [3, 4]]

copied = [\*original] # Like [...original] in JS

copied[0][0] = 999

print("Original:", original)

print("Copied:", copied)

**Output:**

lua

CopyEdit

Original: [[999, 2], [3, 4]]

Copied: [[999, 2], [3, 4]]

🧨 **Shallow copy**: Inner lists are still shared.

### 🔸 For Dictionaries (\*\* operator)

python

CopyEdit

original = {"a": {"nested": 1}, "b": 2}

copied = {\*\*original}

copied["a"]["nested"] = 999

print("Original:", original)

print("Copied:", copied)

**Output:**

yaml

CopyEdit

Original: {'a': {'nested': 999}, 'b': 2}

Copied: {'a': {'nested': 999}, 'b': 2}

🧨 Again, shallow copy — the inner dict is still shared.

### ✅ If You Want a Deep Copy?

Use:

python

CopyEdit

import copy

deep = copy.deepcopy(original)

### ✅ Summary

| Operator | Type of Copy | Notes |
| --- | --- | --- |
| \*list | Shallow copy | Copies outer list only |
| \*\*dict | Shallow copy | Copies top-level keys only |
| copy.copy() | Shallow copy | Similar to above |
| copy.deepcopy() | Deep copy | Recursively copies everything |

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CopyEdit

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## ✅ Does a Coroutine Pause Execution?

Yes, **a coroutine** can **pause itself** — but not the entire program.

## 💡 Here’s the Key Distinction

### 🔹 Coroutine (async def + await)

* **Pauses itself only** when it hits an await.
* While it's paused, the **event loop continues running**, doing other work (like running other coroutines).

So:

**Coroutines pause themselves**, not the main thread or event loop.

### 🔸 Asyncio Event Loop

* The **event loop is the scheduler**.
* It runs coroutines.
* When a coroutine awaits something (e.g. sleep, I/O), the event loop suspends it and picks the next coroutine to run.

### 🧠 Analogy

Imagine the **event loop as a manager**, and **coroutines as employees**:

* Each employee (coroutine) says:

“Hey boss, I’m waiting for a file to download — I’ll be back in 2 minutes.”

* The boss (event loop) replies:

“Cool, I’ll go check on other employees in the meantime.”

No one blocks the manager (event loop), and work gets done efficiently.

### 🔁 Recap

| Concept | Who pauses? | Who keeps going? |
| --- | --- | --- |
| Coroutine + await | The coroutine itself | The event loop continues |
| Thread.sleep (bad) | Whole thread | Entire program might block |
| asyncio.sleep | Only that coroutine pauses | Others continue running |

### 📘 Django Models — Core Concepts Cheat Sheet

#### ✅ 1. Model Basics

* A Django model is a Python class that subclasses django.db.models.Model.
* Each model maps to a single table in the database.
* Fields define table columns (CharField, IntegerField, ForeignKey, etc).

class Book(models.Model):

title = models.CharField(max\_length=200)

author = models.ForeignKey('Author', on\_delete=models.CASCADE)

#### 🔄 2. on\_delete Behaviors in ForeignKey

Specifies what happens when the referenced object is deleted:

| Option | Behavior |
| --- | --- |
| CASCADE | Deletes child when parent is deleted. (Most common) |
| PROTECT | Prevents deletion of parent if child exists. Raises ProtectedError. |
| SET\_NULL | Sets the FK to NULL when parent is deleted (requires null=True). |
| SET\_DEFAULT | Sets FK to default value (requires default= on field). |
| SET(...) | Sets FK to a custom value or callable. |
| DO\_NOTHING | No DB action. Risk of referential integrity issues. |

class Book(models.Model):

author = models.ForeignKey('Author', on\_delete=models.SET\_NULL, null=True)

#### 🔁 3. ManyToManyField

* Models many-to-many relationships.
* Django auto-creates an intermediate table.

class Student(models.Model):

name = models.CharField(max\_length=100)

class Course(models.Model):

title = models.CharField(max\_length=100)

students = models.ManyToManyField(Student)

You can also customize the intermediate table using through=.

class Enrollment(models.Model):

student = models.ForeignKey(Student, on\_delete=models.CASCADE)

course = models.ForeignKey(Course, on\_delete=models.CASCADE)

date\_enrolled = models.DateField()

class Course(models.Model):

title = models.CharField(max\_length=100)

students = models.ManyToManyField(Student, through='Enrollment')

#### ⚙️ 4. Model Meta Class

* Meta is an inner class used to configure model behavior (table name, ordering, constraints, etc).

class Book(models.Model):

title = models.CharField(max\_length=100)

class Meta:

db\_table = 'library\_books' # custom table name

ordering = ['title'] # default ordering

verbose\_name = 'Book'

verbose\_name\_plural = 'Books'

**Common Meta options:**

* db\_table: Custom DB table name.
* ordering: Default ordering of querysets.
* verbose\_name, verbose\_name\_plural: Human-readable names.
* unique\_together / constraints: For composite uniqueness.

### ⚠️ 5. The N+1 Query Problem

**Problem**: When querying related models in a loop, Django may hit the database once for each iteration — causing N+1 queries.

**Example (Inefficient):**

books = Book.objects.all() # 1 query

for book in books:

print(book.author.name) # 1 query per book (N queries)

➡️ If you have 100 books, this results in **1 + 100 = 101 queries!**

#### ✅ Solution: Use select\_related() and prefetch\_related()

|  |  |  |
| --- | --- | --- |
| Method | Use when... | Works on... |
| select\_related() | You have a **ForeignKey or OneToOne** | Single-valued relations |
| prefetch\_related() | You have a **ManyToMany or reverse FK** | Multi-valued relations |

**Using select\_related:**

books = Book.objects.select\_related('author')

for book in books:

print(book.author.name) # Only 1 query for all books + authors!

**Using prefetch\_related:**

courses = Course.objects.prefetch\_related('students')

for course in courses:

for student in course.students.all():

print(student.name)

Great — let's dive into your **custom middleware** idea and implement it in full.

### ✅ Goal:

Create a Django middleware that:

* Adds a **custom response header** called Test-Token
* This token includes:
  + An **access token** (placeholder or real)
  + The **user’s name**, if authenticated

### 🧠 Step-by-step logic:

1. If the user is authenticated, retrieve their username.
2. Generate or fetch an access token.
3. Combine both into a custom header value.
4. Attach it to the **response object**.

### 🧪 Full Middleware Code Example

python

CopyEdit

# middleware/custom\_token.py

class CustomTokenMiddleware:

def \_\_init\_\_(self, get\_response):

self.get\_response = get\_response

def \_\_call\_\_(self, request):

# This is run \*before\* the view is called

response = self.get\_response(request)

# This is run \*after\* the view returns a response

user = getattr(request, 'user', None)

if user and user.is\_authenticated:

username = user.username

access\_token = self.generate\_access\_token(user)

custom\_token = f"{access\_token}:{username}"

response['Test-Token'] = custom\_token

else:

response['Test-Token'] = 'anonymous'

return response

def generate\_access\_token(self, user):

# Just for demonstration — in real use, use JWT or a token system

import hashlib

return hashlib.sha256(user.username.encode()).hexdigest()

### 🛠 How to Use It

1. Add it to your MIDDLEWARE list in settings.py:

python

CopyEdit

MIDDLEWARE = [

...

'middleware.custom\_token.CustomTokenMiddleware',

]

## ✅ 1. ****Custom Managers and QuerySets in Django****

### 🔹 What is a Manager?

A **Manager** in Django is an interface through which Django ORM interacts with your database. By default, every model gets a manager named .objects.

python

CopyEdit

class Book(models.Model):

title = models.CharField(max\_length=100)

# Usage:

books = Book.objects.all()

Here, objects is the default manager. You can replace or extend it to return **filtered querysets** by default.

### 🔹 Why create a custom manager?

Let’s say you have a model with a Boolean field like is\_published, and you only want to work with published items most of the time.

#### ✅ Default Manager:

python

CopyEdit

class Article(models.Model):

title = models.CharField(max\_length=100)

is\_published = models.BooleanField(default=False)

# This gives you ALL articles:

Article.objects.all()

But let’s say **you want to get only published articles** by default. Here’s how:

### 🔹 How to define a custom manager

python

CopyEdit

class PublishedManager(models.Manager):

def get\_queryset(self):

return super().get\_queryset().filter(is\_published=True)

Now use it inside your model:

python

CopyEdit

class Article(models.Model):

title = models.CharField(max\_length=100)

is\_published = models.BooleanField(default=False)

objects = models.Manager() # Default manager

published = PublishedManager() # Custom manager

Now:

python

CopyEdit

Article.objects.all() # Returns all articles

Article.published.all() # Returns only published ones!

This is **exactly** how Soft Delete also works — by customizing get\_queryset() to hide deleted rows.

### 🔹 BONUS: Custom QuerySets

You can make your custom **QuerySet** class to add more methods:

python

CopyEdit

class ArticleQuerySet(models.QuerySet):

def published(self):

return self.filter(is\_published=True)

class Article(models.Model):

title = models.CharField(max\_length=100)

is\_published = models.BooleanField(default=False)

objects = ArticleQuerySet.as\_manager()

Then you can do:

python

CopyEdit

Article.objects.published()

## 🔁 2. ****ManyToMany in Django****

### 🧠 What does it mean?

Let’s say:

* A student can enroll in **many** courses.
* A course can have **many** students.

This is a **Many-to-Many** relationship.

### 🔹 Simple way:

python

CopyEdit

class Student(models.Model):

name = models.CharField(max\_length=100)

class Course(models.Model):

title = models.CharField(max\_length=100)

students = models.ManyToManyField(Student)

Now Django creates a hidden **intermediate table** automatically behind the scenes:

sql

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course\_students(course\_id, student\_id)

You can use:

python

CopyEdit

course = Course.objects.get(id=1)

course.students.all() # All students in the course

student = Student.objects.get(id=1)

student.course\_set.all() # All courses this student enrolled in

### 🔹 Customizing the Intermediate Table

Suppose you want to **track more info** about the relationship — e.g., when the student enrolled.

You need to create a model for the intermediate table.

python

CopyEdit

class Enrollment(models.Model):

student = models.ForeignKey(Student, on\_delete=models.CASCADE)

course = models.ForeignKey(Course, on\_delete=models.CASCADE)

date\_enrolled = models.DateField()

Now connect it using through=:

python

CopyEdit

class Course(models.Model):

title = models.CharField(max\_length=100)

students = models.ManyToManyField(Student, through='Enrollment')

Now you **can't** use course.students.add() anymore, because you must create an Enrollment manually:

python

CopyEdit

Enrollment.objects.create(student=student\_obj, course=course\_obj, date\_enrolled="2024-05-01")

## 👤 3. ****Custom User Model in Django (Over Default**** User****)****

### ❗Why override Django's default User model?

The default User has:

* username, first\_name, last\_name, email, password

But maybe:

* You want to use **email instead of username**
* Or add fields like phone\_number, is\_verified, etc.

### 🔹 Option 1: ****Extend with OneToOneField (NOT recommended)****

This is a "profile" model that extends the existing user:

python

CopyEdit

from django.contrib.auth.models import User

class UserProfile(models.Model):

user = models.OneToOneField(User, on\_delete=models.CASCADE)

phone\_number = models.CharField(max\_length=20)

But this **does not change the User model itself**. You’ll always have two models.

### 🔹 Option 2: ****Custom User Model (Best Practice)****

You make your **own User model from scratch**, inheriting from AbstractBaseUser or AbstractUser.

#### 👉 Simple example using AbstractUser (inherits all functionality):

python

CopyEdit

from django.contrib.auth.models import AbstractUser

from django.db import models

class CustomUser(AbstractUser):

phone\_number = models.CharField(max\_length=20, blank=True, null=True)

Now in settings.py, tell Django to use it:

python

CopyEdit

AUTH\_USER\_MODEL = 'yourapp.CustomUser'

Then create and run migrations.

### 🔹 Want to use Email instead of Username?

Use AbstractBaseUser + BaseUserManager:

python

CopyEdit

from django.contrib.auth.models import AbstractBaseUser, BaseUserManager, PermissionsMixin

class CustomUserManager(BaseUserManager):

def create\_user(self, email, password=None, \*\*extra\_fields):

if not email:

raise ValueError("Email required")

email = self.normalize\_email(email)

user = self.model(email=email, \*\*extra\_fields)

user.set\_password(password)

user.save(using=self.\_db)

return user

def create\_superuser(self, email, password=None, \*\*extra\_fields):

extra\_fields.setdefault("is\_staff", True)

extra\_fields.setdefault("is\_superuser", True)

return self.create\_user(email, password, \*\*extra\_fields)

python

CopyEdit

class CustomUser(AbstractBaseUser, PermissionsMixin):

email = models.EmailField(unique=True)

is\_active = models.BooleanField(default=True)

is\_staff = models.BooleanField(default=False)

objects = CustomUserManager()

USERNAME\_FIELD = 'email'

REQUIRED\_FIELDS = [] # For createsuperuser

## 🧠 Summary

| Concept | Key Idea |
| --- | --- |
| Custom Manager | Let you control .objects to return filtered querysets |
| ManyToMany | Lets both sides of the relation have multiple records |
| Custom User | Best practice for modern apps. Use AbstractUser or AbstractBaseUser |

Perfect. You’re ready to move beyond basics — now it’s time to **solidify your understanding** of **Python internals**, **tricky syntax**, and **interview-level concepts**.

Let’s start with your example and then go into a **list of deep Python questions** (with explanations).

## 🔍 a += 1 vs a = a + 1 in Python

### ✅ Similarity:

Both increment a by 1, and for **immutable types like** int**,** str**, tuple**, they behave the **same way**.

python

CopyEdit

a = 5

a += 1 # a = 6

a = a + 1 # a = 7

### ⚠️ Difference (for ****mutable objects**** like lists):

python

CopyEdit

a = [1, 2]

b = a

a += [3] # modifies in-place

print(a) # [1, 2, 3]

print(b) # [1, 2, 3] ✅ same reference

a = a + [4] # creates a new list

print(a) # [1, 2, 3, 4]

print(b) # [1, 2, 3] ❌ b unchanged

**Why?**

* += calls the **in-place method** (\_\_iadd\_\_)
* a = a + [4] creates a **new list object** using \_\_add\_\_

## 💡 Deep Python Questions That Test True Understanding

Here’s a curated list of questions you should know with real-world dev depth.

### 1. ****Mutable Default Arguments****

python

CopyEdit

def append\_item(item, my\_list=[]):

my\_list.append(item)

return my\_list

print(append\_item(1)) # [1]

print(append\_item(2)) # [1, 2] ❗

**Why does it keep the old list?**

Because default arguments are evaluated **once**, not every time the function is called.

🔧 Fix:

python

CopyEdit

def append\_item(item, my\_list=None):

if my\_list is None:

my\_list = []

### 2. ****is vs ==****

python

CopyEdit

a = 1000

b = 1000

print(a == b) # True

print(a is b) # False ❗

* == checks **value**
* is checks **identity** (memory address)

For small integers (-5 to 256), Python caches them. So:

python

CopyEdit

x = 5

y = 5

print(x is y) # True ✅

### 3. ****List comprehension scope****

python

CopyEdit

x = 5

print([x for x in range(3)])

print(x) # 5 in Python 3 ✅, 2 in Python 2 ❌

List comprehension has its own scope in Python 3.

### 4. ****Generators vs List Comprehension****

python

CopyEdit

a = [x\*x for x in range(1000)]

b = (x\*x for x in range(1000))

* a is a **list in memory**
* b is a **generator** — lazy-loaded, memory-efficient

### 5. ****Why is**** None ****not the same as**** False

python

CopyEdit

a = None

if a:

print("yes")

else:

print("no") # prints "no"

* None is a singleton object
* Only False, 0, '', [], {} and None are falsy

### 6. \*\*Unpacking and \*args, ****kwargs****

python

CopyEdit

def func(a, b, \*args, \*\*kwargs):

pass

func(1, 2, 3, 4, x=5, y=6)

# args = (3, 4)

# kwargs = {'x': 5, 'y': 6}

Unpacking:

python

CopyEdit

a, \*b, c = [1, 2, 3, 4, 5]

# a = 1, b = [2,3,4], c = 5

### 7. ****LEGB Rule (Scope)****

Python looks for variables in:

* **L**ocal
* **E**nclosing
* **G**lobal
* **B**uiltins

python

CopyEdit

x = "global"

def outer():

x = "enclosed"

def inner():

x = "local"

print(x)

inner()

outer() # prints local

### 8. ****Decorators****

A function that wraps another function.

python

CopyEdit

def decorator(func):

def wrapper(\*args, \*\*kwargs):

print("Before call")

result = func(\*args, \*\*kwargs)

print("After call")

return result

return wrapper

@decorator

def say\_hello():

print("Hello")

say\_hello()

### 9. ****Class vs Instance Variables****

python

CopyEdit

class Test:

count = 0

def \_\_init\_\_(self):

self.data = []

a = Test()

b = Test()

a.data.append(1)

print(b.data) # []

print(Test.count) # 0

Test.count += 1

print(a.count) # 1

* self.var → instance-specific
* Class.var → shared

### 10. ****Walrus Operator (:=)****

Introduced in Python 3.8

python

CopyEdit

while (n := input("Enter: ")) != "q":

print(n)

Assigns and compares in one line.

## 🔥 Pro Interview Questions That Test Your Python Brain

| Topic | Sample Question |
| --- | --- |
| Interning | Why are a is b True for a = "hello" and b = "hello"? |
| Copying | Difference between copy.copy() and copy.deepcopy()? |
| Iterators | What makes a class iterable? \_\_iter\_\_() vs \_\_next\_\_() |
| Closures | What are closures and how are they used in Python? |
| Dunder Methods | What is \_\_repr\_\_ vs \_\_str\_\_? What is \_\_eq\_\_, \_\_lt\_\_? |
| Data Classes | Difference between regular class and @dataclass? |
| GIL | What is the Global Interpreter Lock and why does it matter? |
| Coroutines | Difference between Generator and Coroutine (async def) |

## ⚡ Next Steps

If you want, I can:

* Quiz you daily with these types of questions
* Give you one concept per day with explanation and code
* Help you build small real-world Python tools to reinforce concepts

Want to start with **one of those**? Or should I give you a full PDF-style doc covering all deep topics?

## ****1. Interning in Python: Why**** a is b ****is True for**** a = "hello"

### ****What is Interning?****

**Interning** means Python **reuses memory** for **some immutable objects** like:

* Small integers (from -5 to 256)
* Short strings (e.g., "hello", "python")
* Common identifiers

This is an **optimization** for speed and memory.

### ****Example:****

python

CopyEdit

a = "hello"

b = "hello"

print(a == b) # True → values are equal

print(a is b) # True → same memory object

### ****But not always!****

python

CopyEdit

a = "hello world, this is Vishnu Kurup"

b = "hello world, this is Vishnu Kurup"

print(a == b) # True

print(a is b) # False ❗️new object

Long or complex strings are usually **not interned**.

### ****Force Interning****

You can **force interning** using:

python

CopyEdit

import sys

a = sys.intern("long string Vishnu Kurup")

b = sys.intern("long string Vishnu Kurup")

print(a is b) # True ✅

### ****Numbers too:****

python

CopyEdit

x = 100

y = 100

print(x is y) # True (cached small int)

x = 1000

y = 1000

print(x is y) # False (new object)

### ****Why should you care?****

* Use == for value checks, **never** is **for equality**
* is is for **identity** (memory), like:

python

CopyEdit

if x is None: # ✅ correct

### ****Interview-style Trick Question****

python

CopyEdit

a = "py" + "thon"

b = "python"

print(a is b) # True ✅ if both constants

a = "py"

b = a + "thon"

print(b is "python") # False ❌ runtime concat

Let me know if this was clear — and then I’ll move to **Part 2:** copy.copy() **vs** copy.deepcopy() next.

Would you like me to create a document or track all of these as we go?

##### You said:

Yeah go on to nxt

###### ChatGPT said:

Awesome — let’s move on to **Part 2: Copying in Python**.

## ****2.**** copy.copy() ****vs**** copy.deepcopy()

### ****Why do we even need this?****

Python variables **point to memory**. If you just do:

python

CopyEdit

a = [1, 2, [3, 4]]

b = a

Then a **and** b **refer to the same object**. Change one — both change.

### ****What is**** copy.copy()****? (Shallow Copy)****

python

CopyEdit

import copy

a = [1, 2, [3, 4]]

b = copy.copy(a)

print(a == b) # True → values match

print(a is b) # False → different object

BUT:

python

CopyEdit

b[2][0] = 999

print(a) # [1, 2, [999, 4]] ❌ Inner list is still shared!

* **Shallow copy** only clones the top-level object.
* **Nested objects are still shared** (pointers copied).

### ****What is**** copy.deepcopy()****? (Deep Copy)****

python

CopyEdit

import copy

a = [1, 2, [3, 4]]

b = copy.deepcopy(a)

b[2][0] = 999

print(a) # [1, 2, [3, 4]] ✅

* **Deep copy recursively copies everything**, even nested stuff.

### ****Analogy****

| Copy Type | What gets copied | What's still shared |
| --- | --- | --- |
| copy.copy() | Outer object | Inner nested objects |
| copy.deepcopy() | Outer + inner (all levels) | Nothing |

### ****Trick Interview Question:****

python

CopyEdit

a = [[1, 2], [3, 4]]

b = a[:]

b[0][0] = 99

print(a) # [[99, 2], [3, 4]] → Why?

**Answer:** a[:] is a shallow copy, a[0] and b[0] point to the same nested list.

Great! Let’s jump into **Part 3: Iterators in Python**

## ****3. Iterators and Iterables:**** \_\_iter\_\_() ****vs**** \_\_next\_\_()

### ****Basic Idea****

* An **iterable** is something you can loop over (for item in x).
* An **iterator** is the actual object that knows how to **yield the next item**.

### ****What is an Iterable?****

If an object has \_\_iter\_\_(), it’s iterable.

python

CopyEdit

x = [1, 2, 3] # list is iterable

it = iter(x) # returns an iterator

print(next(it)) # 1

### ****What is an Iterator?****

An object is an **iterator** if it:

* Has \_\_iter\_\_() that returns self
* Has a \_\_next\_\_() method

python

CopyEdit

class Count:

def \_\_init\_\_(self):

self.num = 0

def \_\_iter\_\_(self): # makes it iterable

return self

def \_\_next\_\_(self): # makes it an iterator

if self.num < 3:

self.num += 1

return self.num

else:

raise StopIteration

c = Count()

for i in c:

print(i)

**Output:**

CopyEdit

1

2

3

### ****So what’s the difference?****

| Method | Purpose |
| --- | --- |
| \_\_iter\_\_() | Returns the iterator object itself |
| \_\_next\_\_() | Returns the next value |

### ****Under the Hood****

python

CopyEdit

for i in some\_iterable:

print(i)

This is what Python really does:

python

CopyEdit

it = iter(some\_iterable)

while True:

try:

item = next(it)

print(item)

except StopIteration:

break

### ****Trick Interview Question****

python

CopyEdit

x = [1, 2, 3]

y = iter(x)

print(next(y)) # 1

print(next(y)) # 2

for i in y:

print(i) # What prints?

**Answer:** Only 3 prints, because y has already advanced past 1 and 2.

## ****PART 1 — LISTS in Python****

### 1. ****What is a List?****

* An ordered, mutable (changeable) collection.
* Defined using square brackets:

python

CopyEdit

nums = [1, 2, 3]

### 2. ****Key Properties****

| Feature | Detail |
| --- | --- |
| Ordered | Preserves insertion order |
| Mutable | You can change values |
| Heterogeneous | Can hold multiple data types |
| Dynamic | Resizable automatically |

### 3. ****Important List Operations****

python

CopyEdit

nums = [1, 2, 3]

nums.append(4) # [1, 2, 3, 4]

nums.insert(1, 10) # [1, 10, 2, 3, 4]

nums.pop() # Removes last item

nums.remove(10) # Removes value 10

nums.sort() # Sorts in-place

nums.reverse() # Reverses in-place

### 4. ****List Copying Pitfall****

python

CopyEdit

a = [1, 2, 3]

b = a

b[0] = 100

print(a) # [100, 2, 3] -- Because they point to same list

To avoid that:

python

CopyEdit

c = a.copy() # or list(a)

### 5. ****List Comprehensions****

python

CopyEdit

squares = [x\*x for x in range(5)] # [0, 1, 4, 9, 16]

evens = [x for x in range(10) if x % 2 == 0]

### 6. ****Mutable Defaults (Deadly Interview Bug)****

python

CopyEdit

def append\_to\_list(value, my\_list=[]):

my\_list.append(value)

return my\_list

print(append\_to\_list(1)) # [1]

print(append\_to\_list(2)) # [1, 2] — Why??

# FIX:

def safe\_append(value, my\_list=None):

if my\_list is None:

my\_list = []

my\_list.append(value)

return my\_list

### 7. ****Aliasing vs Copying****

python

CopyEdit

x = [[1, 2], [3, 4]]

y = x.copy() # Shallow copy

y[0][0] = 100

print(x) # [[100, 2], [3, 4]] — because inner lists are shared

Use:

python

CopyEdit

import copy

z = copy.deepcopy(x)

### 8. ****Tricky Interview Question****

python

CopyEdit

a = [1, 2, 3]

b = a

a += [4]

print(a) # [1, 2, 3, 4]

print(b) # [1, 2, 3, 4]

Now compare with:

python

CopyEdit

a = [1, 2, 3]

b = a

a = a + [4]

print(a) # [1, 2, 3, 4]

print(b) # [1, 2, 3]

**Why?**

* a += [4] mutates the list
* a = a + [4] creates a new list

## ****PART 2 — DICTIONARIES (****dict****)****

### 1. ****What is a Dictionary?****

* An **unordered**, mutable collection of key-value pairs (as of Python 3.6+, dictionaries preserve insertion order).
* Think of it like a real-world dictionary:

python

CopyEdit

person = {'name': 'Alice', 'age': 25}

### 2. ****Core Properties****

| Feature | Value |
| --- | --- |
| Key-Value | You access values via keys |
| Mutable | Values can be changed |
| Keys Unique | Duplicate keys overwrite |
| Fast Access | O(1) time complexity for lookups |

### 3. ****Common Operations****

python

CopyEdit

d = {'a': 1, 'b': 2}

d['c'] = 3 # Add new key-value

d['a'] = 10 # Update existing key

del d['b'] # Delete key

val = d.get('z', 0) # Get with default fallback

keys = d.keys() # dict\_keys(['a', 'c'])

values = d.values()

items = d.items() # Key-value pairs

### 4. ****Dictionary Comprehension****

python

CopyEdit

squares = {x: x\*x for x in range(5)}

# {0: 0, 1: 1, 2: 4, 3: 9, 4: 16}

### 5. ****Immutability of Keys****

Only **immutable** objects (e.g., strings, numbers, tuples) can be dictionary keys.  
You **can't** use lists or other dictionaries as keys.

python

CopyEdit

d = {[1,2]: "fail"} # ❌ TypeError

### 6. ****Interview Traps****

**Q1: What happens here?**

python

CopyEdit

x = {}

x[0] = "zero"

x[False] = "false"

print(x) # {0: 'false'}

**Why?**  
In Python, False == 0, so the second assignment **overwrites** the first.

**Q2: What happens here?**

python

CopyEdit

x = {[]} # ❌ TypeError: unhashable type: 'list'

Lists are mutable and can't be hashed, so can't be used as keys or set elements.

### 7. ****Mutable Defaults Trap****

python

CopyEdit

from collections import defaultdict

d = defaultdict(list)

d['a'].append(1)

print(d['a']) # [1]

### 8. ****How**** dict ****Works Internally****

* Uses a **hash table** under the hood.
* Keys are **hashed** to find the correct bucket.
* Lookups are O(1) on average.

### 9. setdefault() ****vs**** get()

python

CopyEdit

d = {}

d.setdefault('a', []).append(1)

print(d) # {'a': [1]}

setdefault is like get, but also **sets a default value** if the key is missing.

### 10. ****Merging Dicts****

python

CopyEdit

a = {'x': 1}

b = {'y': 2}

c = {\*\*a, \*\*b} # {'x': 1, 'y': 2}

In Python 3.9+:

python

CopyEdit

c = a | b

Awesome — let’s jump into:

## ✅ ****PART 3 — SETS****

### 1. ****What is a Set?****

* An **unordered** collection of **unique** elements.
* Similar to sets in mathematics.

python

CopyEdit

s = {1, 2, 3}

### 2. ****Key Features****

| Feature | Detail |
| --- | --- |
| Unique elements | Duplicates are auto-removed |
| Mutable | Can add/remove items |
| No indexing | Unordered, no s[0] access |
| Fast lookup | O(1) average time |

python

CopyEdit

s = {1, 2, 3, 2, 1}

print(s) # {1, 2, 3}

### 3. ****Common Operations****

python

CopyEdit

s.add(4) # Add element

s.remove(2) # Remove element (KeyError if missing)

s.discard(5) # Remove, no error if missing

s.pop() # Remove random element

s.clear() # Remove all elements

### 4. ****Set Operations (Like Math)****

python

CopyEdit

a = {1, 2, 3}

b = {3, 4, 5}

a | b # Union: {1, 2, 3, 4, 5}

a & b # Intersection: {3}

a - b # Difference: {1, 2}

a ^ b # Symmetric Diff: {1, 2, 4, 5}

### 5. ****Set Comprehension****

python

CopyEdit

evens = {x for x in range(10) if x % 2 == 0}

### 6. ****Frozen Set****

An **immutable version** of set.

python

CopyEdit

fs = frozenset([1, 2, 3])

# You can't add/remove from fs

## ✅ ****PART 4 — TUPLES****

### 1. ****What is a Tuple?****

* An **immutable**, ordered sequence of elements.

python

CopyEdit

t = (1, 2, 3)

### 2. ****Tuple Features****

| Property | Tuple |
| --- | --- |
| Ordered | Yes |
| Immutable | Yes |
| Allows dupes | Yes |
| Indexing | Yes: t[0] |
| Nesting | Yes |

### 3. ****Packing & Unpacking****

python

CopyEdit

t = 1, 2, 3 # Packing

a, b, c = t # Unpacking

python

CopyEdit

a, \*rest = (1, 2, 3, 4) # a = 1, rest = [2, 3, 4]

### 4. ****Single Element Tuple Trap****

python

CopyEdit

t = (1) # Not a tuple!

t = (1,) # ✅ This is a tuple

### 5. ****Tuple Uses****

* Function returns
* Dictionary keys
* Unpacking in loops or comprehensions
* Data integrity (data shouldn't change)

## ✅ BONUS: ****All Mutable vs Immutable Built-in Data Types in Python****

### ✅ ****Mutable (Can Be Changed)****

| Type | Example |
| --- | --- |
| list | [1, 2, 3] |
| dict | {'a': 1} |
| set | {1, 2, 3} |
| bytearray | bytearray(b'abc') |
| defaultdict | defaultdict(list) |
| deque | collections.deque() |

### ❌ ****Immutable (Cannot Be Changed)****

| Type | Example |
| --- | --- |
| int | 5 |
| float | 3.14 |
| bool | True, False |
| str | 'hello' |
| tuple | (1, 2) |
| frozenset | frozenset([1,2]) |
| bytes | b'abc' |
| complex | 3 + 4j |
| range | range(10) |

⚠️ Note: Immutable means the **object cannot be modified in-place**. But you can reassign a variable to point to a new object.

### 🧠 What is "context" in Django?

In Django, **context** is a Python dictionary that holds key-value pairs, where:

* **keys** are the variable names you want to use in your template
* **values** are the data you want to render

### ✅ Example (Django View + Template):

#### views.py:

python

CopyEdit

from django.shortcuts import render

def dashboard(request):

context = {

'username': 'Vishnu',

'notifications': 5,

}

return render(request, 'dashboard.html', context)

#### dashboard.html:

html

CopyEdit

<h1>Welcome, {{ username }}!</h1>

<p>You have {{ notifications }} new notifications.</p>

In this example:

* context = {'username': 'Vishnu', 'notifications': 5} is passed to the template
* Inside the HTML file, {{ username }} and {{ notifications }} access those values

### 🐍 What about "context" in Python (outside Django)?

* In **plain Python**, "context" can refer to the environment or scope in which a block of code runs.
* Example: Using with statement (context manager):

python

CopyEdit

with open('file.txt', 'r') as f:

content = f.read()

Here, the with statement creates a **context** where the file is open. Once the block is done, the file is closed automatically — this is known as a **context manager**.

### TL;DR

| Term | Meaning |
| --- | --- |
| Django Context | Dictionary sent from view to template |
| Python Context | Scope or environment (e.g., in a with block using context managers) |

Would you like to dive deeper into either of these, like how context processors work in Django?

4o

##### You said:

Url shortener

###### ChatGPT said:

A **URL shortener** is a tool that converts a long URL (like https://example.com/products/category/item?id=12345) into a shorter version (like https://short.ly/abc123). These are useful for sharing, especially on platforms with character limits.

### 🚀 Let's build a ****basic URL shortener**** in Django!

Here’s an overview:

#### 🧱 Models:

python

CopyEdit

# models.py

from django.db import models

import string, random

def generate\_short\_code():

return ''.join(random.choices(string.ascii\_letters + string.digits, k=6))

class URL(models.Model):

original\_url = models.URLField()

short\_code = models.CharField(max\_length=6, unique=True, default=generate\_short\_code)

created\_at = models.DateTimeField(auto\_now\_add=True)

def \_\_str\_\_(self):

return f"{self.short\_code} -> {self.original\_url}"

#### 🧠 Views:

python

CopyEdit

# views.py

from django.shortcuts import render, redirect, get\_object\_or\_404

from .models import URL

from django.http import HttpResponse

def home(request):

if request.method == 'POST':

original\_url = request.POST['original\_url']

url\_obj = URL.objects.create(original\_url=original\_url)

return render(request, 'home.html', {'short\_url': request.build\_absolute\_uri('/') + url\_obj.short\_code})

return render(request, 'home.html')

def redirect\_url(request, short\_code):

url\_obj = get\_object\_or\_404(URL, short\_code=short\_code)

return redirect(url\_obj.original\_url)

#### 🌐 URLs:

python

CopyEdit

# urls.py

from django.urls import path

from . import views

urlpatterns = [

path('', views.home, name='home'),

path('<str:short\_code>/', views.redirect\_url, name='redirect\_url'),

]

#### 🖼️ Template (home.html):

html

CopyEdit

<form method="POST">

{% csrf\_token %}

<input type="url" name="original\_url" placeholder="Enter URL" required>

<button type="submit">Shorten</button>

</form>

{% if short\_url %}

<p>Shortened URL: <a href="{{ short\_url }}">{{ short\_url }}</a></p>

{% endif %}

### ✅ How it works:

1. User submits a long URL via the form.
2. Django generates a short code (6 characters).
3. The short code + base URL becomes the shortened URL.
4. When someone accesses /abc123, Django redirects to the original URL.

Generators in Python are **special types of iterators** that allow you to **generate values on the fly** using yield instead of storing them in memory all at once. They are useful for **efficient memory usage and lazy evaluation**, especially when working with large data sets or infinite sequences.

### 🔧 How Generators Work

A **generator function** looks like a normal function, but it uses the yield keyword to return values **one at a time**, pausing between each and resuming from where it left off.

#### ✅ Example:

python

CopyEdit

def count\_up\_to(max):

count = 1

while count <= max:

yield count

count += 1

python

CopyEdit

counter = count\_up\_to(3)

print(next(counter)) # 1

print(next(counter)) # 2

print(next(counter)) # 3

# next(counter) would raise StopIteration

### ✅ Key Points:

| Concept | Description |
| --- | --- |
| yield | Used to produce a value and pause the generator. State is saved. |
| Generator Function | Function with at least one yield. |
| Lazy Evaluation | Values are produced only when requested. |
| Memory Efficient | Doesn’t store all values in memory (like lists or tuples). |
| Iterable | Can be used in loops (for, next()). |

### 🔁 Generator vs List

#### List:

python

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[ x \* x for x in range(1000000) ] # Uses a lot of memory

#### Generator:

python

CopyEdit

(x \* x for x in range(1000000)) # Uses very little memory

### 📦 Real-Life Uses of Generators

* Reading large files line-by-line.
* Streaming data from APIs or databases.
* Producing infinite sequences (e.g., Fibonacci, primes).
* Pipelines for data processing.

## ✅ Visual Explanation of Generators

Imagine a generator as a **"pause-and-resume" machine**:

python

CopyEdit

def simple\_gen():

print("Start")

yield 1

print("Middle")

yield 2

print("End")

When you use it:

python

CopyEdit

g = simple\_gen()

next(g)

# Output:

# Start

# => 1

next(g)

# Output:

# Middle

# => 2

next(g)

# Output:

# End

# => StopIteration

Each yield:

* Pauses the function.
* Returns a value.
* Remembers where it left off.

## 🔄 Generator vs Async Generator

| Feature | Generator | Async Generator |
| --- | --- | --- |
| Syntax | def + yield | async def + yield |
| Used with | for, next() | async for, await |
| Best for | CPU-bound, synchronous work | I/O-bound, asynchronous work |

### 🧵 Async Generator Example

python

CopyEdit

import asyncio

async def async\_gen():

for i in range(3):

await asyncio.sleep(1) # simulate I/O

yield i

async def main():

async for num in async\_gen():

print(num)

# To run:

# asyncio.run(main())

## 🧠 Generators vs Coroutines

| Concept | Generator | Coroutine |
| --- | --- | --- |
| Purpose | Generate sequence of values lazily | Pause/resume functions for concurrency |
| Keyword | yield | await |
| Use case | Memory-efficient iteration | Non-blocking async programming |
| Example use | Read big files, streaming | Async HTTP calls, DB I/O |

### 🌐 Coroutine Example

python

CopyEdit

import asyncio

async def greet():

await asyncio.sleep(1)

return "Hello!"

async def main():

result = await greet()

print(result)

# asyncio.run(main())

## 🧠 Summary

* **Generators**: Great for streaming data, memory efficiency.
* **Async Generators**: Like generators, but used with await, for asynchronous data streaming.
* **Coroutines**: Functions for asynchronous tasks, often handling I/O operations efficiently.

## ✅ 1. ****CSRF Token Exempt in Django****

### 🔐 What is CSRF?

**CSRF (Cross-Site Request Forgery)** is a type of attack where a malicious website tricks a user’s browser into making unintended requests to your app **while the user is authenticated**.

Django protects against CSRF attacks by requiring a **CSRF token** on POST, PUT, DELETE requests (i.e., unsafe methods).

### ❌ What is @csrf\_exempt?

It's a **Django decorator** used to **disable CSRF protection** on a particular view.

python

CopyEdit

from django.views.decorators.csrf import csrf\_exempt

from django.http import HttpResponse

@csrf\_exempt

def my\_view(request):

return HttpResponse("CSRF check skipped!")

### 🧨 When to use?

* When you're handling **API requests** from external clients (like mobile apps or third-party integrations).
* When you're using **token-based authentication** (e.g., JWT), which **does not rely on cookies**.

⚠️ **Don't use** @csrf\_exempt **unless you understand the security risk**. It makes your view vulnerable to CSRF if the client uses cookies for authentication.

### ✅ Alternative: Use @csrf\_protect

python

CopyEdit

from django.views.decorators.csrf import csrf\_protect

@csrf\_protect

def safe\_view(request):

...

Or for class-based views:

python

CopyEdit

from django.utils.decorators import method\_decorator

@method\_decorator(csrf\_exempt, name='dispatch')

class MyApiView(View):

...

## 🐒 2. ****Monkey Patching in Python****

### 🧠 What is Monkey Patching?

**Monkey patching** means **modifying or extending code at runtime** without changing the original source code. It's often used to fix or alter behavior temporarily.

### ✅ Example:

python

CopyEdit

class Dog:

def speak(self):

return "Woof"

dog = Dog()

print(dog.speak()) # Woof

# 🐒 Monkey patching the method

def new\_speak():

return "Meow"

Dog.speak = new\_speak

print(dog.speak()) # Meow

We changed how Dog.speak() works **without touching** the original class!

### 🧰 Use Cases

* **Testing**: Replace a method with a fake (mock) during tests.
* **Debugging**: Inject logging or fix a bug without changing external libraries.
* **Dynamic behavior**: Patch third-party libraries at runtime.

### ⚠️ Dangers of Monkey Patching

* Hard to debug.
* Breaks encapsulation.
* Can introduce unexpected bugs, especially in large teams or codebases.

### 🔐 Monkey Patching in Real Life Example (Django):

Imagine you want to patch a Django method for debugging:

python

CopyEdit

from django.db import models

original\_save = models.Model.save

def patched\_save(self, \*args, \*\*kwargs):

print("Saving:", self)

return original\_save(self, \*args, \*\*kwargs)

models.Model.save = patched\_save

Now **every model's save() method** prints a message before saving.

## 🔄 Reversing with ****List Slicing****

python

CopyEdit

a = [10, 20, 30, 40, 50]

reversed\_list = a[::-1]

print(reversed\_list) # [50, 40, 30, 20, 10]

### 📌 Why does [::-1] reverse the list?

* **Syntax:** a[start:stop:step]
* You're saying:
  + Start from the end (default when step is negative)
  + Go until the start (default stop is before index 0)
  + Step by -1 → move backwards.

## 🔁 Reversing with range()

python

CopyEdit

for i in range(5, 0, -1):

print(i)

### 💡 What happens here?

* range(start=5, stop=0, step=-1)
* You get: 5, 4, 3, 2, 1
* The stop value **is not included**, so it stops **before** reaching 0.

If you want to reverse a list with range():

python

CopyEdit

a = [10, 20, 30, 40, 50]

for i in range(len(a) - 1, -1, -1):

print(a[i])

This prints the list in reverse:

CopyEdit

50

40

30

20

10

## 🧠 Summary

| Method | How It Works | Example |
| --- | --- | --- |
| a[::-1] | Slice backwards with step = -1 | a = [1,2,3] → [3,2,1] |
| range(5, 0, -1) | Count backward from 5 to 1 | → 5,4,3,2,1 |
| range(len(a)-1, -1, -1) | Index backward in a list | Loop through list in reverse |

## 🧠 1. Built-in Functions (Global Scope)

These work on many data types.

| Function | Description | Example |
| --- | --- | --- |
| len() | Get length | len([1, 2, 3]) → 3 |
| type() | Get data type | type(5) → <class 'int'> |
| str() | Convert to string | str(123) → '123' |
| int() | Convert to int | int("123") → 123 |
| float() | Convert to float | float("3.14") → 3.14 |
| sum() | Sum of elements | sum([1,2,3]) → 6 |
| max() | Max value | max([1,5,3]) → 5 |
| min() | Min value | min([1,5,3]) → 1 |
| sorted() | Sorts elements (returns new list) | sorted([3,1,2]) → [1,2,3] |
| reversed() | Returns reversed iterator | list(reversed([1,2])) |
| range() | Sequence of numbers | list(range(3)) → [0,1,2] |
| enumerate() | Index + item in loop | for i,v in enumerate(...) |
| zip() | Combine iterables | zip([1,2],[‘a’,’b’]) |
| map() | Apply function | map(str, [1, 2]) → '1','2' |
| filter() | Filter items | filter(lambda x:x>2,[1,3]) |
| any() | True if any True | any([False, True]) |
| all() | True if all True | all([True, True]) |

## 📋 2. List Methods (list.)

python

CopyEdit

a = [10, 20, 30]

| Method | Description | Example |
| --- | --- | --- |
| append(x) | Add at end | a.append(40) |
| extend(b) | Add all from b | a.extend([50, 60]) |
| insert(i,x) | Add at position | a.insert(1, 15) |
| remove(x) | Remove first x | a.remove(20) |
| pop() | Remove & return last | a.pop() → 30 |
| index(x) | Find index of x | a.index(10) → 0 |
| count(x) | Count x | a.count(20) → 1 |
| sort() | Sort in place | a.sort() |
| reverse() | Reverse in place | a.reverse() |
| copy() | Shallow copy | b = a.copy() |
| clear() | Empty the list | a.clear() |

## 🔑 3. Dictionary Methods (dict.)

python

CopyEdit

d = {'a': 1, 'b': 2}

| Method | Description | Example |
| --- | --- | --- |
| get(k) | Get value or None | d.get('a') → 1 |
| keys() | All keys | d.keys() → dict\_keys(...) |
| values() | All values | d.values() |
| items() | Key-value pairs | d.items() |
| update(d2) | Merge d2 into d | d.update({'c':3}) |
| pop(k) | Remove and return k's value | d.pop('b') → 2 |
| popitem() | Remove last item (3.7+) | d.popitem() |
| setdefault(k,v) | Return d[k], or set d[k]=v | d.setdefault('x', 0) |
| clear() | Remove all items | d.clear() |
| copy() | Copy dict | d.copy() |

## 📌 4. Set Methods (set())

python

CopyEdit

s = {1, 2, 3}

| Method | Description |
| --- | --- |
| add(x) | Add x |
| remove(x) | Remove x, error if not found |
| discard(x) | Remove x, no error if missing |
| pop() | Remove random element |
| union(s2) | All elements |
| intersection(s2) | Common elements |
| difference(s2) | In s but not s2 |
| symmetric\_difference(s2) | In one but not both |

## 🧮 5. Tuple (tuple())

* Immutable list.
* Supports indexing, slicing, etc.
* No methods like append or remove.

## ✅ Tips for len() & Similar

* len(x) → Works on list, dict, tuple, str, set, etc.
* type(x) → Use to debug what's inside.
* isinstance(x, list) → Check type before calling list methods.

## 🔍 Visual Summary

python

CopyEdit

# Built-in

len(), max(), min(), sum(), sorted(), any(), all()

# List

append(), insert(), pop(), remove(), sort(), reverse()

# Dict

get(), items(), keys(), values(), update(), pop()

# Set

add(), remove(), union(), intersection(), difference()

# Other

range(), map(), filter(), zip(), enumerate()

## 🔒 1. ****Security Middleware****

| Middleware | Purpose |
| --- | --- |
| SecurityMiddleware | Enables several security features (HSTS, SSL redirect, etc.) |
| XFrameOptionsMiddleware | Prevents clickjacking by setting X-Frame-Options header |
| CsrfViewMiddleware | Protects against Cross-Site Request Forgery |
| CommonMiddleware | Adds support for things like APPEND\_SLASH, trailing slash handling |

## 👤 2. ****Session & Authentication Middleware****

| Middleware | Purpose |
| --- | --- |
| SessionMiddleware | Enables session support (stores sessions in DB or other backends) |
| AuthenticationMiddleware | Associates users with requests using sessions |
| MessageMiddleware | Enables cookie- or session-based flash messages via messages framework |

## 🧠 3. ****Locale & Timezone Middleware****

| Middleware | Purpose |
| --- | --- |
| LocaleMiddleware | Enables language selection using the Accept-Language header |
| TimezoneMiddleware | Automatically activates user-specific time zones |

## 🧹 4. ****Response/Request Processing Middleware****

| Middleware | Purpose |
| --- | --- |
| GZipMiddleware | Compresses responses with GZip for performance |
| ConditionalGetMiddleware | Adds support for HTTP 304 (Not Modified) based on ETag/Last-Modified |
| CommonMiddleware | Adds content headers, redirects with/without slash, etc. |

## 🔌 5. ****Others****

| Middleware | Purpose |
| --- | --- |
| BrokenLinkEmailsMiddleware | Emails you 404 errors if configured (useful in prod) |
| AdminEmailHandler (logging handler) | Sends error logs via email to admins |
| StaticFilesMiddleware (dev only) | Serves static files in development (not in production) |

## 🧱 Example MIDDLEWARE Setting

python

CopyEdit

MIDDLEWARE = [

'django.middleware.security.SecurityMiddleware',

'django.contrib.sessions.middleware.SessionMiddleware',

'django.middleware.common.CommonMiddleware',

'django.middleware.csrf.CsrfViewMiddleware',

'django.contrib.auth.middleware.AuthenticationMiddleware',

'django.contrib.messages.middleware.MessageMiddleware',

'django.middleware.clickjacking.XFrameOptionsMiddleware',

]

## ✅ JWT Is Not Built-In

JWT (JSON Web Tokens) is handled by third-party middleware, such as:

* djangorestframework-simplejwt
* django-rest-framework-jwt (older)

These are typically added to your DRF authentication classes, not MIDDLEWARE.

### 🧠 1. ****Monkey Patching at the Class Level**** → Affects ****All Instances****

If you patch a method **on the class**, every existing and future instance will use the new method.

python

CopyEdit

class Dog:

def bark(self):

return "woof"

def new\_bark(self):

return "meow"

Dog.bark = new\_bark # 👈 Monkey patch at class level

d1 = Dog()

d2 = Dog()

print(d1.bark()) # 👉 "meow"

print(d2.bark()) # 👉 "meow"

✔️ All instances now use the new method.

### 🐶 2. ****Monkey Patching at the Instance Level**** → Affects ****Only That Instance****

You can patch the method **only on one object**, using types.MethodType.

python

CopyEdit

import types

class Dog:

def bark(self):

return "woof"

def quiet\_bark(self):

return "..."

d1 = Dog()

d2 = Dog()

d1.bark = types.MethodType(quiet\_bark, d1) # 👈 Only d1 is patched

print(d1.bark()) # 👉 "..."

print(d2.bark()) # 👉 "woof"

✔️ Only d1 is affected; d2 remains unchanged.

### 🧪 Summary

| Patching Level | Affects | Example |
| --- | --- | --- |
| Class | All instances | Dog.bark = new\_func |
| Specific instance | Only that object | d1.bark = MethodType(...) |

Exactly — in **Python**, **there are no strict access controls** like private, protected, or final, and Python does **not prevent monkey patching** at runtime.

### 🔓 Python's Philosophy: "We are all consenting adults here."

This means:

* You **can** override methods and attributes — even **standard library functions**.
* You **won’t get an error** like you would in **Java** (e.g. trying to override a final method).
* **Static methods** and **class methods** in Python can still be monkey-patched — Python won’t stop you.

### 🧱 Comparison with Java and JavaScript:

| Feature | Java | JavaScript | Python |
| --- | --- | --- | --- |
| Method access control | Yes (private, final) | No strict enforcement | No strict enforcement |
| Monkey patching | ❌ Usually disallowed | ✅ Yes (for objects) | ✅ Yes (everywhere) |
| Static method safety | Locked (final static) | Can override dynamically | Can override dynamically |
| Runtime changes | ❌ Mostly static | ✅ Yes | ✅ Yes |

### 🔥 Example: Overriding a built-in method in Python

python

CopyEdit

print = lambda \*args: None # 🙃 Disable all prints

print("This won't show") # Does nothing

### 🧪 Here's how it works:

| Modifier Style | Name Format | Meaning in Python | Can Access From Outside? |
| --- | --- | --- | --- |
| **Public** | name | Default — accessible from anywhere | ✅ Yes |
| **Protected** (⚠️) | \_name | Convention only — "internal use" | ✅ Yes (but shouldn't) |
| **Private** (⚠️) | \_\_name | Name mangled to \_ClassName\_\_name | ❌ No (but still possible) |

### 🔓 Example:

python

CopyEdit

class Dog:

def \_\_init\_\_(self):

self.name = "Rocky" # Public

self.\_sound = "woof" # Protected (by convention)

self.\_\_secret = "I bite!" # Private (name mangling)

d = Dog()

print(d.name) # ✅ OK

print(d.\_sound) # ✅ Technically works, but avoid

# print(d.\_\_secret) # ❌ AttributeError

print(d.\_Dog\_\_secret) # ⚠️ HACKY way to access private var

### 😎 So what’s the takeaway?

* Python trusts the developer: “If you want to shoot yourself in the foot, go ahead.”
* These conventions (\_, \_\_) are respected by tools like linters, IDEs, and doc generators — but **Python won't block you**.
* In contrast, **Java** will enforce access control at compile time.

Here’s a **Python cheatsheet of commonly used methods and functions**, organized by **type** and including **global built-ins** like len(), and **object-specific methods** like list.copy() and str.upper().

### ✅ ****Global Built-in Functions (Work with most types)****

These are not methods, but functions available everywhere:

| Function | Description |
| --- | --- |
| len(x) | Returns length of x |
| type(x) | Returns type of x |
| id(x) | Returns memory address of x |
| str(x) | Converts x to string |
| int(x) | Converts x to integer |
| float(x) | Converts x to float |
| list(x) | Converts iterable x to list |
| set(x) | Converts iterable x to set |
| dict() | Creates empty dictionary |
| sorted(x) | Returns a sorted list from iterable |
| reversed(x) | Returns a reverse iterator |
| enumerate(x) | Returns index-value pairs from iterable |
| zip(a, b) | Pairs elements from two iterables |
| map(f, x) | Applies function to each item of iterable |
| filter(f, x) | Filters items using a function |
| any(x) | True if any element is True |
| all(x) | True if all elements are True |
| sum(x) | Returns the sum of elements in x |
| max(x) | Returns max element |
| min(x) | Returns min element |

### 📜 ****String Methods (****str****)****

python

CopyEdit

s = "vishnu"

| Method | Description |
| --- | --- |
| s.upper() | 'VISHNU' |
| s.lower() | 'vishnu' |
| s.capitalize() | 'Vishnu' |
| s.title() | 'Vishnu' |
| s.strip() | Remove surrounding whitespace |
| s.split() | Splits string into list by spaces (or delimiter) |
| s.join(list) | Joins list into a string with s as separator |
| s.replace(a, b) | Replace substring a with b |
| s.find("i") | Returns index of first match, -1 if not found |
| s.isdigit() | Checks if all characters are digits |
| s.isalpha() | Checks if all are alphabets |
| s.isalnum() | Checks if all are alphanumeric |

### 📋 ****List Methods (****list****)****

python

CopyEdit

l = [1, 2, 3]

| Method | Description |
| --- | --- |
| l.append(x) | Adds x to end |
| l.extend([x, y]) | Adds multiple elements |
| l.insert(i, x) | Inserts x at index i |
| l.remove(x) | Removes first occurrence of x |
| l.pop() | Removes and returns last item |
| l.pop(i) | Removes and returns item at index i |
| l.clear() | Removes all elements |
| l.index(x) | Finds index of first occurrence |
| l.count(x) | Number of times x appears |
| l.sort() | Sorts the list in-place |
| l.reverse() | Reverses the list in-place |
| l.copy() | Shallow copy of the list |

### 🔢 ****Set Methods (****set****)****

python

CopyEdit

s = {1, 2, 3}

| Method | Description |
| --- | --- |
| s.add(x) | Adds x to set |
| s.remove(x) | Removes x, error if not present |
| s.discard(x) | Removes x if present |
| s.pop() | Removes arbitrary element |
| s.clear() | Empties the set |
| s.union(t) | Elements in either set |
| s.intersection(t) | Elements in both |
| s.difference(t) | Elements in s but not in t |
| s.symmetric\_difference(t) | Elements in s or t but not both |

### 🧾 ****Dictionary Methods (****dict****)****

python

CopyEdit

d = {'a': 1, 'b': 2}

| Method | Description |
| --- | --- |
| d.get(k) | Returns value for key k |
| d.keys() | All keys |
| d.values() | All values |
| d.items() | All key-value pairs |
| d.update({...}) | Updates/merges dictionary |
| d.pop(k) | Removes and returns value at key k |
| d.popitem() | Removes and returns arbitrary key-value pair |
| d.clear() | Empties dictionary |
| d.copy() | Shallow copy |
| d.setdefault(k, v) | Inserts k with value v if not present |

### 🔍 ****Tuple Methods (****tuple****)****

python

CopyEdit

t = (1, 2, 3)

| Method | Description |
| --- | --- |
| t.count(x) | Count occurrences of x |
| t.index(x) | Index of x |

### 🔧 ****Object Utility / Static Methods****

You can define static or class methods in your custom classes:

python

CopyEdit

class Demo:

@staticmethod

def utility():

print("Static method")

@classmethod

def construct(cls):

return cls()

* @staticmethod: Doesn't access self or cls, like a utility.
* @classmethod: Uses cls, can construct or modify class state.

### ✨ Bonus: Type Conversion & Creation Shortcuts

| Expression | Meaning |
| --- | --- |
| list("abc") | ['a', 'b', 'c'] |
| dict([(1, 'a'), (2, 'b')]) | Convert list of tuples to dict |
| set("hello") | Unique letters: {'h', 'e', 'l', 'o'} |
| tuple([1,2,3]) | Convert list to tuple |

Here's your code:

python

CopyEdit

squares = []

for x in range(5):

squares.append(lambda: x\*\*2)

print(squares[2]())

print(squares[4]())

### ✅ What you expect:

You might think:

* squares[2]() should evaluate 2\*\*2 = 4
* squares[4]() should evaluate 4\*\*2 = 16

But what you **actually get** is:

CopyEdit

16

16

### ❓ Why?

The issue is **late binding** in Python closures.

#### Key Point:

**Lambdas (and functions) capture variables by reference, not by value.**

So, all the lambda: x\*\*2 functions **remember the same** x — and after the loop finishes, x == 4. Therefore, when you later call any of the lambdas, they all use x = 4, so x\*\*2 = 16.

### ✅ How to fix it

You need to **bind the current value of** x **at each iteration**. One way to do this is using a default argument in the lambda:

python

CopyEdit

squares = []

for x in range(5):

squares.append(lambda x=x: x\*\*2)

print(squares[2]()) # 4

print(squares[4]()) # 16

Now each lambda remembers its own x as a default argument — this works because default arguments are evaluated at definition time.

### Summary:

| Issue | Solution |
| --- | --- |
| Late binding of x | Use lambda x=x: x\*\*2 |

### 1. ✅ ****In a**** for ****loop**** – for ****iteration****

python

CopyEdit

for x in [1, 2, 3]:

print(x)

* This means: "For each x **in** the list [1, 2, 3], do something."
* Here, in is used to **loop over items** in a collection.

### 2. ✅ ****For membership checks**** – for ****validation / existence****

python

CopyEdit

if 3 in [1, 2, 3]:

print("Found it!")

* This means: "Is 3 **in** the list?"
* Here, in checks whether a value **exists in** a collection like a list, set, tuple, string, or dictionary keys.

### 🔍 Other Examples

#### Strings:

python

CopyEdit

if "cat" in "catalog":

print("Yes")

#### Sets:

python

CopyEdit

if "apple" in {"apple", "banana"}:

print("Exists")

#### Dictionaries (keys only):

python

CopyEdit

my\_dict = {"a": 1, "b": 2}

if "a" in my\_dict: # checks keys, not values

print("Key exists")

### 🔑 Summary:

| Use Case | Example | Meaning |
| --- | --- | --- |
| **Iteration** | for x in list: | Go through each element |
| **Validation** | if x in list: | Check if x is a member of list |

## 🐍 ****Python / Django: Using a Custom**** manage2.py

### ✅ What We Learned:

* You **can create a new** manage2.py file and use it in place of manage.py.
* It works as long as you **include the same logic**, especially:

python

CopyEdit

os.environ.setdefault('DJANGO\_SETTINGS\_MODULE', 'your\_project.settings')

from django.core.management import execute\_from\_command\_line

execute\_from\_command\_line(sys.argv)

* You can now run commands like:

bash

CopyEdit

python manage2.py runserver

python manage2.py migrate

* React's manage.py is just an **entry point** — as long as the structure is correct, its name doesn’t matter.