Python Modules & File Operations

Building with Libraries and Managing Data Files

CS 101 - Fall 2025

Welcome to the World of Python Libraries!

> Why Use Modules?
>
> **Modules are like LEGO blocks for programming!** Instead of building everything from scratch, we can use pre-built pieces that experts have already created.
> **Real-World Analogy**: * Like using a **calculator app** instead of building your own calculator * Like using **GPS navigation** instead of memorizing every road * Like using a **recipe book** instead of inventing cooking from scratch!

What You Get

- **Pre-written functions** - tested and reliable
- **Specialized tools** - for math, dates, files, web
- **Time savings** - focus on your logic, not reinventing wheels
- **Professional quality** - used by millions of developers

Today's Journey

1. **Part 1**: Using built-in modules (`calendar`, `math`, `random`)
2. **File Basics**: Reading and writing `.txt` and `.csv` files

3. **Part 2**: Creating your own custom modules

Magic Question: *"What amazing things can I build when I have the right tools?"*

Part 1: Using Python's Built-in Modules

The `import` Statement - Your Magic Key!

> **How to Access Python's Treasure Chest**
>
> The `import` statement is like having a **key to a massive toolshed** filled with specialized tools!

Basic Import Syntax

```
# Method 1: Import entire module
import math
result = math.sqrt(16)  # Use math.function_name

# Method 2: Import specific functions
from math import sqrt, pi
result = sqrt(16)       # Use function directly
area = pi * radius**2

# Method 3: Import with nickname
import calendar as cal
print(cal.month_name[3])  # March
```

```python
# Method 4: Import everything (be careful!)
from math import *
result = sqrt(16)       # All functions available
```

Best Practices

```python
#  GOOD: Clear what you're using
import math
import calendar as cal
from random import randint

#  GOOD: Import specific items
from math import sqrt, pi, sin, cos

#  BE CAREFUL: Importing everything
from math import *  # Can cause name conflicts

#  TIP: Check what's available
import math
print(dir(math))  # Shows all available functions
```

Pro Tip: Import statements go at the top of your file!

Exploring the `calendar` Module

> Time Travel with Python!
>
> The `calendar` module lets you work with dates, find specific days, and even create calendars for any year!

```python
import calendar as cal

# Display a full month calendar
print(cal.month(2025, 11))  # November 2025

# Get information about dates
print(f"Today is: {cal.day_name[cal.weekday(2025, 11, 4)]}")  # Monday

# Find which day of week a date falls on (0=Monday, 6=Sunday)
```

```python
day_number = cal.weekday(2025, 12, 25)  # Christmas 2025
print(f"Christmas 2025 falls on: {cal.day_name[day_number]}")

# Get month as nested lists (perfect for programming!)
month_calendar = cal.monthcalendar(2025, 11)
print("November 2025 as lists:")
for week in month_calendar:
    print(week)  # Each week is a list [Mon, Tue, Wed, Thu, Fri, Sat, Sun]
```

> **!** Important
>
> **Interactive Demo**: Let's find your birthday! What day of the week were you born on?

Calendar Magic: Finding Special Days!

Finding Thanksgiving

```python
import calendar as cal

def find_thanksgiving(year):
    """Find Thanksgiving (4th Thursday of November)"""
    # Get November calendar as nested lists
    november = cal.monthcalendar(year, 11)

    # Find 4th Thursday
    # Check if first week has Thursday
    if november[0][cal.THURSDAY] != 0:
        # First week has Thursday, so 4th is week 3 (0-indexed)
        thanksgiving = november[3][cal.THURSDAY]
    else:
        # First week has no Thursday, so 4th is week 4
        thanksgiving = november[4][cal.THURSDAY]

    return thanksgiving

# Test it out!
for year in [2024, 2025, 2026]:
    day = find_thanksgiving(year)
    print(f"Thanksgiving {year}: November {day}")
```

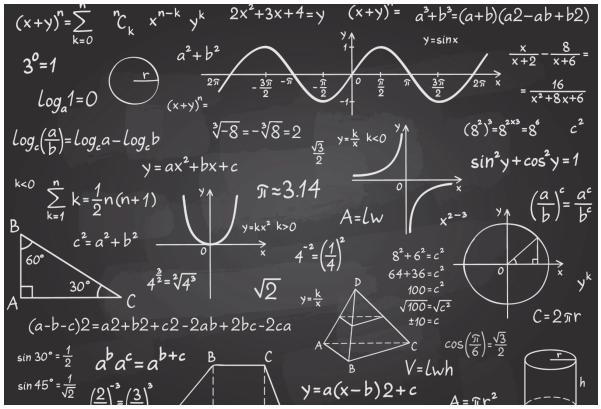
Weekend Counter

```
def count_weekends_in_month(year, month):
    """Count how many Saturdays and Sundays in a month"""
    month_cal = cal.monthcalendar(year, month)
    saturdays = sundays = 0

    for week in month_cal:
        if week[cal.SATURDAY] != 0:  # 0 means no day
            saturdays += 1
        if week[cal.SUNDAY] != 0:
            sundays += 1

    return saturdays, sundays

# How many weekend days in December 2025?
sat, sun = count_weekends_in_month(2025, 12)
print(f"December 2025: {sat} Saturdays, {sun} Sundays")
print(f"Total weekend days: {sat + sun}")
```

Your Turn: Modify this to count school days during the month (Mon-Fri, no weekends days)!

The Math Import

> **!** Important
>
> **Q**: How do you charge-up python for extra functionality when doing math and other things?
> **A**: You would use `import math` in your code to add number crunching power.



The `math` Module - Your Mathematical Superpower!

Essential Math Functions

```
import math

# Basic operations
print(f"Square root of 64: {math.sqrt(64)}")
print(f"2 to the power of 8: {math.pow(2, 8)}")
print(f"Absolute value of -42: {math.fabs(-42)}")

# Rounding functions
x = 3.7
print(f"Floor of {x}: {math.floor(x)}")    # 3
print(f"Ceiling of {x}: {math.ceil(x)}")   # 4

# Advanced functions
print(f"Factorial of 5: {math.factorial(5)}")  # 120
print(f"Log base 10 of 100: {math.log10(100)}")  # 2.0

# Constants
print(f"Pi: {math.pi}")
print(f"e (Euler's number): {math.e}")
```

Trigonometry & Geometry

```
import math

# Trigonometric functions (angles in radians)
```

```python
angle_degrees = 45
angle_radians = math.radians(angle_degrees)

print(f"sin(45°): {math.sin(angle_radians):.3f}")
print(f"cos(45°): {math.cos(angle_radians):.3f}")
print(f"tan(45°): {math.tan(angle_radians):.3f}")

# Convert back to degrees
result = math.degrees(angle_radians)
print(f"Back to degrees: {result}")

# Distance between points (Pythagorean theorem)
def distance(x1, y1, x2, y2):
    return math.sqrt((x2-x1)**2 + (y2-y1)**2)

# Distance from (0,0) to (3,4)
print(f"Distance: {distance(0, 0, 3, 4)}")  # 5.0
```

! Important

Rather than having to write code to approximate things, have the `math` library do it for you!
Q: Why use a library in Python, anyway?
A: You would use a library to make your code more readable (and *trustworthy*) to a maintainer. Having a published library fit to handle your heavy lifting help to ensure smooth operation which will facilitate maintenance.

Interactive Math Demo: Circle Calculator!

i Build a Circle Calculator Together!

Let's use the `math` module to create useful tools!

```python
import math

def circle_calculator(radius):
    """Calculate everything about a circle given its radius"""
    # Area =   × r²
    area = math.pi * radius**2
```

```
    # Circumference = 2 ×   × r
    circumference = 2 * math.pi * radius

    # Diameter = 2 × r
    diameter = 2 * radius

    return {
        'radius': radius,
        'diameter': diameter,
        'area': round(area, 2),
        'circumference': round(circumference, 2)
    }

# Test with different radii
radii = [1, 5, 10, 25]
print("  Circle Calculator Results:")
print("-" * 50)
print(f"{'Radius':<8} {'Diameter':<10} {'Area':<12} {'Circumference'}")
print("-" * 50)

for r in radii:
    info = circle_calculator(r)
    print(f"{info['radius']:<8} {info['diameter']:<10} {info['area']:<12} {info['circumferen
```

Your Turn: Can you add a function to calculate the area of a sphere? (Hint: 4 r^2)!?

The `random` Module - Adding Unpredictability!

Random Numbers & Choices

```
import random

# Random integers
dice_roll = random.randint(1, 6)
print(f"Dice roll: {dice_roll}")

# Random floating point numbers
random_percent = random.random()  # 0.0 to 1.0
print(f"Random percentage: {random_percent:.2%}")

# Random from a specific range
```

```
temperature = random.uniform(20.0, 35.0)  # 20°C to 35°C
print(f"Random temperature: {temperature:.1f}°C")

# Random choices from a list
colors = ['red', 'blue', 'green', 'yellow', 'purple']
chosen_color = random.choice(colors)
print(f"Random color: {chosen_color}")

# Multiple random choices (with replacement)
team = random.choices(colors, k=3)
print(f"Random team colors: {team}")
```

Shuffling & Sampling

```
import random

# Shuffle a list (modifies original)
deck = ['A', '2', '3', '4', '5', '6', '7', '8', '9', '10', 'J', 'Q', 'K']
print(f"Original deck: {deck[:5]}...")  # Show first 5
random.shuffle(deck)
print(f"Shuffled deck: {deck[:5]}...")

# Random sample (without replacement)
students = ['Alice', 'Bob', 'Charlie', 'Diana', 'Eve', 'Frank']
volunteers = random.sample(students, 3)  # Pick 3 students
print(f"Today's volunteers: {volunteers}")

# Set seed for reproducible results
random.seed(42)  # Always gives same "random" sequence
print(f"Seeded random: {random.randint(1, 100)}")
print(f"Next seeded random: {random.randint(1, 100)}")
```

! Important

Interestingly, there is nothing really random about this generator – all numbers come from a look-up system. If you want truly random numbers, then you will have to use another system.
Q: Would this random number generator library serve in security applications?
A: The Random library is used for low security applications.

Let's Build: A Password Generator!

> **Practical Application: Security Tool**
>
> Combine `random` and `string` modules to create a secure password generator!

```
import random
import string

def generate_password(length=12, include_symbols=True):
    """Generate a secure random password"""

    # Build character set
    characters = string.ascii_letters + string.digits  # a-z, A-Z, 0-9

    if include_symbols:
        # Add safe symbols (avoid confusing ones)
        safe_symbols = "!@#$%^&*+-="
        characters += safe_symbols

    # Generate password
    password = ''.join(random.choices(characters, k=length))

    return password

def password_strength_checker(password):
    """Analyze password strength"""
    score = 0
    feedback = []

    if len(password) >= 8:
        score += 1
    else:
        feedback.append("Use at least 8 characters")

    if any(c.isupper() for c in password):
        score += 1
    else:
        feedback.append("Add uppercase letters")

    if any(c.islower() for c in password):
        score += 1
```

```
    else:
        feedback.append("Add lowercase letters")

    if any(c.isdigit() for c in password):
        score += 1
    else:
        feedback.append("Add numbers")

    if any(c in "!@#$%^&*+-=" for c in password):
        score += 1
    else:
        feedback.append("Add special characters")

    strength_levels = ["Very Weak", "Weak", "Fair", "Good", "Strong"]
    strength = strength_levels[min(score, 4)]

    return strength, feedback

# Generate and test passwords
print("  Password Generator Demo")
print("-" * 40)

for length in [8, 12, 16]:
    password = generate_password(length)
    strength, tips = password_strength_checker(password)
    print(f"Length {length}: {password}")
    print(f"Strength: {strength}")
    if tips:
        print(f"Tips: {', '.join(tips)}")
    print()
```

! Important

Q: Why is is important to have such a random looking password?
A: Finding a password is hard word! We remember that this operation is a `O(n)` operation where each of `n` possible passwords must be checked individually.

Your Turn: Module Exploration!

> **!** Hands-On Activity: Discover More Modules!
>
> Try these mini-challenges to explore Python's built-in modules:

Challenge 1: `datetime` Module

```
import datetime

# Find your age in days
birth_date = datetime.date(2008, 5, 15)  # Your birthday
today = datetime.date.today()
age_days = (today - birth_date).days

print(f"You are {age_days} days old!")

# What day will it be in 100 days?
future = today + datetime.timedelta(days=100)
print(f"In 100 days it will be: {future}")

# Your challenge:
# Find what day of the week you were born!
```

Challenge 2: `statistics` Module

```
import statistics

# Analyze test scores
scores = [88, 92, 76, 95, 82, 90, 87, 93, 79, 91]

print(f"Mean: {statistics.mean(scores)}")
print(f"Median: {statistics.median(scores)}")
print(f"Mode: {statistics.mode(scores)}")  # Most common
print(f"Std Dev: {statistics.stdev(scores):.2f}")

# Your challenge:
# Add functions to find the grade distribution!
# (How many A's, B's, C's, etc.)
```

File Operations: Working with Data Files

Understanding File Types

> **File Formats for Data Storage**
>
> Before we dive into code, let's understand **what** files we'll work with and **why**!

Text Files (`.txt`)

- **Best for**: Simple text, notes, logs, configuration
- **Human-readable**: Yes, open in any text editor
- **Structure**: Free-form text, paragraphs
- **Examples**:
  - Student essays
  - Game logs
  - Simple data lists
  - Configuration files

```
Hello World!
This is a simple text file.
Each line can contain any text.
Numbers: 123, 456, 789
```

CSV Files (`.csv`)

- **Best for**: Structured data, spreadsheet-like information
- **Human-readable**: Yes, opens in Excel/Google Sheets
- **Structure**: Rows and columns, separated by commas
- **Examples**:
  - Student grades
  - Inventory lists
  - Survey responses
  - Scientific data

```
Name,Age,Grade,Subject
Alice,16,95,Math
Bob,17,87,Science
Charlie,16,92,Math
```

Types of Files

> **!** Important
>
> So, Like, what do the files look like?

Text Files (`.txt`)

> **i** Note
>
> Text files contain primarily text such as strings. Stories, articles and unstructured data can be contained in a textfile.

```
Hello World!
This is a simple text file.
Each line can contain any text.
Numbers: 123, 456, 789
```

CSV Files (`.csv`)

> **i** Note
>
> **C**omma **S**eparated **V**ariable files contain data in rows and columns. The data entries are separated by (usually) a comma but could have any delimitor seperating them.

```
Name,Age,Grade,Subject
Alice,16,95,Math
Bob,17,87,Science
Charlie,16,92,Math
```

Let's Build a Joke Machine

> **!** Important
>
> The following code here will have to be used at the command line on your local machine. This is because Jupyter Notebooks do not typically handle files. We will use the local machine (rather than Jupyter Notebooks) with the CLI (command line input) to work with files. Cool, right?!

Text Files (`.txt`)

> **Note**
>
> Steps: * Open your favorite editor to create the following file
> **File**: `jokes.txt`

Textfile Contents

```
What did 20 do when it was hungry? Twenty-eight.
Why is grass so dangerous? Because it's full of blades!
Why are mountains so funny? They’re hill areas.
Why wasn’t the cactus invited to hang out with the mushrooms? He wasn’t a fungi.
Why shouldn’t you fundraise for marathons? They just take the money and run.
Why did the crab cross the road? It didn’t-it used the sidewalk.
Why does it take pirates a long time to learn the alphabet? Because they can spend years at
Why can't a nose be 12 inches long? Because then it would be a foot.
Why can’t you put two half-dollars in your pocket? Because two halves make a hole, and your
Why does a moon rock taste better than an Earth rock? It’s a little meteor.
How much do rainbows weigh? Not much. They’re actually pretty light.
What is the most popular fish in the ocean? The starfish.
A slice of apple pie costs $2.50 in Jamaica, $3.75 in Bermuda, and $3 in the Bahamas. Those
Why did the football coach yell at the vending machine? He wanted his quarter back!
I had a joke about paper today, but it was tearable.
What kind of job can you get at a bicycle factory? A spokesperson
What does a condiment wizard perform? Saucery
What's the difference in an alligator and a crocodile? You’ll see one later and one in a whi
What’s the difference between the bird flu and the swine flu? One requires tweetment and the
What’s the difference between ducks and dine-and-dashers? Ducks take care of their bills.
What's the difference between spring rolls and summer rolls? Their seasoning.
What’s the difference between Iron Man and Aluminum Man? Iron Man stops the bad guy. Aluminu
What’s the difference between a poorly dressed man on a unicycle and a well-dressed man on a
What’s the difference between a $20 steak and a $55 steak? February 14th.
What's the best thing about Switzerland? The flag is a big plus.
I went to the aquarium this weekend, but I didn’t stay long -- There’s something fishy about
I found a lion in my closet the other day! When I asked what it was doing there, it said 'Na
What's a cat's favorite instrument? Purrrr-cussion.
Why did the snail paint a giant S on his car? So when he drove by, people could say: 'Look a
What do you call a happy cowboy? A jolly rancher.
What subject do cats like best in school? Hiss-tory.
Humpty Dumpty had a great fall. He said his summer was pretty good too.
My boss told me to dress for the job I want, not for the one I have. So I went in as Batman.
How do you make holy water? You boil the hell out of it.
```

```
Justice is a dish best served cold. Otherwise, it's just water.
Why should you never throw grandpa's false teeth at a vehicle? You might denture car.
Why are Christmas trees bad at knitting? They always drop their needles.
What did the lunch box say to the refrigerator? Don't hate me because I'm a little cooler.
I can always tell when someone is lying. I can tell when they're standing too.
Some people pick their nose, but I was born with mine.
If your house is cold, just stand in the corner. It’s always 90 degrees there.
Why did the scarecrow win an award? Because he was outstanding in his field!
```

Simple Joke Machine

> **!** Important
>
> We will create some code to display all jokes.

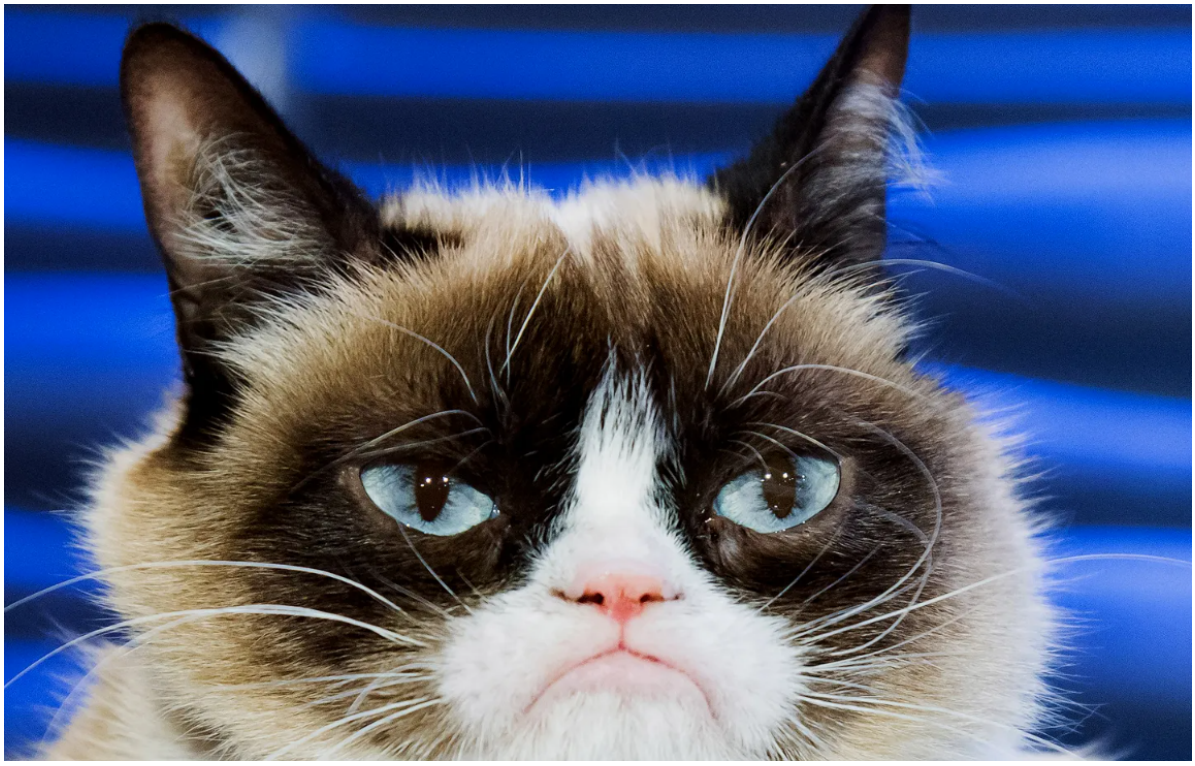
Python File

> **i** Note
>
> Steps: * Now create the following source code file in the same directory.
> **File**: `joke_machine.py`

Python Code

```
myFile = "jokes.txt"

# Open the text file, display contents

with open(myFile, "r") as file:
    content = file.read() # pull the contents from the file
    print(content)
```

Funny, Right?!



One-Liner Joke Machine

> **!** Important
>
> We will create some code to display a randomly selected joke.

Python File

> **i** Note
>
> Steps: * Now create the following source code file in the same directory.
> **File**: `joke_machine_one_liner.py`

Python Code

```python
import random

myFile = "jokes.txt"

# Open the text file, display a random joke

with open(myFile, "r") as file:
    jokes = file.readlines() # pull all lines from the file
    random_joke = random.choice(jokes).strip() # select a random joke
    print(random_joke)
```

Reading Text Files

Let Python READ to You!

> **Tip**
>
> When you use `with open()` then Python closes the book for you. How kind, right?!

```python
# Method 4: Read all lines into a list
with open('student_essay.txt', 'r') as file:
    lines = file.readlines()  # Returns list of lines
    print(f"File has {len(lines)} lines")
    for i, line in enumerate(lines):
        print(f"{i+1}: {line.strip()}")
```

Reading Text Files

> **Tip**
>
> **Step-by-Step File Reading**
> Reading files is like opening a book - you need to open it, read the contents, then close it when done! When you use `open()`, then you have to close the book.
>
> To try these examples, make sure you have the file available!

```
# Method 1: Basic file reading (manual close)
file = open('student_essay.txt', 'r')  # 'r' = read mode
content = file.read()  # Read entire file
print(content)
file.close()  # Always close the file!
```

```
##############################

# Method 2: Read line by line
file = open('student_essay.txt', 'r')
for line_number, line in enumerate(file, 1):
    print(f"Line {line_number}: {line.strip()}")  # strip() removes \n
file.close()
```

```
##############################

# Method 3: Best practice - using 'with' (auto-closes!)
with open('student_essay.txt', 'r') as file:
    content = file.read()
    print(content)
# File automatically closes when indented block ends!
```

Wait! What's the Code Doing?

> **!** Important
>
> Before we move forward, let's look at the code that opens files.

```
import random

myFile = "jokes.txt"

# Open the text file, display a random joke

with open(myFile, "r") as file:
    jokes = file.readlines() # pull all lines from the file
    random_joke = random.choice(jokes).strip() # select a random joke
    print(random_joke)
```

```
with open(myFile,"r") as file:
    jokes = file.readlines()
```

- `myfile` is a string variable
- Opens the `myfile` in **read** mode (not **write** mode)
- `as file:` file content is saved in `file` which is a `TextIOWrapper` object
- `jokes = file.readlines()` parse through `TextIOWrapper`, get the text and save to `jokes`.

Writing Files

Let Python WRITE For You!

> Tip
>
> **Step-by-Step File Writing**
> Writing files is like creating a document - you need to open it, write your content, then close it to save! When you use `open()` with write mode, you can save data permanently.

```
# Method 1: Basic file writing (manual close)
file = open('my_notes.txt', 'w')  # 'w' = write mode (overwrites!)
file.write('This is my first note.\n')
file.write('This is my second note.\n')
file.close()  # Always close to save!
```

```
##############################

# Method 2: Writing multiple lines at once
file = open('shopping_list.txt', 'w')
items = ['Apples\n', 'Bananas\n', 'Milk\n', 'Bread\n']
file.writelines(items)  # Write all lines at once
file.close()
```

```
##############################

# Method 3: Best practice - using 'with' (auto-closes!)
with open('diary.txt', 'w') as file:
    file.write('Today was a great day!\n')
    file.write('I learned about file writing in Python.\n')
# File automatically saves and closes when indented block ends!
```

Important: Write Modes Explained!

> ⚠ Warning
>
> **Be Careful with File Modes!**
> Different modes do different things - choose wisely!

Mode	Name	What It Does	Danger Level
`'w'`	Write	Creates new file or **OVERWRITES** existing file	High - Deletes old content!
`'a'`	Append	Adds to end of existing file or creates new	Safe - Keeps old content
`'r'`	Read	Opens file for reading only	Safe - Can't change file
`'x'`	Exclusive	Creates new file, **FAILS** if exists	Safe - Won't overwrite

```
# DANGER: This erases all old content!
with open('notes.txt', 'w') as file:
    file.write('New content replaces everything!\n')

# SAFE: This adds to the end
with open('notes.txt', 'a') as file:
    file.write('This line gets added to the end.\n')
```

Real Example: Creating a To-Do List

> ❗ Important
>
> Let's see file writing in action with a practical example!

```
# Create a to-do list file
todo_file = "my_tasks.txt"

# Write initial tasks
with open(todo_file, "w") as file:
    file.write("To-Do List for Today\n")
    file.write("=" * 25 + "\n")
    file.write("1. Study Python\n")
```

```
    file.write("2. Complete homework\n")
    file.write("3. Exercise for 30 min\n")

print("To-do list created!")

# Later: Add more tasks
with open(todo_file, "a") as file:
    file.write("4. Call mom\n")
    file.write("5. Read chapter 3\n")

print("Tasks added!")
```

What's Happening?

```
with open(todo_file, "w") as file:
    file.write("To-Do List for Today\n")
```

- `todo_file` is a string variable with filename
- Opens file in **write** mode (creates or overwrites)
- `as file:` gives us a file object to work with
- `file.write()` writes text to the file
- `\n` creates a new line (line break)
- File auto-saves when `with` block ends!

What Results?!

> **Note**
>
> **Result File:** `my_tasks.txt`
>
> ```
> To-Do List for Today
> ========================
> 1. Study Python
> 2. Complete homework
> 3. Exercise for 30 min
> 4. Call mom
> 5. Read chapter 3
> ```

Let's Do Something Cool!

Writing Text Files - Saving Your Data!

Creating New Files

```
# Write a new file
with open('my_story.txt', 'w') as file:  # 'w' = write mode
    file.write("Once upon a time...\n")
    file.write("There was a student learning Python.\n")
    file.write("They discovered the magic of files!")

# Writing multiple lines at once
lines = [
    "Chapter 1: The Beginning\n",
    "It was a dark and stormy night.\n",
    "Perfect weather for coding!\n"
]

with open('novel.txt', 'w') as file:
    file.writelines(lines)  # Write list of lines

print("Files created successfully!")
```

Appending to Files

```
# Add to existing file (don't overwrite!)
with open('my_story.txt', 'a') as file:  # 'a' = append mode
    file.write("\n\nChapter 2: The Adventure Continues\n")
    file.write("Our hero learned about file modes:\n")
    file.write("- 'r' for reading\n")
    file.write("- 'w' for writing (overwrites!)\n")
    file.write("- 'a' for appending (adds to end)\n")

# Safe writing with error handling
filename = 'log.txt'
try:
    with open(filename, 'a') as file:
        file.write(f"Entry at {datetime.datetime.now()}\n")
        file.write("Everything working great!\n")
    print("Log entry added!")
```

```
except FileNotFoundError:
    print(f"Could not find {filename}")
```

Using CSV Files - Structured Data!

> **!** CSV = Comma Separated Values
>
> CSV files are perfect for data that fits in rows and columns, like spreadsheets!

```
import csv

# Reading CSV files - Method 1: Basic reading
with open('students.csv', 'r') as file:
    csv_reader = csv.reader(file)
    headers = next(csv_reader)  # Get the first row (headers)
    print(f"Headers: {headers}")

    for row_number, row in enumerate(csv_reader, 1):
        print(f"Student {row_number}: {row}")

# Reading CSV files - Method 2: Dictionary reader (easier!)
with open('students.csv', 'r') as file:
    csv_reader = csv.DictReader(file)  # Treats first row as headers

    for student in csv_reader:
        name = student['Name']
        grade = student['Grade']
        subject = student['Subject']
        print(f"{name} got {grade}% in {subject}")

# Writing CSV files
student_data = [
    ['Name', 'Age', 'Grade', 'Subject'],
    ['Alice', 16, 95, 'Math'],
    ['Bob', 17, 87, 'Science'],
    ['Charlie', 16, 92, 'Math'],
    ['Diana', 16, 89, 'English']
]

with open('new_students.csv', 'w', newline='') as file:
```

```
    # newline='' prevents extra blank lines in CSV on Windows
    csv_writer = csv.writer(file)
    csv_writer.writerows(student_data)  # Write all rows at once

print("CSV file created!")
```

Demo: Grade Book Manager!

> Let's Build Something Useful!
>
> Create a grade book that can save and load student data!

```
# Import the csv module to work with CSV files
import csv
# Import datetime to add timestamps to grade entries
from datetime import datetime

class GradeBook:
    def __init__(self, filename='gradebook.csv'):
        """Initialize the gradebook with a filename"""
        # Store the CSV filename for saving/loading data
        self.filename = filename
        # Create an empty list to hold all student grade records
        self.students = []
        # Automatically load any existing grades when creating a GradeBook object
        self.load_grades()

    def load_grades(self):
        """Load existing grades from CSV file"""
        try:
            # Try to open the CSV file in read mode
            with open(self.filename, 'r') as file:
                # Create a CSV reader that converts each row into a dictionary
                # Keys come from the header row (Name, Subject, Grade, Date)
                csv_reader = csv.DictReader(file)
                # Convert the reader object to a list and store in self.students
                self.students = list(csv_reader)
                # Confirm how many records were loaded
                print(f"Loaded {len(self.students)} student records")
        except FileNotFoundError:
```

```
            # If the file doesn't exist yet, that's okay - start with empty list
            print(f"No existing gradebook found. Starting fresh!")
            self.students = []

    def add_student(self, name, subject, grade):
        """Add a new student grade"""
        # Create a dictionary to represent one grade entry
        student = {
            'Name': name,           # Student's name
            'Subject': subject,     # Subject/course name
            'Grade': str(grade),    # Convert grade to string for CSV storage
            'Date': datetime.now().strftime('%Y-%m-%d')  # Add today's date in YYYY-MM-DD fo
        }
        # Add this new student record to our list
        self.students.append(student)
        # Confirm the grade was added
        print(f"Added: {name} - {subject}: {grade}%")

    def save_grades(self):
        """Save all grades to CSV file"""
        # Check if there are any grades to save
        if not self.students:
            print("No grades to save!")
            return

        # Open the file in write mode (will overwrite existing file)
        # newline='' prevents extra blank lines in CSV on Windows
        with open(self.filename, 'w', newline='') as file:
            # Define the column headers for our CSV file
            fieldnames = ['Name', 'Subject', 'Grade', 'Date']
            # Create a CSV writer that works with dictionaries
            csv_writer = csv.DictWriter(file, fieldnames=fieldnames)
            # Write the header row (column names)
            csv_writer.writeheader()
            # Write all student records as rows in the CSV
            csv_writer.writerows(self.students)
        # Confirm the save was successful
        print(f"Saved {len(self.students)} grades to {self.filename}")

    def get_student_average(self, name):
        """Calculate average grade for a student"""
        # Use list comprehension to get all grades for this student
```

```
        # Filter students by name, then convert their grades from strings to integers
        student_grades = [int(s['Grade']) for s in self.students if s['Name'] == name]
        # If we found any grades for this student
        if student_grades:
            # Calculate and return the average (sum divided by count)
            return sum(student_grades) / len(student_grades)
        # If no grades found, return None
        return None

    def display_gradebook(self):
        """Display all grades in a nice format"""
        # Check if there are any grades to display
        if not self.students:
            print("Gradebook is empty!")
            return

        # Print a formatted header
        print("\n  GRADEBOOK REPORT")
        print("-" * 50)
        # Print column headers with specific widths using f-string formatting
        # <12 means left-align in 12 characters, <10 means 10 characters, etc.
        print(f"{'Name':<12} {'Subject':<10} {'Grade':<6} {'Date'}")
        print("-" * 50)

        # Loop through each student record and display it
        for student in self.students:
            # Print each row with aligned columns
            # Add '%' to grade and maintain alignment
            print(f"{student['Name']:<12} {student['Subject']:<10} {student['Grade']+'%':<6}

# ========== DEMO: Using the GradeBook ==========

# Create a new GradeBook object (will load existing data if available)
gb = GradeBook()

# Add some sample student grades
# Format: add_student(name, subject, grade)
gb.add_student("Alice", "Math", 95)
gb.add_student("Bob", "Science", 87)
gb.add_student("Alice", "Science", 92)
gb.add_student("Charlie", "Math", 88)
```

```
# Display all grades in a formatted table
gb.display_gradebook()

# Save all grades to the CSV file
gb.save_grades()

# Calculate and display Alice's average grade across all subjects
alice_avg = gb.get_student_average("Alice")
if alice_avg:
    # Display average with one decimal place using :.1f formatting
    print(f"\nAlice's average: {alice_avg:.1f}%")
```

Part 2: Creating Your Own Modules

What Makes a Module?

> Note
>
> **Modules Are Just Python Files!**: Any `.py` file can become a module that other programs can import and use!

Create `math_helpers.py`

```
"""
Math Helper Functions
A collection of useful mathematical utilities
"""

import math

def area_circle(radius):
    """Calculate the area of a circle"""
    return math.pi * radius ** 2

def area_rectangle(length, width):
    """Calculate the area of a rectangle"""
    return length * width
```

```
def area_triangle(base, height):
    """Calculate the area of a triangle"""
    return 0.5 * base * height

def distance_2d(x1, y1, x2, y2):
    """Calculate distance between two points"""
    return math.sqrt((x2 - x1)**2 + (y2 - y1)**2)

def is_perfect_square(n):
    """Check if a number is a perfect square"""
    if n < 0:
        return False
    root = int(math.sqrt(n))
    return root * root == n

# Module-level variables (constants)
GOLDEN_RATIO = (1 + math.sqrt(5)) / 2
PI_ROUNDED = round(math.pi, 4)

# Demo function that runs when module is imported
def demo():
    """Demonstrate all functions in this module"""
    print("  Math Helpers Demo")
    print("-" * 30)
    print(f"Circle area (r=5): {area_circle(5):.2f}")
    print(f"Rectangle area (4x6): {area_rectangle(4, 6)}")
    print(f"Triangle area (b=8, h=5): {area_triangle(8, 5)}")
    print(f"Distance (0,0) to (3,4): {distance_2d(0, 0, 3, 4)}")
    print(f"Is 16 perfect square? {is_perfect_square(16)}")
    print(f"Golden ratio: {GOLDEN_RATIO:.6f}")
```

Using Your Module

```
# Import your custom module
import math_helpers

# Use the functions
radius = 10
area = math_helpers.area_circle(radius)
print(f"Circle with radius {radius} has area: {area:.2f}")

# Import specific functions
```

```python
from math_helpers import distance_2d, is_perfect_square

# Use imported functions directly
dist = distance_2d(1, 1, 4, 5)
print(f"Distance: {dist:.2f}")

# Check perfect squares
numbers = [16, 17, 25, 30, 36]
for num in numbers:
    result = is_perfect_square(num)
    print(f"{num} is perfect square: {result}")

# Access module constants
from math_helpers import GOLDEN_RATIO, PI_ROUNDED
print(f"Golden ratio: {GOLDEN_RATIO}")
print(f"Pi (rounded): {PI_ROUNDED}")

# Run the demo
math_helpers.demo()
```

Advanced Module Features

> **Tip**
>
> **Professional Module Structure**: Let's add advanced features that make modules robust and user-friendly!

```python
"""
student_toolkit.py
A comprehensive toolkit for student-related operations
"""

import csv
import json
from datetime import datetime
import statistics

class StudentManager:
    """Class to manage student data and operations"""
```

```
    def __init__(self):
        self.students = []

    def add_student(self, name, age, grade_level):
        """Add a new student"""
        student = {
            'id': len(self.students) + 1,
            'name': name,
            'age': age,
            'grade_level': grade_level,
            'grades': [],
            'created': datetime.now().isoformat()
        }
        self.students.append(student)
        return student['id']

    def add_grade(self, student_id, subject, grade, date=None):
        """Add a grade for a student"""
        if date is None:
            date = datetime.now().strftime('%Y-%m-%d')

        for student in self.students:
            if student['id'] == student_id:
                grade_entry = {
                    'subject': subject,
                    'grade': grade,
                    'date': date
                }
                student['grades'].append(grade_entry)
                return True
        return False

    def get_student_average(self, student_id):
        """Calculate student's average grade"""
        for student in self.students:
            if student['id'] == student_id:
                grades = [g['grade'] for g in student['grades']]
                return statistics.mean(grades) if grades else 0
        return None

# Utility functions
def calculate_gpa(grades):
```

```
    """Convert grades to GPA (4.0 scale)"""
    if not grades:
        return 0.0

    def grade_to_points(grade):
        if grade >= 97: return 4.0
        elif grade >= 93: return 3.7
        elif grade >= 90: return 3.3
        elif grade >= 87: return 3.0
        elif grade >= 83: return 2.7
        elif grade >= 80: return 2.3
        elif grade >= 77: return 2.0
        elif grade >= 73: return 1.7
        elif grade >= 70: return 1.3
        elif grade >= 67: return 1.0
        else: return 0.0

    points = [grade_to_points(grade) for grade in grades]
    return sum(points) / len(points)

def save_to_csv(students, filename):
    """Save student data to CSV file"""
    with open(filename, 'w', newline='') as file:
        writer = csv.writer(file)
        writer.writerow(['ID', 'Name', 'Age', 'Grade Level', 'Average'])

        for student in students:
            avg_grade = statistics.mean([g['grade'] for g in student['grades']]) if student[
            writer.writerow([
                student['id'],
                student['name'],
                student['age'],
                student['grade_level'],
                round(avg_grade, 2)
            ])

def load_from_json(filename):
    """Load student data from JSON file"""
    try:
        with open(filename, 'r') as file:
            return json.load(file)
    except FileNotFoundError:
```

```
        return []

def save_to_json(students, filename):
    """Save student data to JSON file"""
    with open(filename, 'w') as file:
        json.dump(students, file, indent=2)

# Module constants
GRADE_SCALE = {
    'A+': (97, 100),
    'A': (93, 96),
    'A-': (90, 92),
    'B+': (87, 89),
    'B': (83, 86),
    'B-': (80, 82),
    'C+': (77, 79),
    'C': (73, 76),
    'C-': (70, 72),
    'D': (60, 69),
    'F': (0, 59)
}

def get_letter_grade(numeric_grade):
    """Convert numeric grade to letter grade"""
    for letter, (min_grade, max_grade) in GRADE_SCALE.items():
        if min_grade <= numeric_grade <= max_grade:
            return letter
    return 'F'

# Special behavior when module is run directly
if __name__ == "__main__":
    print("  Student Toolkit Demo")
    print("-" * 30)

    # Create a student manager
    sm = StudentManager()

    # Add some students
    alice_id = sm.add_student("Alice Johnson", 16, 11)
    bob_id = sm.add_student("Bob Smith", 17, 12)

    # Add grades
```

```
    sm.add_grade(alice_id, "Math", 95)
    sm.add_grade(alice_id, "Science", 92)
    sm.add_grade(alice_id, "English", 89)

    sm.add_grade(bob_id, "Math", 87)
    sm.add_grade(bob_id, "Science", 91)

    # Show results
    for student in sm.students:
        avg = sm.get_student_average(student['id'])
        letter = get_letter_grade(avg)
        gpa = calculate_gpa([g['grade'] for g in student['grades']])

        print(f"\n{student['name']} (ID: {student['id']})")
        print(f"  Average: {avg:.1f}% ({letter})")
        print(f"  GPA: {gpa:.2f}")
        print(f"  Grades: {[g['grade'] for g in student['grades']]}")

    # Save data
    save_to_csv(sm.students, 'student_report.csv')
    save_to_json(sm.students, 'student_data.json')
    print("\n Data saved to CSV and JSON files!")
```

Using Your Custom Module

Example 1 of Real-World Applications!

Import and Use

```
# Using your student toolkit
from student_toolkit import (
    StudentManager,
    calculate_gpa,
    get_letter_grade,
    GRADE_SCALE
)

# Create a classroom management system
classroom = StudentManager()

# Add students from your class
students_data = [
```

```
    ("Emily Chen", 16, 11),
    ("Marcus Rodriguez", 17, 11),
    ("Sarah Kim", 16, 11),
    ("Jordan Williams", 17, 11)
]

student_ids = []
for name, age, grade_level in students_data:
    student_id = classroom.add_student(name, age, grade_level)
    student_ids.append(student_id)
    print(f"Added {name} with ID: {student_id}")

# Add grades for each student
subjects = ["Math", "Science", "English", "History"]
import random

print("\n Adding random grades...")
for student_id in student_ids:
    for subject in subjects:
        # Generate realistic grades (70-100)
        grade = random.randint(70, 100)
        classroom.add_grade(student_id, subject, grade)

# Generate class report
print("\n CLASS REPORT")
print("=" * 50)
for student in classroom.students:
    avg = classroom.get_student_average(student['id'])
    letter = get_letter_grade(avg)
    grades_list = [g['grade'] for g in student['grades']]
    gpa = calculate_gpa(grades_list)

    print(f"{student['name']:<15} | Avg: {avg:5.1f}% | Grade: {letter} | GPA: {gpa:.2f}")
```

Using Your Custom Module

Example 2 of Real-World Applications!

Module Organization

```
# Create a package structure
"""
my_school_package/
   __init__.py          # Makes it a package
   students.py          # Student management
   grades.py           # Grade calculations
   reports.py          # Report generation
   utils.py            # Utility functions
"""

# __init__.py file content:
"""
School Management Package
A complete toolkit for managing students and grades
"""

from .students import StudentManager
from .grades import calculate_gpa, get_letter_grade
from .reports import generate_report
from .utils import save_data, load_data

__version__ = "1.0.0"
__author__ = "Your Name"

# Package-level constants
DEFAULT_SUBJECTS = ["Math", "Science", "English", "History"]
PASSING_GRADE = 70

def quick_demo():
    """Quick demonstration of package features"""
    print(f"School Package v{__version__}")
    print("Available modules:")
    print("- StudentManager: Manage student data")
    print("- Grade calculators: GPA and letter grades")
    print("- Report generators: Create summaries")
    print("- Data utilities: Save/load functionality")
```

Module Best Practices & Documentation!

> **!** Writing Professional Modules
>
> Examples of a good way to write code. Follow these practices to create modules that others (and future you!) can easily use!

```
"""
geometry_tools.py
Advanced Geometric Calculations and Shape Analysis

This module provides classes and functions for working with 2D and 3D geometric shapes.
Perfect for math classes, game development, and engineering applications.

Author: "Your Name"
Date: November 2025
Version: 1.0

Example usage:
    from geometry_tools import Circle, Rectangle, calculate_polygon_area

    circle = Circle(5)
    print(f"Circle area: {circle.area()}")

    rect = Rectangle(4, 6)
    print(f"Rectangle perimeter: {rect.perimeter()}")
"""

import math
from typing import List, Tuple

class Shape:
    """Base class for all geometric shapes"""

    def __init__(self, name: str):
        self.name = name

    def area(self) -> float:
        """Calculate the area of the shape"""
        raise NotImplementedError("Subclasses must implement area()")

    def perimeter(self) -> float:
```

```
        """Calculate the perimeter of the shape"""
        raise NotImplementedError("Subclasses must implement perimeter()")

    def __str__(self) -> str:
        """String representation of the shape"""
        return f"{self.name} - Area: {self.area():.2f}, Perimeter: {self.perimeter():.2f}"

class Circle(Shape):
    """A circle defined by its radius"""

    def __init__(self, radius: float):
        super().__init__("Circle")
        if radius <= 0:
            raise ValueError("Radius must be positive")
        self.radius = radius

    def area(self) -> float:
        """Calculate circle area using   × r²"""
        return math.pi * self.radius ** 2

    def perimeter(self) -> float:
        """Calculate circle circumference using 2 ×   × r"""
        return 2 * math.pi * self.radius

    def diameter(self) -> float:
        """Get the circle's diameter"""
        return 2 * self.radius

class Rectangle(Shape):
    """A rectangle defined by length and width"""

    def __init__(self, length: float, width: float):
        super().__init__("Rectangle")
        if length <= 0 or width <= 0:
            raise ValueError("Length and width must be positive")
        self.length = length
        self.width = width

    def area(self) -> float:
        """Calculate rectangle area using length × width"""
        return self.length * self.width
```

```
    def perimeter(self) -> float:
        """Calculate rectangle perimeter using 2 × (length + width)"""
        return 2 * (self.length + self.width)

    def is_square(self) -> bool:
        """Check if the rectangle is actually a square"""
        return abs(self.length - self.width) < 1e-10  # Account for floating point

def calculate_polygon_area(vertices: List[Tuple[float, float]]) -> float:
    """
    Calculate area of a polygon using the shoelace formula

    Args:
        vertices: List of (x, y) coordinate tuples defining the polygon

    Returns:
        The area of the polygon

    Raises:
        ValueError: If fewer than 3 vertices provided

    Example:
        triangle = [(0, 0), (4, 0), (2, 3)]
        area = calculate_polygon_area(triangle)  # Returns 6.0
    """
    if len(vertices) < 3:
        raise ValueError("A polygon must have at least 3 vertices")

    n = len(vertices)
    area = 0.0

    for i in range(n):
        j = (i + 1) % n
        area += vertices[i][0] * vertices[j][1]
        area -= vertices[j][0] * vertices[i][1]

    return abs(area) / 2.0

# Module constants with clear documentation
PI = math.pi  # More readable alias for
DEGREES_TO_RADIANS = math.pi / 180  # Conversion factor
RADIANS_TO_DEGREES = 180 / math.pi  # Conversion factor
```

```python
# Utility functions
def convert_to_radians(degrees: float) -> float:
    """Convert degrees to radians"""
    return degrees * DEGREES_TO_RADIANS

def convert_to_degrees(radians: float) -> float:
    """Convert radians to degrees"""
    return radians * RADIANS_TO_DEGREES

# Demo and testing code
if __name__ == "__main__":
    print("  Geometry Tools Demo")
    print("-" * 40)

    # Test Circle
    circle = Circle(5)
    print(circle)
    print(f"Diameter: {circle.diameter():.2f}")

    # Test Rectangle
    rect = Rectangle(4, 6)
    print(rect)
    print(f"Is square? {rect.is_square()}")

    # Test Square
    square = Rectangle(5, 5)
    print(square)
    print(f"Is square? {square.is_square()}")

    # Test Polygon
    triangle = [(0, 0), (4, 0), (2, 3)]
    triangle_area = calculate_polygon_area(triangle)
    print(f"Triangle area: {triangle_area:.2f}")

    # Test conversions
    angle_deg = 90
    angle_rad = convert_to_radians(angle_deg)
    print(f"{angle_deg}° = {angle_rad:.4f} radians")
```

Hands-On Challenge

Build Your Dream Module!

> Final Project: Create Your Own Utility Module!
>
> Choose one of these ideas or create your own unique module:

Option 1: Game Utilities

```
"""
game_utils.py - Gaming Helper Functions
"""

import random

def roll_dice(sides=6, count=1):
    """Roll dice and return results"""
    return [random.randint(1, sides) for _ in range(count)]

def calculate_damage(base, weapon_bonus, critical=False):
    """Calculate game damage with bonuses"""
    damage = base + weapon_bonus
    if critical:
        damage *= 2
    return damage

class Player:
    def __init__(self, name, health=100):
        self.name = name
        self.health = health
        self.max_health = health
        self.inventory = []

    def take_damage(self, damage):
        self.health = max(0, self.health - damage)
        return self.health <= 0  # Returns True if player died

# Your additions:
# - Magic spells system
# - Inventory management
# - Experience points calculation
```

Option 2: Text Analysis

```
"""
text_analyzer.py - Analyze written text
"""

import string

def word_count(text):
    """Count words in text"""
    return len(text.split())

def character_frequency(text):
    """Count frequency of each character"""
    frequency = {}
    for char in text.lower():
        if char.isalnum():
            frequency[char] = frequency.get(char, 0) + 1
    return frequency

def reading_level(text):
    """Calculate approximate reading level"""
    words = len(text.split())
    sentences = text.count('.') + text.count('!') + text.count('?')
    if sentences == 0:
        return 0
    avg_words_per_sentence = words / sentences
    # Simple formula for reading level
    return min(12, max(1, int(avg_words_per_sentence / 2)))

# Your additions:
# - Sentiment analysis (positive/negative)
# - Common word finder
# - Text summarizer
```

Solution :: Week and Weekend Days

Solution: How many days are there without weekend days in a month?

```
# Finding the number of days of the week, less weekend days, each month.

import calendar as cal
```

```
# Find days in the week
def count_weekends_in_month(year, month):
    """Count how many Saturdays and Sundays in a month"""
    month_cal = cal.monthcalendar(year, month)
    saturdays = sundays = 0

    for week in month_cal:
        if week[cal.SATURDAY] != 0:  # 0 means no day
            saturdays += 1
        if week[cal.SUNDAY] != 0:
            sundays += 1

    return saturdays, sundays

def getMonthLen(year, month):
    """ Find the number of days in a month"""
    myCal = cal.monthcalendar(year, month)
    # get a count of days in month
    count = 0

    for i in range(len(myCal)):
        line =  myCal[i]
        # print(f"my line is {line}")
        for j in line:
            #print(f"j is {j}")
            if j != 0:
                count = count + 1
    #print(f"Number of days : {count}")
    return count

#Find number of week days
month = 12
year = 2025
print(f" Month = {month}")
print(f" Year = {year}")
sat, sun = count_weekends_in_month(year, month)
print(f" Number of weekend days : {sat + sun} ")
print(f" Number of days in month : {getMonthLen(year, month)}")
print(f" Number of weekdays : {getMonthLen(year, month) - (sat + sun)} ")
```

```
# Finding the number of days of the week, less weekend days, each month.

import calendar as cal

# Find days in the week
def count_weekends_in_month(year, month):
    """Count how many Saturdays and Sundays in a month"""
    month_cal = cal.monthcalendar(year, month)
    saturdays = sundays = 0

    for week in month_cal:
        if week[cal.SATURDAY] != 0:  # 0 means no day
            saturdays += 1
        if week[cal.SUNDAY] != 0:
            sundays += 1

    return saturdays, sundays

def getMonthLen(year, month):
    """ Find the number of days in a month"""
    myCal = cal.monthcalendar(year, month)
    # get a count of days in month
    count = 0

    for i in range(len(myCal)):
        line =  myCal[i]
        # print(f"my line is {line}")
        for j in line:
            #print(f"j is {j}")
            if j != 0:
                count = count + 1
    #print(f"Number of days : {count}")
    return count

#Find number of week days
month = 12
year = 2025
print(f" Month = {month}")
print(f" Year = {year}")
sat, sun = count_weekends_in_month(year, month)
print(f" Number of weekend days : {sat + sun} ")
print(f" Number of days in month : {getMonthLen(year, month)}")
```

```
print(f" Number of weekdays : {getMonthLen(year, month) - (sat + sun)} ")
```

```
 Month = 12
 Year = 2025
 Number of weekend days : 8
 Number of days in month : 31
 Number of weekdays : 23
```

Return to Challenge Slide

Solution :: Finding Areas

```
import math

def circle_calculator(radius):
    """Calculate everything about a circle given its radius"""
    # Area =   × r²
    area = math.pi * radius**2

    # Circumference = 2 ×   × r
    circumference = 2 * math.pi * radius

    # Diameter = 2 × r
    diameter = 2 * radius

    # area of sphere = 4 * math.pi * r * r
    sphereArea = 4 * math.pi * radius**2

    # return a dictionary
    return {
        'radius': radius,
        'diameter': diameter,
        'area': round(area, 2),
        'circumference': round(circumference, 2),
        'sphereArea': round(sphereArea, 2)
    }

# Test with different radii
radii = [1, 5, 10, 25]
```

```
print("  Circle Calculator Results:")
print("-" * 80)
print(f"{'Radius':<8} {'Diameter':<10} {'Area':<12} {'Circumference':<16} {'Sphere Area'}")
print("-" * 80)

for r in radii:
    info = circle_calculator(r)
    # pull values from dictionary structure
    print(f"{info['radius']:<8} {info['diameter']:<10} {info['area']:<12} {info['circumferenc
```

```
import math

def circle_calculator(radius):
    """Calculate everything about a circle given its radius"""
    # Area =   × r²
    area = math.pi * radius**2

    # Circumference = 2 ×   × r
    circumference = 2 * math.pi * radius

    # Diameter = 2 × r
    diameter = 2 * radius

    # area of sphere = 4 * math.pi * r * r
    sphereArea = 4 * math.pi * radius**2

    # return a dictionary
    return {
        'radius': radius,
        'diameter': diameter,
        'area': round(area, 2),
        'circumference': round(circumference, 2),
        'sphereArea': round(sphereArea, 2)
    }

# Test with different radii
radii = [1, 5, 10, 25]
print("  Circle Calculator Results:")
print("-" * 80)
print(f"{'Radius':<8} {'Diameter':<10} {'Area':<12} {'Circumference':<16} {'Sphere Area'}")
print("-" * 80)
```

```
for r in radii:
    info = circle_calculator(r)
    # pull values from dictionary structure
    print(f"{info['radius']:<8} {info['diameter']:<10} {info['area']:<12} {info['circumferenc
```

```
 Circle Calculator Results:
--------------------------------------------------------------------------------
Radius   Diameter   Area         Circumference    Sphere Area
--------------------------------------------------------------------------------
1        2          3.14         6.28             6.28
5        10         78.54        31.42            31.42
10       20         314.16       62.83            62.83
25       50         1963.5       157.08           157.08
```

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Summary & Next Steps

You're Now a Module Master!

Skills Unlocked

- **Import mastery**: Using built-in modules (`calendar`, `math`, `random`)
- **File operations**: Reading/writing text and CSV files

- **Module creation**: Building your own reusable code libraries
- **Professional practices**: Documentation, error handling, organization

Modules You've Explored: - `calendar` - Date calculations and calendar generation - `math` - Mathematical functions and constants - `random` - Random numbers and choices
- `csv` - Structured data handling - `datetime` - Working with dates and times

Real-World Applications

- **Data Analysis**: Reading CSV files, calculating statistics
- **File Management**: Organizing and processing text data
- **Code Organization**: Creating reusable function libraries
- **Problem Solving**: Using the right tool for each task

Next Adventures: - Explore more built-in modules (`json`, `requests`, `sqlite3`) - Create package structures with multiple modules - Publish your modules for others to use - Integrate modules into larger projects

Keep Exploring!

> **!** Important
>
> **Remember**: Python has hundreds of built-in modules and thousands of third-party packages. The skills you learned today are your keys to unlock infinite possibilities!
> **Pro Tip**: Check out the Python Module Index to discover more amazing tools!