Advanced Programming

Modules in Python

Ramaseshan Ramachandran

IMPORT STATEMENT

- Gains access to the code of one module in another
- Finds a Python module with a specified name to access the functions and data types defined within that module
- Two functions
  - Searches for the module named in the import statement
  - Binds the results of the search to the local scope
- Import programatically

```python
if __name__ == "__main__":
    import importlib
    my_math = importlib.import_module('math')
    print(my_math.__doc__)
    print(dir(my_math))
```

MODULES

- If the program gets longer, you may want to logically split it into several files for easier maintenance
- A function may also be used in several of your programs
- You want to use it without copying it
- Modules promote code organization and reusability.
- They group related functionalities into logical units
- They prevent global namespace pollution - names are local to the module
- A **module** is a file containing Python code that acts as a reusable building block
  - Self-contained library of functions, variables, and classes

Code organisation

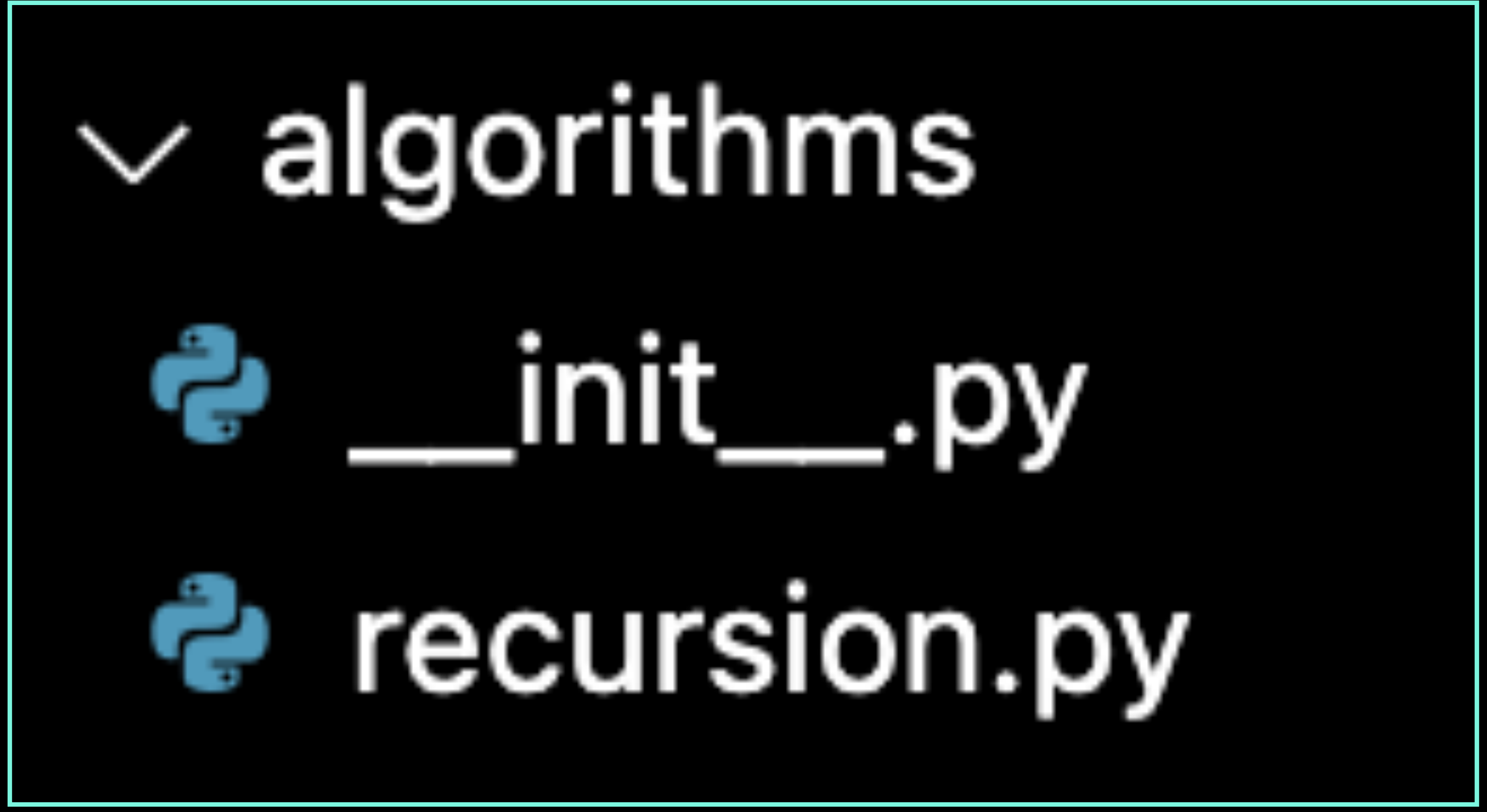
Reusability

Maintainability

Namespace management

MODULE STRUCTURE

```
my_module/
├── __init__.py  # (Optional initialisation code)
├── function1.py
├── function2.py
```



__init__.py

- Marks a directory as a package
- Python interprets it as a package rather than a single module
- Package-level variables or constants
- Performing one-time initializations (e.g., connecting to databases)
- Setting up logging or configuration

Functions in Module “Algorithms”

```
import math
def factorial(n) -> int:

    if not n >= 0:
        raise ValueError("n must be >= 0")
    if math.floor(n) != n:
        raise ValueError("n must be exact integer")
    if n+1 == n:  # catch a value like 1e300
        raise OverflowError("n too large")
    result = 1
    factor = 2
    while factor <= n:
        result *= factor
        factor += 1
    return result

def fibonacci(n) -> int:
   if n <= 1:
       return n
   else:
       return(fibonacci(n-1) + fibonacci(n-2))

if __name__ == "__main__":
    print(factorial(5))
    print(fibonacci(15))
```

if __name__ == "__main__":

- __name__: A special built-in variable set to "__main__"
- Only executes when the file is run as a script
- Useful for tasks specific to standalone execution
- Advantages:
  - Prevents unintended side effects when imported
  - Creates cleaner and more modular code

SCOPE

- The scope determines the visibility and accessibility of variables within different parts code
- Scopes are implemented as dictionaries
- These dictionaries are called namespaces.
- Scope = {name:object}
- Follows Local, Enclosing, Global and built-in (LEGB) rule
- Global scope

```
global_var = 40

def my_function():
    loval_var = 100
    print(global_var)
if __name__ == '__main__':
    print(local_var)
    my_function()
```

```
Built-in Scope
```

Built-in functions and variables that are always accessible

- Examples: print(), len(), True, False.

LEGB RULE

- When Python encounters a variable name
  - Local: It checks if the variable is defined within the current block (function, loop, or conditional).
  - Enclosing: If not found locally, it looks for it in enclosing blocks (outer functions/blocks).
  - Global: If still not found, it checks the global scope of the module.
  - Built-in: If not found globally, it checks the built-in scope

- Minimise global variable usage
- Use descriptive variable names
- Consider using classes to encapsulate related variables and functions, providing better control over their scope

CHECK YOUR UNDERSTANDING

```python
def scope_test():
    def do_local():
        spam = "local spam"

    def do_nonlocal():
        nonlocal spam
        spam = "nonlocal spam"

    def do_global():
        global spam
        spam = "global spam"

    spam = "test spam"
    do_local()
    print("After local assignment:", spam)
    do_nonlocal()
    print("After nonlocal assignment:", spam)
    do_global()
    print("After global assignment:", spam)

if __name__ == '__main__':
    scope_test()
    print("In global scope:", spam)
```

```
After local assignment: test spam

After nonlocal assignment: nonlocal spam

After global assignment: nonlocal spam

In global scope: global spam
```

DECORATOR

- Is a design pattern
- Modifies the behaviour of functions
- Adds or alters its functionality without permanently changing the original code
- Promotes code reuse, readability, and maintainability

Prerequisite

```python
def outer_function(x):
    def inner_function(y):
        return y * 2

    result = inner_function(x)
    return result

def m_by_2(x):
    return x * 2

def calculate(func, x):
    return func(x)

def return_func_as_value(x):
    def calculate(x):
        return x*2
    return calculate

if __name__ == '__main__':
    print(outer_function(5))
    print(calculate(m_by_2,5))
    calc = return_func_as_value(5)
    print(calc(5))
```

DECORATOR SYNTAX

- Takes the original function as an argument (called as wrapper).
  - Inside the decorator, one can perform actions before, after, or around the execution of the wrapped function
- Returns the Wrapper Function
  - Encapsulates the modified behaviour of the original function
- Decoration Syntax:
  - The @ symbol is used to apply the decorator to a function.
  - The decorator function is placed above a function that needs to be decorated

```
@greeting_decorator
def say_hello(name, cmi="CMI"):
```

```
#efficiently computing Fibonacci numbers using a cache
@lru_cache(maxsize=None)
def fibonacci(n):
```

```
@requires_role("admin")
def update_settings(config):
```

DECORATOR - EXAMPLE 1

```python
import datetime

def time_of_day():
    # Get the current hour
    current_hour = datetime.time.hour

    # time ranges
    morning_end = 12
    evening_end = 21

    if morning_start < (current_hour and 12):
        return "Good morning”

    elif evening_start <= (current_hour and 21):
        return "Good evening”

    else:
        return "Good night"
```

```python
# Define a decorator function
def greetings_decorator(func):
    def wrapper(*args, **kwargs):
        # Call the original function
        print(f"{func(*args, **kwargs)}, \
              {time_of_day()}”)
    return wrapper

# Decorator
@greeting_decorator
def say_hello(name, cmi="CMI"):
    return f"Hello, {name} {cmi}!"

if __name__ == "__main__":
    say_hello("Students of ", cmi="ADPG")
```

DECORATOR - EXAMPLE 2

```python
import time

def measure_time(func):
    def wrapper(*args, **kwargs):
        start_time = time.time()
        result = func(*args, **kwargs)
        end_time = time.time()
        print(f"Execution time of {func.__name__}: {end_time - start_time:0.2e} seconds")
        return result
    return wrapper

# Decorate
@measure_time
def example_function(n):
   sum = 0
    for i in range(1, n+1):
        sum += i
    return sum

if __name__ == '__main__':
    result = example_function(1000000)
    print(result)
```

USE CASES OF DECORATORS

- Logging
  - Track function calls and their results for debugging purposes
- Authentication and Authorisation
  - Control access to functions based on user permissions
- Caching
  - Store function results to avoid redundant calculations
- Error Handling
  - Handle exceptions gracefully and provide informative error messages
- Performance Measurement
  - Time how long functions take to execute for optimization

EXERCISE

- Count calls decorator:
  - Create a decorator named count_calls that keeps track of how many times a a factorial function is called and prints the count before each call
- Retry_decorator:
  - Create a decorator named retry_on_wrong_answer that allows a student to retake a simple quiz function (simulated with multiple-choice questions) a certain number of times before failing. The decorator should display the current question, available choices, and track the student's answer and number of attempts
- Rate Limiting Decorator:
  - Implement a rate-limiting decorator rate_limit that restricts the number of times a function can be called within a certain time period