

Lecture III - Building Reusable Functions

Programming with Python

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Quick Recap of the last Lecture

Slicing

- With slicing we can get a range of elements from a sequence
- Syntax: `sequence[start:stop:step]`
- `start` is the index of the first element to include
- `stop` is the index of the first element to exclude
- `step` is the increment between indices

...

💡 Tip

If left out, the step defaults to 1. Else, start defaults to 0 and stop defaults to the length of the sequence. Negative indices can be used to slice from the end of the sequence.

Comparison Operators

- Comparison operators are used to compare two values
- The result of a comparison is a boolean value (`True` or `False`)
- Operators include: `==`, `!=`, `>`, `<`, `>=`, `<=`

...

> Question: Is this `True`?

```
# Careful here!
one = 1
two = 1
print(one == two)
```

True

Control Structures

- Control structures allow us to control the flow of execution
- It includes conditional statements and loops

- Conditional statements: `if`, `elif`, `else`
- Loops: `for` and `while`
- Control flow statements (in loops): `continue` and `break`

...

Note

The statement `continue` skips the rest of the current iteration and moves to the next one in a loop while the `break` statement exits the loop entirely.

Functions in Detail

What is a Function?

- Functions can accept inputs (parameters) and return outputs
- Encapsulate logic, making code easier to maintain
- Functions can be called multiple times from different part
- They help reduce code duplication and improve readability

```
# I'm a function.
type(print)
```

```
builtin_function_or_method
```

...

Important

Remember, methods are functions that are called on an object.

Some Built-in Functions already used

- `print()`: Print text to console
- `input()`: Read text from console
- `len()`: Get the length of a sequence
- `range()`: Generate a sequence of numbers
- `round()`: Round a number to a specified number of decimal places
- `type()`: Get the type of an object
- `int()`: Convert a string to an integer
- `float()`: Convert a string to a floating-point number
- `str()`: Convert an object to a string

Defining a Function

- Use the `def` keyword followed by the function name
- Inside parentheses we list the inputs (parameters)
- The code block within every function starts with a colon (:)

- It is indented, just as the loops from the last lecture

...

```
def greet(a_parameter):
    print(f"Hello, {a_parameter}!")
greet("Students")
```

Hello, Students!

...

💡 Tip

It is common practice to leave out one line after the definition of a function, although we will not always do that in the lecture to save space on the slides.

Comment Functions

- It is good practice to include a comment at the top of your functions
- If you do it with three `"""`, it will appear in the help menu

...

```
def greet():
    """
    This function will be used later and has currently
    absolutely no use for anything.
    """
    pass # Necessary placeholder to avoid error

help(greet)
```

Help on function greet in module __main__:

```
greet()
    This function will be used later and has currently
    absolutely no use for anything.
```

Naming Functions (and Methods)

- Function names should be short, but descriptive
- Use underscores (`_`) instead of spaces in the names
- Avoid using Python keywords as function names (e.g., `print`)
- Try to avoid using built-in functions and methods that have a similar name (e.g., `sum` and `len`)

> Question: Which of the following is a good name for a function?

- `myfunctionthatmultipliesvalues`

- `multiply_two_values`
- `multiplyTwoValues`

Function Parameters

- Parameters are variables that the function accepts
- They allow you to pass data to the function
- Try to name them as variables: short and meaningful
- We can also leave them out or define several inputs!

```
def greet():
    print("Hello, stranger!")
greet()
```

Hello, stranger!

Function Arguments

- Arguments are the actual values passed to the function
- They replace the parameters in the function definition

...

> Question: What could be the correct arguments here?

```
def greet(university_name, lecture):
    print(f"Hello, students at the {university_name}!")
    print(f"You are in lecture {lecture}!")

# Your code here
```

Initializing Parameters

- We can also initialize parameters to a default value!
- To do this we use the `=` sign and provide it with a value
- This is called a keyword argument

```
def greet(lecture="Programming with Python"):
    print(f"You are in lecture '{lecture}'!")

greet()
greet("Super Advanced Programming with Python")
```

You are in lecture 'Programming with Python'!
 You are in lecture 'Super Advanced Programming with Python'!

...



Tip

This is especially useful when we want to avoid errors due to missing arguments!

Multiple Parameters

- We can also have multiple parameters in a function definition
- They are called positional arguments and are separated by commas
- When we call them, they must be provided in the same order
- Alternatively, we could call them by name, as for example in this function call

```
print("h", "i", sep='')
```

...

> Question: What will be printed here?

```
def call_parameters(parameter_a, parameter_b):  
    print(parameter_a, parameter_b)  
  
call_parameters(parameter_b="Hello", parameter_a="World")
```

World Hello

Function Return Values

- Functions can return values using the `return` statement
- The return statement ends the function
- It then returns the specified value

...

```
def simple_multiplication(a,b):  
    result = a*b  
    return result  
print(simple_multiplication(2,21))
```

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...

```
def simple_multiplication(a,b):  
    return a*b # even shorter!  
print(simple_multiplication(2,21))
```

42

Access return values

- We can also save the return value from a function in a variable

- That way we can use it later on in the program

...

```
def simple_multiplication(a,b):  
    return a*b # even shorter!  
  
result = simple_multiplication(2,21)  
print(result)
```

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Returning None

- If we don't specify `return`, functions will return `None`

```
def simple_multiplication(a,b):  
    result = a*b  
  
print(simple_multiplication(2,21))
```

None

...

> Task: Come up with a function that checks whether a number is positive or negative. It returns "positive" for positive numbers and "negative" for negative numbers. If the number is zero, it returns `None`.

...

Tip

You can also use multiple return statements in a function.

Recursion

- Recursion is a technique where a function calls itself
- Helps to break down problems into smaller problems

...

```
def fibonacci(n): # Classical example to introduce recursion  
    if n <= 1:  
        return n  
    else:  
        return fibonacci(n-1) + fibonacci(n-2)  
  
print(fibonacci(6))
```

...

i Note

Recursion can be a powerful tool, but it can also be quite tricky to get right.

Scope

Function Scope

- Variables defined inside a function are local to that function
- They cannot be accessed outside the function

...

```
def greet(name):
    greeting = f"Hello, {name}!"

print(greeting) # This will cause an error
```

...

> Question: Any idea how to access `greeting`?

Global Scope

- Variables defined outside all functions are in the global scope
- They can be accessed from anywhere in the program

...

```
greeting = "Hello, Stranger!"
def greet(name):
    greeting = f"Hello, {name}!"
    return greeting
print(greet("Students")) # Greet students
print(greeting) # Greet ????
```

```
Hello, Students!
Hello, Stranger!
```

...

! Important

We don't change global variables inside a function! The original value can still be accessed from outside the function.

Global Keyword

- Still, we can change the value of `greeting` from inside a function!
- By using the `global` keyword to modify a global variable

...

```
greeting = "Hello, Stranger!"

def greet(name):
    global greeting
    greeting = f"Hello, {name}!"
    return greeting

print(greet("Students")) # Greet students
print(greeting) # Greet students again
```

```
Hello, Students!
Hello, Students!
```

...

>Question: This can be confusing. Do you think you got the idea?

Classes

Classes

- Classes are blueprints for creating objects
- They encapsulate data (attributes) and behavior (methods)
- Objects are instances of classes
- Methods are functions that are defined within a class

...

```
class Students: # Class definition
    def know_answer(self): # Method definition
        print(f"They know the answer to all questions.")

student = Students() # Object instantiation
student.know_answer()
```

```
They know the answer to all questions.
```

Self

- Classes can be quite tricky at first, especially the `self` keyword
- When we call `self` in a method, it refers to the object itself
- It is used to access the attributes and methods of the class
- `self` always needs to be included in method definitions

...


```
# This won't work as self is missing
class Students: # Class definition
    def know_answer(): # Method definition without self
        print(f"They know the answer to all questions.")

student = Students()
student.know_answer()
```

...

>Task: Try it yourself, what is the error?

Naming Classes

- Classes can be named anything, but it is common to use the plural form of their name (e.g., `People`)
- CamelCase is used for class names, and snake_case is used for method and attribute names (e.g., `TallPeople`)
- Classes are usually defined in a file with the same name as their class, but with a `.py` extension

...

Question: Which of the following is a good class name? `smart_student`, `SmartStudent`, or `SmartStudents`

Class Attributes

- Class attributes are attributes that are shared by all class instances
- They are defined within the class but outside any methods

...

>Question: What do you think will happen here?

```
class Students: # Class definition
    smart = True # Class attribute

student_A = Students() # Object instantiation student_A
student_B = Students() # Object instantiation student_B

print(student_A.smart)
print(student_B.smart)
```

```
True
True
```

Instance Attributes

- Instance attributes are attributes unique to each class instance
- They are defined within the `__init__` method

```
class Student: # Class definition
    def __init__(self, name, is_smart): # Method for initialization
        self.name = name
        self.smart = is_smart
    def knows_answer(self): # Method to be called
        if self.smart:
            print(f"{self.name} knows the answer to the question.")
        else:
            print(f"{self.name} does not know the answer to the question.")

student = Student("Buddy", False) # Note, we don't need to call self here!
student.knows_answer()
```

Buddy does not know the answer to the question.

Inheritance

- Inheritance allows a class to inherit attributes and methods
- The class that inherits is called the subclass
- The class that is being inherited from is called the superclass

...

Tip

Don't worry! It can be quite much right now. Hang in there and soon it will get easier again!

Inheritance in Action

```
class Student: # Superclass
    def __init__(self, name):
        self.name = name
    def when_asked(self):
        pass

class SmartStudent(Student): # Subclass
    def when_asked(self):
        return f"{self.name} knows the answer!"

class LazyStudent(Student): # Subclass
    def when_asked(self):
        return f"{self.name} has to ask ChatGPT!"
```

>Task: Create two students. One is smart and the other one is lazy. Make sure that both students reaction to a question is printed.

Encapsulation

- Encapsulation is the concept of bundling data (attributes) and methods (behavior) that operate on the data into a single unit (class)

- It is a key aspect of object oriented programming (OOP)
- It helps in organizing code and controlling access

...

Note

Fortunately, this is an introduction to Python, so we won't go into details of encapsulation.

The End

- Interested in more detail about classes and OOP?
- Check out access modifiers, getters and setters
- They are definitely a bit more complicated for beginners...
- Though they are worth learning if you build complex programs

...

Note

And that's it for today's lecture!
We now have covered the basics of functions and classes. We will continue with some slightly easier topics in the next lectures.

Literature {.title}

Interesting Book to dive deeper

- Thomas, D., & Hunt, A. (2019). The pragmatic programmer, 20th anniversary edition: Journey to mastery (Second edition). Addison-Wesley.

...

Tip

A fantastic textbook to understand the principles of modern software development and how to create effective software. Also available as a really good audiobook!

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For more interesting literature to learn more about Python, take a look at the [literature list](#) of this course.