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



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

i 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

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

Hello, Students!

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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

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```
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

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> 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='')

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> 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

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

42
...
def simple_multiplication(a,b):
    return a*b # even shorter!
print(simple_multiplication(2,21))
```

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

. . .

42

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

result = simple_multiplication(2,21)
print(result)
```

42

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

. . .

> Grouptask: 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.

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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

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

8

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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

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```
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

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```
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

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```
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

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```
# 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

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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

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>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 initalization
        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

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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!"
```

>Grouptask: 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

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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 todays lecture!

We now have covered the basics of funtions 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.

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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.