



Instructor:

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Guide Lines/Instructions:

- Use of Spyder IDE/Anaconda in this lab.
- Create meaningful variable names. Add comments for readability. Indent each line of your code.
- Plagiarism/Cheating is highly discouraged by penalizing to both who tried and one who shared his/her code.

Today's Task:

- Python Environment Setup using Spyder IDE
- Get comfortable with the Python Syntax Specifically Arrays
- Learn to write recursive tasks

Installation Guideline:

- Go to the website [Home --- Spyder IDE](#) and click the download button at the bottom or download from the direct link [Spyder Install](#) (221 MB).
- Run the setup file according to Figure 1. Complete the installation with the emerging instructions.

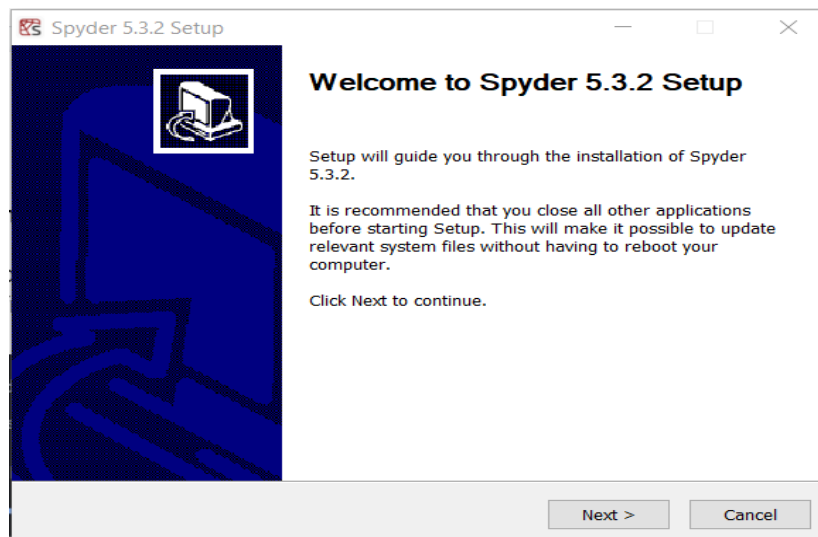


Figure 1 Spyder Installation Interface

- Launch the Spyder from the installation directory.
- You will see the interface according to Figure 2.
- Write your first program in python

```
print ("Hello to Data Structure and Algorithms Course")
```

- Note that python does not require the program template as required in C++ and C#.

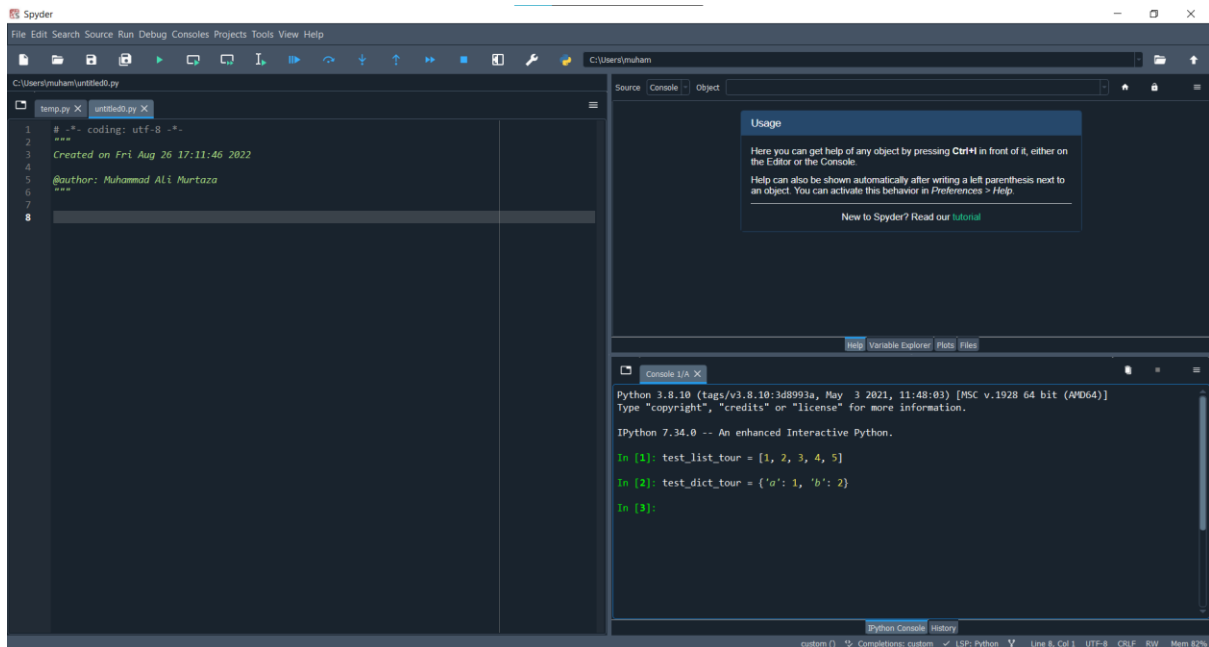


Figure 2 Spyder IDE Home Screen

Part1: Getting Comfortable with Python

Activity 1:

Run the above code using command prompt. Write below the process of running program from cmd (commands).

Activity 2:

Describe the process of code compilation and execution in python. How the byte code will be generated? How the process is different from C#. Write in your own words.

Python is basically a interpreter so it first compile line then execute it then move forward. But in C# whole program compiled first then execute if there are errors in different locaion it will tell us at the end and also tell us their location but in Python it will tell line by line.

Here are some examples that will provide you the roadmap of Conversion from C# to Python.

Example 1.1: Write a Program to display value

C#	Python
<pre>using System; public class ConsoleApp1 { public static void Main() { // declare variable with int datatype int a = 5; // prints the string System.Console.WriteLine("The value of a is: " + a); } }</pre>	<pre># No compulsory library is required for simple programs a = 5 # no terminator restriction print("The value of a is: ", a)</pre>

Example 1.2: Input value from User

<pre>a = input ("Enter the value:") #a is string #conversion of string to int data type b = int(a) print ("Entered value is:" + str(b)) #We need to convert int type variable to string. Because in python concatenation of int and string type variables is not possible without conversion.</pre>
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Example 1.3: Array Declaration of 1D and 2D arrays

<pre>#1D array declaration array = [] #Also initialize at the time of declaration array = [1,2,6,10,4] #2D array arr = [[1,3,2], [1,5,6]]</pre>
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Activity 3:

We do not specify the data type of variable in python. How python will infer the data type. How will you verify the data type of variable in python. Give convincing justification.

<p>Python is basically dynamically-typed language which means python check objects at run time. Python check data types at run time on the bases of their behavior and methods rather than fixed declaration. Well if the data type is string it will be in double quotes, if character it will in single quotes, if int it will without quotes and it will a whole number and if Float it will contains decimal point. That's how we specify data types.</p> <ol style="list-style-type: none">1. "6666" ---> this is a string2. '6' ---> this is a char3. 6666 ---> this is a int4. 66.66 ---> this is a float

Example 1.4: Array of Zeros

```
array = 0 * 10 #array of length 10 having all zeros

#2D array having all zeros
array1 = [[0 for x in range(4)] for y in range(3)]

#we can perform the same task more easily using numpy library
TODO—add numpy code for zeros
```

Example 1.5: 1D array of Random ints

```
import random
array = []
min = 0
max = 20
n = 5
for i in range (0, n):
    num = random. randint (min, max)
    array. append (num)

#Process the same using numpy
--to-do add numpy code
```

Example 1.6: Traversal of an array

<pre>#Traverse in forward direction using for loop str = ["U", "E", "T"] for x in range(len(str)): print(str[x]) array = [32, 1, 9, 31, 12, 22] # Reverse by using a slice # slice (start, end, step) print(array[::-1])</pre>	<pre>#Traverse in backward direction using reverse method array.reverse() print(array) #Traverse through an array using for loop for i in range(len(array)-1, -1, -1): print(array[i])</pre>
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Example 1.7: Slicing of Arrays—Extracting subarrays

Slicing in Python is a feature that enables accessing parts of sequences like strings, tuples, and lists. Here are some examples on arrays that would explain slicing.

Starting subarray	Middle subarray	Ending subarray
<pre>>>> arr = [1,2,3,4,5] >>> arr [:2] [1, 2]</pre>	<pre>>>> arr = [1,2,3,4,5] >>> arr [1:3] [2, 3]</pre>	<pre>>>> arr = [1,2,3,4,5] >>> arr [2:] [3, 4, 5]</pre>
<p>Important In python, subarrays can also be extracted through negative indices.</p> <pre>>>> arr = [1,2,3,4,5] >>> arr [-2:] [4, 5]</pre> <p>Here -1 means the first element from last. -2 means second element from last.</p>		

Example 1.8: Read data from File

Let say we have single file for this code testing named **test.txt** and we have single line written in it as:

```
given_file = open (file = 'test.txt', mode = 'r')
lines = given_file. read ()
```

```
numbers = []
arr = lines.split()
for s in arr:
    num = int(s)
    numbers.append(num)
```

```
print(numbers)
```

test.txt

1
2
3
4
5

Note:

Example modes for opening file in python are:

w → Write mode

r → Read Mode

a → Append Mode

x → Open for exclusive creation, failing if the file already exists

Example 1.9: Write data to File

```
#Write array elements one per line to file

arr = ['Hello world', 'UET']
f = open (file="test.txt", mode="w")
for i in arr:
    f.write (i + "\n")
```

Output:

Hello World
UET

Example 1.10: Play with functions

Pass an array to function	Return array from function
<pre>def display(arr): for i in arr: print(i) array = [1, 2, 3, 4, 5, 6, 7, 8, 9] display(array)</pre>	<pre>def get_name (): names = ['Ali', 'Ahmad', 'Hassan'] return names names= get_name ()</pre>

Activity 4:

What are mutable and immutable data types in python. Give at least three examples for each.

Mutable data types are those whose values can be modify, update or delete after creation....

Eg :- Array,Lists,Dictionares

Immutable data types are those whose values can not be modify, update or delete after creation....

Eg :- Tuples, DataTypes

Part 2: Think Recursively

Example 2.1: Calculate sum of integers

Iterative	Recursive
<pre>sum = 0 for i in range (11): sum += i print(sum)</pre>	<pre>def sum(n): if n == 0: return n else: return n + sum(n-1) print (sum (10))</pre>

Example 2.2: Print array of elements

Iterative	Recursive
<pre>arr = [1,2,3,4,5,6,7,8,9,10] for i in arr: print(i)</pre>	<pre>def printArray (arr, start, end): if start == end: print(arr[start]) else: print(arr[start]) printArray (arr, start+1, end) arr = [1,2,3,4,5,6,7,8,9,10] printArray (arr, 0, len(arr)-1)</pre>

Example 2.3: Calculating power function through recursion.

Iterative	Recursive
<pre>num = 2 power = 5 result = 1 for i in range(power): result = result * num print(result)</pre>	<pre>def power (n, k): if k == 1: return n else: return n * power (n, k-1)</pre>

Example 2.4: Factorial of Number using recursion

<pre>def recur_factorial(num): if num < 0: return -1 elif num == 0 num == 1: return 1 else: return n*recur_factorial(n-1) num = int(input("Enter a number: ")) print("The factorial of",num,"is",recur_factorial(num))</pre>
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Activity 5:

What is recursion? Give some prose and cons of recursion.

Recursion means calling oneself again and again until specific task is completed or not it really helpful when you don't have to apply loops.

Prose: 1. it uses less number of code lines and so the code looks shorter and cleaner

2.increases code readability

Cons: 1.sometimes it cause stack overflow
2. Time and Space complexity is increased.

Activity 6:

How recursive function is evaluated in memory. Give some details

Recursive function evaluation in memory involves the use of a call stack. When a function is called recursively, a new stack frame is created to store local variables and the return address. Each recursive call adds a new frame on top of the previous ones. The base case determines when recursion stops. When the base case is reached, the stack frames are unwound, with return values propagated back up the stack. This process continues until the initial function call completes, allowing the program to continue or exit.

Note:

1. Whenever you are asked to read array, your are required to load array from the file, reading each element per line.
2. Do not take input from console for array.

Problems

<p>1. Look for the index of the given element x in the given array: X = [22,2,1,7,11,13,5,2,9]</p> <p>SearchA(Arr, x) – return array of indices</p> <p>Arr: Array x: element to be searched</p>	<p>Input: Enter the number: 2 Output: Index: 1,7</p>
<p>2. Answer question 1 in the scenario where the input array is already sorted. How much elements you need to check in sorted array.</p> <p>SearchB(Arr, x)-- return array of indices</p> <p>Arr: Array x: element to be searched</p>	<p>Input: Enter the number: 2 Output: Index: 1,7</p>
<p>3. Write a function that takes an array as input, starting and ending index and return the index of minimum element from start to ending index in the array.</p> <p>Minimum(Arr, starting, ending)– return integer</p>	<p>For example, you are given the following inputs Array: [3,4,7,8,0,1,23,-2,-5] StartingIndex: 4 EndingIndex: 7</p> <p>Output: (Return index of minimum element) 7</p>
<p>4. Sort an array X using the above generated function.</p> <p>Hint: Find the smallest element from the unsorted part of the array repeatedly and place it at the start of the array.</p> <p>Sort4(Arr)–return array Arr: Array to be sorted</p>	<p>Output: X = [-5, -4, -3, 0, 1, 1, 4, 35, 100, 101]</p>
<p>5. Extract the relevant portion and print it in the reverse direction from the string s = "University of Engineering and Technology Lahore". Without using any loop and reverse () method.</p> <p>StringReverse(str, starting, ending)–returns string</p>	<p>Output: "ygolonhceT dn"</p>

<p>6. Given a number, the task is to find the sum of its digits using an iterative and recursive method.</p> <p>SumIterative(number) - returns integer</p> <p>SumRecursive(number)-- returns integer</p>	<p>Input: 1524</p> <p>Output: Sum of digits is: 12</p>
<p>7. Find the sum of the given matrix both column- and row-wise.</p> $A = \begin{bmatrix} 1 & 13 & 13 \\ 5 & 11 & 6 \\ 4 & 4 & 9 \end{bmatrix}$ <p>ColumnWiseSum(Mat) - returns 1d array</p> <p>RowWiseSum(Mat) - returns 1d array</p>	<p>Output: Row-wise: 27 22 17</p> <p>Column-wise: 10 28 28</p>
<p>8. Without using any sorting methods, combine two sorted arrays keeping the resultant array sorted in ascending order.</p> <p>A = [0,3,4,10,11]</p> <p>B = [1,8,13,24]</p> <p>SortedMerge(Arr1, Arr2) - returns sorted array</p>	<p>Output: [0,1,3,4,8,10,11,13,24]</p>
<p>9. Write a recursive function that takes a string and returns if the string is palindrome or not.</p> <p>PalindromRecursive(str)- returns a boolean</p>	<p>Input: "radar"</p> <p>Output: Palindrome</p>
<p>10. Sort the given array so that the elements are arranged in the following way while taking ascending order into consideration</p> <p>Sort10(Arr)-returns array</p>	<p>Input: [10, -1, 9, 20, -3, -8, 22, 9, 7]</p> <p>Output: [-8, 7, -3, 9, -1, 9, 10, 20, 22]</p>

What to Submit:

1. Only .py files are allowed.
2. For Lab1, you are required to write all functions in single file, funcs.py
3. For each problem, create a driver .py file
 - a. Lab1.py
4. Functions names input and output should be exactly same.
5. Zip all files, and submit on eduko