

Mastering Python 3 Programming

*Ultimate guide to learn Python coding
fundamentals and real-world applications*

Subburaj Ramasamy



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Dedicated to

*My better half **Chandra** and my sons **Prabhu and Kumar***

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Preface

Mastering Python 3 Programming is a must for every literate. Irrespective of whether you are a seasoned programmer looking to expand your skill set or an absolute beginner taking baby steps into the world of programming, this book is designed to be your companion and comprehensive guidebook to mastering Python.

Python has emerged as one of the most sought-after programming languages due to its agility. Its simplicity, readability, and versatility make it a preferred language for a wide range of applications, from web development and data analysis to artificial intelligence and machine learning.

In this book, we have described everything you need to know to become proficient in Python 3. We will start with the fundamentals, including basic syntax, data types, and control structures, before moving on to more advanced topics such as built-in containers like lists and dictionaries, object-oriented programming, functional programming, and advanced file and exception handling.

Throughout the book, you will find bountiful hands-on examples and exercises to help reinforce your learning. Whether you prefer to follow along with the code examples or dive in and start coding on your own, you will have abundant opportunities to practice and experiment with Python.

One of the fascinating things about Python is its thriving ecosystem of batteries included - libraries and frameworks. In the later chapters, we will explore some of the most popular Python libraries for tasks such as data structures and data visualization, giving you the tools you need to start building your own projects right away.

Whether your goal is to grab a job as a Python developer, advance in your current career, or simply explore the exciting world of programming, this book will provide you with the knowledge and skills you need to succeed. So, without further ado, let us dive in and start exploring the wonderful world of Python 3 programming!

The contents of the book are given chapter-wise below:

Chapter 1: Introduction to Python 3 - Discusses the motivation to learn Python and how to install the Python development environment. We will be discussing programming in the interactive mode and script mode and give examples of both using the above. We will be using IDLE, throughout the book owing to its merits. We will learn

that the Python frozen binaries bundle together the byte code of our program files, along with the Python Virtual Machine interpreter and any Python support files our program needs, into a single package, a single binary executable program like .exe file on Windows. By the end of the chapter, students would have experimented with the interactive mode as well as create frozen binaries in the script mode.

Chapter 2: Algorithmic Problem Solving - In this chapter, the student will learn to design computer based solutions to problems using algorithms and flow charts. At the end of the chapter, we describe some of the popular algorithms in Python. This chapter aims to prepare freshers for programming with algorithmic thinking. Furthermore, the algorithms discussed here are used in the rest of the book.

Chapter 3: Numeric Computations and Console Input - An overview of the major tokens of the Python language, such as identifiers, keywords, constants or literals, and operators, is given in this chapter. We will also discuss expressions, operator precedence, and type conversion. In this chapter, we also introduce console input using input and eval functions. We will discuss operations on the bits using bitwise operators.

Chapter 4: Unicode, Strings and Console Output - In this chapter, we will discuss character coding, strings, and slicing. String methods and methods to modify strings will also be discussed. Then, the chapter teaches converting ASCII characters to numbers and vice versa using ord () and chr () functions. We will then move on to discuss console output. Several methods of formatted printing are also discussed in the chapter. Then we discuss the bytes () function, which returns an immutable bytes object. It can convert strings into bytes objects.

Chapter 5: Selection and Loops - In this chapter, we will discuss relational operators and logical operators. Then we will describe the selection constructs of if, elif, and else and give programs to illustrate their use. Next, we will give examples of nested selection constructs and the use of a ternary operator. Then we will move on to discuss iterations using *while* and then *for* and give examples. We will demonstrate the use of break and continue keywords in programs.

Chapter 6: Functions and Recursion - In this chapter, after discussing the features and benefits of structured programming, we will give examples of calling a function multiple times and calling more than one function in a program. We will also discuss void functions. Then we discuss fruitful functions, return values, runtime stack, and Boolean functions. Then, we will discuss the local and global scope of function parameters. This is followed by positional arguments and default arguments.

Chapter 7: Lists - In this chapter, we carry out an in-depth analysis of the Python container list. Then we will discuss list concatenation, slicing, and nesting. Then we will highlight the

differences between functions and methods in Python and give examples of methods and functions using lists. List comprehension, aliasing list, and cloning lists are also discussed. This chapter also includes several case studies.

Chapter 8: Tuples, Sets, and Dictionaries - In this chapter, we will discuss 3 more containers – tuples, sets, and dictionaries. We will discuss the methods and functions used with all three containers. We will carry out mathematical operations using sets and set comprehension. The chapter gives some examples of dictionaries and iterations over dictionaries, dictionary comprehension, and nested dictionaries.

Chapter 9: Introduction to Object-Oriented Programming - In this chapter, we give an overview of the characteristics of **Object-Oriented Programming (OOP)**. Class as a blueprint for objects, access control, initializer, and destruction of objects are discussed in this chapter. After carrying out operations on objects, the distinction between class variables and instance variables is brought out. The overloading functions supported in Python are illustrated with examples addressing overloading binary operators - minus operator and the equality operator. At the end of the chapter, we discuss documentation strings.

Chapter 10: Inheritance and Polymorphism - In this chapter, we discuss single inheritance, multi-level inheritance, and multiple inheritance. We will give a comparison between containership and inheritance, and implement various types of inheritances. Then we will discuss the *object* class and diamond problem. It is followed by method overriding, polymorphism, and abstract class. This chapter ends with a discussion on iterators, iterable and generators.

Chapter 11: File Handling - This is a comprehensive and important chapter in the book in the context of Machine Learning and big data analytics. We will discuss reading from and writing to text and binary files. Implicit reading is an important addition. It has an interesting case study on counting the occurrence of each word and each alphabet in a text file. **Java Script Object Notation (JSON)** and the pickle solution are interesting and useful in many applications. The CSV Files and Command line arguments are also illustrated in this chapter.

Chapter 12: Exception Handling - We begin the chapter with a listing of exception classes provided by the Python standard library. The chapter describes all the five keywords provided by Python for exception handling. The chapter has two case studies, building an exception class and knowingw the cause of the error in the custom exception class

Chapter 13: Gems of Python - This is one of the power-packed chapters in the book, addressing various special features of Python 3 such as lambda functions, modules, date

and time, functional programming, first class functions, decorator function, namespaces and packages.

Chapter 14: Data Structures and Algorithms using Python - This chapter gives several case studies after explaining stack, queue, and exception handling. The chapter briefly explains algorithm analysis - space complexity, time complexity, and Big Oh notation. We discuss four popular sorting algorithms in this chapter, such as bubble sort, selection sort, insertion sort and merge sort.

Chapter 15: Data Visualization - In this chapter, we will use Python libraries - pandas, Matplotlib and Seaborn to plot various graphs, charts and diagrams using two datasets publicly available on the Internet. The reader will be given URLs to download the data and steps to install libraries.

Chapter 16 : Python Applications and Libraries - In this chapter, we give an overview of applications of Python, including libraries used therein as a ready reckoner to help students to select their future areas of learning. This chapter covers areas such as web development, data science and machine learning, **Natural Language Processing (NLP)**, GUI applications, game development, scripting and automation, web scraping, database applications, **Internet of Things (IoT)** and education.

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Table of Contents

1. Introduction to Python 3	1
Introduction	1
Structure	2
Objectives	2
History of Python.....	3
Major users.....	3
Features of Python 3	4
Applications of Python 3.....	4
Advantages of Python 3	5
Interpreters and compilers.....	7
Python Virtual Machine	7
Interpretation process	8
Versions of Python	9
Python implementations.....	9
Installing Python	9
Interactive mode.....	10
Integrated Development Environment.....	13
<i>What is an Integrated Development Environment?</i>	<i>13</i>
Python's Integrated DeveLopment Environment.....	13
<i>Script mode programming.....</i>	<i>15</i>
<i>Colour coding by IDLE</i>	<i>16</i>
Execution of Python programs.....	16
Dynamically typed vs. statically typed language	17
Memory administration in Python.....	18
Python calculator	18
<i>Addition.....</i>	<i>19</i>
<i>Subtraction</i>	<i>19</i>
<i>Multiplication</i>	<i>20</i>

<i>Division</i>	20
<i>Float division</i>	20
<i>Integer division</i>	21
<i>Modulus</i>	21
<i>Exponentiation</i>	22
Special characters	22
Batteries included philosophy	22
Mathematical functions in Python	23
<i>Sample program with built-in mathematical functions</i>	24
Other built-in functions.....	25
Frozen binaries executables	26
Types of errors in programs.....	26
<i>Syntax errors</i>	26
<i>Semantic errors</i>	27
Conclusion	28
Points to remember	28
Questions.....	29
2. Algorithmic Problem Solving.....	33
Introduction	33
Structure	33
Objectives	34
Computer program development.....	34
Steps in computation	35
<i>Defining the problem</i>	35
<i>Designing a solution to the problem</i>	36
Algorithm.....	36
<i>Flowchart</i>	36
<i>Graphical symbols used in flowcharts</i>	37
<i>Simple sequence</i>	38
<i>Selection pattern</i>	38
<i>Repetition pattern</i>	38

<i>Pseudocode</i>	39
<i>Flowchart versus pseudocode</i>	41
<i>Flowchart</i>	41
<i>Pseudocode</i>	41
Testing algorithm	41
Simple rules governing algorithms	41
Good programming practices	42
Divide and conquer	42
Program design	42
Top-down and bottom-up design.....	42
Data organization and data structures.....	43
Construction of loops	43
Writing programs.....	44
<i>Modular design</i>	44
<i>Choice of variable names</i>	44
<i>Documentation of programs</i>	45
<i>Program testing</i>	45
Sample algorithms	45
<i>Exchanging values of two variables</i>	46
<i>Decimal base to binary base conversion</i>	47
<i>Reversing digits of a natural number</i>	48
<i>Greatest Common Divisor</i>	48
<i>Prime numbers</i>	49
<i>Factorial of a given number</i>	49
<i>Finding the maximum and minimum numbers in a list</i>	50
<i>Inserting a card in a list of sorted cards</i>	51
<i>Guess an integer number in the given range</i>	51
<i>Recursion</i>	52
<i>Generation of the Fibonacci sequence</i>	53
<i>Towers of Hanoi</i>	54
Conclusion	56

Points to remember	56
Questions.....	57
3. Numeric Computations and Console Input.....	61
Introduction	61
Structure	61
Objectives	62
Tokens	62
Identifiers	63
Keywords	63
Literals	64
Python literal types.....	65
Numeric data types	65
Integer operations	66
Real number operations	67
Scientific notation.....	67
Complex numbers.....	68
Type Boolean.....	69
Expressions and operator precedence.....	70
Augmented assignment operators	72
Type conversion	74
Console input	75
<i>eval()</i>	79
Random numbers.....	79
Bitwise operators.....	80
OR operation – $a \mid b$	81
AND operation $a \& b$	81
Complement $\sim a$	81
The left shift $a \ll 4$	82
Right shift $a \gg 2$	82
Exclusive OR of $a \wedge b$	82
Conclusion	83

Points to remember	83
Questions.....	85
4. Unicode, Strings and Console Output	89
Introduction	89
Structure	89
Objectives	90
Character set	90
<i>ASCII code</i>	90
<i>Unicode</i>	91
String.....	93
<i>String concatenation</i>	94
Finding types	94
<i>The str class</i>	95
The str type	96
Multi-line strings.....	97
<i>Method 1: Using triple quotes</i>	97
<i>Method 2: Enclosing the string within parentheses</i>	97
<i>Method 3: Using an escape character \</i>	98
Escaping quotes within strings	98
Escape sequences	98
The index in a string	99
Substring: Slicing.....	100
<i>Reversing a string</i>	101
Immutable strings	102
Repetition	102
String methods	102
Methods for modifying strings	104
Replace substrings with <code>replace()</code>	105
<code>ord()</code> and <code>chr()</code> functions	105
Reversing a string	106
Console input of a string.....	106

Console output	107
Formatted printing.....	109
<i>Using built-in format method</i>	<i>109</i>
<i>Floating point numbers.....</i>	<i>109</i>
<i>Formatting in scientific notation</i>	<i>111</i>
<i>Formatting as a percentage.....</i>	<i>111</i>
<i>Justification while printing.....</i>	<i>111</i>
<i>Formatting integers</i>	<i>112</i>
<i>Formatting strings.....</i>	<i>112</i>
Use of %s as a place holder	113
<i>Using str.format method</i>	<i>113</i>
<i>Passing variables to the placeholder.....</i>	<i>113</i>
<i>Passing values to the placeholders</i>	<i>114</i>
<i>Positional arguments</i>	<i>114</i>
<i>Using Python string module and Template class.....</i>	<i>115</i>
<i>Using fstring</i>	<i>116</i>
<i>Checking whether a string is a palindrome or anagram.....</i>	<i>116</i>
String module constants.....	117
Sequence types	118
Converting string to bytes	118
<i>Method 1: Using bytes(str, enc)</i>	<i>119</i>
<i>Method 2: Using encode</i>	<i>119</i>
Conclusion	120
Points to remember.....	121
Questions.....	123
5. Selection and Loops.....	127
Introduction	127
Structure	127
Objectives	128
Structuring programs	128

Relational operators.....	129
Logical operators.....	130
<i>and operator</i>	130
<i>or operator</i>	131
<i>not operator</i>	132
Selection constructs.....	132
<i>Finding whether a number is positive</i>	133
<i>Swap case</i>	134
<i>Finding the largest of three numbers</i>	135
Nested selection constructs	136
Ternary operator.....	137
Iterations.....	139
<i>While loop</i>	139
<i>Testing whether a number is prime using while loop.</i>	140
<i>The range function</i>	141
<i>For loop</i>	141
<i>Variations in range function</i>	143
<i>The for loop using list</i>	143
<i>Finding maximum and minimum numbers in a list</i>	143
Generation of mathematical tables.....	144
Keywords break and continue	145
<i>Keywords learnt in this chapter</i>	147
Conclusion	148
Points to remember.....	148
Questions.....	150
6. Functions and Recursion.....	155
Introduction	155
Structure	155
Objectives	156
Features of structured programming.....	156
Benefits of structured programming.....	157

Built-in functions.....	158
User-defined functions.....	158
General form of function.....	158
<i>Function definition</i>	159
<i>Function header</i>	159
<i>Function body</i>	159
<i>Function call</i>	159
<i>Sum of two numbers</i>	160
<i>Calling functions multiple times</i>	162
<i>Calling more functions in a program</i>	164
<i>Reverse function</i>	164
<i>addDigits function:</i>	165
<i>The void function</i>	167
Illustrative programs.....	167
<i>Exchange the value of two variables</i>	167
<i>Distance between two points</i>	168
<i>Finding square root of a positive number</i>	169
<i>Finding square root without using math function</i>	169
Fruitful functions	170
Return values.....	171
Another fruitful function	172
Runtime stack	173
Boolean functions.....	174
Divisibility of a number	174
Local and global scope of function parameters	175
More function concepts.....	177
<i>Positional arguments</i>	177
<i>Default arguments</i>	178
<i>Variable length arguments</i>	179
<i>*args and *kwargs</i>	179
<i>Python *args</i>	179

<i>Python **kwargs</i>	180
Recursion.....	181
<i>Euclid GCD recursive program</i>	182
<i>Recursive factorial program</i>	183
<i>Tail recursion</i>	184
<i>Calculating the exponential value in Python</i>	184
Case study: Towers of Hanoi	187
Conclusion	188
Points to remember.....	189
Questions.....	190
7. Lists	195
Introduction	195
Structure	195
Objectives	196
Containers	196
Array	197
List	197
Mutable sequence.....	198
Mutable.....	199
Slicing.....	200
Getting Python keywords online.....	200
List concatenation	201
Nesting of lists	201
Built-in functions.....	202
Difference between functions and methods.....	203
Console input.....	203
List methods.....	204
Use of keyword in.....	206
Loops in list.....	206
<i>Method 1</i>	207
<i>Method 2</i>	207

<i>Method 3</i>	208
<i>Method 4</i>	208
List comprehension.....	208
<i>Creating Pythagorean triplets</i>	210
Aliasing list	210
Cloning lists	211
Passing list and returning list.....	212
<i>Transpose of a matrix</i>	212
Arrays in Python	214
Sum of an array of numbers	217
Case study: Circulate the values of n variables	217
Caution about tabs	219
Case study: Linear search	219
Case study: Binary search	222
Conclusion	224
Points to remember	224
Questions.....	225
8. Tuples, Sets, and Dictionaries	231
Introduction	231
Structure	231
Objectives	232
Tuple.....	232
<i>Built-in functions</i>	233
<i>Creating tuples from other container types</i>	234
<i>Built-in functions contd.</i>	235
<i>Additional operations on tuple</i>	235
<i>Tuple as a return value</i>	237
<i>List as a return value</i>	238
Set	239
<i>Type set</i>	240
<i>The set function</i>	240

Built-in functions.....	241
Methods of set class.....	241
Mathematical operations.....	242
Checking a set in comparison with other sets	244
Set comprehension	244
Dictionary	244
Some examples of dictionaries	245
Iterations over dictionaries.....	245
Method 1	245
Method 2	246
Method 3	246
Method 4	247
Using built-in functions with dictionary.....	247
Dictionary methods	248
Dictionary comprehension	250
Nested dictionaries	251
Conclusion	252
Points to remember	252
Questions.....	253
9. Introduction to Object-Oriented Programming	257
Introduction	257
Structure	257
Objectives	258
Object-oriented programming	258
Encapsulation.....	259
Inheritance.....	260
Polymorphism.....	260
Operator overloading.....	260
Advantages of OOP	261
Class	261
A simple class	262

The self.....	262
Object	262
Access control	263
Object initializer	267
Destruction of object.....	267
The id function and type function.....	269
Carrying out operations on objects	271
Class variables versus instance variables	272
Operator overloading.....	274
Overloading functions supported in Python.....	275
Overloading binary operators.....	276
<i>Overloaded minus operator</i>	276
<i>Overloading unary operator</i>	278
<i>Overloaded == operator</i>	279
Documentation strings.....	281
Conclusion	283
Points to remember.....	283
Questions.....	285
10. Inheritance and Polymorphism	289
Introduction	289
Structure	289
Objectives	290
Reusability.....	290
Inheritance.....	291
<i>Single inheritance</i>	292
<i>Multilevel inheritance</i>	292
<i>Multiple inheritance</i>	293
Implementing reuse.....	294
<i>Containership and inheritance</i>	294
<i>Containership</i>	294
<i>Inheritance</i>	297

<i>Single inheritance</i>	297
<i>Access types revisited</i>	299
<i>Multi-level inheritance</i>	300
<i>Multiple inheritance</i>	301
The object class	303
Diamond problem	304
Method overriding	305
The isinstance function	306
Polymorphism	307
Dynamic binding	311
Abstract class	313
Iterators	315
Iterable	315
User-defined iterators	316
Generators	318
<i>Generator expressions</i>	320
Conclusion	321
Points to remember	322
Questions	323
11. File Handling	327
Introduction	327
Structure	327
Objectives	328
Files	328
Writing to a file	329
<i>Checking existence of a file</i>	329
Reading from a file	331
<i>readline() method</i>	332
<i>readlines() method</i>	334
<i>Implicit reading</i>	334
Text and binary files	335

Mode parameters	336
Copying files	337
Appending text.....	338
The with for file close	339
Case studies	340
<i>Counting occurrence of each word in a text file</i>	<i>340</i>
<i>Counting occurrence of each alphabet in a text file</i>	<i>342</i>
The seek method	344
Writing to binary file and then reading	345
Java Script Object Notation.....	347
<i>Serialization and deserialization</i>	<i>348</i>
<i>Serializing JSON</i>	<i>348</i>
<i>Deserializing JSON</i>	<i>348</i>
<i>Serializing and de-serializing to and from strings.....</i>	<i>350</i>
Pickle solution	351
<i>Pickle versus JSON</i>	<i>353</i>
Case study: CSV files.....	353
Command line arguments	355
<i>File copy from source to destination</i>	<i>356</i>
<i>getopt module.....</i>	<i>356</i>
<i>shutil module</i>	<i>356</i>
Conclusion	357
Points to remember	358
Questions.....	359
12. Exception Handling	365
Introduction	365
Structure	366
Objectives	366
Some standard exceptions	366
Handling exceptions.....	368
The syntax for exception handling	368

Reading file with exception handling	369
The finally keyword.....	371
Word count program with exception handling	372
Multiple except.....	374
Use of else.....	376
Value error.....	377
Raising exceptions.....	379
Case study: Custom exception.....	380
<i>Knowing the cause of the error</i>	382
Conclusion	383
Points to remember	384
Questions.....	385
13. Gems of Python	389
Introduction	389
Structure	389
Objectives	390
Lambda functions	390
<i>Constituents of lambda functions</i>	390
<i>Syntax and examples</i>	390
<i>Using lambdas with Python built-ins</i>	391
<i>Immediately invoked function expression in lambda</i>	392
Modules	392
Module <i>sum.py</i>	392
Module <i>swap_case</i>	393
Module <i>tup_max.py</i>	394
Module <i>prod.py</i>	394
Short names for modules	395
Import a function from a module.....	395
The main module	395
Importing multiple modules.....	396
Symbol table	397

<i>vars()</i> function.....	397
Date and time.....	398
<i>Date and Time now</i>	399
<i>strftime</i> function.....	400
<i>Finding elapsed time</i>	400
<i>Perf_counter</i> function	400
<i>process_time</i> function	401
Functional programming.....	402
<i>Filtering elements in containers</i>	403
<i>map()</i> function.....	404
<i>Reduce()</i> function.....	404
First class functions.....	405
<i>Assigning functions to variables</i>	406
<i>Function passed as parameters to other functions</i>	406
<i>Define functions inside other functions</i>	407
Decorators	407
<i>A simple decorator</i>	407
<i>Function to be decorated</i>	408
<i>def decor(fun)</i>	408
<i>The nested wrap function</i>	409
<i>Assigning and calling</i>	409
<i>Decorator function with arguments</i>	409
<i>@decor1</i>	409
Case study: Comparing methods by execution times	411
<i>Built-in decorators</i>	413
Namespace	413
Packages	415
<i>Importing files from a package</i>	416
Conclusion	417
Points to remember	417
Questions.....	418

14. Data Structures and Algorithms using Python	423
Introduction	423
Structure	423
Objectives	424
Data structures.....	424
Stack	424
<i>Case study: Exception handling in a stack.....</i>	<i>426</i>
Queue.....	428
<i>Case study: Exception handling in queue</i>	<i>430</i>
Algorithm analysis.....	433
<i>Case study: Bubble sort</i>	<i>434</i>
<i>Time complexity of bubble sort</i>	<i>436</i>
<i>Case study: Selection sort.....</i>	<i>436</i>
<i>Time complexity of selection sort</i>	<i>439</i>
<i>Case study: Insertion sort.....</i>	<i>439</i>
<i>Time complexity of insertion sort</i>	<i>441</i>
<i>Case study: Merge sort.....</i>	<i>441</i>
<i>Time complexity of merge sort</i>	<i>444</i>
Conclusion	444
Points to remember	444
Questions.....	446
15. Data Visualization.....	449
Introduction	449
Structure	449
Objectives	450
Importance of data.....	450
Python libraries for data visualization.....	451
Dataset	451
<i>File formats.....</i>	<i>452</i>
DataFrame.....	452
pandas.....	452

Installing pandas	452
Reading head() of csv file.....	452
Reading tail() of csv file.....	453
Matplotlib	454
Scatter diagram.....	454
Relationship between R&D spend and profit.....	455
pandas for visualization	456
Relationship between marketing spend and profit	457
Relationship between administration and profit.....	458
Line chart.....	459
Histogram.....	462
Second dataset	464
Getting the first five records of wines.....	464
Getting the last five records of the dataset.....	465
Getting column headers.....	465
Histogram for wines review	466
Bar chart.....	467
Seaborn	468
Installing seaborn.....	468
Scatter diagram using seaborn	468
Histogram using seaborn	469
Gaussian KDE inside the plot.....	470
Conclusion	471
Points to remember.....	472
Questions.....	472
16. Python Applications and Libraries.....	477
Introduction	477
Structure	477
Objectives	478
Overview of applications of Python.....	478
Libraries used in data structures and algorithms.....	479

Tasks in web development.....	480
<i>Python libraries for web development</i>	482
Machine learning.....	484
<i>Types of machine learning</i>	485
<i>Machine learning algorithms</i>	485
<i>Model evaluation</i>	485
<i>Hyperparameter tuning</i>	485
<i>Machine learning applications</i>	485
<i>Python libraries for machine learning</i>	486
<i>pandas</i>	486
<i>NumPy</i>	486
<i>SciPy</i>	487
<i>Matplotlib</i>	487
<i>Seaborn</i>	487
<i>Scikit Learn</i>	487
<i>TensorFlow</i>	488
<i>Keras</i>	488
<i>Statsmodels</i>	489
<i>Plotly</i>	489
<i>SpaCy</i>	489
<i>Bokeh</i>	490
<i>Gensim</i>	490
<i>Natural Language Processing</i>	490
<i>Theano</i>	491
<i>PyTorch</i>	491
<i>Python libraries for data science</i>	491
Graphical User Interface programming.....	492
<i>Languages and frameworks for GUI programming</i>	493
<i>Python libraries for GUI programming</i>	494
<i>Game development</i>	495
<i>Scripting and automation</i>	495

<i>Web scraping</i>	495
<i>Database applications</i>	495
<i>Internet of Things</i>	496
<i>Education</i>	496
Conclusion	497
Multiple choice questions	497
Questions.....	500
Appendix 1: Python Projects	501
Project 1: Text-to-speech conversion using Python library Google Text To Speech .	501
<i>Google Text To Speech</i>	502
<i>Installation of gTTS</i>	502
<i>Languages supported</i>	502
<i>Program steps to convert text to speech</i>	505
<i>Text to speech conversion of string in English</i>	506
<i>Text to speech conversion of string in Tamil</i>	506
<i>Text to speech conversion of words in a text file in English</i>	507
<i>Text to speech conversion of words in a text file in Tamil language</i>	507
Project 2: Offline text to speech conversion using Python library pyttsx3	508
<i>Playing from a text file</i>	510
Appendix 2: List of Built-in Functions in Python	513
Appendix 3: Answers to Review Questions	519
Index	527-536

CHAPTER 1

Introduction to Python 3

Introduction

Python is one of the popular and widely used high-level programming languages. It is both a procedure-oriented and object-oriented programming language like C++. It is also a web-scripting language like Javascript. The Python Virtual machine, like Java virtual machine, is the key element of Python, which facilitates the portability of Python programs across platforms. Python's **batteries included** philosophy is a boon to the programmers to write compact and error-free code.

In this chapter, we will be learning the history of Python, its features, applications, and advantages. The Python 3 language system matching the operating system in our computer system can be downloaded from www.python.org. After installation, if our computer runs under Windows operating system, we will get the Python command line interpreter and **Integrated Development Environment (IDLE)** under the *start* menu in Windows in the system. We use the statement prompts in the above, in the interactive mode, to confirm our understanding of the Python language syntax. The IDLE, in addition, can be used for writing and executing the programs in script mode. We get a glimpse of the use of mathematical and other functions received along with the Python language system. We will also write simple Python programs in this chapter.

Structure

The chapter covers the following topics:

- History of Python
- Major users
- Features of the language
- Applications of Python 3
- Advantages of Python 3
- Interpreters and compilers
- Python Virtual Machine
- Interpretation process
- Versions of Python
- Python implementations
- Installing Python
- Interactive mode
- Integrated Development Environment
- Execution of Python programs
- Dynamically typed vs. statically typed language
- Memory administration in Python
- Python calculator
- Special characters
- Batteries included philosophy
- Mathematical functions in Python
- Other built-in functions
- Frozen binaries executables
- Types of errors in programs

Objectives

After studying this chapter, you will understand how to invoke the Python command line interpreter, carry out a few calculations, and display a few messages. You would have invoked IDLE, created a new file, typed a program, saved it in a directory, and executed

the program. You would be able to use mathematical and other functions and execute programs in IDLE.

History of Python

Python is a high-level procedure-oriented programming language like BASIC, COBOL, FORTRAN, and C. It is also an object-oriented programming language like C++, C sharp, and Java. It can thus be used for procedure-oriented programming as well as object-oriented programming. Python was released for use in the year 1991 by *Guido Van Rossum* (b 1956) in Netherlands. Python was named after the popular British comedy troupe, Monty Python's Flying Circus. It is freeware and not a proprietary product. We can say that it is community owned. It is an open-source programming language, and software professionals all over the world contribute to the development of the language. Python is managed officially by Python Software Foundation, a not-for-profit organization with its headquarters in Delaware, United States.

Major users

Many world-class organizations, such as those listed below, use Python for the development of software products in their organizations:

- Google
- Facebook
- Instagram
- YouTube
- Spotify
- Quora
- Netflix
- Dropbox

The **National Aeronautics and Space Administration (NASA)**, an independent agency of the U.S. Federal Government responsible for the civilian space program, as well as aeronautics and space research, uses Python to develop their professional applications. It is a meritorious programming language, and hence such big names are using it extensively, and the user base is growing continually, besides also being used by tens of thousands of small/mid to large enterprises.

Python 3 is a popular and high-level computer programming language known for its simplicity, readability, learnability, and versatility. We will briefly peruse the features, applications, and advantages of Python 3 language.

Features of Python 3

Python 3 has many special features, some of them are unique. The special features of Python are listed below:

- **Simple and readable syntax:** Python emphasizes code readability and uses a clean and straightforward syntax, which makes it easy for developers to write and understand code.
- **Interpreted language:** Python is an interpreted language, which means code is executed line by line, making it easy to test and debug.
- **High-level language:** Python abstracts many low-level details, allowing developers to focus on solving problems rather than managing memory and other system-level concerns.
- **Dynamically typed:** Python is dynamically typed, which means variable types are determined at runtime, providing flexibility but requiring careful attention to data types.
- **Multi-paradigm:** Python supports multiple programming paradigms, including procedural, object-oriented, and functional programming.
- **Rich standard library:** Python has a rich standard library that provides modules and packages for a wide range of tasks, reducing the need for reinventing the wheel.
- **Cross-platform:** Python is available on multiple platforms, making it a portable choice for software development.
- **Community and ecosystem:** Python has a large and active community of developers, which means a wealth of third-party libraries, frameworks, and tools are available.

Python 3 is a versatile language with a strong community and ecosystem, making it a valuable choice for various programming tasks and industries.

Applications of Python 3

Python is widely used in a variety of applications, both scientific and commercial. Some applications of Python are listed below:

- **Web development:** Python is used for web development with frameworks like Django and Flask, making it easy to build web applications and APIs.
- **Data analysis and visualization:** Python, along with libraries like NumPy, pandas, and Matplotlib, is widely used for data analysis, scientific computing, and data visualization.

- **Machine learning and AI:** Python has become the de facto language for machine learning and artificial intelligence with libraries such as TensorFlow, PyTorch, and scikit-learn.
- **Scientific computing:** Scientists and researchers use Python for numerical and scientific computing tasks due to its rich ecosystem of scientific libraries.
- **Automation and scripting:** Python is often used for automating repetitive tasks and writing system scripts.
- **Game development:** Python has libraries like Pygame for game development.
- **Desktop applications:** Python can be used to build desktop applications using frameworks like PyQt and Tkinter.
- **Networking and cybersecurity:** Python is used for network programming, penetration testing, and cybersecurity tasks.
- **Education:** Python is a popular choice for teaching programming due to its simplicity and readability.

Advantages of Python 3

The advantages of Python as a programming language are plentiful. Some advantages are highlighted here:

- **Ease of learning:** Python's simple and readable syntax makes it an ideal language for beginners and experienced developers alike.
- **Productivity:** Python's high-level abstractions and rich standard library allow developers to write code quickly and efficiently.
- **Large community:** The large and active Python community means extensive documentation, support, and a wealth of third-party libraries.
- **Cross-platform compatibility:** Python code can run on various platforms with minimal modifications, making it highly portable. Availability of interpreters for a host of operating systems such as Windows, Linux, Ubuntu and Apple's Mac OS.
- **Versatility:** Python is suitable for a wide range of applications, from web development to data science and artificial intelligence.
- **Open source:** Python is open source, which means it is freely available and can be used and modified without cost.
- **Interoperability:** Python can easily integrate with other languages like C/C++ and Java, making it suitable for extending existing software.
- **Community-driven updates:** Python's development is community-driven, with regular updates and improvements.