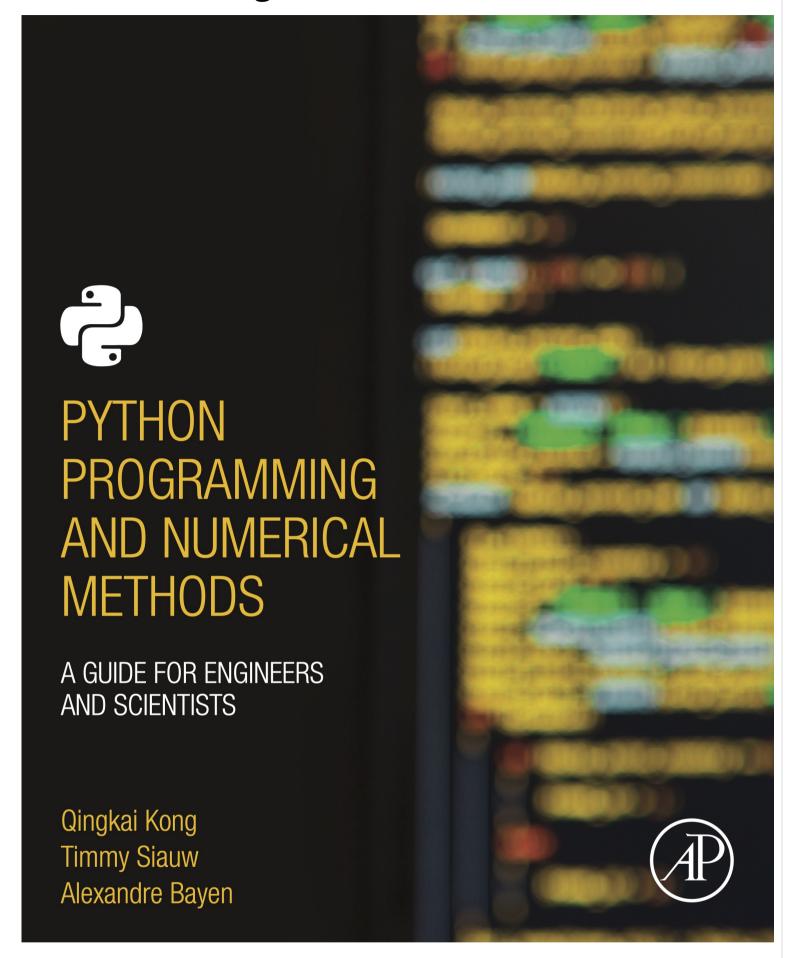
# Python Programming And Numerical Methods: A Guide For Engineers And Scientists



This notebook contains an excerpt from the <u>Python Programming and Numerical Methods - A Guide for Engineers and Scientists</u>, the content is also available at <u>Berkeley Python Numerical Methods</u>.

The copyright of the book belongs to Elsevier. We also have this interactive book online for a better learning experience. The code is released under the MIT license. If you find this content useful, please consider supporting the work on Elsevier or Amazon!

## **Table of Contents**

#### **PREFACE**

## **Acknowledgment**

PART I INTRODUCTION TO PYTHON PROGRAMMING

**:** ■ Contents

Table of Contents

**PREFACE** 

Acknowledgment

PART I INTRODUCTION TO PYTHON

**PROGRAMMING** 

**CHAPTER 1. Python Basics** 

CHAPTER 2. Variables and Basic Data

**Structures** 

**CHAPTER 3. Functions** 

Print to PDF

CHAPTER 4. Branching Statements

CHAPTER 5. Iteration

**CHAPTER 6. Recursion** 

**CHAPTER 7. Object Oriented** 

Programming (OOP)

**CHAPTER 8. Complexity** 

CHAPTER 9. Representation of

<u>Numbers</u>

CHAPTER 10. Errors, Good

Programming Practices, and Debugging

CHAPTER 11. Reading and Writing

<u>Jata</u>

CHAPTER 12. Visualization and Plotting

Piotting

CHAPTER 13. Parallel Your Python

PART II INTRODUCTION TO

NUMERICAL METHODS

CHAPTER 14. Linear Algebra and

Systems of Linear Equations

CHAPTER 15. Eigenvalues and

<u>Eigenvectors</u>

CHAPTER 16. Least Squares

Regression

CHAPTER 17. Interpolation

**CHAPTER 18. Series** 

CHAPTER 19. Root Finding

CHAPTER 20. Numerical

**Differentiation** 

CHAPTER 21. Numerical Integration

CHAPTER 22. Ordinary Differential

Equations (ODEs): Initial-Value

**Problems** 

CHAPTER 23. Ordinary Differential

**Equations: Boundary-Value Problems** 

CHAPTER 24. Fourier Transforms

CHAPTER 25. Introduction to Machine

<u>\_earning</u>

Appendix A. Getting-Started-with-

Python-Windows

#### **CHAPTER 1. Python Basics**

- 1.1 Getting Started with Python
- 1.2 Python as A Calculator
- 1.3 Managing Packages
- 1.4 Introduction to Jupyter Notebook
- 1.5 Logical Expressions and Operators
- 1.6 Summary and Problems

## **CHAPTER 2. Variables and Basic Data Structures**

- 2.1 Variables and Assignment
- 2.2 Data Structure Strings
- 2.3 Data Structure Lists
- 2.4 Data Structure Tuples
- 2.5 Data Structure Sets
- <u>2.6 Data Structure Dictionaries</u>
- 2.7 Introducing Numpy Arrays
- 2.8 Summary and Problems

## **CHAPTER 3. Functions**

- 3.1 Function Basics
- 3.2 Local Variables and Global Variables
- 3.3 Nested Functions
- 3.4 Lambda Functions
- 3.5 Functions as Arguments to Functions
- 3.6 Summary and Problems

## **CHAPTER 4. Branching Statements**

- 4.1 If-Else Statements
- 4.2 Ternary Operators
- 4.3 Summary and Problems

#### **CHAPTER 5. Iteration**

- 5.1 For Loops
- <u>5.2 While Loops</u>
- <u>5.3 Comprehensions</u>
- <u>5.4 Summary and Problems</u>

### **CHAPTER 6. Recursion**

- <u>6.1 Recursive Functions</u>
- <u>6.2 Divide and Conquer</u>
- 6.3 Summary and Problems

## CHAPTER 7. Object Oriented Programming (OOP)

- 7.1 Introduction to OOP
- 7.2 Class and Object
- <u>7.3 Inheritance</u>
- 7.4 Summary and Problems

## **CHAPTER 8. Complexity**

- 8.1 Complexity and Big-O Notation
- <u>8.2 Complexity Matters</u>
- 8.3 The Profiler
- <u>8.4 Summary and Problems</u>

## **CHAPTER 9. Representation of Numbers**

- 9.1 Base-N and Binary
- 9.2 Floating Point Numbers
- 9.3 Round-off Errors
- 9.4 Summary and Problems

## CHAPTER 10. Errors, Good Programming Practices, and Debugging

- 10.1 Error Types
- 10.2 Avoiding Errors
- 10.3 Try/Except
- 10.4 Type Checking
- 10.5 Debugging
- 10.6 Summary and Problems

## **CHAPTER 11. Reading and Writing Data**

- <u>11.1 TXT Files</u>
- <u>11.2 CSV Files</u>
- 11.3 Pickle Files
- 11.4 JSON Files
- 11.5 HDF5 Files
- 11.6 Summary and Problems

## **CHAPTER 12. Visualization and Plotting**

- <u>12.1 2D Plotting</u>
- 12.2 3D Plotting
- 12.3 Working with Maps
- 12.4 Animations and Movies
- 12.5 Summary and Problems

## **CHAPTER 13. Parallel Your Python**

- 13.1 Parallel Computing Basics
- 13.2 Multiprocessing
- <u>13.3 Use joblib</u>
- 13.4 Summary and Problems

#### PART II INTRODUCTION TO NUMERICAL METHODS

## CHAPTER 14. Linear Algebra and Systems of Linear Equations

- 14.1 Basics of Linear Algebra
- 14.2 Linear Transformations
- 14.3 Systems of Linear Equations
- 14.4 Solutions to Systems of Linear Equations
- 14.5 Solve Systems of Linear Equations in Python
- 14.6 Matrix Inversion
- 14.7 Summary and Problems

## **CHAPTER 15. Eigenvalues and Eigenvectors**

- 15.1 Eigenvalues and Eigenvectors Problem Statement
- 15.2 The Power Method
- 15.3 The QR Method
- 15.4 Eigenvalues and Eigenvectors in Python
- 15.5 Summary and Problems

### **CHAPTER 16. Least Squares Regression**

• 16.1 Least Squares Regression Problem Statement

- 16.2 Least Squares Regression Derivation (Linear Algebra)
- 16.3 Least Squares Regression Derivation (Multivariable Calculus)
- 16.4 Least Squares Regression in Python
- 16.5 Least Square Regression for Nonlinear Functions
- 16.6 Summary and Problems

## **CHAPTER 17. Interpolation**

- <u>17.1 Interpolation Problem Statement</u>
- 17.2 Linear Interpolation
- <u>17.3 Cubic Spline Interpolation</u>
- 17.4 Lagrange Polynomial Interpolation
- 17.5 Newton's Polynomial Interpolation
- 17.6 Summary and Problems

#### **CHAPTER 18. Series**

- 18.1 Expressing Functions with Taylor Series
- 18.2 Approximations with Taylor Series
- 18.3 Discussion on Errors
- 18.4 Summary and Problems

## **CHAPTER 19. Root Finding**

- 19.1 Root Finding Problem Statement
- 19.2 Tolerance
- 19.3 Bisection Method
- 19.4 Newton-Raphson Method
- 19.5 Root Finding in Python
- 19.6 Summary and Problems

## **CHAPTER 20. Numerical Differentiation**

- 20.1 Numerical Differentiation Problem Statement
- 20.2 Finite Difference Approximating Derivatives
- 20.3 Approximating of Higher Order Derivatives
- 20.4 Numerical Differentiation with Noise
- 20.5 Summary and Problems

## **CHAPTER 21. Numerical Integration**

- 21.1 Numerical Integration Problem Statement
- 21.2 Riemann's Integral
- 21.3 Trapezoid Rule
- 21.4 Simpson's Rule
- 21.5 Computing Integrals in Python
- 21.6 Summary and Problems

## CHAPTER 22. Ordinary Differential Equations (ODEs): Initial-Value Problems

- 22.1 ODE Initial Value Problem Statement
- 22.2 Reduction of Order
- 22.3 The Euler Method
- 22.4 Numerical Error and Instability
- 22.5 Predictor-Corrector Methods
- 22.6 Python ODE Solvers (IVP)
- 22.7 Advanced Topics
- 22.8 Summary and Problems

## <u>CHAPTER 23. Ordinary Differential Equations: Boundary-Value Problems</u>

- 23.1 ODE Boundary Value Problem Statement
- 23.2 The Shooting Method
- 23.3 Finite Difference Method
- 23.4 Numerical Error and Instability
- 23.5 Python ODE Solvers
- 23.6 Summary and Problems

## **CHAPTER 24. Fourier Transforms**

- 24.1 The Basics of Waves
- 24.2 Discrete Fourier Transform (DFT)
- 24.3 Fast Fourier Transform (FFT)
- 24.4 FFT in Python
- 24.5 Summary and Problems

## **CHAPTER 25. Introduction to Machine Learning**

- 25.1 Concept of Machine Learning
- 25.2 Classification
- 25.3 Regression
- 25.4 Clustering
- 25.5 Summary and Problems

## Appendix A. Getting-Started-with-Python-Windows

© Copyright 2020.