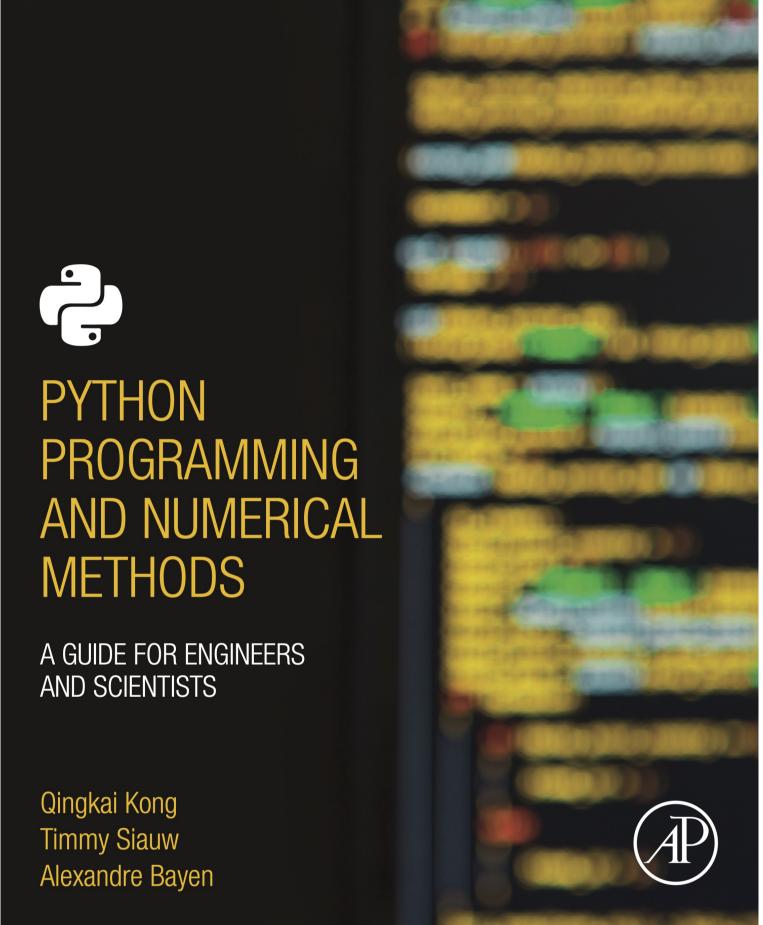
Python Programming And Numerical Methods: A Guide For Engineers And Scientists



at Berkeley Python Numerical Methods.

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 <u>license</u>. If you find this content useful, please consider supporting the work on <u>Elsevier</u> or <u>Amazon!</u>

Table of Contents

PREFACE

Acknowledgment

CHAPTER 1. Python Basics

- 1.2 Python as A Calculator
- 1.3 Managing Packages

■ Contents

Table of Contents

Print to PDF

PREFACE

<u>Acknowledgment</u>

PART I INTRODUCTION TO PYTHON

PROGRAMMING

CHAPTER 1. Python Basics

CHAPTER 2. Variables and Basic Data

Structures

CHAPTER 3. Functions

CHAPTER 4. Branching Statements

CHAPTER 5. Iteration

CHAPTER 6. Recursion

CHAPTER 7. Object Oriented Programming

CHAPTER 8. Complexity

CHAPTER 9. Representation of Numbers

CHAPTER 10. Errors, Good Programming Practices, and Debugging

CHAPTER 11. Reading and Writing Data

CHAPTER 12. Visualization and Plotting

CHAPTER 13. Parallel Your Python

PART II INTRODUCTION TO NUMERICAL **METHODS**

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

CHAPTER 15. Eigenvalues and Eigenvectors

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

Appendix A. Getting-Started-with-Python-

Windows

This notebook contains an excerpt from the Python Programming and Numerical Methods - A Guide for Engineers and Scientists, the content is also available

PART I INTRODUCTION TO PYTHON PROGRAMMING

• 1.1 Getting Started with Python

- 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
- <u>2.2 Data Structure Strings</u>
- 2.3 Data Structure Lists
- 2.4 Data Structure Tuples
- 2.5 Data Structure Sets
- 2.6 Data Structure Dictionaries
- 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
- 5.2 While Loops
- <u>5.3 Comprehensions</u>
- 5.4 Summary and Problems

CHAPTER 6. Recursion

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

CHAPTER 7. Object Oriented Programming (OOP)

- 7.1 Introduction to OOP
- 7.2 Class and Object
- 7.3 Inheritance
- 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
- <u>9.3 Round-off Errors</u>
- 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>
- 11.2 CSV Files
- 11.3 Pickle Files
- 11.4 JSON Files
- 11.5 HDF5 Files
- 11.6 Summary and Problems

CHAPTER 12. Visualization and Plotting

- 12.1 2D Plotting
- 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
- 13.3 Use joblib
- 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

- 17.1 Interpolation Problem Statement
- 17.2 Linear Interpolation
- 17.3 Cubic Spline Interpolation
- <u>17.4 Lagrange Polynomial Interpolation</u>
- 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

CHAPTER 23. Ordinary Differential Equations: Boundary-Value Problems

- 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.