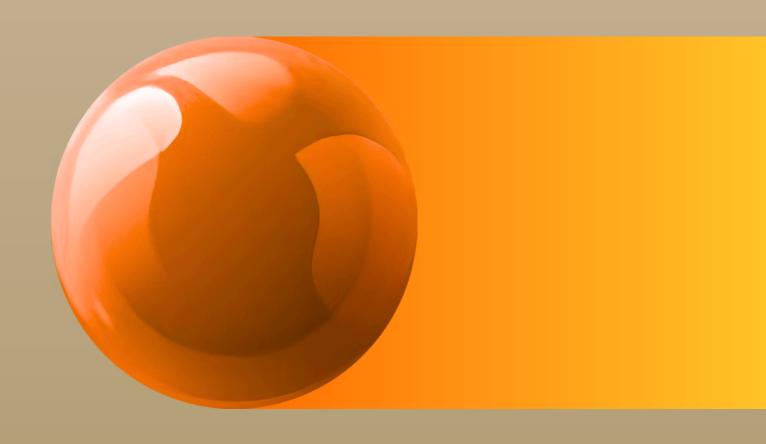
Python series

NumPy Fundamentals





With Code Examples

What is NumPy?

NumPy is a powerful library for numerical computing in Python. It provides support for large, multi-dimensional arrays and matrices, along with a vast collection of high-level mathematical functions to operate on these arrays.



Creating NumPy Arrays

NumPy arrays can be created from Python lists or using special functions.



Array Indexing and Slicing

NumPy arrays can be indexed and sliced like Python lists, but with more flexibility.

Array Operations

NumPy provides a wide range of mathematical operations that can be applied to arrays elementwise or across entire arrays.

```
a = np.array([1, 2, 3])
b = np.array([4, 5, 6])

c = a + b  # Elementwise addition
# Output: [5 7 9]
d = a * b  # Elementwise multiplication
# Output: [4 10 18]
e = np.sum(a)  # Sum of all elements in the array
# Output: 6
```

Broadcasting

NumPy's broadcasting feature allows arithmetic operations between arrays with different shapes.

Array Reshaping

NumPy arrays can be reshaped to different dimensions without changing their data.

Array Concatenation

NumPy provides functions to concatenate arrays along different axes.

Conditions and Boolean Arrays

NumPy allows you to apply conditions and create boolean arrays for advanced indexing and filtering.

```
a = np.array([1, 2, 3, 4, 5])
condition = a > 2
# Output: [False False True True]
b = a[condition] # Filter elements greater than 2
# Output: [3 4 5]
```



Mathematical Functions

NumPy provides a wide range of mathematical functions to perform various operations on arrays.

Loading and Saving Arrays

NumPy provides functions to load and save arrays from/to disk in various formats.

```
# Save an array to a binary file
a = np.array([1, 2, 3, 4])
np.save('data.npy', a)

# Load an array from a binary file
b = np.load('data.npy')
# Output: [1 2 3 4]
```

NumPy and Data Analysis

NumPy seamlessly integrates with other data analysis libraries like Pandas and Matplotlib, making it an essential tool for scientific computing and data analysis in Python.

```
import pandas as pd
import matplotlib.pyplot as plt

data = pd.read_csv('data.csv')
x = data['x'].values # Convert to NumPy array
y = data['y'].values

plt.plot(x, y)
plt.show()
# Displays a line plot using the NumPy arrays x and y
```

Array Statistics

NumPy provides functions to compute various statistical properties of arrays.

```
a = np.array([1, 2, 3, 4, 5])

mean_value = np.mean(a)
# Output: 3.0

median_value = np.median(a)
# Output: 3.0

std_dev = np.std(a)
# Output: 1.4142135623730951
```

Random Sampling

NumPy's random module allows you to generate random numbers and perform random sampling from arrays.

```
import numpy as np

# Generate 5 random numbers between 0 and 1
random_nums = np.random.rand(5)
# Output: [0.37454012 0.95071431 0.73199394 0.59865848 0.15601864]

# Randomly select 3 elements from an array
a = np.array([1, 2, 3, 4, 5, 6, 7, 8, 9, 10])
random_elements = np.random.choice(a, size=3, replace=False)
# Output: [5 9 1]
```

Linear Algebra with NumPy

NumPy provides functions for performing various linear algebra operations on arrays.

```
a = np.array([[1, 2], [3, 4]])
b = np.array([[5, 6], [7, 8]])

# Matrix multiplication
c = np.matmul(a, b)
# Output: [[19 22]
# [43 50]]

# Compute the determinant
det_a = np.linalg.det(a)
# Output: -2.0000000000000000000
```

Array Sorting

NumPy provides functions to sort arrays along one or more axes.

Array Manipulation with NumPy

NumPy provides various functions to manipulate and transform arrays.

```
a = np.array([1, 2, 3, 4, 5])

# Reverse the order of elements
reversed_a = np.flip(a)
# Output: [5 4 3 2 1]

# Repeat elements of the array
repeated_a = np.repeat(a, 2)
# Output: [1 1 2 2 3 3 4 4 5 5]
```

Array Comparisons

NumPy allows you to perform element-wise comparisons between arrays, resulting in boolean arrays.

```
a = np.array([1, 2, 3, 4, 5])
b = np.array([3, 4, 5, 6, 7])

# Element-wise comparison
greater_than = a > b
# Output: [False False False False False]

less_than_equal = a <= b
# Output: [True True True True]</pre>
```