⏱ Hour 5: **NumPy – Arrays, Indexing, Operations**

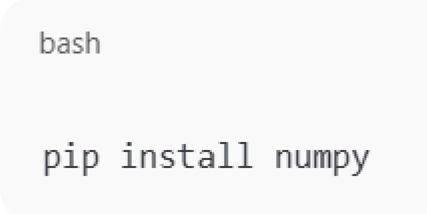
1️⃣ **Introduction to NumPy**

🔹 What is NumPy?

NumPy (Numerical Python) is a Python library used for:

- Numerical computations
- Working with **arrays**
- Faster than Python lists
- Widely used in **Machine Learning & Data Science**

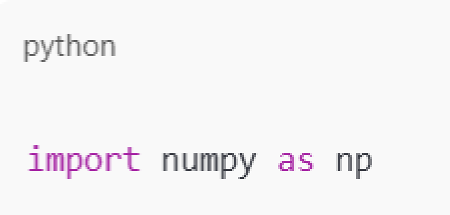
🔹 Installation



bash

```bash
pip install numpy
```

🔹 Import NumPy



python

```python
import numpy as np
```

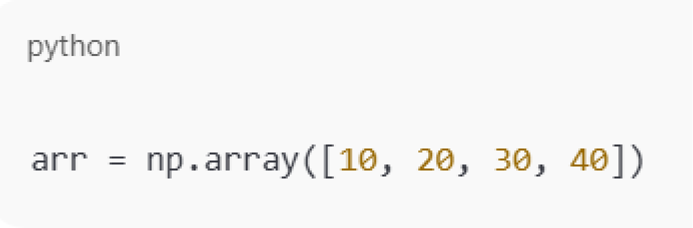
2️⃣ NumPy Arrays

🔹 What is a NumPy Array?

A **NumPy array** is a collection of elements of the **same data type** stored efficiently.

🔹 Creating Arrays

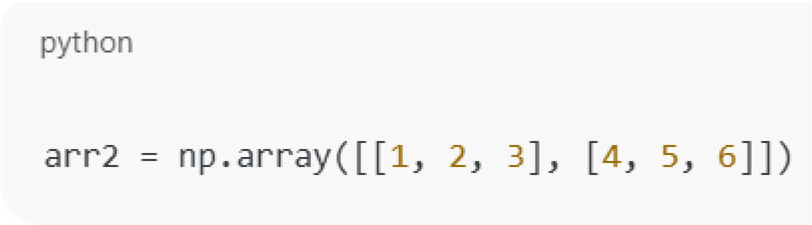
1D Array



python

```python
arr = np.array([10, 20, 30, 40])
```

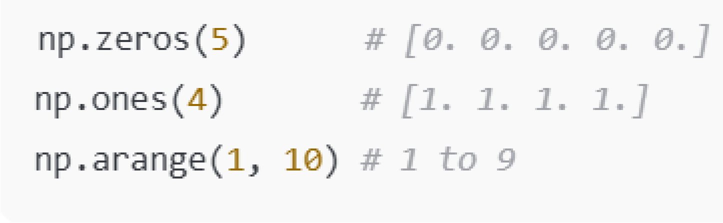
2D Array



python

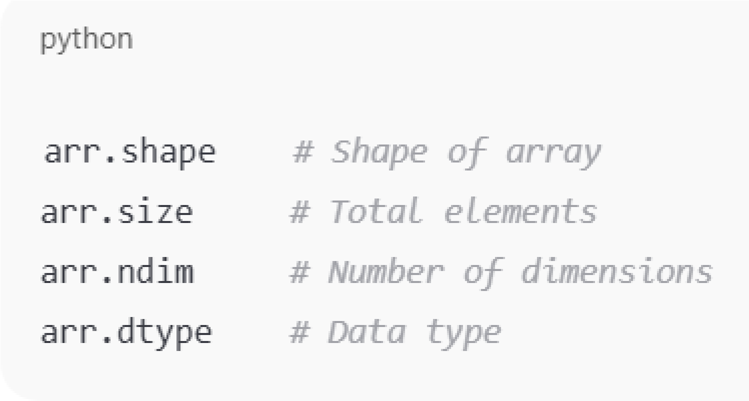
```
arr2 = np.array([[1, 2, 3], [4, 5, 6]])
```

🔹 Special Arrays



```
np.zeros(5)      # [0. 0. 0. 0. 0.]
np.ones(4)       # [1. 1. 1. 1.]
np.arange(1, 10) # 1 to 9
```

3️⃣ Array Properties

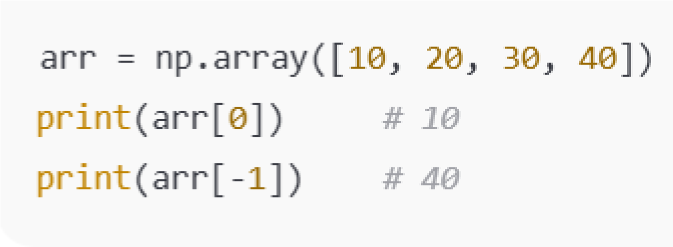


python

```
arr.shape    # Shape of array
arr.size     # Total elements
arr.ndim     # Number of dimensions
arr.dtype    # Data type
```

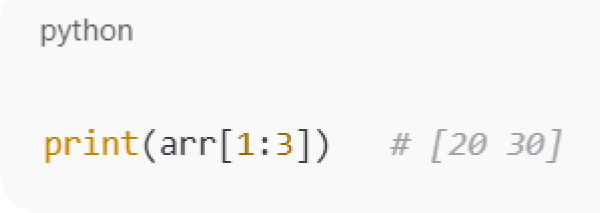
4️⃣ Indexing & Slicing

🔹 Indexing (1D)



```
arr = np.array([10, 20, 30, 40])
print(arr[0])     # 10
print(arr[-1])    # 40
```

🔹 Slicing



python

```
print(arr[1:3])   # [20 30]
```

◆ Indexing (2D)

```python
arr2 = np.array([[1,2,3],[4,5,6]])
print(arr2[0,1])  # 2
```

5 Array Operations

◆ Arithmetic Operations

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

print(a + b)
print(a - b)
print(a * b)
print(a / b)
```

◆ Scalar Operations

```python
print(a * 2)
print(a + 5)
```

6 Mathematical Functions

```
np.sum(a)
np.mean(a)
np.max(a)
np.min(a)
np.sqrt(a)
```

7️⃣ Comparison & Boolean Operations

```python
a > 2
a == 3
```

8️⃣ Reshaping Arrays

```python
arr = np.array([1,2,3,4,5,6])
arr2 = arr.reshape(2,3)
print(arr2)
```

9️⃣ Simple Practice Programs

🔹 Program 1: Create Array and Print Properties

```python
import numpy as np
arr = np.array([5, 10, 15])
print(arr.shape)
print(arr.size)
```

🔹 Program 2: Add Two Arrays

```python
import numpy as np
a = np.array([1,2,3])
b = np.array([4,5,6])
print(a + b)
```

🔑 Important Exam Points

✔ NumPy arrays are faster than lists
✔ Supports vectorized operations
✔ Used heavily in ML & Data Analysis
✔ All elements must be of same type

🧠 ML Connection

NumPy is used in:

- Data preprocessing
- Matrix operations
- Feature scaling
- Mathematical computations in ML models