

numpy.ndarray

```
import numpy as np
# creating arrays
arr = np.array([1, 2, 3]) # 1D array, shape (3,)
arr = np.array([[1, 2], [3, 4]]) # 2D array, shape (2, 2)
arr = np.zeros((rows, cols)) # 2D array of zeros
arr = np.empty((rows, cols, channels)) # 3D array uninitialized
# inspecting arrays
arr.shape # dimensions e.g. (480, 640, 3)
arr.dtype # data type e.g. uint8, float32
arr.ndim # number of dimensions
```

The core data structure in NumPy — a multi-dimensional array of elements all of the same type.

More efficient than Python lists for numerical data as elements are stored contiguously in memory.

Shape describes the dimensions — (rows, cols) for 2D, (rows, cols, channels) for 3D.

numpy.dtype

```
import numpy as np
# common dtypes
np.dtype(np.uint8) # unsigned 8-bit integer (0 to 255)
np.dtype(np.int8) # signed 8-bit integer (-128 to 127)
np.dtype(np.uint16) # unsigned 16-bit integer (0 to 65535)
np.dtype(np.int16) # signed 16-bit integer (-32768 to 32767)
np.dtype(np.int32) # signed 32-bit integer
np.dtype(np.float32) # 32-bit floating point
np.dtype(np.float64) # 64-bit floating point
# checking dtype
arr = np.array([1, 2, 3], dtype=np.float32)
arr.dtype # float32
arr.itemsize # bytes per element → 4
```

Describes the data type of elements stored in a `numpy.ndarray`.

Common types are `uint8` for images (0-255), `float32` for floating point, and `int32` for integers.

The `dtype` determines how many bytes each element takes and how values are interpreted.

numpy.uint8

```
import numpy as np
arr = np.array([0, 128, 255], dtype=np.uint8) # valid values
arr.dtype # uint8
arr.itemsize # 1 byte per element
# wrapping behaviour — values overflow silently
np.uint8(255) + np.uint8(1) # returns 0, not 256
# common usage — converting to uint8 for image saving
arr = np.clip(arr, 0, 255).astype(np.uint8) # safe conversion
```

An unsigned 8-bit integer type commonly used for image data.

Can hold values from 0 to 255 — exactly the range of a single colour channel in an image.

Values that exceed 255 wrap around rather than raising an error — a common source of bugs.



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