NumPy Cheat Sheet

(Version 1)

Array initialization

Create arrays from (potentially nested) Python lists:

Rank 1	`a = np.array([1, 2, 3])`
Rank 2	`b = np.array([[1, 2, 3], [4, 5, 6]])`
Force a datatype	`c = np.array([0, 1, 2], dtype=np.int32)`

Functions to create standard arrays (e.g. all zeros):

Zero-filled array	`a = np.zeros((2,2))`
One-filled array	`b = np.ones((1,2))`
Random array	`d = np.random.rand((2,2))`
Identity matrix	`c = np.eye(2)`
Increasing sequence	`e = np.linspace(2.0, 8.0, 10)`

Note that the first three functions require a shape *tuple* argument, hence the double parentheses.

Data Types

Basic data types:

Unsigned 32 bit integer	`np.uint32`
Signed 64 bit integer	`np.int64`
Single precision floating point	`np.float32`
Double precision floating point	`np.float64`
Boolean	`np.bool`

Array indexing, slicing

Basic indexing notation:

Select the element at the 3rd index	`a[3]`
Select the element at row 2, column 0	`b[2][0]`

Slicing:

Select elements at index 0 and 1	`a[0:2]`
Select all elements in column 1	`b[:,1:2]`
Select first two rows and last two columns	`b[:2,-2:]`

Indexing using a list of indices:

Select elements (1,1) and (2,1)	`b[[1,2],[1,1]]`

Indexing using masking:

Select elements less than 4	`b[b<4]`

Standard arithmetic operations

Elementwise arithmetic operations

Addition	`d = e + f`
Subtraction	`d = e - f`
Multiplication	`d = e * f`
Division	`d = e / f`
Square root	`d = np.sqrt(e)`
Exponentiation	`d = np.exp(e)`
Natural logarithm	`d = np.log(e)`
Cosine	`d = np.cos(e)`

Other functions

Dot/Matrix product	`d = np.dot(e, f)`
	`d = e @ f`

Compute sum of each column	`d = np.sum(b, axis=0)`
Compute max value of each row	`d = np.max(b, axis=1)`
Compute min value of array	`d = np.min(b)`
Transpose matrix	`d = e.T`

Note that `*` and `@` are different. The former does element-wise multiplication, while the latter is a dot or matrix-matrix/vector product depending on the input shapes.

Inspecting arrays

Basic definitions:

Array dimensions	`a.shape`
Number of array dimensions	`a.ndim`
Number of array elements	`a.size`
Number of array elements in a row	`a.shape[0]`
Data type of array elements	`a.dtype`
Cast an array to a different type	`a.astype(np.float32)`

Reshaping, Copying

Reshape an array	`d = a.reshape(6, 1)`

Extend the dimensionality	`# shape (2, 3)`
	`a = np.array([[1, 2, 3], [4, 5, 6]])`
	`# shape (2, 1, 3)`
	`a[:, None, :]`

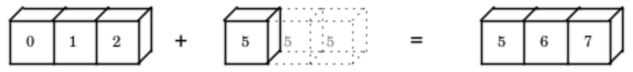
Flatten array to 1D	`a.flatten()`
	`a.reshape((-1, ))`

Create a deep copy of b	`c = np.copy(b)`

Broadcasting

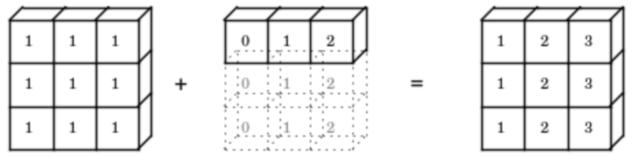
Broadcasting enables operations that combine arrays of different shapes.

$\mathtt{np.arange}(3) + 5$



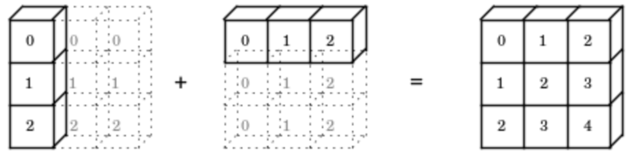
A two dimensional array multiplied by a one dimensional array results in broadcasting if number of 1D array elements matches the number of 2D array columns.

$\mathtt{np.ones}((3,3)) + \mathtt{np.arange}(3)$



Broadcasting can stretch both arrays to form an output array larger than either of the initial arrays.

$\mathtt{np.arange}(3)\mathtt{.reshape}((3,1)) + \mathtt{np.arange}(3)$



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