

# LECTURE 26

## NUMPY II

MCS 275 Spring 2021

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# LECTURE 26: NUMPY II

Course bulletins:

- [Project 3](#) due 6:00pm CDT on Friday March 19.
- Project 3 autograder will open on Monday.

# WHERE WE LEFT OFF

The `numpy` module is used for multidimensional typed arrays.

Vectors (1D arrays) and matrices (2D arrays) are the most frequently used.

Last time we explored ways to make arrays and access elements.

# THE ZEN OF PYTHON

In 2004, Tim Peters wrote a [list of principles](#) that describe the design of Python. One is:

*There should be one---and preferably only one---obvious way to do it.*

# THE ZEN OF NUMPY

In contrast, numpy often offers many ways to accomplish a given task, allowing the user to decide which is best.

Numpy is big, but you can be productive after learning a small subset.

Let's continue working in the [numpy introduction notebook](#).

# UFUNCS

Numpy's "ufuncs" or **universal functions** are functions that can be applied directly to arrays, automatically acting on each element.

Numpy provides a lot of these.

Usually, ufuncs allow you to avoid explicit iteration over array elements (which is much slower).

# BROADCASTING

If an operation expects arrays of the same dimension, but different dimensions are given, numpy attempts to fix this by **broadcasting**—using duplication to extend an array to a higher dimension.

E.g.  $A+1$  works when  $A$  is a numpy array. It adds 1 to each entry. But how?

Broadcasting first turns 1 into an array with the same shape as  $A$  where each entry is 1.

[Details on the rules for broadcasting in VanderPlas.](#)



# AGGREGATIONS

Numpy has operations like sum, product, max, min, all, any, that reduce array dimension.

# MASKS

If  $A$  is an array and  $M$  is an array of `bool` of the same shape, then  $A[M]$  refers to a 1D array that lists elements of  $A$  at positions where  $M$  is `True`.

Often used to test or modify elements of an array that meet certain criteria, e.g.  $A[A > 5] = 5$ .

# REFERENCES

- [Python Data Science Handbook by Jake VanderPlas](#)
  - [Chapter 2](#) contains the introduction to numpy.
  - There is also a print edition from O'Reilly.

# REVISION HISTORY

- 2021-03-12 Add notebook link
- 2021-03-12 Initial publication

