

Complex Indexing Using NumPy



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Overview

Complex indexing operations to access specific elements in an array

Working with boolean array generated using conditions

Introducing arrays with structured data - a precursor to data frames

Working with mismatched arrays using broadcasting rules

Demo

Indexing using arrays of indices

Demo

Fancy indexing using GDP data

Demo

**Indexing with boolean arrays generated
using specified conditions**

Demo

Working with structured data in arrays

Broadcasting

Broadcasting

Describes how NumPy treats arrays with different shapes during arithmetic operations. Subject to certain constraints, the smaller array is “broadcast” across the larger array so that they have compatible shapes.

<https://docs.scipy.org/doc/numpy-1.13.0/user/basics.broadcasting.html>

Compatibility in Broadcasting

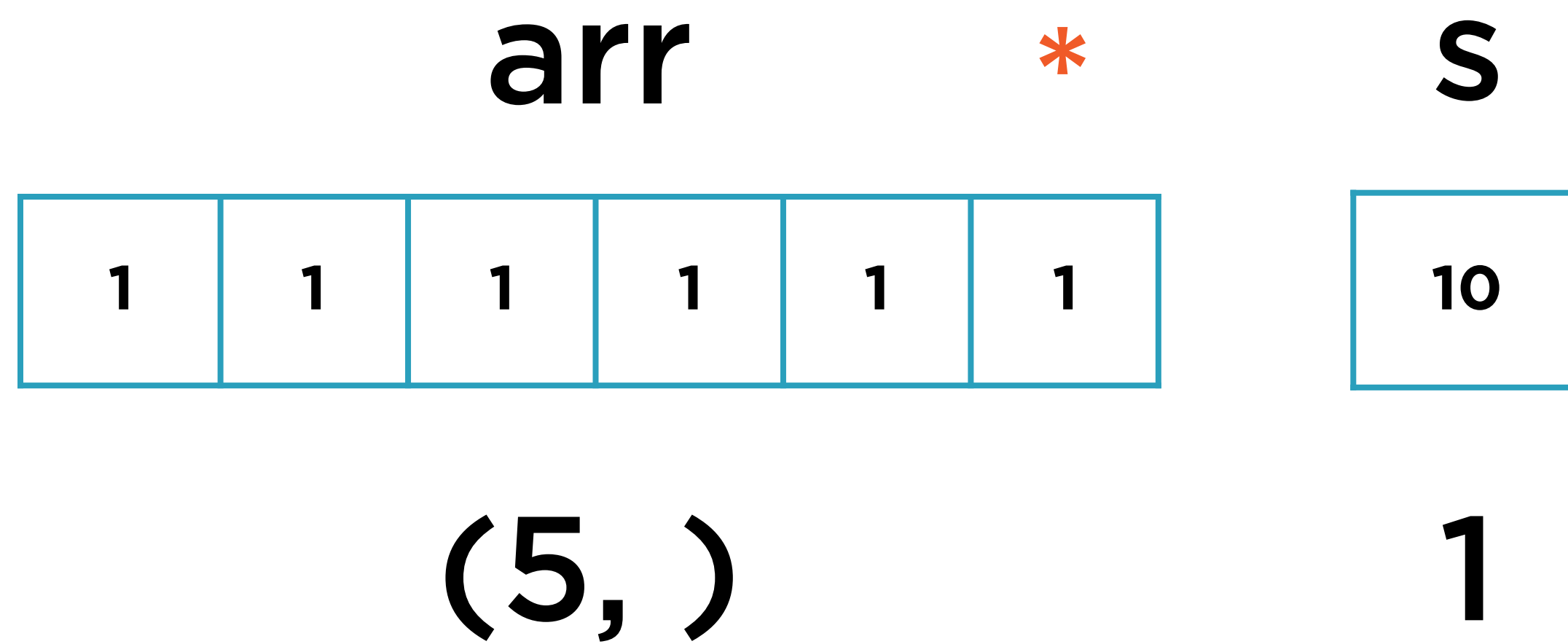
Broadcasting Scalars

Can always broadcast, independent of the other array in the operation

Broadcasting Arrays

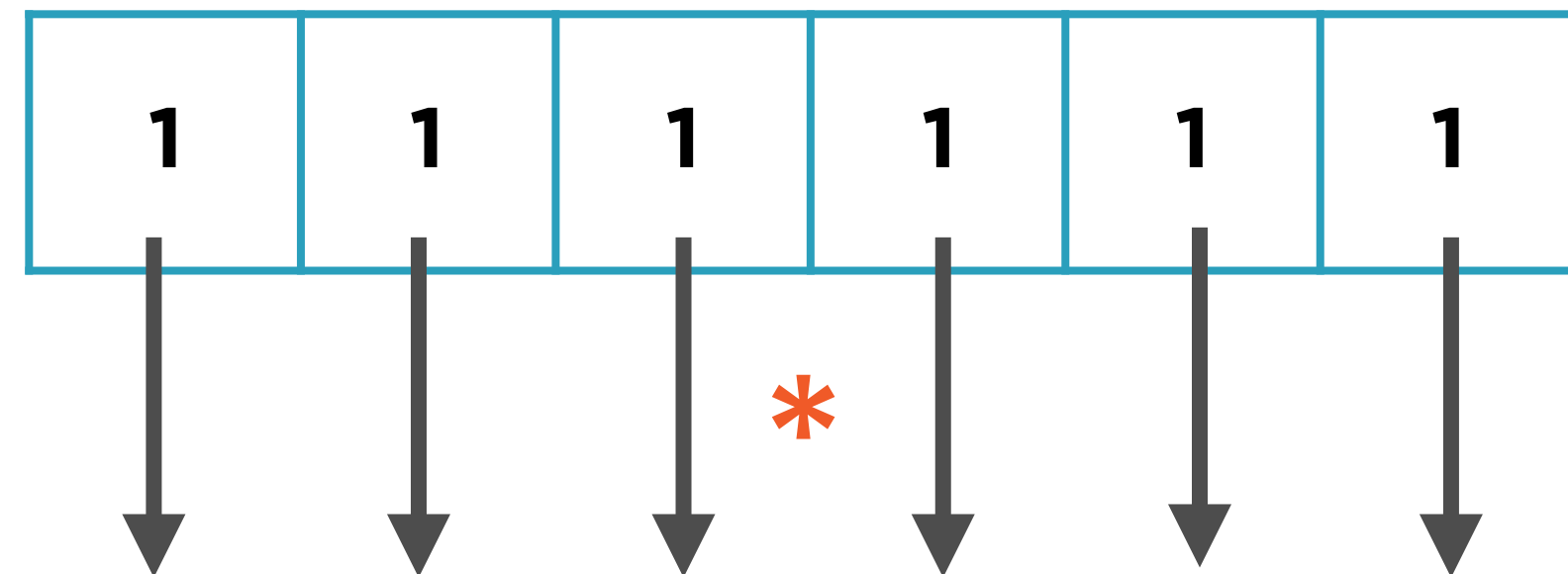
Can only be broadcast if the shapes of the two arrays match

Broadcasting Scalars

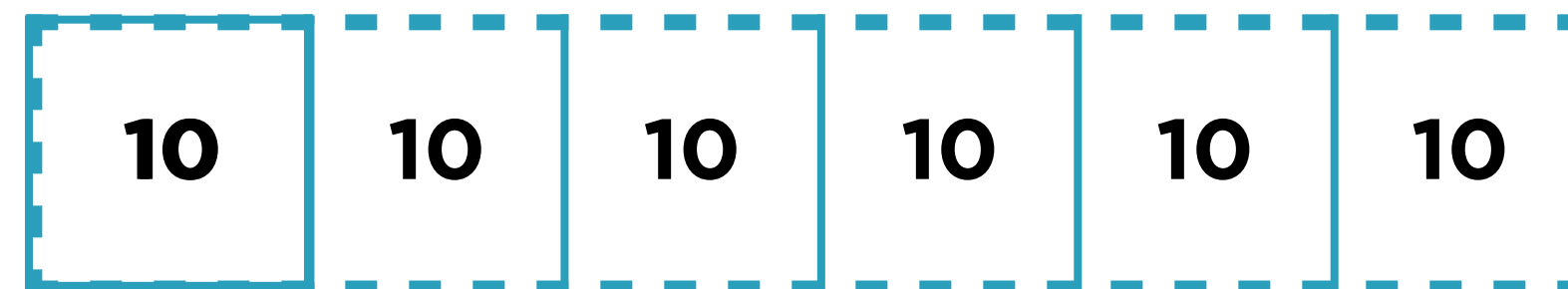


Broadcasting Scalars

arr

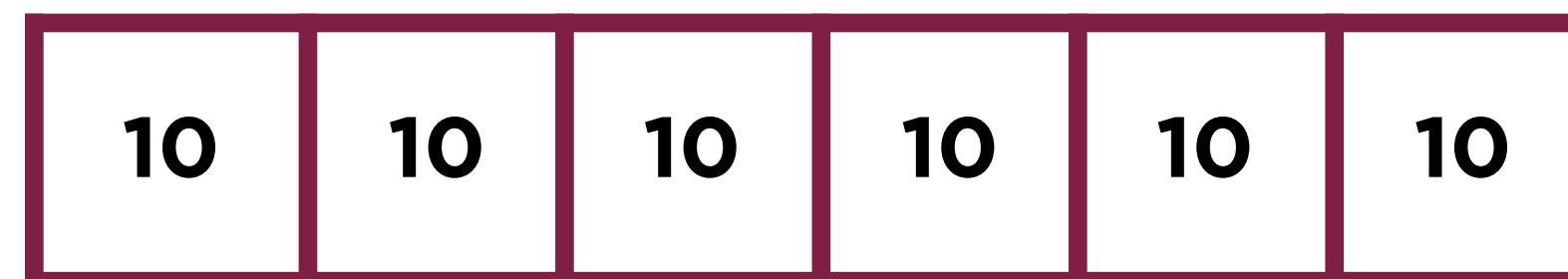


*



S

=



Broadcasting Scalars

arr

1	1	1	1	1	1
1	1	1	1	1	1
1	1	1	1	1	1

*

s

10	10	10	10	10	10
10	10	10	10	10	10
10	10	10	10	10	10

=

10	10	10	10	10	10
10	10	10	10	10	10
10	10	10	10	10	10

Broadcasting

Describes how NumPy treats arrays with different shapes during arithmetic **operations**. Subject to certain constraints, the smaller array is “broadcast” across the larger array so that they have compatible shapes.

Performed on pairs of arrays on an **element-by-element** basis.

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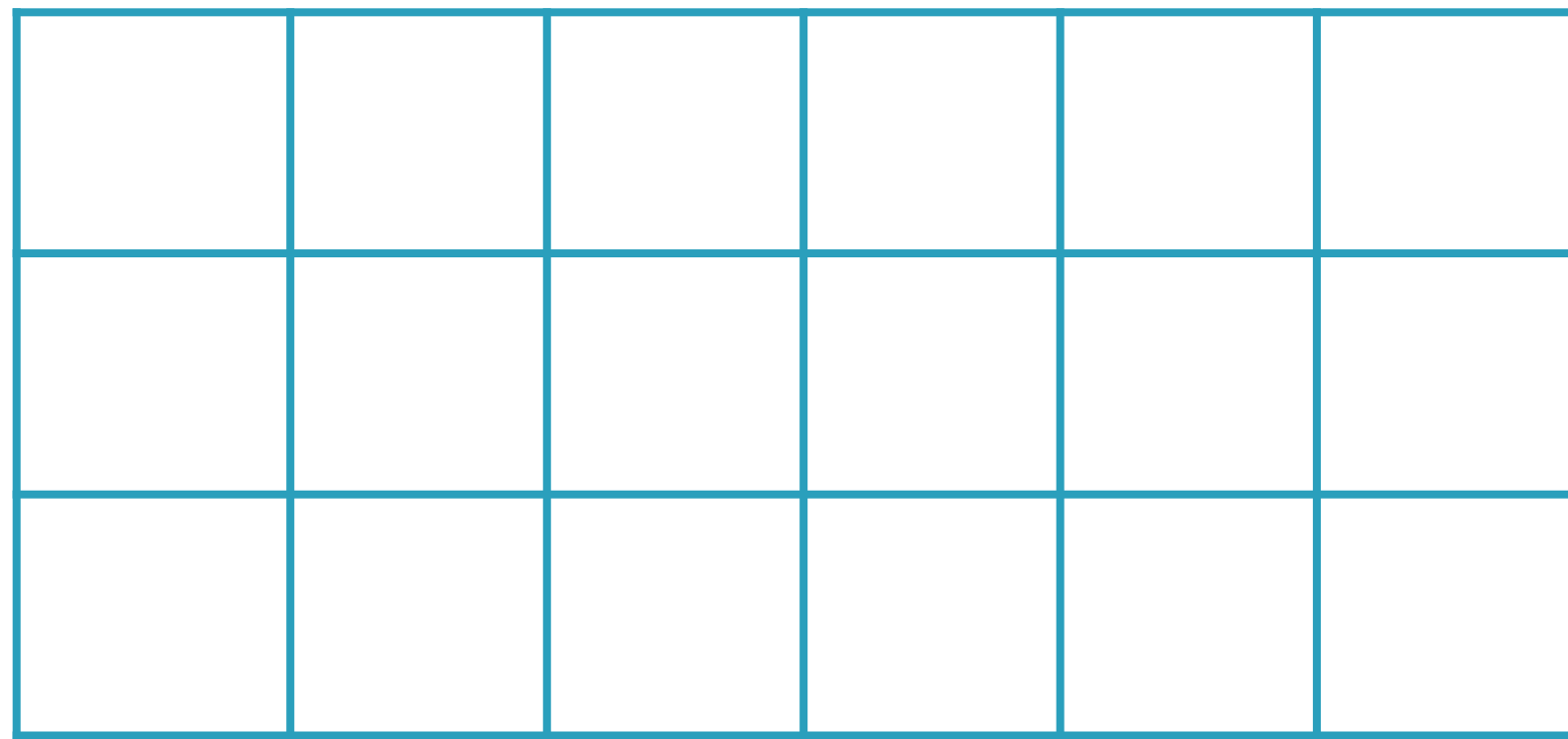
Shapes of the two arrays are compared element-wise

Broadcasting

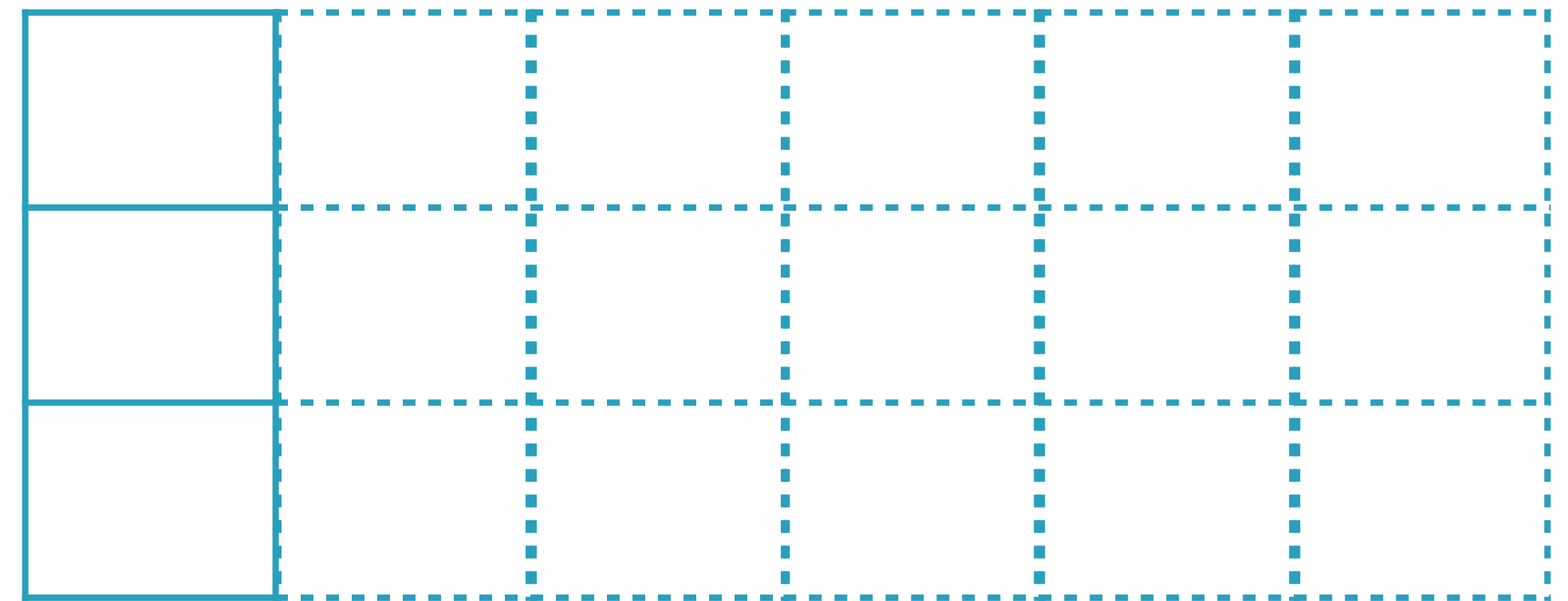
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Broadcasting Constraints



(3, 6)



(3, 1)

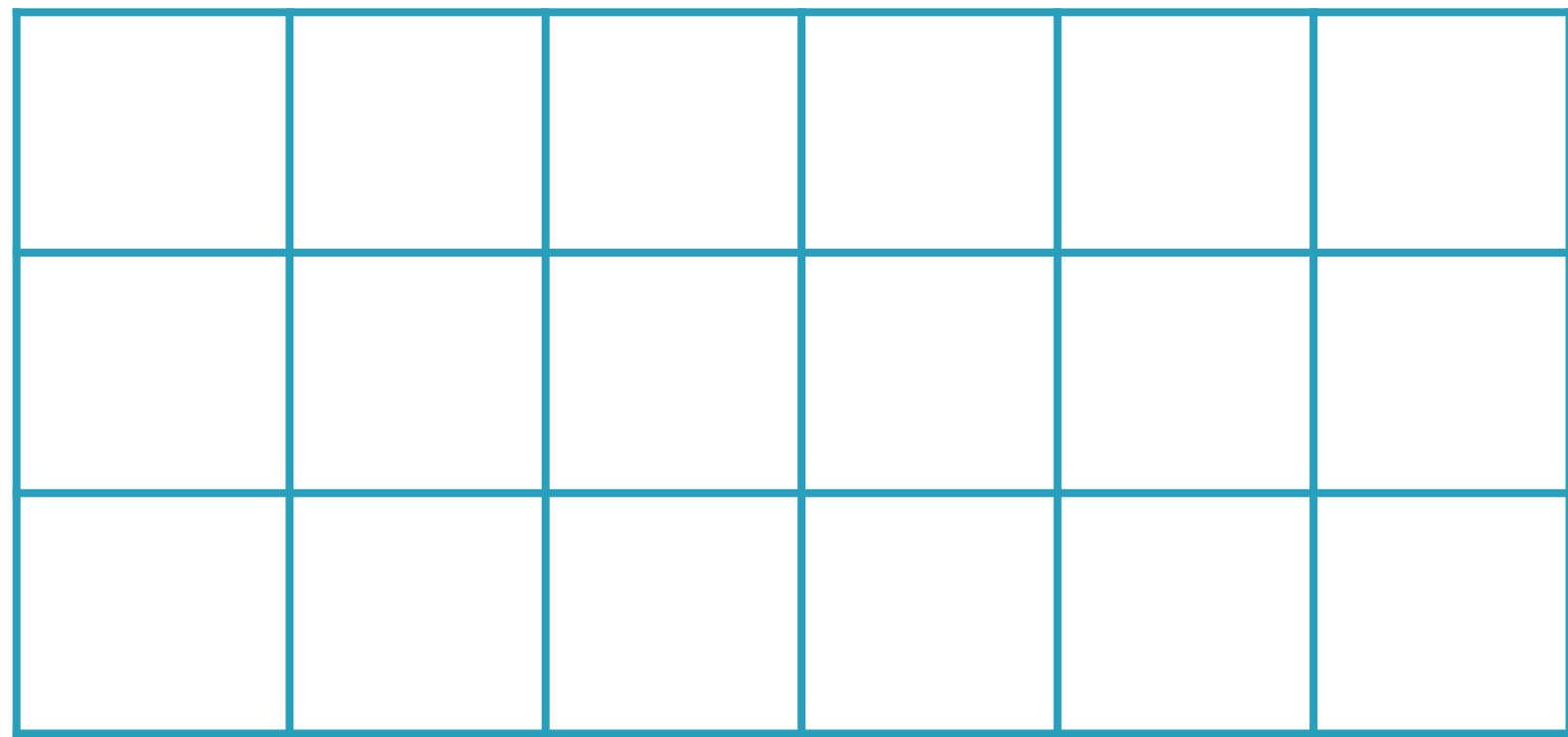
Broadcasting Constraints

(3, 6)

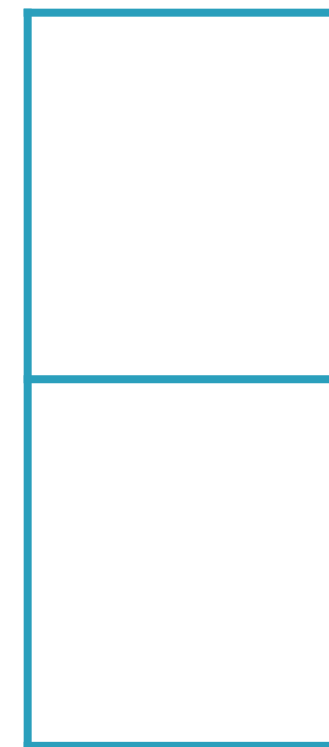
(3, 2)



Broadcasting Constraints



(3, 6)



(2, 1)



Shapes of the two arrays are compared element-wise

Broadcasting

Describes how NumPy treats arrays with different shapes during arithmetic operations. Subject to certain **constraints**, the smaller array is “broadcast” across the larger array so that they have compatible shapes.

Dimensions are considered in reverse order, starting with the trailing dimensions, and working forward

<https://docs.scipy.org/doc/numpy-1.13.0/user/basics.broadcasting.html>

Stretch the smaller array by
making copies of its elements

Broadcasting

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No actual copies made;
computationally and
memory-efficient

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Corresponding dimensions of
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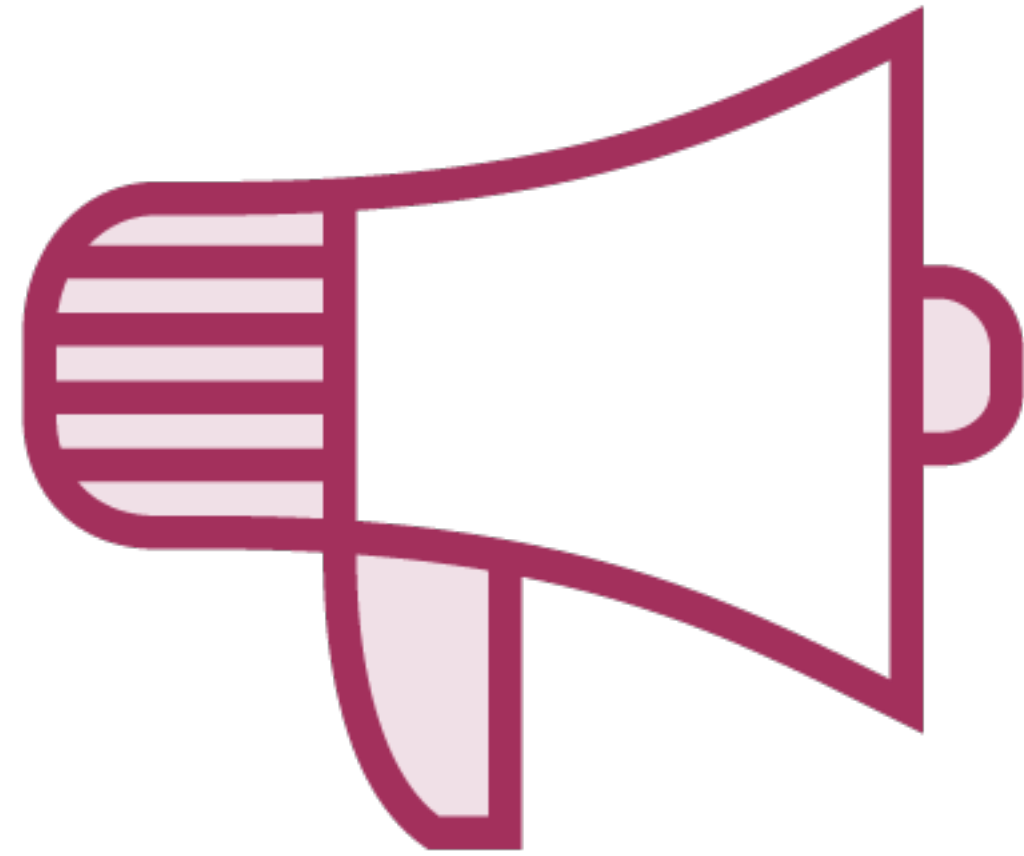
Corresponding dimensions of the arrays must be compatible

Broadcasting

Either corresponding dimensions are equal or one of the two dimensions is 1

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Broadcasting

Powerful: Allows arrays of different shapes to be combined

Memory-efficient: Needless copies avoided

Computationally-efficient: Looping ops in C rather than in Python

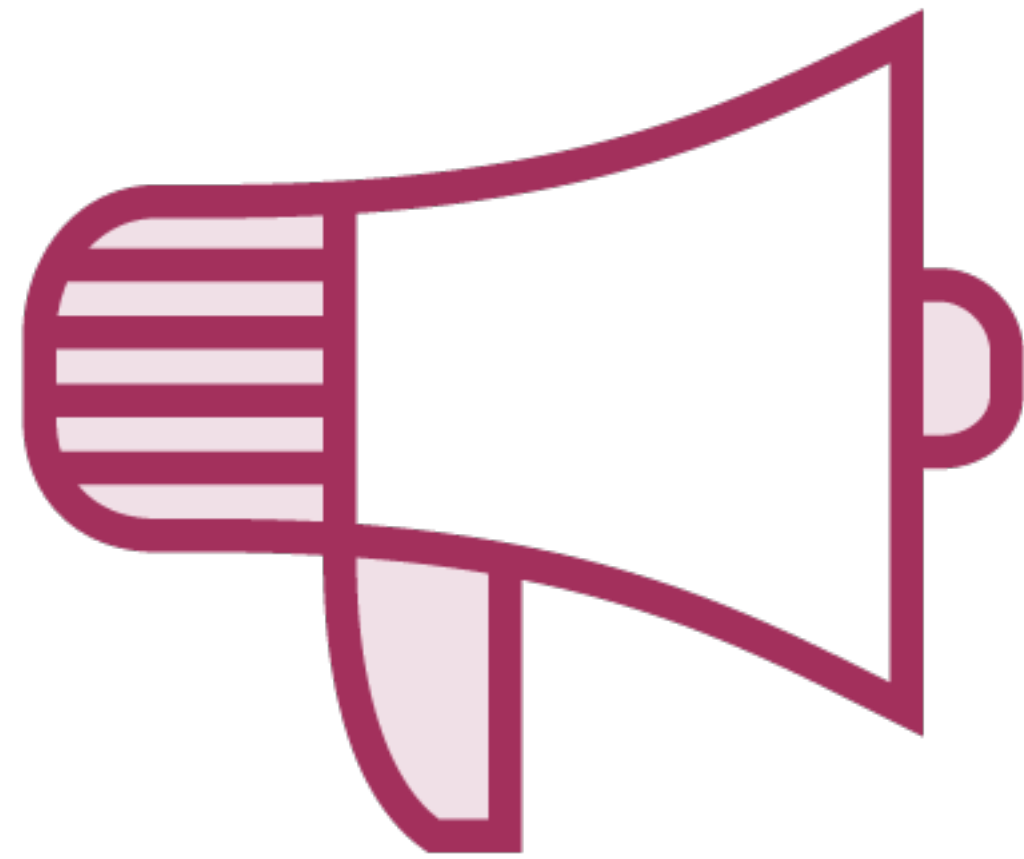
Compatibility in Broadcasting

Broadcasting Scalars

Can always broadcast, independent of the other array in the operation

Broadcasting Arrays

Can only be broadcast if the shapes of the two arrays match



Broadcasting Scalars

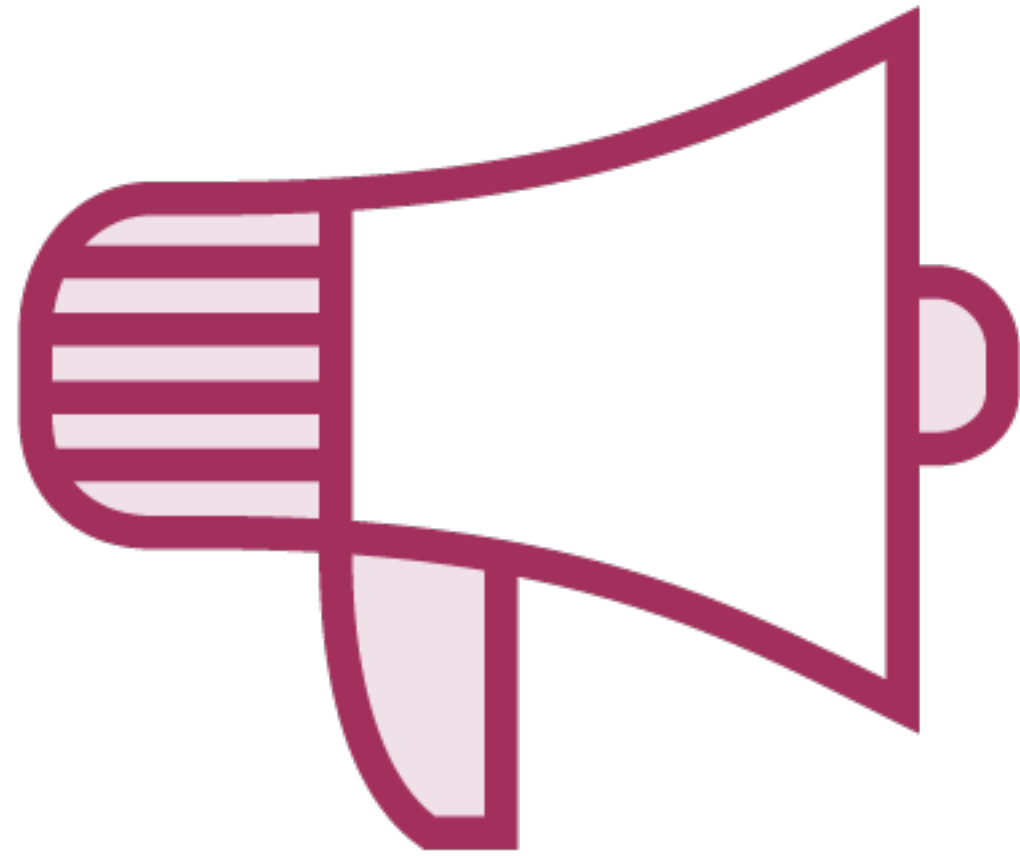
Scalars are easy to broadcast

Just replicate 1 element

Can always broadcast

Independent of the other array

Broadcasting Arrays



Shapes of the two arrays are compared

Starting from trailing end

Each dimension must be compatible

Demo

Broadcasting rules

Demo

Automatic array reshaping

Demo

Vector array stacking

Demo

Histograms

Demo

Miscellaneous functions

Summary

Complex indexing operations to access specific elements in an array

Working with boolean array generated using conditions

Introducing arrays with structured data - a precursor to data frames

Working with mismatched arrays using broadcasting rules