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

Allow operations on arrays with mismatched shapes

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

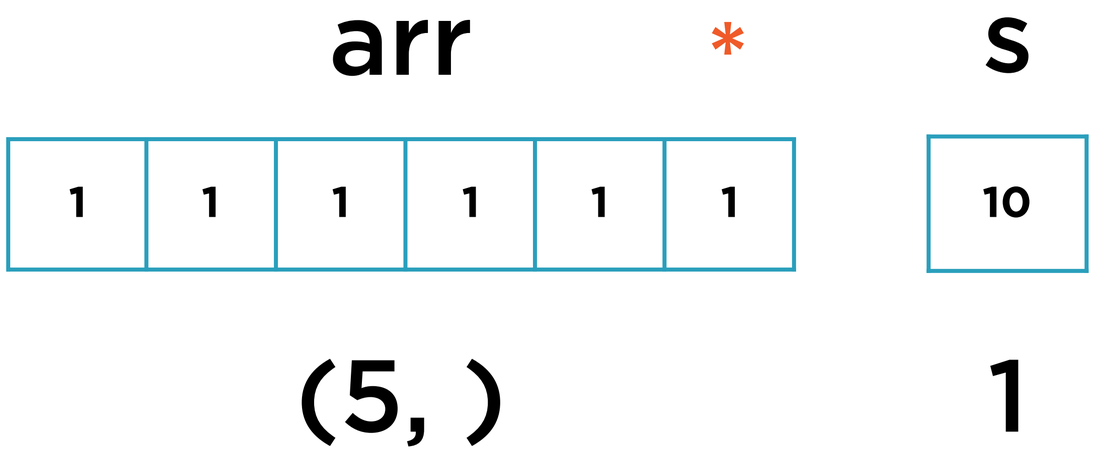
Broadcasting Scalars

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

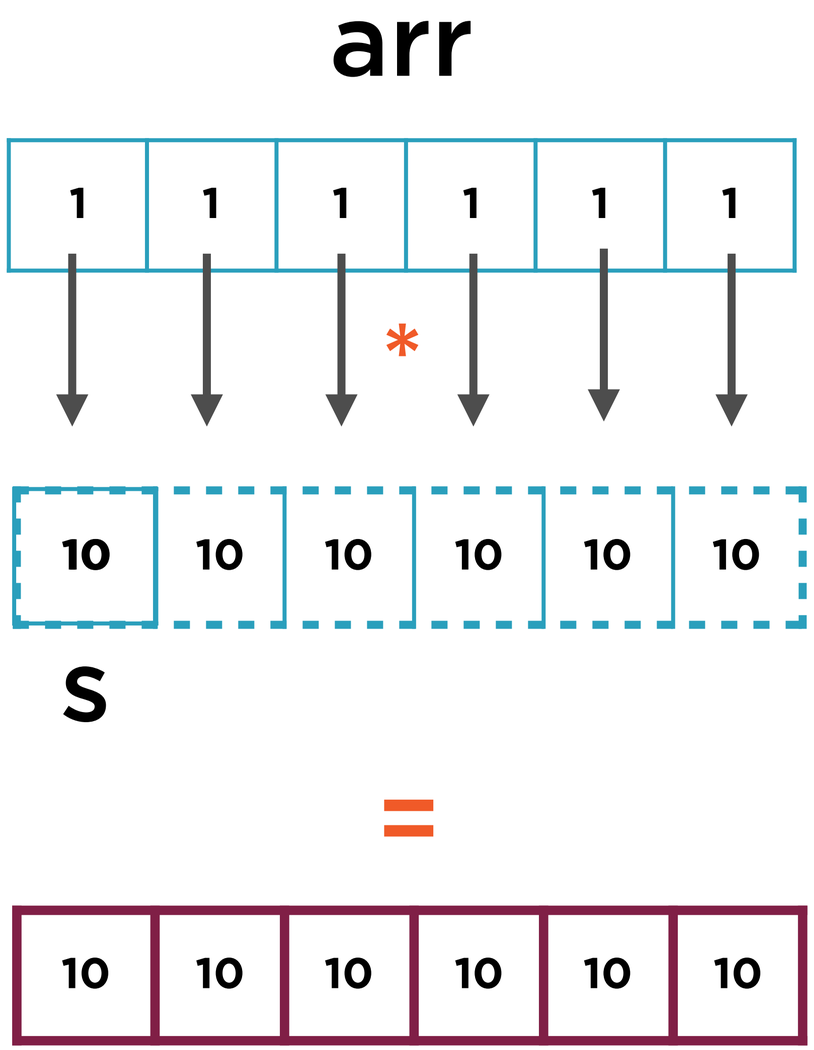
Broadcasting Arrays

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

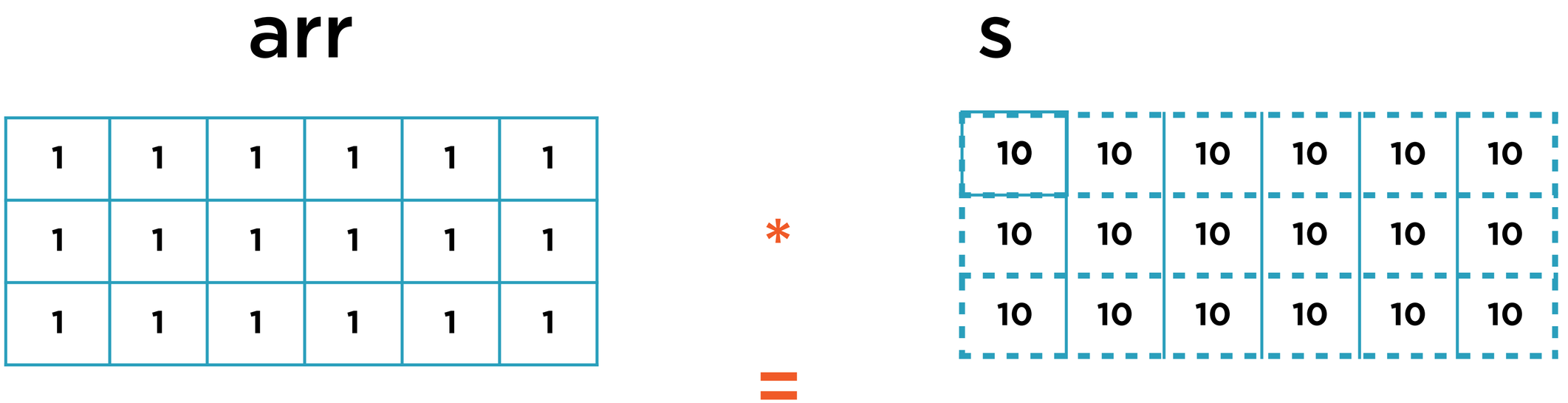
Broadcasting Scalars



Broadcasting Scalars



Broadcasting Scalars



Broadcasting

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

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Shapes of the two arrays are compared element-wise

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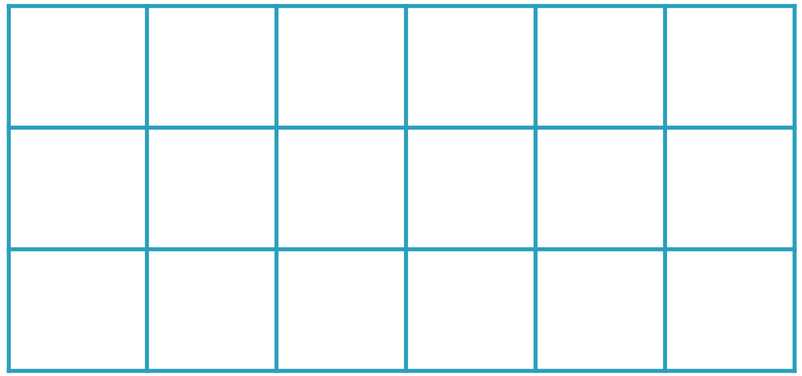
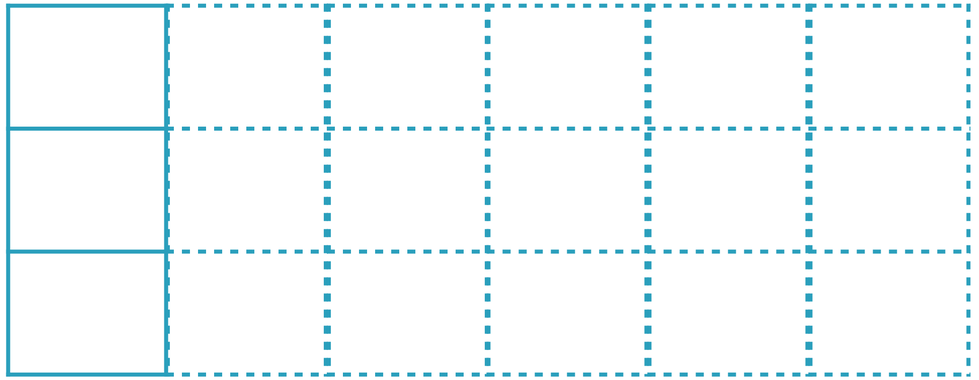
Broadcasting Constraints

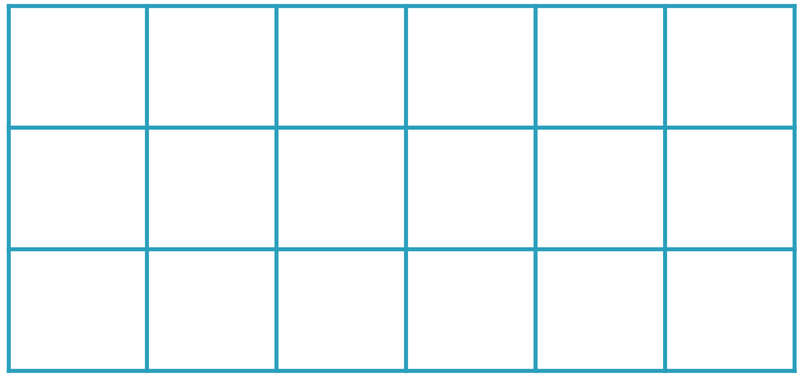


(3, 6)

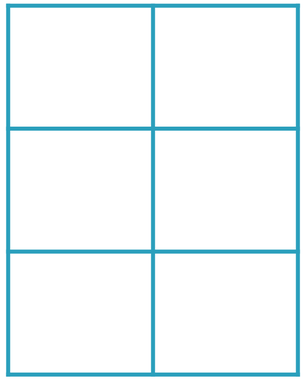


(3, 1)

Broadcasting Constraints

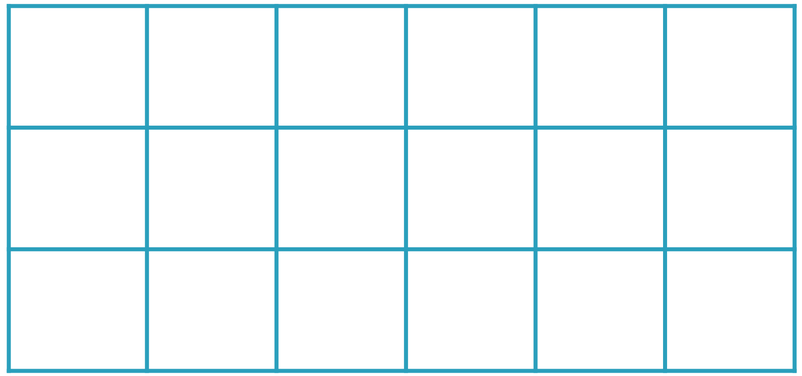


(3, 6)

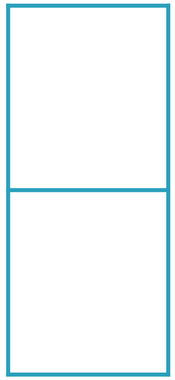


(3, 2)

Broadcasting Constraints



(3, 6)



(2, 1)

Shapes of the two arrays are compared element-wise

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

Broadcasting

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Stretch the smaller array by making copies of its elements

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No actual copies made; computationally and memory-efficient

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Corresponding dimensions of
the arrays must be compatible

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Corresponding dimensions of the arrays must be compatible

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

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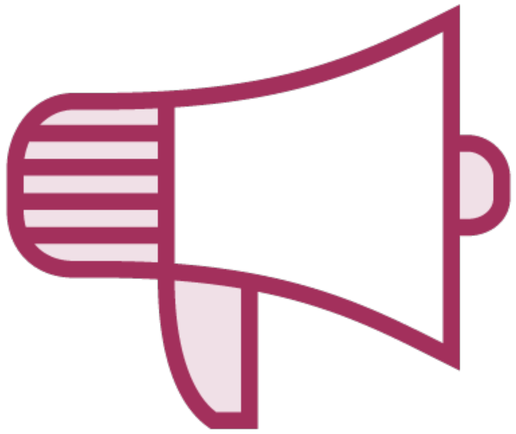
Broadcasting



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

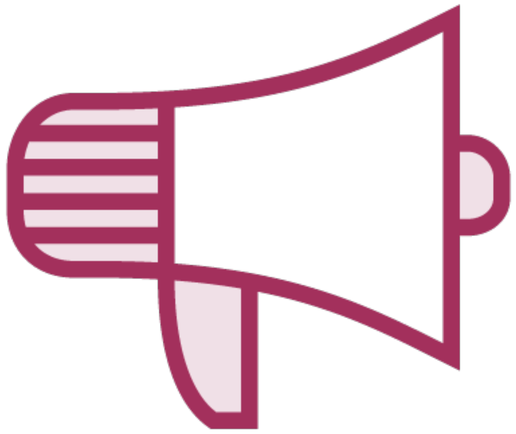
Broadcasting Scalars

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



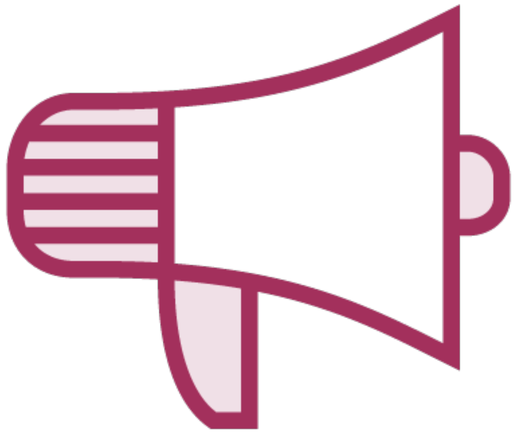
Scalars are easy to broadcast

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