Broadcasting

NumPy

AI

Broadcasting

Broadcasting is a feature in numpy that allows arrays of different shapes to be used in arithmetic operations.

```
a1 = np.array([5, 7, 9])
a2 = a1 + 5
print(a2)
```

a_1 `[1, 2, 3]` (3,) 1×3

a_4

```
[ [1],
  [2],
  [3] ]
```

(3,1) 3×1

---

a_1

(3,)

```
[ [1, 2, 3],
  [1, 2, 3],
  [1, 2, 3] ]
```

a_3

(4,)

a_4

(3,1)

```
[ [1, 1, 1],
  [2, 2, 2],
  [3, 3, 3] ]
```

The smaller array is broadcast across the larger array so that they have compatible shapes

$$a2 = a1 + 5$$

$$a2 = [5, 7, 9] + 5$$ broadcasting

$$a2 = [5, 7, 9] + [5, 5, 5]$$

$$a2 = [10, 12, 14]$$

Broadcasting Rules

When operating on two arrays, Numpy compares their shapes element-wise.

It starts with the trailing (rightmost) dimension

2d are compatible when

1. they are equal, or
2. one of them is 1

```
[1,2,3] + [4,5,6,7,8]
```

Value Error (3,) and (5,) are not compatible

```
[1,2,3] + [4,5,6]
```

Correct
(3,) & (3,)

```
[[1,2,3],
 [3,4,5]] + [4]
```

Correct
(2,3) & (1,)

```
[[1,2,3],
 [3,4,5],
 [6,7,8]] + [[1,2],
             [3,4]]
```

Error
(3,3) & (2,2)

[[1, 2],
  [2, 3],
  [3, 4]] + [1, 2, 3] (3, 2) & (3,)

[[1, 2, 3],
  [3, 4, 5]] + [1, 2, 3] (2, 3) & (3,)

(2, 3, 5) & (4, 1, 5)

```
[
  [[1,1,1,1,1],
   [1,1,1,1,1],
   [1,1,1,1,1]],

  [[1,1,1,1,1],
   [1,1,1,1,1],
   [1,1,1,1,1]]
]
```

```
[[[1,1,1,1,1]],
 [[1,1,1,1,1]],
 [[1,1,1,1,1]],
 [[1,1,1,1,1]]]
```

Error

(2, 3, 5)

(4, 1, 5)

neither same nor equal

one of them is 1

both are same

① (10, 5, 4) & (5, 1) → (10, 5, 4)

② (4, 1, 3) & (5, 4, 5, 1) → (5, 4, 5, 3)

③ (2, 1, 4, 3) & (6, 4, 1, 1) Error

④ (10, 9, 8, 7) & (1, 7) → (10, 9, 8, 7)