Aside 1:
Tensor Broadcasting

The General Broadcasting Rules

- TensorFlow adopts the general broadcasting rules of NumPy

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

  It starts with the **trailing** dimensions, and works its way forward

- Two dimensions are **compatible** when
  1. they are equal, or
  2. one of them is 1
- The size of the resulting array is the **maximum size** along each dimension of the input arrays

- When a tensor is broadcast, its entries are **conceptually copied**

  Broadcasting is a performance optimization, thus,
  for performance reasons, **no actual copying occurs**

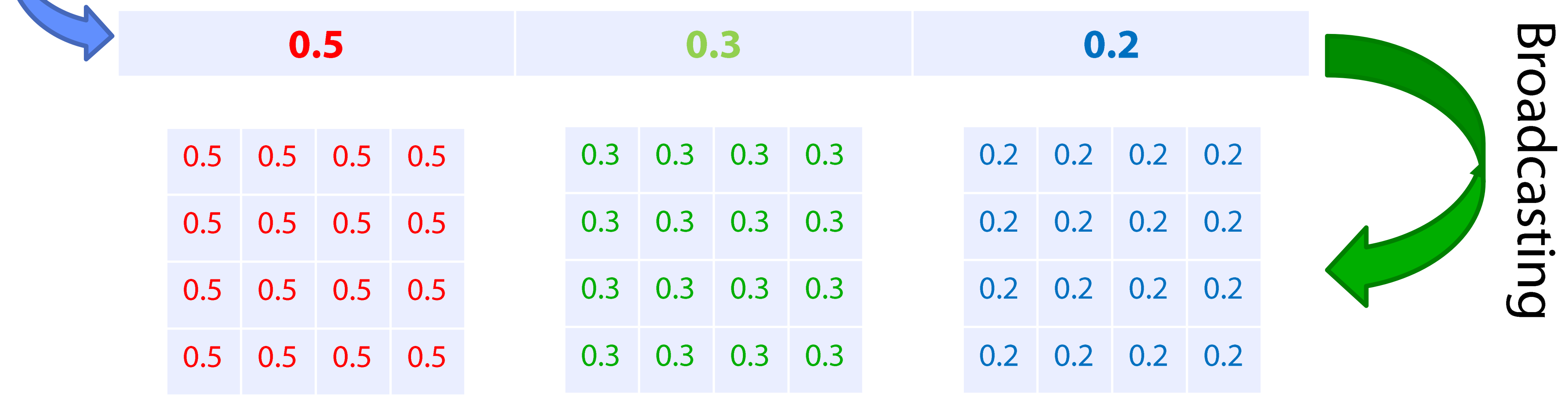
Applying the General Broadcasting Rule

```
A      (2d array):   5 x 4
B      (1d array):       1
Result (2d array):   5 x 4

A      (3d array):  15 x 3 x 1
B      (2d array):       3 x 5
Result (3d array):  15 x 3 x 5

A      (4d array):   8 x 1 x 6 x 5
B      (3d array):       7 x 1 x 5
Result (4d array):   8 x 7 x 6 x 5
```

Broadcasting: another example

- Each channel of an RGB image can be scaled by multiplying the image by a 1-D array (vector) with 3 values.

```
Image  (3d array): 4 x 4 x 3
Scale  (1d array):         3
Result (3d array): 4 x 4 x 3
```



0.5	0.3	0.2

0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5

0.3	0.3	0.3	0.3
0.3	0.3	0.3	0.3
0.3	0.3	0.3	0.3
0.3	0.3	0.3	0.3

0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2
0.2	0.2	0.2	0.2