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Aside 3: 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

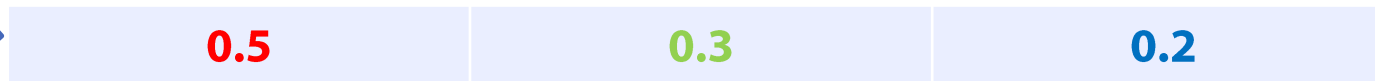
Broadcasting: another example

- 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

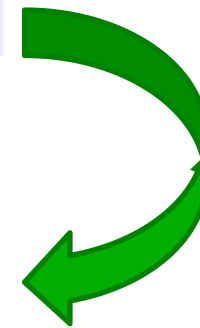
Result (3d array): 4 x 4 x 3



0.5	0.5	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



Broadcasting