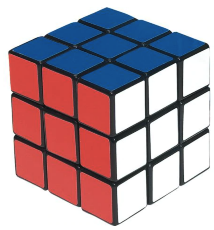
Homework 5



Slicing, Viewing, and Copying Arrays

1. Create two numpy arrays that are 3 x 3 identity matrices:

   - `I_3A`: a coerced list of lists
   - `I_3B`: built using the constructor method `eye()`.

   Be sure that both arrays are of type integer (Section 2.1 in Python Data Science Handbook may be helpful here. You can query the data type attribute of an array by calling the relevant attribute). Check your work by testing the equality of the two arrays.

2. Use slice indexing on `I_3A` to create a new matrix `I_2_UL`, a 2 x 2 identity matrix, from the upper-left corner of `I_3A`. Does creating this object change the nature of `I_3A`?

3. Use slice indexing to change in place the values of `I_2_UL` so that it is a matrix of all 1s. Does this change the nature of `I_3A`?

4. Similar to exercises 2 and 3, use slice indexing on `I_3A` to create a new matrix `I_2_LR` from the lower right corner of `I_3A`. This, time, however, append the `.copy()` method to your slice indexing when you're creating the new array. Use indexing to change in place the values of `I_2_LR` so that it is a matrix of all 1s. Does this change the nature of `I_3A`?

   Broadcasting and vector recycling

5. Consider the following arrays:

```
A = np.array([1])
B = np.array([1, 2, 3])
C = np.array([[4],
              [5],
              [6]])
```

   1. What is the *shape* of each array?

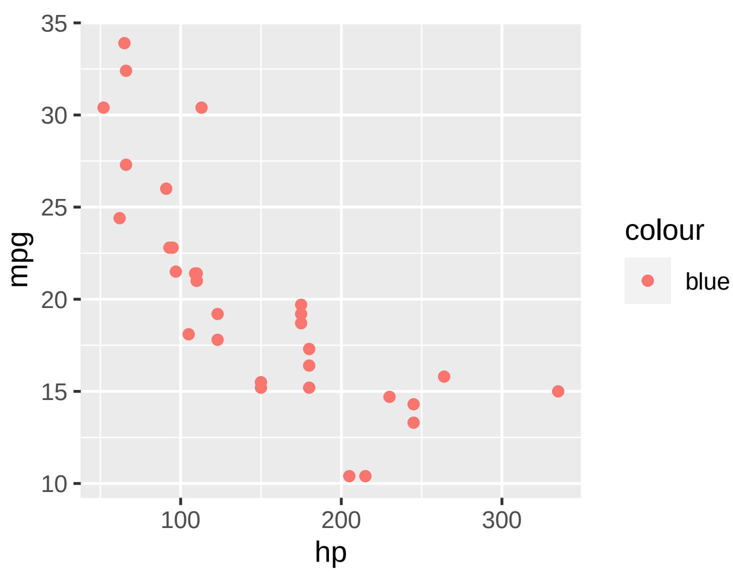
2. Try adding each pair of arrays togethers and observe the result. In a few sentences, describe precisely how Python carries out operations on arrays that differ in their shape.
3. Demonstrate what happens when you add an array of shape `(2, 3)` to it's transpose.

6. While that behavior in Python is called *broadcasting*, the nearest analog in R is called *vector recycling*. Try adding each pair of the following objects together; some of them vectors, some of matrices (special cases of arrays). Based upon the results, precise describe how/if R carries out operations on vectors and matrices of different shape.

```r
A_vec <- 1
A2_vec <- c(1, 2)
B_vec <- c(1, 2, 3)
B_mat <- matrix(c(1, 2, 3), nrow = 1)
C_vec <- c(4, 5, 6)
C_mat <- matrix(c(4, 5, 6), ncol = 1)
```

7. What follows is a simple scatterplot that features one of the most common errors to new users to `{ggplot2}`. Note, though, that it doesn't throw an error! How can this behavior be explained by vector recycling?

```r
library(ggplot2)
ggplot(mtcars, aes(x = hp, y = mpg, color = "blue")) +
    geom_point()
```



Aggregated Operations

8. Use `x = np.random.normal(loc = 7, scale = 2, size = (12, 4))` to generate a 12 x 4 array of random variables, each drawn from $N(\mu = 7, \sigma = 2)$. Treat this as 12 observations on 4 varibles.

    1. Use `dir()` to remind yourself of the methods available to a numpy array. Using

the appropriate method, find the mean, standard deviation, and maximum values within each column.

2. Using the results of these computations, create a new 12 x 4 array called `Z` that is the z-scores corresponding to each of the observations. Check that it is correct by computing it's columnwise mean and standard deviation.
3. Explain how broadcasting was involved in the computations from the previous exercise.