Sampling Methods Guide

In Data 8, we have three methods of generating random values:

1. `np.random.choice(array, sample_size=1)`

   Returns an array of length `sample_size` consisting of items randomly sampled *with replacement* from the array. If you don't specify the `sample_size` argument, it returns just one randomly chosen item.

2. `tbl.sample(n, with_replacement=False)`

   This function takes a sample size `n` (an integer), and an optional argument `with_replacement`, which is a boolean. This function returns a new table where `n` rows are randomly sampled from the original table; by default, `n=tbl.num_rows`. Default is `with_replacement=True`. For sampling without replacement, use argument `with_replacement=False`.

3. `sample_proportions(sample_size, model_proportions)`

   `sample_size` should be an integer, `model_proportions` an array of probabilities that sum up to 1. The function samples `sample_size` objects from the distribution specified by `model_proportions`. It returns an array with the same size as `model_proportions`. Each item in the array corresponds to the proportion of times that item was sampled out of the `sample_size` times. Both the input `model_proportions` and output sum to 1.

Each of these functions can be used interchangeably to sample with replacement. To sample without replacement, we use `tbl.sample(n, with_replacement=False)`.

Let's see how we can use these functions interchangeably:

To simulate 1000 coin flips of a fair coin, we could write:

1. `np.random.choice(make_array("Heads", "Tails"), 1000)`
   This will return an array of 1000 string values that are either `"Heads"` or `"Tails"`.
2. `Table().with_column("Outcome", make_array("Heads", "Tails")).sample(1000)`
   This will return a table with 1000 rows, and a column `"Outcome"`. Each row will have either the string `"Heads"` or the string `"Tails"` in it.

3. `sample_proportions(1000, make_array(0.5, 0.5))`
   This will return an array with two elements in it. The first item will be the simulated proportion of heads in 1000 tosses; the second item will be the simulated proportion of tails in those 1000 tosses.

To count the number of times we roll a 3 in 500 rolls of a fair dice we could write any of the following:

1.
   ```
   rolls = np.random.choice(np.arange(1, 7), 500)
   num_3 = np.count_nonzero(rolls == 3)
   ```

   `rolls` will be assigned to a 500 element array, where each element is a number between 1- 6 representing the face rolled.

   `num_3` is assigned to the number of times we roll a 3 by counting how many times the array of booleans is equal to `True`.

2.
   ```
   dice = Table().with_column("Face", np.arange(1, 7))
   rolls = dice.sample(500)
   num_3 = rolls.where("Face", are.equal_to(3)).num_rows
   ```

   `dice` is assigned to a one-column table with six rows representing sides of a dice. We use this table to sample 500 times default with replacement, and filter our table accordingly.

3.
   ```
   model_proportions = make_array(1/6, 1/6, 1/6, 1/6, 1/6,
   1/6)
   rolls = sample_proportions(500, model_proportions)
   num_3 = rolls.item(2) * 500
   ```

   `model_proportions` represents the theoretical proportions we expect to roll each of the six dice faces, 1/6. We use this array as an argument to `sample_proportions`, which evaluates to a six-element array containing the empirical proportions of each dice face after simulating 500 rolls. To find the number of times we see a three, we multiply the proportion at the second index by the sample size.

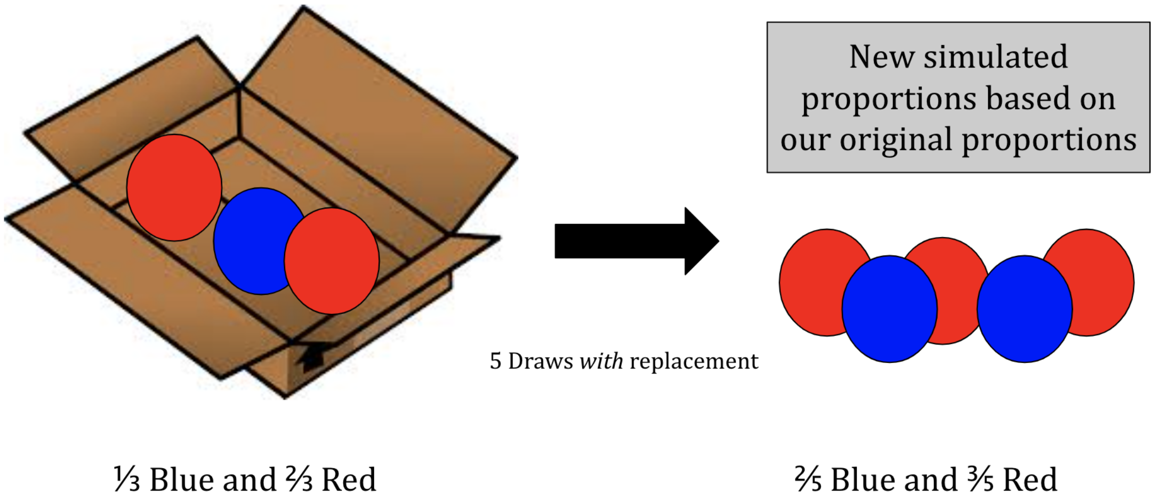
When should we use a specific function?

Because each of these functions are interchangeable, there are no set rules for which function to use. That being said, we can save ourselves some time by following these tips:

1. If we have some `model_proportions` specified in our problem, `sample_proportions` will probably be the simplest function to use!
2. If we are dealing with resampling values or our data is stored in a table already, then `tbl.sample` will probably be the most convenient function to use.
3. If we are choosing from an array of values, `np.random.choice` is often the easiest function to implement, or we can store the values in a table and then use `tbl.sample`.
4. When shuffling the labels for A/B testing, we should always use `tbl.sample(with_replacement=False)` because this is the only way we can sample without replacement.

More on `sample_proportions`

The easiest way to think about `sample_proportions` is through a toy scenario. Let's use the call to `sample_proportions(5, make_array(1/3,2/3))`. Imagine you have a *box of marbles* that contains one blue marble and two red marbles (see image below); this box is a representation of our model proportions ([⅓, ⅔] for this particular problem). The call to `sample_proportions` will make 5 draws **with replacement** to this hypothetical box and write down what color marble that was chosen. Then, it will convert the counts of each color into its associated percentage by dividing by the number of draws taken. The function will return **an array of sampled proportions** in the same order as they were given.


New simulated proportions based on our original proportions
5 Draws *with* replacement
⅓ Blue and ⅔ Red
⅖ Blue and ⅗ Red

These are only general tips; if you want more specific examples of when you might use each function, check out the textbook! For example, [Section 10.2]() has an example of using `tbl.sample` to sample from a table of flights, and [Section 11.2]() has an illustrative example on when to use `sample_proportions`.