# Aggregation

Use aggregation techniques to combine NumPy data and arrays.

## Chapter Goals:

- Learn how to aggregate data in NumPy
- Write code to obtain sums and concatenations of NumPy arrays

### A. Summation

In the chapter on Math, we calculated the sum of individual values between multiple arrays. To sum the values within a single array, we use the `np.sum` function.

The function takes in a NumPy array as its required argument, and uses the `axis` keyword argument in the same way as described in previous chapters. If the `axis` keyword argument is not specified, `np.sum` returns the overall sum of the array.

The code below shows how to use `np.sum`.

```
arr = np.array([[0, 72, 3],
                [1, 3, -60],
                [-3, -2, 4]])
print(np.sum(arr))
print(repr(np.sum(arr, axis=0)))
print(repr(np.sum(arr, axis=1)))
```

In addition to regular sums, NumPy can perform cumulative sums using `np.cumsum`. Like `np.sum`, `np.cumsum` also takes in a NumPy array as a required argument and uses the `axis` argument. If the `axis` keyword argument is not specified, `np.cumsum` will return the cumulative sums for the flattened array.

The code below shows how to use `np.cumsum`. For a 2-D NumPy array, setting

`axis=0` returns an array with cumulative sums across each column, while

`axis=1` returns the array with cumulative sums across each row. Not setting `axis` returns a cumulative sum across all the values of the flattened array.

```
arr = np.array([[0, 72, 3],
                [1, 3, -60],
                [-3, -2, 4]])
print(repr(np.cumsum(arr)))
print(repr(np.cumsum(arr, axis=0)))
print(repr(np.cumsum(arr, axis=1)))
```

### B. Concatenation

An important part of aggregation is combining multiple datasets. In NumPy, this equates to combining multiple arrays into one. The function we use to do this is `np.concatenate`.

Like the summation functions, `np.concatenate` uses the `axis` keyword argument. However, the default value for `axis` is `0` (i.e. dimension 0). Furthermore, the required argument for `np.concatenate` is a list of arrays, which the function combines into a single array.

The code below shows how to use `np.concatenate`, which aggregates arrays by joining them along a specific dimension. For 2-D arrays, not setting the `axis` argument (defaults to `axis=0`) concatenates the arrays vertically. When we set `axis=1`, the arrays are concatenated horizontally.

```
arr1 = np.array([[0, 72, 3],
                 [1, 3, -60],
                 [-3, -2, 4]])
arr2 = np.array([[-15, 6, 1],
                 [8, 9, -4],
                 [5, -21, 18]])
print(repr(np.concatenate([arr1, arr2])))
print(repr(np.concatenate([arr1, arr2], axis=1)))
print(repr(np.concatenate([arr2, arr1], axis=1)))
```

## Time to Code!

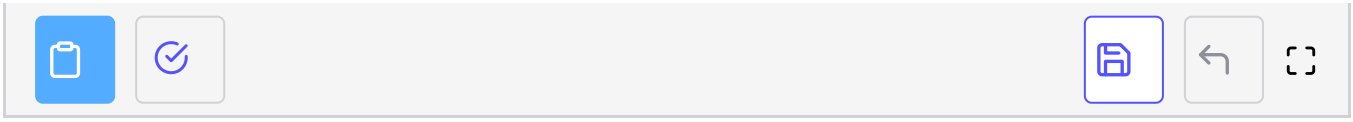
Each coding exercise in this chapter will be to complete a small function that takes in 2-D NumPy matrices as input. The first function to complete is `get_sums`, which returns the overall sum and column sums of `data`.

**Set `total_sum` equal to `np.sum` applied to `data`.**

**Set `col_sum` equal to `np.sum` applied to `data`, with `axis` set to `0`.**

**Return a tuple of `total_sum` and `col_sum`, in that order.**

```
def get_sums(data):
  # CODE HERE
  pass
```

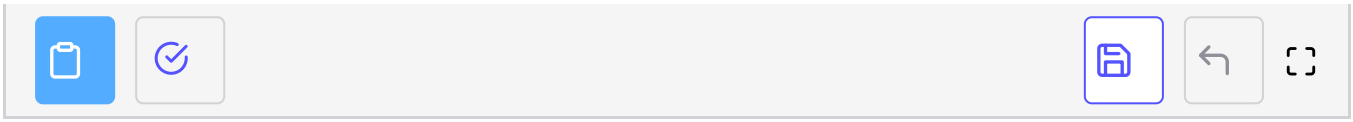


The next function to complete is `get_cumsum`, which returns the cumulative sums for each row of `data`.

**Set `row_cumsum` equal to `np.cumsum` applied to `data` with `axis` set to `1`.**

**Then return `row_cumsum`.**

```
def get_cumsum(data):
  # CODE HERE
  pass
```



The final function, `concat_arrays`, takes in two 2-D NumPy arrays as input. It returns the column-wise and row-wise concatenations of the input arrays.

**Set `col_concat` equal to `np.concatenate` applied to a list of `data1`, `data2`, in that order.**

**Set `row_concat` equal to `np.concatenate` applied to a list of `data1`, `data2`, in that order. The `axis` keyword argument should be set to 1.**

**Return a tuple containing `col_concat` and `row_concat`, in that order.**

```
def concat_arrays(data1, data2):
  # CODE HERE
  pass
```