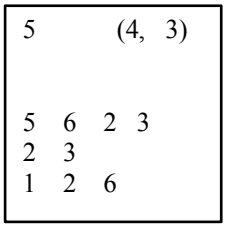
Recursion on the dimensions of an array



In the box to the right is a single integer, 5, a one-dimensional array containing the two integers 4 and 3, and a two-dimensional array, where the three rows contains 4, 2, and 3 integers. The latter is a *ragged array*. Java allows ragged arrays. If you are not familiar with this term, look it up in JavaHyperText.

We want to write a function that will calculate the sum of all the integers in such an array, and it should work even for an array of 2, 3, 4, 5 —any number— of dimensions. We can do that using recursion! This is neat!

Below is the specification of function `arraySum`. Its parameter `obj` has type `Object`, so it can be any object whatsoever. But look carefully at the Precondition, which limits what the parameter can be. It must be an `Integer`, which we consider an array of 0 dimensions, or an Integer array of any number of dimensions.

```
/** Return the sum of all integer values in obj.
  * Precondition: obj is one of the classes: Integer, Integer [], Integer [][], Integer [][][], etc.
  * None of the elements in obj is null. */
public static int arraySum (Object obj)
```

Consider writing function `arraySum` recursively. The base case is obviously a parameter whose type is `Integer`, and we can use operation **`instanceof`** to test for the base case.

In the recursive case, we know that parameter `obj` is an array, so we can cast `obj` down to type `Object []`! We then have the parameter as an array, and we can call function `arraySum` recursively on each of its elements and add their returned values together. So, we write function `arraySum` like this:

```
/** Return the sum of all integers in obj.
  * Precondition: obj is one of the classes: Integer, Integer [], Integer [][], Integer [][][], etc.
  * Precondition. None of the elements in obj is null. */
public static int arraySum (Object obj) {
  if (obj instanceof Integer) return (Integer) obj;

  // obj is an Object array
  Object [] oba= (Object []) obj;
  int sum= 0;
  for (Object ob: oba)
      sum= sum + arraySum (ob);
  return sum;
}
```

What a beautiful little recursive function that is!

Plop this function into some Java class and try it out on the examples we give below. Note that an integer like 5 represents an `Integer` object that contains that integer.

- For the argument 5, the value 5 is returned.
- For the argument array {1, 2, 3}, 6 is returned because 1+2+3 = 6.
- For the argument array {{1, 2, 5}, {3, 4}}, 15 is returned because 1+2+5+3+4 = 15.
- For the argument array {{{1}, {0, 3}, {}}, {{1,2,3}, {3}}}, 13 is returned because 1+0+3+0+1+2+3+3 = 13.