Problem Set 2

Assigned: Feb. 6
Due: Feb. 13

The grader for this homework will be Rahul Manghwani. His email address is manghwani7@gmail.com.

Exercise 1

Consider the following recursive method

```java
public static int f(int n) {
    if (n<=0) return 1;
    int sum = 1;
    for (int i = 0; i < n; i++)
        sum = sum + 2*f(i);
    return sum;
}
```

Show a trace of the execution of this method for f(3), similar to those in the notes for lecture 3. Your trace should show the values of the local variables `sum` and `i` associated with each call to `f`.

Exercise 2

A. Using the class `IntList` defined in lecture 3, write a method `static void runningSum(IntList l)` that destructively replaces the value in each node `n` by the sum of the values in the tail of the list starting at `n`. For example, if the initial state is this:

```
2 3 5 7  
B C DA
```

the final state should be this:

```
17 15 12 7  
A B C D
```

Your method should work by replacing the value fields; it should not be necessary to create any new `IntList` objects.

B. Repeat part A, but this time use recursion down the owner of method. That is, the signature of the method should be `public void runningSum()` and you should apply it to list `l` by calling `l.runningSum();`.
Exercise 3

If you have a list of numbers $L = [X_1, X_2, \ldots, X_k]$ and you have a two place numerical function $f(A, B)$, then the reduction of $L$ by $f$ is the value $f(X_1, f(X_2, f(X_3, \ldots, f(X_{k-1}, X_k)) \ldots))$.

For instance if $L$ is the list $[2, 3, 5, 7]$ and $p(A, B) = A + B$ then the reduction of $L$ by $p$ is $2+(3+(5+7)) = 17$.

If $q(A, B) = A * B$ then the reduction of $L$ by $q$ is $2*(3*(5*7)) = 210$.

If $r(A, B) = 2B - A$ then the reduction of $L$ by $r$ is $r(2, r(3, r(5, 7))) = r(2, r(3, 9)) = r(2, 15) = 28$.

Using the same technique used in the class `ApplierInt` from lecture 2, show how an interface can be written that allows you to write a general `Reduce` function to the values in an `int` array. Specifically, you should:

- Write an interface `ReduceFun` that has one abstract method `int f(int a, int b)`.
- Write three classes that instantiate `ReduceFun` and that override $f$ with methods that instantiate the above three functions $p, q, r$.
- Write a static method `int ReduceArray(ReduceFun w, int[] a)` which returns the reduction of $a$ by $w$.
- Write a small main function which is a driver illustrating the use of all this.

Note: It is not required, but I strongly recommend for this assignment that you actually get this running.

Honors Exercise

Repeat both parts of exercise 2, but do it non-destructively; that is, the original list structure remains unchanged, and you create a whole new list structure for the running sums. The method signatures should be, respectively

```java
public static IntList runningSum(IntList l)
```
and

```java
public IntList runningSum()
```