

## Lab 2

This lab will practice higher order procedures, especially procedures that return other procedures.

### 1. Procedures returning numbers.

- (a) Write a procedure named `double`  
parameter: a number  
result: the argument multiplied by 2.  
`(double 4) --> 8`
- (b) Write a procedure named `triple`  
parameter: a number  
result: the argument multiplied by 3.  
`(triple 4) --> 12`
- (c) Write a procedure named `mul`  
parameters: two numbers  
result: multiplies the first argument by the second.  
`(mul 4 2) --> 8`  
`(mul 4 3) --> 12`

### 2. Procedures returning procedures.

- (a) Write a procedure `make-double`  
No parameters.  
Result: a procedure of one parameter, that multiplies its argument by 2.  
`((make-double) 4) --> 8`  
`(define double (make-double))`  
`(double 4) --> 8`
- (b) Write a procedure `make-triple`  
No parameters.  
Result: a procedure of one parameter, that multiplies its argument by 3.  
`((make-triple) 4) --> 12`  
`(define triple (make-triple))`  
`(triple 4) --> 12`
- (c) Write a procedure `make-mul`, generalizing `make-double` and `make-triple`  
One parameter, a number.  
Result: a procedure of one parameter, that multiplies its argument by the given number.  
`(define double (make-mul 2))`  
`(double 4) --> 8`  
`((make-mul 3) 4) --> 12`

3. Define a procedure `doublefn` that takes a procedure of one argument as an argument and returns a procedure that applies the original procedure twice. That is, if passed the function  $f$ , the `(doublefn f)` returns a procedure that computes  $f(f(x))$ .

For example, if `inc` is a procedure that adds one to its single argument, then `(double inc)` should itself be a procedure that adds 2.

- (a) Define `doublefn`.
- (b) What is the value returned by  
`((doublefn (doublefn (doublefn inc))) 5)`
- (c) What is the value returned by  
`((doublefn (doublefn doublefn)) inc) 5)`  
Make sure you understand why (i.e. you could do this on a test without the scheme interpreter at your side)

Submit all 3 parts and well-chosen test cases on paper to the TA (or by the start of class Tuesday) to receive full credit.