More on Recursive

- Recursion vs. Iteration
- Why Recursion?
- Common Errors in Writing Recursive Methods:

Recursion vs. Iteration

- In general, an iterative version of a method will execute more efficiently in terms of time and space than a recursive version.
- This is because the overhead involved in entering and exiting a function in terms of stack I/O is avoided in iterative version.
- Sometimes we are forced to use iteration because stack cannot handle enough activation records - Example: power(2, 5000))

Why Recursion?

- Usually recursive algorithms have less code, therefore algorithms can be easier to write and understand - e.g. Towers of Hanoi. However, avoid using excessively recursive algorithms even if the code is simple.

- Sometimes recursion provides a much simpler solution. Obtaining the same result using iteration requires complicated coding - e.g. Quicksort, Towers of Hanoi, etc.

- Recursive methods provide a very natural mechanism for processing recursive data structures. A recursive data structure is a data structure that is defined recursively – e.g. Tree.

- Functional programming languages such as Clean, FP, Haskell, Miranda, and SML do not have explicit loop constructs. In these languages looping is achieved by recursion.

Why Recursion?

- Some recursive algorithms are more efficient than equivalent iterative algorithms.
- Example:

```
public static long power1 (int x, int n) {
   long product = 1;
   for (int i = 1; i <= n; i++)
      product *= x;
   return product;
}
```

```
public static long power2 (int x, int n) {
   if (n == 1) return x;
   else if (n == 0)return 1;
   else {
      long t = power2(x , n / 2);
      if ((n % 2) == 0) return t * t;
      else return x * t * t;
   }
}
```

Common Errors in Writing Recursive Methods

- The method does not call itself directly or indirectly.

- Non-terminating Recursive Methods (Infinite recursion):
  a) No base case.

```
int badFactorial(int x) {
   return x * badFactorial(x-1);
}
```

  b) The base case is never reached for some parameter values.

```
int anotherBadFactorial(int x) {
   if(x == 0)
      return 1;
   else
      return x*(x-1)*anotherBadFactorial(x -2);
      // When x is odd, we never reach the base case!!
}
```

Common Errors in Writing Recursive Methods

- Post increment and decrement operators must not be used since the update will not occur until AFTER the method call - infinite recursion.

```
public static int sumArray (int[ ] x, int index) {
   if (index == x.length)return 0;
   else
      return x[index] + sumArray (x, index++);
}
```

- Local variables must not be used to accumulate the result of a recursive method. Each recursive call has its own copy of local variables.

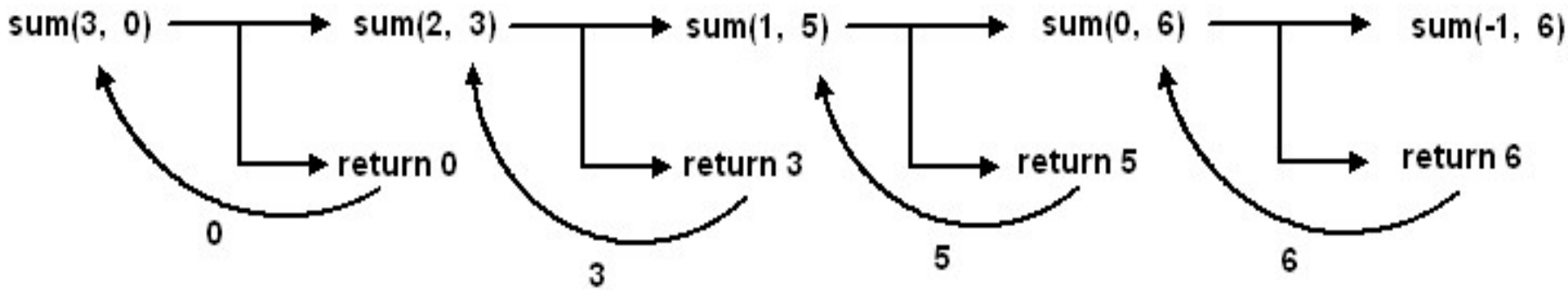
```
public static int sumArray (int[ ] x, int index) {
   int sum = 0;
   if (index == x.length)return sum;
   else {
      sum += x[index];
      return sumArray(x,index + 1);
   }
}
```

Common Errors in Writing Recursive Methods

- Wrong placement of **return** statement.
- Consider the following method that is supposed to calculate the sum of the first **n** integers:

```
public static int sum (int n, int result) {
   if (n >= 0)
      sum(n - 1, n + result);
   return result;
}
```

- When **result** is initialized to **0**, the method returns **0** for whatever value of the parameter **n**. The result returned is that of the final **return** statement to be executed. Example: A trace of the call sum(3, 0) is:

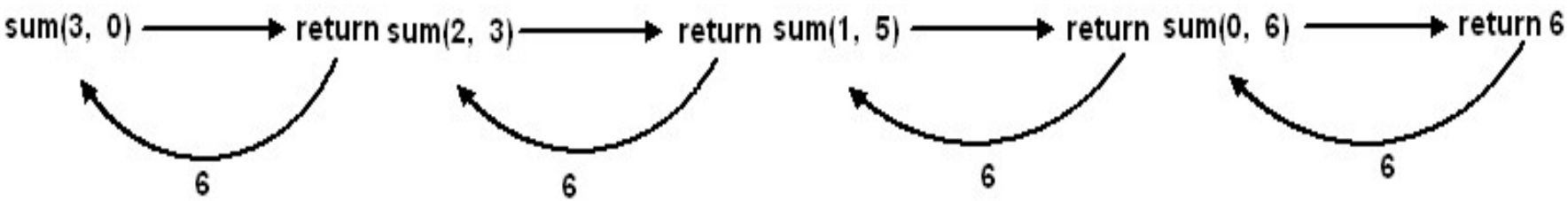


Common Errors in Writing Recursive Methods

- A correct version of the method is:

```
public static int sum(int n, int result){
   if (n == 0)
      return result;
   else
      return sum(n-1, n + result);
}
```

- Example: A trace of the call sum(3, 0) is:



Common Errors in Writing Recursive Methods

- The use of instance or static variables in recursive methods should be avoided.
- Although it is not an error, it is bad programming practice. These variables may be modified by code outside the method and cause the recursive method to return wrong result.

```
public class Sum{
   private int sum;

   public int sumArray(int[ ] x, int index){
      if(index == x.length)
         return sum;
      else {
         sum += x[index];
         return sumArray(x,index + 1);
      }
   }
}
```