1. What are the problems with the following recursive methods?

```
// What are the problems of the following recursive methods

public static double f1(int n) {
    return f1(n - 1) + 1.0 / n;
}

public static double f2(int n) {
    if (n == 1) {
        return 1.0;
    } else {
        return f2(n) + 1.0 / n;
    }
}

public static String f3(int n) {
    String s = f3(n - 3) + n + f3(n - 2) + n;
    if (n <= 0) {
        return "";
    } else {
        return s;
    }
}

public static int f4(int n) {
    if (n <= 0)
        return 0;
    else
        return f4(n / 3 + 1) + n - 1;
}
```

Answer:

f1	no base case
f2	non-base case is not reduced to base case
f3	base case can never be reached
f4	For any n>0, it can never reach to base case

2. Given the factorial definition below, provide a recursive and iterative algorithm and compare their time and space complexity. Assume N is non-negative.

0! = 1

N! = N * (N-1)!, when N>0

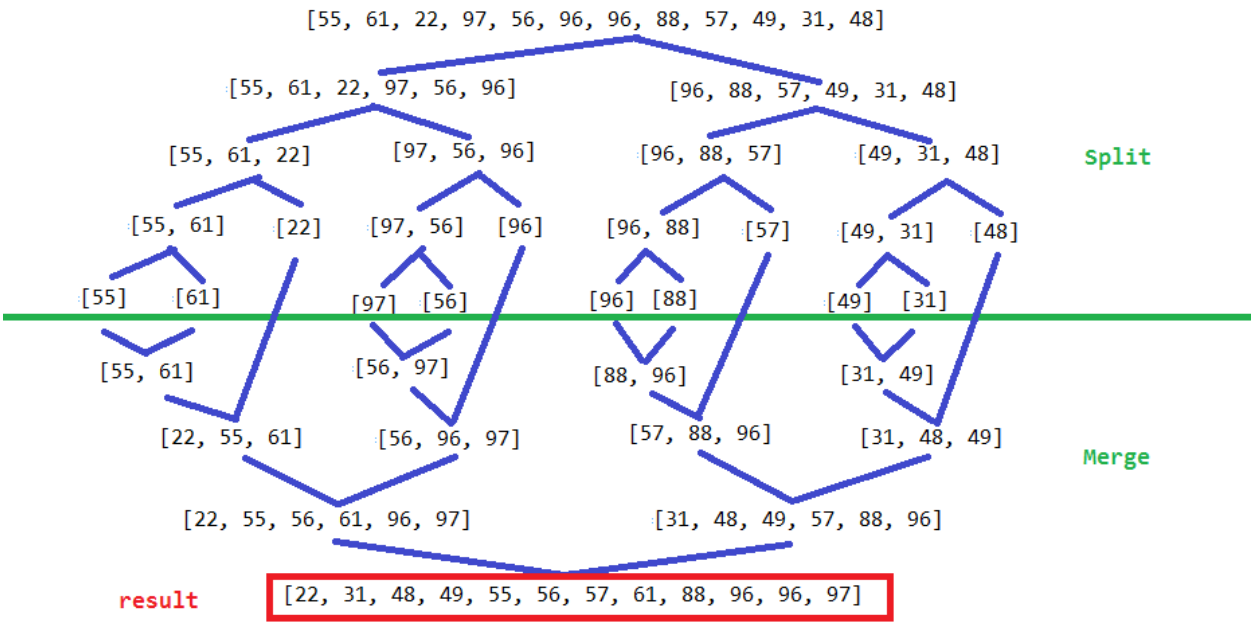
Answer:

```
// best-case, worst-case, average-case running time: O(n)
// best-case, worst-case, average-case space complexity: O(n)
public static long fact_R(int n) {
    if (n==0) {
        return 1;
    } else {
        return n*fact_R(n-1);
    }
}

// best-case, worst-case, average-case running time: O(n)
// best-case, worst-case, average-case space complexity: O(1)
public static long fact_I(int n) {
    long result = 1;
    for (int m = n; m>0; m--) {
        result *= m;
    }
    return result;
}
```

3. Show how the following array is sorted with top-down merge sort – a: [55, 61, 22, 97, 56, 96, 96, 88, 57, 49, 31, 48].

Answer:



4. Show how the following array is sorted with bottom-up merge sort

a: [55, 61, 22, 97, 56, 96, 96, 88, 57, 49, 31, 48]

```
a: [55| 61| 22| 97| 56| 96| 96| 88| 57| 49| 31| 48]

subarray size =  1 merge result

a: [55, 61| 22, 97| 56, 96| 88, 96| 49, 57| 31, 48]

subarray size =  2 merge result

a: [22, 55, 61, 97| 56, 88, 96, 96| 31, 48, 49, 57]

subarray size =  4 merge result

a: [22, 55, 56, 61, 88, 96, 96, 97| 31, 48, 49, 57]

subarray size =  8 merge result

a: [22, 31, 48, 49, 55, 56, 57, 61, 88, 96, 96, 97]
```