Recursion
(by Nicholas Ruozzi and Lisa Minich)

Recursion is similar to induction in reverse. We want to take the $k^{th}$ state and reduce it to the $(k-1)^{th}$ state. For example:

Summing up the numbers 0 through $k$ can be done iteratively:

```java
int sum = 0;
for(int i=1; i <= k; i++)
{
    sum += i;
}
```
or recursively:

```java
public int sum(int n)
{
    if(n==0) //base case
        return 0;
    else  //recursive case
        return sum(n-1) + n;
}
```

Where the $n^{th}$ state is added to the $(n-1)^{th}$ state for all $n$ greater than the base case. Which in this example was 0.

**Tail Recursion:**
A method is tail recursive if the last action of the recursive method is the recursive call. For example, the solutions to problems 1 and 2 are not tail recursive, but the solution to problem 3 is tail recursive. Because recursion builds frame upon frame of the stack, the additional overhead required by non-tail recursive functions could be costly for large inputs.

**Problem 1 (Reverse a string recursively):**

```java
public String reverseString(String word)
{
    if(word == null || word.equals("")
        return word;
    else
        return reverseString(word.substring(1, word.length())) + word.substring(0,1);
}
```
Problem 2 (Remove consecutive duplicates from a string recursively):

For example, convert “aabccba” to “abcba”

```java
public String removeDuplicates(String word) {
    if(word == null || word.length() <= 1)
        return word;
    else if( word.charAt(0) == word.charAt(1) )
        return removeDuplicates(word.substring(1, word.length()));
    else
        return word.charAt(0) + removeDuplicates(word.substring(1, word.length()));
}
```

Problem 3 (Compute n mod m without using %):

```java
public int modulus(int val, int divisor) {
    if(val < divisor)
        return val;
    else
        return modulus(val - divisor, divisor);
}
```

Problem 1 (again) with Tail Recursion:
Someone asked in section if it was possible to convert non-tail recursive functions into
tail recursive ones. The answer is usually yes. To illustrate how this can be done, I will
rewrite problem one using tail recursion. To do this, I will utilize a helper function.

```java
public String reverseString(String word) {
    return tailReverse(word, "");
}

public String tailReverse(String word, String res) {
    if(word == null || word.equals(""))
        return res;
    else
        return tailReverse(word.substring(1, word.length()), res + word.charAt(0));
}
```

tailReverse is a tail recursive method that reverses a string.

Parsing:
All of the information on parsing can be found in the lecture notes.