

Department of Computer Science

Introduction to Recursion

Dr. Chia-Ling Tsai

Outline

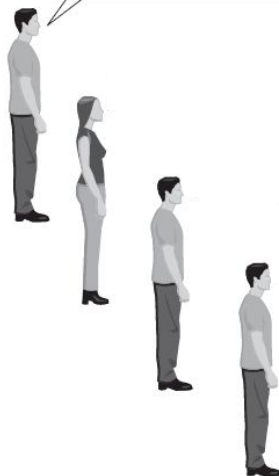
- Definition
- A non-programming example
- First example
- Recursive binary search

Definition

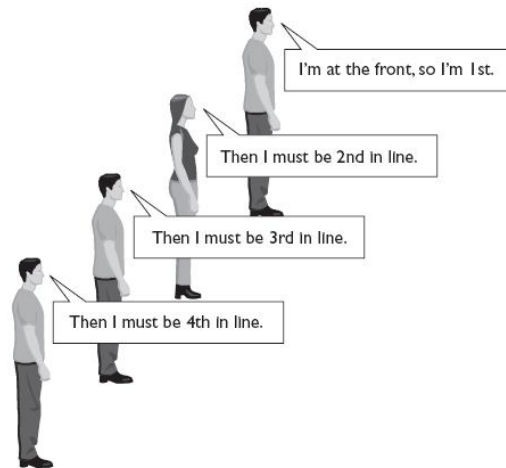
- We're very used to iterative approach by now
 - Actions are repeated using a loop
- Recursion is a programming technique in which a method calls itself.

Non-Programming Example

What place are you in line?



(continue)



First Example—summation

■ Iterative solution:

```
public static int sum_iterative(int[] numbers)
{
    int sum = 0;
    for (int i=0; i<numbers.length; i++) {
        sum += numbers[i];
    }
    return sum;
}
```

■ Recursive solution:

```
public static int sum_recursive(int[] numbers, int end)
{
    if (end<0) {
        // base case
        return 0;
    } else {
        // recursive case
        int partial_sum = sum_recursive(numbers, end-1);
        return partial_sum+numbers[end];
    }
}
```

Recursive Binary Search

- Can we make the binary search recursive?

```
public static int binary(int[] numbers, int target)
{
    int min=0;
    int max=numbers.length-1;

    while (min<=max) {
        int mid=(max+min)/2;
        if (numbers[mid]==target){
            return mid; // found it!
        } else if (numbers[mid]<target) {
            min=mid+1; // too small
        } else { //numbers[mid] > target
            max=mid-1; // too large
        }
    }
    return -1; // not found
}
```

(continue)

- The recursive version:

```
public static int binary_recursive( int[] numbers, int target,
                                   int min, int max)
{
    int mid = (max+min)/2;

    if (min>max) {
        // base case
        return -1; // not found
    } else if (numbers[mid]==target) {
        // another base case
        return mid;
    } else if (numbers[mid]<target) {
        // recursive case
        return binary_recursive(numbers, target, mid+1, max);
    } else {
        // another recursive case
        return binary_recursive(numbers, target, min, mid-1);
    }
}
```

Insertion Sort

- Let's try a recursive version of selection sort with the input {12, 123, 1, 28, 183, 16}

0	1	2	3	4	5
12	123	1	28	183	16

