Week 2: Recursion and Sorting

Recursion

What is recursion

> Recursion (adjective: recursive) occurs when a thing is defined in terms of itself or of its type. Recursion is used in a variety of disciplines ranging from linguistics to logic. The most common application of recursion is in mathematics and computer science, where a function being defined is applied within its own definition. While this apparently defines an infinite number of instances (function values), it is often done in such a way that no infinite loop or infinite chain of references can occur.

- from Wikipedia the free encylopedia

Recursion Pattern

- Recursion: when a method calls itself
- Classic example: factorial function

Linear Recusion

- Test for **base cases**
  - Begin by testing for a set of base cases
  - Every possible chain of recursive calls *must* eventually reach a base case
- Preform a single recursive call

```
public void recursiveMethod(int n) {
    if (n <= 0) {
        return 0;
    } else if (n%2 == 0) {
        return 1 + recursiveMethod(n/2);
    } else {
        return 1 + recursiveMethod(n-1);
    }
}
```

- In linaer recursive calls it only calls one of itself

```
public void ReverseArray(int[] A, inti, intj) {
    if(i < j) {
        inttmp= A[i];
        A[i] = A[j];
        A[j] = tmp;
        ReverseArray(A, i+1, j-1);
```

```
    }
}
```

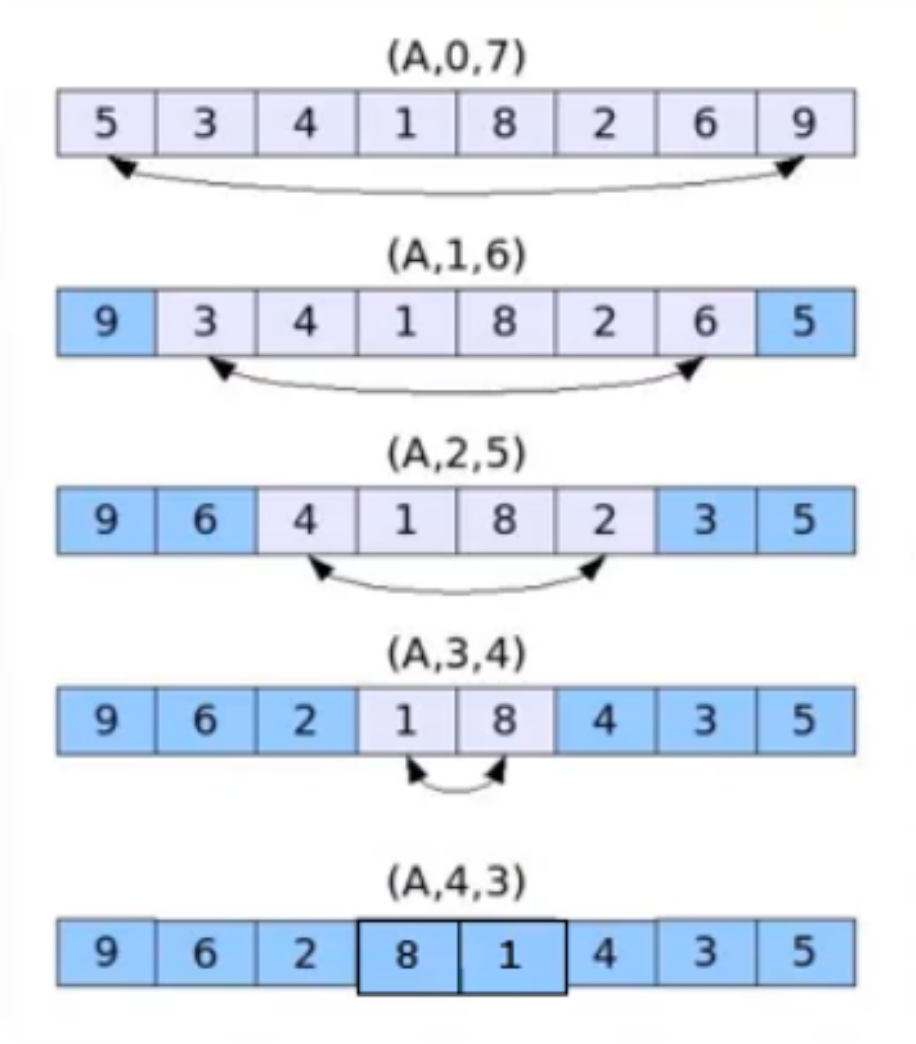


Figure 1: Reverse array recursivly demo

Defining Arguments for Recursion

- Recursive methods may require additional parameters
- We defined array reversal as `ReverseArray(A, i, j)` not `ReverseArray(A)`
- Operands are passed forward via parameters
- Simple case: result of recursion is passed back via return

Tail Recursion

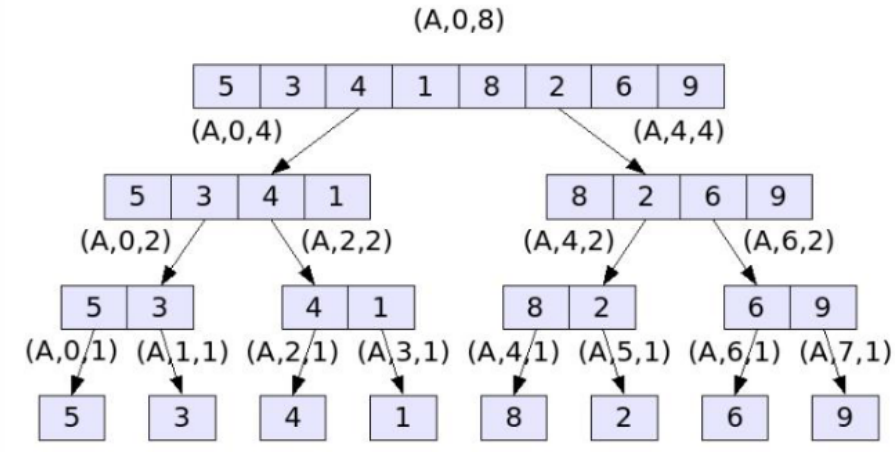
- Recursive call as the last step
- Easily converted into iterative forms, the `ReverseArray` function aboave can be easily turned into a loop:

```
public void ReverseArray2(int[]A, inti, intj    ) {
    while( i< j ) {
        inttmp= A[i];
        A[i] = A[j];
        A[j] = tmp;
        i+= 1; j -= 1;
    }
}
```

Binary Recursion

- Two calls for each non-base case

```
public int BinarySum(int[]A, inti, intlen) {
    if(len== 1) {
        return A[i];
    } else {
        return BinarySum(A, i, len/2)+ BinarySum(A, i+ len/2, len/2);
    }
}
```



Multiple Recursion

- Multiple recursion makes potentially many recursive calls

Recursion Activity

- Use recursion to design an algorithm that sorts an array of n integers
- We will call this selectionSort Base Case
- `n = 1`
  - Single-element input
  - Nothing to sort! Recursive Case
- Scan each element of the arrfasdfasdfay – find the largest ($e_{\max} i$))

7	5	3	5	7	8	6	5	1	2
					^				

- Swap $e_{\max}$with the last element of the array

7	5	3	5	7	2	6	5	1	8
					^				^

- Repeat this process on the first $n - 1$ elements

7	5	3	5	7	2	6	5	1

```
Algorithm selectionSort(A, n)
  if n > 1 then
      maxIndex <- 0
      for i := 1 to <- 1 do
          if A[i] > A[maxIndex] then
              maxIndex <- i
          swap(A[maxIndex], A[n -1])
          selectionSort(A, n -1)
```