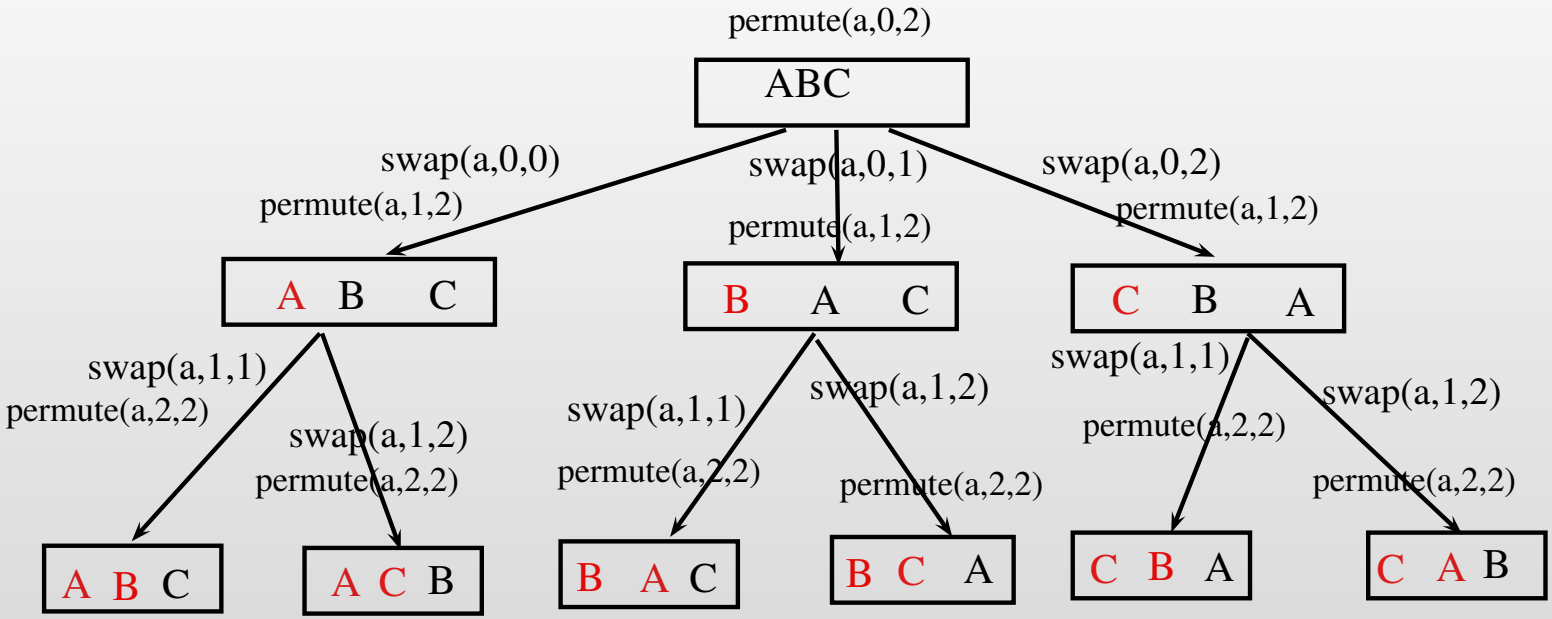
How about permutations?
Note that, permutation(abc) $\rightarrow$

- a + permutation(bc) $\rightarrow$ abc, acb
- b + permutation(ac) $\rightarrow$ bac, bca
- c + permutation(ab) $\rightarrow$ cab, cba

Recursive function for printing all permutations of a given string

```
void permute(char a[], int i, int n)
{//i=current start index
   int j;
   if (i == n) printf("%s\n", a);
   else{
        for (j = i; j <= n; j++){
          swap(a,i,j);
          permute(a, i+1, n);
          swap(a,i,j); //backtrack
        }
    }
}
```

The recursive function call sequence

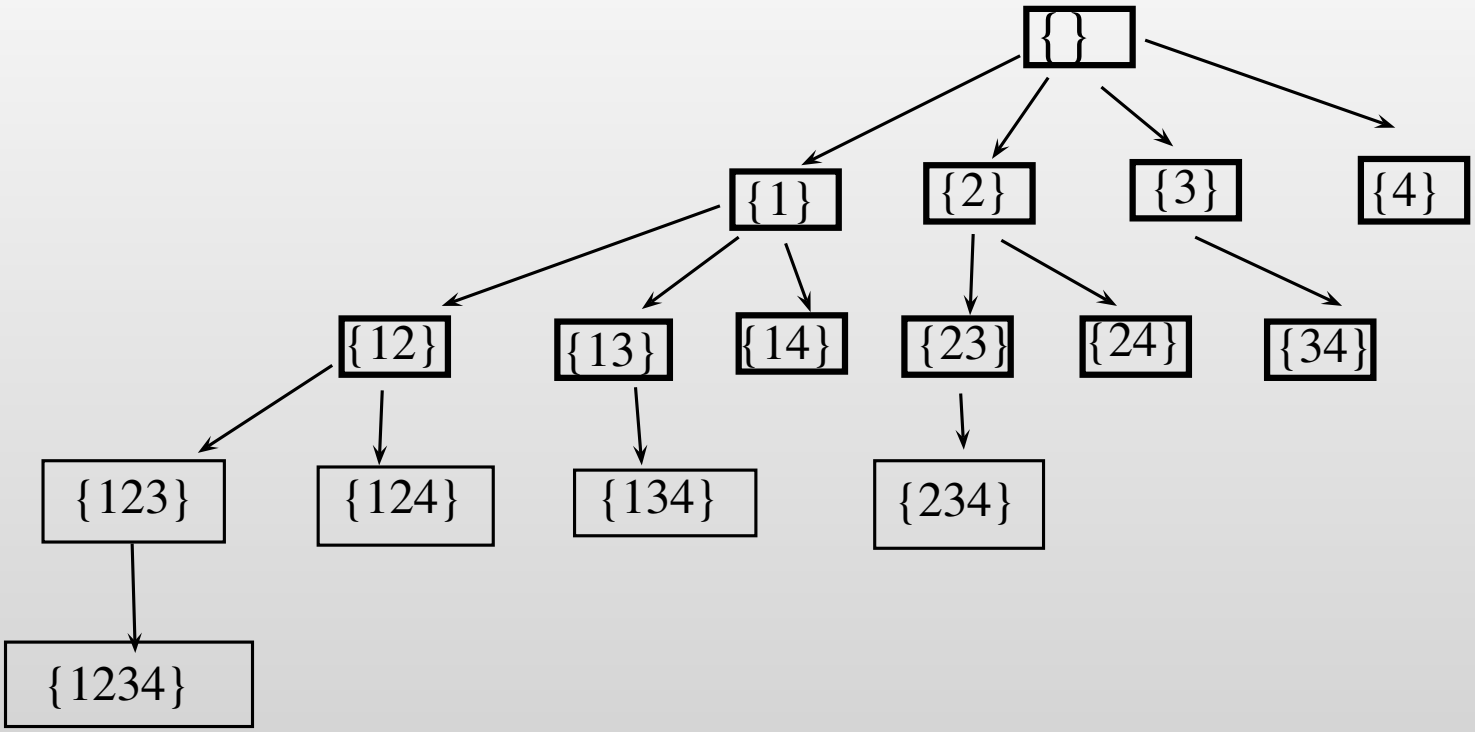


- Before each function call, position of a letter is fixed (marked in red) after swapping
- After any call returns, swapping is again performed to restore state
- Printing is done at leaf level

Another Problem

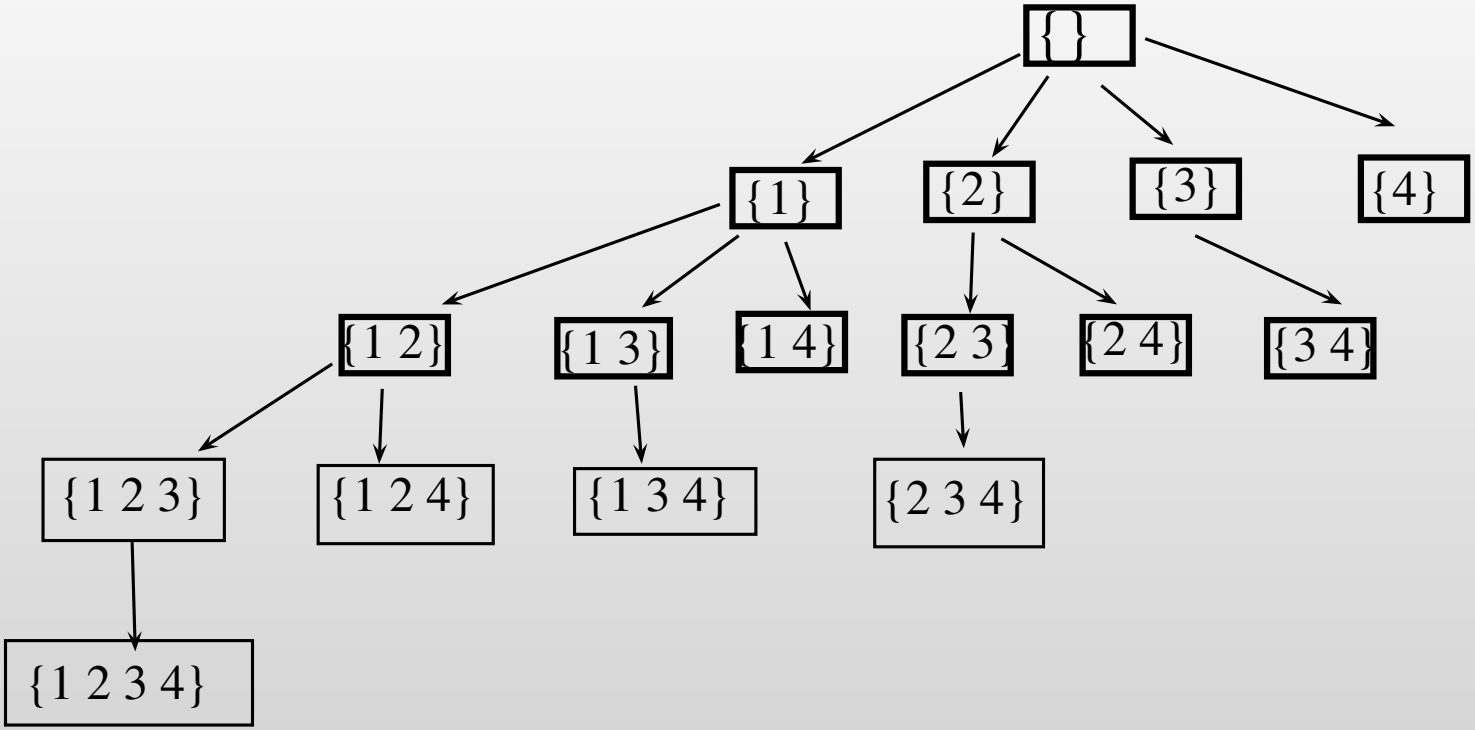
Write a recursive function which takes as argument an integer n and prints all possible subsets of the set $\{1, 2, 3, \cdots, n\}$.

Assignment 10: recursion tree, n=4



- With each call, a possible subset is printed
- The printing is done w.r.t. natural ordering of 1,2,3, etc
- 1, 12, 123, 1234, 124, 13, 14, 2, 23, ...

What exactly is happening



- At recursion depth k, you print all subsets of size k
- Let us say, you printed $\{2\}$ at depth 1. Next make possible calls for printing subsets of size 2 which *occur after* $\{2\}$ i.e., $\{2,3\}$ and $\{2,4\}$.

A sample solution

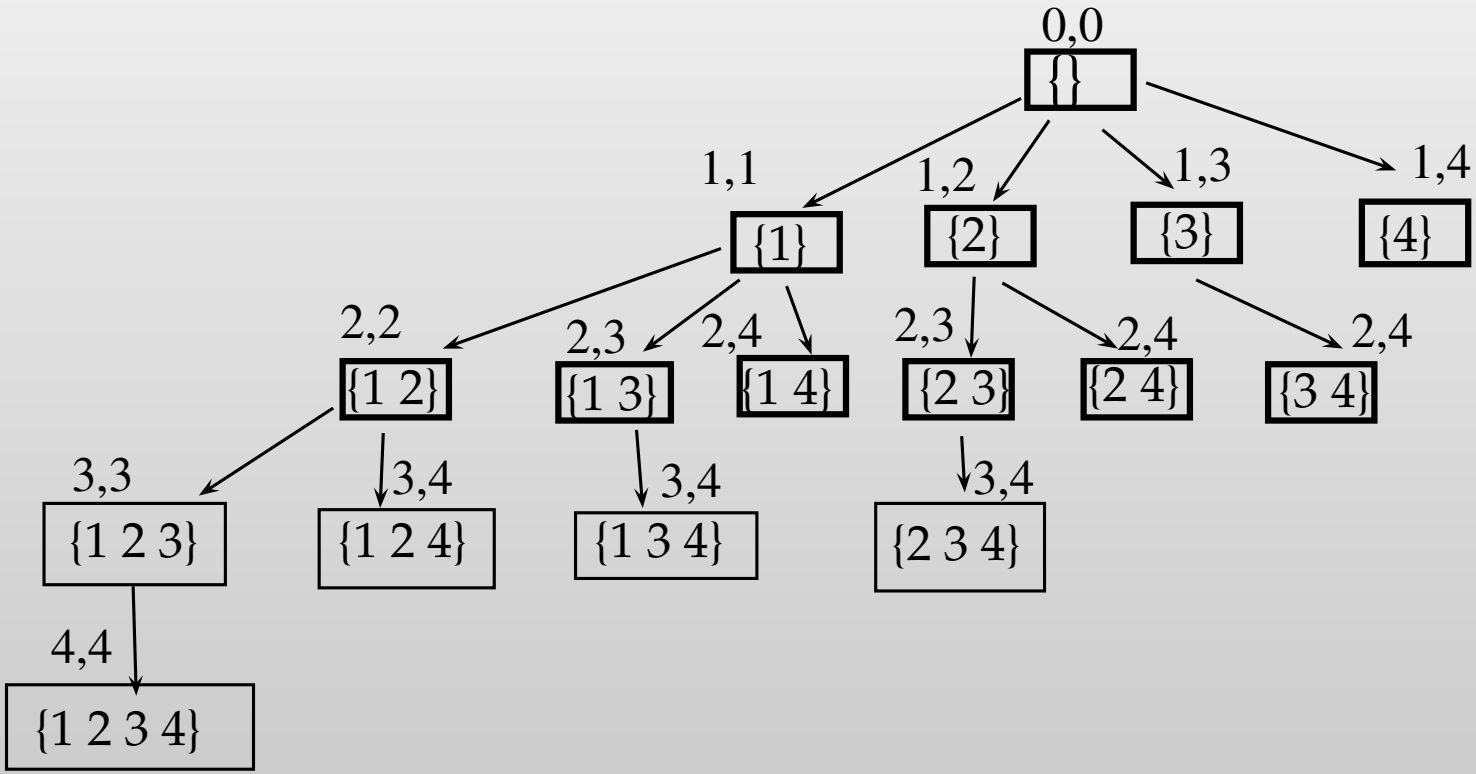
```
int main ()
{
   int A[MAX_SIZE];
   int n;
   printf("Enter n:");
   scanf("%d", &n);
   subset(A,0,0,n); // the recursive call
   return 0;
}
```

- prints the empty string and initiates subsequent calls

```
void subset (int A[],int k,int j,int n)
{//k is recursion dept
//j is last value written by previous call
   int i,l;
   printf("{");
   for(i=0;i<k;i++)
      printf("%d ",A[i]);
   printf("}\n");
   for (i=j+1;i<=n;++i)
   {
      A[k]=i;
      subset(A, k+1, i, n);
   }
}
```

- print current content
- populate array before next call
- make call with parameters: depth, last value written

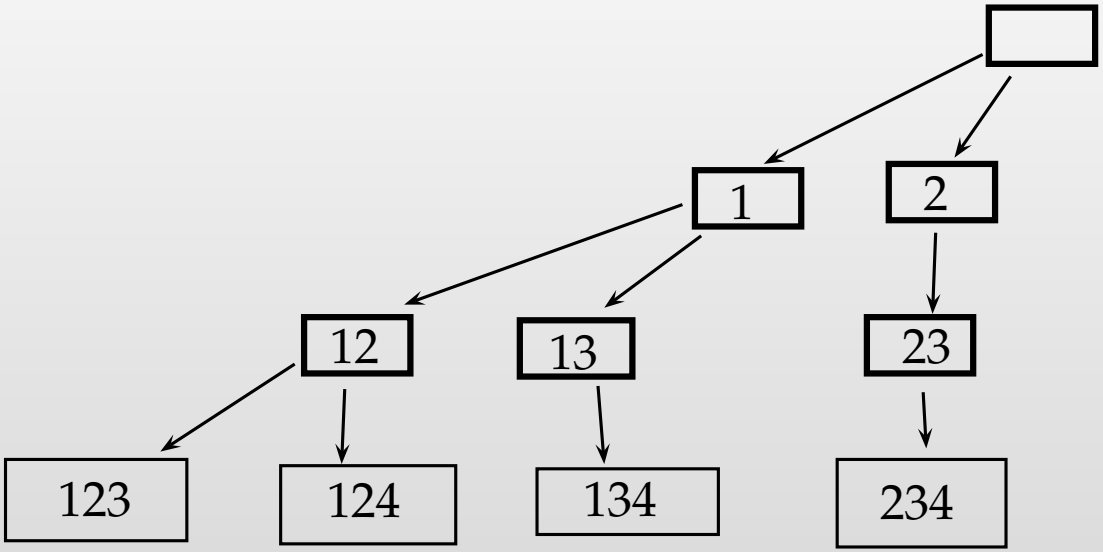
Recursion tree labeled with function call parameters k,j



A variant

Write a recursive function which takes as argument integers n and $k \leq n$ and prints all possible subsets of the set $\{1, 2, 3, \cdots, n\}$ of size k (i.e. ${}^{n}C_{k}$).

Recursion tree: n=4, k=3



- In this case, printing is done only at the leaf nodes.
- Write the recursive function without a loop?? Yes, you can do this by adding another variable in the recursive call apart from those remembering the depth and last value written.