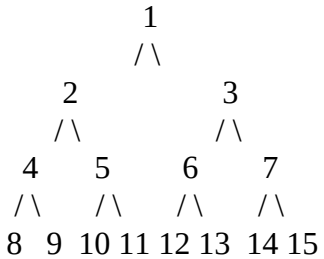
C Language Programming: Homework #5
Assigned on 11/12/2019(Tuesday), Due on 11/19/2019(Tuesday)

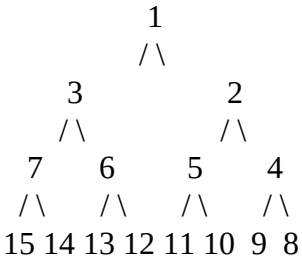
1. [10] Write three versions of the function that computes ***f*** defined as follows: **f(i)** = **f(i**–1) + **f(i**–2) + **f(i**–3), and **f**(0) = 0, **f**(1) = 1, **f**(2) = 2, for **i** >=0,
   (1) purely recursive
   (2) iterative
   (3) a modified recursive function using recursion and an array to avoid redundant computation.

2. [15] Given a set ***I*** of ***n*** 16-bit ranges denoded by [b_i, e_i] for i = 0 to n – 1, where $0 \le b_i \le 65535$ and $0 \le e_i \le 65535$.
   (a) Write a function that takes this set of ranges as the first paramenter (***I***) and a 16-bit number ***v*** as the second parameter and the third parameter is the set of ranges (***R***) that covers ***v***. For example, if the set of input ranges is ***I*** = {[3, 19], [11, 33], [18, 80], [80, 100]} and ***v*** = 18, then ***R*** = {[3, 19], [11, 33], [18, 80] }.
   (b) Write another function that takes this set of ranges as the first paramenter (***I***) for input and a set of 16-bit numbers (***T***) (p_i for i = 0 to k – 1) as the second parameter for output so that T is the union of b_i – 1 and e_i for i = 0 to n – 1. For example, if the set of input ranges is ***I*** = {[3, 19], [11, 33], [18, 80], [80, 100]}, then ***T*** = {2, 10, 17, 19, 33, 79, 80, 100}.

3. [30] Assume a binary tree of integers is stored in array ***int a[SIZE]*** and SIZE = 2^s as follows. The tree size (2^v – 1) is stored in element a[0], the integer in root is stored in a[1], and the integers in a[i]'s two children are stored in a[2**i*] and a[2**i* +1] for i = 1 to 2^{v-1} – 1. For example, when we declare an array ***int a[SIZE]*** = {15,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15}, it means we have a binary tree illustrated as



Before mirror



after mirror

   mirror a subtree rooted at node i = mirror the subtree rooted at node 2i and
   mirror the subtree rooted at node 2i+1
   (a) Write a recursive function that can mirror a binary tree.
   (b) Write a iterative function that can mirror a binary tree.
   Please define the function prototype and decribe its parameters.

4. [15] Our Internet IP address is 32 bits, which is usually represented as four 8-bit numbers seperated by dot signed (129.160.96.1). Please a program based on command line arguments to do the following:
   (a) Input an IP address in the format of four numbers and three dot signs and store it in an unsigned variable and then print out its 32-bit bit pattern.
   (b) Input a 32-bit bit pattern and print out it as an IP address in the dot format.

5. [15] Please trace the following program and show what gets printed? Explain. Also, modify this program to write a recursive program ***int combinations(A, n, k)*** that you can print out all the combinations of ***k*** numbers out of ***n*** different numbers stored in an array ***A*** with additional rules: (1) the order of A[0], A[1], ..., A[n-1] must remain and (2) the sequence of these ***k*** numbers must be in an increasing order. For example, assume there are 4 numbers 4, 1, 2, 3 stored in array ***int A[4]***. Calling this recursive function ***combinations***(A, 4, 2) will return a count 3 and print out (1, 2), (1, 3),

and (2, 3), or calling combinations(A, 4, 3) will return a count 1 and print out (1, 2, 3). Your recursive program must consider to avoid the unnecessary recursive function calls.

```
#include <stdio.h>
#define N 4
int boolfunc(int *var, int m);
int recursivebool(int *var, int n);
main()
{
  int varbool[20];
  recursivebool(varbool, N);
}
int boolfunc(int *var, int m)
{
  int result=var[0], i;
  for (i=1; i<m; i++) result = (result && var[i]);
  return result;
}
```

```
int recursivebool(int *var, int n)
{
  int localvar[20], i, j;

  if (n == 0){
    for(i=0; i<N; i++) printf("%d ", var[i]);
    printf("%d\n", boolfunc(var, N));
    return;
  }

  for (j=0; j<=1; j++) {
    var[n-1] = j;
    recursivebool(var, n - 1);
  }
}
```

6. [15] Please trace the following program and explain what it is doing. Explain the idea of this function and show an example. Can you simplify line 14?

```
int determinant(int f[][10],int x)
{
 1. int pr=1, c[10], d=0, b[10][10], j, p, q, t;
 2. if(x==2) return (f[1][1]*f[2][2] - f[1][2]*f[2][1]);

 3. for (j=1; j<=x; j++){
 4.       int r=1,s=1;
 5.       for (p=1; p<=x; p++) {
 6.          for (q=1; q<=x; q++) {
 7.               if (p!=1 && q!=j) {
 8.                  b[r][s]=f[p][q];
 9.                  s++;
 10.                 if(s > x-1) { r++; s=1; }
 11.              }
 12.         }
 13.      }
 14.      for(t=1,pr=1;t<=(1+j);t++) pr=(-1)*pr;
 15.      c[j] = pr*determinant(b,x-1);
 16.  }
 17.  for(j=1,d=0;j<=x;j++) d += (f[1][j]*c[j]);
 18.  return(d);
}
```