CS19003: Programming and Data Structures Laboratory

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Table of Contents

1 Tutorial: Functions

2 Tutorial: Recursive Functions

A mathematical function

$$
\begin{array}{rlll}
 & = 0 & & \textit{if}\ \mathrm{n} = 0, \\
f(n) & = 2n - 1 & & \textit{if}\ \mathrm{n} > 0, \\
 & = -2n & & \textit{if}\ \mathrm{n} < 0
\end{array}
$$

- It would be nice to compute f such that

```
int main ()
{
  int n;
  while (1) {
  printf("Input n : "); scanf("%d",&n);
  printf("f(%d)=%d\n", n, f(n));
  }
}
```

And that is possible

```
int f ( int n )
{
    if (n == 0) return (0);
    else if (n > 0) return (2*n-1);
    else return (-2*n);
}
int main ()
{
    int n;
    while (1) {
    printf("Input n : "); scanf("%d",&n);
    printf("f(%d)=%d\n", n, f(n));
    }
}
```

Function Definition

```
return_type function_name (argument_list)
{
  function body
}
```

- Example

```
int gcd ( int a , int b )
{ int c;
  /* body */
  return c;
}
int main()
{ int x, y, z;
  /* body */
  z=gcd(x,y);
}
```

A more elaborate usage

```
int gcd ( int a , int b )
{
  int r;
  /* body */
  return r;
}
int main ()
{
  int i, j, s = 0;
  for (i=1; i<=20; ++i) {
    for (j=i; j<=20; ++j) {
      s += gcd(j,i);
    }
  }
  printf("The desired sum = %d\n", s);
}
```

Passing arguments by value

```
int gcd ( int a , int b )
{
   /*when called, a=j, b=i*/
   int r,...;
   /*any local assignment on a, b does not
   change i,j in main */

   ......./* body */
   return r;
}
int main ()
{
   ...........
   s += gcd(j,i);
   ...........
}
```

Passing arguments by value

```
int gcd ( int a , int b )
{
  int r,...; /* local variables like a,b*/
  /* r is not defined outside gcd() */

  ......./* body */
return r;
}
int main ()
{
  int r = 5; /* a different 'r' */
  ...........
  s += gcd(j,i);
  ...........
}
```

Passing arguments by value

```
int gcd ( int a , int b ) /*a=10,b=6*/
{
  int r,...;

  ......./* body */
return r; /*r=2*/
}
int main ()
{
  int r = 5;
  ............./*j=10,i=6,r= 5*/
  ...r=r+j..../*j=10,i=6,r=15*/
  s += gcd(j,i); /*s+=2*/
  ............./*j=10,i=6,r=15*/
}
```

Passing an array

When you pass an array, the computation effects the array passed by main

```
void bubble(int A[], int n)
{ /*no return type*/
  int c,d,temp;
  for (c=n-2; c>=0; --c){
    for (d=0; d<=c; ++d){
      if (A[d] > A[d+1]){
        temp = A[d];
        A[d] = A[d+1];
        A[d+1] = temp;
      }
    }
  }
}
```

We shall explain the reason later

Passing an array

```
int main()
{
  int array[100], n, k;
  printf("Enter no. of elements\n");
  scanf("%d", &n);
  printf("Enter %d integers\n", n);
  for (k = 0; k < n; k++)
    scanf("%d", &array[k]);
  bubble(array, n); /*array is passed*/
  printf("Sorted list\n");
  for ( k = 0 ; k < n ; k++ )
     printf("%d,", array[k]);
  printf("\n");
  return 0; /*sorting reflected on array[]*/
}
```

Table of Contents

1 Tutorial: Functions

2 Tutorial: Recursive Functions

The well known Fibonacci function

$$
\begin{array}{rll}
 & = 0 & \textit{if}\ \mathrm{n} = 0, \\
f(n) & = 1 & \textit{if}\ \mathrm{n} = 1, \\
 & = f(n-1) + f(n-2) & \textit{if}\ \mathrm{n} \geq 2
\end{array}
$$

- Similarly, many other well known functions can be defined *recursively*, i.e., in terms of itself

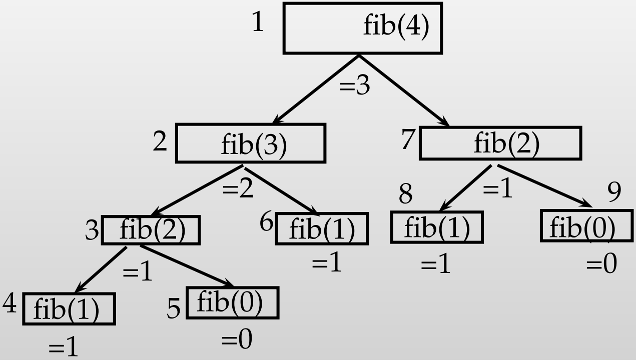
```
int fib ( int n )
 {
    if (n == 0) return (0);
    if (n == 1) return (1);
    return (fib(n-1)+fib(n-2));
 }
```

Why does this work

```
int fib ( int n )
 {
     if (n == 0) return (0);
     if (n == 1) return (1);
     return (fib(n-1)+fib(n-2));
 }
```

- Each call instance of fib works with its own copy of *n*
- The computer "remembers" every previous state of the problem. This information is "held" by the computer on the "activation stack" (i.e., inside of each function's workspace).

The recursive function call sequence

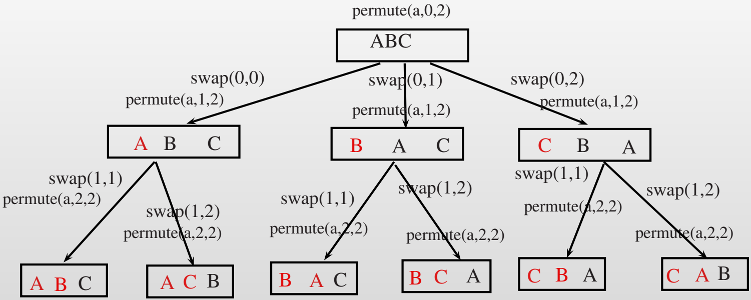


- The call sequence: 1,2,3,..
- The return sequence: 4,5,3,6,2,8,9,7,1

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], a[j]);
        permute(a, i+1, n);
        swap(a[i], a[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

Thank You