CME 112- Programming Languages II

Week 5
Pointers

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People never make mistakes are people who do nothing. And the biggest mistake in life is to think yourself perfect. ~Y. Emre

Call by Value and Call by Reference

- Normally a value of parameter sent to a function does not change. And modifications in function does not effect original variable.

- The case in which the original variable is not changed but its copy is sent to a function is called "***call by value***" or "***pass by value***".

- Sometimes we need to return more than one value from a function or we need the original variable changed by the function.

Call by Value and Call by Reference)

- For this purposes we use "***call by reference***" or "***pass by reference***

- In call by reference, arguments are not passed with their values, but with their addresses. Thus, all modifications on arguments effect the original variable.

Call by Value


```c
#include <stdio.h>
void arttir(int);
int main14(void)
{
   int i;
   i = 5;
   printf("oncesi %d\n", i);
   arttir(i);
   printf("sonrasi %d\n", i);
   getchar();

   return 0;
}

void arttir(int k)
{
   k++;
}
```

Call by Reference


```c
#include <stdio.h>
void increment(int *);
int main(void)
{
   int i;
   i = 5;
   printf("oncesi %d\n", i);
   increment(&i);
   printf("sonrasi %d\n", i);
   getchar();

   return 0;
}

void increment(int *k)
{
   (*k)++;
}
```

Call by Reference

- If your function has to return more than one value, pass by reference usage is necessary.
- Because return keyword can only return one value from function.
- For example, we want to write a division function that gives division result and remainder.
- In this case, divided number and divisor is sent to function and remainder and division should be returned back from function.
- As return keyword can only return one value, second value must be returned by reference method.

Call by Reference


```c
#include<stdio.h>
int bolme_islemi( int, int, int * );
int main( void )
{
    int bolunen, bolen;
    int bolum, kalan;
    bolunen = 13;
    bolen = 4;
    bolum = bolme_islemi( bolunen, bolen, &kalan );
    printf( "Bolum: %d Kalan: %d\n", bolum, kalan );
    getchar();
    return 0;
}
int bolme_islemi( int bolunen, int bolen, int *kalan )
{
    *kalan = bolunen % bolen;
    return bolunen / bolen;
}
```

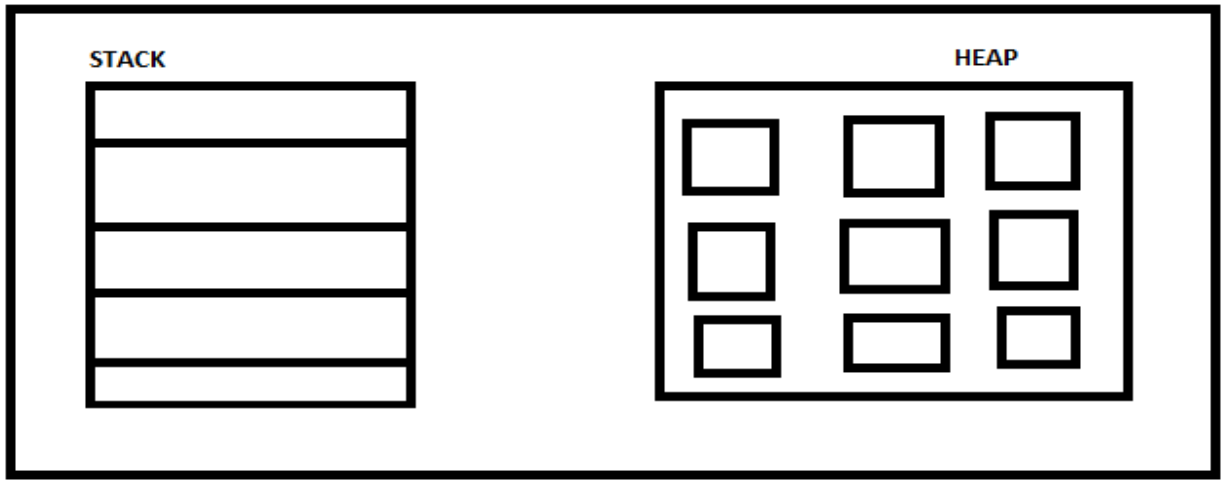
Dynamic Memory Alocation

- When a program executes, the operating system reserves space to run program (stack and heap).

- The stack is memory space where functions and their locally defined variables reside.
- The heap is reserved for program and it is an empty section to use for allocating memory at runtime.

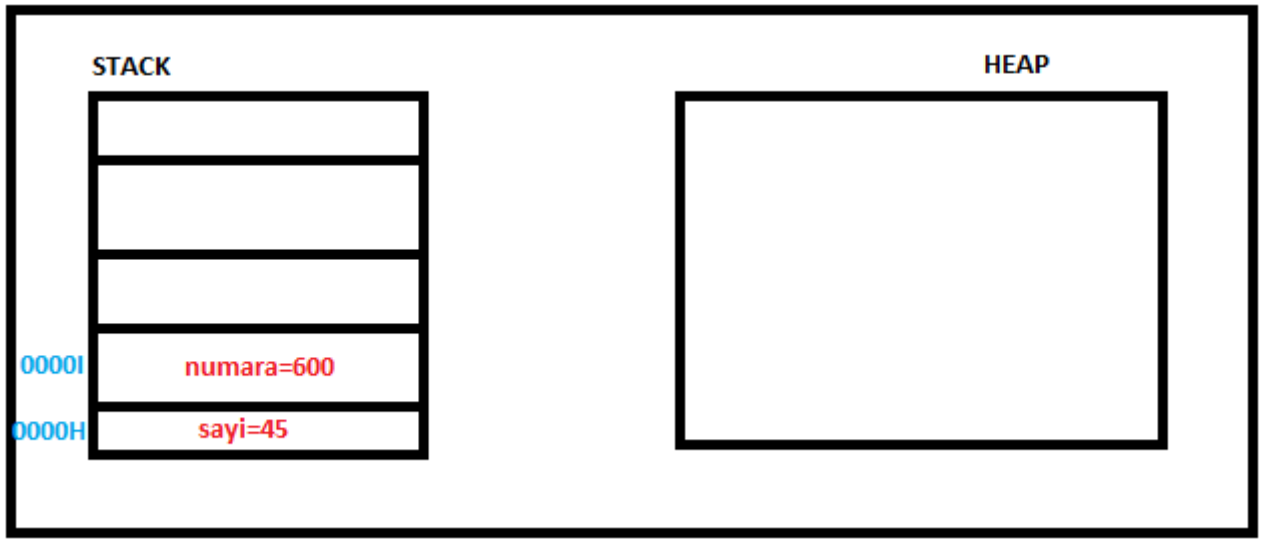
Stack and Heap

- Stack and heap are the logical parts of memory.
- Stack works in LIFO (Last in First Out) principal. If considered as a box: one of the books that you put in the box is placed on top of the other. Latest added book is accessed first.
- Heap is like a farm of programmer and usage of it is in responsibility of programmer.



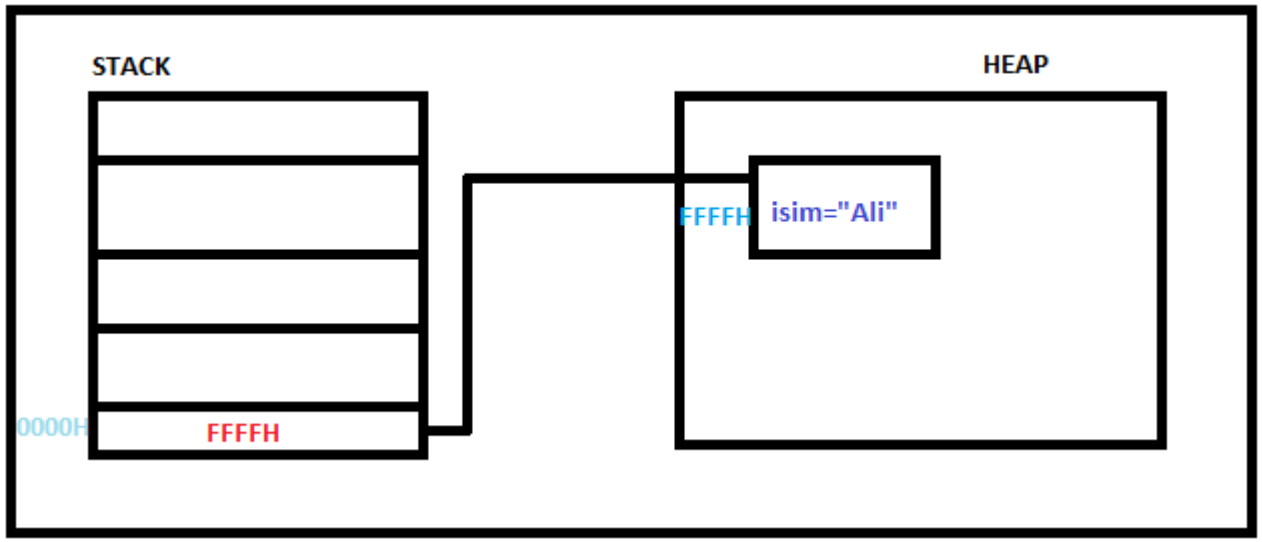
Stack and Heap

- While we store value type variables, pointer variables and code addresses in the stack.
- Stack is faster than heap. Because working principal of stack is easy and spaces that we want to reach are placed one after the other.



Stack and Heap

- Memory spaces that is shown by pointers are stored in the heap space.
- Heap is slower than stack. Because to reach an object in the heap we should perform a complex search as we put an object into any empty space in heap.



Dynamic Memory Allocation

- We may need an array whose number of elements may vary according to needs.

- For such kind of need, creating a large array to solve the problem may consume memory in vain.

- More effective solution is usage of dynamic memory allocation.

Dynamic Memory Allocation

- In dynamic memory allocation, amount of memory needed is determined during the execution of program.

- ***malloc***, ***calloc***, or ***realloc*** are the three functions used to manipulate memory.

- These commonly used functions are available through the **stdlib** library, so you must include this library in order to use them.

#include<stdlib.h>

Malloc() Function

- Malloc function is used to allocate a block of memory for one variable.

- If there is not enough memory available, malloc will return NULL.

```
int *ptr;
ptr = (int *) malloc(n*sizeof(int));
```

Calloc() Function

- Calloc function is also used to allocate a block of memory.
- If there is not enough memory available, calloc will return NULL.
- Unlike malloc function, it takes two arguments.

```
char *ptr;
ptr = (char *)calloc(10, sizeof(char));
```

Realloc() Function

- Realloc is used to resize an allocated memory space.

- A pointer that will point the starting address of resized memory space and new size are passed to realloc function as parameter.

```
void *realloc(void *ptr, size_t size);
```

Free() Function

- In high level programming languages such as (C#, Java) removing unused objects from memory is achieved automatically by Garbage Collector.

- Unfortunately, there is no garbage collector for C language and bad and good programmer is separated easily with this issue.

Free() Function

- How important an effective memory management is may be understood when we write large programs.

- We should avoid consuming unnecessary memory.

- Every call to an malloc or calloc function you must have a corresponding call to free.

```
int *ptr;
ptr = (int *) malloc(n*sizeof(int));
free(ptr);
```

Example 1


```c
#include <stdio.h>
#include <stdlib.h>
int main(void)
{
    int n,i,*ptr,sum=0;
    printf("Eleman sayısını girin\n");
    scanf("%d",&n);

    ptr= (int *)malloc(n*sizeof(int));
    if(ptr==NULL)
    {
        printf("Yeterli hafıza yok");
    }
    printf("Dizi elemanlarını girin\n");
    for(i=0;i<n;i++)
    {
        scanf("%d",ptr+i);
        sum += *(ptr+i);
    }
    printf("Toplam = %d",sum);
    getchar();
    getchar();
    return 0;
}
```

Example 2

```c
#include <stdio.h>
#include<stdlib.h>
int *dizileri_birlestir( int [], int, int [], int );
int main( void )
{
    int i;
    int liste_1[5] = { 6, 7, 8, 9, 10 };
    int liste_2[7] = {13, 7, 12, 9, 7, 1, 14 };
    // sonucun dondurulmesi icin pointer tanimliyoruz
    int *ptr;

    ptr = dizileri_birlestir( liste_1, 5, liste_2, 7 );

    // ptr isimli pointer'i bir dizi olarak dusunebiliriz
    for( i = 0; i < 12; i++ )
        printf("%d ", ptr[i] );
    printf("\n");

    return 0;
}
```

Example 2


```
21  int *dizileri_birlestir( int dizi_1[], int boyut_1,
22                           int dizi_2[], int boyut_2 )
23  {
24      int *sonuc = (int *)calloc( boyut_1+boyut_2, sizeof(int) );
25      int i, k;
26      // Birinci dizinin degerleri ataniyor.
27      for( i = 0; i < boyut_1; i++ )
28          sonuc[i] = dizi_1[i];
29
30      // Ikinci dizinin degerleri ataniyor.
31      for( k = 0; k < boyut_2; i++, k++ ) {
32          sonuc[i] = dizi_2[k];
33      }
34
35      // Geriye sonuc dizisi gonderiliyor.
36      return sonuc;
37  }
```

Next Week

- Examples with Pointers

References

- Doç. Dr. Fahri Vatansever, “Algoritma Geliştirme ve Programlamaya Giriş”, Seçkin Yayıncılık, 12. Baskı, 2015.
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Any Questions ?

Thanks for listening

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