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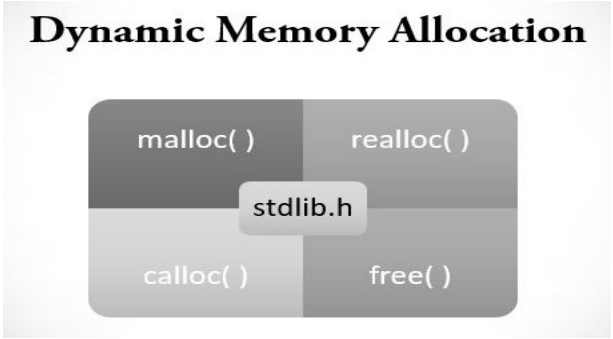
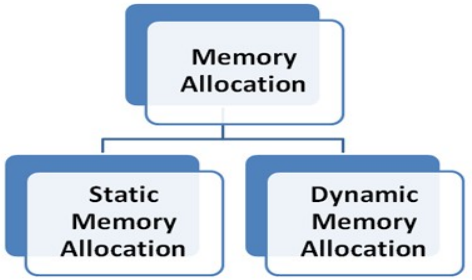
CHAPTER - 9
DYNAMIC MEMORY ALLOCATION

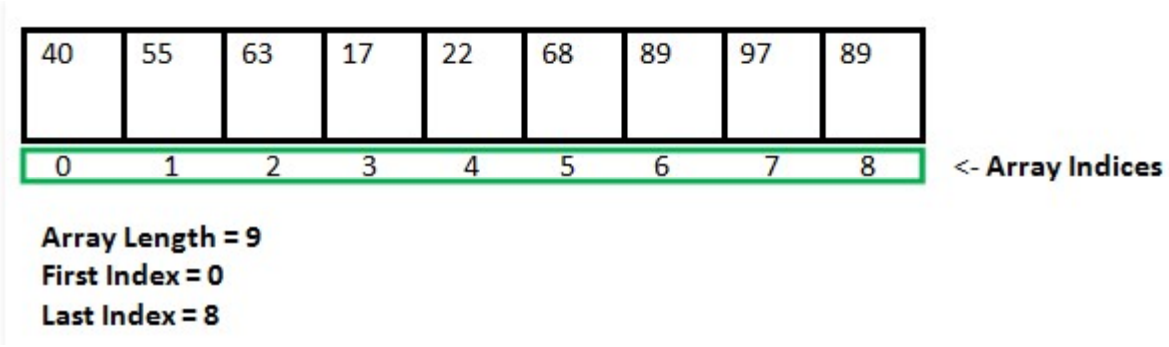




Subject : PPS **Code : 3110003**	**Prepared By:** **Asst. Prof. Rupali Patel** **(CSE Department, ACET)**	AMIRAJ COLLEGE OF ENGINEERING & TECHNOLOGY

Dynamic Memory Allocation

Since C is a structured language, it has some fixed rules for programming. One of it includes changing the size of an array. An array is collection of items stored at continuous memory locations.



As it can be seen that the length (size) of the array above made is 9. But what if there is a requirement to change this length (size).

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Dynamic Memory Allocation (cont..)

- If there is a situation where only 5 elements are needed to be entered in this array. In this case, the remaining 4 indices are just wasting memory in this array. So there is a requirement to lessen the length (size) of the array from 9 to 5.
- Take another situation. In this, there is an array of 9 elements with all 9 indices filled. But there is a need to enter 3 more elements in this array. In this case 3 indices more are required. So the length (size) of the array needs to be changed from 9 to 12.

This procedure is referred to as **Dynamic Memory Allocation in C**.

Therefore, C **Dynamic Memory Allocation** can be defined as a procedure in which the size of a data structure (like Array) is changed during the runtime.

Dynamic Memory Allocation (cont..)

C provides some functions to achieve these tasks. There are 4 library functions provided by C defined under **<stdlib.h>** header file to facilitate dynamic memory allocation in C programming.

They are:

1. malloc()
2. calloc()
3. free()
4. realloc()

C Malloc() Method

“malloc” or **“memory allocation”** method in C is used to dynamically allocate a single large block of memory with the specified size. It returns a pointer of type void which can be cast into a pointer of any form.

Syntax:

ptr = (cast-type*) malloc(byte-size)

Example:

ptr = (int*) malloc(100 * sizeof(int));

Since the size of int is 4 bytes, this statement will allocate 400 bytes of memory. And, the pointer ptr holds the address of the first byte in the allocated memory.

C Malloc() Method Example

```
#include <stdio.h>
#include <stdlib.h>
int main()
{
   int* ptr;
   int n, i;
   n = 5;
   printf("Enter number of elements:
%d\n", n);
   ptr = (int*)malloc(n * sizeof(int));
   if (ptr == NULL)
  {
    printf("Memory not allocated.\n");
            exit(0);
   }
   else
   {
printf("Memory successfully allocated
using malloc.\n");
        for (i = 0; i < n; ++i)
{
            ptr[i] = i + 1;
            }
 printf("The elements of the array are: ");
  for (i = 0; i < n; ++i)
  {
      printf("%d, ", ptr[i]);
   }
  }
     return 0;
}
```

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C Calloc() Method

“calloc” or **“contiguous allocation”** method in C is used to dynamically allocate the specified number of blocks of memory of the specified type. It initializes each block with a default value ‘0’.

Syntax:

ptr = (cast-type*)calloc(n, element-size);

Example:

ptr = (float*) calloc(25, sizeof(float));

This statement allocates contiguous space in memory for 25 elements each with the size of the float.. And, the pointer ptr holds the address of the first byte in the allocated memory.

C Calloc() Method (cont..)

```
#include <stdio.h>
#include <stdlib.h>
 int main()
{
   int* ptr;
   int n, i;
   n = 5;
   printf("Enter number of elements: %d\n",
n);
   ptr = (int*)calloc(n, sizeof(int));
   if (ptr == NULL)
{
     printf("Memory not allocated.\n");
                          exit(0);
              }
   else
{
  printf("Memory successfully allocated
using calloc.\n");
    for (i = 0; i < n; ++i)
    {
                          ptr[i] = i + 1;
    }

     printf("The elements of the array are: ");
    for (i = 0; i < n; ++i)
              {
              printf("%d, ", ptr[i]);
              }
   }
     return 0;
}
```

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C Free() Method

“free” method in C is used to dynamically **de-allocate** the memory. The memory allocated using functions malloc() and calloc() is not de-allocated on their own. Hence the free() method is used, whenever the dynamic memory allocation takes place. It helps to reduce wastage of memory by freeing it.

Syntax:

free(ptr);

C Free() Method Example

```
#include <stdio.h>
#include <stdlib.h>
 int main()
{
    int *ptr, *ptr1;
    int n, i;
    n = 5;
    printf("Enter number of elements:
%d\n", n);
    ptr = (int*)malloc(n * sizeof(int));
    ptr1 = (int*)calloc(n, sizeof(int));
    if (ptr == NULL || ptr1 == NULL)
    {
            printf("Memory not
allocated.\n");
            exit(0);
     }
    else
    {
            printf("Memory successfully
allocated using malloc.\n");
            free(ptr);
            printf("Malloc Memory
successfully freed.\n");
            printf("\nMemory successfully
allocated using calloc.\n");
            free(ptr1);
            printf("Calloc Memory
successfully freed.\n");
     }
     return 0;
}
```

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C Realloc() Method

“realloc” or **“re-allocation”** method in C is used to dynamically change the memory allocation of a previously allocated memory. In other words, if the memory previously allocated with the help of malloc or calloc is insufficient, realloc can be used to **dynamically re-allocate memory**.

Syntax:

ptr = realloc(ptr, newSize);

where ptr is reallocated with new size 'newSize'.

C Realloc() Method Example

```
#include <stdio.h>
#include <stdlib.h>
 int main()
{
     int* ptr;
     int n, i;
     n = 5;
     printf("Enter number of elements: %d\n", n);
     ptr = (int*)calloc(n, sizeof(int));
     if (ptr == NULL)
{
       printf("Memory not allocated.\n");
       exit(0);
   }
       Else
{
   printf("Memory successfully allocated using
calloc.\n");
  for (i = 0; i < n; ++i)
{
         ptr[i] = i + 1;
  }
  printf("The elements of the array are: ");
  for (i = 0; i < n; ++i)
{
          printf("%d, ", ptr[i]);
        }
        n = 10;
  printf("\n\nEnter the new size of the array: %d\n", n);
   ptr = realloc(ptr, n * sizeof(int));
 printf("Memory successfully re-allocated using
realloc.\n");
  for (i = 5; i < n; ++i)
{
                ptr[i] = i + 1;
   }
   printf("The elements of the array are: ");
   for (i = 0; i < n; ++i)
 {
                printf("%d, ", ptr[i]);
   }
         free(ptr);
   }
     return 0;
}
```

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