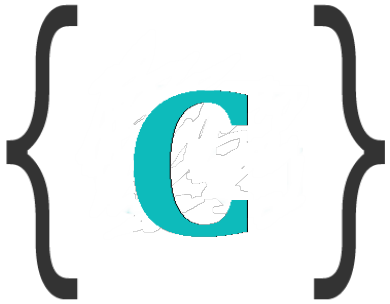

IT 112: Introduction to Programming

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Lecture 23,24,25

Structure in Structure

- Here we will learn to handle structure in a structure in C programming language.
- We have already learned how to create and access members of a structures in the structure tutorial.
- Now, lets add a structure inside a structure and learn how to work with it.

- In the following example we have a student structure. Inside it we have another structure address to hold the address detail.

```
// student structure having address structure inside
struct student {
        char name[255];
        char id[20];
        // address of the student
        struct {
                char line1[255];
                char line2[255];
                char city[255];
                char state[100];
                char country[255];
                char pincode[20];
                } address;
        };
```

- In the above code snippet we can see that we have an address structure inside the student structure.

- We already know by now that to access any member of a structure variable we use the . operator.

- So, if we want to access the name member of the student structure we have to write the following.

  std.name

- Similarly if we want to access the city member of the address structure which is inside the student structure, we have to write the following.

  std.address.city

- code we will take student detail from the user and then print the output. (5)

Pointers and Structures

- Here we will learn to use pointers with structures in C Programming Language.

Creating a structure

Lets start by creating a structure variable student as shown below.

```
// student structure
struct student {
char id[15];
char firstname[64];
char lastname[64];
float points;
};
```

- Now we will create a student structure variable std. For this we will write the following code.

```
// student structure variable
struct student std;
```

Access the members of a structure

- We know that to access a member of a structure we use the . operator.

- In the following example we are accessing the members of the student structure.

```
printf("ID: %s\n", std.id);
printf("First Name: %s\n", std.firstname);
printf("Last Name: %s\n", std.lastname);
printf("Points: %f\n", std.points);
```

Creating pointer for structure

- Following is the syntax to create a pointer for a structure.

  struct tagName *ptrName;

- So, to create a pointer for the student structure we will write the following code.

  struct student *ptr;

Assigning structure variable to pointer

- We use the following syntax to assign a structure variable address to a pointer.

  ptrName = &structVarName;

- In the following example we are assigning the address of the structure variable std to the structure pointer variable ptr. So, ptr is pointing at std.

  ptr = &std;

Accessing the members of a structure via pointer

- We use the arrow operator also known as member selection operator -> to access the members of a structure via pointer variable.

- Following is the syntax for accessing members of a structure via pointer.

  ptrName->member

- In the following example we are accessing the firstname member of the student structure via pointer variable ptr.

  printf("First Name: %s", ptr->firstname);

- Code (6)

Pointers and Array of Structures

- **Create an array of structure variable**
- In the following example we are considering the student structure that we created in the previous tutorial and we are creating an array of student structure variable std of size 3 to hold details of three students.

```
// student structure
struct student
        {
        char id[15];
        char firstname[64];
        char lastname[64];
        float points;
        };
// student structure variable
struct student std[3];
```

- We can represent the std array variable as following.

```
struct student {
  char id[15];
  char firstname[64];
  char lastname[64];
  float points;
};
```

```
struct student std[3];
```

	id	firstname	lastname	points
std[0]				
std[1]				
std[2]				

Create pointer variable for structure

- Now we will create a pointer variable that will hold the starting address of the student structure variable std.

```
// student structure pointer variable
struct student *ptr = NULL;

// assign std to ptr
ptr = std;
```

- Note! std is an array variable and the name of the array variable points at the memory location so, we are assigning it to the structure pointer variable ptr.

- Accessing each element of the structure array variable via pointer
- For this we will first set the pointer variable ptr to point at the starting memory location of std variable. For this we write ptr = std;.
- Then, we can increment the pointer variable using increment operator ptr++ to make the pointer point at the next element of the structure array variable i.e., from str[0] to str[1].
- We will loop three times as there are three students. So, we will increment pointer variable twice. First increment will move pointer ptr from std[0] to std[1] and the second increment will move pointer ptr from std[1] to std[2].
- To reset the pointer variable ptr to point at the starting memory location of structure variable std we write ptr = std;.
- Code (7)

Passing structure pointer to function

- **Create a structure**
- In the following example are are creating a student structure.

```
// student structure
struct student
        {
        char id[15];
        char firstname[64];
        char lastname[64];
        float points;
        };
```

Function declaration to accept structure pointer

- Following is the syntax of the function declaration that accepts structure pointer.

```
returnType functionName(struct tagName *);
```

- returnType is the return type of the function functionName. If the function is not returning anything then set it to void. The function takes structure tagName pointer.

- In the following example we are creating two function declarations that takes address of student structure.

```
void getDetail(struct student *);
void displayDetail(struct student *);
```

- **Creating an array of structure variable**
- We will now create an array of student structure variable by writing the following code.

```
// student structure variable
struct student std[3];
```

- So, we have created an array of student structure variable of size 3 to store the detail of three students.

- We can represent the std array variable as follows.

```
struct student {
  char id[15];
  char firstname[64];
  char lastname[64];
  float points;
};
```

```
struct student std[3];
```

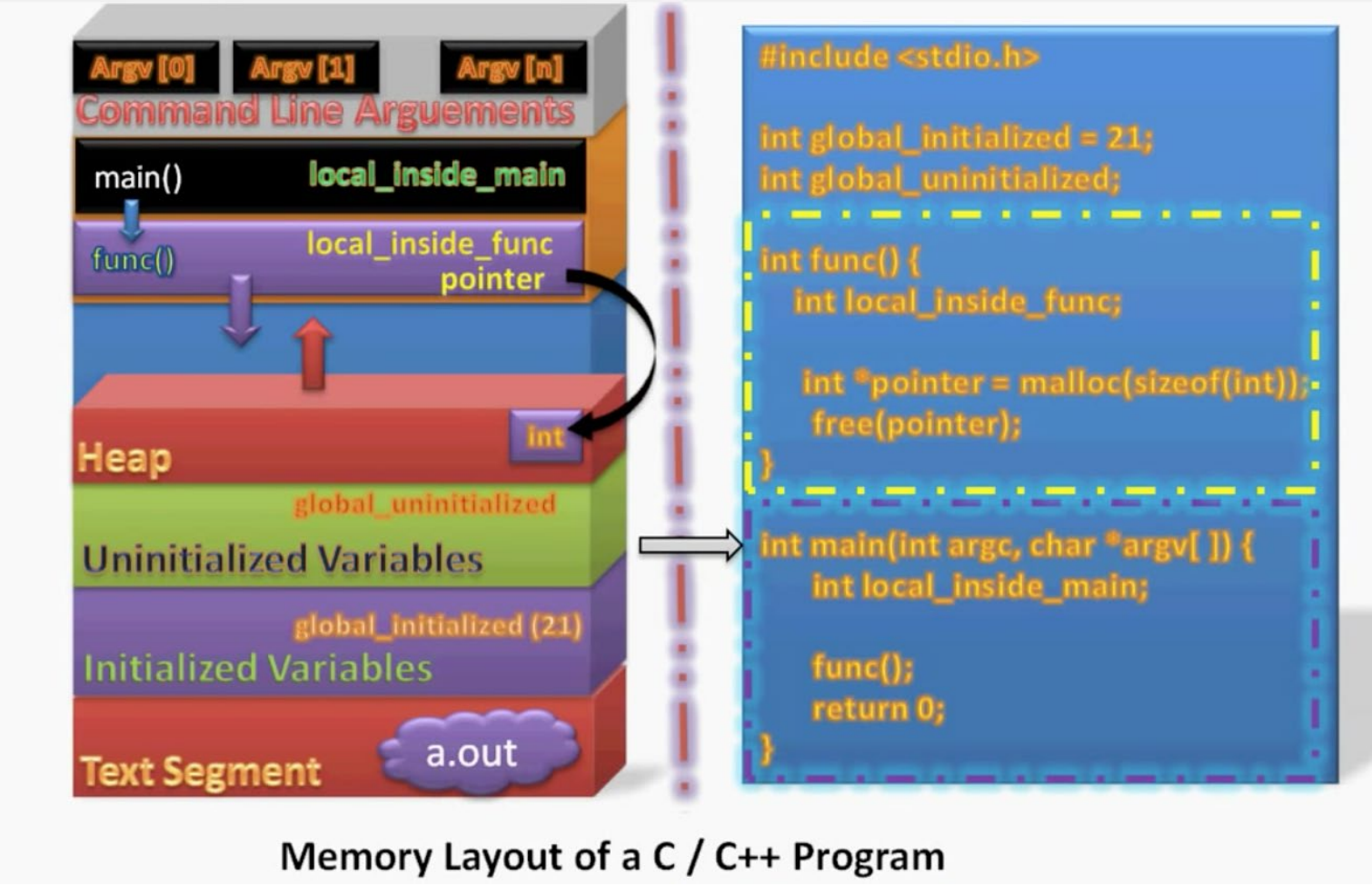
	id	firstname	lastname	points
std[0]				
std[1]				
std[2]				

- Code (8)

DYNAMIC list(array)

- YOU NEED TO IMPLIMENT ARRAY (like) VARIABLE, BUT SIZE IS NOT KNOWN and SIZE IS DYNAMICALLY CAHNGING
- For example, customer list, inventory and many more….
- What will your approach ? **Array** ?
  - Array elements need to be stored at contiguous memory locations
  - Run time resizing of the array is expensive
  - If array is not full,

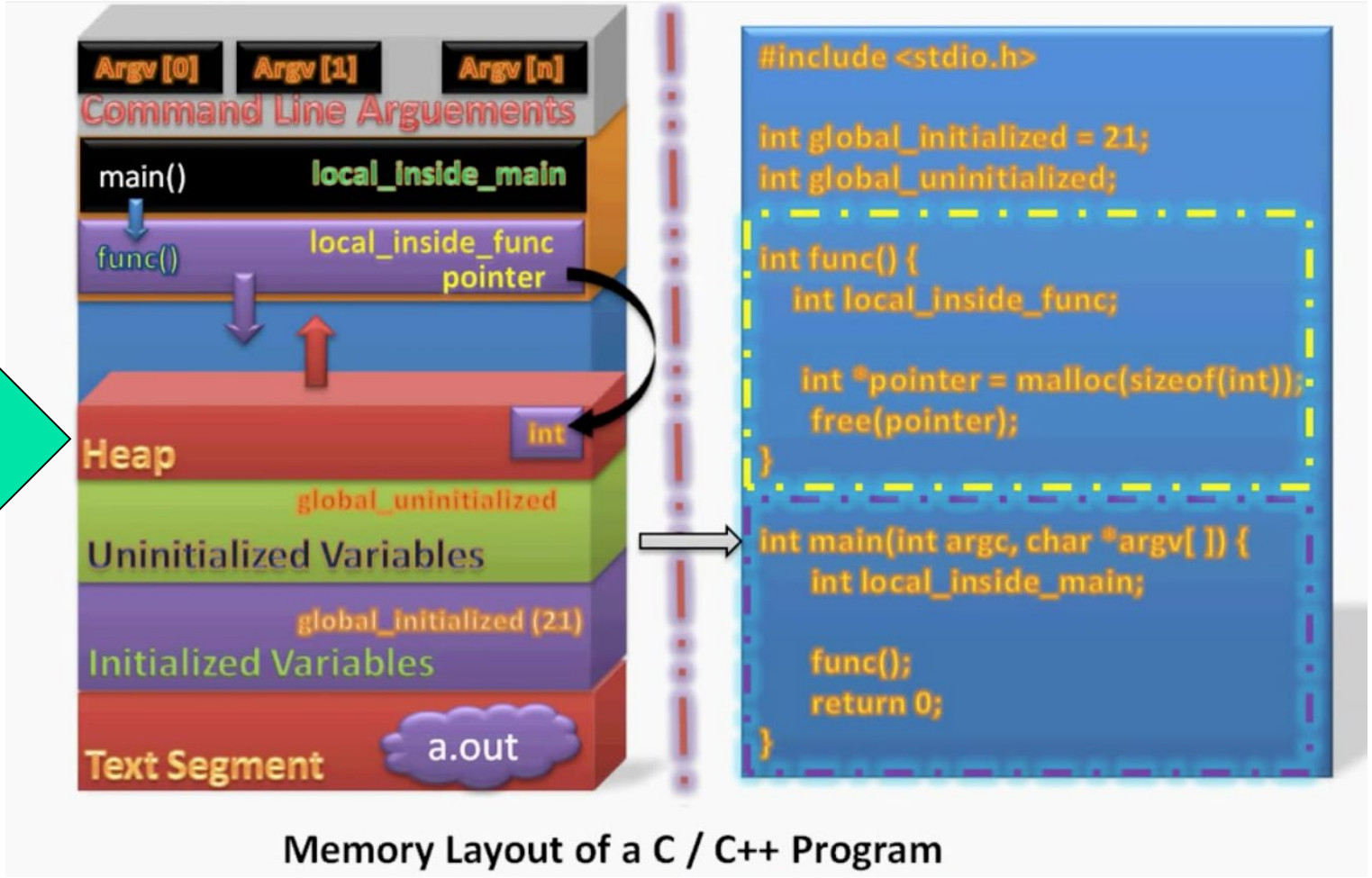
Dynamic Allocation of Memory



Memory Layout of a C / C++ Program

Dynamic Allocation of Memory

Dynamic Allocation



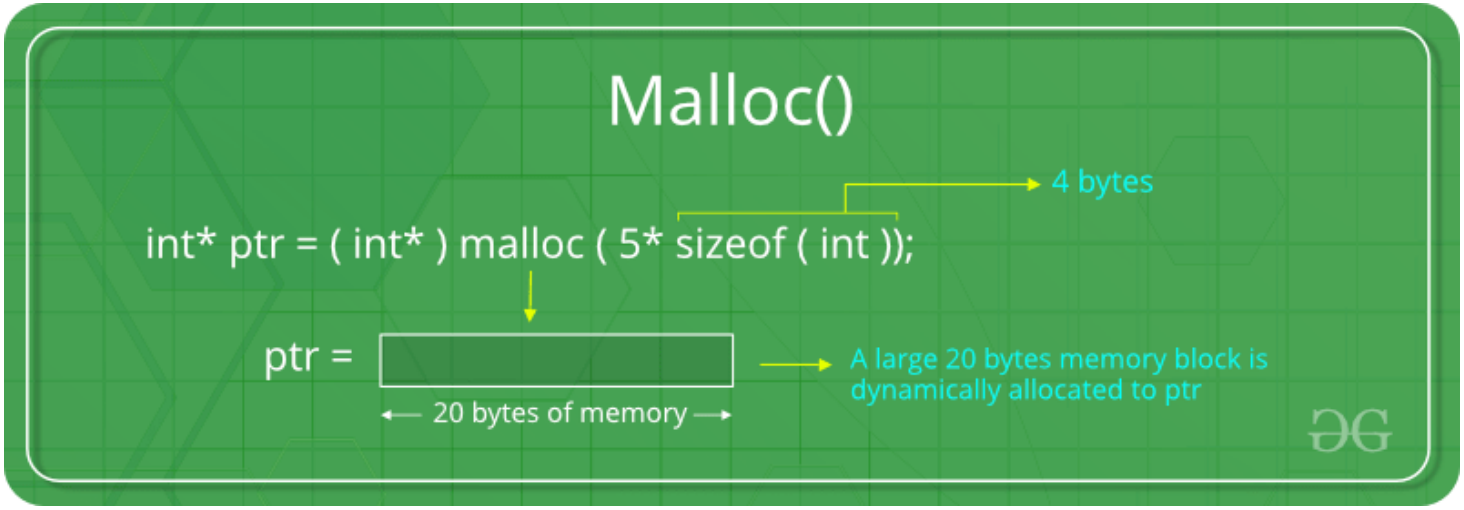
Memory Layout of a C / C++ Program

Malloc()

- void * malloc(unsigned Int NumBytes)

Typical Use

DataType * ptr = (DataType*) malloc(byte-size)

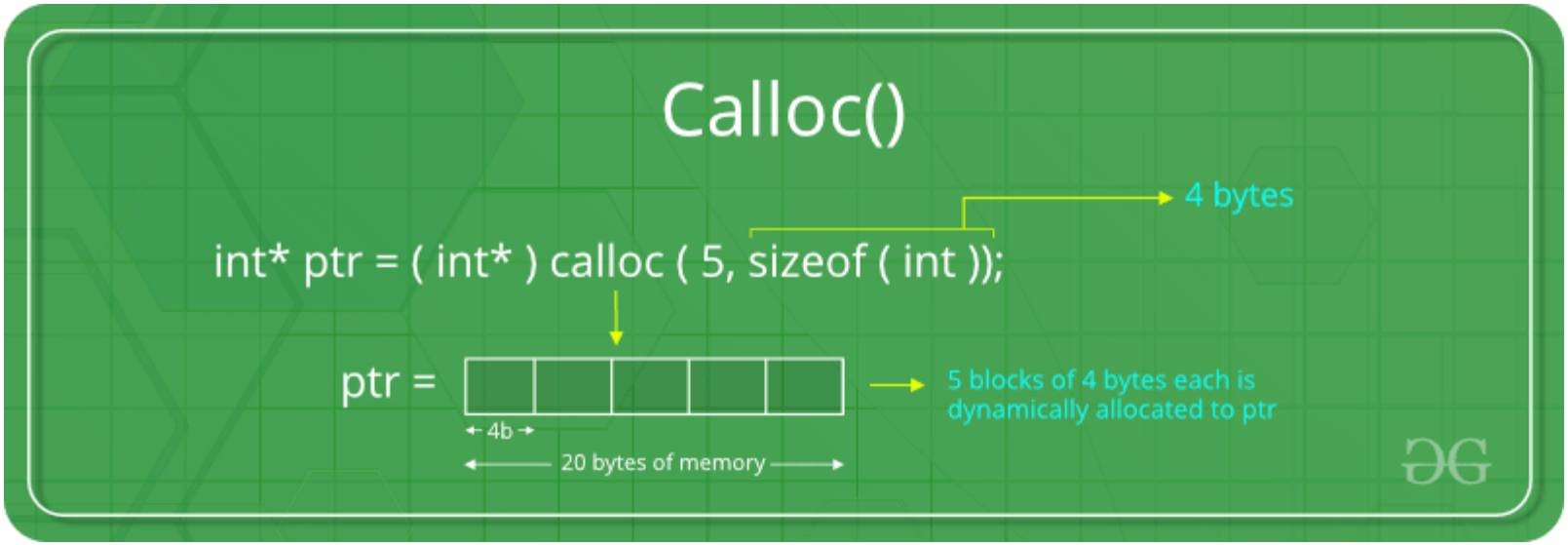


Calloc()

- void * malloc(unsigned Int num_elements, unsigned Int element_size)

Typical Use

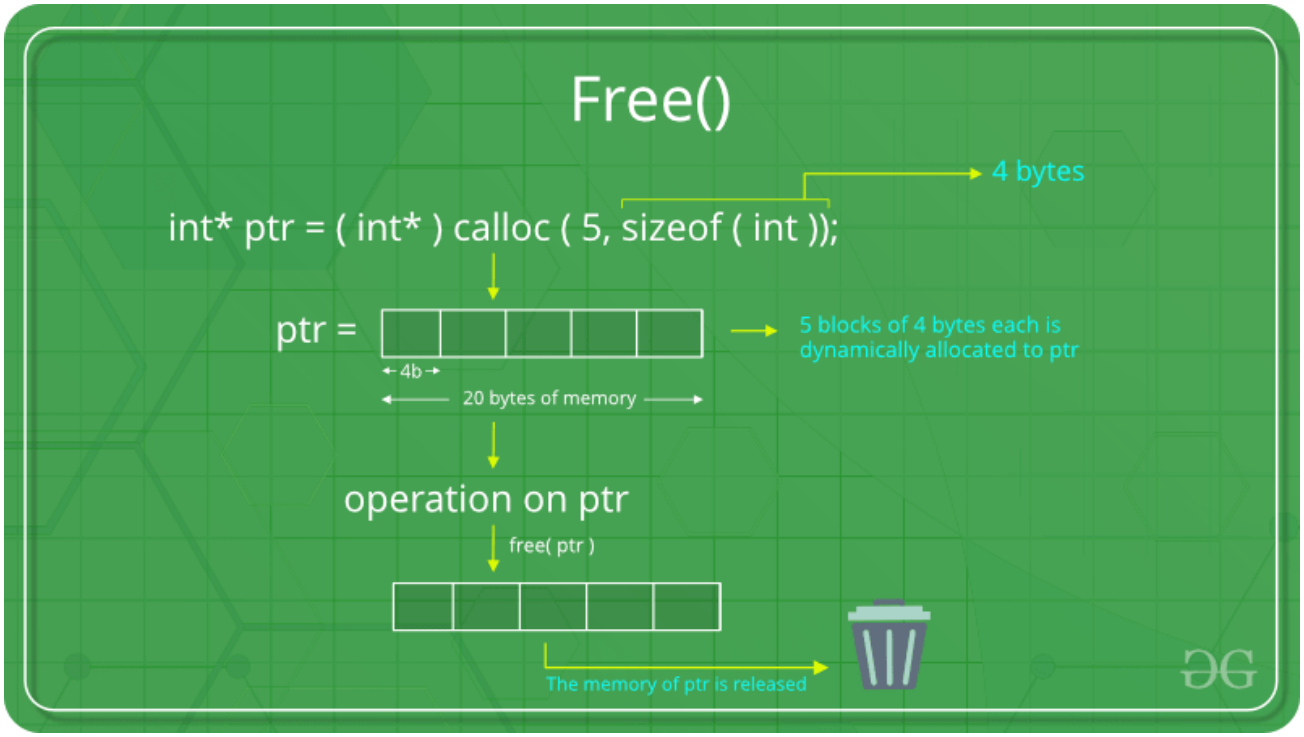
```
DataType * ptr = (DataType*) calloc(N, sizeof(DataType))
```



free()

- De-allocate the memory (allocated by malloc() and calloc()) ones it's use is over to prevent wastage of memory

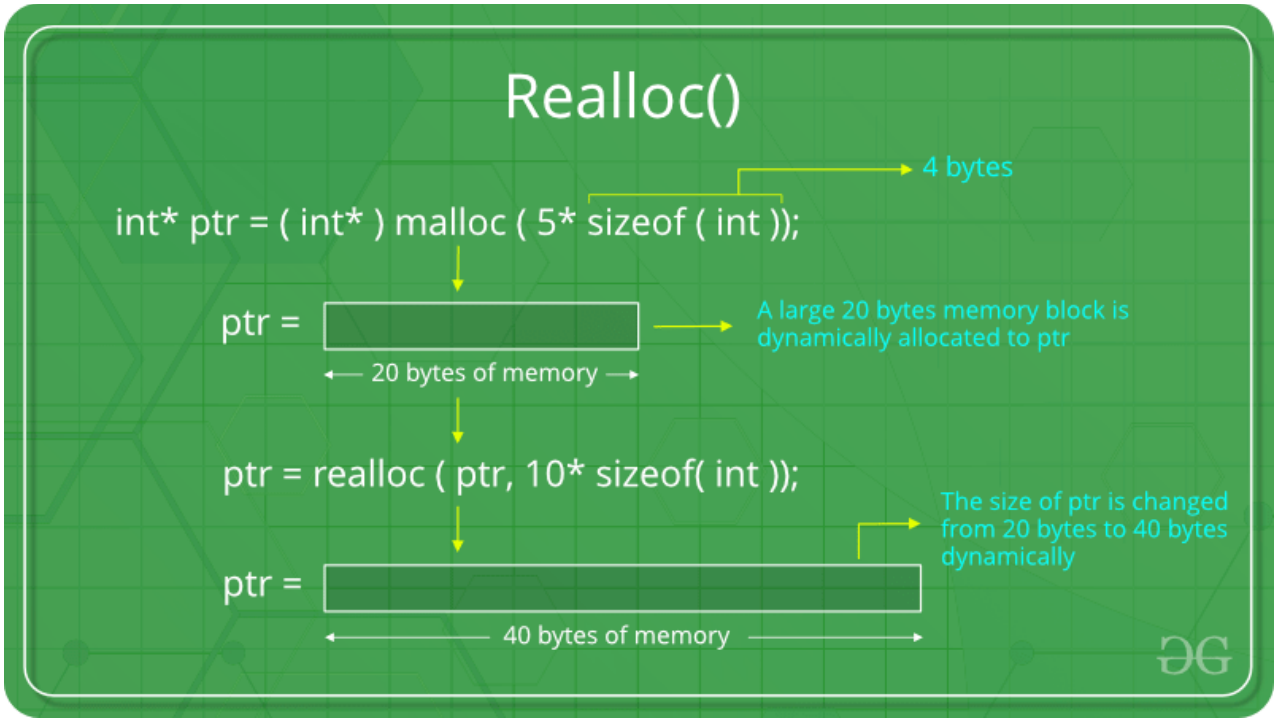
free(ptr)



Realloc()

- Re-allocation or extention of already allocated memory
- maintains the already present value

```
ptr = realloc(ptr, newSize);
```

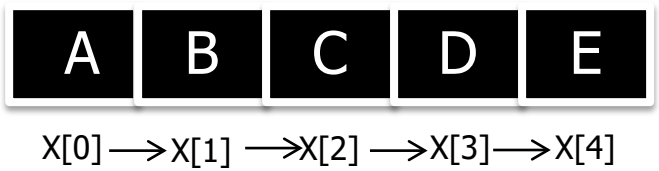


Dynamic Memory Allocation

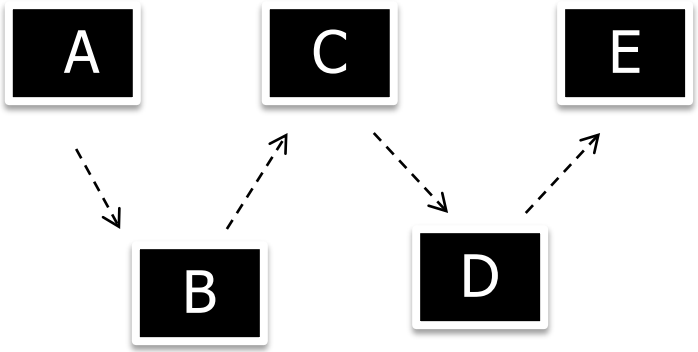
- Whenever space is insufficient during memory allocation malloc(),calloc(), and realloc() return NULL value

DYNAMMIC list(array)

char X[]={'A', 'B', 'C', 'D', 'E'}



Here, We have location information



Generate each node/element as per requirement using dynamic allocation

However, allocated memory is not in continuous form

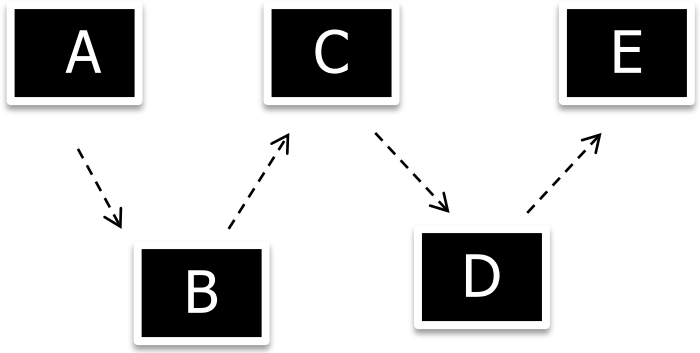
Then, How we can link the elements

Dynamic allocation

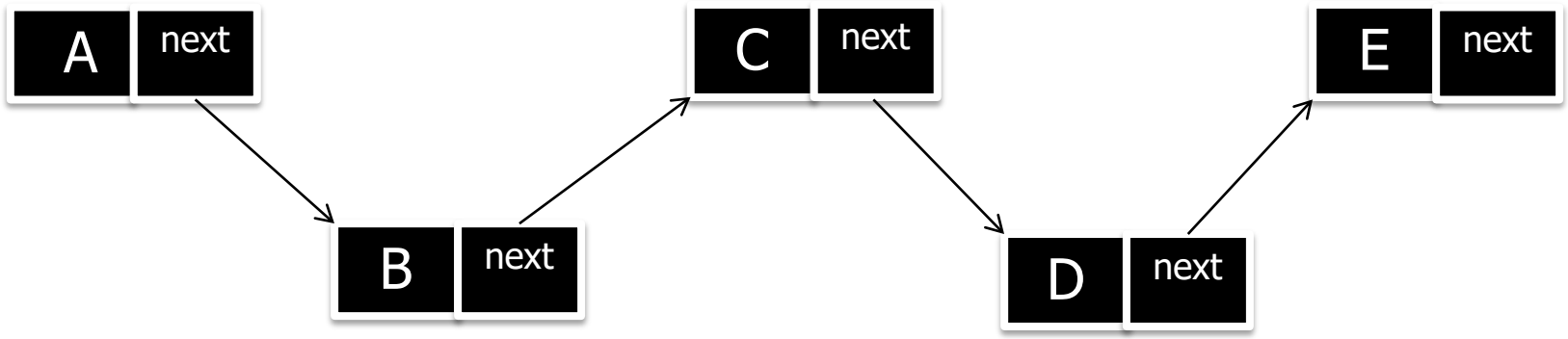
```
struct Node
        {
        int data;
        char gender;
        };
```

```
struct Node *ptr;
ptr = (struct Node*)malloc(sizeof(struct Node));
```

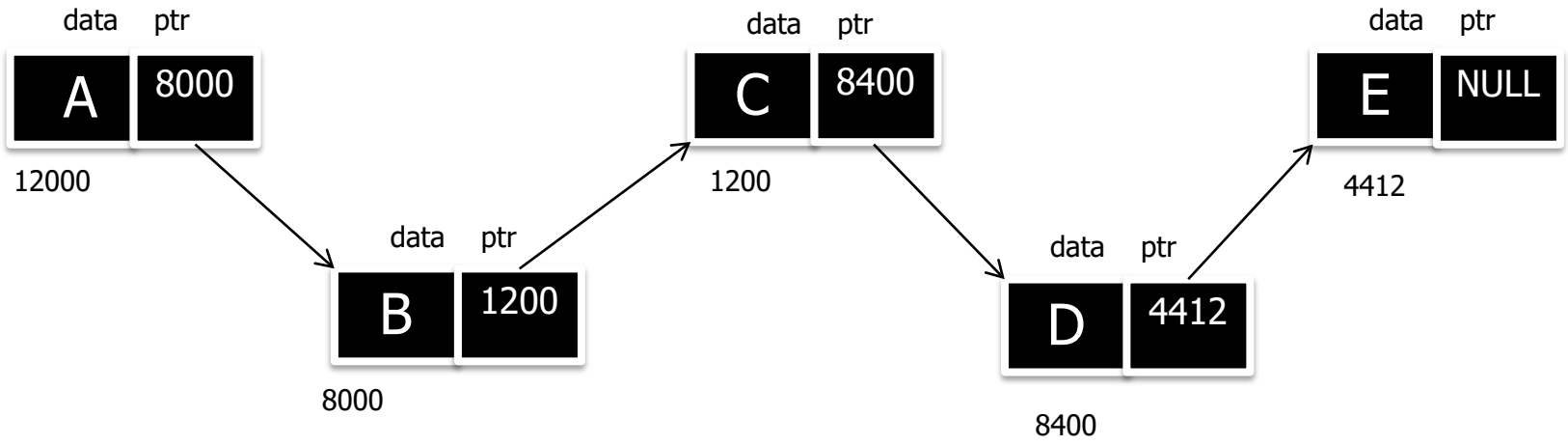
Dynamic allocation



Associate some other information with node such that it keep record of next node



Link List




```
struct Node {
        int data;
        struct Node* next;
        };
```

```
struct Node *n;
n = (struct Node*)malloc(sizeof(struct Node));
```

LINK LIST creation (for learning)

```
struct Node {
        int data;
        struct Node* next;
};

int main()
  {
      struct Node* head = NULL;
      struct Node* second = NULL;
      struct Node* third = NULL;

      // allocate 3 nodes in the heap
      head = (struct Node*)malloc(sizeof(struct Node));
      second = (struct Node*)malloc(sizeof(struct Node));
      third = (struct Node*)malloc(sizeof(struct Node));

      head->data = 1; // assign data in first node
      head->next = second; // Link first node with second

      second->data = 2; // assign data to second node
      second->next = third;

      third->data = 3; // assign data to third node
      third->next = NULL;


      return 0;
  }
```

LINK LIST creation (in practice)

```
struct Node{
    int data;
    struct Node *next;
};

int main()
{
    struct Node* head=NULL;
    struct Node* last=NULL;
    struct Node*  tmp=NULL;
    char flag;
    printf("\ndo you want to add node (y/n) : ");
    scanf("%c", &flag);
    while(flag=='y')
    {
        tmp = (struct Node *)malloc(sizeof(struct Node));
        printf("\nEnter data value: ");
        scanf("%d",&tmp->data);
        getchar();
        tmp->next = NULL;
        if(head==NULL)
        {
            head=tmp;
            last=tmp;
        }
        else
        {
           last->next = tmp;
           last=tmp;
        }
       printf("\ndo you want to add node (y/n) : ");
       scanf("%c", &flag);
    }
return 0;
}
```

LINK LIST Traversal

```
void printList(struct Node* n)
{
        while (n != NULL) {
                printf(" %d, ", n->data);
                n = n->next;
        }
}
```

calling
printList(head);

Array Vs. link list

Arrays	Linked list
Fixed size: Resizing is expensive	Dynamic size
Insertions and Deletions are inefficient: Elements are usually shifted	Insertions and Deletions are efficient: No shifting
Random access i.e., efficient indexing	No random access → Not suitable for operations requiring accessing elements by index such as sorting
No memory waste if the array is full or almost full; otherwise may result in much memory waste.	Since memory is allocated dynamically(acc. to our need) there is no waste of memory.
Sequential access is faster [Reason: Elements in contiguous memory locations]	Sequential access is slow [Reason: Elements not in contiguous memory locations]