CS1100 – Introduction to Programming

Instructor: Shweta Agrawal
Lecture 28

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- Data Types in C, Operators. Input and the Output.
- Modifying the control flow in Programs `if-else`, `switch`, loops : `while`, `do-while`, `for`.
- `Arrays` and `Strings` in C.
- Functions & modular programming.
- Recursion.

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- Pointers in C, Pass by reference
- Dynamic memory allocation
- Structures in C

$\Big\}$ Up Next...

More on pointers : Segmentation Fault

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- What is the output of this piece of code?

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#include<stdio.h>
int main() {
    int count;
    int *countPtr;

    count = *countPtr;
    printf("%d\n", count);
}
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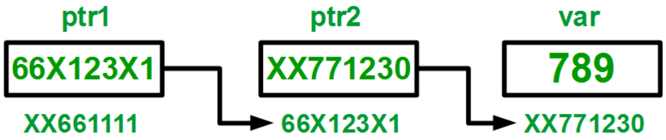
Unpredictable !!

More on Pointers : Pointer to pointers



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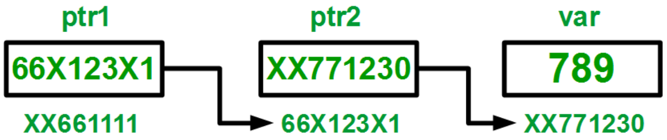

Syntax: `type **ptrname`

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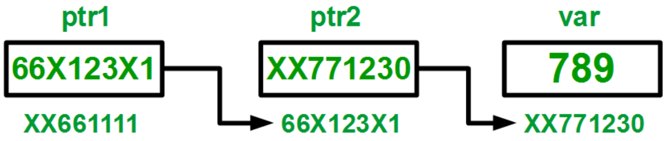

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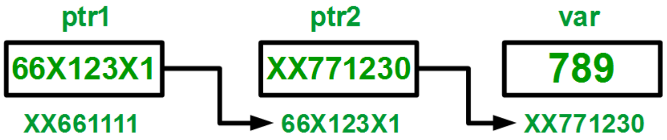

Syntax: `type **ptrname` Example : `int **ptr;`

```
int var = 789;
int *ptr2;
int **ptr1; // pointer which points to an integer pointer.
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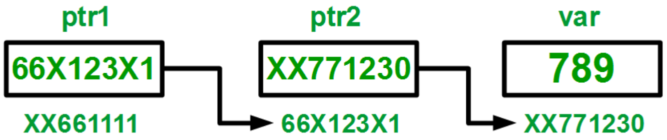
More on Pointers : Pointer to pointers



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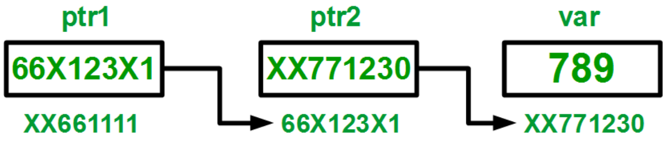
More on Pointers : Pointer to pointers



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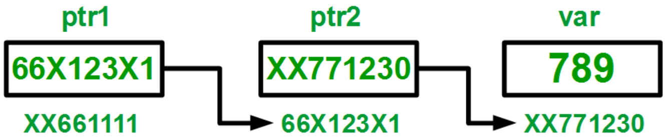

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ptr2 = &var; // storing address of var in ptr2.
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What are the values of `var`, `*ptr2`, `**ptr1`?

Pointers and Arrays

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- The dereferncing `*board` will gives us the array element `board[0];`
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- This pointer `board` can only point to this array and cannot be reassigned.

Pointers and Arrays

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int arr[4];
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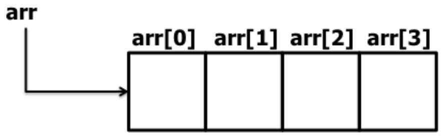

Array access using pointers

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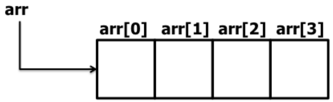

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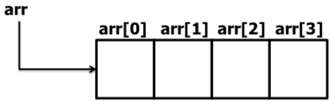

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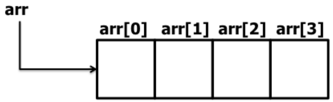

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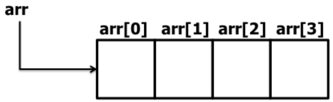

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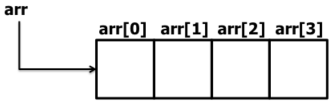

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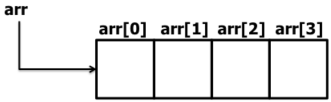

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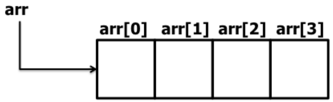

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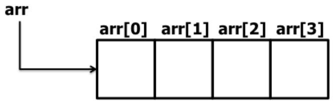

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- `arr[i]` is same as `*(arr+i)`.

Array access using pointers

```c
#include<stdio.h>

int main()
{
    int A[10] = {12, 3, 4, 5, 8, 16, 7, 88, 19, 10};
    int *ptr = &A[0];
    int i;

    for (i=0; i<10; i++) {
        printf("%d\t", A[i]);
        printf("%d\t", *(ptr+i));
        printf("%d\n", *ptr+i);
    }
}
```

Arrays and pointers

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        printf("%d\t", *(ptr+i));
        printf("%d\n", *ptr+i);
    }
}
```

string copy using pointers

```
#include<stdio.h>
#include<string.h>
void mystrcpy(char *source, char *dest) {
     int len = strlen(source);
     int i;
     for (i = 0; i < len; i++) {
         dest[i] = source[i];
     }
     dest[i] = '\0';
}

void main() {
    char s1[20] = "This is a string";
    char s2[20];

    mystrcpy(s1, s2);
    printf("%s\n", s2);
}
```

Another string copy using pointers

```
#include<stdio.h>
#include<string.h>
void mystrcpy(char *source, char *dest) {
     while(*source) {
        *dest = *source;
        dest++;
        source++;
     }
     *dest = '\0';
}

void main() {
    char s1[20] = "This is a string";
    char s2[20];

    mystrcpy(s1, s2);
    printf("%s\n", s2);
}
```

Reading input using pointers

```
#include <stdio.h>
int main() {
  int i, x[6], sum = 0;
  printf("Enter 6 numbers: ");
  for(i = 0; i < 6; ++i) {
  // Equivalent to scanf("%d", &x[i]);
      scanf("%d", x+i);

  // Equivalent to sum += x[i]
      sum += *(x+i);
  }
  printf("Sum = %d", sum);
  return 0;
}
```

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  How about `char Names[3][11]`?

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  How about `char Names[3][11]`?
- Use `char* Names[3]`
  - “Names” is an array of pointers to characters.

```
#include<stdio.h>
main() {
    char *Names[3]={"Sai", "Narasimhan", "Lakshmi"};
    int i;
    for (i=0; i<3; i++) {
       printf("%s\n",Names[i]);
    }
}
```

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main() {
    char *Names[3];
    int i;

    for (i=0; i<3; i++) {
        printf("Enter Name %d\t", i+1);
        scanf("%s", Names[i]);
    }
}
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main() {
    char *Names[3];
    int i;

    for (i=0; i<3; i++) {
        printf("Enter Name %d\t", i+1);
        scanf("%s", Names[i]);
    }
}
```

This program is incorrect! There is no memory allocated for `Names[i]`. The program most likely gives a core dump.

An array of pointers – Another program

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```
#include<stdio.h>
int main() {
    char *Names[3]; char temp[100]; int i;

    for (i=0; i<3; i++) {
        scanf("%s", temp);
        Names[i] = temp;
        printf("String input %s\n",Names[i]);
    }
    for (i=0; i<3; i++) {
        printf("String output %s\n",Names[i]);
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}
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    }
    for (i=0; i<3; i++) {
        printf("String output %s\n",Names[i]);
    }
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This program is still incorrect! All 3 array locations point to the same array temp.

Allocating memory using malloc

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  int *ptr;
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- The input to malloc is size of the memory required.
- malloc returns a pointer to the memory allocated – the type of the pointer is `(void *)`.
- Note the typecasting into `(int *)`.
- Memory obtained using malloc is destroyed only when it is explicitly freed or the program terminates.
- This is unlike variables which are unavailable outside their scope.

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#include<stdlib.h>
#include<string.h>
int main() {
    char *Names[3]; char temp[100]; int i;
    for (i=0; i<3; i++) {
      scanf("%s", temp);
      Names[i]=(char *)malloc(sizeof(strlen(temp)));
      strcpy(Names[i], temp);
      printf("String input %s\n",Names[i]);
    }
    for (i=0; i<3; i++)
      printf("String output %s\n",Names[i]);
    return 0;
}
```

An array of pointers – a correct program

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      strcpy(Names[i], temp);
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    }
    for (i=0; i<3; i++)
      printf("String output %s\n",Names[i]);
    return 0;
}
```

Note the use of malloc and also the stdlib.h

2D Arrays using pointers

Consider the following declaration:
int nums[2][3] $= \{\{16, 18, 20\}, \{25, 26, 27\}\}$;
How to reference these elements using pointers?

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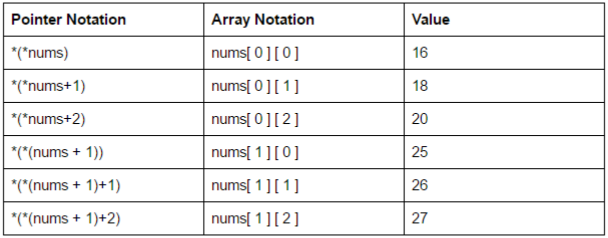
In general, nums[i][j] is equivalent to *(*(nums+i)+j)



Pointer Notation	Array Notation	Value
*(*nums)	nums[0] [0]	16
*(*nums+1)	nums[0] [1]	18
*(*nums+2)	nums[0] [2]	20
((nums + 1))	nums[1] [0]	25
((nums + 1)+1)	nums[1] [1]	26
((nums + 1)+2)	nums[1] [2]	27

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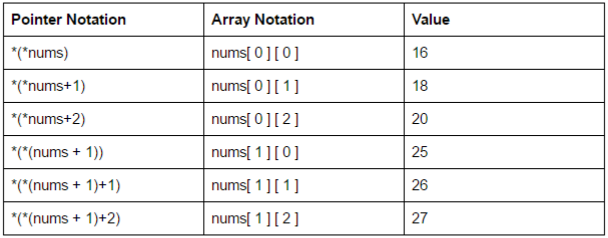

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- This method is useful when you do not have any address assigned to the pointer.
- Declaration: int *p = NULL
- if(ptr) : succeeds if p is not null
- if(!ptr) : succeeds if p is null

More practice: Pointers and strings

```
#include <stdio.h>
#include <string.h>
int main()
{
char str[]="Hello Guru99!";
char *p;
p=str;
printf("First character is:%c\n",*p);
p =p+1;
printf("Next character is:%c\n",*p);
printf("Printing all the characters in a string\n");
p=str;  //reset the pointer
for(int i=0;i<strlen(str);i++)
{
printf("%c\n",*p);
p++;
}
return 0;
}
```