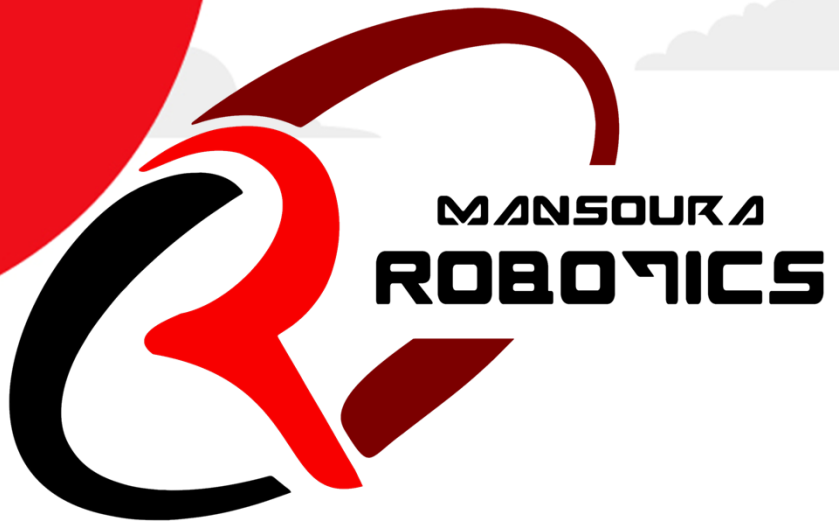
Pointers in C

Lecture 6



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01

Introduction to Pointers in C

Introduction to Pointers

Pointer is a data type used to hold an address of another variable. Pointers are one of the most important advantages of C programming.

Syntax:

```
Pointee_Type    *Pointer_Name;
```
Or
```
Pointee_Type*    Pointer_Name;
```
Or
```
Pointee_Type  *  Pointer_Name;
```

Example

```
int *ptr ;
int* ptr ;
int * ptr;
```

No difference between the 3 syntax. All of them define a pointer that points to ***int*** type

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The Address-Of Operator

The address-of operator is a unary operator represented by the symbol &. It gives the address of any variable if it is preceded the variable name.

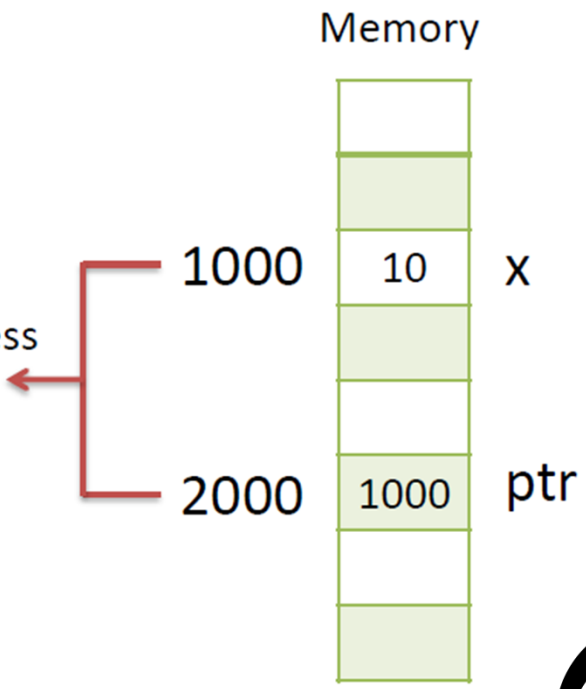
Example:

```
int x= 10;
int* ptr;
ptr = &x;
```

Define int named x and initialize it with value 10

Define pointer to int named ptr

Initialize ptr with the address of x



Note

keep in mind that the pointer itself is a variable and has an address in the memory like any variable. The only difference is that the pointer holds an address of another variable

The dereference operator

The dereference operator is a unary operator represented by the symbol *. It operates on a pointer variable, and gives the ability to access the variable that the pointer points to.

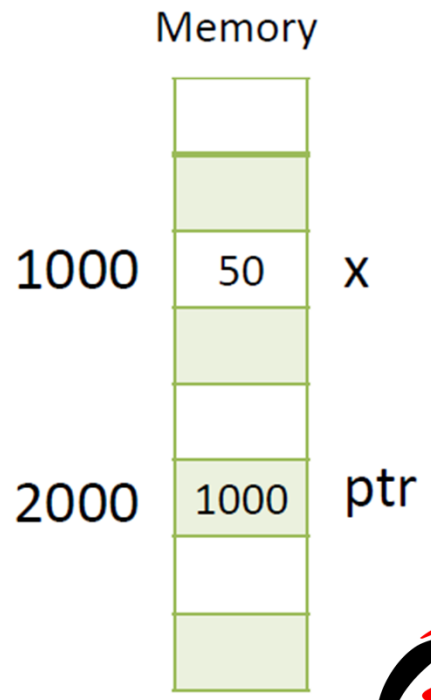
Example:

```
int x= 10;
int* ptr;
ptr = &x;
```

Define int named x and initialize it with value 10

Define pointer to int named ptr

Initialize ptr with the address of x




```
*ptr = 50;
```

This line means go to ptr, find out what is inside it and consider it address and jump to it, then assign 50

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LAB1

Write a C code defines an int initialized with 10, then print it, then define a pointer that points to that int and change the value of the int through the pointer to be 20, then print it again.

Expected Output

```
X before change is: 10
X after change is: 20
```

Time to Code

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Pass by value Vs. pass by address

```
int z;
```

Pass by Value

means you are making a copy in memory of the actual parameter's value that is passed in, a copy of the contents of the actual parameter.

```
void ByValue_func(int x);
```
← Function takes an argument by value

```
ByValue_func(z);
```
← Pass the variable z by value

Pass by Address

Sometimes called pass by reference, means you are making a copy in memory of the address of the actual parameter.

```
void ByAddress_func(int *ptr);
```
← Function takes an address as argument

```
ByAddress_func(&z);
```
← Pass the variable z by address

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LAB2

Write a C code that ask the user to enter 2 values and save them in two variables, then the program sends these variables by address to a function that returns the summation of them. The program then prints the result.

Expected Output

```
Please Enter Value 1:  10
Please Enter Value 2:  30
The result is:  40
```

Time to Code

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LAB3

Write a C code that ask the user to enter 2 values and save them in two variables, then the program sends these variables to function that calculates the summation and subtraction of them, the function returns the 2 results and return them in two pointers received as input arguments
then print the 2 results.

Expected Output

```
Please Enter Value 1:  15
Please Enter Value 2:  5
The result of Summation   is:  20
The result of Subtraction is:  10
```

Time to Code

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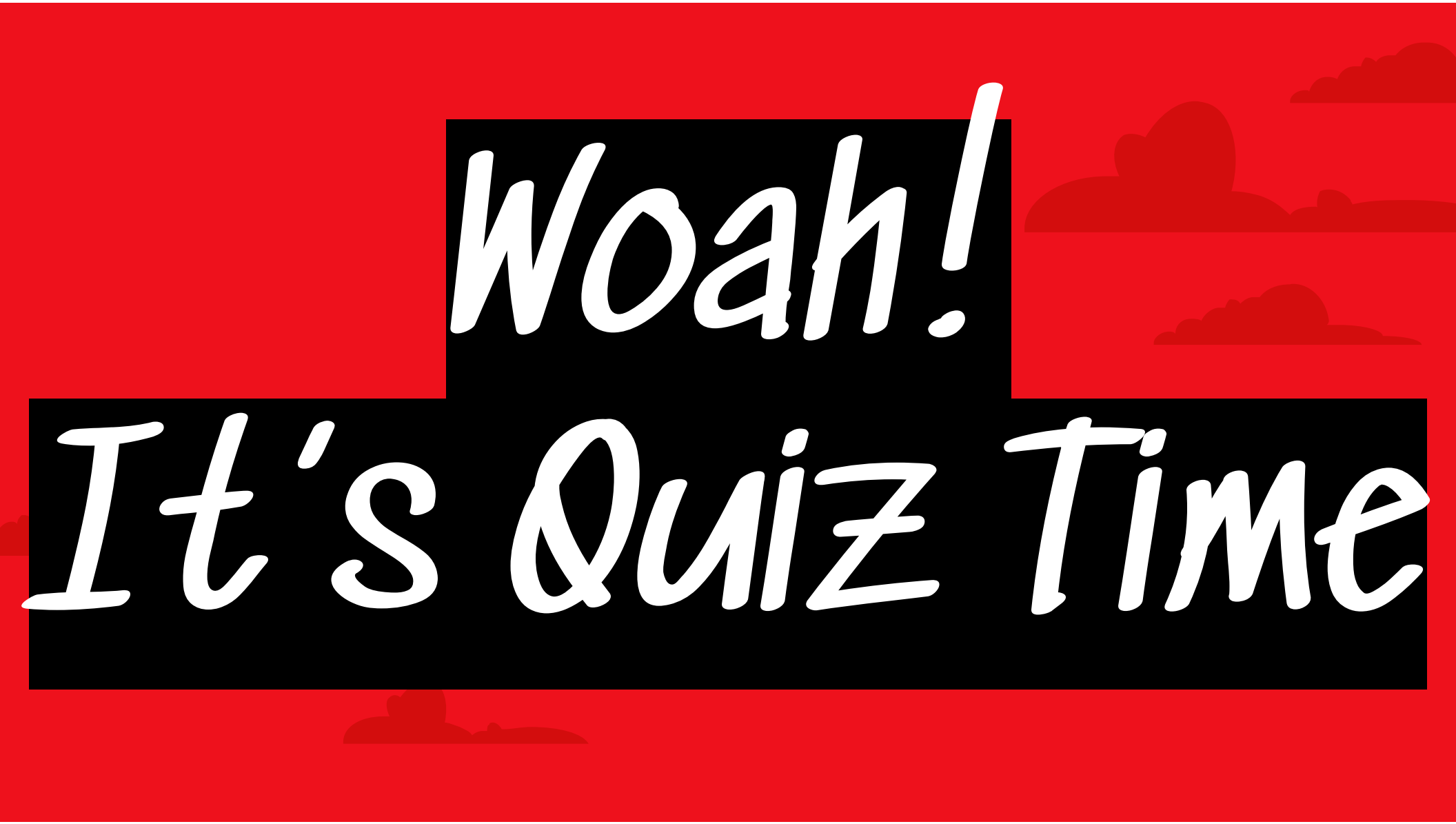

Woah!
It's Quiz Time

Quiz

What will be the output of the following lines:

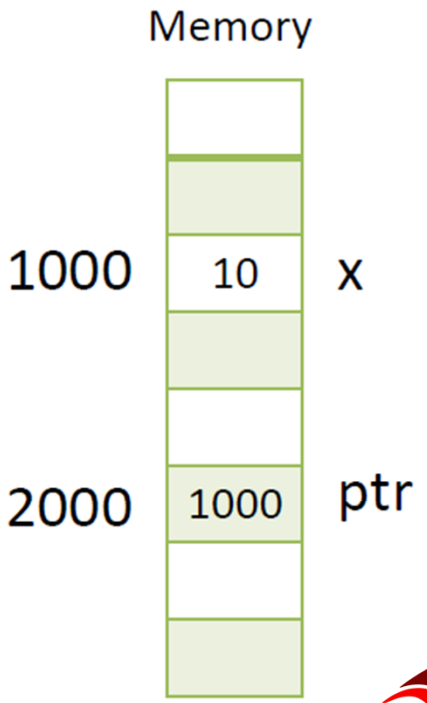
a. `printf("%d",x);`

b. `printf("%p", &x);`

c. `printf("%p", ptr);`

d. `printf("%d", *ptr);`

e. `printf("%p",&ptr);`



Note: %p used to print an address

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Quiz

What will be the output of the following lines:

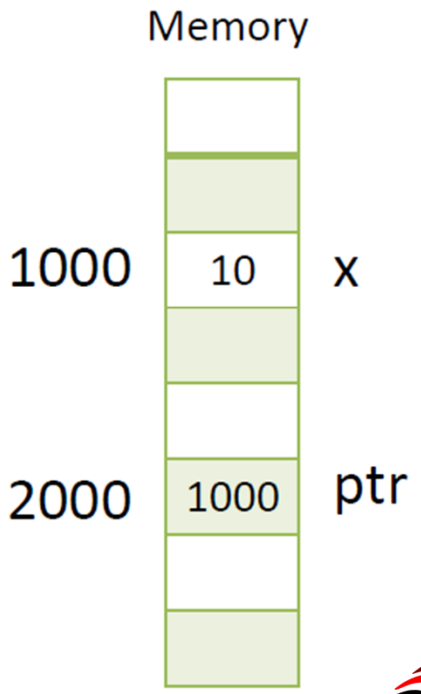
a. `printf("%d",x);` → 10

b. `printf("%p", &x);` → 1000

c. `printf("%p", ptr);` → 1000

d. `printf("%d", *ptr);` → 10

e. `printf("%p",&ptr);` → 2000



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02

Operations on Pointers

Operations on Pointers

```
int x= 10;
int* ptr;
ptr = &x;
```

1- Increment

Increments the pointer value by one step (The step is the size of the pointee)

Example

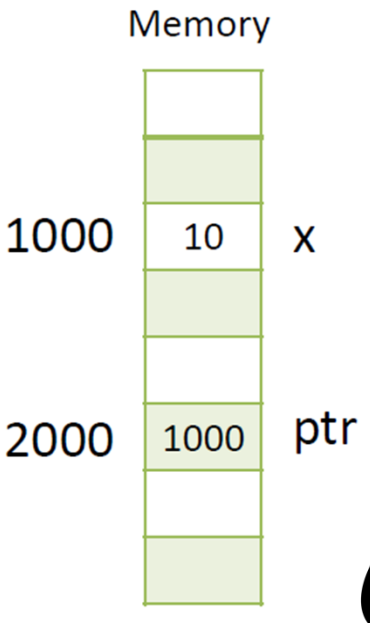
```
prt ++; /* Assuming int is 4 bytes */
        /* prt now = 1004          */
```

2- Decrement

Decrements the pointer value by one step

Example

```
prt --; /* Assuming int is 4 bytes */
        /* prt now = 996           */
```



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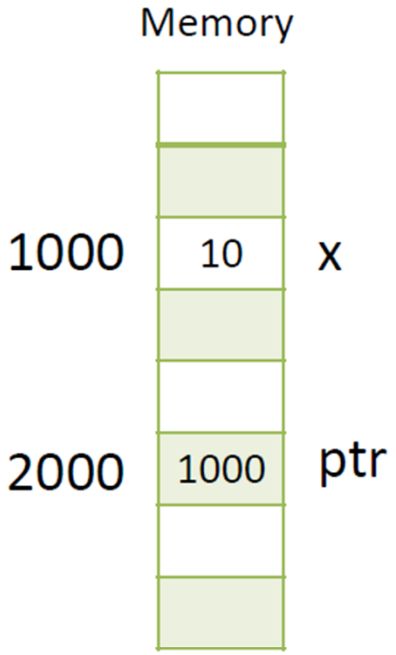
Operations on Pointers

3- Subtraction

a- Subtract value from the pointer

Example

```
ptr = ptr - 4; /* Assuming int is 4 byte */
               /* ptr now =  .984        */
```



b- Subtract pointer from pointer

Example

```
int x = ptr1 - ptr2; /* Assuming ptr1 = 2000 and ptr2 = 1000              */
                     /* Both of them are pointers to int which is 4 byte */
                     /* ptr1 - ptr2 returns number of steps between them */
                     /* difference between them is a value = 250         */
```

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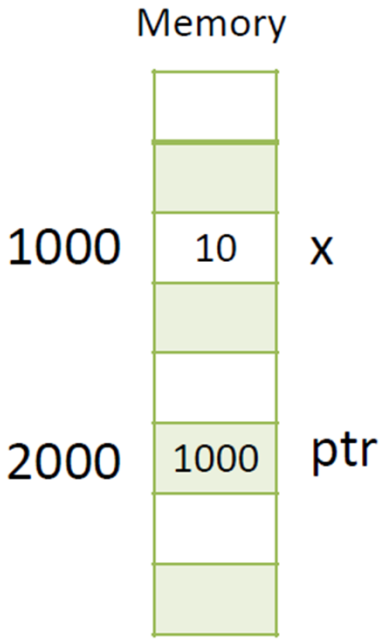
Operations on Pointers

4- Addition

a- Add value to the pointer

Example

```
ptr = ptr + 4; /* Assuming int is 4 byte */
               /* ptr now = 1016          */
```



b- Add pointer to pointer

Not Allowed, compilation Error

LAB4

Write a C code that calculates the summation of an array using a pointer on its first element.

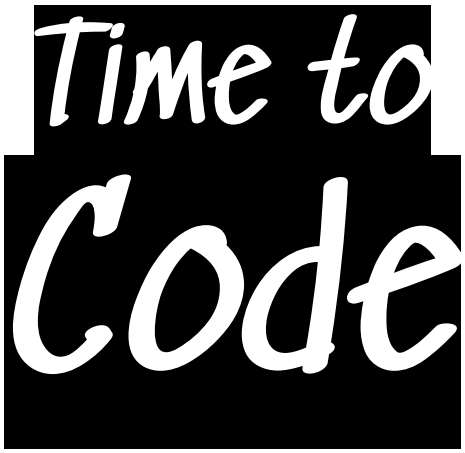
Notes:

1- Name of the array is the address of the first element in it.

i.e. int arr[10]; /* arr is the same as &arr[0] */

2- All elements of the array and saved sequentially in the memory.

i.e. if you have a pointer to the first element in the array, increme
makes the pointer points to the second element.



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03

Passing array to function

Passing array to function

Remember that ***name of the array is the address of its first element.***
i.e. if we have an array:

int arr[10];

Then *arr* is the same as *&arr[0].*

Which means if you passed the array name *arr* to function called *func* for example, then you are passing address to int. So, the function *func* prototype should be declared as:
*void func (int *ptr);*

Now, inside the function func, **ptr* means that you are accessing the first element of the array, **(ptr+1)* means that you are accessing the second element of the array, and so on …

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Subscriptor vs Dereference Operators

The subscriptor operator ([ ]) which used before with the array can be used also with pointer !

if we have a pointer

*int *ptr;*

Then ptr[0] is the same as *ptr

Also, ptr[1] is the same as *(ptr+1)

Also, ptr[10] is the same as *(ptr+10).

What is the output of this code ... ?

```
#include <stdio.h>

void func(int * ptr);

int arr[10] = {1,2,3,4,5,6,7,8,9,10};

void main(void)
{
    func(arr);
}

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

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LAB5

Do You Like Math ... ?

Write a C code that define 2 arrays, and send them to a function that apply scalar multiplication between the two arrays and return the result, the main function then will print the result.

$$\begin{pmatrix} a_1 & a_2 & \cdots & a_n \end{pmatrix} \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix} = a_1 b_1 + a_2 b_2 + \cdots + a_n b_n$$

Time to Code

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04

Special Types of Pointers

Dangling Pointer

Dangling pointer is a pointer that points to deleted or de-allocated object.

Can You see the dangling pointer here ... ?

```c
#include <stdio.h>

int* func(void);

void main(void)
{
    int *ptr = func();

    printf("%d", *ptr);
}

int* func(void)
{
    int x = 10;
    return &x;
}
```

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Wild Pointer

Wild pointer is any pointer that is used before initialization.

Can You see the wild pointer here ... ?

```c
#include <stdio.h>

void main(void)
{
    int *ptr;

    printf("%d", *ptr);
}
```

Thank you!

Do you have any questions?

Assignment 1

Write a C code that defines a function which takes an array as input argument and apply the bubble sorting algorithm on it, then print the result

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Assignment 2

Write a C code that define 3 int variables x, y and z and 3 pointers to int p, q and r. Set x, y, z to three distinct values. Set p, q, r to the addresses of x, y, z respectively.

a- Print with labels the values of x, y, z, p, q, r, *p, *q, *r.

b- Print the message: Swapping pointers.

c- Execute the swap code: r = p; p = q; q = r;

d- Print with labels the values of x, y, z, p, q, r, *p, *q, *r.

Can you expect the output before you run the program … ?

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