Computer Programming (b)

E1124

Lecture 3

Pointers and References

INSTRUCTOR

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Contents

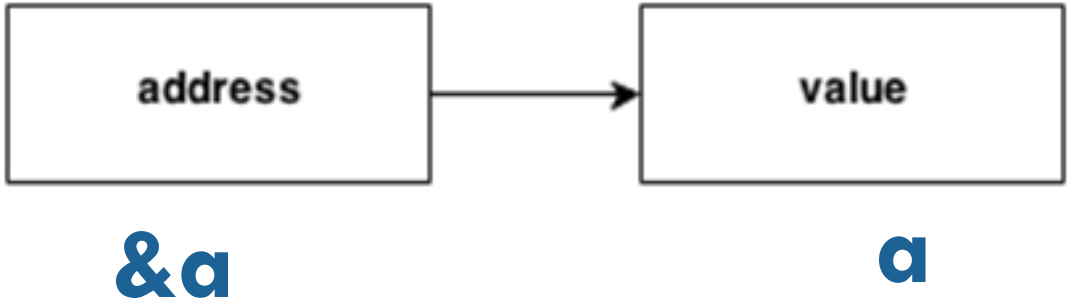
Objectives

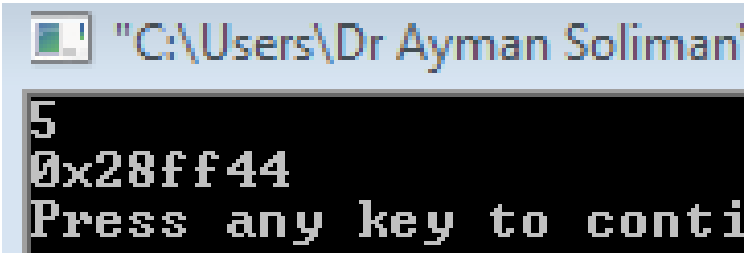
- Learn about the pointer data type and pointer variables
- Explore how to declare and manipulate pointer variables
- Learn about the address of operator and the dereferencing operator
- Learn about pointer arithmetic
- Pointers and its relations with Arrays

Introduction

- Variable is a name for a piece of memory that holds a value.
- A memory address is automatically assigned to the variable, and any value we assign to the variable is stored in this memory address.
- **Example:-**

```
#include <iostream.h>
int main()
{
        int a=5;
        cout<<a<<endl;      // print the content of a variable
        cout<<&a<<endl;     // print the address of a variable
        return 0;
}
```





Pointer Variables

- **Pointer variable:** content is a memory address
- Declaring Pointer Variables: Syntax

```
dataType *identifier;
```

- **Examples**:
- int *p;
- char *ch;
- int* fun_1(); // returning a pointer from a function

➢ Initialize and assign a value to a pointer

➢ **initialize pointer with address of variable value**

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

➢ **assigning pointer**

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

➢ **Not allowed initialization**

```
int *ptr = 5;
```

or

```
double *ptr = 0x006ffe44;
```

or

```
double value = 10;
int *ptr = & value;
```

//data types must be same

➢ Pointer Variables (cont.)

- These statements are equivalent

```
int *p;
int* p;
int * p;
```

- The character * can appear anywhere between type name and variable name

- In the statement

```
int* p, q;
```

only p is the pointer variable, not q; here q is an int variable

- The following statement declares both p and q to be pointer variables of the type int

```
int   *p, *q;
```

➢ Dereferencing Operator (*)

- C++ uses * as the binary multiplication operator and as a unary operator
- When used as a unary operator, *
  - ✓ Called dereferencing operator or indirection operator
  - ✓ The dereference operator (*) used to access the value at a particular address:

```
int x = 25;
int *p;
p = &x;    //store the address of x in p
```

- The following statement prints the value stored in the memory space pointed to by p, which is the value of x.

```
cout << *p << endl;
```

- The following statement stores 55 in the memory location pointed to by p—that is, in x.

```
*p = 55;
```

Address of Operator (&)

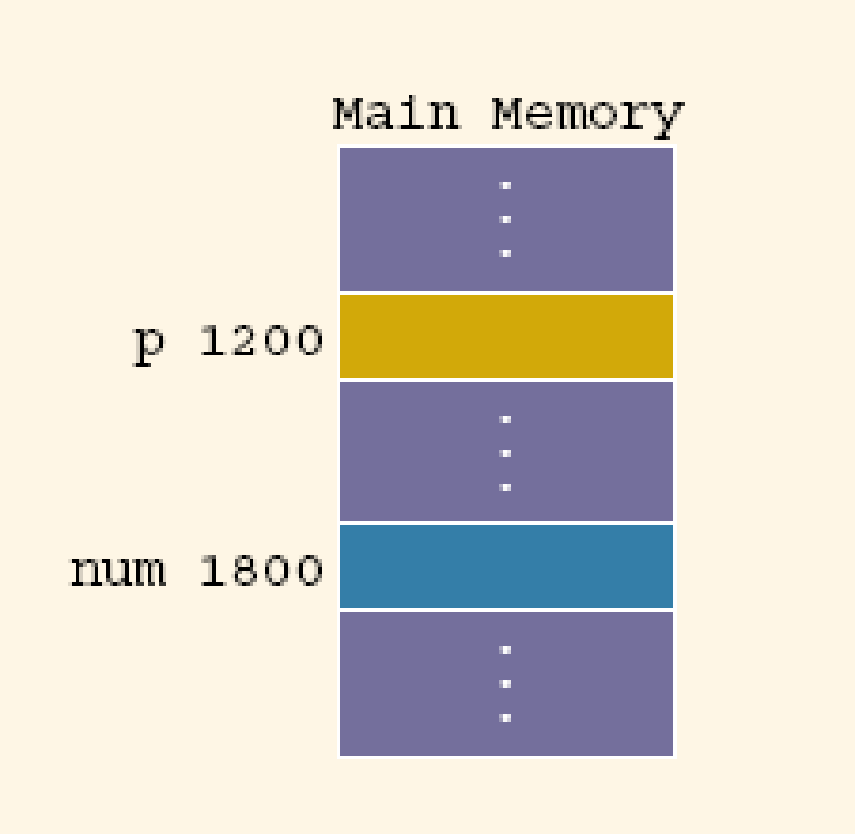
- The ampersand, &, is called the address of operator
- The address of operator is a unary operator that returns the address of its operand
- **Example:-**

```
#include <iostream.h>
int main()
{
    double b=5.5;
    cout<<b<<endl;      // print the content of b variable
    cout<<&b<<endl;     // print the address of b variable
    cout<<*&b<<endl;    // print the content of of address of b variable
    return 0;
}
```

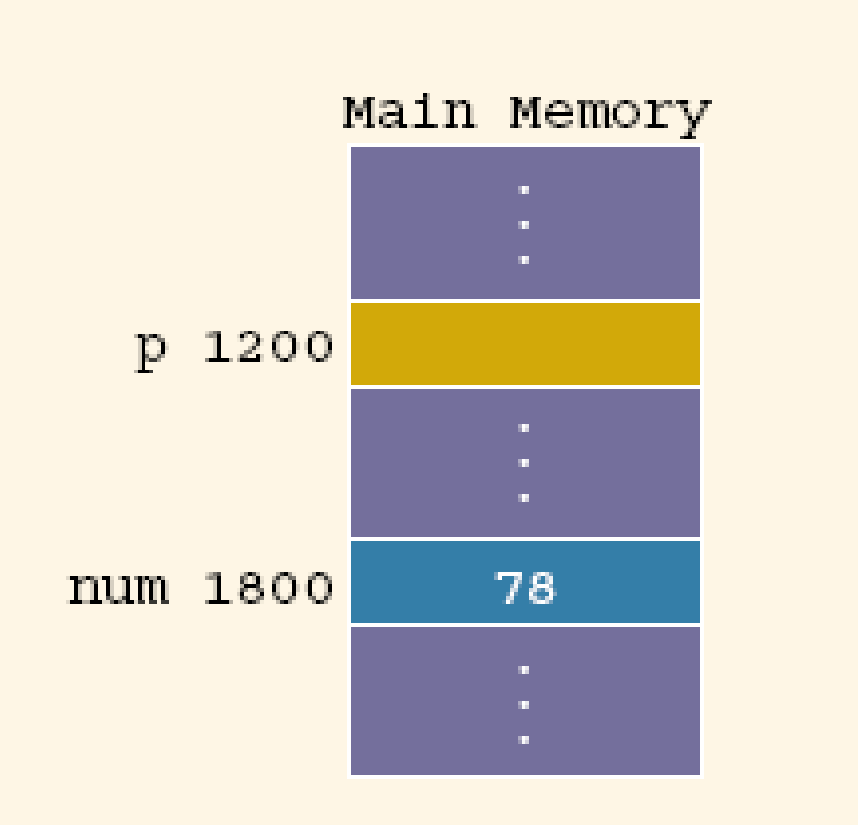
```
"C:\Users\Dr Ayman Soliman\Docu
5.5
0x28ff40
5.5
Press any key to continue
```

Example 1

- Int *p;
- Int num;

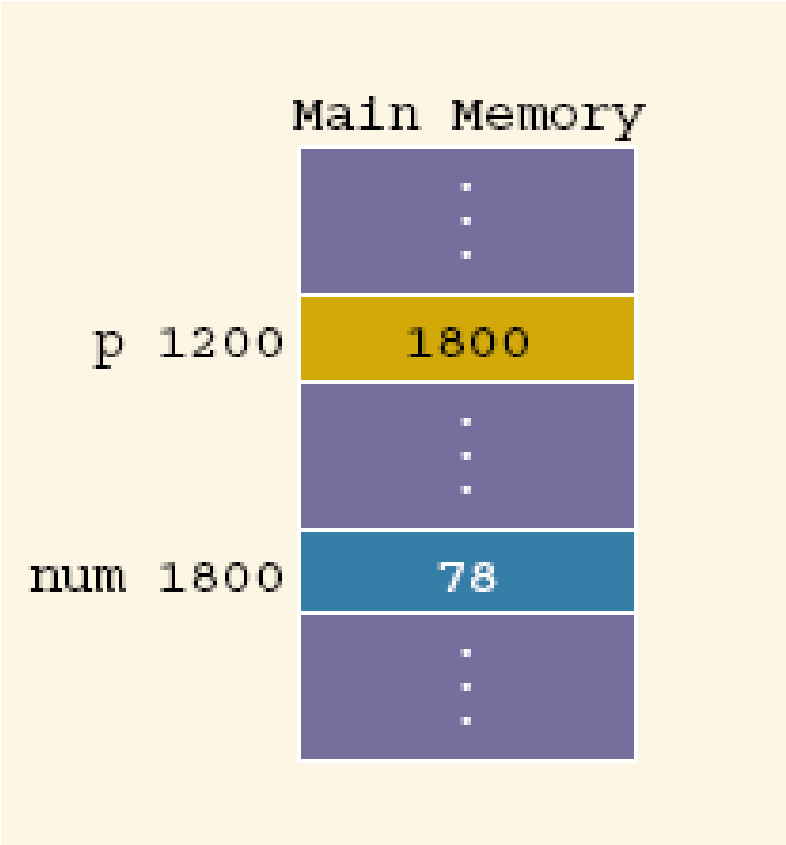


- Num = 78;

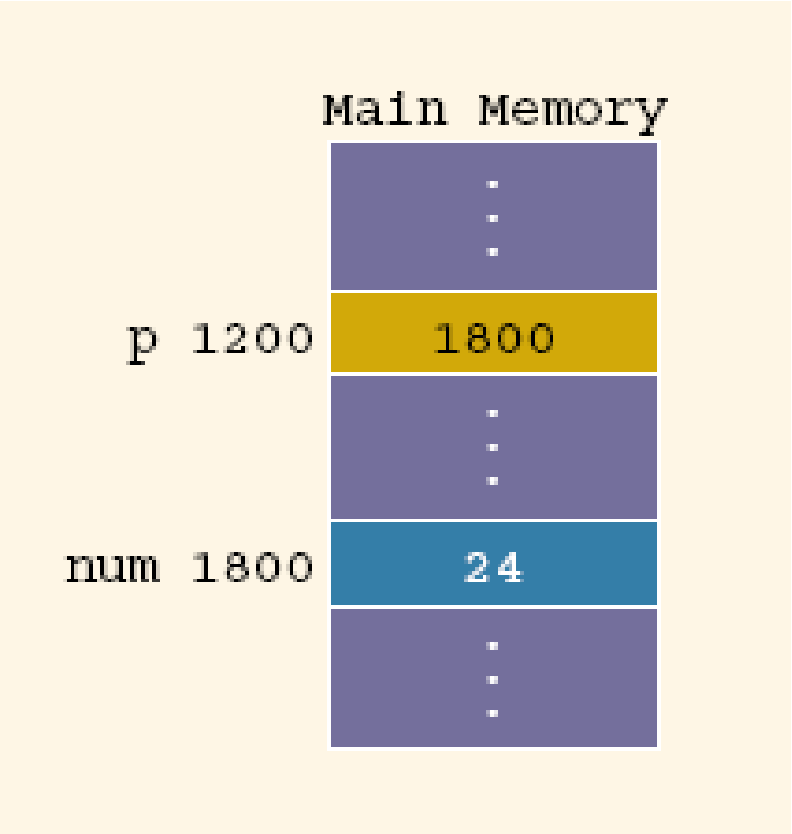


➢ Example 1 (cont.)

➢ P = #



➢ *p = 24;



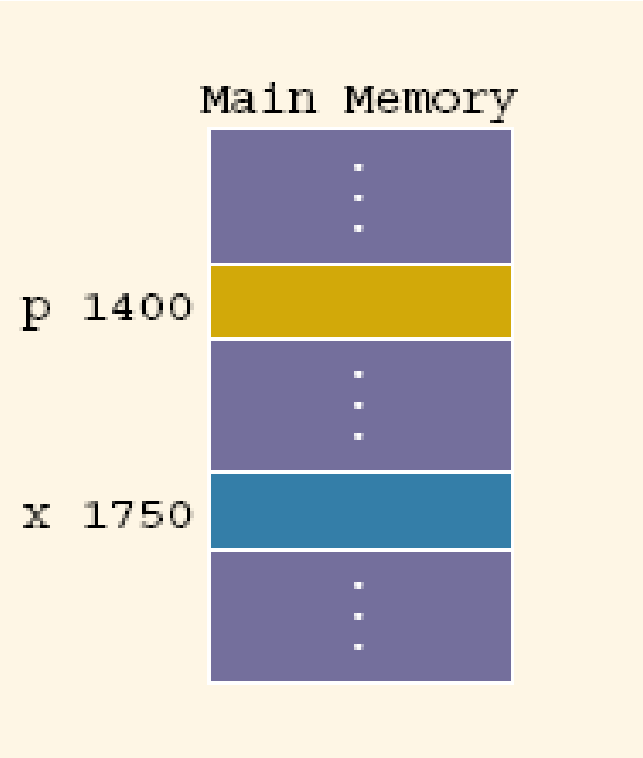
➢ Example 1 (cont.)

❑ **<u>&p, p, and *p all have different meanings.</u>**

- &p means the address of p.
- p means the content of p.
- *p means the content of the memory location pointed to by p.

Example 2

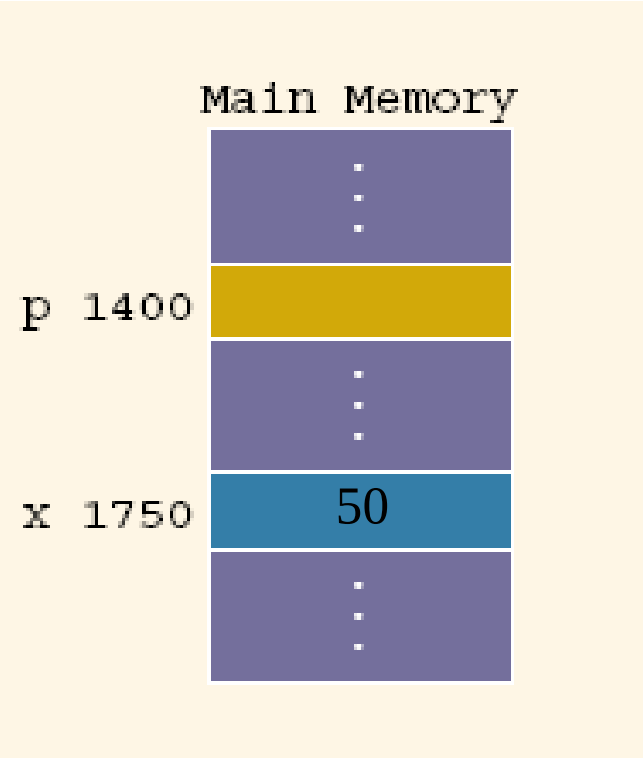
- Int *p;
- Int x;



	value
&p	1400
P	??? (unknown)
*p	does not exist (undefined)
&x	1750
X	??? (unknown)

➢ Example 2 (cont.)

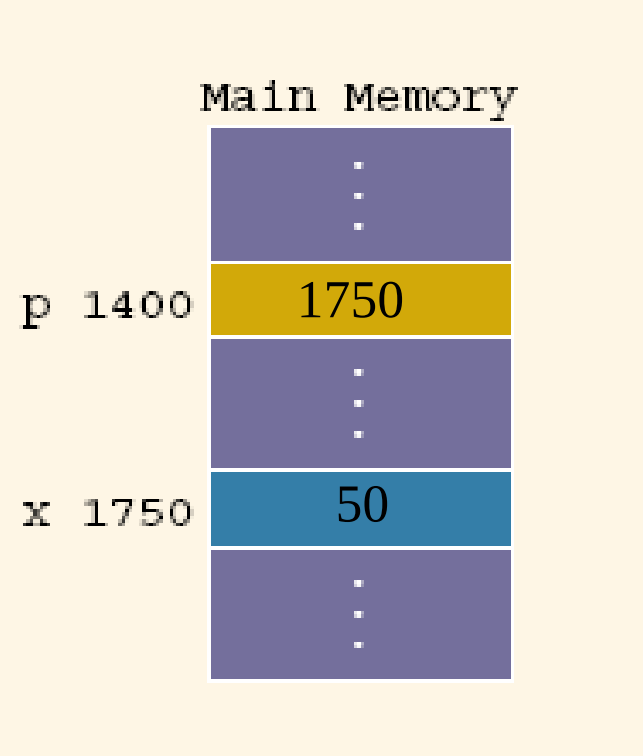
➢ x = 50;



	value
&p	1400
P	??? (unknown)
*p	does not exist (undefined)
&x	1750
X	50

➢ Example 2 (cont.)

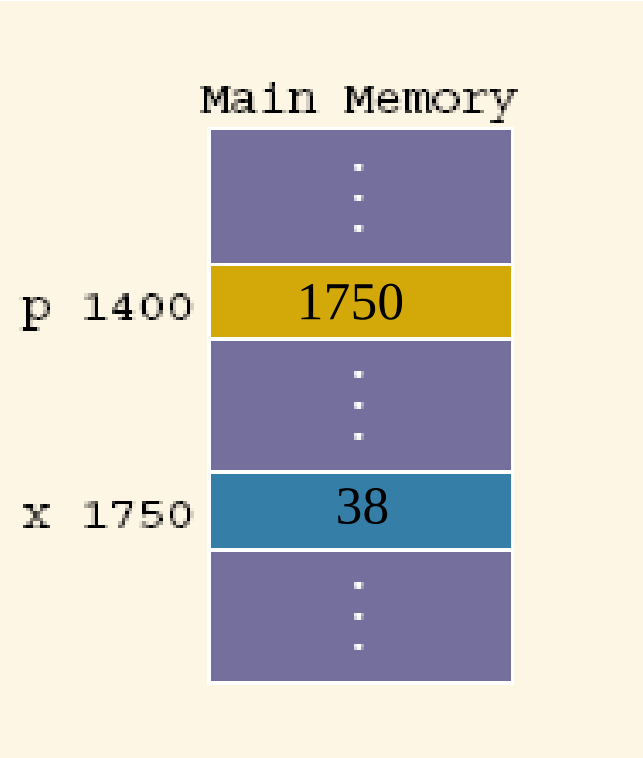
➢ p = &x;



	value
&p	1400
P	1750
*p	50
&x	1750
X	50

➢ Example 2 (cont.)

➢ *p = 38;



	value
&p	1400
P	1750
*p	38
&x	1750
X	38

➢ Pointers and Arrays

```
#include <iostream.h>
int main()
{
    int array[5]={1,3,5,7,9};
    cout<<"the array has address: "<<array<<endl;       // prints the array address
    cout<<"element 0 has address: "<<&array[0]<<endl;   // prints element 0 address
    cout<<"element 1 has address: "<<&array[1]<<endl;   // prints element 1 address
    cout<<"element 2 has address: "<<&array[2]<<endl;   // prints element 2 address
    cout<<"element 3 has address: "<<&array[3]<<endl;   // prints element 3 address
    cout<<"element 4 has address: "<<&array[4]<<endl;   // prints element 4 address
    cout<<*array<<endl;                                 // dereferencing an array returns element 0
    int *x=array;
    cout<<*x<<endl;

    return 0;
}
```

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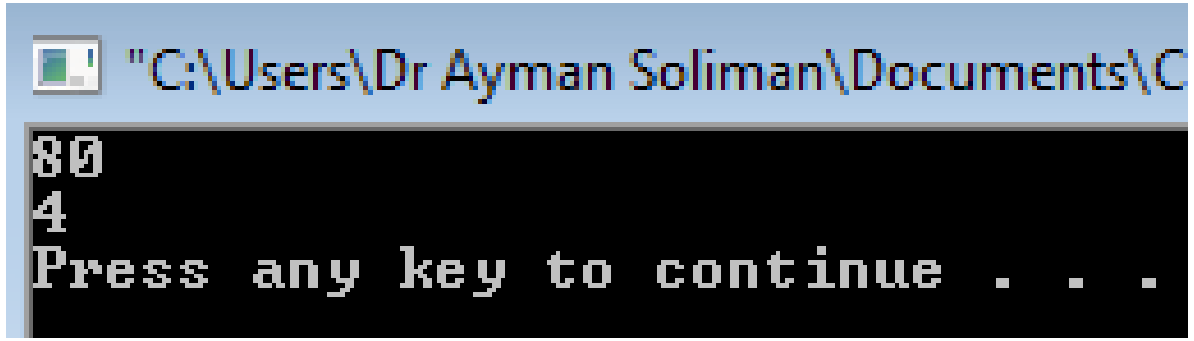
```
the array has address: 0x28ff20
element 0 has address: 0x28ff20
element 1 has address: 0x28ff24
element 2 has address: 0x28ff28
element 3 has address: 0x28ff2c
element 4 has address: 0x28ff30
1
1
Press any key to continue . . .
```

➢ Pointers and Arrays (cont.)

```
#include <iostream.h>
// implicity convert parameter array[] to *array
void size(double array[])          // void size(int *array)
{ // array is treated as pointer here, not a fixed array
    cout<<sizeof(array)<<endl;
}

int main()
{
    double array[]={1,3,5,7,9,11,13,15,17,19};
    cout<<sizeof(array)<<endl;      // size of data type * array length
    size(array);
    return 0;
}
```



➢ Pointers and Arrays (cont.)

➢ The C++ allows to perform integer addition or subtraction operations on pointers.

	Memory Address	Memory Contents		
ptr	0x 6ffe20	Byte 0:	0000 0001	*ptr
ptr + 1	0x 6ffe21	Byte 1:	0000 0010	*(ptr + 1)
ptr + 2	0x 6ffe22	Byte 2:	0000 0011	*(ptr + 2)
	0x 6ffe23	Byte 3:	0000 0100	
	0x 6ffe24	Byte 4:	0000 0101	
	0x 6ffe25	Byte 5:	0000 0110	
ptr + 6	0x 6ffe26	Byte 6:	0000 0111	*(ptr + 6)

➢ Pointers and Arrays (cont.)

```
#include <iostream>
 using namespace std;
int main()
{
short x[]={10,20,30,40};
short *ptr=x;

cout << "value " << *(ptr)  << " has address of "<<ptr  <<'\n';
cout << "value " << *(ptr+1)<< " has address of "<<ptr+1<<'\n';
cout << "value " << *(ptr+2)<< " has address of "<<ptr+2<<'\n';
cout << "value " << *(ptr+3)<< " has address of "<<ptr+3<<'\n';
 return 0;
}
```

```
value 10 has address of 0x6ffe30
value 20 has address of 0x6ffe32
value 30 has address of 0x6ffe34
value 40 has address of 0x6ffe36
```

	Memory Address	Memory Contents
ptr	0x 6ffe30	10
ptr + 1	0x 6ffe32	20
	0x 6ffe34	30
	0x 6ffe36	40

➢ Pointers and Arrays (cont.)

```
#include <iostream>
 using namespace std;
int main()
{
int x[]={10,20,30,40};
int *ptr=x;

cout << "value " << *(ptr)  << " has address of "<<ptr  <<'\n';
cout << "value " << *(ptr+1)<< " has address of "<<ptr+1<<'\n';
cout << "value " << *(ptr+2)<< " has address of "<<ptr+2<<'\n';
cout << "value " << *(ptr+3)<< " has address of "<<ptr+3<<'\n';
 return 0;
}
```

```
value 10 has address of 0x6ffe20
value 20 has address of 0x6ffe24
value 30 has address of 0x6ffe28
value 40 has address of 0x6ffe2c
```

Memory Address	Memory Contents
0x 6ffe20	10
0x 6ffe24	20
0x 6ffe28	30
0x 6ffe2c	40

The result of a pointer arithmetic expression always multiplies the integer operand by the size of the object being pointed to (scaling).


Thank
you