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Introduction to 'C++' Language

Pointers and Structure in C Plus Plus

Module 1 - Pointers in C Plus Plus

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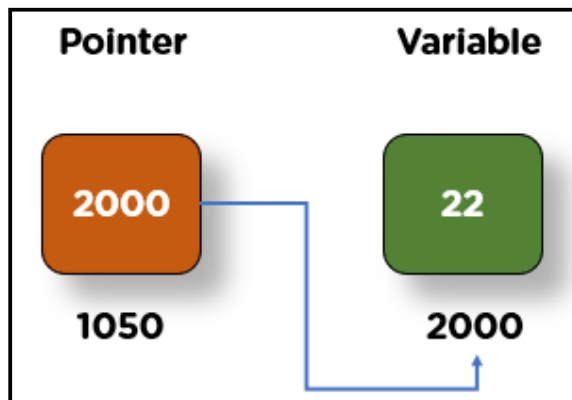
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What is a Pointer in C++?

In C++, every variable has its unique address or location in the computer's memory, and this special address is called memory address. You can define a pointer as the variable that holds the memory address of some other variable. It allows the developer to deal with the memory.



Here 2000 is the address of a variable stored by the pointer, and 22 is the variable's value.

The basic syntax for the pointer in C++ is:

Syntax:

**Data\_type \*pointer\_name;**

Here, the data type can be int, char, double, etc. The pointer name can be anything with the \* sign. The \* operator declares the variable is a pointer.

Initialization of Pointer

Example:

```
int a = 30;
int *ptr = &a
```

Here 'a' is the variable of data type int, and 30 is the value that is assigned to this variable a. Pointer ptr is referring directly to the value a, so here ptr will

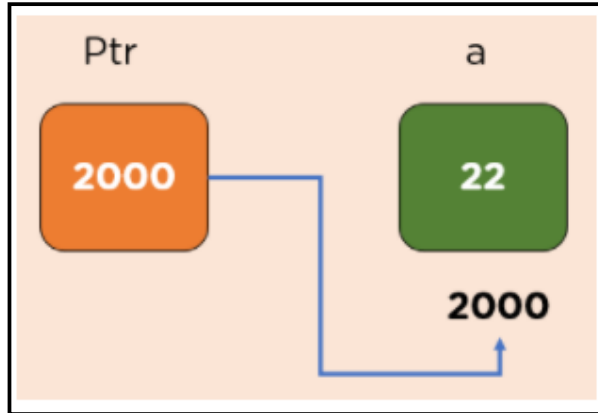
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store the address of variable a. `&(address-of operator)` is used to acquire the address of data stored in variable a.

### Dereference Operator in Pointer

It provides you access to the data that is stored at the memory address.



When you use the dereference operator with ptr, it will point to the memory address of variable a, i.e. 2000, which is also its own(ptr) value. Then, it will point to the value stored at the memory address, i.e. 22.

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Solved Example

```
#include <iostream>
using namespace std;

int main() {
    int x = 42;    // Regular variable
    int *ptr = &x; // Pointer to x

    cout << "Address of x: " << &x << endl;
    cout << "Value stored in ptr (address of x): " << ptr << endl;
    cout << "Value at address stored in ptr: " << *ptr << endl;

    *ptr = 100;    // Modify x through the pointer
    cout << "New value of x: " << x << endl;

    return 0;
}
```

**Output:**

Address of x: 0x100  
Value stored in ptr (address of x): 0x100  
Value at address stored in ptr: 42  
New value of x: 100

Pointer Arithmetic

There are some arithmetic operations that you can perform on a pointer in C++ because the pointer stores an address which is a numeric value. And the arithmetic operators are:

- Increment Operator (++)
- Decrement Operator (--)
- Addition (+)
- Subtraction (-)

**Increment Operator:** When you increment a pointer, the size of its type increments its address. For example, for incrementing an integer pointer whose address is 450, after increment, it will be 454 because the int type size is 4 bytes.

**Decrement Operator:** When you decrement the pointer, its address will be decremented by the size of its type.



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Both increment and decrement operations on a pointer are used to traverse through the array because, on increment, the pointer will point to the following memory address of the next element. On decrement, it will point to the previous memory address.

**Addition:** When you perform an addition operation to the pointer ptr by 1, i.e. ptr+1, then it will point to the next memory address. Similarly, if you add 3 to ptr, then it will point to the address that is three times the size of the type of pointer, 3\* (size of) type.

**Subtraction:** When you subtract on a pointer, it will decrease the address by n\* (size of) type.

### Using Pointers to Access Elements of the Array

In an array, the name is referred to as the address of array inside the memory and that is why while assigning the address of an array to a pointer we don't use ampersand sign &, because the array name denotes the address of the first element in the array.

So, to access the elements of the array, you can use a dereference operator with the array name.

### Solved Example

```
#include <iostream>
using namespace std;

int main() {
    // Array declaration
    int records[5] = {10, 20, 30, 40, 50};

    // Using pointer arithmetic to print each element
    cout << "Elements of the array using pointer arithmetic:" << endl;
    for (int i = 0; i < 5; i++) {
        cout << "records[" << i << "] = " << *(records + i) << endl;
    }

    return 0;
}
```

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Explanation of the Code:

1. Array Declaration:

```
int records[5] = {10, 20, 30, 40, 50};
```

This declares an array records with 5 elements.

2. Pointer Arithmetic:

○ The name of the array (records) acts as a pointer to the first element of the array.

○ Using records + i, we move the pointer to the memory address of the i-th element in the array.

○ Using the dereference operator \*, we get the value at that memory location.

3. Loop:

○ The for loop iterates through the array, printing each element using \*(records + i).

Output:

Elements of the array using pointer arithmetic:

```
records[0] = 10
```

```
records[1] = 20
```

```
records[2] = 30
```

```
records[3] = 40
```

```
records[4] = 50
```

Passing Pointers to Functions in C++

Passing pointers to functions in C++ allows you to directly manipulate the memory address of variables or arrays. This is useful for efficient memory use and for passing large data structures to functions without copying them.

Why Pass Pointers to Functions?

- To modify the actual value of a variable in the calling function.
- To avoid copying large objects, improving efficiency.
- To handle arrays and dynamic memory efficiently.

Syntax for Passing Pointers

The function receives a pointer as its parameter. The caller provides the address of a variable or an array.

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Solved Example: Modifying a Variable

```
#include <iostream>
using namespace std;

// Function to modify the value using a pointer
void modifyValue(int *ptr) {
    *ptr = 100; // Change the value at the address pointed to by ptr
}

int main() {
    int x = 10;
    cout << "Before: x = " << x << endl;

    modifyValue(&x); // Pass the address of x to the function
    cout << "After: x = " << x << endl;

    return 0;
}
```

**Output:**  
Before: x = 10  
After: x = 100

Solved Example: Swapping Two Variables

You can swap two variables by passing their pointers to a function.

```
#include <iostream>
using namespace std;

// Function to swap two variables using pointers
void swap(int *a, int *b) {
    int temp = *a;
    *a = *b;
    *b = temp;
}

int main() {
    int x = 5, y = 10;

    cout << "Before swap: x = " << x << ", y = " << y << endl;
}
```

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```
swap(&x, &y); // Pass addresses of x and y  
cout << "After swap: x = " << x << ", y = " << y << endl;  
  
return 0;  
}
```

**Output:**

Before swap: x = 5, y = 10  
After swap: x = 10, y = 5

Assignment

Ques 1: Write a program to declare an integer variable and a pointer. Assign the variable's address to the pointer and print the value and address using the pointer.

Ques 2: Create an array of 5 integers and use a pointer to print all the elements of the array.

Ques 3: Write a function that takes a pointer to an integer as an argument and modifies the value to its square.

Ques 4: Declare two integer variables, swap their values using pointers, and print the result.

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