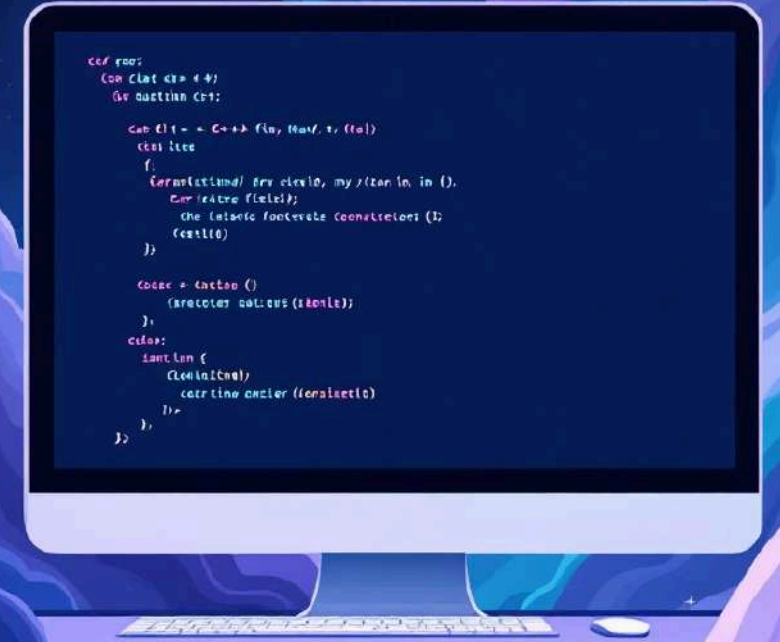


Pointers and Dynamic Memory in C++

A ready-made lecture plan with practical examples for studying one of the most important topics in C++ programming. Understanding pointers is key to efficient memory management and creating high-performance applications.



Lecture Structure

01

Introduction to Pointers

Basic concepts and purpose of pointers in programming

02

Syntax Fundamentals

Operators & and *, pointer types, and working with addresses

03

Pointers and Functions

Passing parameters by pointer and modifying values

04

Dynamic Memory

New/delete operators and memory management

05

Arrays and Pointers

Relationship between arrays and pointers, pointer arithmetic

What is a Pointer?

Definition

A pointer is a variable that stores the memory address of another variable

Why are they needed?

- Working with arrays
- Dynamic data structures
- Efficient data transfer

Accessing memory

From abstract code to direct interaction with computer memory

Key Operators

- **&** — get variable address
- ***** — dereference pointer
- **int*** — declare a pointer to an int

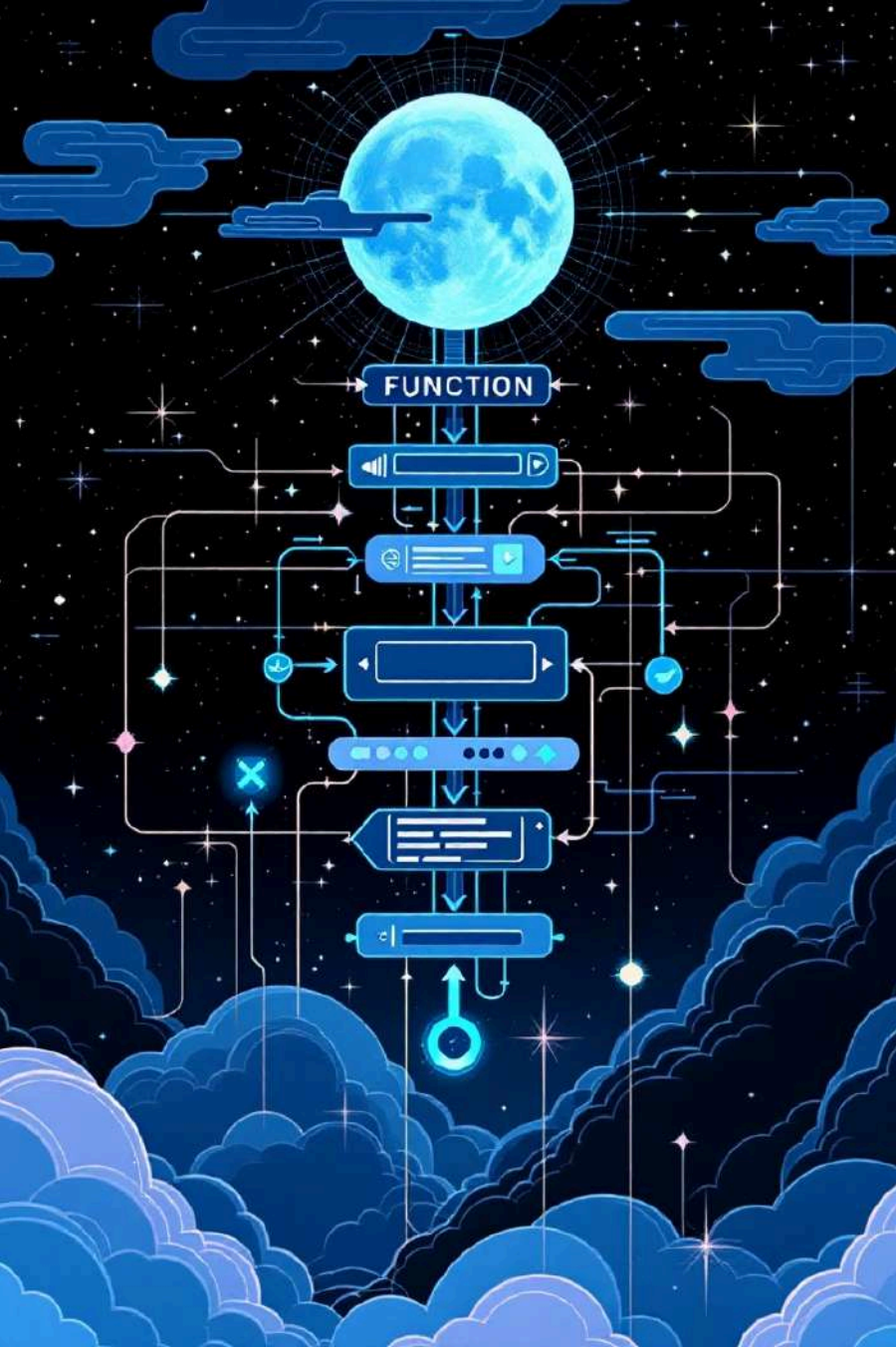
```
int a = 10;  
int *p = &a;  
cout << "Value: " << *p;  
cout << "Address: " << p;
```

Made with **Gamma**

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Pointers in Functions

1

Pass by Pointer

An alternative to references for modifying variables

2

Modification outside function

Ability to change variable values from other scopes

```
void increment(int *x) {  
    (*x)++;  
}  
int main() {  
    int a = 5;  
    increment(&a); // а теперь равно 6  
}
```


Dynamic Memory



Static Allocation

Memory is allocated at compile time, size is fixed



Dynamic Allocation

Memory is allocated at runtime using `new`



Memory Deallocation

Mandatory use of `delete` to prevent leaks

📌 Important! Each call to `new` must be matched by a call to `delete`



Dynamic Arrays

```
int n;  
cout << "Enter size: "; // Введите размер:  
cin >> n;  
  
int *arr = new int[n]; // dynamically allocate array  
  
for (int i = 0; i < n; i++) {  
    arr[i] = i * i; // fill with squares of numbers  
}  
  
for (int i = 0; i < n; i++) {  
    cout << arr[i] << " ";  
}  
  
delete[] arr; // free memory
```

This example demonstrates creating an array with a size determined at program runtime.



Relationship between Arrays and Pointers

1

Array Name

Pointer to the first element

2

Pointer Arithmetic

$p+1$ points to the next element

3

Accessing Elements

$*(p+i)$ is equivalent to `arr[i]`

```
int arr[3] = {10, 20, 30};  
int *p = arr;  
cout << *p << endl; // 10  
cout << *(p + 1) << endl; // 20  
cout << *(p + 2) << endl; // 30
```





Key Takeaways



Direct Memory Access

Pointers allow direct interaction with memory addresses



Close Relationship with Arrays

Understanding pointers is critical for working with arrays



Flexible Memory Management

`new` and `delete` operators provide dynamic allocation



Caution with Errors

Incorrect pointer usage is a common cause of crashes

Review Questions

Pointer Operators

What is the difference between the `&` and `*` operators?

Array Types

What is the difference between a static and a dynamic array?

Memory Management

What happens if you forget to call `delete`?

Ready to move on to practical seminar sessions? The next step is creating dynamic data structures and solving pointer-related problems!

