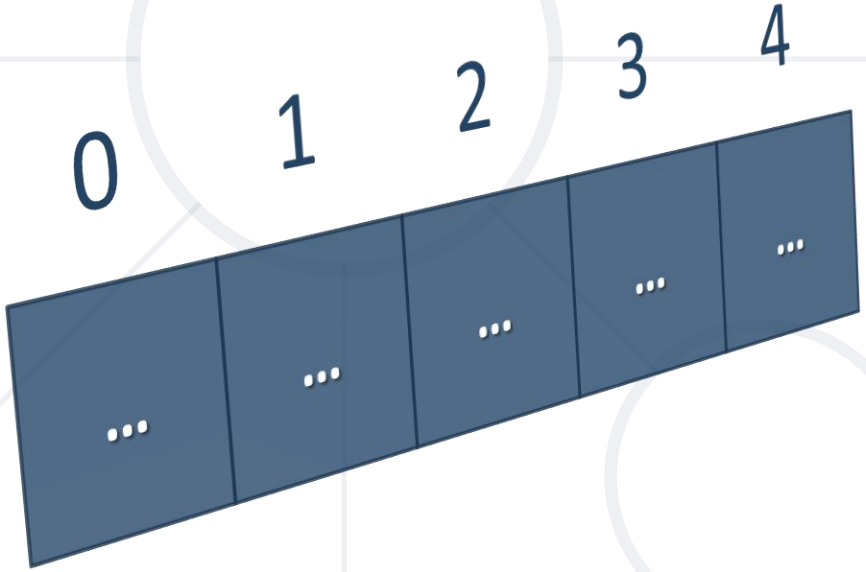
Arrays

Fixed-Size Sequences of Elements



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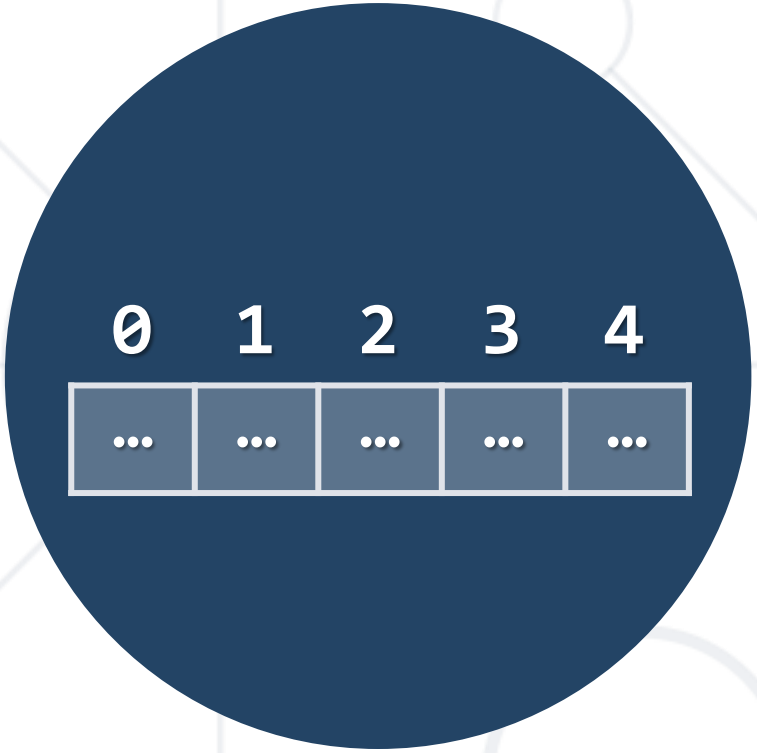

What are Arrays?

What Are Arrays?

- In programming, an **array** is a **sequence of elements**

- Elements are numbered from **0** to **Length-1**
- All elements are of the **same type**
- Arrays have **fixed size** and cannot be resized

Creating Arrays

Creating C++ Arrays

- Declaring

```
{data type} {identifier}[{array size}];
```

- Arrays have some special **initialization syntax**

```
{data type} {identifier}[N] = {elem0, elem1, ..., elemN-1};
```

- There can be less than N elements, **but not more**

```
int numbers[5] = { 10, 9, 12, 31, 15 };
```

Index	0	1	2	3	4
Value	10	9	12	31	15

Declaring and Initializing

Array Declaration

- Array size must be an **integer**. Size can be:
  - a **literal**
  - a **constexpr**

```
double numbers[7];
constexpr int NUM_LETTERS = 26;
char alphabet[NUM_LETTERS];
```

- You can also declare an array **without a specified size**
  - The compiler is smart enough to get the elements' count we put inside the braces

```
int numbersToFive[] = { 1, 2, 3, 4, 5 };
```

Array Initialization

- { } initializes elements (comma-separated values)
  - if less values than array size: **remaining get default values**
  - if more values than array size: **compilation error**

```
double values[3] = {3.14};
double sameValues[3] = {3.14, 0, 0};
```

- Other rules are the same as for primitives:
  - Can only be **initialized once**
  - Can be made **const**

Reading and Printing Arrays

Accessing Array Elements

- The indexing operator [ ] gives access to any array element

```
int array[{index}] = 10;
int value = array[{index}];
```

- Once you access the element, treat it as a **normal variable**

```
int array[3] = { 20, 30, 40 };
cout << "First->" << array[0]
     << "Second->"<< array[1]
     << "Third->" << array[2] << endl;
```

Reading an Array

- Arrays are often read-in from some input, **instead of initialized**
- Common approach: **run a loop to read-in a number of elements**
  - Example: read-in a specified number of elements from console

```
for (int i = 0; i < n; i++)
{
    cin >> arr[i];
}
```

Printing an Array

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- You will commonly need to display **all elements of an array**
- Common approach: **loop over the elements, print each**

```
for (int i = 0; i < n; i++)
{
    cout << arr[i] << endl;
}
```

Read and Print an Array

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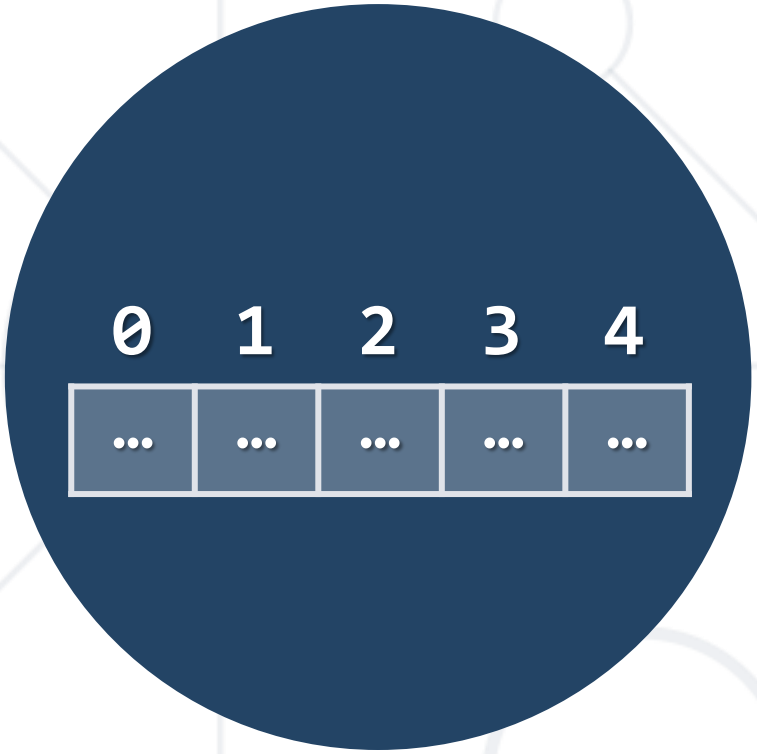
```
const int length = 20;

int array[length];
cout << "Enter elements in array: " << endl;
for (int i = 0; i < length; i++)
{
    cin >> array[i];
}
cout << "Elements in array: " << endl;
for (int i = 0; i < length; i++)
{
    cout << array[i] << " ";
}
```



Arrays as Function Parameters

Arrays as Function Parameters

- Array parameters are declared the same way arrays are declared
  - Usually necessary to add an `int` parameter with the size

```
void print(int array[], int size)
{
  for (int i = 0; i < size; i++)
  {
    cout << array[i] << " ";
  }
  cout << endl;
}
```

```
int main()
{
  int numbers[] = {1, 2, 3};
  print(numbers, 3);
  return 0;
}
```

Arrays and Functions - Specifics

- Functions work with the original array the caller uses
  - If the function **changes an element**, the caller's array is modified
  - Array elements are passed **by reference**

- Functions can't return **static** arrays created in them
  - Arrays are essentially **memory addresses**
  - The memory they point to **is freed when the function exits**

Arrays as Pointers

Arrays as Pointers

- **Pointer** - a variable that holds the **address** of another variable in the memory
  - The address stores its **value**
  - Pointers have **data type**
- **Arrays** can be represented as pointers
  - The array is a **sequence of variables stored in memory**
  - The array name points to the first item

Arrays as Pointers

- Examples:

```
int *ptr;
int arr[4];
ptr = arr;

ptr + 0 is equivalent to &arr[0];
ptr + 1 is equivalent to &arr[1];
ptr + 2 is equivalent to &arr[2];
ptr + 3 is equivalent to &arr[3];
```

```
*ptr == arr[0];
*(ptr + 1) is equivalent to arr[1];
*(ptr + 2) is equivalent to arr[2];
```

Range-Based For Loop

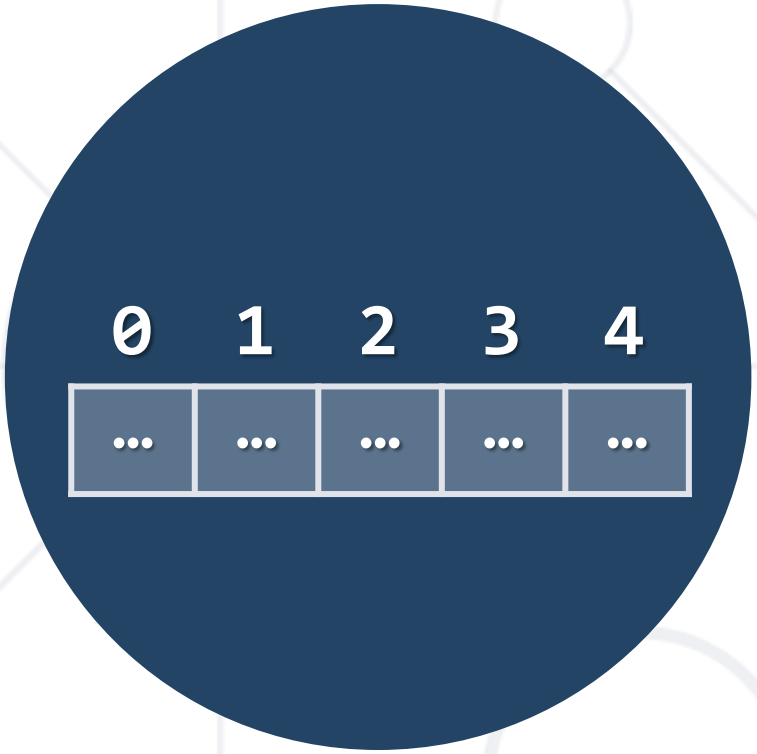
Range-Based For Loop

- Syntax:

```
for(const DataType& element : array)
```

  - Body will execute **once for each element** in the array
  - On each iteration, `element` will be the next item in the array

```
int numbers[] = { 13, 42, 69 };
for (int num : numbers)
{
    cout << num << endl;
}
```



<array> Header

<array> Header

- The `array` class knows its size, can be returned from functions

```
#include<array>
```

- Declaring and Initializing:

```
array<int, 5> arr = { 1, 2, 3, 4, 5 };
```

- `arr.size()` gives you the size of the array
- Use the `[]` operator like with normal arrays to access elements

Summary

- Arrays hold a **sequence** of elements
  - Elements are numbered from `0` to `length-1`
- **Creating** an array
- Accessing array elements by **index**
- **Printing** array elements
- Range-based **for loop**

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