

What is the default value assigned to array elements in C#?

In C#, the default values depend on the type of the array:

- For `int`, `float`, `double`: the default is `0`.
 - For `bool`: the default is `false`.
 - For `char`: the default is `'\0'` (null character).
 - For `string` and reference types: the default is `null`.
 - For `int` : the default is `0`.
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What is the difference between `Array.Clone()` and `Array.Copy()`?

Array.Clone()

Creates a shallow copy of the entire array.

A new array of the same type and length

Changes in `arr2` don't affect `arr1` (because it's a new array),

but if the array contains reference types (like objects), both arrays still point to the same objects.

Array.Copy()

Copies elements from one array to another, starting at specified indexes.

Nothing (it's a void method).

What is the difference between `GetLength()` and `Length` for multi dimensional arrays?

Length

- **Returns:** The **total number of elements** in the entire array (all dimensions).

GetLength(dimension)

- **Returns:** The **number of elements in a specific dimension**.
 - **Parameter:** Takes an `int` index (starting from 0 for the first dimension).
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What is the difference between `Array.Copy()` and `Array.ConstrainedCopy()`?

Array.Copy()

- **Purpose:**
Copies elements from one array to another.
- **Behavior:**
 - Performs a shallow copy.
 - Fast and commonly used.
 - Less strict with type safety and exception rollback.

Array.ConstrainedCopy()

- Purpose:
Like `Array.Copy()`, but with additional safety for copying across AppDomains and ensuring atomicity (no partial copy).
 - Behavior:
 - Performs extra checks to ensure type safety.
 - If any error occurs, no data is copied at all (rollback).
 - Slower due to these checks.
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Why is `foreach` preferred for read-only operations on arrays?

- `foreach` makes the code **cleaner** and easier to understand.
 - You don't have to deal with indexes manually.
 - `foreach` is **read-only** by design.
 - You **can't modify** the array elements inside a `foreach` loop (directly).
 - This protects the array from accidental changes.
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Why is input validation important when working with user inputs?

Prevents Errors and Crashes

Enhances Security

input validation helps prevent **security vulnerabilities** like:

- **SQL Injection**
 - **Cross-site Scripting (XSS)**
 - **Command Injection**
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How can you format the output of a 2D array for better readability?

- `PadLeft(4)` ensures each number takes **at least 4 characters of space**, so columns are aligned.
 - `GetLength(0)` gives the number of rows.
 - `GetLength(1)` gives the number of columns.
 - `Console.WriteLine()` moves to the next line after each row.
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When should you prefer a `switch` statement over `if-else`?

- `switch` is **more readable and cleaner** than many `if-else` blocks.
 - `switch` helps prevent missing conditions.
 - The `default` block can catch any unexpected values.
 - `switch` can be faster than `if-else` when compiled (especially with many cases).
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What is the time complexity of `Array.Sort()`?



Case	Time Complexity
Average case (most of the time)	$O(n \log n)$
Best case (data is nearly sorted)	$O(n \log n)$
Worst case (data is very unsorted)	$O(n \log n)$

Which loop (for or foreach) is more efficient for calculating the sum of an array, and why?

for loop is slightly more efficient in some scenarios:

Why?


- `for` uses an **index**, so the compiler can optimize it better.
- `foreach` uses an **enumerator** internally, which adds a tiny overhead (like creating an object that keeps track of the position).
- This difference is **very small**, and usually **not noticeable** for small or medium arrays.

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مين أسرع؟ `for` ولا `foreach`؟
اللاتنين بيستخدموا ال `Loops` على `Elements`. بس في فرق كبير من ناحية `Performance`.
خصوصاً لو شغال على داتا كتير أو في `App` حساس للأداء.
المقارنة:

- 1. السرعة مع ال `Arrays`:
`for` أسرع لأنه بيستخدم `(index)` علطول زي `arr[i]`
`foreach` بيستخدم حاجة اسمها `Enumerator` ودي بتضيف شوية `Cost` بسيطة.
- 2. مع `(List, Dictionary)`:
`foreach` ممكن يسبب شوية ضغط على `Performance` لأنه بيعمل تخصيصات في الذاكرة `(Heap Allocations)`.
`for` بيتجنب ده لأنه بيستخدم `index` من غير `Memory` إضافية.
- 3. `modification` على الداتا:
`foreach` بيرفض تعديل العناصر أثناء التكرار (يعمل `Exception`).
`for` بيسمحك تعدل وتحذف براحتك لأنك بتتحكم بالفهرس.
- 4. تحسين الأداء `(JIT Optimizations)`:
ال `JIT Compiler` بيقدر يحسن الكود بتاع `for` بشكل أفضل لأنه أبسط من ناحية البنية.

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What's the default size of the stack and heap, and what are the considerations?

✚ Stack:

- **Default Size in C# (.NET):**
 - Around **1 MB (1 megabyte)** per thread.
- **Important Notes:**
 - Stack size is **fixed** when the thread is created.
 - If the stack usage exceeds its limit → you get a **StackOverflowException**.
 - Stored in the stack:
 - Local variables.
 - Method calls (call stack).
 - Value types (unless boxed).

✚ Heap:

- **Default Size:**
 - No fixed size — it starts small and grows as needed.
 - On modern systems, it can grow up to **several gigabytes**, depending on available memory.
- **Important Notes:**
 - The heap stores:
 - Reference types (like objects, arrays, strings).
 - Managed by the **Garbage Collector (GC)** in .NET.
 - Performance can be affected by:
 - Too many object allocations.
 - Frequent garbage collection cycles.

what is time complexity?

Time complexity is a way to describe **how the runtime of an algorithm grows** as the size of the input (**n**) increases.

It gives you a **mathematical measure** of the **efficiency** of an algorithm — especially how it performs as the input becomes very large.

Because two different algorithms might do the same task, but one is way faster for big inputs. Time complexity helps us:

- Compare algorithms
- Predict performance
- Optimize code

🔍 Big-O Notation:

We use **Big-O** notation to express time complexity.

It describes the **upper bound** of time taken by an algorithm — in the worst-case scenario.