



Garbage Collection

.NET

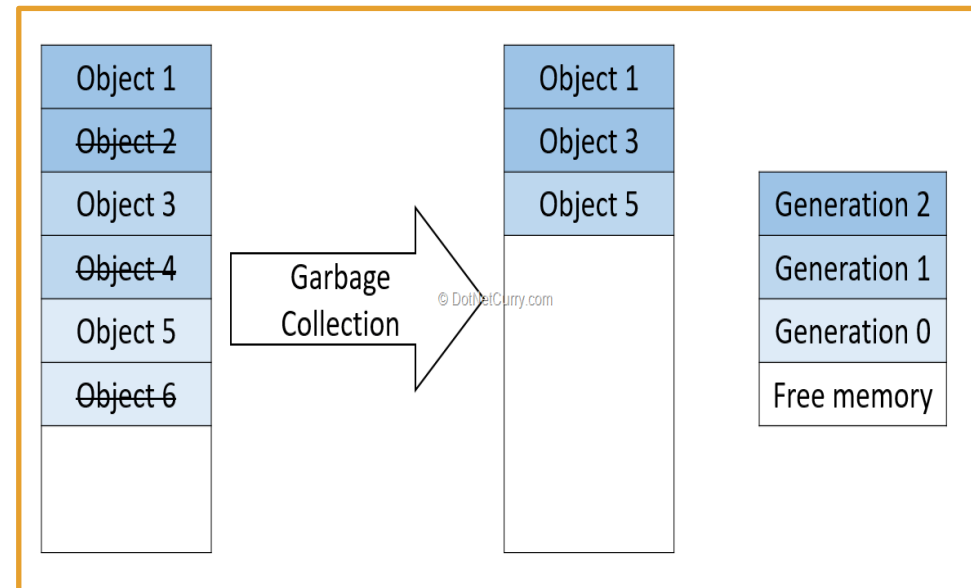
*.NET's **Garbage Collector** manages the allocation and release of memory for your application. It checks for objects in the managed **heap** that are no longer being used by the application and reclaims their memory.*

[HTTPS://DOCS.MICROSOFT.COM/EN-US/DOTNET/STANDARD/GARBAGE-COLLECTION/](https://docs.microsoft.com/en-us/dotnet/standard/garbage-collection/)

Fundamentals of memory

<https://docs.microsoft.com/en-us/dotnet/standard/garbage-collection/fundamentals#fundamentals-of-memory>

- Each **process** (program) has 2GB of virtual memory allocated.
- In C#, you cannot decide where or how memory is allocated during the process.
- The **Garbage Collector (GC)** allocates and frees memory.
- Virtual memory has three states:
 - Free
 - unallocated
 - available
 - Reserved
 - available
 - unusable for other processes
 - must be committed in order to store data
 - Committed
 - assigned to physical storage
- The frequency of **garbage collection** depends on the volume of allocations and the amount of survived memory on the managed heap.

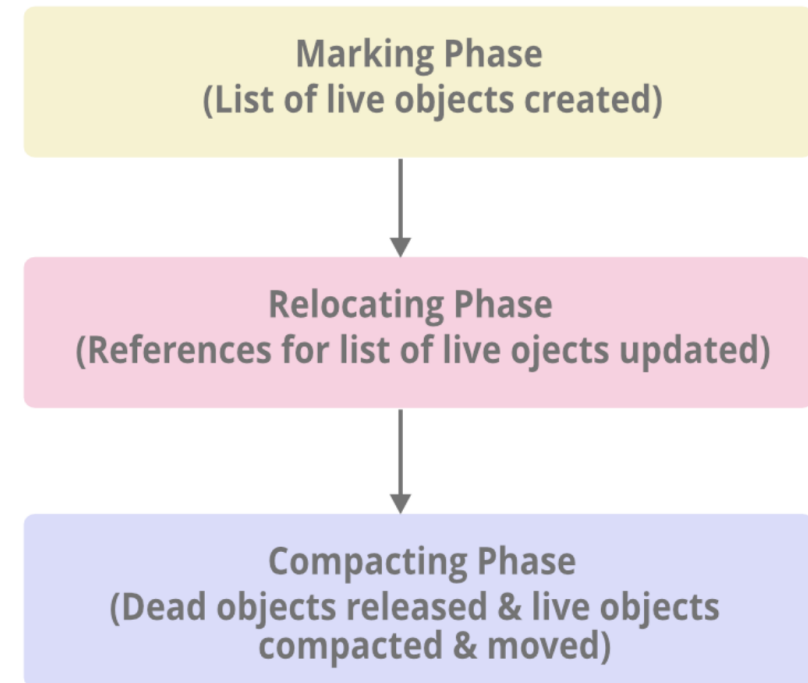


Benefits of Garbage Collection

<https://docs.microsoft.com/en-us/dotnet/standard/garbage-collection/fundamentals>

- No memory leaks.
- Efficient memory allocation.
- GC automatically reclaims unused objects, clears memory, and makes memory available.
- Constructors do not have to initialize every data field.
- GC makes sure that one object cannot use the contents of another object.

Phase in Garbage Collection

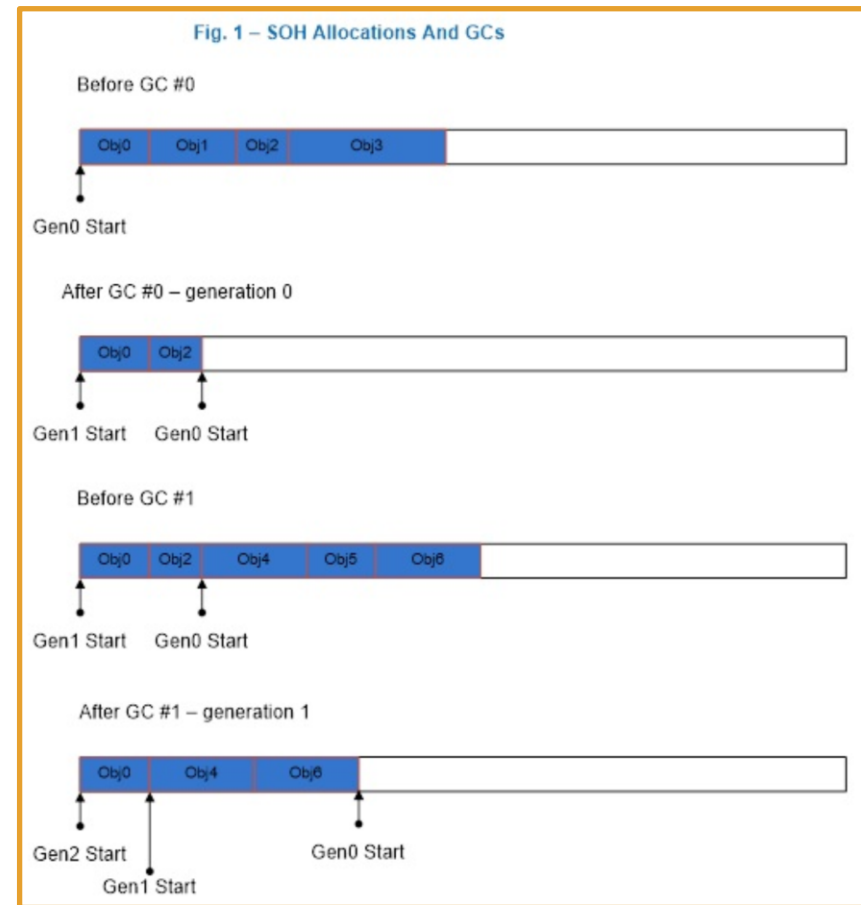


Managed Heap

<https://docs.microsoft.com/en-us/dotnet/standard/garbage-collection/fundamentals>

<https://docs.microsoft.com/en-us/dotnet/standard/garbage-collection/large-object-heap>

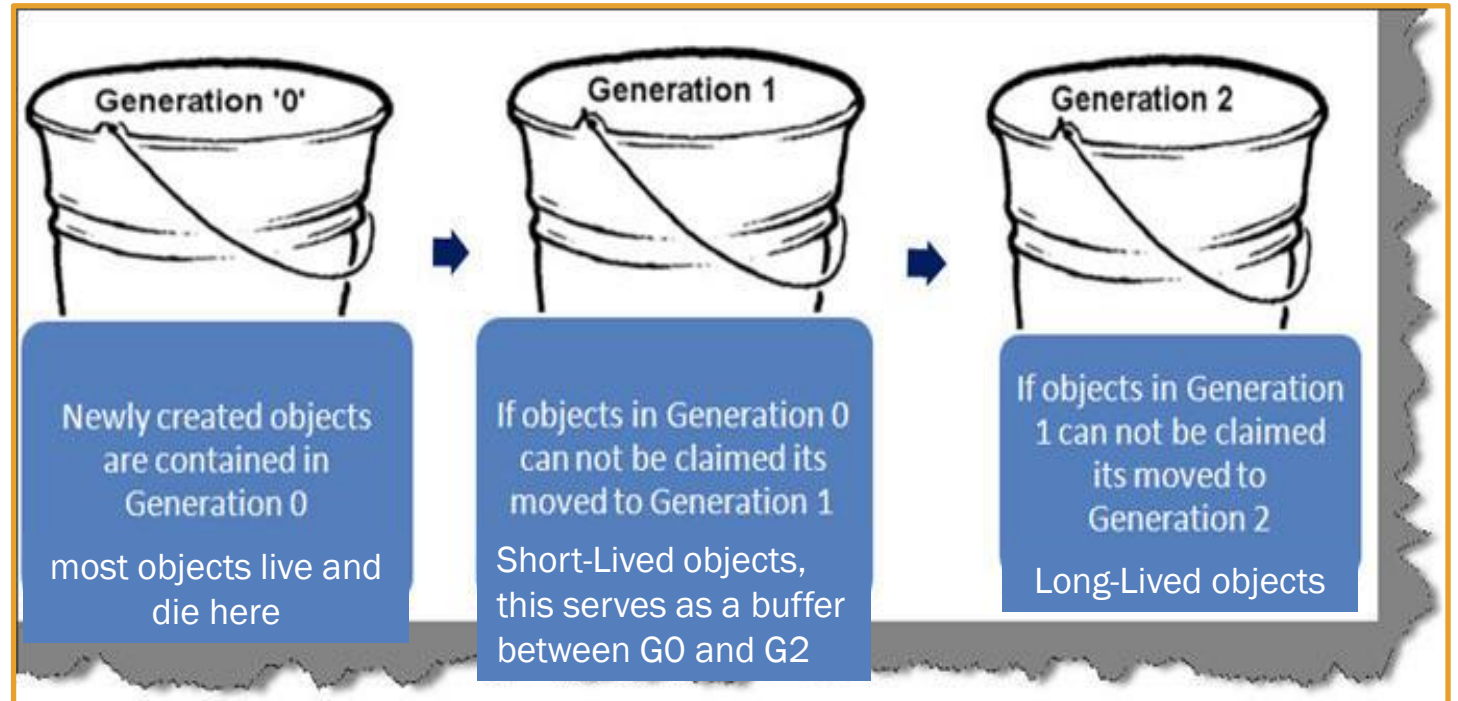
- The **GC** allocates a segment of memory, called the **Managed Heap**, to store and manage objects.
- There is one **Managed Heap** for each managed process.
- The **GC** calls the Windows **VirtualAlloc()** to reserve memory and **VirtualFree()** to release memory.
- The **GC** divides objects into small and large objects. Large Objects (arrays) go on the **Large Object Heap (LOH)**, Small objects(instances) go on the **Small Object Heap (SOH)**.



Heap Object Generations

<https://docs.microsoft.com/en-us/dotnet/standard/garbage-collection/fundamentals#generations>

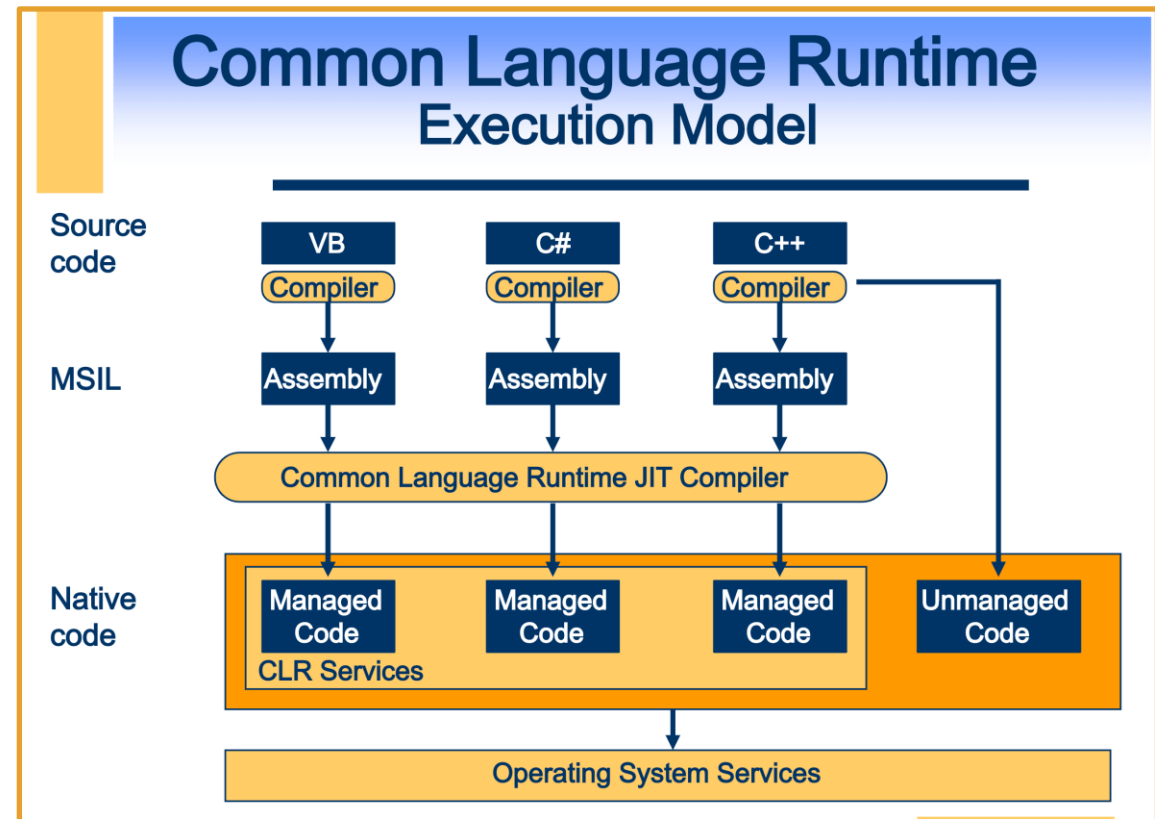
- **Garbage collection** happens on a whole generation at once.
- Objects that survive a **garbage collection** ('survivors') are promoted to the next generation.
- When **GC** sees that survival rate is high, it allocates more memory to that generation.
- After **Garbage Collection**, survivors are 'compacted' (defragmentation) to the older end of the memory segment.



Managed Code

<https://docs.microsoft.com/en-us/dotnet/standard/managed-code>

- **Managed code** is code managed by the **Common Language Runtime (CLR)** at runtime.
- The **CLR** provides memory management (**GC**), security boundaries, and **type** safety.
- **Managed code** is written in a high-level language that can be run on top of .NET.
- Code is compiled into **Intermediate Language (IL, MSIL, CIL)** code, which the **CLR** compiles and executes.
- The **CLR** manages the **Just-In-Time** compiling code from **IL** to machine code that can be run on any CPU.
- The **CLR** knows what your code is doing and can *manage* it.



Unmanaged Code

<https://docs.microsoft.com/en-us/dotnet/framework/interop/>

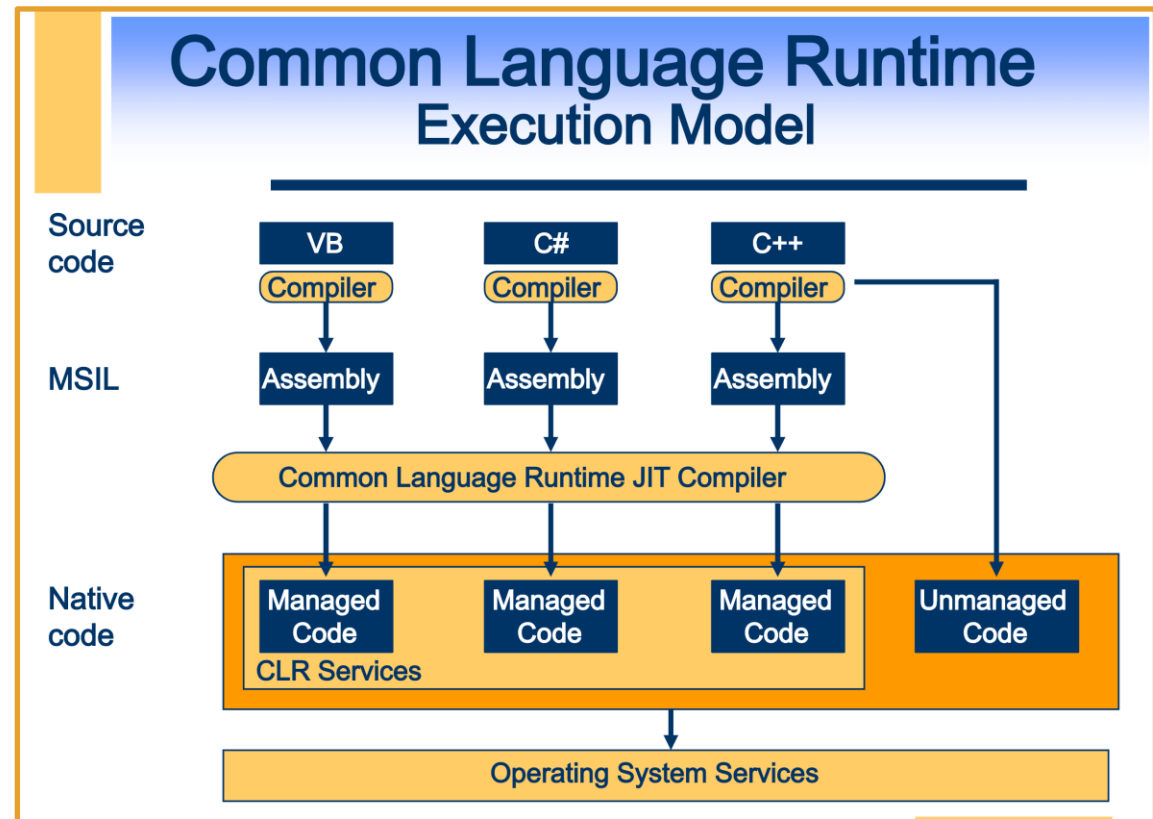
Code that runs outside the *CLR* is called *Unmanaged Code*.

The .NET Framework promotes interaction with [COM](#) components, COM+ services, external type libraries, and many operating system services.

Data types, method signatures, and error-handling mechanisms vary between managed and unmanaged object models.

Examples of Unmanaged Code:

- COM components,
- ActiveX interfaces,
- Windows API functions.



IDisposable Interface

<https://docs.microsoft.com/en-us/dotnet/api/system.idisposable?view=netframework-4.8>

- The **Garbage Collector (GC)** has no knowledge of unmanaged resources (open files and streams).
- ***IDisposable*** provides a method for releasing unmanaged resources.
- To use the ***IDisposable*** interface, call the object's ***IDisposable.Dispose*** implementation when finished using it.

```
// A base class that implements IDisposable.  
// By implementing IDisposable, you are announcing that  
// instances of this type allocate scarce resources.  
public class MyResource: IDisposable  
{  
    // Pointer to an external unmanaged resource
```

```
// Dispose managed resources.  
component.Dispose();
```

using block and IDisposable

<https://docs.microsoft.com/en-us/dotnet/csharp/language-reference/keywords/using-statement>

Provides a convenient syntax that ensures the correct use of *IDisposable* objects.

```
using (var font1 = new Font("Arial", 10.0f))  
{  
    byte charset = font1.GdiCharSet;  
}
```

When the lifetime of an *IDisposable* object is limited to a single method, it should be declared and instantiated in a **using** statement. The **using** statement calls **.Dispose()** on the object and causes the object itself to go out of scope as soon as **.Dispose()** is called. Within the **using** block, the object is read-only and cannot be modified or reassigned.

Using Block

<https://docs.microsoft.com/en-us/dotnet/api/system.idisposable?view=net-5.0>

If your language supports a construct such as the **using** statement in C#, you can use it instead of explicitly calling **Idisposable.Dispose()**.

```
public WordCount(string filename)
{
    if (! File.Exists(filename))
        throw new FileNotFoundException("The file does not exist.");

    this.filename = filename;
    string txt = String.Empty;
    using (StreamReader sr = new StreamReader(filename)) {
        txt = sr.ReadToEnd();
    }
    nWords = Regex.Matches(txt, pattern).Count;
}
```

The **using** statement is a syntactic convenience. At compile time, the language compiler converts a using statement to a **try/finally** block.

using block

<https://docs.microsoft.com/en-us/dotnet/csharp/language-reference/keywords/using-statement>

The **using** statement ensures that **.Dispose()** is called even if an exception occurs within the **using** block. You can achieve the same result by putting the object inside a **try** block and then calling **.Dispose()** in a finally block.

A **using** block is expanded to a **try/catch** block at compile time. Note the curly braces create a limited scope for the object.

```
{
    var font1 = new Font("Arial", 10.0f);
    try
    {
        byte charset = font1.GdiCharSet;
    }
    finally
    {
        if (font1 != null)
            ((IDisposable)font1).Dispose();
    }
}
```

```
using (var font1 = new Font("Arial", 10.0f))
{
    byte charset = font1.GdiCharSet;
}
```