# Garbage Collection

.NET

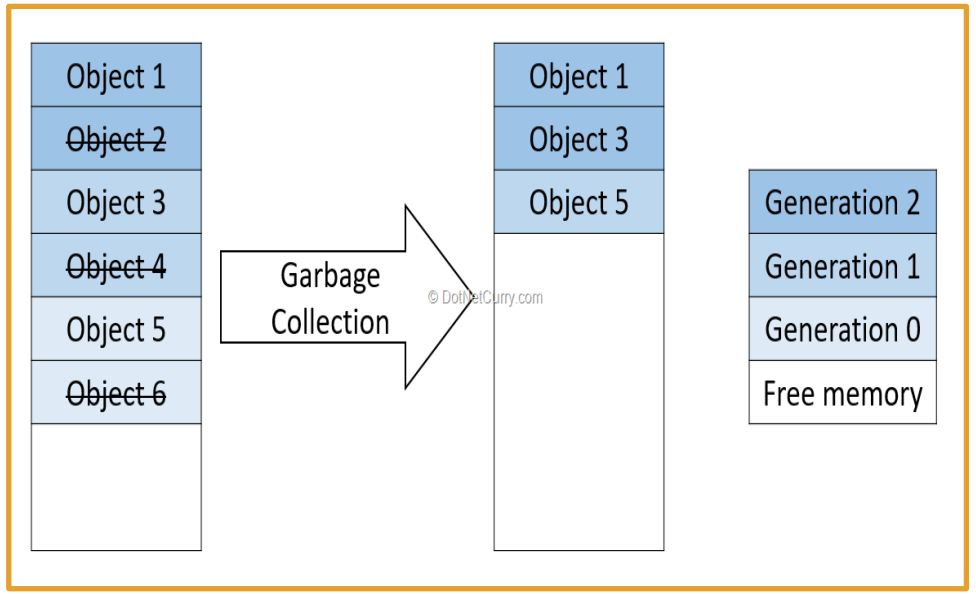
*.NET's **Garbage Collector** manages the allocation and release of memory for your application. It checks for objects in the managed **heap** that are no longer being used by the application and reclaims their memory.*

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

# Fundamentals of memory

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

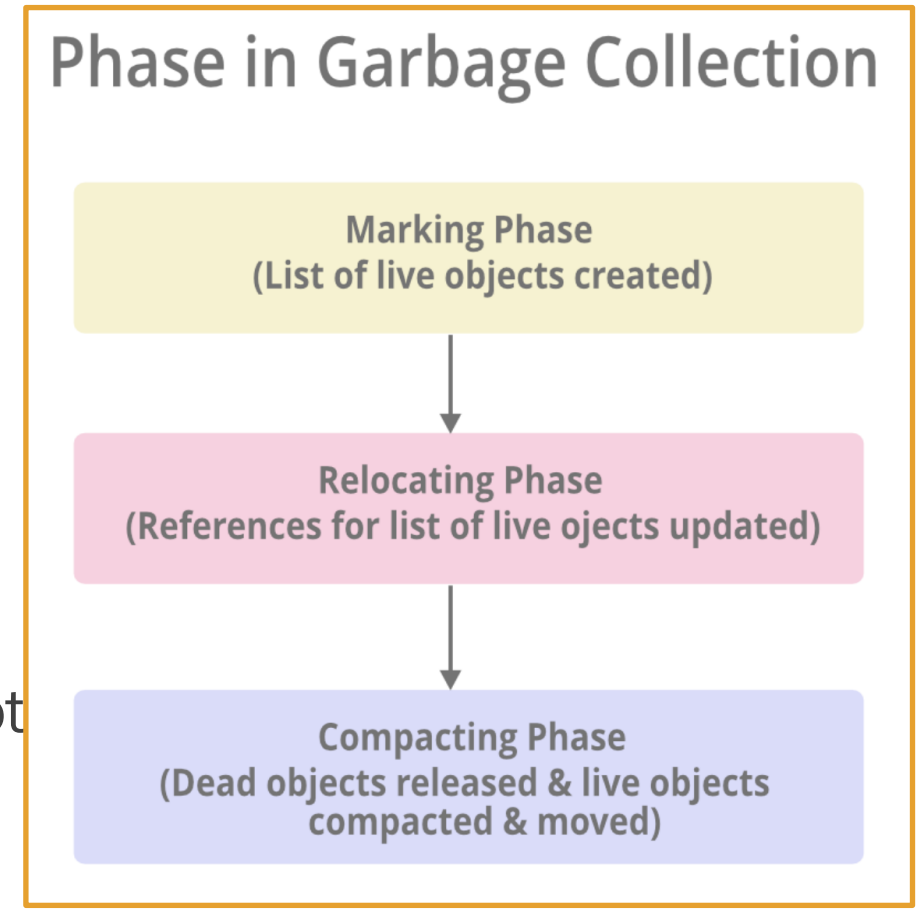
- Each ***process*** (program) has 2GB of virtual memory allocated.
- In C#, you cannot decide where or how memory is allocated during the process.
- The ***Garbage Collector (GC)*** allocates and frees memory.
- Virtual memory has three states:
  - Free
    - unallocated
    - available
  - Reserved
    - 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

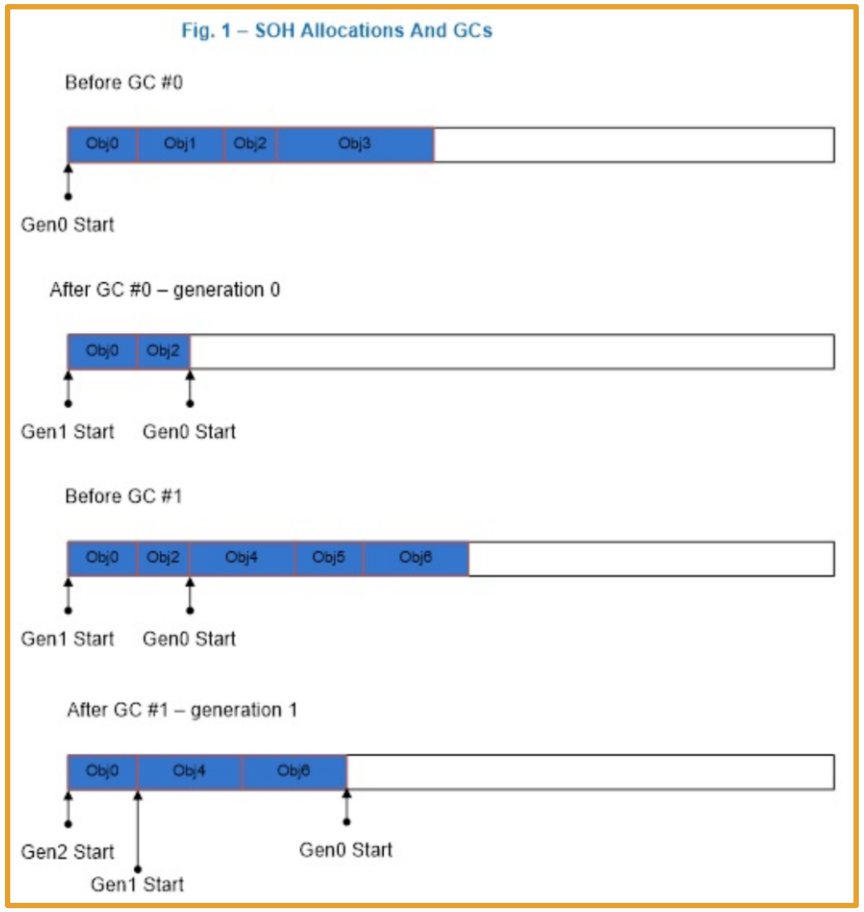
- No memory leaks.
- Efficient memory allocation.
- GC automatically reclaims unused objects, clears memory, and makes memory available.
- Constructors do not have to initialize every data field.
- GC makes sure that one object cannot use the contents of another object.



# 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

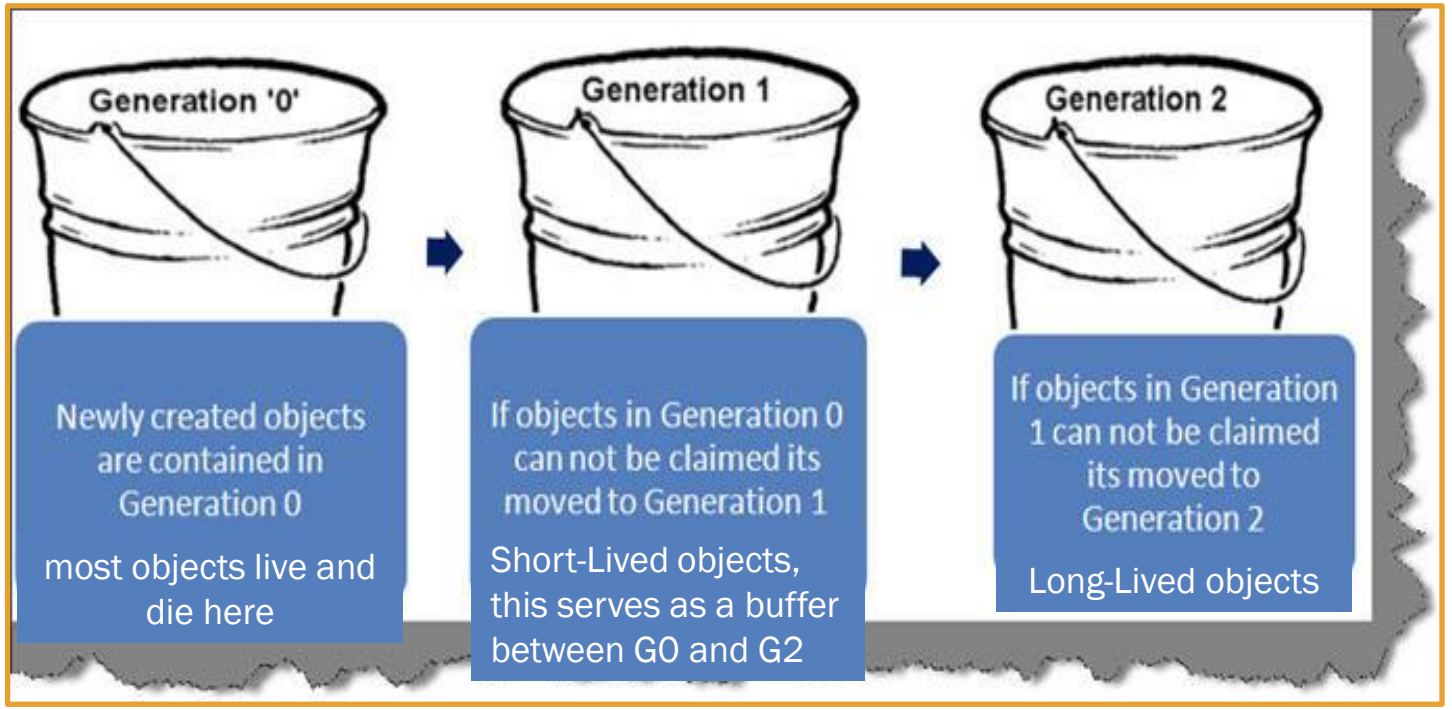
- The ***GC*** allocates a segment of memory, called the ***Managed Heap,*** to store and manage objects.
- There is one ***Managed Heap*** for each managed process.
- The ***GC*** calls the Windows ***VirtualAlloc()*** to reserve memory and ***VirtualFree()*** to release memory.
- The ***GC*** divides 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

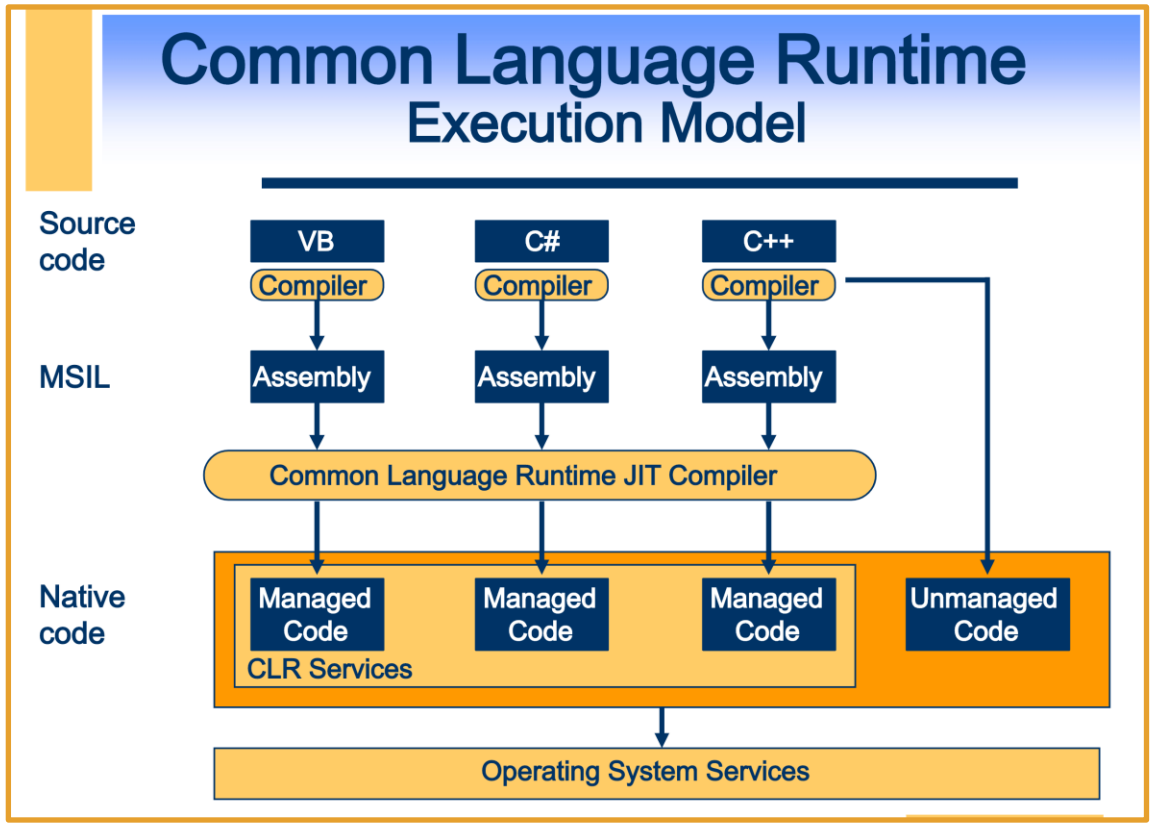
- ***Garbage collection*** happens on a whole generation at once.
- Objects that survive a ***garbage collection*** ('survivors') are promoted to the next generation.
- When ***GC*** sees that survival rate is high, it allocates more memory to that generation.
- After ***Garbage Collection***, survivors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

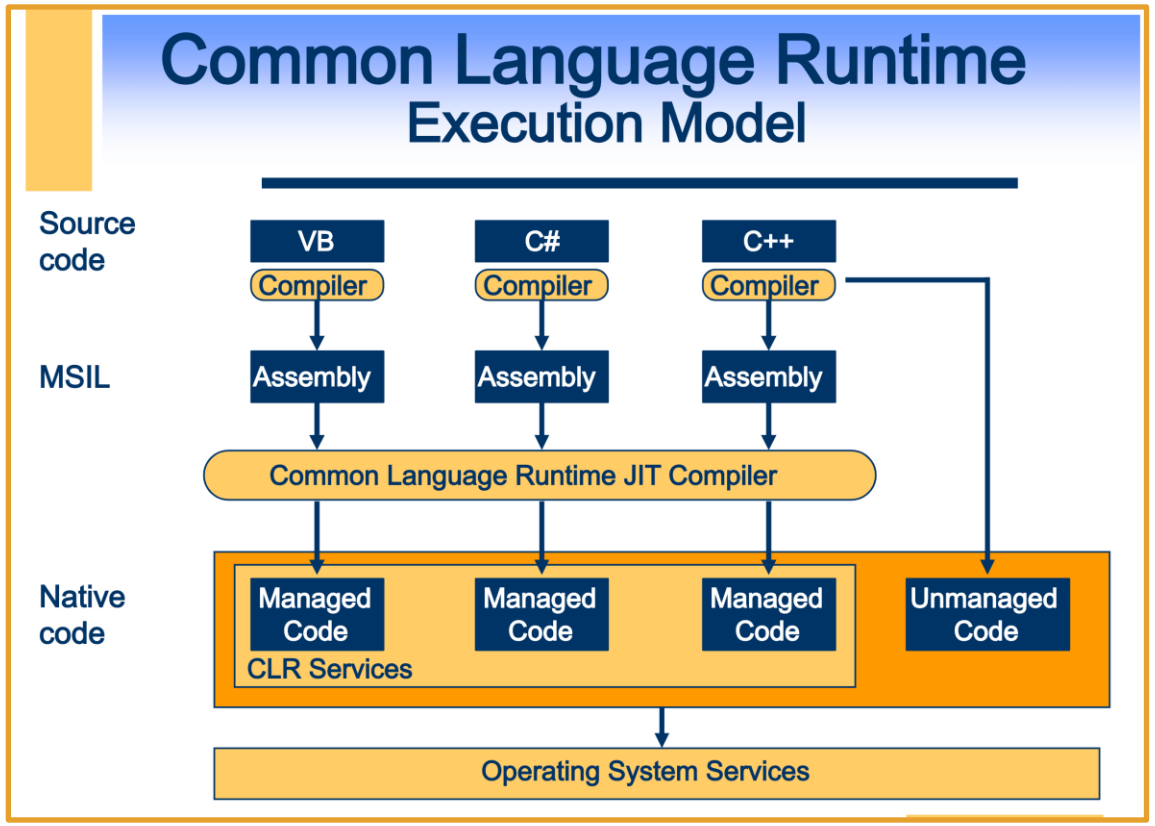
Code that runs outside the *CLR* is called *Unmanaged Code*.

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

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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;
}
```