

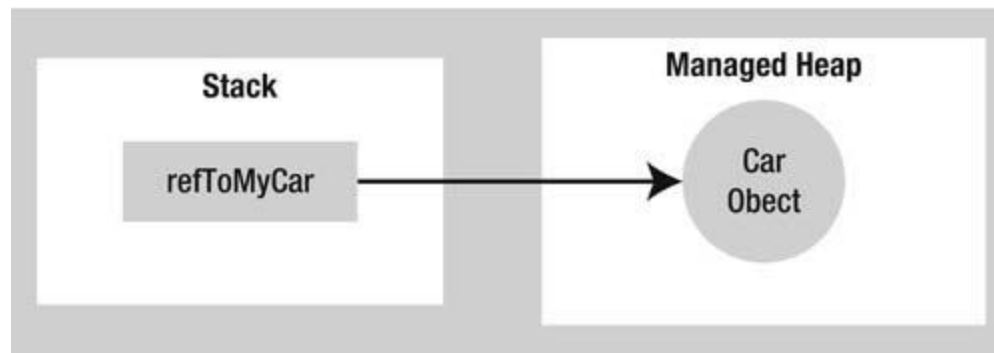
The Basics of Object Lifetime. Disposing objects.

AGENDA

- The Basics of Object Lifetime
- Building Finalizable Objects
- Building Disposable Objects
- Dispose pattern

The Basics of Object Lifetime

References to objects on the managed heap

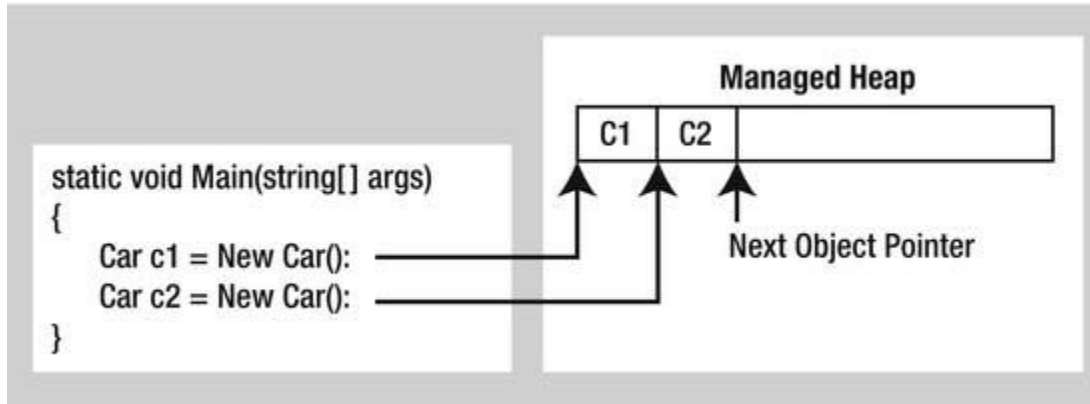


```
Car refToMyCar = new Car("Zippy", 50);
```

- **Rule** Allocate a class instance onto the managed heap using the new keyword and forget about it.

The Basics of Object Lifetime

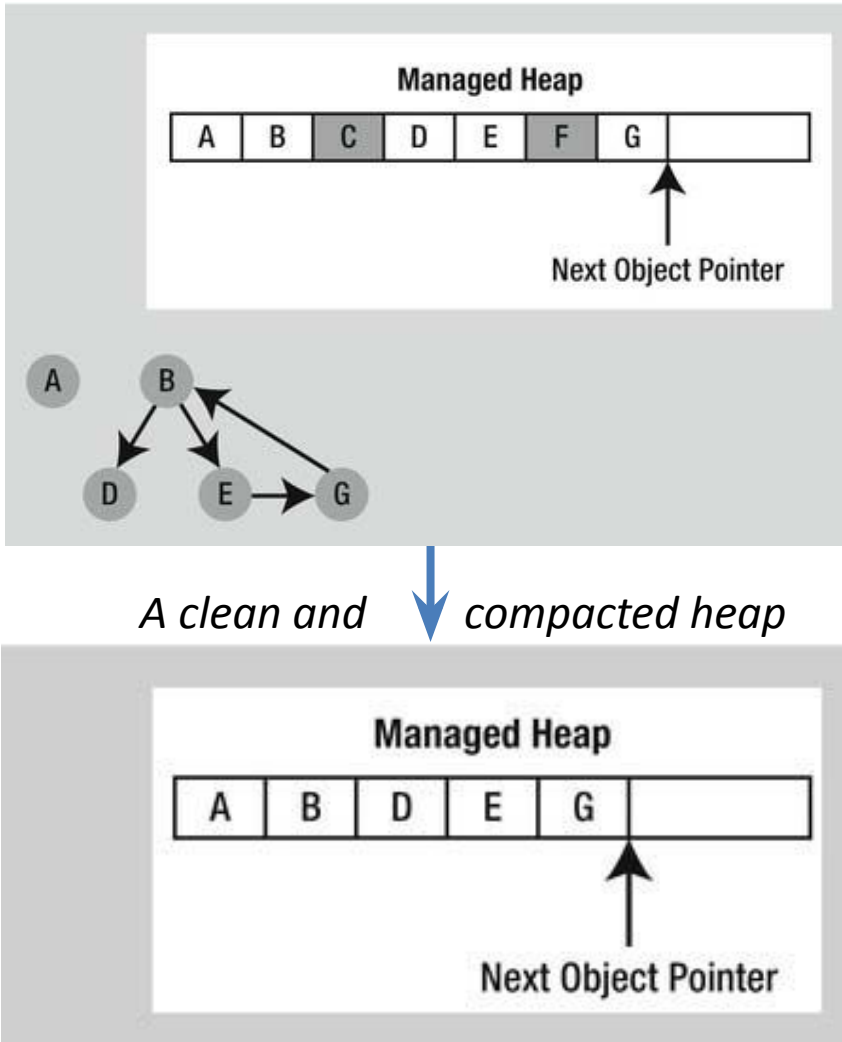
The details of allocating objects onto the managed heap



■ **Rule** If the managed heap does not have sufficient memory to allocate a requested object, a garbage collection will occur.

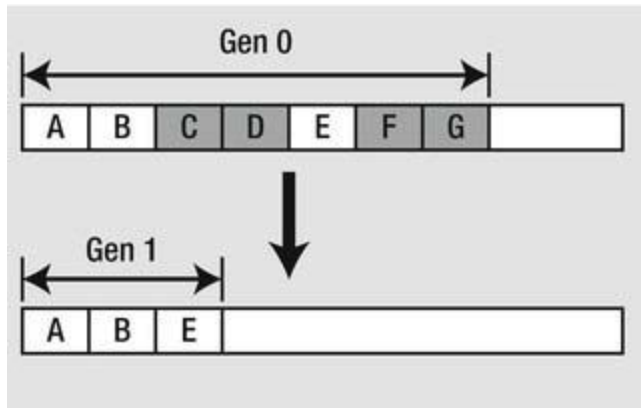
`c2=null;`
! assigning a reference to null does not force the garbage collector to remove the object from the heap.

The Role of Application Roots



- **Root** is a storage location containing a reference to an object on the managed heap:
 - References to global objects
 - References to any static objects/static fields
 - References to local objects within an application's code base
 - References to object parameters passed into a method
 - References to objects waiting to be *finalized*
 - Any CPU register that references an object

Object Generations



- Each object on the heap belongs to one of the following generations:
 - *Generation 0*: Identifies a newly allocated object that has never been marked for collection.
 - *Generation 1*: Identifies an object that has survived a garbage collection (i.e., it was marked for collection but was not removed due to the fact that the sufficient heap space was acquired).
 - *Generation 2*: Identifies an object that has survived more than one sweep of the garbage collector.

■ **Note** Generations 0 and 1 are termed *ephemeral generations*.

Building Finalizable Objects

```
// System.Object
public class Object
{
    ...
    protected virtual void Finalize() {}
}
```

- it is not possible to directly call an object's **Finalize()** method from a class instance .
- the *garbage collector* will call an object's **Finalize()** method before removing the object from memory.

■ **Rule** The reason to override **Finalize()** is if your C# class is making use of unmanaged resources via **PInvoke** or complex COM interoperability tasks. The reason is that you are manipulating memory that the CLR cannot manage.

Building Finalizable Objects

```
// Override System.Object.Finalize() via finalizer syntax.
class MyResourceWrapper
{
    ~MyResourceWrapper()
    {
        // Clean up unmanaged resources here.

        // Beep when destroyed (testing purposes only!)
        Console.Beep();
    }
}
```

- You can't override the `Finalize()` method directly in your class, but you may use of a **destructor** syntax to achieve the same effect.
- **Destructor** never takes an access modifier (implicitly protected), never takes parameters, and can't be overloaded (only one finalizer per class).

Building Disposable Objects

```
public interface IDisposable
{
    void Dispose();
}
```

- **Structures** and **class** types can both implement **IDisposable** (unlike overriding `Finalize()`, which is reserved for class types), as the object user (not the garbage collector) invokes the `Dispose()` method.
- When the ***object user*** is finished using the object, the **object user manually calls `Dispose()`** before allowing the object reference to drop out of scope.

Building Disposable Objects

■ **Rule** It is a good idea to call `Dispose()` on any object you directly create if the object supports `IDisposable`. The assumption you should make is that if the class designer chose to support the `Dispose()` method, the type has some cleanup to perform. If you forget, memory will eventually be cleaned up (so don't panic), but it could take longer than necessary.

```
class Program
{
    static void Main(string[] args)
    {
        Console.WriteLine("***** Fun with Dispose *****\n");
        MyResourceWrapper rw = new MyResourceWrapper();
        if (rw is IDisposable)
            rw.Dispose();
        Console.ReadLine();
    }
}
```

Building Disposable Objects

- A number of types in the base class libraries that do implement the **IDisposable** interface provide a (somewhat confusing) alias to the **Dispose()** method, in an attempt to make the disposal-centric method sound more natural for the defining type.
- The **System.IO.FileStream** class implements **IDisposable** (and therefore supports a **Dispose()** method), it also defines the following **Close()** method that is used for the same purpose:

```
static void DisposeFileStream()
{
    FileStream fs = new FileStream("myFile.txt", FileMode.OpenOrCreate);

    // Confusing, to say the least!
    // These method calls do the same thing!
    fs.Close();
    fs.Dispose();
}
```

using

```
static void Main(string[] args)
{
    Console.WriteLine("***** Fun with Dispose *****\n");
    MyResourceWrapper rw = new MyResourceWrapper ();
    try
    {
```

■ **Note** If you attempt to “use” an object that does not implement **IDisposable**, you will receive a **compiler error**.

```
void Main(string[] args)
{
    Console.WriteLine("***** Fun with Dispose *****\n");
    // Dispose is called automatically when the
    // using scope exits.
    using(MyResourceWrapper rw = new MyResourceWrapper())
    {
        // Use rw object.
    }
}
```



```
// A sophisticated resource wrapper.
public class MyResourceWrapper : IDisposable
{
    // The garbage collector will call this method if the
    // object user forgets to call Dispose().
    ~MyResourceWrapper()
    {
        // Clean up any internal unmanaged resources.
        // Do not call Dispose() on any managed objects.
    }

    // The object user will call this method to clean up
    // resources ASAP.
    public void Dispose()
    {
        // Clean up unmanaged resources here.
        // Call Dispose() on other contained disposable objects.

        // No need to finalize if user called Dispose(),
        // so suppress finalization.
        GC.SuppressFinalize(this);
    }
}
```

GC.SuppressFinalize() informs the CLR that it is no longer necessary to call the destructor when this object is garbage-collected

Dispose pattern

- The **Dispose** Pattern is intended to standardize the usage and implementation of finalizers and the IDisposable interface.
 - √ **DO** implement the Basic Dispose Pattern on types containing instances of disposable types.
 - √ **DO** implement the Basic Dispose Pattern and provide a finalizer on types holding resources that need to be freed explicitly and that do not have finalizers.
 - √ **CONSIDER** implementing the Basic Dispose Pattern on classes that themselves don't hold unmanaged resources or disposable objects but are likely to have subtypes that do.

Dispose pattern

- 1) Involves implementing the **System.IDisposable** interface
- 2) Declare the **Dispose(bool)** method that implements all resource cleanup logic to be shared between the Dispose method and the optional finalizer.

```
public class DisposableResourceHolder : IDisposable
{
    private SafeHandle resource; // handle to a resource
    public DisposableResourceHolder()
    {
        this.resource = ... // allocates the resource
    }
    public void Dispose()
    {
        Dispose(true);
        GC.SuppressFinalize(this);
    }
    protected virtual void Dispose(bool disposing){
        if (disposing){
            if (resource!= null) resource.Dispose();
        }
    }
}
```

Dispose pattern

- **DO NOT** make the parameterless Dispose method virtual.
- The Dispose(bool) method is the one that should be overridden by subclasses.

- **// bad design**

```
public class DisposableResourceHolder : IDisposable
{
    public virtual void Dispose(){ ... }
    protected virtual void Dispose(bool disposing){ ... }
}
```

- **// good design**

```
public class DisposableResourceHolder : IDisposable
{
    public void Dispose(){ ... }
    protected virtual void Dispose(bool disposing){ ... }
}
```


Dispose pattern

- √ **DO** allow the Dispose(bool) method to be called more than once. The method might choose to do nothing after the first call.

```
public class DisposableResourceHolder : IDisposable
{
    bool disposed = false;

    protected virtual void Dispose(bool disposing)
    {
        if(disposed) return;
        // cleanup
        ...
        disposed = true;
    }
}
```

Dispose pattern

- ✓ **DO** throw an [ObjectDisposedException](#) from any member that cannot be used after the object has been disposed of.

- ```
public class DisposableResourceHolder : IDisposable
{
 bool disposed = false;
 SafeHandle resource; // handle to a resource

 public void DoSomething()
 {
 if(disposed) throw new ObjectDisposedException(...);
 // now call some native methods using the resource
 ...
 }
 protected virtual void Dispose(bool disposing)
 {
 if(disposed) return;
 // cleanup
 ...
 disposed = true;
 }
}
```

# Dispose pattern

- ✓ **CONSIDER** providing method Close(), in addition to the Dispose(), if close is standard terminology in the area.
- 

```
public class Stream : IDisposable
{
 IDisposable.Dispose(){
 Close();
 }
 public void Close()
 {
 Dispose(true);
 GC.SuppressFinalize(this);
 }
}
```

# Questions ?

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