What Happens When the Garbage Collector Runs?

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pluralsight
hardcore dev and IT training

What is the **Garbage Collector**?

How **IDisposable** works with the GC

Best Practice implementation of IDisposable

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> The .NET Framework's garbage collector manages the allocation and release of memory for your application

— MSDN

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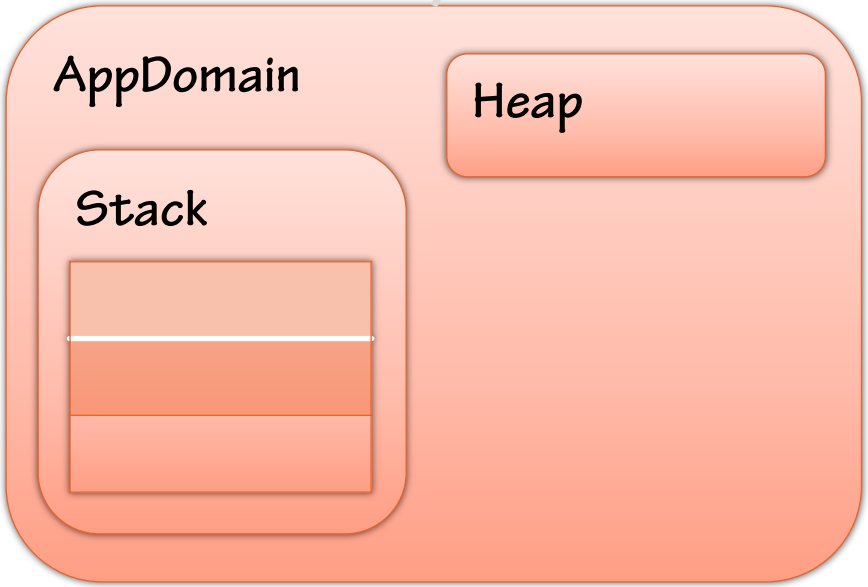
GC 101

```
var obj = new MayUseUnmanagedResources();
```



App creates instance

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GC 101

```
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```

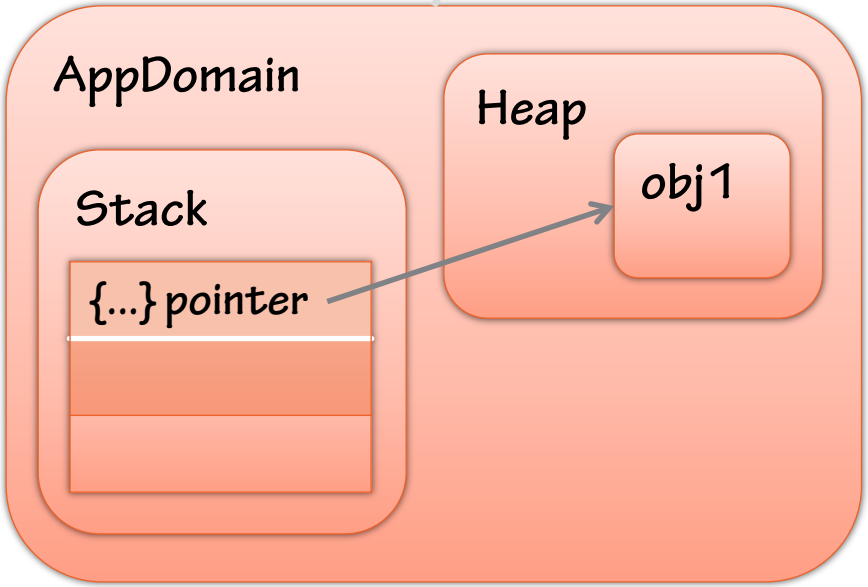

App creates instance

.NET allocates memory

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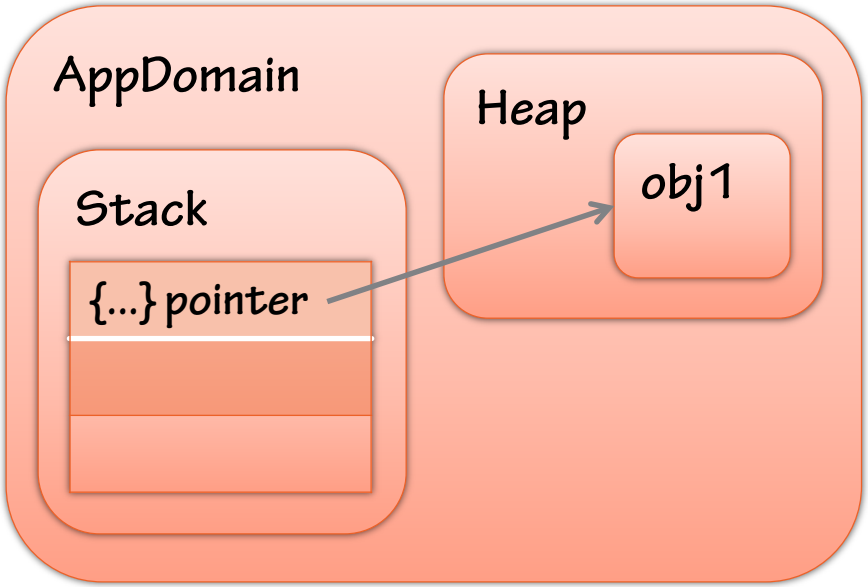
GC 101



App creates instance

.NET allocates memory

App ends

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GC 101

App creates instance

.NET allocates memory

App ends

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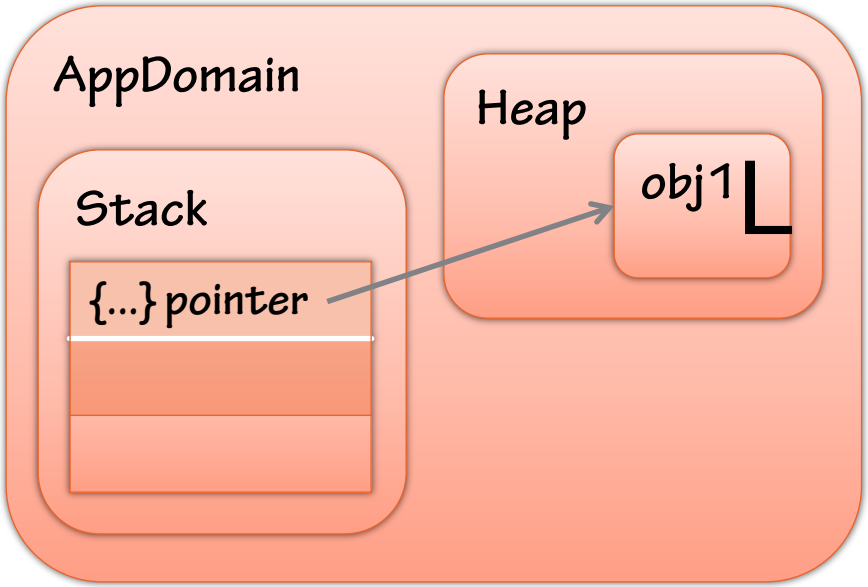
GC 101



App creates instance

.NET allocates memory

GC runs

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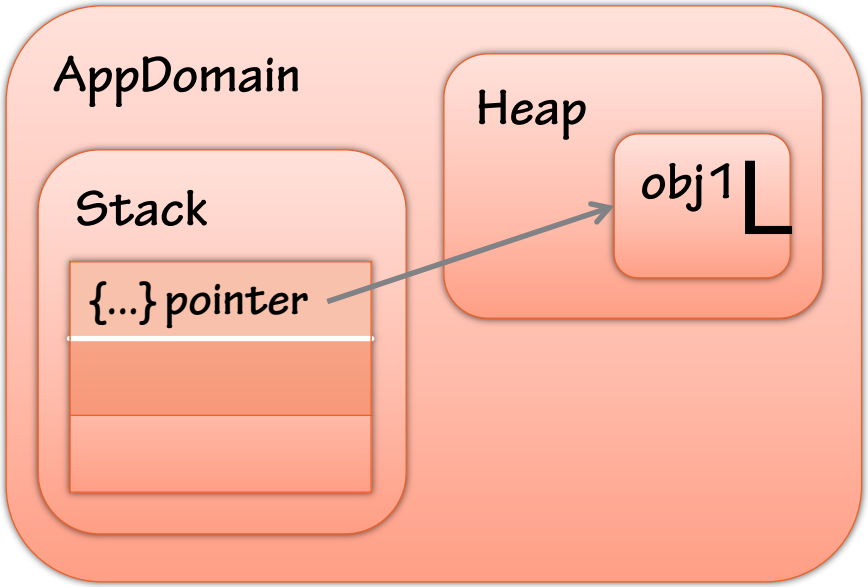
GC 101



App creates instance

.NET allocates memory

GC runs

Deallocates dead objects

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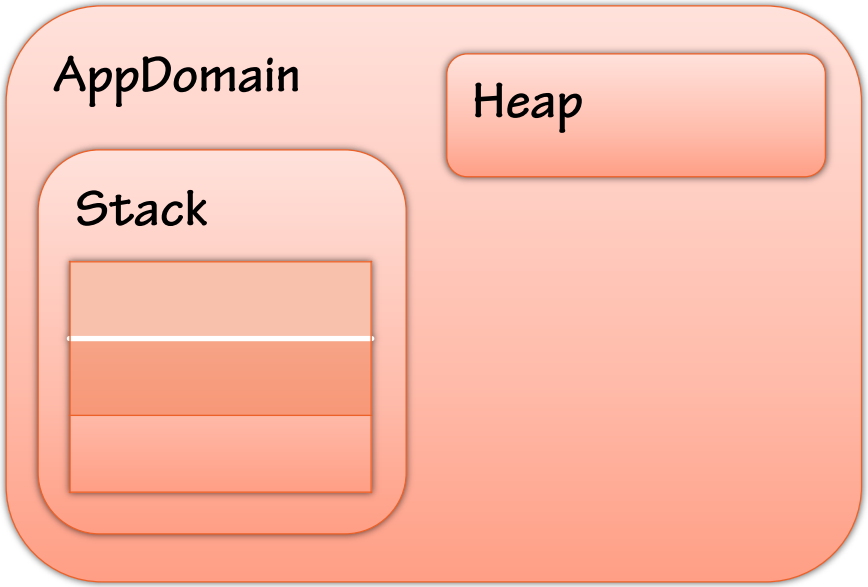
GC 101



App creates instance

.NET allocates memory

GC runs

Deallocates dead objects

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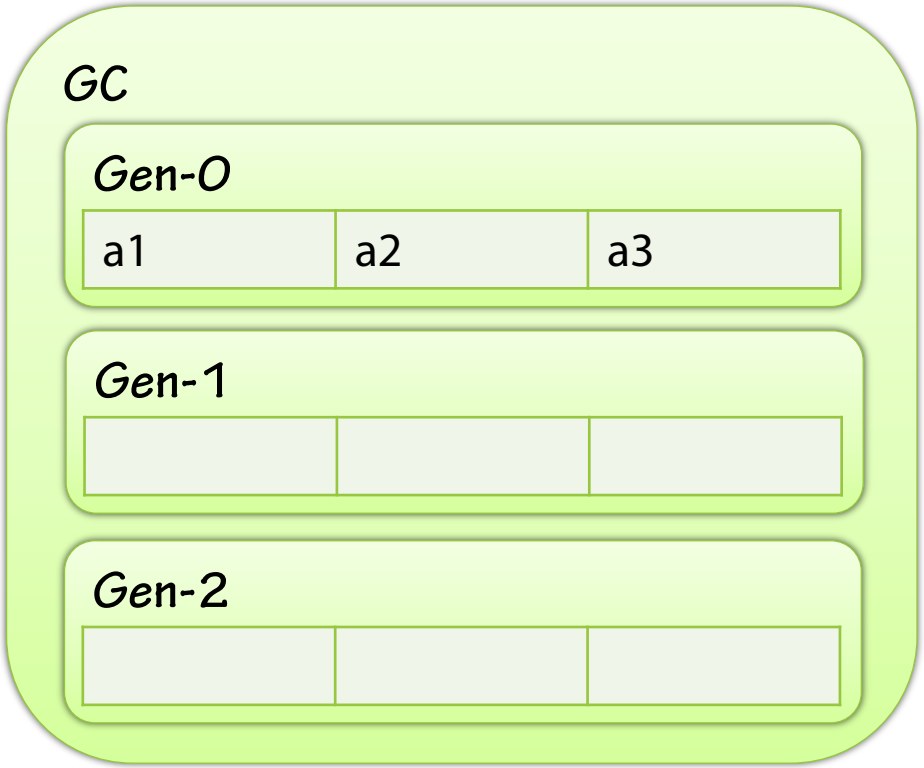
GC Generations



Short-lived in gen-0

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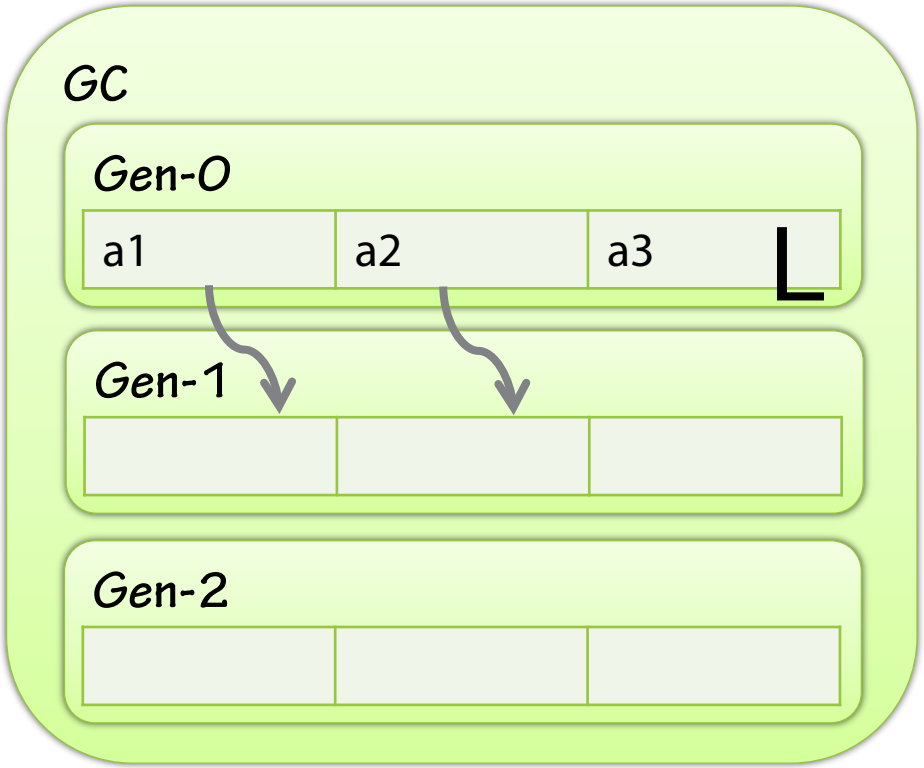
GC Generations



Short-lived in gen-0

Move from gen-0 to gen-1

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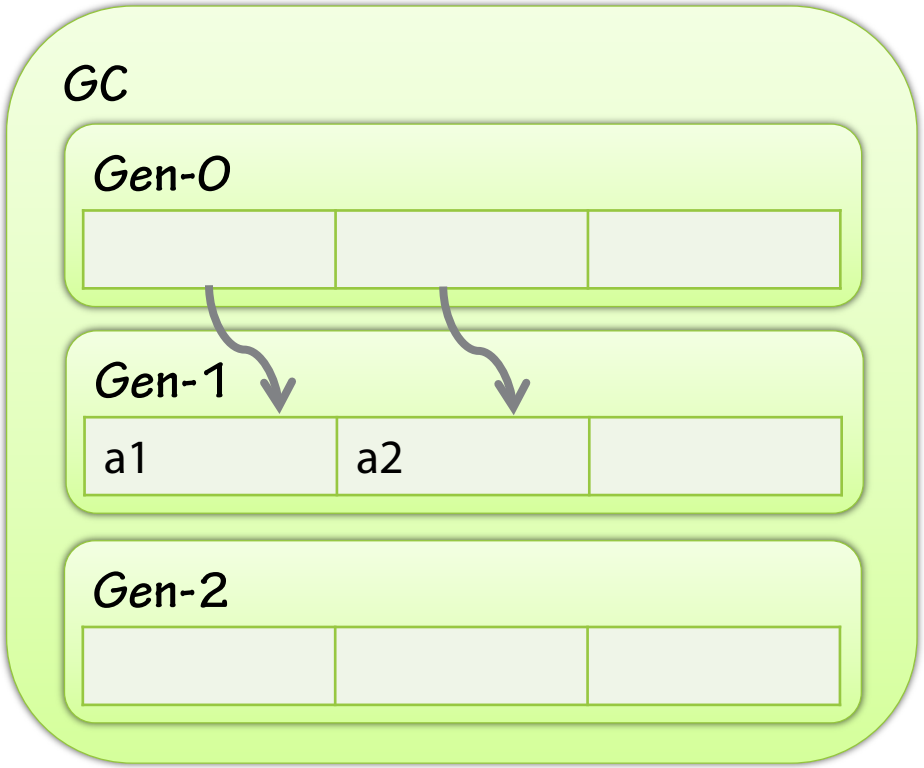
GC Generations



Short-lived in gen-0

Move from gen-0 to gen-1

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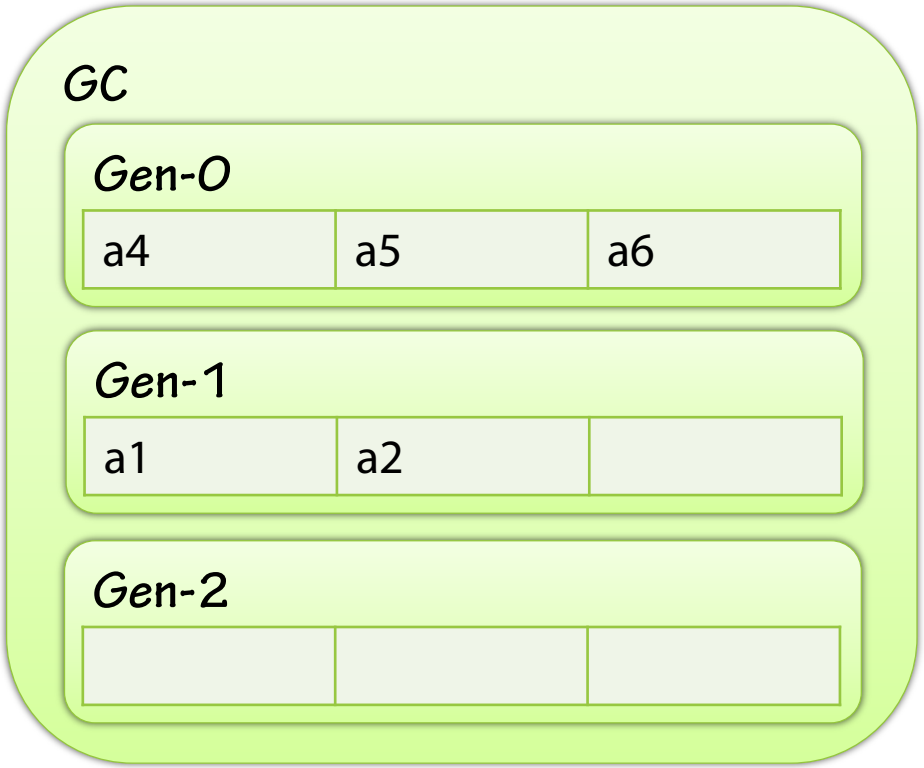
GC Generations



Short-lived in gen-0

Move from gen-0 to gen-1

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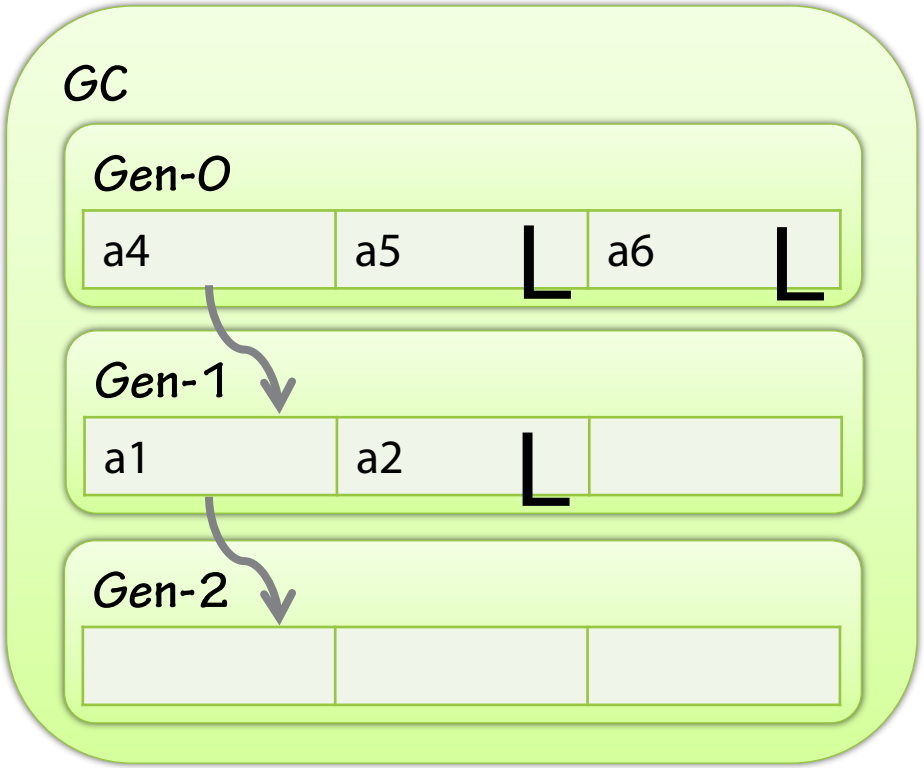
GC Generations



Short-lived in gen-0

Move from gen-0 to gen-1

Move from gen-1 to gen-2

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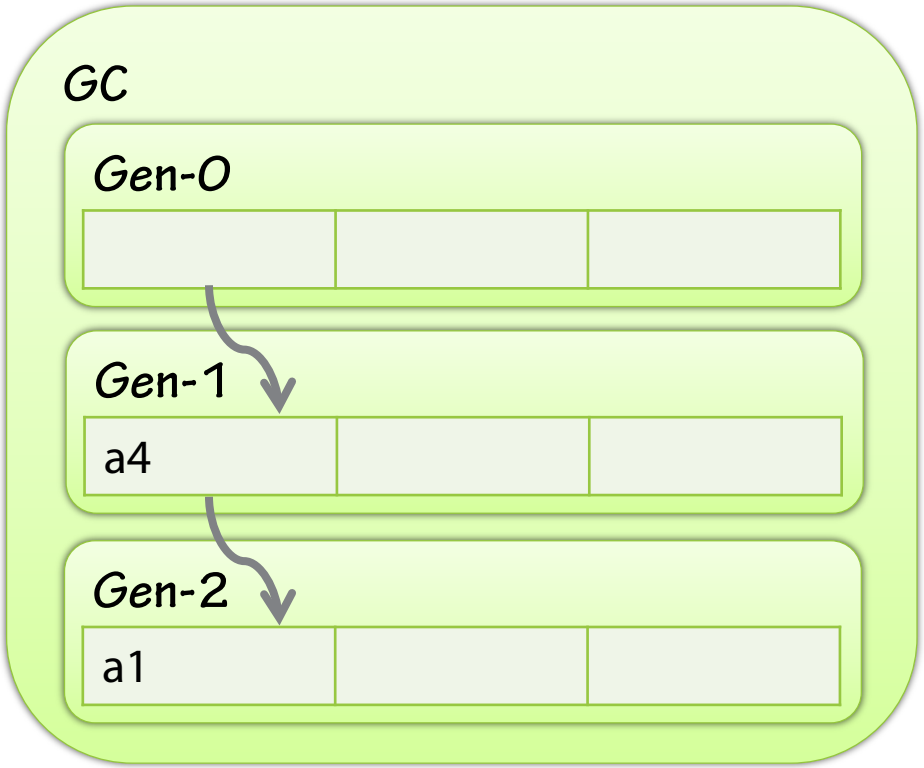
GC Generations



Short-lived in gen-0

Move from gen-0 to gen-1

Move from gen-1 to gen-2

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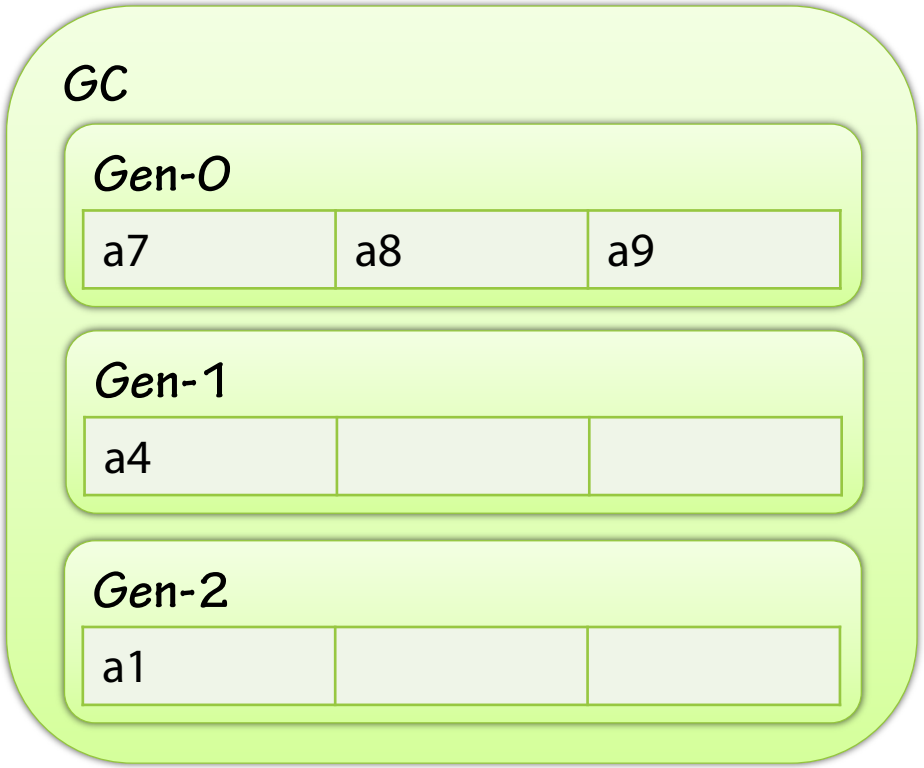
GC Generations



Short-lived in gen-0

Move from gen-0 to gen-1

Move from gen-1 to gen-2

Minimizing GC workload

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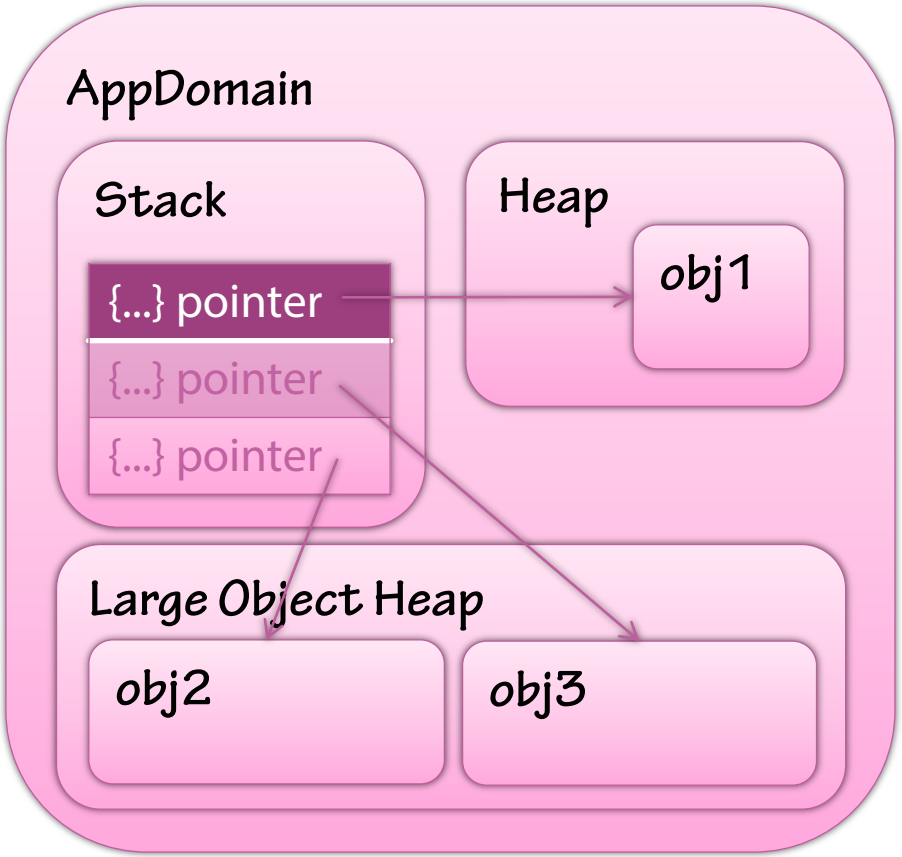
Heap Compression



Heap

Large object heap

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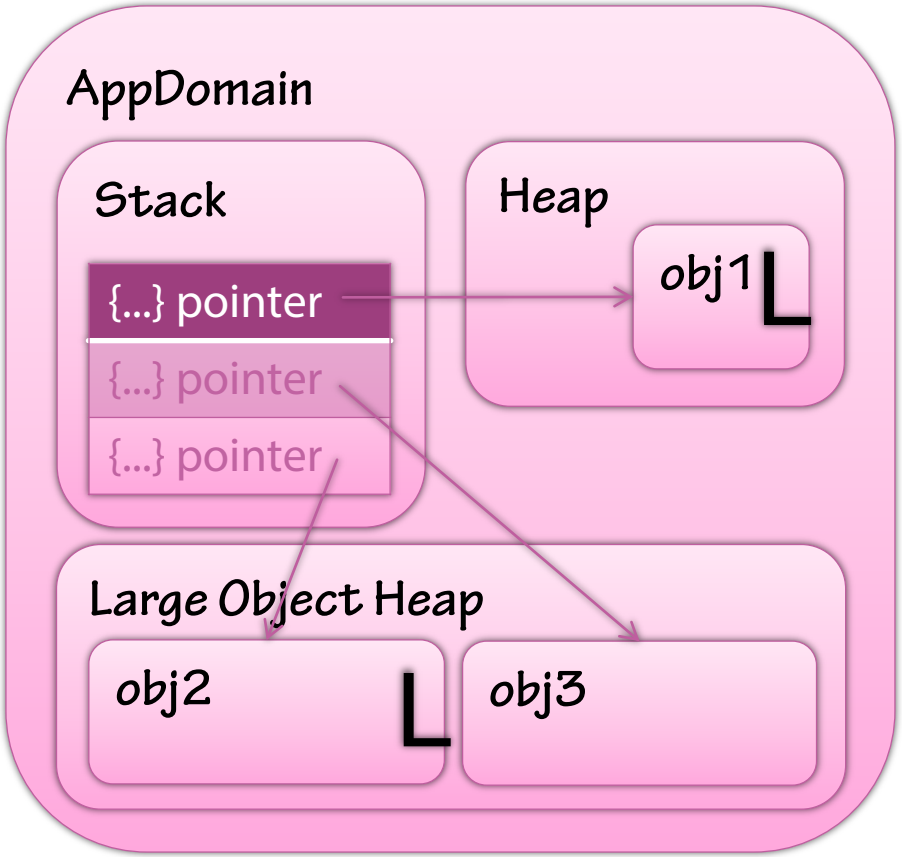
Heap Compression



Heap

Large object heap

GC Runs

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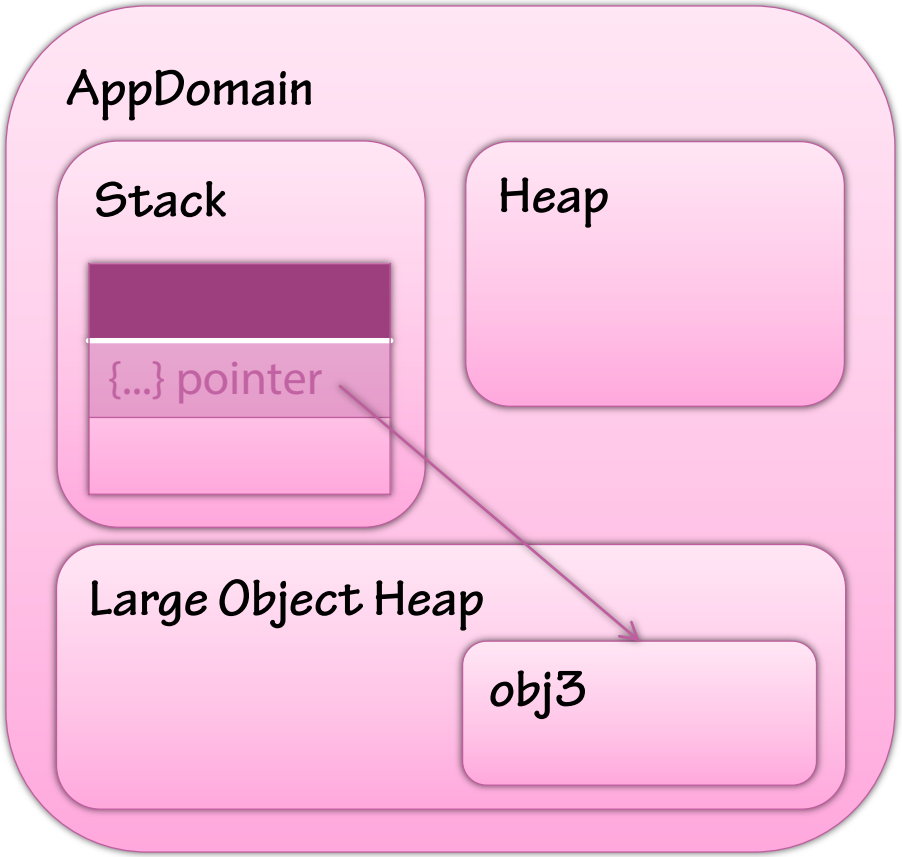
Heap Compression



Heap

Large object heap

GC Runs

Deallocates objects

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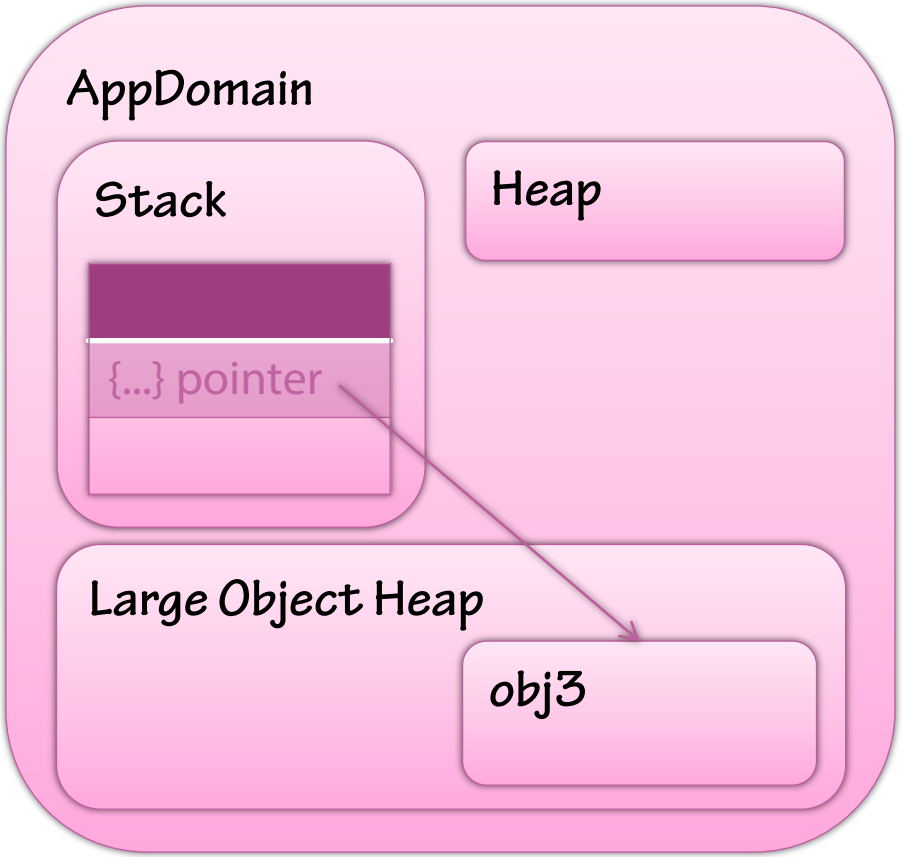
Heap Compression



- Heap
- Large object heap
- GC Runs
- Deallocates objects
- Compresses Heap

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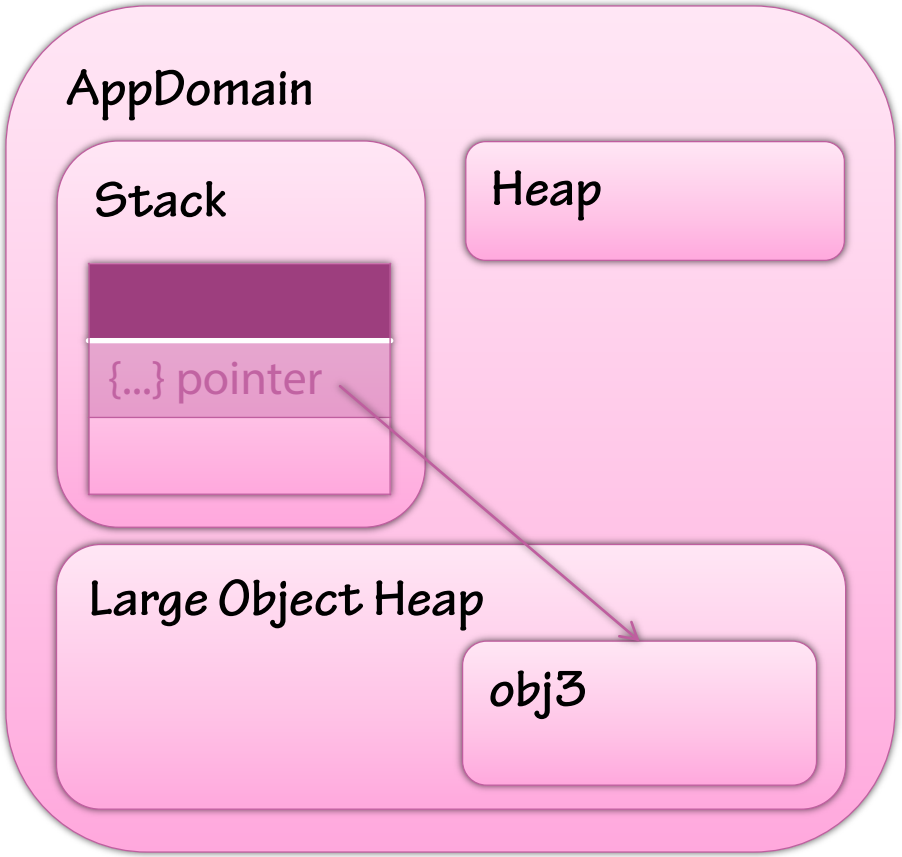
Heap Compression



Heap

Large object heap

GC Runs

Deallocates objects

Compresses Heap

Not Large Object Heap

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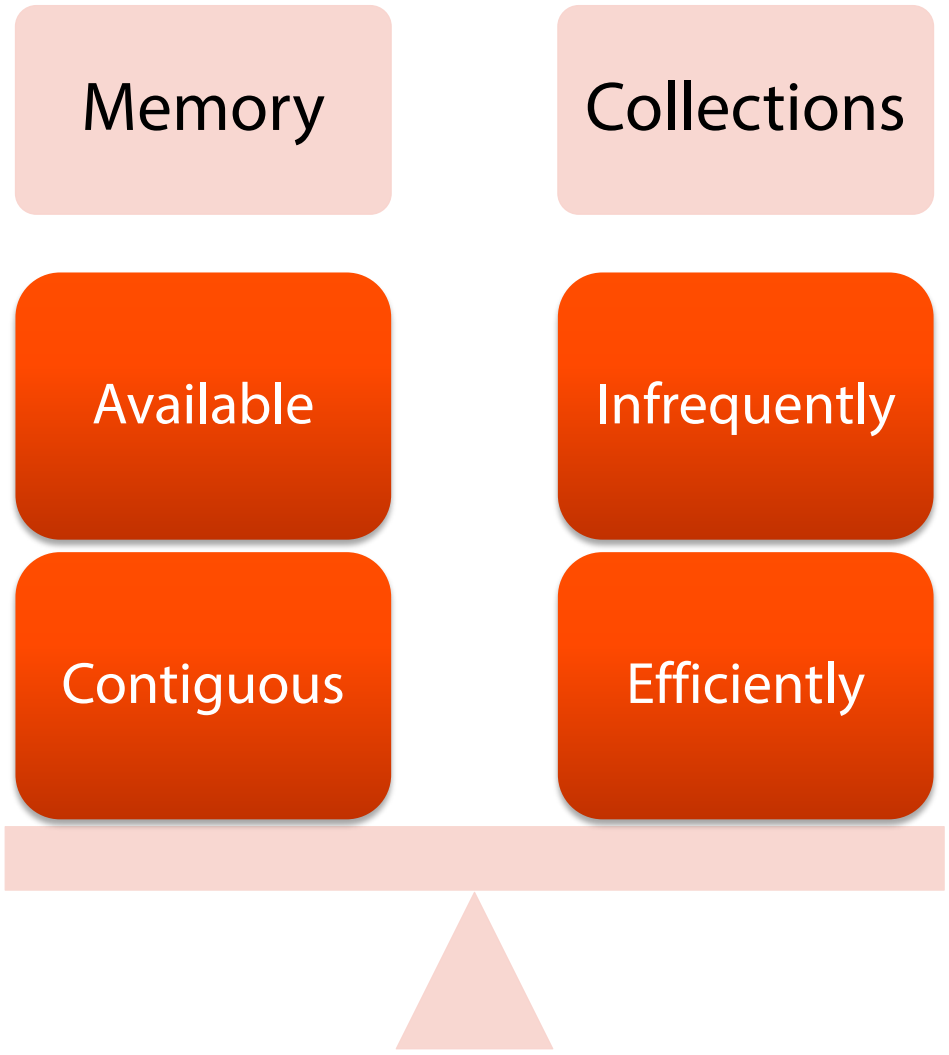
Balancing Concerns



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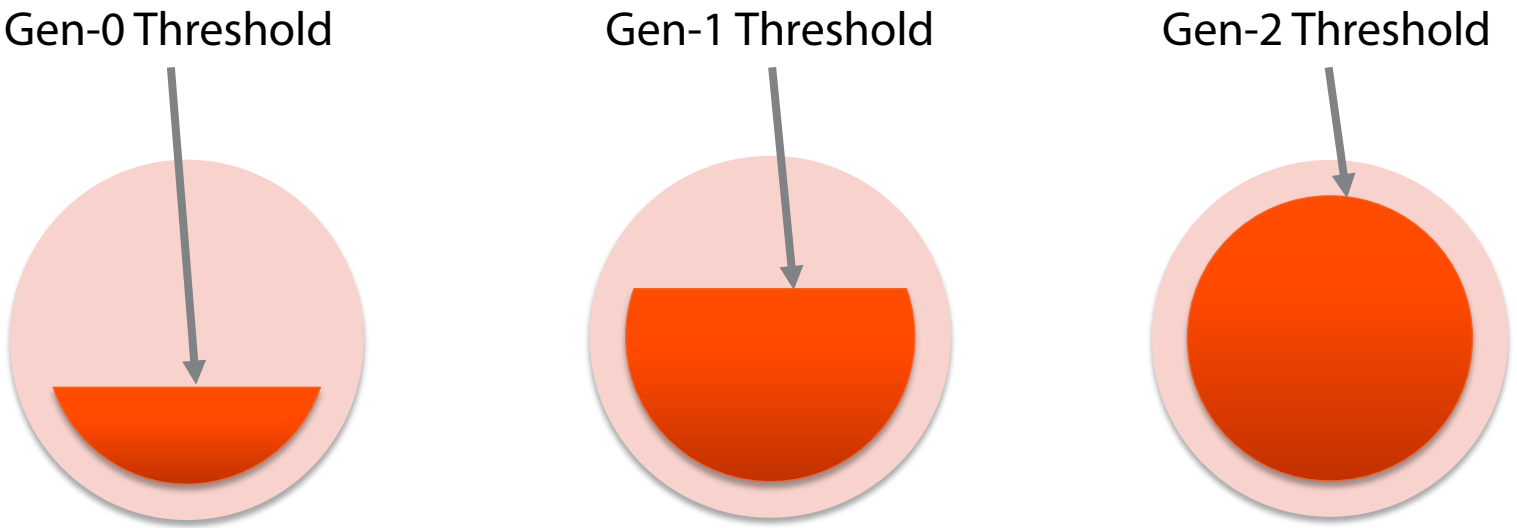
When Does the GC Collect?



Generation-0 Collection

Generation-1 Collection

Generation-2 Collection

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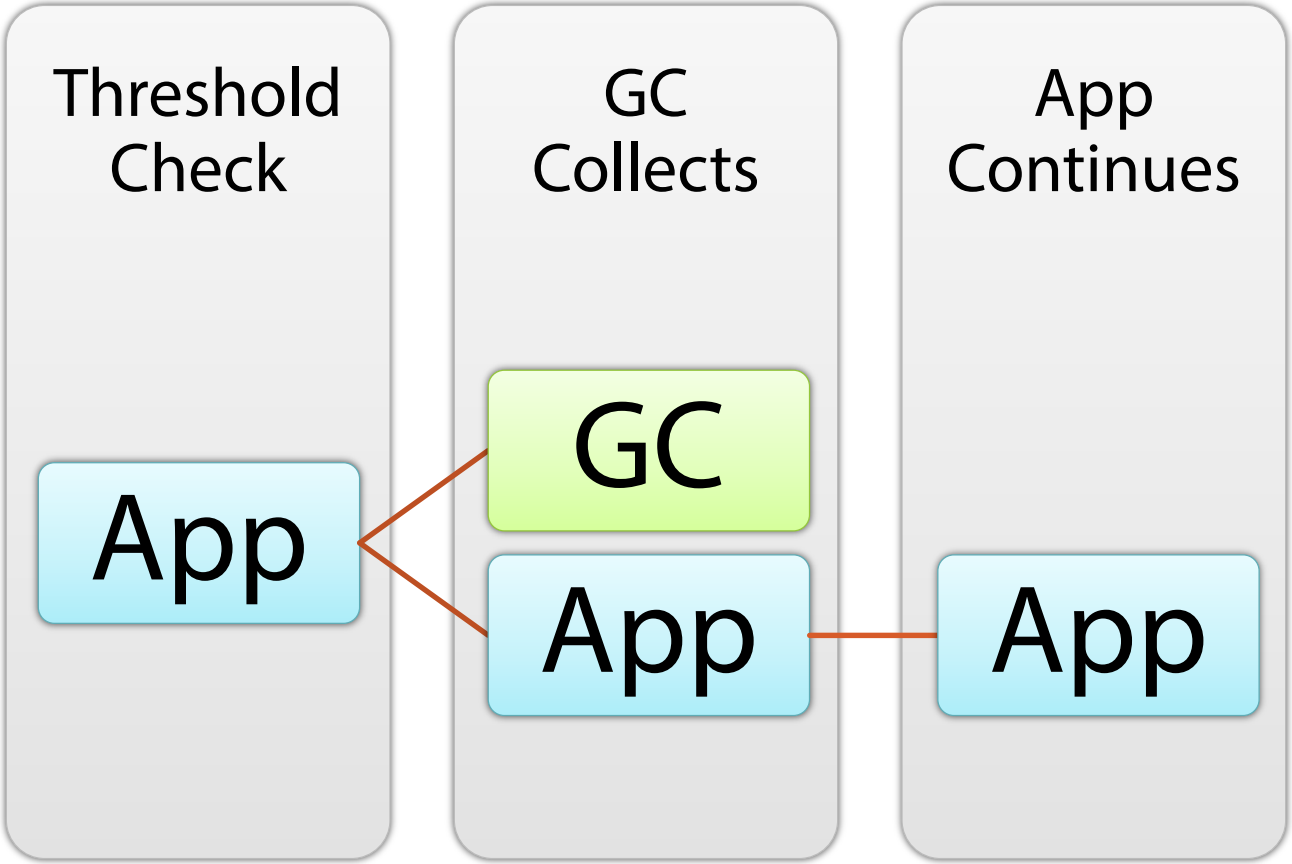
How Does the GC Run?



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Demo 1: Profiling DatabaseState

Goal

Demonstrate object allocation and GC collection

Walkthrough

Profile memory usage for app using DatabaseState

Walkthrough

Force garbage collection and show memory usage

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Demo 1: Profiling DatabaseState

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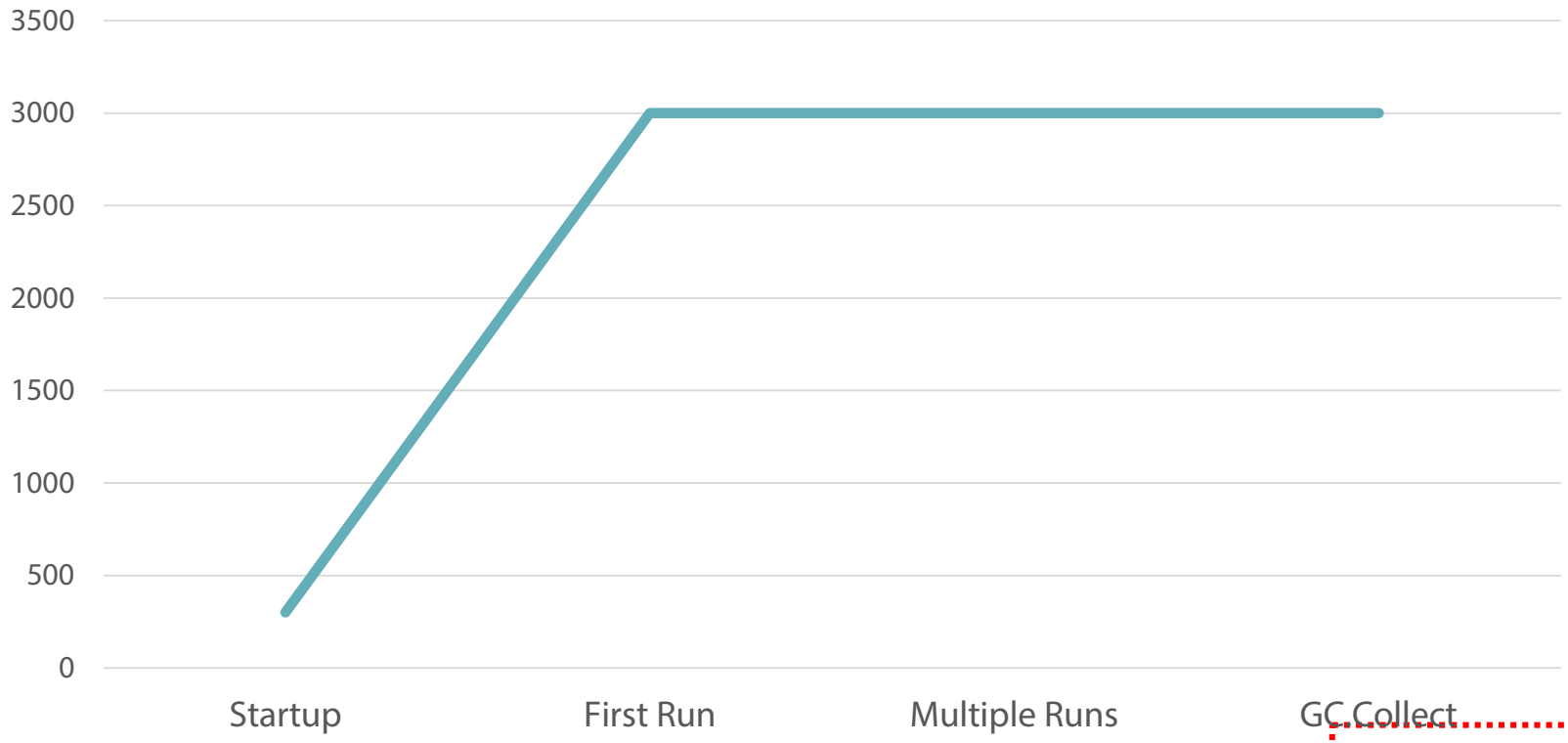
Demo 1: Profiling DatabaseState

```
private static DatabaseState _DatabaseState;
```



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Demo 1: Profiling DatabaseState

```
var databaseState = new DatabaseState();
```

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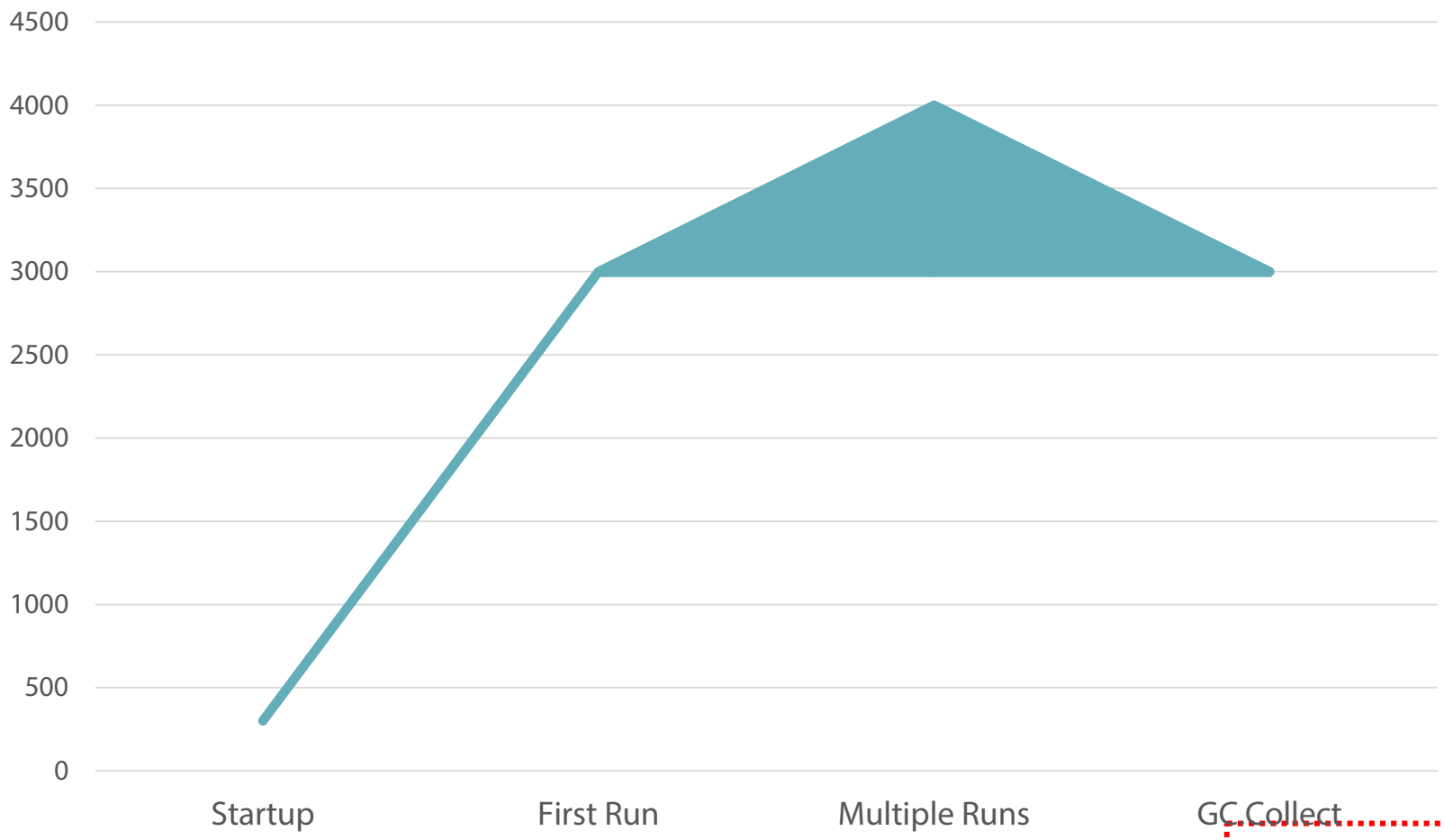
Demo 1: Profiling SqlConnection



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Demo 2: Implementing IDisposable

Goal

Show correct implementation of IDisposable

Walkthrough

Implement IDisposable using standard pattern

Walkthrough

Run under memory profiler and show memory usage

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Demo 2: Implementing IDisposable

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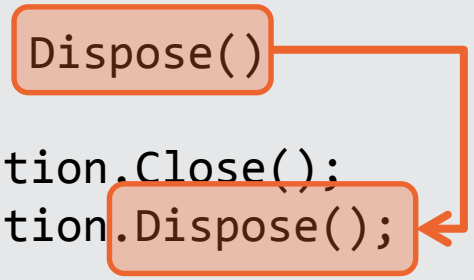
Demo 2: Implementing IDisposable

```
public class DatabaseState : IDisposable
{
    private SqlConnection _connection;

    /* ... */

    public void Dispose()
    {
        _connection.Close();
        _connection.Dispose();
    }
}
```



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Best Practice #2

If you use IDisposable objects as instance fields, implement IDisposable

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Best Practice #2

```
public class DatabaseState : IDisposable
{
    private SqlConnection _connection;
```

```
public void Dispose()
{
    Dispose(true);
    GC.SuppressFinalize(this);
}
```

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Best Practice #2

```
protected virtual void Dispose(bool disposing)
{
    if (disposing)
    {
        if (_connection != null)
        {
            _connection.Dispose();
            _connection = null;
        }
    }
}
```

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Best Practice #3

Allow Dispose() to be called multiple times and don't throw exceptions

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Best Practice #3

```
protected virtual void Dispose(bool disposing)
{
    if (disposing)
    {
        if (_connection != null)
        {
            _connection.Dispose();
            _connection = null;
        }
    }
}
```

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Dispose and Finalize

```
public class ClassWithFinalizer : IDisposable
{
    public void Dispose() { /* ... */ }

    ~ClassWithFinalizer() { /* ... */ }
}
```

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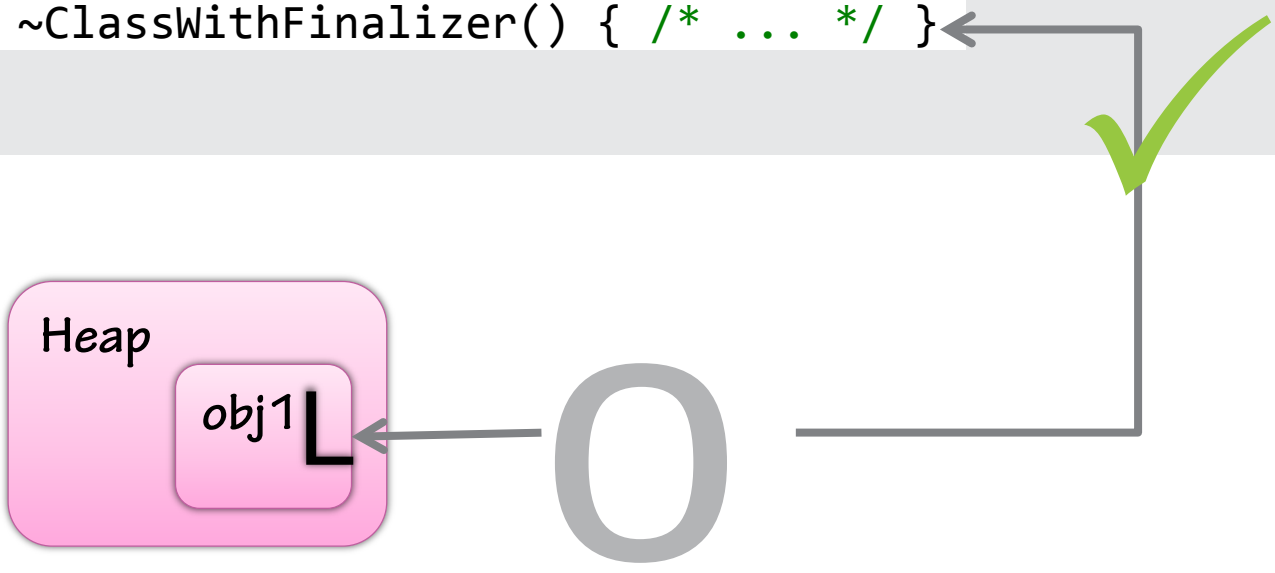
Dispose and Finalize

```
public class ClassWithFinalizer : IDisposable
{
    public void Dispose() { /* ... */ }

    ~ClassWithFinalizer() { /* ... */ }
}
```



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Demo 3: Dispose and Finalize

Goal

Show correct implementation of Dispose and Finalize

Walkthrough

Clean up managed resources when disposing in the derived class

Walkthrough

Clean up unmanaged resources in the finalizer

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Demo 3: Dispose and Finalize

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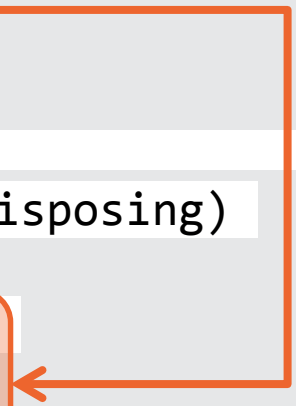
Demo 3: Dispose and Finalize

```
public class UnmanagedDatabaseState : DatabaseState
{
    private SqlCommand _command;
    private IntPtr _unmanagedPointer;
```

```
protected override void Dispose(bool disposing)
{
    if (disposing && _command != null)
    {
        _command.Dispose();
        _command = null;
    }
    //unmanaged resources...
    base.Dispose(disposing);
}
```



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Demo 3: Dispose and Finalize

```
protected override void Dispose(bool disposing)
{
    //managed resources...
    if (_unmanagedPointer != IntPtr.Zero)
    {
        Marshal.FreeHGlobal(_unmanagedPointer);
        _unmanagedPointer = IntPtr.Zero;
    }
    base.Dispose(disposing);
}
```

```
~UnmanagedDatabaseState()
{
    Dispose(false);
}
```

Best Practice #4

Implement IDisposable to support disposing resources in a class hierarchy

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Best Practice #4

```
public class DatabaseState : IDisposable

public void Dispose()
{
    Dispose(true);
    GC.SuppressFinalize(this);
}

protected virtual void Dispose(bool disposing)
```

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Best Practice #5

If you use unmanaged resources, declare a finalizer which cleans them up

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Best Practice #5

```
~UnmanagedDatabaseState()
{
    Dispose(false);
}
```

```
protected override void Dispose(bool disposing)
{
    //managed resources...
    if (_unmanagedPointer != IntPtr.Zero)
    {
        Marshal.FreeHGlobal(_unmanagedPointer);
        _unmanagedPointer = IntPtr.Zero;
    }
    base.Dispose(disposing);
}
```

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Summary

- **What does the Garbage Collector do?**
  - Keeping available memory free
  - Without impacting performance
- **When the GC runs**
  - When it decides to
  - Could have build-up of dead objects
- **Implementing IDisposable**
  - Disposing managed resources
  - Expecting Dispose to be repeatedly called
  - Allowing inheritors to dispose their resources
  - Using finalizers to clean up unmanaged resources

What Happens if you don't Dispose?

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