

Module 04: "Singleton"



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Agenda

- ▶ Introductory Example: Today's Magic Number
- ▶ Pattern: Singleton
- ▶ 6 Different Singleton Implementations
- ▶ Overview of Singleton Pattern
- ▶ Pattern or Anti-pattern?
- ▶ Beware...!

Introductory Example: Today's Magic Number

```
class Magic
{
    public int Number { get; }

    public Magic()
    {
        Number = ...;
    }
}
```

```
Magic m1 = new Magic();
Console.WriteLine( m1.Number );

Magic m2 = new Magic();
Console.WriteLine( m2.Number );
```

Challenges

- ▶ How do we ensure that all clients receive the same, unique object when needing a **Magic** object?
- ▶ How do we ensure there will only be created a single object of a given type?
- ▶ How do we ensure that the instance will only be created `_exactly_` when needed?

Pattern: Singleton

- ▶ *Ensure that a class only has one instance, and provide a global point of access to it.*
- ▶ Outline
 - Make sure that the entire application uses the same single instance of class
 - Create class object in a lazy manner (only if/when needed)
 - Save resources when class is resource-intensive
 - Control access to creation of instances
- ▶ Origin: Gang of Four

1. Simple Singleton

Not thread-safe!

```
sealed class Magic
{
    public static Magic Instance
    {
        get
        {
            if (_instance is null) { _instance = new Magic(); }
            return _instance;
        }
    }
    private static Magic? _instance;
    ...
    private Magic() { ... }
}
```


```
Magic m1 = Magic.Instance;
Console.WriteLine(m1.Number);
```

```
Magic m2 = Magic.Instance;
Console.WriteLine(m2.Number);
```

2. Simple Thread-safe Singleton

```
sealed class Magic
{
    public static Magic Instance
    {
        get
        {
            lock( _sync )
            {
                if ( _instance is null) { _instance = new Magic(); }
                return _instance;
            }
        }
    }
    ...
    private static readonly object _sync = new object();
}
```

Inefficient locking



3. Double-check Lock Singleton

```
public static Magic Instance  
{
```

```
    get  
    {
```

```
        if (_instance is null)
```

```
        {
```

```
            lock (_sync)
```

```
            {
```

```
                if( _instance is null) { _instance = new Magic(); }
```

```
            }
```

```
        }
```

```
        return _instance;
```

```
    }
```

```
}
```

```
private static volatile Magic? _instance;
```

Hmmmm....?!



4. Lock-free Thread-safe Singleton

Simple, thread-safe,
but slightly un-lazy

```
sealed class Magic
```

```
{
```

```
    public int Number { get; }
```

```
    public static Magic Instance { get; } = new Magic();
```

```
    static Magic() { } // <-- To prevent beforefieldinit in IL
```

```
    private Magic() { ... }
```

```
}
```



BeforeFieldInit in IL

- ▶ The CLI specification (ECMA 335) states in section 8.9.5:
 1. *A type may have a type-initializer method, or not.*
 2. *A type may be specified as having a relaxed semantic for its type-initializer method (for convenience below, we call this relaxed semantic BeforeFieldInit)*
 3. *If marked BeforeFieldInit then the type's initializer method is executed at, or sometime before, first access to any static field defined for that type*
 4. *If not marked BeforeFieldInit then that type's initializer method is executed at (i.e., is triggered by):*
 1. *first access to any static or instance field of that type, or*
 2. *first invocation of any static, instance or virtual method of that type*
- ▶ From Jon Skeet's brilliant discussion:
 - <http://csharpindepth.com/Articles/General/Beforefieldinit.aspx>

5. Lock-free, Lazy Thread-safe Singleton

```
sealed class Magic
{
    public int Number { get; }

    public static Magic Instance => Inner._instance;

    private Magic() { ... }
```

Actually works nicely!



```
private class Inner
{
    static Inner() { } // <-- To prevent beforefieldinit in IL
    internal static readonly Magic _instance = new Magic();
}
```

```
}
```


6. Beautiful, Lazy, Thread-safe Singleton

```
sealed class Magic
{
    public int Number { get; }

    private Magic() { ... }

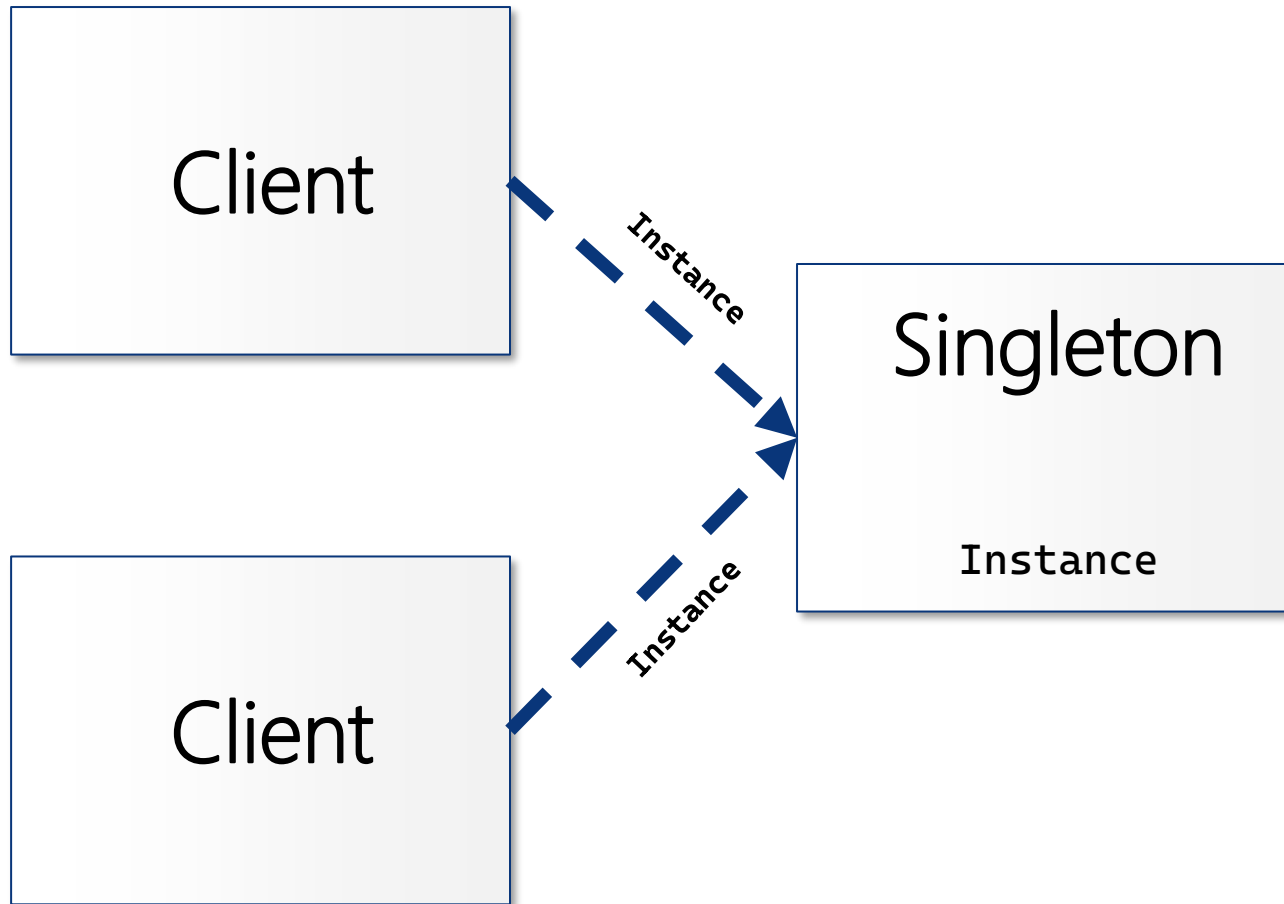
    public static Magic Instance => _lazyInstance.Value;

    private static readonly Lazy<Magic> _lazyInstance
        = new Lazy<Magic>(() => new Magic());
}
```



- Uses **Lazy<T>** from .NET 4.0 (and above):
 - <https://msdn.microsoft.com/en-us/library/dd642331.aspx>

Overview of Singleton Pattern



Overview of Singleton Pattern

- ▶ Singleton
 - Class instantiates the one and only instance when first needed
 - Keeps track of constructed instance and supplies it to clients
- ▶ Client
 - Obtains instance by accessing Singleton.**Instance** property
 - Cannot create instances of Singleton itself

Pattern or Anti-pattern?

- ▶ Does not support construction parameters
- ▶ “Emulates” global variables
- ▶ Not easily testable
- ▶ Singleton class has multiple responsibilities
 - Managing object creation and lifetime
 - “Regular” class responsibilities
- ▶ Promotes tight coupling
 - Can be alleviated using a factory, however
 - IoC container can also help enforcing Singleton instancing

Beware...!

- ▶ Simple, but deceptively subtle and complex
- ▶ Read the fine print:
 - Should be sealed!
 - Should not be serializable
 - Singleton instance is only unique within AppDomain boundary



WINCUBATE

Jesper Gulmann Henriksen

PhD, MCT, MCSD, MCPD

Phone : +45 22 12 36 31

Email : jgh@wincubate.net

WWW : <http://www.wincubate.net>

Ringgårdsvej 4A

8270 Højbjerg

Denmark