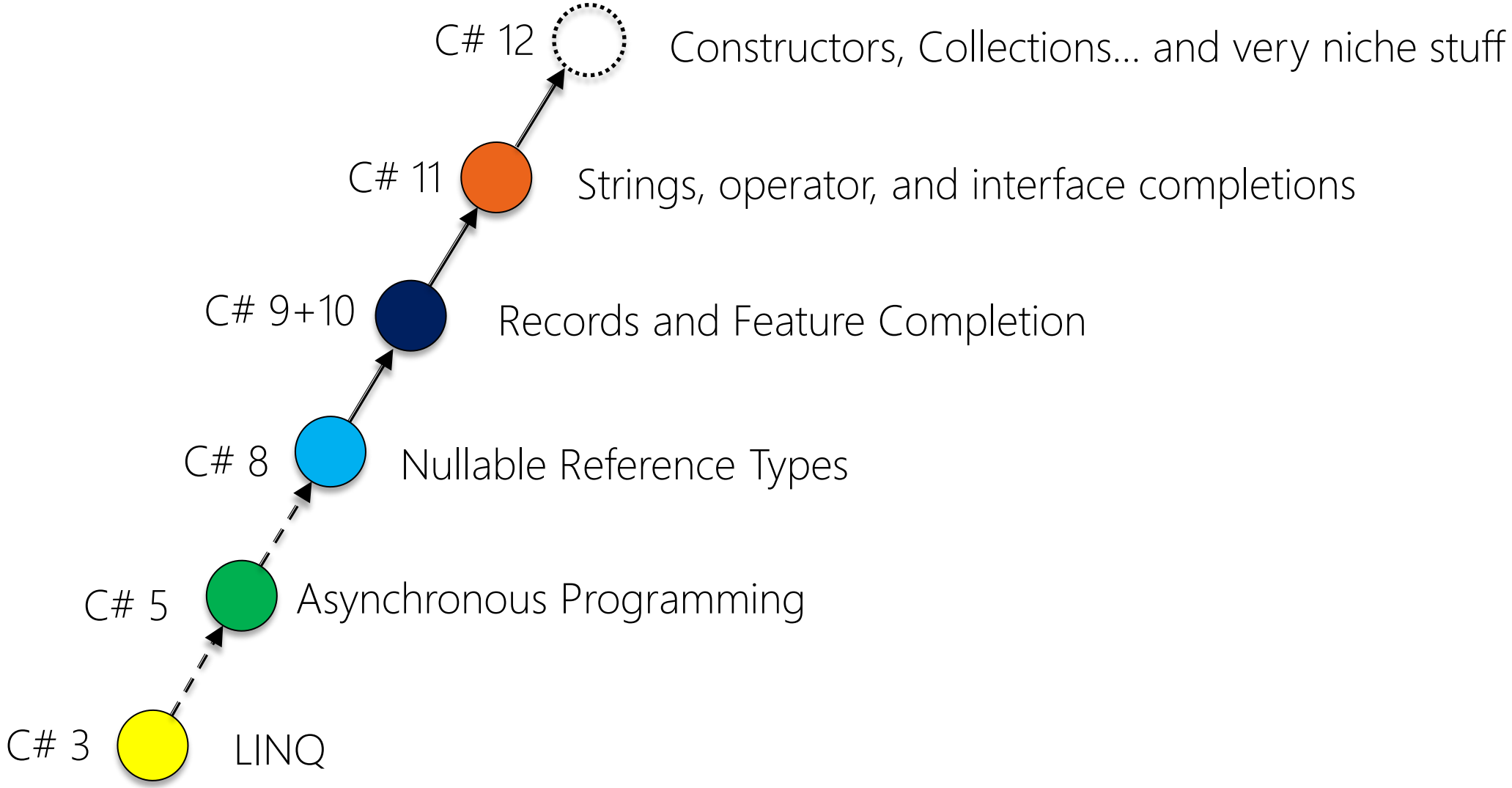
Module 06:

"Newest Features in C# 12"

Major Evolutions of C#



Agenda

- Introduction
- Object-Oriented Improvements
- Collection Improvements
- Method Improvements
- Namespaces and Usings
- Unsafe Improvements
- Summary

Introducing Primary Constructors

- Classes can now have *primary constructors*

```
class BankAccount(decimal initialBalance)
{
    public decimal Balance { get; private set; } = initialBalance;

    public void Deposit(decimal amount) => Balance += amount;
}
```

- Looks like the primary constructors for records…
  - …but not identical!

- Note: Constructor parameters available throughout entire type

Parameter Capturing

- Primary constructor parameters can be captured lambda-style

```
class BankAccount(decimal initialBalance)
{
    ...
    public void Deposit(decimal amount)
    {
        Balance += amount;
        WriteLine( $"Balance is now {Balance:c} (initially: {initialBalance})" );
    }
}
```

- *Potentially* in scope for the *entire* lifespan of the type

- Note:
  - Not readonly…!
  - Initialization vs. Computation
  - Can "uncapture" if desired

Constructor Chaining

- Primary constructor must be at the top of the constructor chain

```
class BankAccount(decimal initialBalance)
{
    public decimal Balance { get; private set; } = initialBalance;

    public BankAccount() : this(0)
    {
    }
}
```

- All other usual rules regarding constructor chaining apply
  - E.g. for inheritance

Use Cases for Primary Constructors

- Many excellent use cases for constructors

- "Use Primary Constructor"
- "Use Primary Constructor (And Remove Fields)"

- Primary constructors still work for Dependency Injection
  - But required dependencies are slightly less explicit

Primary Constructors for Structs

- Also available for structs

```
struct Money(int euro, int cents)
{
    public int Euro { get; init; } = euro;
    public int Cents { get; init; } = cents;

    public override readonly string ToString() => $"EUR {Euro}:{Cents:d2}";
}
```

- Works in a manner similar to classes, except
  - For classes the default constructor is not created when primary constructor
  - For structs the default constructor is created regardless

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Collection Expressions

- Unified collection syntax across a multitude of collection types

```
class LookupTable(List<string> elements, Func<string, string> mapping)
{
    public LookupTable() : this([], s => s) {}

    public string Get(Index index) => mapping(elements[index]);
}
```

```
List<string> elements = ["Hello", "World", "Booyah"];
```

- Essentially the construction syntax corresponding to the matching syntax of C# 11

Supported Collection Types

- Arrays
- `Span<T>` and `ReadOnlySpan<T>`
- Types with collection initializer, such as `List<T>` and `Dictionary<K,V>`

- (and actually more such as `ImmutableArray<T>` and custom types)

```
int[] array = [1, 2, 3, 4, 5, 6, 7, 8];
List<string> list = ["one", "two", "three"];
Span<char> span = ['a', 'b', 'c', 'd', 'e', 'f', 'h', 'i'];
int[][] array2d = [[1, 2, 3], [4, 5, 6], [7, 8, 9]];

// Create an enumerable? (WTF?!)
IEnumerable<int> enumerable = [1, 2, 3];
```

Spread Operator

- The *spread operator* replaces its argument with the elements from that collection

```
int[] row0 = [1, 2, 3];
int[] row1 = [4, 5, 6];
int[] row2 = [7, 8, 9];

int[] all = [.. row0, .. row1, .. row2];

foreach (var element in all)
{
    Console.WriteLine(element);
}
```

- Argument must be an enumerable expression

Frozen Collections

- .NET 8 introduces a new set of *Frozen Collections*
  - `FrozenSet<T>`
  - `FrozenDictionary<K,V>`

```
using System.Collections.Frozen;

List<int> list = [11, 22, 33];
FrozenSet<int> frozen = list.ToFrozenSet(); // Now read-only
if(frozen.TryGetValue(22, out int actualValue))
{
    Console.WriteLine($"Got {actualValue}");
}
```

- "But why"? Performance..! ☺
  - There is no `FrozenList<T>`

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Default and **params** Parameters in Lambdas

- Lambda expressions are now allowed default parameters like regular methods

```
var add = (int x, int y = 100) => x + y;

Console.WriteLine(add(42));
```

- Similarly, **params** is now allowed

```
var total = (params int[] elements) => elements.Sum();

Console.WriteLine(total(11, 22, 33));
```

`ref readonly` Parameters

- As a fine-graining of the `in` modifier, the `ref readonly` modifier is now allowed:

```
double CalculateDistance(ref readonly Point3D first, in Point3D second = default)
{
    double xDiff = first.X - second.X;
    double yDiff = first.Y - second.Y;
    double zDiff = first.Z - second.Z;

    return Sqrt(xDiff * xDiff + yDiff * yDiff + zDiff * zDiff);
}
```

- Can be used to force by-reference instead of the potential copying of `in`

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Alias Any Type

- Now also *unnamed* types can be aliased with the **`using`** keyword

```
using Vector3D = (double x, double y, double z);

var v1 = (1, 2, 3);
var v2 = (4, 5, 6);
Console.WriteLine(AddVectors(v1, v2));

static Vector3D AddVectors(Vector3D first,Vector3D second) =>
    (first.x + second.x, first.y + second.y, first.z + second.z);
```

- Great for tuple types and pointer types
- Remember global usings? ☺

- Note: Cannot be nullable reference types at top-level

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Inline Array Types

- Inlined and laid out sequentially

```
Buffer buffer = new();
buffer[0] = "Hello";
buffer[1] = "Inline";

Console.WriteLine(buffer[0]);

[System.Runtime.CompilerServices.InlineArray(10)]
public struct Buffer
{
    private object _element0;
}
```

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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