

Module 16: "Iterator"



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Agenda

- ▶ Introductory Example: Playing Cards
- ▶ Challenges
- ▶ **IEnumerable**
- ▶ **IEnumerable<T>**
- ▶ Implementing the Iterator Pattern
- ▶ Pattern: Iterator
- ▶ Overview of Iterator Pattern
- ▶ Iterator Pattern and LINQ Queries

Introductory Example: Playing Cards

```
class Deck
{
    private List<Card> _cards;

    public Deck()
    {
        _cards = new();
        ...
    }
    public Card Deal() { ... }
    public void Shuffle() { ... }
}
```

```
struct Card : IComparable
{
    public Suit Suit { get; }
    public Rank Rank { get; }

    public Card(
        Suit suit, Rank rank )
    {
        Suit = suit;
        Rank = rank;
    }
}
```

```
Deck deck = new Deck();
deck.Shuffle();
Card card = deck.Deal();
Console.WriteLine( card );
```

Challenges

- ▶ How can clients iterate through the elements of the Deck without internal state being directly exposed?
- ▶ How do we perform LINQ queries on the Card elements in Deck?

Pattern: Iterator

- ▶ *Provide a way to access the elements of an aggregate object sequentially without exposing its underlying representation.*
- ▶ Outline
 - Facilitate iteration through a read-only collection of elements of the aggregate using **foreach**
 - Facilitate LINQ for querying elements of the aggregate
 - Implement **IEnumerable<T>** for element type T
- ▶ Origin: Gang of Four (+ extended by .NET)

IEnumerable

- ▶ .NET has the **IEnumerable** interface built in.

```
namespace System.Collections
{
    interface IEnumerable
    {
        IEnumerator GetEnumerator();
    }
}
```

```
interface IEnumerator
{
    object Current { get; }
    bool MoveNext();
    void Reset();
}
```

- ▶ Arrays and collection classes all implement this interface

Implementing **IEnumerable**

- ▶ You can implement the Iterator Pattern by implementing **IEnumerable** in your own types

```
class Deck : IEnumerable
{
    private List<Card> _cards;

    public Deck() { ... }
    public Card Deal() { ... }
    public void Shuffle() { ... }

    public IEnumerator GetEnumerator() { ... }
}
```

Iterator Syntax in C#

- ▶ C# provides powerful mechanisms for easy creation of iterator methods

```
public IEnumerator GetEnumerator()  
{  
    int i = 0;  
    while (true)  
    {  
        yield return _cards[i++];  
        if (i == _cards.Count)  
        {  
            yield break;  
        }  
    }  
}
```


IEnumerable<T>

- ▶ Class must implement the **IEnumerable<T>** interface for LINQ to work.

```
namespace System.Collections.Generic
{
    interface IEnumerable<out T> : IEnumerable
    {
        IEnumerator<T> GetEnumerator();
    }
}
```

- ▶ But...

```
interface IEnumerator<T>
{
    T Current { get; }
    bool MoveNext();
    void Reset();
}
```

Background:

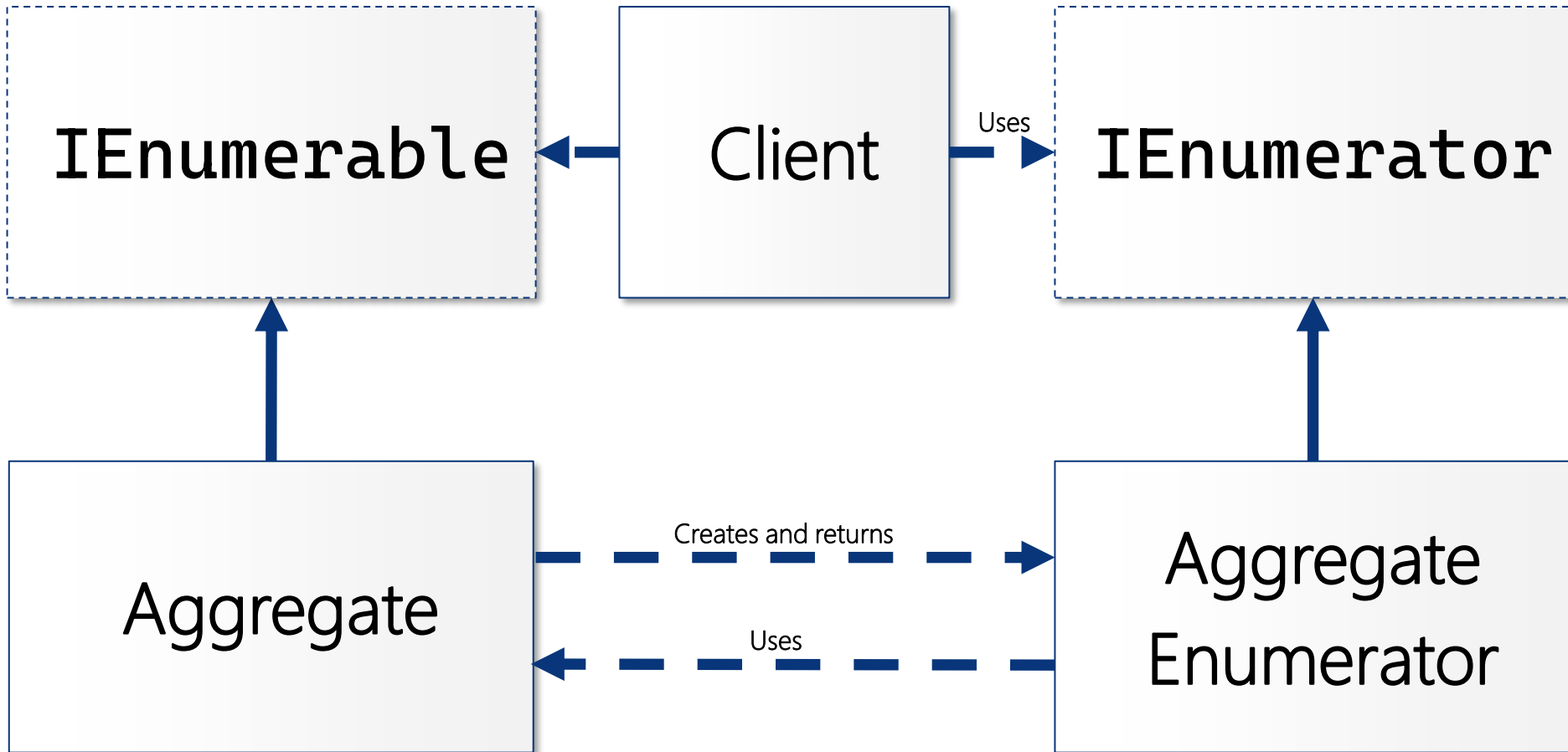
Explicit Interface Implementation

```
interface IArtist
{
    void Draw();
}
```

```
interface IGunslinger
{
    void Draw();
}
```

```
class ArtisticCowboy : IArtist, IGunslinger
{
    public void Draw()
    {
        Console.WriteLine( "Swinging brush, painting canvas..." );
    }
    void IGunslinger.Draw()
    {
        Console.WriteLine("Drawing Colt .45 from gun belt...");
    }
}
```

Overview of Iterator Pattern



Overview of Iterator Pattern

- ▶ Client
 - Asks Aggregate for Aggregate Enumerator
 - Uses Aggregate Enumerator for traversing elements
- ▶ Aggregate
 - Contains elements to be iterated
 - Creates Aggregate Enumerator and returns it to Client
- ▶ Aggregate Enumerator
 - Contains method for iterating the elements of the Aggregate
 - References the elements of the Aggregate when needed by Client

Iterator Pattern and LINQ Queries

- ▶ Added bonus:
 - If implementing the Iterator Pattern with **IEnumerable<T>** the type is queryable with LINQ

```
Deck deck = new Deck();  
deck.Shuffle();  
  
var query = deck.Where(c => c.Suit == Suit.Hearts);  
foreach (Card card in query)  
{  
    Console.WriteLine($"{card} ");  
}
```



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