

LINQ

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LINQ – A query language – like SQL

- Preconditions

- For every Data structure that support the interface:

```
public interface IEnumerable<out T>  
{  
    IEnumerator<T> GetEnumerator();  
}
```

- The **IEnumerator** interface consists of three methods:

```
bool MoveNext();  
void Reset();  
T Current { get; }
```

LINQ – A query language – like SQL

```
foreach (var t in anyDataStructure){ // initial Reset  
  
    the variable t // point at Current  
  
} // MoveNext -> true if a next element exists otherwise false  
    conditional for continuing looping
```

LINQ – A query language – like SQL

- What can you do with LINQ
- Make queries into the data structure
- You have two forms
 - Query Language
 - Fluent syntax (Method calls)

LINQ – A query language – like SQL

- Example Query Language

```
var titlesAndYears =  
  
from m in movies  
where (m.Year < 1996 && m.Year > 1980)  
orderby m.Year  
select new {m.Title, m.Year};
```

LINQ – A query language – like SQL

- Example Fluent syntax

```
var titlesAndYears =
```

```
movies.Where(m => m.Year < 1996 && m.Year > 1980).  
OrderBy(m => m.Year).Select new {m.Title, m.Year};
```

LINQ – A query language – like SQL

- **Strength of LINQ**
 - Can be used on any datastructure if only the **IEnumerable** interface is implemented
 - I.e on a datastructure of your own, if the **IEnumerable** interface is implemented

You can use Select, Where, Orderby,

LINQ – A more advanced use

- LINQ as **Data Transformation**
 - Direct transformation
 - Aggregate functionality
- **Set-oriented** operation with LINQ
- **Parallel** LINQ (PLINQ)

LINQ – Data Transformation

- I have
- Movie: Title, Year, DurationInMins, StudioName

- I wish
- MovieInfo: Title, YearSince1900, TimeHours

```
List<MovieInfo> miList =  
    movies.Select(m => new MovieInfo(  
        m.Title,  
        m.Year - 1900,  
        m.DurationInMins / 60.0)  
    )  
    .ToList();
```

LINQ – Data Transformation

```
public static List<V> TransformItems<T, V>(
    List<T> items, Func<T,V> transformer)
{
    List<V> transformedItems = new List<V>();
    foreach (T item in items)
    {
        V transformedItem = transformer(item);
        transformedItems.Add(transformedItem);
    }
    return transformedItems;
}
```

Convert from T to V



Call:

```
List<MovieInfo> miList = Transformer.TransformItems<Movie, MovieInfo>(
    movies, m => new MovieInfo(
        m.Title, m.Year - 1900, m.DurationInMins / 60.0)
    );
```

LINQ – Actions at the object level

I wish:

```
movies.Select(m => Console.WriteLine(m)); // not working !
```

On List:

```
movies.ForEach(m => Console.WriteLine(m));  
movies.ForEach(Console.WriteLine);
```

LINQ convert to List:

```
movies  
    .Select(m => $"{m.Title}, made in {m.Year}")  
    .ToList() // this do the trick ☺  
    .ForEach(Console.WriteLine);
```

LINQ – Aggregation (different functions)

Examples:

```
List<int> numbers = new List<int>{ 21, 8, 14, 45, 30, 9, 22 };
```

```
int sum = numbers.Sum();
```

```
int max = numbers.Max();
```

```
double avg = numbers.Average();
```

LINQ – Aggregation (different functions)

General description:

```
public static T Aggregate(  
    IEnumerable<V> collection,    // the collection  
    Func<T> initialValueFunc,    // the starting value  
    Func<T,V,T> updateValueFunc) // what to do in each iteration  
{  
    T value = initialValueFunc();  
    foreach (V item in collection)  
    {  
        value = updateValueFunc(value, item);  
    }  
    return value;  
}
```

LINQ – Aggregation (different functions)

```
List<int> numbers = new List<int> { 21, 8, 14, 45 };
int product = AggregateCalculator<int,int>.Aggregate(
    numbers,                // collection
    () => 1,                // initial value
    (val, item) => val * item); // each iteration
Console.WriteLine($"Product is {product}");
```

```
List<string> words = new List<string>{ "This ", "is ", "Sparta!" };
string concatStr = AggregateCalculator<string, string>.Aggregate(
    words,                // collection
    () => "",             // initial value
    (val, item) => val + item); // each iteration
Console.WriteLine(concatStr);
```

LINQ – Set-oriented operation with LINQ

Method	Called on	Argument	Description
Except	A	B	Returns items which are in A but <u>not</u> in B.
Intersect	A	B	Returns items which are in both A <u>and</u> B.
Union	A	B	Returns items which are in either A <u>or</u> B.
Distinct	A	(none)	Removes duplicate items from A
Concat	A	B	Concatenates B to A.

If you like to support logical equality => implement the Equal-methods in the class!

LINQ – Parallel LINQ (PLINQ)

Seen Threads / Tasks for handling CPU bounds

In LINQ we have a build in functionality to parallel calculations called PLINQ

LINQ – Parallel LINQ (PLINQ)

Example – finding prime numbers – WITHOUT parallel

Method to investigate
if number is a prime

```
Stopwatch watch = new Stopwatch();  
watch.Restart();
```

```
IEnumerable<int> primes = Enumerable.Range(2, 1000000).Where(IsPrime);
```

```
int primesCount = primes.Count();  
watch.Stop();
```

```
Console.WriteLine($"Primes up to 1,000,000: {primesCount}");
```

```
Console.WriteLine($"Time spent: {watch.ElapsedMilliseconds} ms");
```



LINQ – Parallel LINQ (PLINQ)

Same example – finding prime numbers – WITH parallel

```
Stopwatch watch = new Stopwatch();  
watch.Restart();
```

```
IEnumerable<int> primes = Enumerable.Range(2, 1000000)  
    .AsParallel()           // THIS do the trick  
    .AsOrdered()           // Keep the same order  
    .Where(IsPrime);
```

```
int primesCount = primes.Count();  
watch.Stop();  
Console.WriteLine($"Primes up to 1,000,000: {primesCount}");  
Console.WriteLine($"Time spent: {watch.ElapsedMilliseconds} ms");
```

Extension Methods

- The method is static– often in a static class
- The first parameter to the method has the type of the type the method should be used on
- This first parameter is preceded by the keyword **this**.

Example:

```
public static class SomeClass
{
    public static <returnValue> ExtensionMethod (this ClassToExtent obj)
    {
        // do the work;
    }
}
```

That's it

- **Small demo**
- **Training: PRO.3.4, PRO.3.7**

- **And the Mandatory Assignment**

