LINQ

Задача

Создать метод для фильтрации массивов целых чисел, но с возможностью указания алгоритма, применяемого для фильтрации.

Использование делегатов

```
public class Common
    {
        public delegate bool IntFilter(int i);
        public static int[] FilterArrayOfInts(int[] ints,
IntFilter filter)
        {
            List<int> aList = new List<int>();
            foreach (int i in ints)
            {
                if (filter(i))
                {
                    aList.Add(i);
                }
            }
            return (aList.ToArray());
        }
    }
```

Использование делегатов

```
class Program
    {
        public static bool IsOdd(int i)
        {
            return ((i & 1) == 1);
        }
        static void Main(string[] args)
        {
            int[] nums = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 };
            int[] oddNums = Common.FilterArrayOfInts(nums,
IsOdd);
            foreach (int i in oddNums)
                Console.WriteLine(i);
        }
    }
```

Использование анонимных методов

```
int[] nums = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 };
    int[] oddNums = Common.FilterArrayOfInts(nums,
delegate (int i)
    { return ((i & 1) == 1); });
foreach (int i in oddNums)
      Console.WriteLine(i);
```

Использование лямбда-выражений

```
(параметр1, параметр2, параметр3) => выражение

(параметр1, параметр2, параметр3) =>
{
   оператор1;
   оператор2;
   оператор3;
   return(тип_возврата_лямбда_выражения);
}
```

Использование лямбда-выражений

1. `x => x`
2. `x => x.Length>0`
3. `s => s.Length`
4. `(x,y) => x==y`
5. `(x,y) =>`

```
{if (x>y)
   return(x);
else
   return(y);
}
```

Использование лямбда-выражений

```
int[] nums = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 };
        int[] oddNums =
Common.FilterArrayOfInts(nums, i => ((i & 1) == 1));
foreach (int i in oddNums)
      Console.WriteLine(i);
```

LINQ ***(Language Integrated Query)***

По большей части LINQ ориентирован на ***запросы*** — будь то запросы, возвращающие набор подходящих объектов, единственный объект или подмножество полей из объекта либо набора объектов.

В LINQ этот возвращенный набор называется *последовательностью (sequence)*. Большинство последовательностей LINQ имеют тип IEnumerable<T>, где T — тип данных объектов, находящихся в последовательности.

LINQ

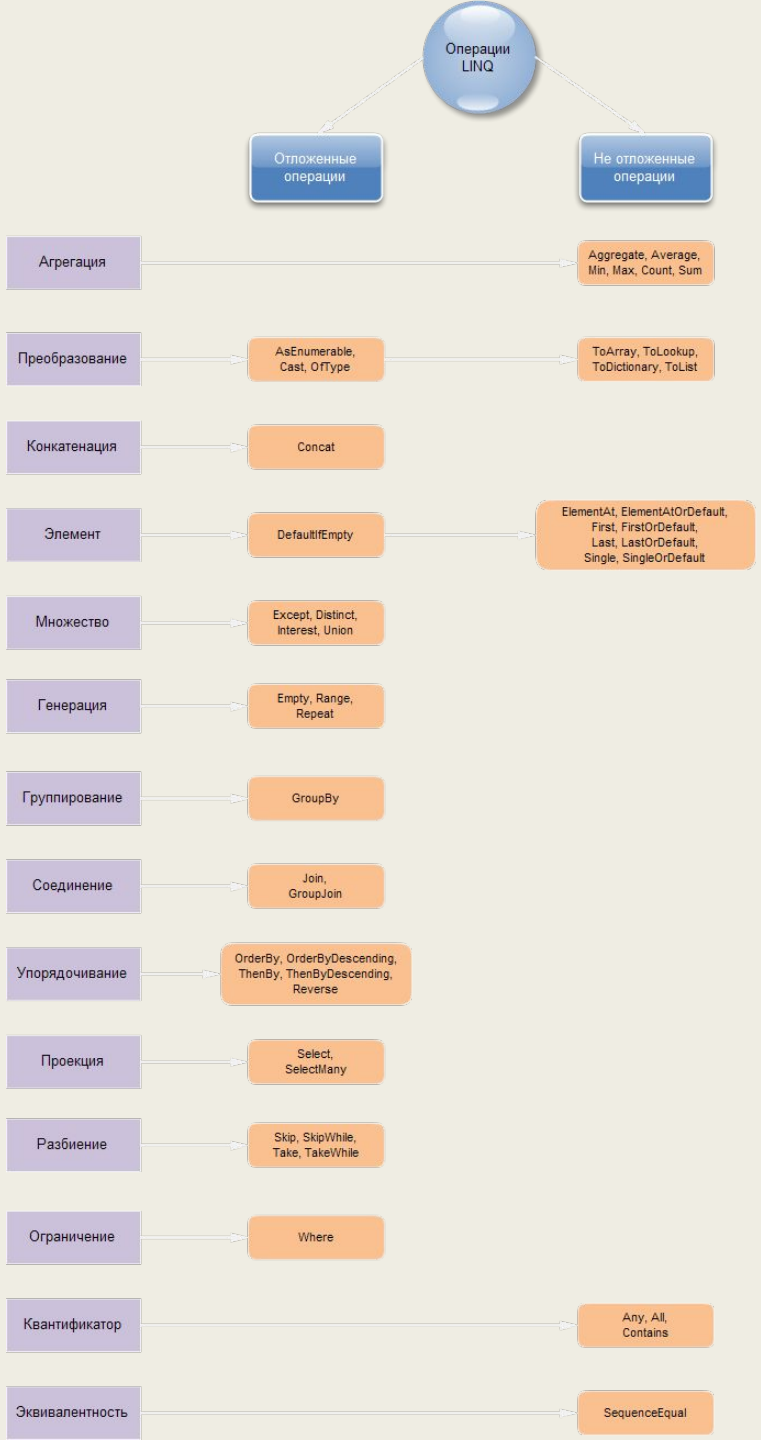
- **LINQ to Objects**: применяется для работы с массивами и коллекциями
- **LINQ to Entities**: используется при обращении к базам данных через технологию Entity Framework
- **LINQ to Sql**: технология доступа к данным в MS SQL Server
- **LINQ to XML**: применяется при работе с файлами XML
- **LINQ to DataSet**: применяется при работе с объектом DataSet
- **Parallel LINQ (PLINQ)**: используется для выполнения параллельных запросов

LINQ *(Language Integrated Query)*

```
string[] numbers = { "40", "2012", "176", "5" };


// Преобразуем массив строк в массив типа int
используя LINQ
int[] nums = numbers.Select(s =>
Int32.Parse(s)).ToArray();


foreach (int n in nums)
     Console.Write(n + " ");
```

LINQ *(Language Integrated Query)*

```
string[] numbers = { "40", "2012", "176", "5" };

// Преобразуем массив строк в массив типа int и
сортируем по возрастанию используя LINQ

int[] nums = numbers.Select(s =>
Int32.Parse(s)).OrderBy(s => s).ToArray();
```


Операции LINQ
Отложенные операции
Не отложенные операции
Агрегация
Aggregate, Average, Min, Max, Count, Sum
Преобразование
AsEnumerable, Cast, OfType
ToArray, ToLookup, ToDictionary, ToList
Конкатенация
Concat
Элемент
DefaultIfEmpty
ElementAt, ElementAtOrDefault, First, FirstOrDefault, Last, LastOrDefault, Single, SingleOrDefault
Множество
Except, Distinct, Interest, Union
Генерация
Empty, Range, Repeat
Группирование
GroupBy
Соединение
Join, GroupJoin
Упорядочивание
OrderBy, OrderByDescending, ThenBy, ThenByDescending, Reverse
Проекция
Select, SelectMany
Разбиение
Skip, SkipWhile, Take, TakeWhile
Ограничение
Where
Квантификатор
Any, All, Contains
Эквивалентность
SequenceEqual

Ленивые (отложенные) вычисления

Ленивые вычисления (англ. *lazy evaluation*, также *отложенные вычисления*) — применяемая в некоторых языках программирования стратегия вычисления, согласно которой вычисления следует откладывать до тех пор, пока не понадобится их.

Метод Enumerable.Range(Int32, Int32)

```
public static
System.Collections.Generic.IEnumerable<int> Range
(int start, int count);
```

```
var mas = Enumerable.Range(2,10);
foreach (int num in mas)
   Console.WriteLine(num);
```

Enumerable.Repeat<TResult>(TResult, Int32)

```
public static
System.Collections.Generic.IEnumerable<TResult>
Repeat<TResult> (TResult element, int count);

IEnumerable<string> strings =
        Enumerable.Repeat("I like programming.", 15);
foreach (String str in strings)
{
   Console.WriteLine(str);
}
```

Enumerable.Concat<TSource> (IEnumerable<TSource>, IEnumerable<TSource>)

```
public static
System.Collections.Generic.IEnumerable<TSource>
Concat<TSource> (this
System.Collections.Generic.IEnumerable<TSource> first,
System.Collections.Generic.IEnumerable<TSource>
second);
```

Enumerable.Concat<TSource> (IEnumerable<TSource>, IEnumerable<TSource>)

```
var mas1 = Enumerable.Range(1,10);
var mas2 = Enumerable.Repeat(1, 10);
var mas_union = Enumerable.Concat(mas1, mas2);
var mas_union2 = mas1.Concat(mas2);
```

Метод Enumerable.Where

```
public static
System.Collections.Generic.IEnumerable<TSource>
Where<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,bool> predicate);
```

```
var mas1 = Enumerable.Range(1,10);
var mas2 = mas1.Where(x => x%2==0);
```

Метод Enumerable.Where

```
public static
System.Collections.Generic.IEnumerable<TSource>
Where<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,int,bool> predicate);
```

```
int[] numbers = { 0, 30, 20, 15, 90, 85, 40, 75 };
IEnumerable<int> query = numbers.Where((number, index)
=> number <= index * 10);
```

Метод Enumerable.Count

```
public static int Count<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source);
```

```
string[] fruits = { "apple", "banana", "mango", "orange",
"passionfruit", "grape" };
int numberOfFruits = fruits.Count();
```

Метод Enumerable.Count

```
public static int Count<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,bool> predicate);
```

```
string[] fruits = { "apple", "banana", "mango", "orange",
"passionfruit", "grape" };
int numberOfFruits = fruits.Count(s => s.First()== 'a');
```

Метод Enumerable.First

```
public static TSource First<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source);

int[] numbers = { 9, 34, 65, 92, 87, 435, 3, 54,
                  83, 23, 87, 435, 67, 12, 19 };

int first = numbers.First();

Console.WriteLine(first);
```

Метод Enumerable.First

```
public static TSource First<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,bool> predicate);

int[] numbers = { 9, 34, 65, 92, 87, 435, 3, 54,
                  83, 23, 87, 435, 67, 12, 19 };

int first = numbers.First(number => number > 80);

Console.WriteLine(first);
```

Метод Enumerable.FirstOrDefault

```
public static TSource FirstOrDefault<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,bool> predicate);
```

```
string[] names = { "Hartono, Tommy", "Adams, Terry", "Andersen,
Henriette Thaulow", "Hedlund, Magnus", "Ito, Shu" };

string firstLongName = names.FirstOrDefault(name => name.Length
> 20);

Console.WriteLine("The first long name is '{0}'.",
firstLongName);
```

Метод Enumerable.Last

```
int[] numbers = { 9, 34, 65, 92, 87, 435, 3, 54,
                  83, 23, 87, 67, 12, 19 };

int last = numbers.Last();
```

```
int[] numbers = { 9, 34, 65, 92, 87, 435, 3, 54,
                  83, 23, 87, 67, 12, 19 };

int last = numbers.Last(num => num > 80);
```

Метод Enumerable.LastOrDefault

```
string[] fruits = { };
string last = fruits.LastOrDefault();
Console.WriteLine(
    String.IsNullOrEmpty(last) ? "<string is null or
empty>" : last);


double[] numbers = { 49.6, 52.3, 51.0, 49.4, 50.2, 48.3
};
double last50 = numbers.LastOrDefault(n => Math.Round(n)
== 50.0);
```

Метод Enumerable.LastOrDefault

```
double last40 = numbers.LastOrDefault(n => Math.Round(n)
== 40.0);
Console.WriteLine( "The last number that rounds to 40 is
{0}.", last40 == 0.0 ? "<DOES NOT EXIST>" :
last40.ToString());
```

Метод Enumerable.Sum

```
public static float Sum (this
System.Collections.Generic.IEnumerable<float> source);
```

```
List<float> numbers = new List<float> { 43.68F, 1.25F,
583.7F, 6.5F };

float sum = numbers.Sum();

Console.WriteLine("The sum of the numbers is {0}.",
sum);
```

Метод Enumerable.Sum

```
public static float Sum<TSource> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,float> selector);
```

Метод Enumerable.Sum

```
List<Package> packages = new List<Package> {
 new Package { Company = "Vineyard", Weight = 25.2 },
 new Package { Company = "Lucerne", Weight = 18.7},
 new Package { Company = "Wingtip Toys", Weight = 6.0 },
 new Package { Company = "Adventure", Weight = 33.8 } };

double totalWeight = packages.Sum(pkg => pkg.Weight);
Console.WriteLine("The total weight of the packages is: {0}",
totalWeight);
}
```

Метод Enumerable.Average

```
public static int Average (this
System.Collections.Generic.IEnumerable<int> source);
```

```
List<int> grades = new List<int> { 78, 92, 100, 37, 81
};

double average = grades.Average();

Console.WriteLine("The average grade is {0}.",
average);
```

Метод Enumerable.Average

```
public static double Average<TSource> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,long> selector);

 string[] numbers = { "10007", "37", "299846234235" };

 double average = numbers.Average(num =>
 Convert.ToInt64(num));

 Console.WriteLine("The average is {0}.", average);
```

Метод Enumerable.Min

```
public static decimal Min (this
System.Collections.Generic.IEnumerable<decimal> source);
```

```
double[] doubles = { 1.5E+104, 9E+103, -2E+103 };

double min = doubles.Min();

Console.WriteLine("The smallest number is {0}.", min);
```

Метод Enumerable.Min

```
public static TResult Min<TSource,TResult> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,TResult> selector);

 double[] doubles = { 1.5E+104, 9E+103, -2E+103 };

 double min = doubles.Min(x => Math.Abs(x));

 Console.WriteLine("The smallest absolute is {0}.",
 min);
```

Метод Enumerable.Max

```
public static decimal Max (this
System.Collections.Generic.IEnumerable<decimal> source);
```

```
double[] doubles = { 1.5E+104, 9E+103, -2E+103 };

double min = doubles.Max();

Console.WriteLine("The biggest number is {0}.", max);
```

Метод Enumerable.Max

```
public static TResult Max<TSource,TResult> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,TResult> selector);

 double[] doubles = { 1.5E+104, 9E+103, -2E+103 };

 double min = doubles.Max(x => Math.Abs(x));

 Console.WriteLine("The biggest absolute is {0}.", min);
```

Метод ElementAt

```
public static TSource ElementAt<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, int index);
```

Метод ElementAt

```
string[] names =  { "Hartono, Tommy", "Adams, Terry", "Andersen, Henriette Thaulow", "Hedlund, Magnus", "Ito, Shu" };

Random random = new Random(DateTime.Now.Millisecond);

string name = names.ElementAt(random.Next(0, names.Length));

Console.WriteLine("The name chosen at random is '{0}'.", name);
```

Метод **ElementAtOrDefault**

```
public static TSource ElementAtOrDefault<TSource>
(this System.Collections.Generic.IEnumerable<TSource>
source, int index);
```

Метод **ElementAtOrDefault**

```
int index = 20;

string name = names.ElementAtOrDefault(index);

Console.WriteLine("The name chosen at index {0} is
'{1}'.", index, String.IsNullOrEmpty(name) ? "<no name
at this index>" : name);
```

Метод Reverse

```
public static
System.Collections.Generic.IEnumerable<TSource>
Reverse<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source);
```

Метод Reverse

```
char[] apple = { 'a', 'p', 'p', 'l', 'e' };
char[] reversed = apple.Reverse().ToArray();
foreach (char chr in reversed)
{
    Console.Write(chr + " ");
}
Console.WriteLine();
```

Метод Enumerable.OrderBy

```
public static
System.Linq.IOrderedEnumerable<TSource>
OrderBy<TSource,TKey> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,TKey> keySelector);
```

Метод Enumerable.OrderBy

```
public static void OrderByEx1()
{
    Pet[] pets = { new Pet { Name="Barley", Age=8 },
                   new Pet { Name="Boots", Age=4 },
                   new Pet { Name="Whiskers", Age=1 } };
    IEnumerable<Pet> query = pets.OrderBy(pet => pet.Age);
    foreach (Pet pet in query)
    {
        Console.WriteLine("{0} - {1}", pet.Name, pet.Age);
    }
}
```

Метод Enumerable.OrderBy

```
public static System.Linq.IOrderedEnumerable<TSource>
OrderBy<TSource,TKey> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,TKey> keySelector,
System.Collections.Generic.IComparer<TKey> comparer);
```

Метод Enumerable.OrderByDescending

```
public static System.Linq.IOrderedEnumerable<TSource>
OrderByDescending<TSource,TKey> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,TKey> keySelector,
System.Collections.Generic.IComparer<TKey> comparer);
```

Метод Enumerable.OrderByDescending

```
public static System.Linq.IOrderedEnumerable<TSource>
OrderByDescending<TSource,TKey> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,TKey> keySelector);
```

Метод Enumerable.ThenBy

```
public static System.Linq.IOrderedEnumerable<TSource>
ThenBy<TSource,TKey> (this
System.Linq.IOrderedEnumerable<TSource> source,
Func<TSource,TKey> keySelector,
System.Collections.Generic.IComparer<TKey> comparer);
```

Метод Enumerable.ThenBy

```
public static System.Linq.IOrderedEnumerable<TSource>
ThenBy<TSource,TKey> (this
System.Linq.IOrderedEnumerable<TSource> source,
Func<TSource,TKey> keySelector);
```

Метод Enumerable.ThenBy

```
string[] fruits = { "grape", "passionfruit", "banana",
"mango", "orange", "raspberry", "apple", "blueberry" };

IEnumerable<string> query = fruits.OrderBy(fruit =>
fruit.Length).ThenBy(fruit => fruit);


foreach (string fruit in query)
{
    Console.WriteLine(fruit);
}
```

Метод Enumerable.ThenByDescending

```
public class CaseInsensitiveComparer : IComparer<string>
{
    public int Compare(string x, string y)
    {
        return string.Compare(x, y, true);
    }
}
```

Метод Enumerable.ThenByDescending

```
public static void ThenByDescendingEx1()
{ string[] fruits = { "apPLe", "baNanA", "apple", "APple",
"orange", "BAnana", "ORANGE", "apPLE" };
IEnumerable<string> query = fruits
.OrderBy(fruit => fruit.Length)
.ThenByDescending(fruit => fruit, new
CaseInsensitiveComparer());
}
```

Метод Take

```
public static
System.Collections.Generic.IEnumerable<TSource>
Take<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, int count);
```

Метод Take

```
int[] grades = { 59, 82, 70, 56, 92, 98, 85 };


IEnumerable<int> topThreeGrades =
    grades.OrderByDescending(grade =>
grade).Take(3);


Console.WriteLine("The top three grades are:");
foreach (int grade in topThreeGrades)
{
    Console.WriteLine(grade);
}
```

Метод TakeWhile

```
public static
System.Collections.Generic.IEnumerable<TSource>
TakeWhile<TSource> (this
System.Collections.Generic.IEnumerable<TSource> source,
Func<TSource,bool> predicate);
```

Метод TakeWhile

```
string[] fruits = { "apple", "banana", "mango",
"orange", "passionfruit", "grape" };


IEnumerable<string> query = fruits.TakeWhile(fruit =>
String.Compare("orange", fruit, true) != 0);


foreach (string fruit in query)
{
    Console.WriteLine(fruit);
}
```

Метод TakeWhile

```
public static
System.Collections.Generic.IEnumerable<TSource>
TakeWhile<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,int,bool> predicate);
```

Метод TakeWhile

```
string[] fruits = { "apple", "passionfruit", "banana",
"mango", "orange", "blueberry", "grape", "strawberry" };


IEnumerable<string> query =
    fruits.TakeWhile((fruit, index) => fruit.Length >=
index);


foreach (string fruit in query)
{
    Console.WriteLine(fruit);
}
```

Метод Skip

```
public static
System.Collections.Generic.IEnumerable<TSource>
Skip<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, int count);
```

Метод Skip

```
int[] grades = { 59, 82, 70, 56, 92, 98, 85 };

IEnumerable<int> lowerGrades =
    grades.OrderByDescending(g => g).Skip(3);

Console.WriteLine("All grades except the top three are:");
foreach (int grade in lowerGrades)
{
    Console.WriteLine(grade);
}
```

Метод SkipWhile

```
public static
System.Collections.Generic.IEnumerable<TSource>
SkipWhile<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,bool> predicate);
```

Метод SkipWhile

```
int[] grades = { 59, 82, 70, 56, 92, 98, 85 };
IEnumerable<int> lowerGrades =
    grades
    .OrderByDescending(grade => grade)
    .SkipWhile(grade => grade >= 80);
Console.WriteLine("All grades below 80:");
foreach (int grade in lowerGrades)
{
    Console.WriteLine(grade);
}
```

Метод SkipWhile

```
public static
System.Collections.Generic.IEnumerable<TSource>
SkipWhile<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,int,bool> predicate);
```

Метод SkipWhile

```
int[] amounts = { 5000, 2500, 9000, 8000, 6500, 4000, 1500, 5500 };

IEnumerable<int> query =

    amounts.SkipWhile((amount, index) => amount > index * 1000);


foreach (int amount in query)

{

    Console.WriteLine(amount);

}
```

Метод SkipLast

```
public static
System.Collections.Generic.IEnumerable<TSource>
SkipLast<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source, int count);
```

Метод Select

```
public static
System.Collections.Generic.IEnumerable<TResult>
Select<TSource,TResult> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,int,TResult> selector);
```

Метод Select

```
string[] fruits = { "apple", "banana", "mango",
"orange", "passionfruit", "grape" };


var query =
    fruits.Select((fruit, index) =>
 new { index, str = fruit.Substring(0, index) });


foreach (var obj in query)
{
    Console.WriteLine("{0}", obj);
}
```

Метод Select

```
public static
System.Collections.Generic.IEnumerable<TResult>
Select<TSource,TResult> (this
System.Collections.Generic.IEnumerable<TSource>
source, Func<TSource,TResult> selector);
```

Метод Select

```
IEnumerable<int> squares =
    Enumerable.Range(1, 10).Select(x => x * x);

foreach (int num in squares)
{
    Console.WriteLine(num);
}
```

Метод SelectMany

```
public static
System.Collections.Generic.IEnumerable<TResult>
SelectMany<TSource,TResult> (this
System.Collections.Generic.IEnumerable<TSource>
source,
Func<TSource,System.Collections.Generic.IEnumerable
<TResult>> selector);
```

Метод SelectMany

```
PetOwner[] petOwners =
{ new PetOwner { Name="Higa, Sidney",
          Pets = new List<string>{ "Scruffy", "Sam" } },
  new PetOwner { Name="Ashkenazi, Ronen",
          Pets = new List<string>{ "Walker", "Sugar" } },
  new PetOwner { Name="Price, Vernette",
          Pets = new List<string>{ "Scratches", "Diesel" } }
};
```

Метод SelectMany

```
IEnumerable<string> query1 =
petOwners.SelectMany(petOwner => petOwner.Pets);

IEnumerable<List<String>> query2 =
petOwners.Select(petOwner => petOwner.Pets);
```

Метод SelectMany

```
var query = petOwners .SelectMany(petOwner =>
petOwner.Pets, (petOwner, petName) => new { petOwner,
petName })
```

```
IEnumerable<string> query = petOwners.SelectMany((petOwner,
index) => petOwner.Pets.Select(pet => index + pet));
```

Метод Zip

```
public static
System.Collections.Generic.IEnumerable<TResult>
Zip<TFirst,TSecond,TResult> (this
System.Collections.Generic.IEnumerable<TFirst>
first,
System.Collections.Generic.IEnumerable<TSecond>
second, Func<TFirst,TSecond,TResult>
resultSelector);
```

Метод Zip

```
int[] numbers = { 1, 2, 3, 4 };
string[] words = { "one", "two", "three" };

var numbersAndWords = numbers.Zip(words, (first,
second) => first + " " + second);

foreach (var item in numbersAndWords)
    Console.WriteLine(item);
```

Метод Zip

```
public static
System.Collections.Generic.IEnumerable<ValueTuple<T
First,TSecond>> Zip<TFirst,TSecond> (this
System.Collections.Generic.IEnumerable<TFirst>
first,
System.Collections.Generic.IEnumerable<TSecond>
second);
```

Метод Disctinct

```
public static
System.Collections.Generic.IEnumerable<TSource>
Distinct<TSource> (this
System.Collections.Generic.IEnumerable<TSource>
source);
```

Метод Disctinct

```
List<int> ages = new List<int> { 21, 46, 46, 55,
17, 21, 55, 55 };


IEnumerable<int> distinctAges = ages.Distinct();


Console.WriteLine("Distinct ages:");


foreach (int age in distinctAges)
{
    Console.WriteLine(age);
}
```

Метод Disctinct

```
public class Product : IEquatable<Product>
{
    public string Name { get; set; }
    public int Code { get; set; }
    public bool Equals(Product other)
    {
   if (Object.ReferenceEquals(other, null)) return false;
   if (Object.ReferenceEquals(this, other)) return true;
   return Code.Equals(other.Code) && Name.Equals(other.Name);
    }
```

Метод Disctinct

```
public override int GetHashCode()
{
   int hashProductName = Name == null ? 0 :
Name.GetHashCode();
   int hashProductCode = Code.GetHashCode();
   return hashProductName ^ hashProductCode;
}
```