

LinksPlatform's Platform.Collections Class Library

1.1 ./csharp/Platform.Collections/Arrays/ArrayFiller[TElement, TReturnConstant].cs

```
1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Arrays
7 {
8     public class ArrayFiller<TElement, TReturnConstant> : ArrayFiller<TElement>
9     {
10         protected readonly TReturnConstant _returnConstant;
11
12         [MethodImpl(MethodImplOptions.AggressiveInlining)]
13         public ArrayFiller(TElement[] array, long offset, TReturnConstant returnConstant) :
14             ↪ base(array, offset) => _returnConstant = returnConstant;
15
16         [MethodImpl(MethodImplOptions.AggressiveInlining)]
17         public ArrayFiller(TElement[] array, TReturnConstant returnConstant) : this(array, 0,
18             ↪ returnConstant) { }
19
20         [MethodImpl(MethodImplOptions.AggressiveInlining)]
21         public TReturnConstant AddAndReturnConstant(TElement element) =>
22             ↪ _array.AddAndReturnConstant(ref _position, element, _returnConstant);
23
24         [MethodImpl(MethodImplOptions.AggressiveInlining)]
25         public TReturnConstant AddFirstAndReturnConstant(ICollection<TElement> elements) =>
26             ↪ _array.AddFirstAndReturnConstant(ref _position, elements, _returnConstant);
27
28         [MethodImpl(MethodImplOptions.AggressiveInlining)]
29         public TReturnConstant AddAllAndReturnConstant(ICollection<TElement> elements) =>
30             ↪ _array.AddAllAndReturnConstant(ref _position, elements, _returnConstant);
31
32         [MethodImpl(MethodImplOptions.AggressiveInlining)]
33         public TReturnConstant AddSkipFirstAndReturnConstant(ICollection<TElement> elements) =>
34             ↪ _array.AddSkipFirstAndReturnConstant(ref _position, elements, _returnConstant);
35     }
36 }
```

1.2 ./csharp/Platform.Collections/Arrays/ArrayFiller[TElement].cs

```
1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Arrays
7 {
8     public class ArrayFiller<TElement>
9     {
10         protected readonly TElement[] _array;
11         protected long _position;
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public ArrayFiller(TElement[] array, long offset)
15         {
16             _array = array;
17             _position = offset;
18         }
19
20         [MethodImpl(MethodImplOptions.AggressiveInlining)]
21         public ArrayFiller(TElement[] array) : this(array, 0) { }
22
23         [MethodImpl(MethodImplOptions.AggressiveInlining)]
24         public void Add(TElement element) => _array[_position++] = element;
25
26         [MethodImpl(MethodImplOptions.AggressiveInlining)]
27         public bool AddAndReturnTrue(TElement element) => _array.AddAndReturnConstant(ref
28             ↪ _position, element, true);
29
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         public bool AddFirstAndReturnTrue(ICollection<TElement> elements) =>
32             ↪ _array.AddFirstAndReturnConstant(ref _position, elements, true);
33
34         [MethodImpl(MethodImplOptions.AggressiveInlining)]
35         public bool AddAllAndReturnTrue(ICollection<TElement> elements) =>
36             ↪ _array.AddAllAndReturnConstant(ref _position, elements, true);
37
38         [MethodImpl(MethodImplOptions.AggressiveInlining)]
39         public bool AddSkipFirstAndReturnTrue(ICollection<TElement> elements) =>
40             ↪ _array.AddSkipFirstAndReturnConstant(ref _position, elements, true);
41     }
42 }
```

```

36         public bool AddSkipFirstAndReturnTrue(IList<TElement> elements) =>
           ↪ _array.AddSkipFirstAndReturnConstant(ref _position, elements, true);
37     }
38 }

```

1.3 ./csharp/Platform.Collections/Arrays/ArrayPool.cs

```

1  using System.Runtime.CompilerServices;
2
3  namespace Platform.Collections.Arrays
4  {
5      public static class ArrayPool
6      {
7          public static readonly int DefaultSizesAmount = 512;
8          public static readonly int DefaultMaxArraysPerSize = 32;
9
10         /// <summary>
11         /// <para>Allocation of an array of a specified size from the array pool.</para>
12         /// <para>Выделение массива указанного размера из пула массивов.</para>
13         /// </summary>
14         /// <typeparam name="T"><para>The array elements type.</para><para>Тип элементов
           ↪ массива.</para></typeparam>
15         /// <param name="size"><para>The allocated array size.</para><para>Размер выделяемого
           ↪ массива.</para></param>
16         /// <returns>
17         /// <para>The array from a pool of arrays.</para>
18         /// <para>Массив из пула массивов.</para>
19         /// </returns>
20         [MethodImpl(MethodImplOptions.AggressiveInlining)]
21         public static T[] Allocate<T>(long size) => ArrayPool<T>.ThreadInstance.Allocate(size);
22
23         /// <summary>
24         /// <para>Freeing an array into an array pool.</para>
25         /// <para>Освобождение массива в пул массивов.</para>
26         /// </summary>
27         /// <typeparam name="T"><para>The array elements type.</para><para>Тип элементов
           ↪ массива.</para></typeparam>
28         /// <param name="array"><para>The array to be freed into the pull.</para><para>Массив
           ↪ который нужно освободить в пул.</para></param>
29         [MethodImpl(MethodImplOptions.AggressiveInlining)]
30         public static void Free<T>(T[] array) => ArrayPool<T>.ThreadInstance.Free(array);
31     }
32 }

```

1.4 ./csharp/Platform.Collections/Arrays/ArrayPool[T].cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Disposables;
5  using Platform.Collections.Stacks;
6
7  namespace Platform.Collections.Arrays
8  {
9      /// <summary>
10      /// <para>Represents a set of arrays ready for reuse.</para>
11      /// <para>Представляет собой набор массивов готовых к повторному использованию.</para>
12      /// </summary>
13      /// <typeparam name="T"><para>The array elements type.</para><para>Тип элементов
           ↪ массива.</para></typeparam>
14      /// <remarks>
15      /// Original idea from
           ↪ http://geekswithblogs.net/blackrob/archive/2014/12/18/array-pooling-in-csharp.aspx
16      /// </remarks>
17      public class ArrayPool<T>
18      {
19          // May be use Default class for that later.
20          [ThreadStatic]
21          private static ArrayPool<T> _threadInstance;
22          internal static ArrayPool<T> ThreadInstance => _threadInstance ?? (_threadInstance = new
           ↪ ArrayPool<T>());
23
24          private readonly int _maxArraysPerSize;
25          private readonly Dictionary<long, Stack<T[]>> _pool = new Dictionary<long,
           ↪ Stack<T[]>>(ArrayPool.DefaultSizesAmount);
26
27          /// <summary>
28          /// <para>Initializes a new instance of the ArrayPool class using the specified maximum
           ↪ number of arrays per size.</para>
29          /// <para>Инициализирует новый экземпляр класса ArrayPool, используя указанное
           ↪ максимальное количество массивов на каждый размер.</para>

```

```

30     /// </summary>
31     /// <param name="maxArraysPerSize"><para>The maximum number of arrays in the pool per
    → size.</para><para>Максимальное количество массивов в пуле на каждый
    → размер.</para></param>
32     [MethodImpl(MethodImplOptions.AggressiveInlining)]
33     public ArrayPool<T>(int maxArraysPerSize) => _maxArraysPerSize = maxArraysPerSize;
34
35     /// <summary>
36     /// <para>Initializes a new instance of the ArrayPool class using the default maximum
    → number of arrays per size.</para>
37     /// <para>Инициализирует новый экземпляр класса ArrayPool, используя максимальное
    → количество массивов на каждый размер по умолчанию.</para>
38     /// </summary>
39     [MethodImpl(MethodImplOptions.AggressiveInlining)]
40     public ArrayPool() : this(ArrayPool.DefaultMaxArraysPerSize) { }
41
42     /// <summary>
43     /// <para>Retrieves an array from the pool, which will automatically return to the pool
    → when the container is disposed.</para>
44     /// <para>Извлекает из пула массив, который автоматически вернётся в пул при
    → высвобождении контейнера.</para>
45     /// </summary>
46     /// <param name="size"><para>The allocated array size.</para><para>Размер выделяемого
    → массива.</para></param>
47     /// <returns>
48     /// <para>The disposable container containing either a new array or an array from the
    → pool.</para>
49     /// <para>Высвобождаемый контейнер содержащий либо новый массив, либо массив из
    → пула.</para>
50     /// </returns>
51     [MethodImpl(MethodImplOptions.AggressiveInlining)]
52     public Disposable<T[]> AllocateDisposable(long size) => (Allocate(size), Free);
53
54     /// <summary>
55     /// <para>Replaces the array with another array from the pool with the specified
    → size.</para>
56     /// <para>Заменяет массив на другой массив из пула с указанным размером.</para>
57     /// </summary>
58     /// <param name="source"><para>The source array.</para><para>Исходный
    → массив.</para></param>
59     /// <param name="size"><para>A new array size.</para><para>Новый размер
    → массива.</para></param>
60     /// <returns>
61     /// <para>An array with a new size.</para>
62     /// <para>Массив с новым размером.</para>
63     /// </returns>
64     [MethodImpl(MethodImplOptions.AggressiveInlining)]
65     public Disposable<T[]> Resize(Disposable<T[]> source, long size)
66     {
67         var destination = AllocateDisposable(size);
68         T[] sourceArray = source;
69         if (!sourceArray.IsNullOrEmpty())
70         {
71             T[] destinationArray = destination;
72             Array.Copy(sourceArray, destinationArray, size < sourceArray.LongLength ? size :
    → sourceArray.LongLength);
73             source.Dispose();
74         }
75         return destination;
76     }
77
78     /// <summary>
79     /// <para>Clears the pool.</para>
80     /// <para>Очищает пул.</para>
81     /// </summary>
82     [MethodImpl(MethodImplOptions.AggressiveInlining)]
83     public virtual void Clear() => _pool.Clear();
84
85     /// <summary>
86     /// <para>Retrieves an array with the specified size from the pool.</para>
87     /// <para>Извлекает из пула массив с указанным размером.</para>
88     /// </summary>
89     /// <param name="size"><para>The allocated array size.</para><para>Размер выделяемого
    → массива.</para></param>
90     /// <returns>
91     /// <para>An array from the pool or a new array.</para>
92     /// <para>Массив из пула или новый массив.</para>

```

```

93     /// </returns>
94     [MethodImpl(MethodImplOptions.AggressiveInlining)]
95     public virtual T[] Allocate(long size) => size <= 0L ? Array.Empty<T>() :
        ↳ _pool.GetOrDefault(size)?.PopOrDefault() ?? new T[size];
96
97     /// <summary>
98     /// <para>Frees the array to the pool for later reuse.</para>
99     /// <para>Освобождает массив в пул для последующего повторного использования.</para>
100    /// </summary>
101    /// <param name="array"><para>The array to be freed into the pool.</para><para>Массив
        ↳ который нужно освободить в пул.</para></param>
102    [MethodImpl(MethodImplOptions.AggressiveInlining)]
103    public virtual void Free(T[] array)
104    {
105        if (array.IsNullOrEmpty())
106        {
107            return;
108        }
109        var stack = _pool.GetOrAdd(array.LongLength, size => new
            ↳ Stack<T[]>(_maxArraysPerSize));
110        if (stack.Count == _maxArraysPerSize) // Stack is full
111        {
112            return;
113        }
114        stack.Push(array);
115    }
116 }
117 }

```

1.5 ./csharp/Platform.Collections/Arrays/ArrayString.cs

```

1  using System.Runtime.CompilerServices;
2  using Platform.Collections.Segments;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Arrays
7  {
8      public class ArrayString<T> : Segment<T>
9      {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         public ArrayString(int length) : base(new T[length], 0, length) { }
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public ArrayString(T[] array) : base(array, 0, array.Length) { }
15
16         [MethodImpl(MethodImplOptions.AggressiveInlining)]
17         public ArrayString(T[] array, int length) : base(array, 0, length) { }
18     }
19 }

```

1.6 ./csharp/Platform.Collections/Arrays/CharArrayExtensions.cs

```

1  using System.Runtime.CompilerServices;
2
3  namespace Platform.Collections.Arrays
4  {
5      public static unsafe class CharArrayExtensions
6      {
7          /// <summary>
8          /// <para>Generates a hash code for an array segment with the specified offset and
            ↳ length. The hash code is generated based on the values of the array elements
            ↳ included in the specified segment.</para>
9          /// <para>Генерирует хэш-код сегмента массива с указанным смещением и длиной. Хэш-код
            ↳ генерируется на основе значений элементов массива входящих в указанный
            ↳ сегмент.</para>
10         /// </summary>
11         /// <param name="array"><para>The array to hash.</para><para>Массив для
            ↳ хеширования.</para></param>
12         /// <param name="offset"><para>The offset from which reading of the specified number of
            ↳ elements in the array starts.</para><para>Смещение, с которого начинается чтение
            ↳ указанного количества элементов в массиве.</para></param>
13         /// <param name="length"><para>The number of array elements used to calculate the
            ↳ hash.</para><para>Количество элементов массива, на основе которых будет вычислен
            ↳ хэш.</para></param>
14         /// <returns>
15         /// <para>The hash code of the segment in the array.</para>
16         /// <para>Хэш-код сегмента в массиве.</para>
17         /// </returns>
18         /// <remarks>

```

```

19  /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783
20  ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L833
21  /// </remarks>
22  [MethodImpl(MethodImplOptions.AggressiveInlining)]
23  public static int GenerateHashCode(this char[] array, int offset, int length)
24  {
25      var hashSeed = 5381;
26      var hashAccumulator = hashSeed;
27      fixed (char* arrayPointer = &array[offset])
28      {
29          for (char* charPointer = arrayPointer, last = charPointer + length; charPointer
30              ↪ < last; charPointer++)
31          {
32              hashAccumulator = (hashAccumulator << 5) + hashAccumulator ^ *charPointer;
33          }
34      }
35      return hashAccumulator + (hashSeed * 1566083941);
36  }
37  /// <summary>
38  /// <para>Checks if all elements of two lists are equal.</para>
39  /// <para>Проверяет равны ли все элементы двух списков.</para>
40  /// </summary>
41  /// <param name="left"><para>The first compared array.</para><para>Первый массив для
42  ↪ сравнения.</para></param>
43  /// <param name="leftOffset"><para>The offset from which reading of the specified number
44  ↪ of elements in the first array starts.</para><para>Смещение, с которого начинается
45  ↪ чтение элементов в первом массиве.</para></param>
46  /// <param name="length"><para>The number of checked elements.</para><para>Количество
47  ↪ проверяемых элементов.</para></param>
48  /// <param name="right"><para>The second compared array.</para><para>Второй массив для
49  ↪ сравнения.</para></param>
50  /// <param name="rightOffset"><para>The offset from which reading of the specified
51  ↪ number of elements in the second array starts.</para><para>Смещение, с которого
52  ↪ начинается чтение элементов в втором массиве.</para></param>
53  /// <returns>
54  /// <para>True if the segments of the passed arrays are equal to each other otherwise
55  ↪ false.</para>
56  /// <para>True, если сегменты переданных массивов равны друг другу, иначе же
57  ↪ false.</para>
58  /// </returns>
59  /// <remarks>
60  /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783
61  ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L364
62  /// </remarks>
63  [MethodImpl(MethodImplOptions.AggressiveInlining)]
64  public static bool ContentEqualTo(this char[] left, int leftOffset, int length, char[]
65  ↪ right, int rightOffset)
66  {
67      fixed (char* leftPointer = &left[leftOffset])
68      {
69          fixed (char* rightPointer = &right[rightOffset])
70          {
71              char* leftPointerCopy = leftPointer, rightPointerCopy = rightPointer;
72              if (!CheckArraysMainPartForEquality(ref leftPointerCopy, ref
73              ↪ rightPointerCopy, ref length))
74              {
75                  return false;
76              }
77              CheckArraysRemainderForEquality(ref leftPointerCopy, ref rightPointerCopy,
78              ↪ ref length);
79              return length <= 0;
80          }
81      }
82  }
83  [MethodImpl(MethodImplOptions.AggressiveInlining)]
84  private static bool CheckArraysMainPartForEquality(ref char* left, ref char* right, ref
85  ↪ int length)
86  {
87      while (length >= 10)
88      {
89          if ((* (int*)left != *(int*)right)
90              || (*(int*)(left + 2) != *(int*)(right + 2))
91              || (*(int*)(left + 4) != *(int*)(right + 4))
92              || (*(int*)(left + 6) != *(int*)(right + 6))
93              || (*(int*)(left + 8) != *(int*)(right + 8)))

```

```

80         {
81             return false;
82         }
83         left += 10;
84         right += 10;
85         length -= 10;
86     }
87     return true;
88 }
89
90 [MethodImpl(MethodImplOptions.AggressiveInlining)]
91 private static void CheckArraysRemainderForEquality(ref char* left, ref char* right, ref
    → int length)
92 {
93     // This depends on the fact that the String objects are
94     // always zero terminated and that the terminating zero is not included
95     // in the length. For odd string sizes, the last compare will include
96     // the zero terminator.
97     while (length > 0)
98     {
99         if (*(int*)left != *(int*)right)
100         {
101             break;
102         }
103         left += 2;
104         right += 2;
105         length -= 2;
106     }
107 }
108 }
109 }

```

1.7 ./csharp/Platform.Collections/Arrays/GenericArrayExtensions.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4
5  namespace Platform.Collections.Arrays
6  {
7      public static class GenericArrayExtensions
8      {
9          /// <summary>
10         /// <para>Checks if an array exists, if so, checks the array length using the index
            → variable type int, and if the array length is greater than the index - return
            → array[index], otherwise - default value.</para>
11         /// <para>Проверяет, существует ли массив, если да - идет проверка длины массива с
            → помощью переменной index, и если длина массива больше индекса - возвращает
            → array[index], иначе - значение по умолчанию.</para>
12         /// </summary>
13         /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
            → массива.</para></typeparam>
14         /// <param name="array"><para>Array that will participate in
            → verification.</para><para>Массив который будет участвовать в
            → проверке.</para></param>
15         /// <param name="index"><para>Number type int to compare.</para><para>Число типа int для
            → сравнения.</para></param>
16         /// <returns><para>Array element or default value.</para><para>Элемент массива или же
            → значение по умолчанию.</para></returns>
17         [MethodImpl(MethodImplOptions.AggressiveInlining)]
18         public static T GetElementOrDefault<T>(this T[] array, int index) => array != null &&
            → array.Length > index ? array[index] : default;
19
20         /// <summary>
21         /// <para>Checks whether the array exists, if so, checks the array length using the
            → index variable type long, and if the array length is greater than the index - return
            → array[index], otherwise - default value.</para>
22         /// <para>Проверяет, существует ли массив, если да - идет проверка длины массива с
            → помощью переменной index, и если длина массива больше индекса - возвращает
            → array[index], иначе - значение по умолчанию.</para>
23         /// </summary>
24         /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
            → массива.</para></typeparam>
25         /// <param name="array"><para>Array that will participate in
            → verification.</para><para>Массив который будет участвовать в
            → проверке.</para></param>
26         /// <param name="index"><para>Number type long to compare.</para><para>Число типа long
            → для сравнения.</para></param>

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```

27  /// <returns><para>Array element or default value.</para><para>Элемент массива или же
    ↳ значение по умолчанию.</para></returns>
28  [MethodImpl(MethodImplOptions.AggressiveInlining)]
29  public static T GetElementOrDefault<T>(this T[] array, long index) => array != null &&
    ↳ array.LongLength > index ? array[index] : default;
30
31  /// <summary>
32  /// <para>Checks whether the array exist, if so, checks the array length using the index
    ↳ variable type int, and if the array length is greater than the index, set the element
    ↳ variable to array[index] and return true.</para>
33  /// <para>Проверяет, существует ли массив, если да, то идет проверка длины массива с
    ↳ помощью переменной index типа int, и если длина массива больше значения index,
    ↳ устанавливает значение переменной element - array[index] и возвращает true.</para>
34  /// </summary>
35  /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
    ↳ массива.</para></typeparam>
36  /// <param name="array"><para>Array that will participate in
    ↳ verification.</para><para>Массив который будет участвовать в
    ↳ проверке.</para></param>
37  /// <param name="index"><para>Number type int to compare.</para><para>Число типа int для
    ↳ сравнения.</para></param>
38  /// <param name="element"><para>Passing the argument by reference, if successful, it
    ↳ will take the value array[index] otherwise default value.</para><para>Передает
    ↳ аргумент по ссылке, в случае успеха он примет значение array[index] в противном
    ↳ случае значение по умолчанию.</para></param>
39  /// <returns><para>True if successful otherwise false.</para><para>True в случае успеха,
    ↳ в противном случае false</para></returns>
40  [MethodImpl(MethodImplOptions.AggressiveInlining)]
41  public static bool TryGetElement<T>(this T[] array, int index, out T element)
42  {
43      if (array != null && array.Length > index)
44      {
45          element = array[index];
46          return true;
47      }
48      else
49      {
50          element = default;
51          return false;
52      }
53  }
54
55  /// <summary>
56  /// <para>Checks whether the array exist, if so, checks the array length using the
    ↳ index variable type long, and if the array length is greater than the index, set the
    ↳ element variable to array[index] and return true.</para>
57  /// <para>Проверяет, существует ли массив, если да, то идет проверка длины массива с
    ↳ помощью переменной index типа long, и если длина массива больше значения index,
    ↳ устанавливает значение переменной element - array[index] и возвращает true.</para>
58  /// </summary>
59  /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
    ↳ массива.</para></typeparam>
60  /// <param name="array"><para>Array that will participate in
    ↳ verification.</para><para>Массив который будет участвовать в
    ↳ проверке.</para></param>
61  /// <param name="index"><para>Number type long to compare.</para><para>Число типа long
    ↳ для сравнения.</para></param>
62  /// <param name="element"><para>Passing the argument by reference, if successful, it
    ↳ will take the value array[index] otherwise default value.</para><para>Передает
    ↳ аргумент по ссылке, в случае успеха он примет значение array[index] в противном
    ↳ случае значение по умолчанию.</para></param>
63  /// <returns><para>True if successful otherwise false.</para><para>True в случае успеха,
    ↳ в противном случае false</para></returns>
64  [MethodImpl(MethodImplOptions.AggressiveInlining)]
65  public static bool TryGetElement<T>(this T[] array, long index, out T element)
66  {
67      if (array != null && array.LongLength > index)
68      {
69          element = array[index];
70          return true;
71      }
72      else
73      {
74          element = default;
75          return false;
76      }
77  }

```

```

78     /// <summary>
79     /// <para>Copying of elements from one array to another array.</para>
80     /// <para>Копирует элементы из одного массива в другой массив.</para>
81     /// </summary>
82     /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
83     → массива.</para></typeparam>
84     /// <param name="array"><para>The array to copy.</para><para>Массив который необходимо
85     → скопировать.</para></param>
86     /// <returns><para>Copy of the array.</para><para>Копию массива.</para></returns>
87     [MethodImpl(MethodImplOptions.AggressiveInlining)]
88     public static T[] Clone<T>(this T[] array)
89     {
90         var copy = new T[array.LongLength];
91         Array.Copy(array, 0L, copy, 0L, array.LongLength);
92         return copy;
93     }
94     /// <summary>
95     /// <para>Shifts all the elements of the array by one position to the right.</para>
96     /// <para>Сдвигает вправо все элементы массива на одну позицию.</para>
97     /// </summary>
98     /// <typeparam name="T"><para>The array item type.</para><para>Тип элементов
99     → массива.</para></typeparam>
100    /// <param name="array"><para>The array to copy from.</para><para>Массив для
101    → копирования.</para></param>
102    /// <returns>
103    /// <para>Array with a shift of elements by one position.</para>
104    /// <para>Массив со сдвигом элементов на одну позицию.</para>
105    /// </returns>
106    [MethodImpl(MethodImplOptions.AggressiveInlining)]
107    public static IList<T> ShiftRight<T>(this T[] array) => array.ShiftRight(1L);
108    /// <summary>
109    /// <para>Shifts all elements of the array to the right by the specified number of
110    → elements.</para>
111    /// <para>Сдвигает вправо все элементы массива на указанное количество элементов.</para>
112    /// </summary>
113    /// <typeparam name="T"><para>The array item type.</para><para>Тип элементов
114    → массива.</para></typeparam>
115    /// <param name="array"><para>The array to copy from.</para><para>Массив для
116    → копирования.</para></param>
117    /// <param name="skip"><para>The number of items to shift.</para><para>Количество
118    → сдвигаемых элементов.</para></param>
119    /// <returns>
120    /// <para>If the value of the shift variable is less than zero - an <see
121    → cref="NotImplementedException"/> exception is thrown, but if the value of the shift
122    → variable is 0 - an exact copy of the array is returned. Otherwise, an array is
123    → returned with the shift of the elements.</para>
124    /// <para>Если значение переменной shift меньше нуля - выбрасывается исключение <see
125    → cref="NotImplementedException"/>, если же значение переменной shift равно 0 -
126    → возвращается точная копия массива. Иначе возвращается массив со сдвигом
127    → элементов.</para>
128    /// </returns>
129    [MethodImpl(MethodImplOptions.AggressiveInlining)]
130    public static IList<T> ShiftRight<T>(this T[] array, long shift)
131    {
132        if (shift < 0)
133        {
134            throw new NotImplementedException();
135        }
136        if (shift == 0)
137        {
138            return array.Clone<T>();
139        }
140        else
141        {
142            var restrictions = new T[array.LongLength + shift];
143            Array.Copy(array, 0L, restrictions, shift, array.LongLength);
144            return restrictions;
145        }
146    }
147    /// <summary>
148    /// <para>Adding in array the passed element at the specified position and increments
149    → position value by one.</para>

```



```

139 /// <para>Добавляет в массив переданный элемент на указанную позицию и увеличивает
140     ↳ значение position на единицу.</para>
141 /// </summary>
142 /// <typeparam name="T"><para>Array elements type.</para>Тип элементов
143     ↳ массива.</para></typeparam>
144 /// <param name="array"><para>The array to add the element to.</para><para>Массив в
145     ↳ который необходимо добавить элемент.</para></param>
146 /// <param name="position"><para>A reference to the position of type int where the
147     ↳ element will be added.</para><para>Ссылка на позицию типа int, в которую будет
148     ↳ добавлен элемент.</para></param>
149 /// <param name="element"><para>The element to add to the array.</para><para>Элемент,
150     ↳ который нужно добавить в массив.</para></param>
151 [MethodImpl(MethodImplOptions.AggressiveInlining)]
152 public static void Add<T>(this T[] array, ref int position, T element) =>
153     ↳ array[position++] = element;
154
155 /// <summary>
156 /// <para>Adding in array the passed element at the specified position and increments
157     ↳ position value by one.</para>
158 /// <para>Добавляет в массив переданный элемент на указанную позицию и увеличивает
159     ↳ значение position на единицу.</para>
160 /// </summary>
161 /// <typeparam name="T"><para>Array elements type.</para>Тип элементов
162     ↳ массива.</para></typeparam>
163 /// <param name="array"><para>The array to add the element to.</para><para>Массив в
164     ↳ который необходимо добавить элемент.</para></param>
165 /// <param name="position"><para>A reference to the position of type long where the
166     ↳ element will be added.</para><para>Ссылка на позицию типа long, в которую будет
167     ↳ добавлен элемент.</para></param>
168 /// <param name="element"><para>The element to add to the array</para><para>Элемент
169     ↳ который необходимо добавить в массив.</para></param>
170 [MethodImpl(MethodImplOptions.AggressiveInlining)]
171 public static void Add<T>(this T[] array, ref long position, T element) =>
172     ↳ array[position++] = element;
173
174 /// <summary>
175 /// <para>Adding in array the passed element, at the specified position, increments
176     ↳ position value by one and returns the value of the passed constant.</para>
177 /// <para>Добавляет в массив переданный элемент на указанную позицию, увеличивает
178     ↳ значение position на единицу и возвращает значение переданной константы.</para>
179 /// </summary>
180 /// <typeparam name="TElement"><para>The array element type.</para><para>Тип элемента
181     ↳ массива.</para></typeparam>
182 /// <typeparam name="TReturnConstant"><para>Type of return constant.</para><para>Тип
183     ↳ возвращаемой константы.</para></typeparam>
184 /// <param name="array"><para>The array to add the element to.</para><para>Массив в
185     ↳ который необходимо добавить элемент.</para></param>
186 /// <param name="position"><para>Reference to the position to which the element will be
187     ↳ added.</para><para>Ссылка на позицию, в которую будет добавлен
188     ↳ элемент.</para></param>
189 /// <param name="element"><para>The element to add to the array.</para><para>Элемент
190     ↳ который необходимо добавить в массив.</para></param>
191 /// <param name="returnConstant"><para>The constant value that will be
192     ↳ returned.</para><para>Значение константы, которое будет возвращено.</para></param>
193 /// <returns>
194     ↳ <para>The constant value passed as an argument.</para>
195     ↳ <para>Значение константы, переданное в качестве аргумента.</para>
196 /// </returns>
197 [MethodImpl(MethodImplOptions.AggressiveInlining)]
198 public static TReturnConstant AddAndReturnConstant<TElement, TReturnConstant>(this
199     ↳ TElement[] array, ref long position, TElement element, TReturnConstant
200     ↳ returnConstant)
201 {
202     array.Add(ref position, element);
203     return returnConstant;
204 }
205
206 /// <summary>
207 /// <para>Adds the first element from the passed collection to the array, at the
208     ↳ specified position and increments position value by one.</para>
209 /// <para>Добавляет в массив первый элемент из переданной коллекции, на указанную
210     ↳ позицию и увеличивает значение position на единицу.</para>
211 /// </summary>
212 /// <typeparam name="T"><para>Array element type.</para><para>Тип элементов
213     ↳ массива.</para></typeparam>

```

```

185 /// <param name="array"><para>The array to add the element to.</para><para>Массив в
186   → который необходимо добавить элемент.</para></param>
187 /// <param name="position"><para>Reference to the position to which the element will be
188   → added.</para><para>Ссылка на позицию, в которую будет добавлен
189   → элемент.</para></param>
190 /// <param name="elements"><para>List, the first element of which will be added to the
191   → array.</para><para>Список, первый элемент которого будет добавлен в
192   → массив.</para></param>
193 [MethodImpl(MethodImplOptions.AggressiveInlining)]
194 public static void AddFirst<T>(this T[] array, ref long position, IList<T> elements) =>
195   → array[position++] = elements[0];
196
197 /// <summary>
198 /// <para>Adds the first element from the passed collection to the array, at the
199   → specified position, increments position value by one and returns the value of the
200   → passed constant.</para>
201 /// <para>Добавляет в массив первый элемент из переданной коллекции, на указанную
202   → позицию, увеличивает значение position на единицу и возвращает значение переданной
203   → константы.</para>
204 /// </summary>
205 /// <typeparam name="TElement"><para>The array element type.</para><para>Тип элемента
206   → массива.</para></typeparam>
207 /// <typeparam name="TReturnConstant"><para>Type of return constant.</para><para>Тип
208   → возвращаемой константы.</para></typeparam>
209 /// <param name="array"><para>The array to add the element to.</para><para>Массив в
210   → который необходимо добавить элемент.</para></param>
211 /// <param name="position"><para>Reference to the position to which the element will be
212   → added.</para><para>Ссылка на позицию, в которую будет добавлен
213   → элемент.</para></param>
214 /// <param name="elements"><para>List, the first element of which will be added to the
215   → array.</para><para>Список, первый элемент которого будет добавлен в
216   → массив.</para></param>
217 /// <param name="returnConstant"><para>The constant value that will be
218   → returned.</para><para>Значение константы, которое будет возвращено.</para></param>
219 /// <returns>
220 /// <para>The constant value passed as an argument.</para>
221 /// <para>Значение константы, переданное в качестве аргумента.</para>
222 /// </returns>
223 [MethodImpl(MethodImplOptions.AggressiveInlining)]
224 public static TReturnConstant AddFirstAndReturnConstant<TElement, TReturnConstant>(this
225   → TElement[] array, ref long position, IList<TElement> elements, TReturnConstant
226   → returnConstant)
227 {
228     array.AddFirst(ref position, elements);
229     return returnConstant;
230 }
231
232 /// <summary>
233 /// <para>Adding in array all elements from the passed collection, at the specified
234   → position, increases the position value by the number of elements added and returns
235   → the value of the passed constant.</para>
236 /// <para>Добавляет в массив все элементы из переданной коллекции, на указанную позицию,
237   → увеличивает значение position на количество добавленных элементов и возвращает
238   → значение переданной константы.</para>
239 /// </summary>
240 /// <typeparam name="TElement"><para>The array element type.</para><para>Тип элемента
241   → массива.</para></typeparam>
242 /// <typeparam name="TReturnConstant"><para>Type of return constant.</para><para>Тип
243   → возвращаемой константы.</para></typeparam>
244 /// <param name="array"><para>The array to add the element to.</para><para>Массив в
245   → который необходимо добавить элементы.</para></param>
246 /// <param name="position"><para>Reference to the position from which elements will be
247   → added to the array.</para><para>Ссылка на позицию, начиная с которой будут
248   → добавляться элементы в массив.</para></param>
249 /// <param name="elements"><para>List, whose elements will be added to the
250   → array.</para><para>Список, элементы которого будут добавлены в
251   → массив.</para></param>
252 /// <param name="returnConstant"><para>The constant value that will be
253   → returned.</para><para>Значение константы, которое будет возвращено.</para></param>
254 /// <returns>
255 /// <para>The constant value passed as an argument.</para>
256 /// <para>Значение константы, переданное в качестве аргумента.</para>
257 /// </returns>
258 [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

227 public static TReturnConstant AddAllAndReturnConstant<TElement, TReturnConstant>(this
    ↳ TElement[] array, ref long position, IList<TElement> elements, TReturnConstant
    ↳ returnConstant)
228 {
229     array.AddAll(ref position, elements);
230     return returnConstant;
231 }
232
233 /// <summary>
234 /// <para>Adding in array a collection of elements, starting from a specific position
    ↳ and increases the position value by the number of elements added.</para>
235 /// <para>Добавляет в массив все элементы коллекции, начиная с определенной позиции и
    ↳ увеличивает значение position на количество добавленных элементов.</para>
236 /// </summary>
237 /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
    ↳ массива.</para></typeparam>
238 /// <param name="array"><para>The array to add the element to.</para><para>Массив в
    ↳ который необходимо добавить элементы.</para></param>
239 /// <param name="position"><para>Reference to the position from which elements will be
    ↳ added to the array.</para><para>Ссылка на позицию, начиная с которой будут
    ↳ добавляться элементы в массив.</para></param>
240 /// <param name="elements"><para>List, whose elements will be added to the
    ↳ array.</para><para>Список, элементы которого будут добавлены в
    ↳ массив.</para></param>
241 [MethodImpl(MethodImplOptions.AggressiveInlining)]
242 public static void AddAll<T>(this T[] array, ref long position, IList<T> elements)
243 {
244     for (var i = 0; i < elements.Count; i++)
245     {
246         array.Add(ref position, elements[i]);
247     }
248 }
249
250 /// <summary>
251 /// <para>Adding in array all elements of the collection, skipping the first position,
    ↳ increments position value by one and returns the value of the passed constant.</para>
252 /// <para>Добавляет в массив все элементы коллекции, пропуская первую позицию,
    ↳ увеличивает значение position на единицу и возвращает значение переданной
    ↳ константы.</para>
253 /// </summary>
254 /// <typeparam name="TElement"><para>The array element type.</para><para>Тип элемента
    ↳ массива.</para></typeparam>
255 /// <typeparam name="TReturnConstant"><para>Type of return constant.</para><para>Тип
    ↳ возвращаемой константы.</para></typeparam>
256 /// <param name="array"><para>The array to add items to.</para><para>Массив в который
    ↳ необходимо добавить элементы.</para></param>
257 /// <param name="position"><para>Reference to the position from which to start adding
    ↳ elements.</para><para>Ссылка на позицию, с которой начинается добавление
    ↳ элементов.</para></param>
258 /// <param name="elements"><para>List, whose elements will be added to the
    ↳ array.</para><para>Список, элементы которого будут добавлены в
    ↳ массив.</para></param>
259 /// <param name="returnConstant"><para>The constant value that will be
    ↳ returned.</para><para>Значение константы, которое будет возвращено.</para></param>
260 /// </returns>
261 /// <para>The constant value passed as an argument.</para>
262 /// <para>Значение константы, переданное в качестве аргумента.</para>
263 /// </returns>
264 [MethodImpl(MethodImplOptions.AggressiveInlining)]
265 public static TReturnConstant AddSkipFirstAndReturnConstant<TElement,
    ↳ TReturnConstant>(this TElement[] array, ref long position, IList<TElement> elements,
    ↳ TReturnConstant returnConstant)
266 {
267     array.AddSkipFirst(ref position, elements);
268     return returnConstant;
269 }
270
271 /// <summary>
272 /// <para>Adding in array all elements of the collection, skipping the first position
    ↳ and increments position value by one.</para>
273 /// <para>Добавляет в массив все элементы коллекции, пропуская первую позицию и
    ↳ увеличивает значение position на единицу.</para>
274 /// </summary>
275 /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
    ↳ массива.</para></typeparam>

```

```

276     /// <param name="array"><para>The array to add items to.</para><para>Массив в который
    ↪ необходимо добавить элементы.</para></param>
277     /// <param name="position"><para>Reference to the position from which to start adding
    ↪ elements.</para><para>Ссылка на позицию, с которой начинается добавление
    ↪ элементов.</para></param>
278     /// <param name="elements"><para>List, whose elements will be added to the
    ↪ array.</para><para>Список, элементы которого будут добавлены в
    ↪ массив.</para></param>
279     [MethodImpl(MethodImplOptions.AggressiveInlining)]
280     public static void AddSkipFirst<T>(this T[] array, ref long position, IList<T> elements)
    ↪ => array.AddSkipFirst(ref position, elements, 1);
281
282     /// <summary>
283     /// <para>Adding in array all but the first element, skipping a specified number of
    ↪ positions and increments position value by one.</para>
284     /// <para>Добавляет в массив все элементы коллекции, кроме первого, пропуская
    ↪ определенное количество позиций и увеличивает значение position на единицу.</para>
285     /// </summary>
286     /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
    ↪ массива.</para></typeparam>
287     /// <param name="array"><para>The array to add items to.</para><para>Массив в который
    ↪ необходимо добавить элементы.</para></param>
288     /// <param name="position"><para>Reference to the position from which to start adding
    ↪ elements.</para><para>Ссылка на позицию, с которой начинается добавление
    ↪ элементов.</para></param>
289     /// <param name="elements"><para>List, whose elements will be added to the
    ↪ array.</para><para>Список, элементы которого будут добавлены в
    ↪ массив.</para></param>
290     /// <param name="skip"><para>Number of elements to skip.</para><para>Количество
    ↪ пропускаемых элементов.</para></param>
291     [MethodImpl(MethodImplOptions.AggressiveInlining)]
292     public static void AddSkipFirst<T>(this T[] array, ref long position, IList<T> elements,
    ↪ int skip)
293     {
294         for (var i = skip; i < elements.Count; i++)
295         {
296             array.Add(ref position, elements[i]);
297         }
298     }
299 }
300 }

```

1.8 ./csharp/Platform.Collections/BitString.cs

```

1  using System;
2  using System.Collections.Concurrent;
3  using System.Collections.Generic;
4  using System.Numerics;
5  using System.Runtime.CompilerServices;
6  using System.Threading.Tasks;
7  using Platform.Exceptions;
8  using Platform.Ranges;
9
10 // ReSharper disable ForCanBeConvertedToForeach
11 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
12
13 namespace Platform.Collections
14 {
15     /// <remarks>
16     /// А что если хранить карту значений, где каждый бит будет означать присутствует ли блок в
    ↪ 64 бит в массиве значений.
17     /// 64 бита по 0 бит, будут означать отсутствие 64-х блоков по 64 бита. Т.е. упаковка 512
    ↪ байт в 8 байт.
18     /// Подобный принцип можно применять и к 64-ём блокам и т.п. По сути это карта значений. С
    ↪ помощью которой можно быстро
19     /// проверять есть ли значения непосредственно далее (ниже по уровню).
20     /// Или как таблица виртуальной памяти где номер блока означает его присутствие и адрес.
21     /// </remarks>
22     public class BitString : IEquatable<BitString>
23     {
24         private static readonly byte[] [] _bitsSetIn16Bits;
25         private long[] _array;
26         private long _length;
27         private long _minPositiveWord;
28         private long _maxPositiveWord;
29
30         public bool this[long index]
31         {
32             [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

33     get => Get(index);
34     [MethodImpl(MethodImplOptions.AggressiveInlining)]
35     set => Set(index, value);
36 }
37
38 public long Length
39 {
40     [MethodImpl(MethodImplOptions.AggressiveInlining)]
41     get => _length;
42     [MethodImpl(MethodImplOptions.AggressiveInlining)]
43     set
44     {
45         if (_length == value)
46         {
47             return;
48         }
49         Ensure.Always.ArgumentInRange(value, GetValidLengthRange(), nameof(Length));
50         // Currently we never shrink the array
51         if (value > _length)
52         {
53             var words = GetWordsCountFromIndex(value);
54             var oldWords = GetWordsCountFromIndex(_length);
55             if (words > _array.LongLength)
56             {
57                 var copy = new long[words];
58                 Array.Copy(_array, copy, _array.LongLength);
59                 _array = copy;
60             }
61             else
62             {
63                 // What is going on here?
64                 Array.Clear(_array, (int)oldWords, (int)(words - oldWords));
65             }
66             // What is going on here?
67             var mask = (int)(_length % 64);
68             if (mask > 0)
69             {
70                 _array[oldWords - 1] &= (1L << mask) - 1;
71             }
72         }
73         else
74         {
75             // Looks like minimum and maximum positive words are not updated
76             throw new NotImplementedException();
77         }
78         _length = value;
79     }
80 }
81
82 #region Constructors
83
84 [MethodImpl(MethodImplOptions.AggressiveInlining)]
85 static BitString()
86 {
87     _bitsSetIn16Bits = new byte[65536][];
88     int i, c, k;
89     byte bitIndex;
90     for (i = 0; i < 65536; i++)
91     {
92         // Calculating size of array (number of positive bits)
93         for (c = 0, k = 1; k <= 65536; k <= 1)
94         {
95             if ((i & k) == k)
96             {
97                 c++;
98             }
99         }
100         var array = new byte[c];
101         // Adding positive bits indices into array
102         for (bitIndex = 0, c = 0, k = 1; k <= 65536; k <= 1)
103         {
104             if ((i & k) == k)
105             {
106                 array[c++] = bitIndex;
107             }
108             bitIndex++;
109         }
110         _bitsSetIn16Bits[i] = array;
111     }

```

```

112     }
113
114     [MethodImpl(MethodImplOptions.AggressiveInlining)]
115     public BitString(BitString other)
116     {
117         Ensure.Always.ArgumentNotNull(other, nameof(other));
118         _length = other._length;
119         _array = new long[GetWordsCountFromIndex(_length)];
120         _minPositiveWord = other._minPositiveWord;
121         _maxPositiveWord = other._maxPositiveWord;
122         Array.Copy(other._array, _array, _array.LongLength);
123     }
124
125     [MethodImpl(MethodImplOptions.AggressiveInlining)]
126     public BitString(long length)
127     {
128         Ensure.Always.ArgumentInRange(length, GetValidLengthRange(), nameof(length));
129         _length = length;
130         _array = new long[GetWordsCountFromIndex(_length)];
131         MarkBordersAsAllBitsReset();
132     }
133
134     [MethodImpl(MethodImplOptions.AggressiveInlining)]
135     public BitString(long length, bool defaultValue)
136         : this(length)
137     {
138         if (defaultValue)
139         {
140             SetAll();
141         }
142     }
143
144     #endregion
145
146     [MethodImpl(MethodImplOptions.AggressiveInlining)]
147     public BitString Not()
148     {
149         for (var i = 0L; i < _array.LongLength; i++)
150         {
151             _array[i] = ~_array[i];
152             RefreshBordersByWord(i);
153         }
154         return this;
155     }
156
157     [MethodImpl(MethodImplOptions.AggressiveInlining)]
158     public BitString ParallelNot()
159     {
160         var threads = Environment.ProcessorCount / 2;
161         if (threads <= 1)
162         {
163             return Not();
164         }
165         var partitioner = Partitioner.Create(0L, _array.LongLength, _array.LongLength /
166             ↪ threads);
167         Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
168             ↪ MaxDegreeOfParallelism = threads }, range =>
169         {
170             var maximum = range.Item2;
171             for (var i = range.Item1; i < maximum; i++)
172             {
173                 _array[i] = ~_array[i];
174             }
175         });
176         MarkBordersAsAllBitsSet();
177         TryShrinkBorders();
178         return this;
179     }
180
181     [MethodImpl(MethodImplOptions.AggressiveInlining)]
182     public BitString VectorNot()
183     {
184         if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
185         {
186             return Not();
187         }
188         var step = Vector<long>.Count;
189         if (_array.Length < step)
190         {

```

```

189         return Not();
190     }
191     VectorNotLoop(_array, step, 0, _array.Length);
192     MarkBordersAsAllBitsSet();
193     TryShrinkBorders();
194     return this;
195 }
196
197 [MethodImpl(MethodImplOptions.AggressiveInlining)]
198 public BitString ParallelVectorNot()
199 {
200     var threads = Environment.ProcessorCount / 2;
201     if (threads <= 1)
202     {
203         return VectorNot();
204     }
205     if (!Vector.IsHardwareAccelerated)
206     {
207         return ParallelNot();
208     }
209     var step = Vector<long>.Count;
210     if (_array.Length < (step * threads))
211     {
212         return VectorNot();
213     }
214     var partitioner = Partitioner.Create(0, _array.Length, _array.Length / threads);
215     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
216         ↪ MaxDegreeOfParallelism = threads }, range => VectorNotLoop(_array, step,
217         ↪ range.Item1, range.Item2));
218     MarkBordersAsAllBitsSet();
219     TryShrinkBorders();
220     return this;
221 }
222
223 [MethodImpl(MethodImplOptions.AggressiveInlining)]
224 static private void VectorNotLoop(long[] array, int step, int start, int maximum)
225 {
226     var i = start;
227     var range = maximum - start - 1;
228     var stop = range - (range % step);
229     for (; i < stop; i += step)
230     {
231         (~new Vector<long>(array, i)).CopyTo(array, i);
232     }
233     for (; i < maximum; i++)
234     {
235         array[i] = ~array[i];
236     }
237 }
238
239 [MethodImpl(MethodImplOptions.AggressiveInlining)]
240 public BitString And(BitString other)
241 {
242     EnsureBitStringHasTheSameSize(other, nameof(other));
243     GetCommonOuterBorders(this, other, out long from, out long to);
244     var otherArray = other._array;
245     for (var i = from; i <= to; i++)
246     {
247         _array[i] &= otherArray[i];
248         RefreshBordersByWord(i);
249     }
250     return this;
251 }
252
253 [MethodImpl(MethodImplOptions.AggressiveInlining)]
254 public BitString ParallelAnd(BitString other)
255 {
256     var threads = Environment.ProcessorCount / 2;
257     if (threads <= 1)
258     {
259         return And(other);
260     }
261     EnsureBitStringHasTheSameSize(other, nameof(other));
262     GetCommonOuterBorders(this, other, out long from, out long to);
263     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
264     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
265         ↪ MaxDegreeOfParallelism = threads }, range =>

```

```

264         var maximum = range.Item2;
265         for (var i = range.Item1; i < maximum; i++)
266         {
267             _array[i] &= other._array[i];
268         }
269     });
270     MarkBordersAsAllBitsSet();
271     TryShrinkBorders();
272     return this;
273 }
274
275 [MethodImpl(MethodImplOptions.AggressiveInlining)]
276 public BitString VectorAnd(BitString other)
277 {
278     if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
279     {
280         return And(other);
281     }
282     var step = Vector<long>.Count;
283     if (_array.Length < step)
284     {
285         return And(other);
286     }
287     EnsureBitStringHasTheSameSize(other, nameof(other));
288     GetCommonOuterBorders(this, other, out int from, out int to);
289     VectorAndLoop(_array, other._array, step, from, to + 1);
290     MarkBordersAsAllBitsSet();
291     TryShrinkBorders();
292     return this;
293 }
294
295 [MethodImpl(MethodImplOptions.AggressiveInlining)]
296 public BitString ParallelVectorAnd(BitString other)
297 {
298     var threads = Environment.ProcessorCount / 2;
299     if (threads <= 1)
300     {
301         return VectorAnd(other);
302     }
303     if (!Vector.IsHardwareAccelerated)
304     {
305         return ParallelAnd(other);
306     }
307     var step = Vector<long>.Count;
308     if (_array.Length < (step * threads))
309     {
310         return VectorAnd(other);
311     }
312     EnsureBitStringHasTheSameSize(other, nameof(other));
313     GetCommonOuterBorders(this, other, out int from, out int to);
314     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
315     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
316         ↪ MaxDegreeOfParallelism = threads }, range => VectorAndLoop(_array, other._array,
317         ↪ step, range.Item1, range.Item2));
318     MarkBordersAsAllBitsSet();
319     TryShrinkBorders();
320     return this;
321 }
322
323 [MethodImpl(MethodImplOptions.AggressiveInlining)]
324 static private void VectorAndLoop(long[] array, long[] otherArray, int step, int start,
325 ↪ int maximum)
326 {
327     var i = start;
328     var range = maximum - start - 1;
329     var stop = range - (range % step);
330     for (; i < stop; i += step)
331     {
332         (new Vector<long>(array, i) & new Vector<long>(otherArray, i)).CopyTo(array, i);
333     }
334     for (; i < maximum; i++)
335     {
336         array[i] &= otherArray[i];
337     }
338 }
339
340 [MethodImpl(MethodImplOptions.AggressiveInlining)]
341 public BitString Or(BitString other)

```



```

339 {
340     EnsureBitStringHasTheSameSize(other, nameof(other));
341     GetCommonOuterBorders(this, other, out long from, out long to);
342     for (var i = from; i <= to; i++)
343     {
344         _array[i] |= other._array[i];
345         RefreshBordersByWord(i);
346     }
347     return this;
348 }
349
350 [MethodImpl(MethodImplOptions.AggressiveInlining)]
351 public BitString ParallelOr(BitString other)
352 {
353     var threads = Environment.ProcessorCount / 2;
354     if (threads <= 1)
355     {
356         return Or(other);
357     }
358     EnsureBitStringHasTheSameSize(other, nameof(other));
359     GetCommonOuterBorders(this, other, out long from, out long to);
360     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
361     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
362         ↪ MaxDegreeOfParallelism = threads }, range =>
363     {
364         var maximum = range.Item2;
365         for (var i = range.Item1; i < maximum; i++)
366         {
367             _array[i] |= other._array[i];
368         }
369     });
370     MarkBordersAsAllBitsSet();
371     TryShrinkBorders();
372     return this;
373 }
374
375 [MethodImpl(MethodImplOptions.AggressiveInlining)]
376 public BitString VectorOr(BitString other)
377 {
378     if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
379     {
380         return Or(other);
381     }
382     var step = Vector<long>.Count;
383     if (_array.Length < step)
384     {
385         return Or(other);
386     }
387     EnsureBitStringHasTheSameSize(other, nameof(other));
388     GetCommonOuterBorders(this, other, out int from, out int to);
389     VectorOrLoop(_array, other._array, step, from, to + 1);
390     MarkBordersAsAllBitsSet();
391     TryShrinkBorders();
392     return this;
393 }
394
395 [MethodImpl(MethodImplOptions.AggressiveInlining)]
396 public BitString ParallelVectorOr(BitString other)
397 {
398     var threads = Environment.ProcessorCount / 2;
399     if (threads <= 1)
400     {
401         return VectorOr(other);
402     }
403     if (!Vector.IsHardwareAccelerated)
404     {
405         return ParallelOr(other);
406     }
407     var step = Vector<long>.Count;
408     if (_array.Length < (step * threads))
409     {
410         return VectorOr(other);
411     }
412     EnsureBitStringHasTheSameSize(other, nameof(other));
413     GetCommonOuterBorders(this, other, out int from, out int to);
414     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);

```

```

414         Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
415             ↪ MaxDegreeOfParallelism = threads }, range => VectorOrLoop(_array, other._array,
416             ↪ step, range.Item1, range.Item2));
417         MarkBordersAsAllBitsSet();
418         TryShrinkBorders();
419         return this;
420     }
421     [MethodImpl(MethodImplOptions.AggressiveInlining)]
422     static private void VectorOrLoop(long[] array, long[] otherArray, int step, int start,
423     ↪ int maximum)
424     {
425         var i = start;
426         var range = maximum - start - 1;
427         var stop = range - (range % step);
428         for (; i < stop; i += step)
429         {
430             (new Vector<long>(array, i) | new Vector<long>(otherArray, i)).CopyTo(array, i);
431         }
432         for (; i < maximum; i++)
433         {
434             array[i] |= otherArray[i];
435         }
436     }
437     [MethodImpl(MethodImplOptions.AggressiveInlining)]
438     public BitString Xor(BitString other)
439     {
440         EnsureBitStringHasTheSameSize(other, nameof(other));
441         GetCommonOuterBorders(this, other, out long from, out long to);
442         for (var i = from; i <= to; i++)
443         {
444             _array[i] ^= other._array[i];
445             RefreshBordersByWord(i);
446         }
447         return this;
448     }
449     [MethodImpl(MethodImplOptions.AggressiveInlining)]
450     public BitString ParallelXor(BitString other)
451     {
452         var threads = Environment.ProcessorCount / 2;
453         if (threads <= 1)
454         {
455             return Xor(other);
456         }
457         EnsureBitStringHasTheSameSize(other, nameof(other));
458         GetCommonOuterBorders(this, other, out long from, out long to);
459         var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
460         Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
461             ↪ MaxDegreeOfParallelism = threads }, range =>
462         {
463             var maximum = range.Item2;
464             for (var i = range.Item1; i < maximum; i++)
465             {
466                 _array[i] ^= other._array[i];
467             }
468         });
469         MarkBordersAsAllBitsSet();
470         TryShrinkBorders();
471         return this;
472     }
473     [MethodImpl(MethodImplOptions.AggressiveInlining)]
474     public BitString VectorXor(BitString other)
475     {
476         if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
477         {
478             return Xor(other);
479         }
480         var step = Vector<long>.Count;
481         if (_array.Length < step)
482         {
483             return Xor(other);
484         }
485         EnsureBitStringHasTheSameSize(other, nameof(other));
486         GetCommonOuterBorders(this, other, out int from, out int to);
487         VectorXorLoop(_array, other._array, step, from, to + 1);

```

```

488     MarkBordersAsAllBitsSet();
489     TryShrinkBorders();
490     return this;
491 }
492
493 [MethodImpl(MethodImplOptions.AggressiveInlining)]
494 public BitString ParallelVectorXor(BitString other)
495 {
496     var threads = Environment.ProcessorCount / 2;
497     if (threads <= 1)
498     {
499         return VectorXor(other);
500     }
501     if (!Vector.IsHardwareAccelerated)
502     {
503         return ParallelXor(other);
504     }
505     var step = Vector<long>.Count;
506     if (_array.Length < (step * threads))
507     {
508         return VectorXor(other);
509     }
510     EnsureBitStringHasTheSameSize(other, nameof(other));
511     GetCommonOuterBorders(this, other, out int from, out int to);
512     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
513     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
514         ↪ MaxDegreeOfParallelism = threads }, range => VectorXorLoop(_array, other._array,
515         ↪ step, range.Item1, range.Item2));
516     MarkBordersAsAllBitsSet();
517     TryShrinkBorders();
518     return this;
519 }
520
521 [MethodImpl(MethodImplOptions.AggressiveInlining)]
522 static private void VectorXorLoop(long[] array, long[] otherArray, int step, int start,
523     ↪ int maximum)
524 {
525     var i = start;
526     var range = maximum - start - 1;
527     var stop = range - (range % step);
528     for (; i < stop; i += step)
529     {
530         (new Vector<long>(array, i) ^ new Vector<long>(otherArray, i)).CopyTo(array, i);
531     }
532     for (; i < maximum; i++)
533     {
534         array[i] ^= otherArray[i];
535     }
536 }
537
538 [MethodImpl(MethodImplOptions.AggressiveInlining)]
539 private void RefreshBordersByWord(long wordIndex)
540 {
541     if (_array[wordIndex] == 0)
542     {
543         if (wordIndex == _minPositiveWord && wordIndex != _array.LongLength - 1)
544         {
545             _minPositiveWord++;
546         }
547         if (wordIndex == _maxPositiveWord && wordIndex != 0)
548         {
549             _maxPositiveWord--;
550         }
551     }
552     else
553     {
554         if (wordIndex < _minPositiveWord)
555         {
556             _minPositiveWord = wordIndex;
557         }
558         if (wordIndex > _maxPositiveWord)
559         {
560             _maxPositiveWord = wordIndex;
561         }
562     }
563 }
564
565 [MethodImpl(MethodImplOptions.AggressiveInlining)]
566 public bool TryShrinkBorders()

```

```

564 {
565     GetBorders(out long from, out long to);
566     while (from <= to && _array[from] == 0)
567     {
568         from++;
569     }
570     if (from > to)
571     {
572         MarkBordersAsAllBitsReset();
573         return true;
574     }
575     while (to >= from && _array[to] == 0)
576     {
577         to--;
578     }
579     if (to < from)
580     {
581         MarkBordersAsAllBitsReset();
582         return true;
583     }
584     var bordersUpdated = from != _minPositiveWord || to != _maxPositiveWord;
585     if (bordersUpdated)
586     {
587         SetBorders(from, to);
588     }
589     return bordersUpdated;
590 }
591
592 [MethodImpl(MethodImplOptions.AggressiveInlining)]
593 public bool Get(long index)
594 {
595     Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
596     return (_array[GetWordIndexFromIndex(index)] & GetBitMaskFromIndex(index)) != 0;
597 }
598
599 [MethodImpl(MethodImplOptions.AggressiveInlining)]
600 public void Set(long index, bool value)
601 {
602     if (value)
603     {
604         Set(index);
605     }
606     else
607     {
608         Reset(index);
609     }
610 }
611
612 [MethodImpl(MethodImplOptions.AggressiveInlining)]
613 public void Set(long index)
614 {
615     Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
616     var wordIndex = GetWordIndexFromIndex(index);
617     var mask = GetBitMaskFromIndex(index);
618     _array[wordIndex] |= mask;
619     RefreshBordersByWord(wordIndex);
620 }
621
622 [MethodImpl(MethodImplOptions.AggressiveInlining)]
623 public void Reset(long index)
624 {
625     Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
626     var wordIndex = GetWordIndexFromIndex(index);
627     var mask = GetBitMaskFromIndex(index);
628     _array[wordIndex] &= ~mask;
629     RefreshBordersByWord(wordIndex);
630 }
631
632 [MethodImpl(MethodImplOptions.AggressiveInlining)]
633 public bool Add(long index)
634 {
635     var wordIndex = GetWordIndexFromIndex(index);
636     var mask = GetBitMaskFromIndex(index);
637     if ((_array[wordIndex] & mask) == 0)
638     {
639         _array[wordIndex] |= mask;
640         RefreshBordersByWord(wordIndex);
641         return true;
642     }

```

```

643     else
644     {
645         return false;
646     }
647 }
648
649 [MethodImpl(MethodImplOptions.AggressiveInlining)]
650 public void SetAll(bool value)
651 {
652     if (value)
653     {
654         SetAll();
655     }
656     else
657     {
658         ResetAll();
659     }
660 }
661
662 [MethodImpl(MethodImplOptions.AggressiveInlining)]
663 public void SetAll()
664 {
665     const long fillValue = unchecked((long)0xffffffffffffffff);
666     var words = GetWordsCountFromIndex(_length);
667     for (var i = 0; i < words; i++)
668     {
669         _array[i] = fillValue;
670     }
671     MarkBordersAsAllBitsSet();
672 }
673
674 [MethodImpl(MethodImplOptions.AggressiveInlining)]
675 public void ResetAll()
676 {
677     const long fillValue = 0;
678     GetBorders(out long from, out long to);
679     for (var i = from; i <= to; i++)
680     {
681         _array[i] = fillValue;
682     }
683     MarkBordersAsAllBitsReset();
684 }
685
686 [MethodImpl(MethodImplOptions.AggressiveInlining)]
687 public List<long> GetSetIndices()
688 {
689     var result = new List<long>();
690     GetBorders(out long from, out long to);
691     for (var i = from; i <= to; i++)
692     {
693         var word = _array[i];
694         if (word != 0)
695         {
696             AppendAllSetBitIndices(result, i, word);
697         }
698     }
699     return result;
700 }
701
702 [MethodImpl(MethodImplOptions.AggressiveInlining)]
703 public List<ulong> GetSetUInt64Indices()
704 {
705     var result = new List<ulong>();
706     GetBorders(out ulong from, out ulong to);
707     for (var i = from; i <= to; i++)
708     {
709         var word = _array[i];
710         if (word != 0)
711         {
712             AppendAllSetBitIndices(result, i, word);
713         }
714     }
715     return result;
716 }
717
718 [MethodImpl(MethodImplOptions.AggressiveInlining)]
719 public long GetFirstSetBitIndex()
720 {
721     var i = _minPositiveWord;

```

```

722     var word = _array[i];
723     if (word != 0)
724     {
725         return GetFirstSetBitForWord(i, word);
726     }
727     return -1;
728 }
729
730 [MethodImpl(MethodImplOptions.AggressiveInlining)]
731 public long GetLastSetBitIndex()
732 {
733     var i = _maxPositiveWord;
734     var word = _array[i];
735     if (word != 0)
736     {
737         return GetLastSetBitForWord(i, word);
738     }
739     return -1;
740 }
741
742 [MethodImpl(MethodImplOptions.AggressiveInlining)]
743 public long CountSetBits()
744 {
745     var total = 0L;
746     GetBorders(out long from, out long to);
747     for (var i = from; i <= to; i++)
748     {
749         var word = _array[i];
750         if (word != 0)
751         {
752             total += CountSetBitsForWord(word);
753         }
754     }
755     return total;
756 }
757
758 [MethodImpl(MethodImplOptions.AggressiveInlining)]
759 public bool HaveCommonBits(BitString other)
760 {
761     EnsureBitStringHasTheSameSize(other, nameof(other));
762     GetCommonInnerBorders(this, other, out long from, out long to);
763     var otherArray = other._array;
764     for (var i = from; i <= to; i++)
765     {
766         var left = _array[i];
767         var right = otherArray[i];
768         if (left != 0 && right != 0 && (left & right) != 0)
769         {
770             return true;
771         }
772     }
773     return false;
774 }
775
776 [MethodImpl(MethodImplOptions.AggressiveInlining)]
777 public long CountCommonBits(BitString other)
778 {
779     EnsureBitStringHasTheSameSize(other, nameof(other));
780     GetCommonInnerBorders(this, other, out long from, out long to);
781     var total = 0L;
782     var otherArray = other._array;
783     for (var i = from; i <= to; i++)
784     {
785         var left = _array[i];
786         var right = otherArray[i];
787         var combined = left & right;
788         if (combined != 0)
789         {
790             total += CountSetBitsForWord(combined);
791         }
792     }
793     return total;
794 }
795
796 [MethodImpl(MethodImplOptions.AggressiveInlining)]
797 public List<long> GetCommonIndices(BitString other)
798 {
799     EnsureBitStringHasTheSameSize(other, nameof(other));
800     GetCommonInnerBorders(this, other, out long from, out long to);

```

```

801     var result = new List<long>();
802     var otherArray = other._array;
803     for (var i = from; i <= to; i++)
804     {
805         var left = _array[i];
806         var right = otherArray[i];
807         var combined = left & right;
808         if (combined != 0)
809         {
810             AppendAllSetBitIndices(result, i, combined);
811         }
812     }
813     return result;
814 }
815
816 [MethodImpl(MethodImplOptions.AggressiveInlining)]
817 public List<ulong> GetCommonUInt64Indices(BitString other)
818 {
819     EnsureBitStringHasTheSameSize(other, nameof(other));
820     GetCommonBorders(this, other, out ulong from, out ulong to);
821     var result = new List<ulong>();
822     var otherArray = other._array;
823     for (var i = from; i <= to; i++)
824     {
825         var left = _array[i];
826         var right = otherArray[i];
827         var combined = left & right;
828         if (combined != 0)
829         {
830             AppendAllSetBitIndices(result, i, combined);
831         }
832     }
833     return result;
834 }
835
836 [MethodImpl(MethodImplOptions.AggressiveInlining)]
837 public long GetFirstCommonBitIndex(BitString other)
838 {
839     EnsureBitStringHasTheSameSize(other, nameof(other));
840     GetCommonInnerBorders(this, other, out long from, out long to);
841     var otherArray = other._array;
842     for (var i = from; i <= to; i++)
843     {
844         var left = _array[i];
845         var right = otherArray[i];
846         var combined = left & right;
847         if (combined != 0)
848         {
849             return GetFirstSetBitForWord(i, combined);
850         }
851     }
852     return -1;
853 }
854
855 [MethodImpl(MethodImplOptions.AggressiveInlining)]
856 public long GetLastCommonBitIndex(BitString other)
857 {
858     EnsureBitStringHasTheSameSize(other, nameof(other));
859     GetCommonInnerBorders(this, other, out long from, out long to);
860     var otherArray = other._array;
861     for (var i = to; i >= from; i--)
862     {
863         var left = _array[i];
864         var right = otherArray[i];
865         var combined = left & right;
866         if (combined != 0)
867         {
868             return GetLastSetBitForWord(i, combined);
869         }
870     }
871     return -1;
872 }
873
874 [MethodImpl(MethodImplOptions.AggressiveInlining)]
875 public override bool Equals(object obj) => obj is BitString @string ? Equals(@string) :
    ↪ false;
876
877 [MethodImpl(MethodImplOptions.AggressiveInlining)]
878 public bool Equals(BitString other)

```

```

879 {
880     if (_length != other._length)
881     {
882         return false;
883     }
884     var otherArray = other._array;
885     if (_array.Length != otherArray.Length)
886     {
887         return false;
888     }
889     if (_minPositiveWord != other._minPositiveWord)
890     {
891         return false;
892     }
893     if (_maxPositiveWord != other._maxPositiveWord)
894     {
895         return false;
896     }
897     GetCommonBorders(this, other, out ulong from, out ulong to);
898     for (var i = from; i <= to; i++)
899     {
900         if (_array[i] != otherArray[i])
901         {
902             return false;
903         }
904     }
905     return true;
906 }
907
908 [MethodImpl(MethodImplOptions.AggressiveInlining)]
909 private void EnsureBitStringHasTheSameSize(BitString other, string argumentName)
910 {
911     Ensure.Always.ArgumentNotNull(other, argumentName);
912     if (_length != other._length)
913     {
914         throw new ArgumentException("Bit string must be the same size.", argumentName);
915     }
916 }
917
918 [MethodImpl(MethodImplOptions.AggressiveInlining)]
919 private void MarkBordersAsAllBitsReset() => SetBorders(_array.LongLength - 1, 0);
920
921 [MethodImpl(MethodImplOptions.AggressiveInlining)]
922 private void MarkBordersAsAllBitsSet() => SetBorders(0, _array.LongLength - 1);
923
924 [MethodImpl(MethodImplOptions.AggressiveInlining)]
925 private void GetBorders(out long from, out long to)
926 {
927     from = _minPositiveWord;
928     to = _maxPositiveWord;
929 }
930
931 [MethodImpl(MethodImplOptions.AggressiveInlining)]
932 private void GetBorders(out ulong from, out ulong to)
933 {
934     from = (ulong)_minPositiveWord;
935     to = (ulong)_maxPositiveWord;
936 }
937
938 [MethodImpl(MethodImplOptions.AggressiveInlining)]
939 private void SetBorders(long from, long to)
940 {
941     _minPositiveWord = from;
942     _maxPositiveWord = to;
943 }
944
945 [MethodImpl(MethodImplOptions.AggressiveInlining)]
946 private Range<long> GetValidIndexRange() => (0, _length - 1);
947
948 [MethodImpl(MethodImplOptions.AggressiveInlining)]
949 private static Range<long> GetValidLengthRange() => (0, long.MaxValue);
950
951 [MethodImpl(MethodImplOptions.AggressiveInlining)]
952 private static void AppendAllSetBitIndices(List<ulong> result, ulong wordIndex, long
    ↪ wordValue)
953 {
954     GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
    ↪ bits32to47, out byte[] bits48to63);

```



```

955     AppendAllSetIndices(result, wordIndex, bits00to15, bits16to31, bits32to47,
956         ↪ bits48to63);
957 }
958 [MethodImpl(MethodImplOptions.AggressiveInlining)]
959 private static void AppendAllSetBitIndices(List<long> result, long wordIndex, long
960     ↪ wordValue)
961 {
962     GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
963         ↪ bits32to47, out byte[] bits48to63);
964     AppendAllSetBitIndices(result, wordIndex, bits00to15, bits16to31, bits32to47,
965         ↪ bits48to63);
966 }
967 [MethodImpl(MethodImplOptions.AggressiveInlining)]
968 private static long CountSetBitsForWord(long word)
969 {
970     GetBits(word, out byte[] bits00to15, out byte[] bits16to31, out byte[] bits32to47,
971         ↪ out byte[] bits48to63);
972     return bits00to15.LongLength + bits16to31.LongLength + bits32to47.LongLength +
973         ↪ bits48to63.LongLength;
974 }
975 [MethodImpl(MethodImplOptions.AggressiveInlining)]
976 private static long GetFirstSetBitForWord(long wordIndex, long wordValue)
977 {
978     GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
979         ↪ bits32to47, out byte[] bits48to63);
980     return GetFirstSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
981 }
982 [MethodImpl(MethodImplOptions.AggressiveInlining)]
983 private static long GetLastSetBitForWord(long wordIndex, long wordValue)
984 {
985     GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
986         ↪ bits32to47, out byte[] bits48to63);
987     return GetLastSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
988 }
989 [MethodImpl(MethodImplOptions.AggressiveInlining)]
990 private static void AppendAllSetBitIndices(List<long> result, long i, byte[] bits00to15,
991     ↪ byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
992 {
993     for (var j = 0; j < bits00to15.Length; j++)
994     {
995         result.Add(bits00to15[j] + (i * 64));
996     }
997     for (var j = 0; j < bits16to31.Length; j++)
998     {
999         result.Add(bits16to31[j] + 16 + (i * 64));
1000     }
1001     for (var j = 0; j < bits32to47.Length; j++)
1002     {
1003         result.Add(bits32to47[j] + 32 + (i * 64));
1004     }
1005     for (var j = 0; j < bits48to63.Length; j++)
1006     {
1007         result.Add(bits48to63[j] + 48 + (i * 64));
1008     }
1009 }
1010 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1011 private static void AppendAllSetIndices(List<ulong> result, ulong i, byte[] bits00to15,
1012     ↪ byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
1013 {
1014     for (var j = 0; j < bits00to15.Length; j++)
1015     {
1016         result.Add(bits00to15[j] + (i * 64));
1017     }
1018     for (var j = 0; j < bits16to31.Length; j++)
1019     {
1020         result.Add(bits16to31[j] + 16UL + (i * 64));
1021     }
1022     for (var j = 0; j < bits32to47.Length; j++)
1023     {
1024         result.Add(bits32to47[j] + 32UL + (i * 64));
1025     }
1026     for (var j = 0; j < bits48to63.Length; j++)
1027     {
1028         result.Add(bits48to63[j] + 48UL + (i * 64));
1029     }
1030 }

```

```

1022     for (var j = 0; j < bits48to63.Length; j++)
1023     {
1024         result.Add(bits48to63[j] + 48UL + (i * 64));
1025     }
1026 }
1027
1028 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1029 private static long GetFirstSetBit(long i, byte[] bits00to15, byte[] bits16to31, byte[]
    ↪ bits32to47, byte[] bits48to63)
1030 {
1031     if (bits00to15.Length > 0)
1032     {
1033         return bits00to15[0] + (i * 64);
1034     }
1035     if (bits16to31.Length > 0)
1036     {
1037         return bits16to31[0] + 16 + (i * 64);
1038     }
1039     if (bits32to47.Length > 0)
1040     {
1041         return bits32to47[0] + 32 + (i * 64);
1042     }
1043     return bits48to63[0] + 48 + (i * 64);
1044 }
1045
1046 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1047 private static long GetLastSetBit(long i, byte[] bits00to15, byte[] bits16to31, byte[]
    ↪ bits32to47, byte[] bits48to63)
1048 {
1049     if (bits48to63.Length > 0)
1050     {
1051         return bits48to63[bits48to63.Length - 1] + 48 + (i * 64);
1052     }
1053     if (bits32to47.Length > 0)
1054     {
1055         return bits32to47[bits32to47.Length - 1] + 32 + (i * 64);
1056     }
1057     if (bits16to31.Length > 0)
1058     {
1059         return bits16to31[bits16to31.Length - 1] + 16 + (i * 64);
1060     }
1061     return bits00to15[bits00to15.Length - 1] + (i * 64);
1062 }
1063
1064 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1065 private static void GetBits(long word, out byte[] bits00to15, out byte[] bits16to31, out
    ↪ byte[] bits32to47, out byte[] bits48to63)
1066 {
1067     bits00to15 = _bitsSetIn16Bits[word & 0xffffu];
1068     bits16to31 = _bitsSetIn16Bits[(word >> 16) & 0xffffu];
1069     bits32to47 = _bitsSetIn16Bits[(word >> 32) & 0xffffu];
1070     bits48to63 = _bitsSetIn16Bits[(word >> 48) & 0xffffu];
1071 }
1072
1073 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1074 public static void GetCommonInnerBorders(BitString left, BitString right, out long from,
    ↪ out long to)
1075 {
1076     from = Math.Max(left._minPositiveWord, right._minPositiveWord);
1077     to = Math.Min(left._maxPositiveWord, right._maxPositiveWord);
1078 }
1079
1080 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1081 public static void GetCommonOuterBorders(BitString left, BitString right, out long from,
    ↪ out long to)
1082 {
1083     from = Math.Min(left._minPositiveWord, right._minPositiveWord);
1084     to = Math.Max(left._maxPositiveWord, right._maxPositiveWord);
1085 }
1086
1087 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1088 public static void GetCommonOuterBorders(BitString left, BitString right, out int from,
    ↪ out int to)
1089 {
1090     from = (int)Math.Min(left._minPositiveWord, right._minPositiveWord);
1091     to = (int)Math.Max(left._maxPositiveWord, right._maxPositiveWord);
1092 }
1093

```

```

1094     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1095     public static void GetCommonBorders(BitString left, BitString right, out ulong from, out
    →   ulong to)
1096     {
1097         from = (ulong)Math.Max(left._minPositiveWord, right._minPositiveWord);
1098         to = (ulong)Math.Min(left._maxPositiveWord, right._maxPositiveWord);
1099     }
1100
1101     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1102     public static long GetWordsCountFromIndex(long index) => (index + 63) / 64;
1103
1104     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1105     public static long GetWordIndexFromIndex(long index) => index >> 6;
1106
1107     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1108     public static long GetBitMaskFromIndex(long index) => 1L << (int)(index & 63);
1109
1110     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1111     public override int GetHashCode() => base.GetHashCode();
1112
1113     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1114     public override string ToString() => base.ToString();
1115 }
1116 }

```

1.9 ./csharp/Platform.Collections/BitStringExtensions.cs

```

1  using System.Runtime.CompilerServices;
2  using Platform.Random;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections
7  {
8      public static class BitStringExtensions
9      {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         public static void SetRandomBits(this BitString @string)
12         {
13             for (var i = 0; i < @string.Length; i++)
14             {
15                 var value = RandomHelpers.Default.NextBoolean();
16                 @string.Set(i, value);
17             }
18         }
19     }
20 }

```

1.10 ./csharp/Platform.Collections/Concurrent/ConcurrentQueueExtensions.cs

```

1  using System.Collections.Concurrent;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections.Concurrent
8  {
9      public static class ConcurrentQueueExtensions
10     {
11         [MethodImpl(MethodImplOptions.AggressiveInlining)]
12         public static IEnumerable<T> DequeueAll<T>(this ConcurrentQueue<T> queue)
13         {
14             while (queue.TryDequeue(out T item))
15             {
16                 yield return item;
17             }
18         }
19     }
20 }

```

1.11 ./csharp/Platform.Collections/Concurrent/ConcurrentStackExtensions.cs

```

1  using System.Collections.Concurrent;
2  using System.Runtime.CompilerServices;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Concurrent
7  {
8      public static class ConcurrentStackExtensions
9      {

```

```

10     [MethodImpl(MethodImplOptions.AggressiveInlining)]
11     public static T PopOrDefault<T>(this ConcurrentStack<T> stack) => stack.TryPop(out T
    ↳ value) ? value : default;
12
13     [MethodImpl(MethodImplOptions.AggressiveInlining)]
14     public static T PeekOrDefault<T>(this ConcurrentStack<T> stack) => stack.TryPeek(out T
    ↳ value) ? value : default;
15 }
16 }

```

1.12 ./csharp/Platform.Collections/EnsureExtensions.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Diagnostics;
4  using System.Runtime.CompilerServices;
5  using Platform.Exceptions;
6  using Platform.Exceptions.ExtensionRoots;
7
8  #pragma warning disable IDE0060 // Remove unused parameter
9  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
10
11 namespace Platform.Collections
12 {
13     public static class EnsureExtensions
14     {
15         #region Always
16
17         [MethodImpl(MethodImplOptions.AggressiveInlining)]
18         public static void ArgumentNotEmpty<T>(this EnsureAlwaysExtensionRoot root,
    ↳ ICollection<T> argument, string argumentName, string message)
19         {
20             if (argument.IsNullOrEmpty())
21             {
22                 throw new ArgumentException(message, argumentName);
23             }
24         }
25
26         [MethodImpl(MethodImplOptions.AggressiveInlining)]
27         public static void ArgumentNotEmpty<T>(this EnsureAlwaysExtensionRoot root,
    ↳ ICollection<T> argument, string argumentName) => ArgumentNotEmpty(root, argument,
    ↳ argumentName, null);
28
29         [MethodImpl(MethodImplOptions.AggressiveInlining)]
30         public static void ArgumentNotEmpty<T>(this EnsureAlwaysExtensionRoot root,
    ↳ ICollection<T> argument) => ArgumentNotEmpty(root, argument, null, null);
31
32         [MethodImpl(MethodImplOptions.AggressiveInlining)]
33         public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
    ↳ string argument, string argumentName, string message)
34         {
35             if (string.IsNullOrEmpty(argument))
36             {
37                 throw new ArgumentException(message, argumentName);
38             }
39         }
40
41         [MethodImpl(MethodImplOptions.AggressiveInlining)]
42         public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
    ↳ string argument, string argumentName) => ArgumentNotEmptyAndNotWhiteSpace(root,
    ↳ argument, argumentName, null);
43
44         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45         public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
    ↳ string argument) => ArgumentNotEmptyAndNotWhiteSpace(root, argument, null, null);
46
47         #endregion
48
49         #region OnDebug
50
51         [Conditional("DEBUG")]
52         public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
    ↳ ICollection<T> argument, string argumentName, string message) =>
    ↳ Ensure.Always.ArgumentNotEmpty(argument, argumentName, message);
53
54         [Conditional("DEBUG")]
55         public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
    ↳ ICollection<T> argument, string argumentName) =>
    ↳ Ensure.Always.ArgumentNotEmpty(argument, argumentName, null);
56

```

```

57     [Conditional("DEBUG")]
58     public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
    ↪     ICollection<T> argument) => Ensure.Always.ArgumentNotEmpty(argument, null, null);
59
60     [Conditional("DEBUG")]
61     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
    ↪     root, string argument, string argumentName, string message) =>
    ↪     Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument, argumentName, message);
62
63     [Conditional("DEBUG")]
64     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
    ↪     root, string argument, string argumentName) =>
    ↪     Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument, argumentName, null);
65
66     [Conditional("DEBUG")]
67     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
    ↪     root, string argument) => Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument,
    ↪     null, null);
68
69     #endregion
70 }
71 }

```

1.13 ./csharp/Platform.Collections/ICollectionExtensions.cs

```

1  using System.Collections.Generic;
2  using System.Linq;
3  using System.Runtime.CompilerServices;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections
8  {
9      public static class ICollectionExtensions
10     {
11         [MethodImpl(MethodImplOptions.AggressiveInlining)]
12         public static bool IsNullOrEmpty<T>(this ICollection<T> collection) => collection ==
    ↪     null || collection.Count == 0;
13
14         [MethodImpl(MethodImplOptions.AggressiveInlining)]
15         public static bool AllEqualToDefault<T>(this ICollection<T> collection)
16         {
17             var equalityComparer = EqualityComparer<T>.Default;
18             return collection.All(item => equalityComparer.Equals(item, default));
19         }
20     }
21 }

```

1.14 ./csharp/Platform.Collections/IDictionaryExtensions.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections
8  {
9      public static class IDictionaryExtensions
10     {
11         [MethodImpl(MethodImplOptions.AggressiveInlining)]
12         public static TValue GetOrDefault<TKey, TValue>(this IDictionary<TKey, TValue>
    ↪     dictionary, TKey key)
13         {
14             dictionary.TryGetValue(key, out TValue value);
15             return value;
16         }
17
18         [MethodImpl(MethodImplOptions.AggressiveInlining)]
19         public static TValue GetOrAdd<TKey, TValue>(this IDictionary<TKey, TValue> dictionary,
    ↪     TKey key, Func<TKey, TValue> valueFactory)
20         {
21             if (!dictionary.TryGetValue(key, out TValue value))
22             {
23                 value = valueFactory(key);
24                 dictionary.Add(key, value);
25                 return value;
26             }
27             return value;
28         }
29     }
30 }

```

```
29     }
30 }
```

1.15 ./csharp/Platform.Collections/Lists/CharIListExtensions.cs

```
1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 namespace Platform.Collections.Lists
5 {
6     public static class CharIListExtensions
7     {
8         /// <summary>
9         /// <para>Generates a hash code for the entire list based on the values of its
10         ///     ↪ elements.</para>
11         /// <para>Генерирует хэш-код всего списка, на основе значений его элементов.</para>
12         /// </summary>
13         /// <param name="list"><para>The list to be hashed.</para><para>Список для
14         ///     ↪ хеширования.</para></param>
15         /// <returns>
16         /// <para>The hash code of the list.</para>
17         /// <para>Хэш-код списка.</para>
18         /// </returns>
19         /// <remarks>
20         /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783
21         ///     ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L833
22         /// </remarks>
23         [MethodImpl(MethodImplOptions.AggressiveInlining)]
24         public static int GenerateHashCode(this IList<char> list)
25         {
26             var hashSeed = 5381;
27             var hashAccumulator = hashSeed;
28             for (var i = 0; i < list.Count; i++)
29             {
30                 hashAccumulator = (hashAccumulator << 5) + hashAccumulator ^ list[i];
31             }
32             return hashAccumulator + (hashSeed * 1566083941);
33         }
34
35         /// <summary>
36         /// <para>Compares two lists for equality.</para>
37         /// <para>Сравнивает два списка на равенство.</para>
38         /// </summary>
39         /// <param name="left"><para>The first compared list.</para><para>Первый список для
40         ///     ↪ сравнения.</para></param>
41         /// <param name="right"><para>The second compared list.</para><para>Второй список для
42         ///     ↪ сравнения.</para></param>
43         /// <returns>
44         /// <para>True, if the passed lists are equal to each other otherwise false.</para>
45         /// <para>True, если переданные списки равны друг другу, иначе false.</para>
46         /// </returns>
47         [MethodImpl(MethodImplOptions.AggressiveInlining)]
48         public static bool EqualTo(this IList<char> left, IList<char> right) =>
49             ↪ left.EqualTo(right, ContentEqualTo);
50
51         /// <summary>
52         /// <para>Compares each element in the list for equality.</para>
53         /// <para>Сравнивает на равенство каждый элемент списка.</para>
54         /// </summary>
55         /// <param name="left"><para>The first compared list.</para><para>Первый список для
56         ///     ↪ сравнения.</para></param>
57         /// <param name="right"><para>The second compared list.</para><para>Второй список для
58         ///     ↪ сравнения.</para></param>
59         /// <returns>
60         /// <para>If at least one element of one list is not equal to the corresponding element
61         ///     ↪ from another list returns false, otherwise - true.</para>
62         /// <para>Если как минимум один элемент одного списка не равен соответствующему элементу
63         ///     ↪ из другого списка возвращает false, иначе - true.</para>
64         /// </returns>
65         [MethodImpl(MethodImplOptions.AggressiveInlining)]
66         public static bool ContentEqualTo(this IList<char> left, IList<char> right)
67         {
68             for (var i = left.Count - 1; i >= 0; --i)
69             {
70                 if (left[i] != right[i])
71                 {
72                     return false;
73                 }
74             }
75         }
76     }
77 }
```

```

65         return true;
66     }
67 }
68 }

```

1.16 ./csharp/Platform.Collections/Lists/IListComparer.cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  namespace Platform.Collections.Lists
5  {
6      public class IListComparer<T> : IComparer<IList<T>>
7      {
8          /// <summary>
9          /// <para>Compares two lists.</para>
10         /// <para>Сравнивает два списка.</para>
11         /// </summary>
12         /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
13         → списка.</para></typeparam>
14         /// <param name="left"><para>The first compared list.</para><para>Первый список для
15         → сравнения.</para></param>
16         /// <param name="right"><para>The second compared list.</para><para>Второй список для
17         → сравнения.</para></param>
18         /// <returns>
19         /// <para>
20         ///     A signed integer that indicates the relative values of <paramref name="left" />
21         → and <paramref name="right" /> lists' elements, as shown in the following table.
22         ///     <list type="table">
23         ///         <listheader>
24         ///             <term>Value</term>
25         ///             <description>Meaning</description>
26         ///         </listheader>
27         ///         <item>
28         ///             <term>Is less than zero</term>
29         ///             <description>First non equal element of <paramref name="left" /> list is
30         → less than first not equal element of <paramref name="right" /> list.</description>
31         ///         </item>
32         ///         <item>
33         ///             <term>Zero</term>
34         ///             <description>All elements of <paramref name="left" /> list equals to all
35         → elements of <paramref name="right" /> list.</description>
36         ///         </item>
37         ///         <item>
38         ///             <term>Is greater than zero</term>
39         ///             <description>First non equal element of <paramref name="left" /> list is
40         → greater than first not equal element of <paramref name="right" /> list.</description>
41         ///         </item>
42         ///     </list>
43         /// <para>
44         /// <para>
45         ///     Целое число со знаком, которое указывает относительные значения элементов
46         → списков <paramref name="left" /> и <paramref name="right" /> как показано в
47         → следующей таблице.
48         ///     <list type="table">
49         ///         <listheader>
50         ///             <term>Значение</term>
51         ///             <description>Смысл</description>
52         ///         </listheader>
53         ///         <item>
54         ///             <term>Меньше нуля</term>
55         ///             <description>Первый не равный элемент <paramref name="left" /> списка
56         → меньше первого неравного элемента <paramref name="right" /> списка.</description>
57         ///         </item>
58         ///         <item>
59         ///             <term>Ноль</term>
60         ///             <description>Все элементы <paramref name="left" /> списка равны всем
61         → элементам <paramref name="right" /> списка.</description>
62         ///         </item>
63         ///         <item>
64         ///             <term>Больше нуля</term>
65         ///             <description>Первый не равный элемент <paramref name="left" /> списка
66         → больше первого неравного элемента <paramref name="right" /> списка.</description>
67         ///         </item>
68         ///     </list>
69         /// </para>
70         /// </returns>
71         [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

60         public int Compare(IList<T> left, IList<T> right) => left.CompareTo(right);
61     }
62 }

```

1.17 ./csharp/Platform.Collections/Lists/IListEqualityComparer.cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  namespace Platform.Collections.Lists
5  {
6      public class IListEqualityComparer<T> : IEqualityComparer<IList<T>>
7      {
8          /// <summary>
9          /// <para>Compares two lists for equality.</para>
10         /// <para>Сравнивает два списка на равенство.</para>
11         /// </summary>
12         /// <param name="left"><para>The first compared list.</para><para>Первый список для
13         ↪ сравнения.</para></param>
14         /// <param name="right"><para>The second compared list.</para><para>Второй список для
15         ↪ сравнения.</para></param>
16         /// <returns>
17         /// <para>If the passed lists are equal to each other, true is returned, otherwise
18         ↪ false.</para>
19         /// <para>Если переданные списки равны друг другу, возвращается true, иначе же
20         ↪ false.</para>
21         /// </returns>
22         [MethodImpl(MethodImplOptions.AggressiveInlining)]
23         public bool Equals(IList<T> left, IList<T> right) => left.EqualTo(right);
24
25         /// <summary>
26         /// <para>Generates a hash code for the entire list based on the values of its
27         ↪ elements.</para>
28         /// <para>Генерирует хэш-код всего списка, на основе значений его элементов.</para>
29         /// </summary>
30         /// <param name="list"><para>Hash list.</para><para>Список для
31         ↪ хеширования.</para></param>
32         /// <returns>
33         /// <para>The hash code of the list.</para>
34         /// <para>Хэш-код списка.</para>
35         /// </returns>
36         [MethodImpl(MethodImplOptions.AggressiveInlining)]
37         public int GetHashCode(IList<T> list) => list.GenerateHashCode();
38     }
39 }

```

1.18 ./csharp/Platform.Collections/Lists/IListExtensions.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4
5  namespace Platform.Collections.Lists
6  {
7      public static class IListExtensions
8      {
9          /// <summary>
10         /// <para>Gets the element from specified index if the list is not null and the index is
11         ↪ within the list's boundaries, otherwise it returns default value of type T.</para>
12         /// <para>Получает элемент из указанного индекса, если список не является null и индекс
13         ↪ находится в границах списка, в противном случае он возвращает значение по умолчанию
14         ↪ типа T.</para>
15         /// </summary>
16         /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
17         ↪ списка.</typeparam>
18         /// <param name="list"><para>The checked list.</para><para>Проверяемый
19         ↪ список.</param></param>
20         /// <param name="index"><para>The index of element.</para><para>Индекс
21         ↪ элемента.</param></param>
22         /// <returns>
23         /// <para>If the specified index is within list's boundaries, then - list[index],
24         ↪ otherwise the default value.</para>
25         /// <para>Если указанный индекс находится в пределах границ списка, тогда - list[index],
26         ↪ иначе же значение по умолчанию.</para>
27         /// </returns>
28         [MethodImpl(MethodImplOptions.AggressiveInlining)]
29         public static T GetElementOrDefault<T>(this IList<T> list, int index) => list != null &&
30         ↪ list.Count > index ? list[index] : default;
31     }
32 }

```



```

23 /// <summary>
24 /// <para>Checks if a list is passed, checks its length, and if successful, copies the
    → value of list [index] into the element variable. Otherwise, the element variable has
    → a default value.</para>
25 /// <para>Проверяет, передан ли список, сверяет его длину и в случае успеха копирует
    → значение list[index] в переменную element. Иначе переменная element имеет значение
    → по умолчанию.</para>
26 /// </summary>
27 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
28 /// <param name="list"><para>The checked list.</para><para>Список для
    → проверки.</para></param>
29 /// <param name="index"><para>The index of element.</para><para>Индекс
    → элемента.</para></param>
30 /// <param name="element"><para>Variable for passing the index
    → value.</para><para>Переменная для передачи значения индекса.</para></param>
31 /// <returns>
32 /// <para>True on success, false otherwise.</para>
33 /// <para>True в случае успеха, иначе false.</para>
34 /// </returns>
35 [MethodImpl(MethodImplOptions.AggressiveInlining)]
36 public static bool TryGetElement<T>(this IList<T> list, int index, out T element)
37 {
38     if (list != null && list.Count > index)
39     {
40         element = list[index];
41         return true;
42     }
43     else
44     {
45         element = default;
46         return false;
47     }
48 }
49
50 /// <summary>
51 /// <para>Adds a value to the list.</para>
52 /// <para>Добавляет значение в список.</para>
53 /// </summary>
54 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
55 /// <param name="list"><para>The list to add the value to.</para><para>Список в который
    → нужно добавить значение.</para></param>
56 /// <param name="element"><para>The item to add to the list.</para><para>Элемент который
    → нужно добавить в список.</para></param>
57 /// <returns>
58 /// <para>True value in any case.</para>
59 /// <para>Значение true в любом случае.</para>
60 /// </returns>
61 [MethodImpl(MethodImplOptions.AggressiveInlining)]
62 public static bool AddAndReturnTrue<T>(this IList<T> list, T element)
63 {
64     list.Add(element);
65     return true;
66 }
67
68 /// <summary>
69 /// <para>Adds the value with first index from other list to this list.</para>
70 /// <para>Добавляет в этот список значение с первым индексом из другого списка.</para>
71 /// </summary>
72 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
73 /// <param name="list"><para>The list to add the value to.</para><para>Список в который
    → нужно добавить значение.</para></param>
74 /// <param name="elements"><para>The item to add to the list.</para><para>Элемент
    → который нужно добавить в список</para></param>
75 /// <returns>
76 /// <para>True value in any case.</para>
77 /// <para>Значение true в любом случае.</para>
78 /// </returns>
79 [MethodImpl(MethodImplOptions.AggressiveInlining)]
80 public static bool AddFirstAndReturnTrue<T>(this IList<T> list, IList<T> elements)
81 {
82     list.AddFirst(elements);
83     return true;
84 }
85

```

```

86  /// <summary>
87  /// <para>Adds a value to the list at the first index.</para>
88  /// <para>Добавляет значение в список по первому индексу.</para>
89  /// </summary>
90  /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
91  /// <param name="list"><para>The list to add the value to.</para><para>Список в который
    → нужно добавить значение.</para></param>
92  /// <param name="elements"><para>The item to add to the list.</para><para>Элемент
    → который нужно добавить в список</para></param>
93  [MethodImpl(MethodImplOptions.AggressiveInlining)]
94  public static void AddFirst<T>(this IList<T> list, IList<T> elements) =>
    → list.Add(elements[0]);
95
96  /// <summary>
97  /// <para>Adds all elements from other list to this list and returns true.</para>
98  /// <para>Добавляет все элементы из другого списка в этот список и возвращает
    → true.</para>
99  /// </summary>
100  /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
101  /// <param name="list"><para>The list to add the values to.</para><para>Список в который
    → нужно добавить значения.</para></param>
102  /// <param name="elements"><para>List of values to add.</para><para>Список значений
    → которые необходимо добавить.</para></param>
103  /// <returns>
104  /// <para>True value in any case.</para>
105  /// <para>Значение true в любом случае.</para>
106  /// </returns>
107  [MethodImpl(MethodImplOptions.AggressiveInlining)]
108  public static bool AddAllAndReturnTrue<T>(this IList<T> list, IList<T> elements)
109  {
110      list.AddAll(elements);
111      return true;
112  }
113
114  /// <summary>
115  /// <para>Adds all elements from other list to this list.</para>
116  /// <para>Добавляет все элементы из другого списка в этот список.</para>
117  /// </summary>
118  /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
119  /// <param name="list"><para>The list to add the values to.</para><para>Список в который
    → нужно добавить значения.</para></param>
120  /// <param name="elements"><para>The list of values to add.</para><para>Список значений
    → которые необходимо добавить.</para></param>
121  [MethodImpl(MethodImplOptions.AggressiveInlining)]
122  public static void AddAll<T>(this IList<T> list, IList<T> elements)
123  {
124      for (var i = 0; i < elements.Count; i++)
125      {
126          list.Add(elements[i]);
127      }
128  }
129
130  /// <summary>
131  /// <para>Adds values to the list skipping the first element.</para>
132  /// <para>Добавляет значения в список пропуская первый элемент.</para>
133  /// </summary>
134  /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
135  /// <param name="list"><para>The list to add the values to.</para><para>Список в который
    → нужно добавить значения.</para></param>
136  /// <param name="elements"><para>The list of values to add.</para><para>Список значений
    → которые необходимо добавить.</para></param>
137  /// <returns>
138  /// <para>True value in any case.</para>
139  /// <para>Значение true в любом случае.</para>
140  /// </returns>
141  [MethodImpl(MethodImplOptions.AggressiveInlining)]
142  public static bool AddSkipFirstAndReturnTrue<T>(this IList<T> list, IList<T> elements)
143  {
144      list.AddSkipFirst(elements);
145      return true;
146  }
147
148  /// <summary>

```

```

149 /// <para>Adds values to the list skipping the first element.</para>
150 /// <para>Добавляет значения в список пропуская первый элемент.</para>
151 /// </summary>
152 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    ↳ списка.</para></typeparam>
153 /// <param name="list"><para>The list to add the values to.</para><para>Список в который
    ↳ нужно добавить значения.</para></param>
154 /// <param name="elements"><para>List of values to add.</para><para>Список значений
    ↳ которые необходимо добавить.</para></param>
155 [MethodImpl(MethodImplOptions.AggressiveInlining)]
156 public static void AddSkipFirst<T>(this IList<T> list, IList<T> elements) =>
    ↳ list.AddSkipFirst(elements, 1);
157
158 /// <summary>
159 /// <para>Adds values to the list skipping a specified number of first elements.</para>
160 /// <para>Добавляет в список значения пропуская определенное количество первых
    ↳ элементов.</para>
161 /// </summary>
162 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    ↳ списка.</para></typeparam>
163 /// <param name="list"><para>The list to add the values to.</para><para>Список в который
    ↳ нужно добавить значения.</para></param>
164 /// <param name="elements"><para>List of values to add.</para><para>Список значений
    ↳ которые необходимо добавить.</para></param>
165 /// <param name="skip"><para>Number of elements to skip.</para><para>Количество
    ↳ пропускаемых элементов.</para></param>
166 [MethodImpl(MethodImplOptions.AggressiveInlining)]
167 public static void AddSkipFirst<T>(this IList<T> list, IList<T> elements, int skip)
168 {
169     for (var i = skip; i < elements.Count; i++)
170     {
171         list.Add(elements[i]);
172     }
173 }
174
175 /// <summary>
176 /// <para>Reads the number of elements in the list.</para>
177 /// <para>Считывает число элементов списка.</para>
178 /// </summary>
179 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    ↳ списка.</para></typeparam>
180 /// <param name="list"><para>The checked list.</para><para>Список для
    ↳ проверки.</para></param>
181 /// <returns>
182 /// <para>The number of items contained in the list or 0.</para>
183 /// <para>Число элементов содержащихся в списке или же 0.</para>
184 /// </returns>
185 [MethodImpl(MethodImplOptions.AggressiveInlining)]
186 public static int GetCountOrZero<T>(this IList<T> list) => list?.Count ?? 0;
187
188 /// <summary>
189 /// <para>Compares two lists for equality.</para>
190 /// <para>Сравнивает два списка на равенство.</para>
191 /// </summary>
192 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    ↳ списка.</para></typeparam>
193 /// <param name="left"><para>The first compared list.</para><para>Первый список для
    ↳ сравнения.</para></param>
194 /// <param name="right"><para>The second compared list.</para><para>Второй список для
    ↳ сравнения.</para></param>
195 /// <returns>
196 /// <para>If the passed lists are equal to each other, true is returned, otherwise
    ↳ false.</para>
197 /// <para>Если переданные списки равны друг другу, возвращается true, иначе же
    ↳ false.</para>
198 /// </returns>
199 [MethodImpl(MethodImplOptions.AggressiveInlining)]
200 public static bool EqualTo<T>(this IList<T> left, IList<T> right) => EqualTo(left,
    ↳ right, ContentEqualTo);
201
202 /// <summary>
203 /// <para>Compares two lists for equality.</para>
204 /// <para>Сравнивает два списка на равенство.</para>
205 /// </summary>
206 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    ↳ списка.</para></typeparam>

```

```

207  /// <param name="left"><para>The first compared list.</para><para>Первый список для
    → проверки.</para></param>
208  /// <param name="right"><para>The second compared list.</para><para>Второй список для
    → сравнения.</para></param>
209  /// <param name="contentEqualityComparer"><para>Function to test two lists for their
    → content equality.</para><para>Функция для проверки двух списков на равенство их
    → содержимого.</para></param>
210  /// <returns>
211  /// <para>If the passed lists are equal to each other, true is returned, otherwise
    → false.</para>
212  /// <para>Если переданные списки равны друг другу, возвращается true, иначе же
    → false.</para>
213  /// </returns>
214  [MethodImpl(MethodImplOptions.AggressiveInlining)]
215  public static bool EqualTo<T>(this IList<T> left, IList<T> right, Func<IList<T>,
    → IList<T>, bool> contentEqualityComparer)
216  {
217      if (ReferenceEquals(left, right))
218      {
219          return true;
220      }
221      var leftCount = left.GetCountOrZero();
222      var rightCount = right.GetCountOrZero();
223      if (leftCount == 0 && rightCount == 0)
224      {
225          return true;
226      }
227      if (leftCount == 0 || rightCount == 0 || leftCount != rightCount)
228      {
229          return false;
230      }
231      return contentEqualityComparer(left, right);
232  }
233
234  /// <summary>
235  /// <para>Compares each element in the list for identity.</para>
236  /// <para>Сравнивает на равенство каждый элемент списка.</para>
237  /// </summary>
238  /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
239  /// <param name="left"><para>The first compared list.</para><para>Первый список для
    → сравнения.</para></param>
240  /// <param name="right"><para>The second compared list.</para><para>Второй список для
    → сравнения.</para></param>
241  /// <returns>
242  /// <para>If at least one element of one list is not equal to the corresponding element
    → from another list returns false, otherwise - true.</para>
243  /// <para>Если как минимум один элемент одного списка не равен соответствующему элементу
    → из другого списка возвращает false, иначе - true.</para>
244  /// </returns>
245  [MethodImpl(MethodImplOptions.AggressiveInlining)]
246  public static bool ContentEqualTo<T>(this IList<T> left, IList<T> right)
247  {
248      var equalityComparer = EqualityComparer<T>.Default;
249      for (var i = left.Count - 1; i >= 0; --i)
250      {
251          if (!equalityComparer.Equals(left[i], right[i]))
252          {
253              return false;
254          }
255      }
256      return true;
257  }
258
259  /// <summary>
260  /// <para>Creates an array by copying all elements from the list that satisfy the
    → predicate. If no list is passed, null is returned.</para>
261  /// <para>Создаёт массив, копируя из списка все элементы которые удовлетворяют
    → предикату. Если список не передан, возвращается null.</para>
262  /// </summary>
263  /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
    → списка.</para></typeparam>
264  /// <param name="list"><para>The list to copy from.</para><para>Список для копирования.</para></param>
265  /// <param name="predicate"><para>A function that determines whether an element should
    → be copied.</para><para>Функция определяющая должен ли копироваться
    → элемент.</para></param>
266  /// <returns>

```

```

267 /// <para>An array with copied elements from the list.</para>
268 /// <para>Массив с скопированными элементами из списка.</para>
269 /// </returns>
270 [MethodImpl(MethodImplOptions.AggressiveInlining)]
271 public static T[] ToArray<T>(this IList<T> list, Func<T, bool> predicate)
272 {
273     if (list == null)
274     {
275         return null;
276     }
277     var result = new List<T>(list.Count);
278     for (var i = 0; i < list.Count; i++)
279     {
280         if (predicate(list[i]))
281         {
282             result.Add(list[i]);
283         }
284     }
285     return result.ToArray();
286 }
287
288 /// <summary>
289 /// <para>Copies all the elements of the list into an array and returns it.</para>
290 /// <para>Копирует все элементы списка в массив и возвращает его.</para>
291 /// </summary>
292 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
293   ↳ списка.</para></typeparam>
294 /// <param name="list"><para>The list to copy from.</para><para>Список для
295   ↳ копирования.</para></param>
296 /// <returns>
297 /// <para>An array with all the elements of the passed list.</para>
298 /// <para>Массив со всеми элементами переданного списка.</para>
299 /// </returns>
300 [MethodImpl(MethodImplOptions.AggressiveInlining)]
301 public static T[] ToArray<T>(this IList<T> list)
302 {
303     var array = new T[list.Count];
304     list.CopyTo(array, 0);
305     return array;
306 }
307
308 /// <summary>
309 /// <para>Executes the passed action for each item in the list.</para>
310 /// <para>Выполняет переданное действие для каждого элемента в списке.</para>
311 /// </summary>
312 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
313   ↳ списка.</para></typeparam>
314 /// <param name="list"><para>The list of elements for which the action will be
315   ↳ executed.</para><para>Список элементов для которых будет выполняться
316   ↳ действие.</para></param>
317 /// <param name="action"><para>A function that will be called for each element of the
318   ↳ list.</para><para>Функция которая будет вызываться для каждого элемента
319   ↳ списка.</para></param>
320 [MethodImpl(MethodImplOptions.AggressiveInlining)]
321 public static void ForEach<T>(this IList<T> list, Action<T> action)
322 {
323     for (var i = 0; i < list.Count; i++)
324     {
325         action(list[i]);
326     }
327 }
328
329 /// <summary>
330 /// <para>Generates a hash code for the entire list based on the values of its
331   ↳ elements.</para>
332 /// <para>Генерирует хэш-код всего списка, на основе значений его элементов.</para>
333 /// </summary>
334 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
335   ↳ списка.</para></typeparam>
336 /// <param name="list"><para>Hash list.</para><para>Список для
337   ↳ хеширования.</para></param>
338 /// <returns>
339 /// <para>The hash code of the list.</para>
340 /// <para>Хэш-код списка.</para>
341 /// </returns>
342 /// <remarks>

```

```

333 /// Based on http://stackoverflow.com/questions/263400/what-is-the-best-algorithm-for-an
334   → -overridden-system-object-gethashcode
335 /// </remarks>
336 [MethodImpl(MethodImplOptions.AggressiveInlining)]
337 public static int GenerateHashCode<T>(this IList<T> list)
338 {
339     var hashAccumulator = 17;
340     for (var i = 0; i < list.Count; i++)
341     {
342         hashAccumulator = unchecked((hashAccumulator * 23) + list[i].GetHashCode());
343     }
344     return hashAccumulator;
345 }
346
347 /// <summary>
348 /// <para>Compares two lists.</para>
349 /// <para>Сравнивает два списка.</para>
350 /// </summary>
351 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
352   → списка.</para></typeparam>
353 /// <param name="left"><para>The first compared list.</para><para>Первый список для
354   → сравнения.</para></param>
355 /// <param name="right"><para>The second compared list.</para><para>Второй список для
356   → сравнения.</para></param>
357 /// <returns>
358 /// <para>
359 ///     A signed integer that indicates the relative values of <paramref name="left" />
360   → and <paramref name="right" /> lists' elements, as shown in the following table.
361 ///     <list type="table">
362 ///         <listheader>
363 ///             <term>Value</term>
364 ///             <description>Meaning</description>
365 ///         </listheader>
366 ///         <item>
367 ///             <term>Is less than zero</term>
368 ///             <description>First non equal element of <paramref name="left" /> list is
369   → less than first not equal element of <paramref name="right" /> list.</description>
370 ///         </item>
371 ///         <item>
372 ///             <term>Zero</term>
373 ///             <description>All elements of <paramref name="left" /> list equals to all
374   → elements of <paramref name="right" /> list.</description>
375 ///         </item>
376 ///         <item>
377 ///             <term>Is greater than zero</term>
378 ///             <description>First non equal element of <paramref name="left" /> list is
379   → greater than first not equal element of <paramref name="right" /> list.</description>
380 ///         </item>
381 ///     </list>
382 /// </para>
383 /// <para>
384 ///     Целое число со знаком, которое указывает относительные значения элементов
385   → списков <paramref name="left" /> и <paramref name="right" /> как показано в
386   → следующей таблице.
387 ///     <list type="table">
388 ///         <listheader>
389 ///             <term>Значение</term>
390 ///             <description>Смысл</description>
391 ///         </listheader>
392 ///         <item>
393 ///             <term>Меньше нуля</term>
394 ///             <description>Первый не равный элемент <paramref name="left" /> списка
395   → меньше первого неравного элемента <paramref name="right" /> списка.</description>
396 ///         </item>
397 ///         <item>
398 ///             <term>Ноль</term>
399 ///             <description>Все элементы <paramref name="left" /> списка равны всем
400   → элементам <paramref name="right" /> списка.</description>
401 ///         </item>
402 ///         <item>
403 ///             <term>Больше нуля</term>
404 ///             <description>Первый не равный элемент <paramref name="left" /> списка
405   → больше первого неравного элемента <paramref name="right" /> списка.</description>
406 ///         </item>
407 ///     </list>
408 /// </para>
409 /// </returns>

```

```

397 [MethodImpl(MethodImplOptions.AggressiveInlining)]
398 public static int CompareTo<T>(this IList<T> left, IList<T> right)
399 {
400     var comparer = Comparer<T>.Default;
401     var leftCount = left.GetCountOrZero();
402     var rightCount = right.GetCountOrZero();
403     var intermediateResult = leftCount.CompareTo(rightCount);
404     for (var i = 0; intermediateResult == 0 && i < leftCount; i++)
405     {
406         intermediateResult = comparer.Compare(left[i], right[i]);
407     }
408     return intermediateResult;
409 }
410
411 /// <summary>
412 /// <para>Skips one element in the list and builds an array from the remaining
413   → elements.</para>
414 /// <para>Пропускает один элемент списка и составляет из оставшихся элементов
415   → массив.</para>
416 /// </summary>
417 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
418   → списка.</para></typeparam>
419 /// <param name="list"><para>The list to copy from.</para><para>Список для
420   → копирования.</para></param>
421 /// <returns>
422 /// <para>If the list is empty, returns an empty array, otherwise - an array with a
423   → missing first element.</para>
424 /// <para>Если список пуст, возвращает пустой массив, иначе - массив с пропущенным
425   → первым элементом.</para>
426 /// </returns>
427 [MethodImpl(MethodImplOptions.AggressiveInlining)]
428 public static T[] SkipFirst<T>(this IList<T> list) => list.SkipFirst(1);
429
430 /// <summary>
431 /// <para>Skips the specified number of elements in the list and builds an array from
432   → the remaining elements.</para>
433 /// <para>Пропускает указанное количество элементов списка и составляет из оставшихся
434   → элементов массив.</para>
435 /// </summary>
436 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
437   → списка.</para></typeparam>
438 /// <param name="list"><para>The list to copy from.</para><para>Список для
439   → копирования.</para></param>
440 /// <param name="skip"><para>The number of items to skip.</para><para>Количество
441   → пропускаемых элементов.</para></param>
442 /// <returns>
443 /// <para>If the list is empty, or the number of skipped elements is greater than the
444   → list, returns an empty array, otherwise - an array with the specified number of
445   → missing elements.</para>
446 /// <para>Если список пуст, или количество пропускаемых элементов больше списка -
447   → возвращает пустой массив, иначе - массив с указанным количеством пропущенных
448   → элементов.</para>
449 /// </returns>
450 [MethodImpl(MethodImplOptions.AggressiveInlining)]
451 public static T[] SkipFirst<T>(this IList<T> list, int skip)
452 {
453     if (list.IsNullOrEmpty() || list.Count <= skip)
454     {
455         return Array.Empty<T>();
456     }
457     var result = new T[list.Count - skip];
458     for (int r = skip, w = 0; r < list.Count; r++, w++)
459     {
460         result[w] = list[r];
461     }
462     return result;
463 }
464
465 /// <summary>
466 /// <para>Shifts all the elements of the list by one position to the right.</para>
467 /// <para>Сдвигает вправо все элементы списка на одну позицию.</para>
468 /// </summary>
469 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
470   → списка.</para></typeparam>
471 /// <param name="list"><para>The list to copy from.</para><para>Список для
472   → копирования.</para></param>
473 /// <returns>

```

```

457 /// <para>Array with a shift of elements by one position.</para>
458 /// <para>Массив со сдвигом элементов на одну позицию.</para>
459 /// </returns>
460 [MethodImpl(MethodImplOptions.AggressiveInlining)]
461 public static IList<T> ShiftRight<T>(this IList<T> list) => list.ShiftRight(1);
462
463 /// <summary>
464 /// <para>Shifts all elements of the list to the right by the specified number of
465   → elements.</para>
466 /// <para>Сдвигает вправо все элементы списка на указанное количество элементов.</para>
467 /// </summary>
468 /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
469   → списка.</para></typeparam>
470 /// <param name="list"><para>The list to copy from.</para><para>Список для
471   → копирования.</para></param>
472 /// <param name="skip"><para>The number of items to shift.</para><para>Количество
473   → сдвигаемых элементов.</para></param>
474 /// <returns>
475 /// <para>If the value of the shift variable is less than zero - an <see
476   → cref="NotImplementedException"/> exception is thrown, but if the value of the shift
477   → variable is 0 - an exact copy of the array is returned. Otherwise, an array is
478   → returned with the shift of the elements.</para>
479 /// <para>Если значение переменной shift меньше нуля - выбрасывается исключение <see
480   → cref="NotImplementedException"/>, если же значение переменной shift равно 0 -
481   → возвращается точная копия массива. Иначе возвращается массив со сдвигом
482   → элементов.</para>
483 /// </returns>
484 [MethodImpl(MethodImplOptions.AggressiveInlining)]
485 public static IList<T> ShiftRight<T>(this IList<T> list, int shift)
486 {
487     if (shift < 0)
488     {
489         throw new NotImplementedException();
490     }
491     if (shift == 0)
492     {
493         return list.ToArray();
494     }
495     else
496     {
497         var result = new T[list.Count + shift];
498         for (int r = 0, w = shift; r < list.Count; r++, w++)
499         {
500             result[w] = list[r];
501         }
502         return result;
503     }
504 }
505 }
506 }

```

1.19 ./csharp/Platform.Collections/Lists/ListFiller.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 namespace Platform.Collections.Lists
5 {
6     public class ListFiller<TElement, TReturnConstant>
7     {
8         protected readonly List<TElement> _list;
9         protected readonly TReturnConstant _returnConstant;
10
11         /// <summary>
12         /// <para>Initializes a new instance of the ListFiller class.</para>
13         /// <para>Инициализирует новый экземпляр класса ListFiller.</para>
14         /// </summary>
15         /// <param name="list"><para>The list to be filled.</para><para>Список который будет
16           → заполняться.</para></param>
17         /// <param name="returnConstant"><para>The value for the constant returned by
18           → corresponding methods.</para><para>Значение для константы возвращаемой
19           → соответствующими методами.</para></param>
20         [MethodImpl(MethodImplOptions.AggressiveInlining)]
21         public ListFiller(List<TElement> list, TReturnConstant returnConstant)
22         {
23             _list = list;
24             _returnConstant = returnConstant;
25         }
26     }
27 }

```



```

24 [MethodImpl(MethodImplOptions.AggressiveInlining)]
25 public ListFiller(List<TElement> list) : this(list, default) { }
26
27 /// <summary>
28 /// <para>Adds an item to the end of the list.</para>
29 /// <para>Добавляет элемент в конец списка.</para>
30 /// </summary>
31 /// <param name="element"><para>Element to add.</para><para>Добавляемый
   ↳ элемент.</para></param>
32 [MethodImpl(MethodImplOptions.AggressiveInlining)]
33 public void Add(TElement element) => _list.Add(element);
34
35 /// <summary>
36 /// <para>Adds an item to the end of the list and return true.</para>
37 /// <para>Добавляет элемент в конец списка и возвращает true.</para>
38 /// </summary>
39 /// <param name="element"><para>Element to add.</para><para>Добавляемый
   ↳ элемент.</para></param>
40 /// <returns>
41 /// <para>True value in any case.</para>
42 /// <para>Значение true в любом случае.</para>
43 /// </returns>
44 [MethodImpl(MethodImplOptions.AggressiveInlining)]
45 public bool AddAndReturnTrue(TElement element) => _list.AddAndReturnTrue(element);
46
47 /// <summary>
48 /// <para>Adds a value to the list at the first index and return true.</para>
49 /// <para>Добавляет значение в список по первому индексу и возвращает true.</para>
50 /// </summary>
51 /// <param name="element"><para>Element to add.</para><para>Добавляемый
   ↳ элемент.</para></param>
52 /// <returns>
53 /// <para>True value in any case.</para>
54 /// <para>Значение true в любом случае.</para>
55 /// </returns>
56 [MethodImpl(MethodImplOptions.AggressiveInlining)]
57 public bool AddFirstAndReturnTrue(ICollection<TElement> elements) =>
   ↳ _list.AddFirstAndReturnTrue(elements);
58
59 /// <summary>
60 /// <para>Adds all elements from other list to this list and returns true.</para>
61 /// <para>Добавляет все элементы из другого списка в этот список и возвращает
   ↳ true.</para>
62 /// </summary>
63 /// <param name="elements"><para>List of values to add.</para><para>Список значений
   ↳ которые необходимо добавить.</para></param>
64 /// <returns>
65 /// <para>True value in any case.</para>
66 /// <para>Значение true в любом случае.</para>
67 /// </returns>
68 [MethodImpl(MethodImplOptions.AggressiveInlining)]
69 public bool AddAllAndReturnTrue(ICollection<TElement> elements) =>
   ↳ _list.AddAllAndReturnTrue(elements);
70
71 /// <summary>
72 /// <para>Adds values to the list skipping the first element.</para>
73 /// <para>Добавляет значения в список пропуская первый элемент.</para>
74 /// </summary>
75 /// <param name="elements"><para>The list of values to add.</para><para>Список значений
   ↳ которые необходимо добавить.</para></param>
76 /// <returns>
77 /// <para>True value in any case.</para>
78 /// <para>Значение true в любом случае.</para>
79 /// </returns>
80 [MethodImpl(MethodImplOptions.AggressiveInlining)]
81 public bool AddSkipFirstAndReturnTrue(ICollection<TElement> elements) =>
   ↳ _list.AddSkipFirstAndReturnTrue(elements);
82
83 /// <summary>
84 /// <para>Adds an item to the end of the list and return constant.</para>
85 /// <para>Добавляет элемент в конец списка и возвращает константу.</para>
86 /// </summary>
87 /// <param name="element"><para>Element to add.</para><para>Добавляемый
   ↳ элемент.</para></param>
88 /// <returns>
89 /// <para>Constant value in any case.</para>
90 /// <para>Значение константы в любом случае.</para>

```

```

91     /// </returns>
92     [MethodImpl(MethodImplOptions.AggressiveInlining)]
93     public TReturnConstant AddAndReturnConstant(TElement element)
94     {
95         _list.Add(element);
96         return _returnConstant;
97     }
98
99     /// <summary>
100    /// <para>Adds a value to the list at the first index and return constant.</para>
101    /// <para>Добавляет значение в список по первому индексу и возвращает константу.</para>
102    /// </summary>
103    /// <param name="element"><para>Element to add.</para><para>Добавляемый
    → элемент.</para></param>
104    /// <returns>
105    /// <para>Constant value in any case.</para>
106    /// <para>Значение константы в любом случае.</para>
107    /// </returns></returns>
108    [MethodImpl(MethodImplOptions.AggressiveInlining)]
109    public TReturnConstant AddFirstAndReturnConstant(ICollection<TElement> elements)
110    {
111        _list.AddFirst(elements);
112        return _returnConstant;
113    }
114
115    /// <summary>
116    /// <para>Adds all elements from other list to this list and returns constant.</para>
117    /// <para>Добавляет все элементы из другого списка в этот список и возвращает
    → константу.</para>
118    /// </summary>
119    /// <param name="elements"><para>List of values to add.</para><para>Список значений
    → которые необходимо добавить.</para></param>
120    /// <returns>
121    /// <para>Constant value in any case.</para>
122    /// <para>Значение константы в любом случае.</para>
123    /// </returns>
124    [MethodImpl(MethodImplOptions.AggressiveInlining)]
125    public TReturnConstant AddAllAndReturnConstant(ICollection<TElement> elements)
126    {
127        _list.AddAll(elements);
128        return _returnConstant;
129    }
130
131    /// <summary>
132    /// <para>Adds values to the list skipping the first element and return constant
    → value.</para>
133    /// <para>Добавляет значения в список пропуская первый элемент и возвращает значение
    → константы.</para>
134    /// </summary>
135    /// <param name="elements"><para>The list of values to add.</para><para>Список значений
    → которые необходимо добавить.</para></param>
136    /// <returns>
137    /// <para>constant value in any case.</para>
138    /// <para>Значение константы в любом случае.</para>
139    /// </returns>
140    [MethodImpl(MethodImplOptions.AggressiveInlining)]
141    public TReturnConstant AddSkipFirstAndReturnConstant(ICollection<TElement> elements)
142    {
143        _list.AddSkipFirst(elements);
144        return _returnConstant;
145    }
146 }
147 }

```

1.20 ./csharp/Platform.Collections.Segments/CharSegment.cs

```

1  using System.Linq;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Collections.Arrays;
5  using Platform.Collections.Lists;
6
7  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9  namespace Platform.Collections.Segments
10 {
11     public class CharSegment : Segment<char>
12     {
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

14     public CharSegment(IList<char> @base, int offset, int length) : base(@base, offset,
    ↪     length) { }
15
16     [MethodImpl(MethodImplOptions.AggressiveInlining)]
17     public override int GetHashCode()
18     {
19         // Base can be not an array, but still IList<char>
20         if (Base is char[] baseArray)
21         {
22             return baseArray.GenerateHashCode(Offset, Length);
23         }
24         else
25         {
26             return this.GenerateHashCode();
27         }
28     }
29
30     [MethodImpl(MethodImplOptions.AggressiveInlining)]
31     public override bool Equals(Segment<char> other)
32     {
33         bool contentEqualityComparer(IList<char> left, IList<char> right)
34         {
35             // Base can be not an array, but still IList<char>
36             if (Base is char[] baseArray && other.Base is char[] otherArray)
37             {
38                 return baseArray.ContentEqualTo(Offset, Length, otherArray, other.Offset);
39             }
40             else
41             {
42                 return left.ContentEqualTo(right);
43             }
44         }
45         return this.EqualTo(other, contentEqualityComparer);
46     }
47
48     public override bool Equals(object obj) => obj is Segment<char> charSegment ?
    ↪     Equals(charSegment) : false;
49
50     [MethodImpl(MethodImplOptions.AggressiveInlining)]
51     public static implicit operator string(CharSegment segment)
52     {
53         if (!(segment.Base is char[] array))
54         {
55             array = segment.Base.ToArray();
56         }
57         return new string(array, segment.Offset, segment.Length);
58     }
59
60     [MethodImpl(MethodImplOptions.AggressiveInlining)]
61     public override string ToString() => this;
62 }
63 }

```

1.21 ./csharp/Platform.Collections.Segments/Segment.cs

```

1  using System;
2  using System.Collections;
3  using System.Collections.Generic;
4  using System.Runtime.CompilerServices;
5  using Platform.Collections.Arrays;
6  using Platform.Collections.Lists;
7
8  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
9
10 namespace Platform.Collections.Segments
11 {
12     public class Segment<T> : IEquatable<Segment<T>>, IList<T>
13     {
14         public IList<T> Base
15         {
16             [MethodImpl(MethodImplOptions.AggressiveInlining)]
17             get;
18         }
19         public int Offset
20         {
21             [MethodImpl(MethodImplOptions.AggressiveInlining)]
22             get;
23         }
24         public int Length
25         {

```

```

26         [MethodImpl(MethodImplOptions.AggressiveInlining)]
27         get;
28     }
29
30     [MethodImpl(MethodImplOptions.AggressiveInlining)]
31     public Segment(ICollection<T> @base, int offset, int length)
32     {
33         Base = @base;
34         Offset = offset;
35         Length = length;
36     }
37
38     [MethodImpl(MethodImplOptions.AggressiveInlining)]
39     public override int GetHashCode() => this.GenerateHashCode();
40
41     [MethodImpl(MethodImplOptions.AggressiveInlining)]
42     public virtual bool Equals(Segment<T> other) => this.EqualTo(other);
43
44     [MethodImpl(MethodImplOptions.AggressiveInlining)]
45     public override bool Equals(object obj) => obj is Segment<T> other ? Equals(other) :
46         ↪ false;
47
48     #region ICollection
49     public T this[int i]
50     {
51         [MethodImpl(MethodImplOptions.AggressiveInlining)]
52         get => Base[Offset + i];
53         [MethodImpl(MethodImplOptions.AggressiveInlining)]
54         set => Base[Offset + i] = value;
55     }
56
57     public int Count
58     {
59         [MethodImpl(MethodImplOptions.AggressiveInlining)]
60         get => Length;
61     }
62
63     public bool IsReadOnly
64     {
65         [MethodImpl(MethodImplOptions.AggressiveInlining)]
66         get => true;
67     }
68
69     [MethodImpl(MethodImplOptions.AggressiveInlining)]
70     public int IndexOf(T item)
71     {
72         var index = Base.IndexOf(item);
73         if (index >= Offset)
74         {
75             var actualIndex = index - Offset;
76             if (actualIndex < Length)
77             {
78                 return actualIndex;
79             }
80         }
81         return -1;
82     }
83
84     [MethodImpl(MethodImplOptions.AggressiveInlining)]
85     public void Insert(int index, T item) => throw new NotSupportedException();
86
87     [MethodImpl(MethodImplOptions.AggressiveInlining)]
88     public void RemoveAt(int index) => throw new NotSupportedException();
89
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     public void Add(T item) => throw new NotSupportedException();
92
93     [MethodImpl(MethodImplOptions.AggressiveInlining)]
94     public void Clear() => throw new NotSupportedException();
95
96     [MethodImpl(MethodImplOptions.AggressiveInlining)]
97     public bool Contains(T item) => IndexOf(item) >= 0;
98
99     [MethodImpl(MethodImplOptions.AggressiveInlining)]
100    public void CopyTo(T[] array, int arrayIndex)
101    {
102        for (var i = 0; i < Length; i++)
103        {
104            array.Add(ref arrayIndex, this[i]);

```

```

105     }
106 }
107
108 [MethodImpl(MethodImplOptions.AggressiveInlining)]
109 public bool Remove(T item) => throw new NotSupportedException();
110
111 [MethodImpl(MethodImplOptions.AggressiveInlining)]
112 public IEnumerator<T> GetEnumerator()
113 {
114     for (var i = 0; i < Length; i++)
115     {
116         yield return this[i];
117     }
118 }
119
120 [MethodImpl(MethodImplOptions.AggressiveInlining)]
121 IEnumerator IEnumerable.GetEnumerator() => GetEnumerator();
122
123 #endregion
124 }
125 }

```

1.22 ./csharp/Platform.Collections.Segments.Walkers.AllSegmentsWalkerBase.cs

```

1 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
2
3 namespace Platform.Collections.Segments.Walkers
4 {
5     public abstract class AllSegmentsWalkerBase
6     {
7         public static readonly int DefaultMinimumStringSegmentLength = 2;
8     }
9 }

```

1.23 ./csharp/Platform.Collections.Segments.Walkers.AllSegmentsWalkerBase[T, TSegment].cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Segments.Walkers
7 {
8     public abstract class AllSegmentsWalkerBase<T, TSegment> : AllSegmentsWalkerBase
9         where TSegment : Segment<T>
10     {
11         private readonly int _minimumStringSegmentLength;
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         protected AllSegmentsWalkerBase(int minimumStringSegmentLength) =>
15             ↪ _minimumStringSegmentLength = minimumStringSegmentLength;
16
17         [MethodImpl(MethodImplOptions.AggressiveInlining)]
18         protected AllSegmentsWalkerBase() : this(DefaultMinimumStringSegmentLength) { }
19
20         [MethodImpl(MethodImplOptions.AggressiveInlining)]
21         public virtual void WalkAll(ICollection<T> elements)
22         {
23             for (int offset = 0, maxOffset = elements.Count - _minimumStringSegmentLength;
24                 ↪ offset <= maxOffset; offset++)
25             {
26                 for (int length = _minimumStringSegmentLength, maxLength = elements.Count -
27                     ↪ offset; length <= maxLength; length++)
28                 {
29                     Iteration(CreateSegment(elements, offset, length));
30                 }
31             }
32
33             [MethodImpl(MethodImplOptions.AggressiveInlining)]
34             protected abstract TSegment CreateSegment(ICollection<T> elements, int offset, int length);
35
36             [MethodImpl(MethodImplOptions.AggressiveInlining)]
37             protected abstract void Iteration(TSegment segment);
38         }
39     }
40 }

```

1.24 ./csharp/Platform.Collections.Segments.Walkers.AllSegmentsWalkerBase[T].cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3

```

```

4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Segments.Walkers
7  {
8      public abstract class AllSegmentsWalkerBase<T> : AllSegmentsWalkerBase<T, Segment<T>>
9      {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         protected override Segment<T> CreateSegment(IList<T> elements, int offset, int length)
12             => new Segment<T>(elements, offset, length);
13     }

```

1.25 ./csharp/Platform.Collections.Segments.Walkers/AllSegmentsWalkerExtensions.cs

```

1  using System.Runtime.CompilerServices;
2
3  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5  namespace Platform.Collections.Segments.Walkers
6  {
7      public static class AllSegmentsWalkerExtensions
8      {
9         [MethodImpl(MethodImplOptions.AggressiveInlining)]
10         public static void WalkAll(this AllSegmentsWalkerBase<char> walker, string @string) =>
11             walker.WalkAll(@string.ToCharArray());
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public static void WalkAll<TSegment>(this AllSegmentsWalkerBase<char, TSegment> walker,
15             string @string) where TSegment : Segment<char> =>
16             walker.WalkAll(@string.ToCharArray());
17     }

```

1.26 ./csharp/Platform.Collections.Segments.Walkers/DictionaryBasedDuplicateSegmentsWalkerBase[T, Segment<T>].cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections.Segments.Walkers
8  {
9      public abstract class DictionaryBasedDuplicateSegmentsWalkerBase<T, TSegment> :
10         DuplicateSegmentsWalkerBase<T, TSegment>
11         where TSegment : Segment<T>
12     {
13         public static readonly bool DefaultResetDictionaryOnEachWalk;
14
15         private readonly bool _resetDictionaryOnEachWalk;
16         protected IDictionary<TSegment, long> Dictionary;
17
18         [MethodImpl(MethodImplOptions.AggressiveInlining)]
19         protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
20             dictionary, int minimumStringSegmentLength, bool resetDictionaryOnEachWalk)
21             : base(minimumStringSegmentLength)
22         {
23             Dictionary = dictionary;
24             _resetDictionaryOnEachWalk = resetDictionaryOnEachWalk;
25         }
26
27         [MethodImpl(MethodImplOptions.AggressiveInlining)]
28         protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
29             dictionary, int minimumStringSegmentLength) : this(dictionary,
30             minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
31
32         [MethodImpl(MethodImplOptions.AggressiveInlining)]
33         protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
34             dictionary) : this(dictionary, DefaultMinimumStringSegmentLength,
35             DefaultResetDictionaryOnEachWalk) { }
36
37         [MethodImpl(MethodImplOptions.AggressiveInlining)]
38         protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength,
39             bool resetDictionaryOnEachWalk) : this(resetDictionaryOnEachWalk ? null : new
40             Dictionary<TSegment, long>(), minimumStringSegmentLength, resetDictionaryOnEachWalk)
41         { }
42
43         [MethodImpl(MethodImplOptions.AggressiveInlining)]
44         protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
45             this(minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }

```

```

37     [MethodImpl(MethodImplOptions.AggressiveInlining)]
38     protected DictionaryBasedDuplicateSegmentsWalkerBase() :
    ↪     this(DefaultMinimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
39
40     [MethodImpl(MethodImplOptions.AggressiveInlining)]
41     public override void WalkAll(ICollection<T> elements)
42     {
43         if (_resetDictionaryOnEachWalk)
44         {
45             var capacity = Math.Ceiling(Math.Pow(elements.Count, 2) / 2);
46             Dictionary = new Dictionary<TSegment, long>((int)capacity);
47         }
48         base.WalkAll(elements);
49     }
50
51     [MethodImpl(MethodImplOptions.AggressiveInlining)]
52     protected override long GetSegmentFrequency(TSegment segment) =>
    ↪     Dictionary.GetOrDefault(segment);
53
54     [MethodImpl(MethodImplOptions.AggressiveInlining)]
55     protected override void SetSegmentFrequency(TSegment segment, long frequency) =>
    ↪     Dictionary[segment] = frequency;
56 }
57 }

```

1.27 ./csharp/Platform.Collections.Segments.Walkers/DictionaryBasedDuplicateSegmentsWalkerBase[T].cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Segments.Walkers
7  {
8      public abstract class DictionaryBasedDuplicateSegmentsWalkerBase<T> :
    ↪     DictionaryBasedDuplicateSegmentsWalkerBase<T, Segment<T>>
9      {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<Segment<T>, long>
    ↪     dictionary, int minimumStringSegmentLength, bool resetDictionaryOnEachWalk) :
    ↪     base(dictionary, minimumStringSegmentLength, resetDictionaryOnEachWalk) { }
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<Segment<T>, long>
    ↪     dictionary, int minimumStringSegmentLength) : base(dictionary,
    ↪     minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
15
16         [MethodImpl(MethodImplOptions.AggressiveInlining)]
17         protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<Segment<T>, long>
    ↪     dictionary) : base(dictionary, DefaultMinimumStringSegmentLength,
    ↪     DefaultResetDictionaryOnEachWalk) { }
18
19         [MethodImpl(MethodImplOptions.AggressiveInlining)]
20         protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength,
    ↪     bool resetDictionaryOnEachWalk) : base(minimumStringSegmentLength,
    ↪     resetDictionaryOnEachWalk) { }
21
22         [MethodImpl(MethodImplOptions.AggressiveInlining)]
23         protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
    ↪     base(minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
24
25         [MethodImpl(MethodImplOptions.AggressiveInlining)]
26         protected DictionaryBasedDuplicateSegmentsWalkerBase() :
    ↪     base(DefaultMinimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
27     }
28 }

```

1.28 ./csharp/Platform.Collections.Segments.Walkers/DuplicateSegmentsWalkerBase[T, TSegment].cs

```

1  using System.Runtime.CompilerServices;
2
3  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5  namespace Platform.Collections.Segments.Walkers
6  {
7      public abstract class DuplicateSegmentsWalkerBase<T, TSegment> : AllSegmentsWalkerBase<T,
    ↪     TSegment>
8      where TSegment : Segment<T>
9      {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

11     protected DuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
12         ↪ base(minimumStringSegmentLength) { }
13
14     [MethodImpl(MethodImplOptions.AggressiveInlining)]
15     protected DuplicateSegmentsWalkerBase() : base(DefaultMinimumStringSegmentLength) { }
16
17     [MethodImpl(MethodImplOptions.AggressiveInlining)]
18     protected override void Iteration(TSegment segment)
19     {
20         var frequency = GetSegmentFrequency(segment);
21         if (frequency == 1)
22         {
23             OnDuplicateFound(segment);
24         }
25         SetSegmentFrequency(segment, frequency + 1);
26     }
27
28     [MethodImpl(MethodImplOptions.AggressiveInlining)]
29     protected abstract void OnDuplicateFound(TSegment segment);
30
31     [MethodImpl(MethodImplOptions.AggressiveInlining)]
32     protected abstract long GetSegmentFrequency(TSegment segment);
33
34     [MethodImpl(MethodImplOptions.AggressiveInlining)]
35     protected abstract void SetSegmentFrequency(TSegment segment, long frequency);
36 }

```

1.29 ./csharp/Platform.Collections.Segments.Walkers/DuplicateSegmentsWalkerBase[T].cs

```

1 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
2
3 namespace Platform.Collections.Segments.Walkers
4 {
5     public abstract class DuplicateSegmentsWalkerBase<T> : DuplicateSegmentsWalkerBase<T,
6         ↪ Segment<T>>
7     {
8     }
9 }

```

1.30 ./csharp/Platform.Collections.Sets/ISetExtensions.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Sets
7 {
8     public static class ISetExtensions
9     {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         public static void AddAndReturnVoid<T>(this ISet<T> set, T element) => set.Add(element);
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public static void RemoveAndReturnVoid<T>(this ISet<T> set, T element) =>
15             ↪ set.Remove(element);
16
17         [MethodImpl(MethodImplOptions.AggressiveInlining)]
18         public static bool AddAndReturnTrue<T>(this ISet<T> set, T element)
19         {
20             set.Add(element);
21             return true;
22         }
23
24         [MethodImpl(MethodImplOptions.AggressiveInlining)]
25         public static bool AddFirstAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
26         {
27             AddFirst(set, elements);
28             return true;
29         }
30
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public static void AddFirst<T>(this ISet<T> set, IList<T> elements) =>
33             ↪ set.Add(elements[0]);
34
35         [MethodImpl(MethodImplOptions.AggressiveInlining)]
36         public static bool AddAllAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
37         {
38             set.AddAll(elements);
39             return true;
40         }
41     }
42 }

```



```

38     }
39
40     [MethodImpl(MethodImplOptions.AggressiveInlining)]
41     public static void AddAll<T>(this ISet<T> set, IList<T> elements)
42     {
43         for (var i = 0; i < elements.Count; i++)
44         {
45             set.Add(elements[i]);
46         }
47     }
48
49     [MethodImpl(MethodImplOptions.AggressiveInlining)]
50     public static bool AddSkipFirstAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
51     {
52         set.AddSkipFirst(elements);
53         return true;
54     }
55
56     [MethodImpl(MethodImplOptions.AggressiveInlining)]
57     public static void AddSkipFirst<T>(this ISet<T> set, IList<T> elements) =>
58         ↪ set.AddSkipFirst(elements, 1);
59
60     [MethodImpl(MethodImplOptions.AggressiveInlining)]
61     public static void AddSkipFirst<T>(this ISet<T> set, IList<T> elements, int skip)
62     {
63         for (var i = skip; i < elements.Count; i++)
64         {
65             set.Add(elements[i]);
66         }
67     }
68
69     [MethodImpl(MethodImplOptions.AggressiveInlining)]
70     public static bool DoNotContains<T>(this ISet<T> set, T element) =>
71         ↪ !set.Contains(element);
72 }

```

1.31 ./csharp/Platform.Collections/Sets/SetFiller.cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Sets
7  {
8      public class SetFiller<TElement, TReturnConstant>
9      {
10         protected readonly ISet<TElement> _set;
11         protected readonly TReturnConstant _returnConstant;
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public SetFiller(ISet<TElement> set, TReturnConstant returnConstant)
15         {
16             _set = set;
17             _returnConstant = returnConstant;
18         }
19
20         [MethodImpl(MethodImplOptions.AggressiveInlining)]
21         public SetFiller(ISet<TElement> set) : this(set, default) { }
22
23         [MethodImpl(MethodImplOptions.AggressiveInlining)]
24         public void Add(TElement element) => _set.Add(element);
25
26         [MethodImpl(MethodImplOptions.AggressiveInlining)]
27         public bool AddAndReturnTrue(TElement element) => _set.AddAndReturnTrue(element);
28
29         [MethodImpl(MethodImplOptions.AggressiveInlining)]
30         public bool AddFirstAndReturnTrue(IList<TElement> elements) =>
31             ↪ _set.AddFirstAndReturnTrue(elements);
32
33         [MethodImpl(MethodImplOptions.AggressiveInlining)]
34         public bool AddAllAndReturnTrue(IList<TElement> elements) =>
35             ↪ _set.AddAllAndReturnTrue(elements);
36
37         [MethodImpl(MethodImplOptions.AggressiveInlining)]
38         public bool AddSkipFirstAndReturnTrue(IList<TElement> elements) =>
39             ↪ _set.AddSkipFirstAndReturnTrue(elements);
40
41         [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

39     public TReturnConstant AddAndReturnConstant(TElement element)
40     {
41         _set.Add(element);
42         return _returnConstant;
43     }
44
45     [MethodImpl(MethodImplOptions.AggressiveInlining)]
46     public TReturnConstant AddFirstAndReturnConstant(ICollection<TElement> elements)
47     {
48         _set.AddFirst(elements);
49         return _returnConstant;
50     }
51
52     [MethodImpl(MethodImplOptions.AggressiveInlining)]
53     public TReturnConstant AddAllAndReturnConstant(ICollection<TElement> elements)
54     {
55         _set.AddAll(elements);
56         return _returnConstant;
57     }
58
59     [MethodImpl(MethodImplOptions.AggressiveInlining)]
60     public TReturnConstant AddSkipFirstAndReturnConstant(ICollection<TElement> elements)
61     {
62         _set.AddSkipFirst(elements);
63         return _returnConstant;
64     }
65 }
66 }

```

1.32 ./csharp/Platform.Collections.Stacks.DefaultStack.cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Stacks
7  {
8      public class DefaultStack<TElement> : Stack<TElement>, IStack<TElement>
9      {
10         public bool IsEmpty
11         {
12             [MethodImpl(MethodImplOptions.AggressiveInlining)]
13             get => Count <= 0;
14         }
15     }
16 }

```

1.33 ./csharp/Platform.Collections.Stacks.IStack.cs

```

1  using System.Runtime.CompilerServices;
2
3  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5  namespace Platform.Collections.Stacks
6  {
7      public interface IStack<TElement>
8      {
9         bool IsEmpty
10         {
11             [MethodImpl(MethodImplOptions.AggressiveInlining)]
12             get;
13         }
14
15         [MethodImpl(MethodImplOptions.AggressiveInlining)]
16         void Push(TElement element);
17
18         [MethodImpl(MethodImplOptions.AggressiveInlining)]
19         TElement Pop();
20
21         [MethodImpl(MethodImplOptions.AggressiveInlining)]
22         TElement Peek();
23     }
24 }

```

1.34 ./csharp/Platform.Collections.Stacks.IStackExtensions.cs

```

1  using System.Runtime.CompilerServices;
2
3  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5  namespace Platform.Collections.Stacks

```

```

6 {
7     public static class IStackExtensions
8     {
9         [MethodImpl(MethodImplOptions.AggressiveInlining)]
10        public static void Clear<T>(this IStack<T> stack)
11        {
12            while (!stack.IsEmpty)
13            {
14                _ = stack.Pop();
15            }
16        }
17
18        [MethodImpl(MethodImplOptions.AggressiveInlining)]
19        public static T PopOrDefault<T>(this IStack<T> stack) => stack.IsEmpty ? default :
20            ↪ stack.Pop();
21
22        [MethodImpl(MethodImplOptions.AggressiveInlining)]
23        public static T PeekOrDefault<T>(this IStack<T> stack) => stack.IsEmpty ? default :
24            ↪ stack.Peek();
25    }
26 }

```

1.35 ./csharp/Platform.Collections/Stacks/IStackFactory.cs

```

1 using Platform.Interfaces;
2
3 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5 namespace Platform.Collections.Stacks
6 {
7     public interface IStackFactory<TElement> : IFactory<IStack<TElement>>
8     {
9     }
10 }

```

1.36 ./csharp/Platform.Collections/Stacks/StackExtensions.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Stacks
7 {
8     public static class StackExtensions
9     {
10        [MethodImpl(MethodImplOptions.AggressiveInlining)]
11        public static T PopOrDefault<T>(this Stack<T> stack) => stack.Count > 0 ? stack.Pop() :
12            ↪ default;
13
14        [MethodImpl(MethodImplOptions.AggressiveInlining)]
15        public static T PeekOrDefault<T>(this Stack<T> stack) => stack.Count > 0 ? stack.Peek()
16            ↪ : default;
17    }
18 }

```

1.37 ./csharp/Platform.Collections/StringExtensions.cs

```

1 using System;
2 using System.Globalization;
3 using System.Runtime.CompilerServices;
4
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Collections
8 {
9     public static class StringExtensions
10    {
11        [MethodImpl(MethodImplOptions.AggressiveInlining)]
12        public static string CapitalizeFirstLetter(this string @string)
13        {
14            if (@string.IsNullOrEmpty(@string))
15            {
16                return @string;
17            }
18            var chars = @string.ToCharArray();
19            for (var i = 0; i < chars.Length; i++)
20            {
21                var category = char.GetUnicodeCategory(chars[i]);
22                if (category == UnicodeCategory.UppercaseLetter)
23                {
24                    return @string;
25                }
26            }
27        }
28    }
29 }

```

```

25     }
26     if (category == UnicodeCategory.LowercaseLetter)
27     {
28         chars[i] = char.ToUpper(chars[i]);
29         return new string(chars);
30     }
31 }
32 return @string;
33 }
34
35 [MethodImpl(MethodImplOptions.AggressiveInlining)]
36 public static string Truncate(this string @string, int maxLength) =>
    ↪ string.IsNullOrEmpty(@string) ? @string : @string.Substring(0,
    ↪ Math.Min(@string.Length, maxLength));
37
38 [MethodImpl(MethodImplOptions.AggressiveInlining)]
39 public static string TrimSingle(this string @string, char charToTrim)
40 {
41     if (!string.IsNullOrEmpty(@string))
42     {
43         if (@string.Length == 1)
44         {
45             if (@string[0] == charToTrim)
46             {
47                 return "";
48             }
49             else
50             {
51                 return @string;
52             }
53         }
54         else
55         {
56             var left = 0;
57             var right = @string.Length - 1;
58             if (@string[left] == charToTrim)
59             {
60                 left++;
61             }
62             if (@string[right] == charToTrim)
63             {
64                 right--;
65             }
66             return @string.Substring(left, right - left + 1);
67         }
68     }
69     else
70     {
71         return @string;
72     }
73 }
74 }
75 }

```

1.38 ./csharp/Platform.Collections/Trees/Node.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 // ReSharper disable ForCanBeConvertedToForeach
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Collections.Trees
8 {
9     public class Node
10     {
11         private Dictionary<object, Node> _childNodes;
12
13         public object Value
14         {
15             [MethodImpl(MethodImplOptions.AggressiveInlining)]
16             get;
17             [MethodImpl(MethodImplOptions.AggressiveInlining)]
18             set;
19         }
20
21         public Dictionary<object, Node> ChildNodes
22         {
23             [MethodImpl(MethodImplOptions.AggressiveInlining)]
24             get => _childNodes ?? (_childNodes = new Dictionary<object, Node>());
25         }
26     }
27 }

```

```

26
27 public Node this[object key]
28 {
29     [MethodImpl(MethodImplOptions.AggressiveInlining)]
30     get => GetChild(key) ?? AddChild(key);
31     [MethodImpl(MethodImplOptions.AggressiveInlining)]
32     set => SetChildValue(value, key);
33 }
34
35 [MethodImpl(MethodImplOptions.AggressiveInlining)]
36 public Node(object value) => Value = value;
37
38 [MethodImpl(MethodImplOptions.AggressiveInlining)]
39 public Node() : this(null) { }
40
41 [MethodImpl(MethodImplOptions.AggressiveInlining)]
42 public bool ContainsChild(params object[] keys) => GetChild(keys) != null;
43
44 [MethodImpl(MethodImplOptions.AggressiveInlining)]
45 public Node GetChild(params object[] keys)
46 {
47     var node = this;
48     for (var i = 0; i < keys.Length; i++)
49     {
50         node.ChildNodes.TryGetValue(keys[i], out node);
51         if (node == null)
52         {
53             return null;
54         }
55     }
56     return node;
57 }
58
59 [MethodImpl(MethodImplOptions.AggressiveInlining)]
60 public object GetChildValue(params object[] keys) => GetChild(keys)?.Value;
61
62 [MethodImpl(MethodImplOptions.AggressiveInlining)]
63 public Node AddChild(object key) => AddChild(key, new Node(null));
64
65 [MethodImpl(MethodImplOptions.AggressiveInlining)]
66 public Node AddChild(object key, object value) => AddChild(key, new Node(value));
67
68 [MethodImpl(MethodImplOptions.AggressiveInlining)]
69 public Node AddChild(object key, Node child)
70 {
71     ChildNodes.Add(key, child);
72     return child;
73 }
74
75 [MethodImpl(MethodImplOptions.AggressiveInlining)]
76 public Node SetChild(params object[] keys) => SetChildValue(null, keys);
77
78 [MethodImpl(MethodImplOptions.AggressiveInlining)]
79 public Node SetChild(object key) => SetChildValue(null, key);
80
81 [MethodImpl(MethodImplOptions.AggressiveInlining)]
82 public Node SetChildValue(object value, params object[] keys)
83 {
84     var node = this;
85     for (var i = 0; i < keys.Length; i++)
86     {
87         node = SetChildValue(value, keys[i]);
88     }
89     node.Value = value;
90     return node;
91 }
92
93 [MethodImpl(MethodImplOptions.AggressiveInlining)]
94 public Node SetChildValue(object value, object key)
95 {
96     if (!ChildNodes.TryGetValue(key, out Node child))
97     {
98         child = AddChild(key, value);
99     }
100     child.Value = value;
101     return child;
102 }
103 }
104 }

```

1.39 ./csharp/Platform.Collections.Tests/ArrayTests.cs

```
1 using Xunit;
2 using Platform.Collections.Arrays;
3
4 namespace Platform.Collections.Tests
5 {
6     public class ArrayTests
7     {
8         [Fact]
9         public void GetElementTest()
10        {
11            var nullArray = (int[])null;
12            Assert.Equal(0, nullArray.GetElementOrDefault(1));
13            Assert.False(nullArray.TryGetElement(1, out int element));
14            Assert.Equal(0, element);
15            var array = new int[] { 1, 2, 3 };
16            Assert.Equal(3, array.GetElementOrDefault(2));
17            Assert.True(array.TryGetElement(2, out element));
18            Assert.Equal(3, element);
19            Assert.Equal(0, array.GetElementOrDefault(10));
20            Assert.False(array.TryGetElement(10, out element));
21            Assert.Equal(0, element);
22        }
23    }
24 }
```

1.40 ./csharp/Platform.Collections.Tests/BitStringTests.cs

```
1 using System;
2 using System.Collections;
3 using Xunit;
4 using Platform.Random;
5
6 namespace Platform.Collections.Tests
7 {
8     public static class BitStringTests
9     {
10        [Fact]
11        public static void BitGetSetTest()
12        {
13            const int n = 250;
14            var bitArray = new BitArray(n);
15            var bitString = new BitString(n);
16            for (var i = 0; i < n; i++)
17            {
18                var value = RandomHelpers.Default.NextBoolean();
19                bitArray.Set(i, value);
20                bitString.Set(i, value);
21                Assert.Equal(value, bitArray.Get(i));
22                Assert.Equal(value, bitString.Get(i));
23            }
24        }
25
26        [Fact]
27        public static void BitVectorNotTest()
28        {
29            TestToOperationsWithSameMeaning((x, y, w, v) =>
30            {
31                x.VectorNot();
32                w.Not();
33            });
34        }
35
36        [Fact]
37        public static void BitParallelNotTest()
38        {
39            TestToOperationsWithSameMeaning((x, y, w, v) =>
40            {
41                x.ParallelNot();
42                w.Not();
43            });
44        }
45
46        [Fact]
47        public static void BitParallelVectorNotTest()
48        {
49            TestToOperationsWithSameMeaning((x, y, w, v) =>
50            {
51                x.ParallelVectorNot();
52                w.Not();
53            });
54        }
55    }
56 }
```

```

53     });
54 }
55
56 [Fact]
57 public static void BitVectorAndTest()
58 {
59     TestToOperationsWithSameMeaning((x, y, w, v) =>
60     {
61         x.VectorAnd(y);
62         w.And(v);
63     });
64 }
65
66 [Fact]
67 public static void BitParallelAndTest()
68 {
69     TestToOperationsWithSameMeaning((x, y, w, v) =>
70     {
71         x.ParallelAnd(y);
72         w.And(v);
73     });
74 }
75
76 [Fact]
77 public static void BitParallelVectorAndTest()
78 {
79     TestToOperationsWithSameMeaning((x, y, w, v) =>
80     {
81         x.ParallelVectorAnd(y);
82         w.And(v);
83     });
84 }
85
86 [Fact]
87 public static void BitVectorOrTest()
88 {
89     TestToOperationsWithSameMeaning((x, y, w, v) =>
90     {
91         x.VectorOr(y);
92         w.Or(v);
93     });
94 }
95
96 [Fact]
97 public static void BitParallelOrTest()
98 {
99     TestToOperationsWithSameMeaning((x, y, w, v) =>
100    {
101        x.ParallelOr(y);
102        w.Or(v);
103    });
104 }
105
106 [Fact]
107 public static void BitParallelVectorOrTest()
108 {
109     TestToOperationsWithSameMeaning((x, y, w, v) =>
110    {
111        x.ParallelVectorOr(y);
112        w.Or(v);
113    });
114 }
115
116 [Fact]
117 public static void BitVectorXorTest()
118 {
119     TestToOperationsWithSameMeaning((x, y, w, v) =>
120    {
121        x.VectorXor(y);
122        w.Xor(v);
123    });
124 }
125
126 [Fact]
127 public static void BitParallelXorTest()
128 {
129     TestToOperationsWithSameMeaning((x, y, w, v) =>
130    {

```

```

131         x.ParallelXor(y);
132         w.Xor(v);
133     });
134 }
135
136 [Fact]
137 public static void BitParallelVectorXorTest()
138 {
139     TestToOperationsWithSameMeaning((x, y, w, v) =>
140     {
141         x.ParallelVectorXor(y);
142         w.Xor(v);
143     });
144 }
145
146 private static void TestToOperationsWithSameMeaning(Action<BitString, BitString,
147     ↪ BitString, BitString> test)
148 {
149     const int n = 5654;
150     var x = new BitString(n);
151     var y = new BitString(n);
152     while (x.Equals(y))
153     {
154         x.SetRandomBits();
155         y.SetRandomBits();
156     }
157     var w = new BitString(x);
158     var v = new BitString(y);
159     Assert.False(x.Equals(y));
160     Assert.False(w.Equals(v));
161     Assert.True(x.Equals(w));
162     Assert.True(y.Equals(v));
163     test(x, y, w, v);
164     Assert.True(x.Equals(w));
165 }
166 }

```

1.41 ./csharp/Platform.Collections.Tests/CharsSegmentTests.cs

```

1 using Xunit;
2 using Platform.Collections.Segments;
3
4 namespace Platform.Collections.Tests
5 {
6     public static class CharsSegmentTests
7     {
8         [Fact]
9         public static void GetHashCodeEqualsTest()
10         {
11             const string testString = "test test";
12             var testArray = testString.ToCharArray();
13             var firstHashCode = new CharSegment(testArray, 0, 4).GetHashCode();
14             var secondHashCode = new CharSegment(testArray, 5, 4).GetHashCode();
15             Assert.Equal(firstHashCode, secondHashCode);
16         }
17
18         [Fact]
19         public static void EqualsTest()
20         {
21             const string testString = "test test";
22             var testArray = testString.ToCharArray();
23             var first = new CharSegment(testArray, 0, 4);
24             var second = new CharSegment(testArray, 5, 4);
25             Assert.True(first.Equals(second));
26         }
27     }
28 }

```

1.42 ./csharp/Platform.Collections.Tests/ListTests.cs

```

1 using System.Collections.Generic;
2 using Xunit;
3 using Platform.Collections.Lists;
4
5 namespace Platform.Collections.Tests
6 {
7     public class ListTests
8     {
9         [Fact]
10

```



```

11     public void GetElementTest()
12     {
13         var nullList = (IList<int>)null;
14         Assert.Equal(0, nullList.GetElementOrDefault(1));
15         Assert.False(nullList.TryGetElement(1, out int element));
16         Assert.Equal(0, element);
17         var list = new List<int>() { 1, 2, 3 };
18         Assert.Equal(3, list.GetElementOrDefault(2));
19         Assert.True(list.TryGetElement(2, out element));
20         Assert.Equal(3, element);
21         Assert.Equal(0, list.GetElementOrDefault(10));
22         Assert.False(list.TryGetElement(10, out element));
23         Assert.Equal(0, element);
24     }
25 }
26 }

```

1.43 ./csharp/Platform.Collections.Tests/StringTests.cs

```

1  using Xunit;
2
3  namespace Platform.Collections.Tests
4  {
5      public static class StringTests
6      {
7          [Fact]
8          public static void CapitalizeFirstLetterTest()
9          {
10             Assert.Equal("Hello", "hello".CapitalizeFirstLetter());
11             Assert.Equal("Hello", "Hello".CapitalizeFirstLetter());
12             Assert.Equal(" Hello", " hello".CapitalizeFirstLetter());
13         }
14
15         [Fact]
16         public static void TrimSingleTest()
17         {
18             Assert.Equal("", "".TrimSingle('\'));
19             Assert.Equal("", ""'.TrimSingle('\'));
20             Assert.Equal("hello", "'hello'".TrimSingle('\'));
21             Assert.Equal("hello", "hello'".TrimSingle('\'));
22             Assert.Equal("hello", "'hello".TrimSingle('\'));
23         }
24     }
25 }

```

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