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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Arrays
{
    public class ArrayFiller<TElement, TReturnConstant> : ArrayFiller<TElement>
    {
        protected readonly TReturnConstant _returnConstant;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayFiller(TElement[] array, long offset, TReturnConstant returnConstant) : base(array, offset) => _returnConstant = returnConstant;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayFiller(TElement[] array, TReturnConstant returnConstant) : this(array, 0, returnConstant) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddAndReturnConstant(TElement element) => _array.AddAndReturnConstant(ref _position, element, _returnConstant);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddFirstAndReturnConstant(IList<TElement> elements) => _array.AddFirstAndReturnConstant(ref _position, elements, _returnConstant);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddAllAndReturnConstant(IList<TElement> elements) => _array.AddAllAndReturnConstant(ref _position, elements, _returnConstant);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddSkipFirstAndReturnConstant(IList<TElement> elements) => _array.AddSkipFirstAndReturnConstant(ref _position, elements, _returnConstant);
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Arrays
{
    public class ArrayFiller<TElement>
    {
        protected readonly TElement[] _array;
        protected long _position;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayFiller(TElement[] array, long offset)
        {
            _array = array;
            _position = offset;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayFiller(TElement[] array) : this(array, 0) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Add(TElement element) => _array[_position++] = element;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddAndReturnTrue(TElement element) => _array.AddAndReturnConstant(ref _position, element, true);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddFirstAndReturnTrue(IList<TElement> elements) => _array.AddFirstAndReturnConstant(ref _position, elements, true);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddAllAndReturnTrue(IList<TElement> elements) => _array.AddAllAndReturnConstant(ref _position, elements, true);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
```

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

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

```
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Arrays
{
    public static class ArrayPool
    {
        public static readonly int DefaultSizesAmount = 512;
        public static readonly int DefaultMaxArraysPerSize = 32;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T[] Allocate<T>(long size) => ArrayPool<T>.ThreadInstance.Allocate(size);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void Free<T>(T[] array) => ArrayPool<T>.ThreadInstance.Free(array);
    }
}
```

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

```
using System;
using System.Collections.Generic;
using System.Runtime.CompilerServices;
using Platform.Disposables;
using Platform.Collections.Stacks;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Arrays
{
    /// <remarks>
    /// Original idea from
    ↪ http://geekswithblogs.net/blackrob/archive/2014/12/18/array-pooling-in-csharp.aspx
    /// </remarks>
    public class ArrayPool<T>
    {
        // May be use Default class for that later.
        [ThreadStatic]
        private static ArrayPool<T> _threadInstance;
        internal static ArrayPool<T> ThreadInstance => _threadInstance ?? (_threadInstance = new
        ↪ ArrayPool<T>());

        private readonly int _maxArraysPerSize;
        private readonly Dictionary<long, Stack<T[]>> _pool = new Dictionary<long,
        ↪ Stack<T[]>>(ArrayPool.DefaultSizesAmount);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayPool(int maxArraysPerSize) => _maxArraysPerSize = maxArraysPerSize;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayPool() : this(ArrayPool.DefaultMaxArraysPerSize) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Disposable<T[]> AllocateDisposable(long size) => (Allocate(size), Free);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Disposable<T[]> Resize(Disposable<T[]> source, long size)
        {
            var destination = AllocateDisposable(size);
            T[] sourceArray = source;
            if (!sourceArray.IsNullOrEmpty())
            {
                T[] destinationArray = destination;
                Array.Copy(sourceArray, destinationArray, size < sourceArray.LongLength ? size :
                ↪ sourceArray.LongLength);
                source.Dispose();
            }
            return destination;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public virtual void Clear() => _pool.Clear();

```

```
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public virtual T[] Allocate(long size) => size <= 0L ? Array.Empty<T>() :
        ↪ _pool.GetOrDefault(size)?.PopOrDefault() ?? new T[size];

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public virtual void Free(T[] array)
        {
            if (array.IsNullOrEmpty())
            {
                return;
            }
            var stack = _pool.GetOrAdd(array.LongLength, size => new
            ↪ Stack<T[]>(_maxArraysPerSize));
            if (stack.Count == _maxArraysPerSize) // Stack is full
            {
                return;
            }
            stack.Push(array);
        }
    }
}
```

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

```
using System.Runtime.CompilerServices;
using Platform.Collections.Segments;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Arrays
{
    public class ArrayString<T> : Segment<T>
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayString(int length) : base(new T[length], 0, length) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayString(T[] array) : base(array, 0, array.Length) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ArrayString(T[] array, int length) : base(array, 0, length) { }
    }
}
```

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

```
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Arrays
{
    public static unsafe class CharArrayExtensions
    {
        /// <remarks>
        /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783
        ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L833
        /// </remarks>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static int GenerateHashCode(this char[] array, int offset, int length)
        {
            var hashSeed = 5381;
            var hashAccumulator = hashSeed;
            fixed (char* arrayPointer = &array[offset])
            {
                for (char* charPointer = arrayPointer, last = charPointer + length; charPointer
                ↪ < last; charPointer++)
                {
                    hashAccumulator = (hashAccumulator << 5) + hashAccumulator ^ *charPointer;
                }
            }
            return hashAccumulator + (hashSeed * 1566083941);
        }

        /// <remarks>
        /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783
        ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L364
        /// </remarks>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool ContentEqualTo(this char[] left, int leftOffset, int length, char[]
        ↪ right, int rightOffset)
```

```
        {
            fixed (char* leftPointer = &left[leftOffset])
            {
                fixed (char* rightPointer = &right[rightOffset])
                {
                    char* leftPointerCopy = leftPointer, rightPointerCopy = rightPointer;
                    if (!CheckArraysMainPartForEquality(ref leftPointerCopy, ref
                    ↪  rightPointerCopy, ref length))
                    {
                        return false;
                    }
                    CheckArraysRemainderForEquality(ref leftPointerCopy, ref rightPointerCopy,
                    ↪  ref length);
                    return length <= 0;
                }
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static bool CheckArraysMainPartForEquality(ref char* left, ref char* right, ref
        ↪  int length)
        {
            while (length >= 10)
            {
                if ((*(int*)left != *(int*)right)
                 || (*(int*)(left + 2) != *(int*)(right + 2))
                 || (*(int*)(left + 4) != *(int*)(right + 4))
                 || (*(int*)(left + 6) != *(int*)(right + 6))
                 || (*(int*)(left + 8) != *(int*)(right + 8)))
                {
                    return false;
                }
                left += 10;
                right += 10;
                length -= 10;
            }
            return true;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static void CheckArraysRemainderForEquality(ref char* left, ref char* right, ref
        ↪  int length)
        {
            // This depends on the fact that the String objects are
            // always zero terminated and that the terminating zero is not included
            // in the length. For odd string sizes, the last compare will include
            // the zero terminator.
            while (length > 0)
            {
                if (*(int*)left != *(int*)right)
                {
                    break;
                }
                left += 2;
                right += 2;
                length -= 2;
            }
        }
    }
}
```

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

```
using System;
using System.Collections.Generic;
using System.Runtime.CompilerServices;

namespace Platform.Collections.Arrays
{
    public static class GenericArrayExtensions
    {
        /// <summary>
        /// <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>
        /// <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>
        /// </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 учавствовать 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 учавствовать в
            ↪  проверке.</para></param>
26          /// <param name="index"><para>Number type long to compare.</para><para>Число типа long
            ↪  для сравнения.</para></param>
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
            ↪  varible 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 учавствовать 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 varible 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 учавствовать 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
79          /// <summary>
80          /// <para>Copying  of elements from one array to another array.</para>
81          /// <para>Копирует  элементы из одного массива в другой массив.</para>
82          /// </summary>
83          /// <typeparam name="T"><para>Array elements type.</para><para>Тип элементов
            ↪  массива.</para></typeparam>
84          /// <param name="array"><para>The array  to copy.</para><para>Массив который необходимо
            ↪  скопировать.</para></param>
85          /// <returns><para>Copy of the array.</para><para>Копию массива.</para></returns>
86          [MethodImpl(MethodImplOptions.AggressiveInlining)]
87          public static T[] Clone<T>(this T[] array)
88          {
89              var copy = new T[array.LongLength];
90              Array.Copy(array, 0L, copy, 0L, array.LongLength);
91              return copy;
92          }
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
            ↪  массива.</para></typeparam>
99          /// <param name="array"><para>The array to copy from.</para><para>Массив для
            ↪  копирования.</para></param>
100         /// <returns>
101         /// <para>Array with a shift of elements by one position.</para>
102         /// <para>Массив со сдвигом элементов на одну позицию.</para>
103         /// </returns>
104         [MethodImpl(MethodImplOptions.AggressiveInlining)]
105         public static IList<T> ShiftRight<T>(this T[] array) => array.ShiftRight(1L);
106
107         /// <summary>
108         /// <para>Shifts all elements of the array to the right by the specified number of
            ↪  elements.</para>
109         /// <para>Сдвигает вправо все элементы массива на указанное количество элементов.</para>
110         /// </summary>
111         /// <typeparam name="T"><para>The array item type.</para><para>Тип элементов
            ↪  массива.</para></typeparam>
112         /// <param name="array"><para>The array to copy from.</para><para>Массив для
            ↪  копирования.</para></param>
113         /// <param name="skip"><para>The number of items to shift.</para><para>Количество
            ↪  сдвигаемых элементов.</para></param>
114         /// <returns>
```

```
115         /// <para>If the value of the shift variable is less than zero - an <see
            ↪  cref="NotImplementedException"/> exception is thrown, but if the value of the shift
            ↪  variable is 0 - an exact copy of the array is returned. Otherwise, an array is
            ↪  returned with the shift of the elements.</para>
116         /// <para>Если значение переменной shift меньше нуля - выбрасывается исключение <see
            ↪  cref="NotImplementedException"/>, если же значение переменной shift равно 0 -
            ↪  возвращается точная копия массива. Иначе возвращается массив со сдвигом
            ↪  элементов.</para>
117         /// </returns>
118         [MethodImpl(MethodImplOptions.AggressiveInlining)]
119         public static IList<T> ShiftRight<T>(this T[] array, long shift)
120         {
121             if (shift < 0)
122             {
123                 throw new NotImplementedException();
124             }
125             if (shift == 0)
126             {
127                 return array.Clone<T>();
128             }
129             else
130             {
131                 var restrictions = new T[array.LongLength + shift];
132                 Array.Copy(array, 0L, restrictions, shift, array.LongLength);
133                 return restrictions;
134             }
135         }
136
137         /// <summary>
138         /// <para>Adding in array the passed element at the specified position and increments
            ↪  position value by one.</para>
139         /// <para>Добавляет в массив переданный элемент на указанную позицию и увеличивает
            ↪  значение position на единицу.</para>
140         /// </summary>
141         /// <typeparam name="T"><para>Array elements type.</para>Тип элементов
            ↪  массива.<para></typeparam>
142         /// <param name="array"><para>The array to add the element to.</para><para>Массив в
            ↪  который необходимо добавить элемент.</para></param>
143         /// <param name="position"><para>A reference to the position of type int where the
            ↪  element will be added.</para><para>Ссылка на позицию типа int, в которую будет
            ↪  добавлен элемент.</para></param>
144         /// <param name="element"><para>The element to add to the array.</para><para>Элемент,
            ↪  который нужно добавить в массив.</para></param>
145         [MethodImpl(MethodImplOptions.AggressiveInlining)]
146         public static void Add<T>(this T[] array, ref int position, T element) =>
            ↪  array[position++] = element;
147
148         /// <summary>
149         /// <para>Adding in array the passed element at the specified position and increments
            ↪  position value by one.</para>
150         /// <para>Добавляет в массив переданный элемент на указанную позицию и увеличивает
            ↪  значение position на единицу.</para>
151         /// </summary>
152         /// <typeparam name="T"><para>Array elements type.</para>Тип элементов
            ↪  массива.<para></typeparam>
153         /// <param name="array"><para>The array to add the element to.</para><para>Массив в
            ↪  который необходимо добавить элемент.</para></param>
154         /// <param name="position"><para>A reference to the position of type long where the
            ↪  element will be added.</para><para>Ссылка на позицию типа long, в которую будет
            ↪  добавлен элемент.</para></param>
155         /// <param name="element"><para>The element to add to the array</para><para>Элемент
            ↪  который необходимо добавить в массив.</para></param>
156         [MethodImpl(MethodImplOptions.AggressiveInlining)]
157         public static void Add<T>(this T[] array, ref long position, T element) =>
            ↪  array[position++] = element;
158
159         /// <summary>
160         /// <para>Adding in array the passed element, at the specified position, increments
            ↪  position value by one and returns the value of the passed constant.</para>
161         /// <para>Добавляет в массив переданный элемент на указанную позицию, увеличивает
            ↪  значение position на единицу и возвращает значение переданной константы.</para>
162         /// </summary>
163         /// <typeparam name="TElement"><para>The array element type.</para><para>Тип элемента
            ↪  массива.</para></typeparam>
164         /// <typeparam name="TReturnConstant"><para>Type of return constant.</para><para>Тип
            ↪  возвращаемой константы.</para></typeparam>
```

```
165         /// <param name="array"><para>The array to add the element to.</para><para>Массив в
            ↪ который необходимо добавить элемент.</para></param>
166         /// <param name="position"><para>Reference to the position to which the element will be
            ↪ added.</para><para>Ссылка на позицию, в которую будет добавлен
            ↪ элемент.</para></param>
167         /// <param name="element"><para>The element to add to the array.</para><para>Элемент
            ↪ который необходимо добавить в массив.</para></param>
168         /// <param name="returnConstant"><para>The constant value that will be
            ↪ returned.</para><para>Значение константы, которое будет возвращено.</para></param>
169         /// <returns>
170         /// <para>The constant value passed as an argument.</para>
171         /// <para>Значение константы, переданное в качестве аргумента.</para>
172         /// </returns>
173         [MethodImpl(MethodImplOptions.AggressiveInlining)]
174         public static TReturnConstant AddAndReturnConstant<TElement, TReturnConstant>(this
            ↪ TElement[] array, ref long position, TElement element, TReturnConstant
            ↪ returnConstant)
175         {
176             array.Add(ref position, element);
177             return returnConstant;
178         }
179
180         /// <summary>
181         /// <para>Adds the first element from the passed collection to the array, at the
            ↪ specified position and increments position value by one.</para>
182         /// <para>Добавляет в массив первый элемент из переданной коллекции, на указанную
            ↪ позицию и увеличивает значение position на единицу.</para>
183         /// </summary>
184         /// <typeparam name="T"><para>Array element type.</para><para>Тип элементов
            ↪ массива.</para></typeparam>
185         /// <param name="array"><para>The array to add the element to.</para><para>Массив в
            ↪ который необходимо добавить элемент.</para></param>
186         /// <param name="position"><para>Reference to the position to which the element will be
            ↪ added.</para><para>Ссылка на позицию, в которую будет добавлен
            ↪ элемент.</para></param>
187         /// <param name="elements"><para>List, the first element of which will be added to the
            ↪ array.</para><para>Список, первый элемент которого будет добавлен в
            ↪ массив.</para></param>
188         [MethodImpl(MethodImplOptions.AggressiveInlining)]
189         public static void AddFirst<T>(this T[] array, ref long position, IList<T> elements) =>
            ↪ array[position++] = elements[0];
190
191         /// <summary>
192         /// <para>Adds the first element from the passed collection to the array, at the
            ↪ specified position, increments position value by one and returns the value of the
            ↪ passed constant.</para>
193         /// <para>Добавляет в массив первый элемент из переданной коллекции, на указанную
            ↪ позицию, увеличивает значение position на единицу и возвращает значение переданной
            ↪ константы.</para>
194         /// </summary>
195         /// <typeparam name="TElement"><para>The array element type.</para><para>Тип элемента
            ↪ массива.</para></typeparam>
196         /// <typeparam name="TReturnConstant"><para>Type of return constant.</para><para>Тип
            ↪ возвращаемой константы.</para></typeparam>
197         /// <param name="array"><para>The array to add the element to.</para><para>Массив в
            ↪ который необходимо добавить элемент.</para></param>
198         /// <param name="position"><para>Reference to the position to which the element will be
            ↪ added.</para><para>Ссылка на позицию, в которую будет добавлен
            ↪ элемент.</para></param>
199         /// <param name="elements"><para>List, the first element of which will be added to the
            ↪ array.</para><para>Список, первый элемент которого будет добавлен в
            ↪ массив.</para></param>
200         /// <param name="returnConstant"><para>The constant value that will be
            ↪ returned.</para><para>Значение константы, которое будет возвращено.</para></param>
201         /// <returns>
202         /// <para>The constant value passed as an argument.</para>
203         /// <para>Значение константы, переданное в качестве аргумента.</para>
204         /// </returns>
205         [MethodImpl(MethodImplOptions.AggressiveInlining)]
206         public static TReturnConstant AddFirstAndReturnConstant<TElement, TReturnConstant>(this
            ↪ TElement[] array, ref long position, IList<TElement> elements, TReturnConstant
            ↪ returnConstant)
207         {
208             array.AddFirst(ref position, elements);
209             return returnConstant;
210         }
```

```
211
212         /// <summary>
213         /// <para>Adding in array all elements from the passed collection, at the specified
            ↪  position, increases the position value by the number of elements added and returns
            ↪  the value of the passed constant.</para>
214         /// <para>Добавляет в массив все элементы из переданной коллекции, на указанную позицию,
            ↪  увеличивает значение position на количество добавленных элементов и возвращает
            ↪  значение переданной константы.</para>
215         /// </summary>
216         /// <typeparam name="TElement"><para>The array element type.</para><para>Тип элемента
            ↪  массива.</para></typeparam>
217         /// <typeparam name="TReturnConstant"><para>Type of return constant.</para><para>Тип
            ↪  возвращаемой константы.</para></typeparam>
218         /// <param name="array"><para>The array to add the element to.</para><para>Массив в
            ↪  который необходимо добавить элементы.</para></param>
219         /// <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>
220         /// <param name="elements"><para>List, whose elements will be added to the
            ↪  array.</para><para>Список, элементы которого будут добавленны в
            ↪  массив.</para></param>
221         /// <param name="returnConstant"><para>The constant value that will be
            ↪  returned.</para><para>Значение константы, которое будет возвращено.</para></param>
222         /// <returns>
223         /// <para>The constant value passed as an argument.</para>
224         /// <para>Значение константы, переданное в качестве аргумента.</para>
225         /// </returns>
226         [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 добавленны 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 добавленны 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 добавленны 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 добавленны 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;
```

```
using System.Runtime.CompilerServices;
using System.Threading.Tasks;
using Platform.Exceptions;
using Platform.Ranges;

// ReSharper disable ForCanBeConvertedToForeach
#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections
{
    /// <remarks>
    /// А что если хранить карту значений, где каждый бит будет означать присутствует ли блок в 64 бит в массиве значений.
    /// 64 бита по 0 бит, будут означать отсутствие 64-х блоков по 64 бита. Т.е. упаковка 512 байт в 8 байт.
    /// Подобный принцип можно применять и к 64-ём блокам и т.п. По сути это карта значений. С помощью которой можно быстро
    /// проверять есть ли значения непосредственно далее (ниже по уровню).
    /// Или как таблица виртуальной памяти где номер блока означает его присутствие и адрес.
    /// </remarks>
    public class BitString : IEquatable<BitString>
    {
        private static readonly byte[][] _bitsSetIn16Bits;
        private long[] _array;
        private long _length;
        private long _minPositiveWord;
        private long _maxPositiveWord;

        public bool this[long index]
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => Get(index);
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            set => Set(index, value);
        }

        public long Length
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => _length;
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            set
            {
                if (_length == value)
                {
                    return;
                }
                Ensure.Always.ArgumentInRange(value, GetValidLengthRange(), nameof(Length));
                // Currently we never shrink the array
                if (value > _length)
                {
                    var words = GetWordsCountFromIndex(value);
                    var oldWords = GetWordsCountFromIndex(_length);
                    if (words > _array.LongLength)
                    {
                        var copy = new long[words];
                        Array.Copy(_array, copy, _array.LongLength);
                        _array = copy;
                    }
                    else
                    {
                        // What is going on here?
                        Array.Clear(_array, (int)oldWords, (int)(words - oldWords));
                    }
                    // What is going on here?
                    var mask = (int)(_length % 64);
                    if (mask > 0)
                    {
                        _array[oldWords - 1] &= (1L << mask) - 1;
                    }
                }
                else
                {
                    // Looks like minimum and maximum positive words are not updated
                    throw new NotImplementedException();
                }
                _length = value;
            }
        }
```

```
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         {
```

```
            var threads = Environment.ProcessorCount / 2;
            if (threads <= 1)
            {
                return Not();
            }
            var partitioner = Partitioner.Create(0L, _array.LongLength, _array.LongLength /
            ↪  threads);
            Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
            ↪  MaxDegreeOfParallelism = threads }, range =>
            {
                var maximum = range.Item2;
                for (var i = range.Item1; i < maximum; i++)
                {
                    _array[i] = ~_array[i];
                }
            });
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString VectorNot()
        {
            if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
            {
                return Not();
            }
            var step = Vector<long>.Count;
            if (_array.Length < step)
            {
                return Not();
            }
            VectorNotLoop(_array, step, 0, _array.Length);
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString ParallelVectorNot()
        {
            var threads = Environment.ProcessorCount / 2;
            if (threads <= 1)
            {
                return VectorNot();
            }
            if (!Vector.IsHardwareAccelerated)
            {
                return ParallelNot();
            }
            var step = Vector<long>.Count;
            if (_array.Length < (step * threads))
            {
                return VectorNot();
            }
            var partitioner = Partitioner.Create(0, _array.Length, _array.Length / threads);
            Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
            ↪  MaxDegreeOfParallelism = threads }, range => VectorNotLoop(_array, step,
            ↪  range.Item1, range.Item2));
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        static private void VectorNotLoop(long[] array, int step, int start, int maximum)
        {
            var i = start;
            var range = maximum - start - 1;
            var stop = range - (range % step);
            for (; i < stop; i += step)
            {
                (~new Vector<long>(array, i)).CopyTo(array, i);
            }
            for (; i < maximum; i++)
            {
                array[i] = ~array[i];
```

```
        }
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    public BitString And(BitString other)
    {
        EnsureBitStringHasTheSameSize(other, nameof(other));
        GetCommonOuterBorders(this, other, out long from, out long to);
        var otherArray = other._array;
        for (var i = from; i <= to; i++)
        {
            _array[i] &= otherArray[i];
            RefreshBordersByWord(i);
        }
        return this;
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    public BitString ParallelAnd(BitString other)
    {
        var threads = Environment.ProcessorCount / 2;
        if (threads <= 1)
        {
            return And(other);
        }
        EnsureBitStringHasTheSameSize(other, nameof(other));
        GetCommonOuterBorders(this, other, out long from, out long to);
        var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
        Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
        ↪  MaxDegreeOfParallelism = threads }, range =>
        {
            var maximum = range.Item2;
            for (var i = range.Item1; i < maximum; i++)
            {
                _array[i] &= other._array[i];
            }
        });
        MarkBordersAsAllBitsSet();
        TryShrinkBorders();
        return this;
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    public BitString VectorAnd(BitString other)
    {
        if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
        {
            return And(other);
        }
        var step = Vector<long>.Count;
        if (_array.Length < step)
        {
            return And(other);
        }
        EnsureBitStringHasTheSameSize(other, nameof(other));
        GetCommonOuterBorders(this, other, out int from, out int to);
        VectorAndLoop(_array, other._array, step, from, to + 1);
        MarkBordersAsAllBitsSet();
        TryShrinkBorders();
        return this;
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    public BitString ParallelVectorAnd(BitString other)
    {
        var threads = Environment.ProcessorCount / 2;
        if (threads <= 1)
        {
            return VectorAnd(other);
        }
        if (!Vector.IsHardwareAccelerated)
        {
            return ParallelAnd(other);
        }
        var step = Vector<long>.Count;
        if (_array.Length < (step * threads))
        {
            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 {
                ↪  MaxDegreeOfParallelism = threads }, range => VectorAndLoop(_array, other._array,
                ↪  step, range.Item1, range.Item2));
316             MarkBordersAsAllBitsSet();
317             TryShrinkBorders();
318             return this;
319         }
320 
321         [MethodImpl(MethodImplOptions.AggressiveInlining)]
322         static private void VectorAndLoop(long[] array, long[] otherArray, int step, int start,
            ↪  int maximum)
323         {
324             var i = start;
325             var range = maximum - start - 1;
326             var stop = range - (range % step);
327             for (; i < stop; i += step)
328             {
329                 (new Vector<long>(array, i) & new Vector<long>(otherArray, i)).CopyTo(array, i);
330             }
331             for (; i < maximum; i++)
332             {
333                 array[i] &= otherArray[i];
334             }
335         }
336 
337         [MethodImpl(MethodImplOptions.AggressiveInlining)]
338         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 {
                ↪  MaxDegreeOfParallelism = threads }, range =>
362             {
363                 var maximum = range.Item2;
364                 for (var i = range.Item1; i < maximum; i++)
365                 {
366                     _array[i] |= other._array[i];
367                 }
368             });
369             MarkBordersAsAllBitsSet();
370             TryShrinkBorders();
371             return this;
372         }
373 
374         [MethodImpl(MethodImplOptions.AggressiveInlining)]
375         public BitString VectorOr(BitString other)
376         {
377             if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
378             {
379                 return Or(other);
380             }
381             var step = Vector<long>.Count;
382             if (_array.Length < step)
383             {
384                 return Or(other);
```

```
            }
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonOuterBorders(this, other, out int from, out int to);
            VectorOrLoop(_array, other._array, step, from, to + 1);
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString ParallelVectorOr(BitString other)
        {
            var threads = Environment.ProcessorCount / 2;
            if (threads <= 1)
            {
                return VectorOr(other);
            }
            if (!Vector.IsHardwareAccelerated)
            {
                return ParallelOr(other);
            }
            var step = Vector<long>.Count;
            if (_array.Length < (step * threads))
            {
                return VectorOr(other);
            }
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonOuterBorders(this, other, out int from, out int to);
            var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
            Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
            ↪  MaxDegreeOfParallelism = threads }, range => VectorOrLoop(_array, other._array,
            ↪  step, range.Item1, range.Item2));
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        static private void VectorOrLoop(long[] array, long[] otherArray, int step, int start,
        ↪  int maximum)
        {
            var i = start;
            var range = maximum - start - 1;
            var stop = range - (range % step);
            for (; i < stop; i += step)
            {
                (new Vector<long>(array, i) | new Vector<long>(otherArray, i)).CopyTo(array, i);
            }
            for (; i < maximum; i++)
            {
                array[i] |= otherArray[i];
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString Xor(BitString other)
        {
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonOuterBorders(this, other, out long from, out long to);
            for (var i = from; i <= to; i++)
            {
                _array[i] ^= other._array[i];
                RefreshBordersByWord(i);
            }
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString ParallelXor(BitString other)
        {
            var threads = Environment.ProcessorCount / 2;
            if (threads <= 1)
            {
                return Xor(other);
            }
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonOuterBorders(this, other, out long from, out long to);
            var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
```

```
            Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions { MaxDegreeOfParallelism = threads }, range =>
            {
                var maximum = range.Item2;
                for (var i = range.Item1; i < maximum; i++)
                {
                    _array[i] ^= other._array[i];
                }
            });
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString VectorXor(BitString other)
        {
            if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
            {
                return Xor(other);
            }
            var step = Vector<long>.Count;
            if (_array.Length < step)
            {
                return Xor(other);
            }
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonOuterBorders(this, other, out int from, out int to);
            VectorXorLoop(_array, other._array, step, from, to + 1);
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString ParallelVectorXor(BitString other)
        {
            var threads = Environment.ProcessorCount / 2;
            if (threads <= 1)
            {
                return VectorXor(other);
            }
            if (!Vector.IsHardwareAccelerated)
            {
                return ParallelXor(other);
            }
            var step = Vector<long>.Count;
            if (_array.Length < (step * threads))
            {
                return VectorXor(other);
            }
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonOuterBorders(this, other, out int from, out int to);
            var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
            Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions { MaxDegreeOfParallelism = threads }, range => VectorXorLoop(_array, other._array, step, range.Item1, range.Item2));
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        static private void VectorXorLoop(long[] array, long[] otherArray, int step, int start, int maximum)
        {
            var i = start;
            var range = maximum - start - 1;
            var stop = range - (range % step);
            for (; i < stop; i += step)
            {
                (new Vector<long>(array, i) ^ new Vector<long>(otherArray, i)).CopyTo(array, i);
            }
            for (; i < maximum; i++)
            {
                array[i] ^= otherArray[i];
            }
        }
```

```
534
535         [MethodImpl(MethodImplOptions.AggressiveInlining)]
536         private void RefreshBordersByWord(long wordIndex)
537         {
538             if (_array[wordIndex] == 0)
539             {
540                 if (wordIndex == _minPositiveWord && wordIndex != _array.LongLength - 1)
541                 {
542                     _minPositiveWord++;
543                 }
544                 if (wordIndex == _maxPositiveWord && wordIndex != 0)
545                 {
546                     _maxPositiveWord--;
547                 }
548             }
549             else
550             {
551                 if (wordIndex < _minPositiveWord)
552                 {
553                     _minPositiveWord = wordIndex;
554                 }
555                 if (wordIndex > _maxPositiveWord)
556                 {
557                     _maxPositiveWord = wordIndex;
558                 }
559             }
560         }
561
562         [MethodImpl(MethodImplOptions.AggressiveInlining)]
563         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++)
```

```
            {
                var word = _array[i];
                if (word != 0)
                {
                    AppendAllSetBitIndices(result, i, word);
                }
            }
            return result;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public List<ulong> GetSetUInt64Indices()
        {
            var result = new List<ulong>();
            GetBorders(out ulong from, out ulong to);
            for (var i = from; i <= to; i++)
            {
                var word = _array[i];
                if (word != 0)
                {
                    AppendAllSetBitIndices(result, i, word);
                }
            }
            return result;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public long GetFirstSetBitIndex()
        {
            var i = _minPositiveWord;
            var word = _array[i];
            if (word != 0)
            {
                return GetFirstSetBitForWord(i, word);
            }
            return -1;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public long GetLastSetBitIndex()
        {
            var i = _maxPositiveWord;
            var word = _array[i];
            if (word != 0)
            {
                return GetLastSetBitForWord(i, word);
            }
            return -1;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public long CountSetBits()
        {
            var total = 0L;
            GetBorders(out long from, out long to);
            for (var i = from; i <= to; i++)
            {
                var word = _array[i];
                if (word != 0)
                {
                    total += CountSetBitsForWord(word);
                }
            }
            return total;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool HaveCommonBits(BitString other)
        {
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonInnerBorders(this, other, out long from, out long to);
            var otherArray = other._array;
            for (var i = from; i <= to; i++)
            {
                var left = _array[i];
                var right = otherArray[i];
                if (left != 0 && right != 0 && (left & right) != 0)
                {
                    return true;
```

```
                }
            }
            return false;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public long CountCommonBits(BitString other)
        {
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonInnerBorders(this, other, out long from, out long to);
            var total = 0L;
            var otherArray = other._array;
            for (var i = from; i <= to; i++)
            {
                var left = _array[i];
                var right = otherArray[i];
                var combined = left & right;
                if (combined != 0)
                {
                    total += CountSetBitsForWord(combined);
                }
            }
            return total;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public List<long> GetCommonIndices(BitString other)
        {
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonInnerBorders(this, other, out long from, out long to);
            var result = new List<long>();
            var otherArray = other._array;
            for (var i = from; i <= to; i++)
            {
                var left = _array[i];
                var right = otherArray[i];
                var combined = left & right;
                if (combined != 0)
                {
                    AppendAllSetBitIndices(result, i, combined);
                }
            }
            return result;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public List<ulong> GetCommonUInt64Indices(BitString other)
        {
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonBorders(this, other, out ulong from, out ulong to);
            var result = new List<ulong>();
            var otherArray = other._array;
            for (var i = from; i <= to; i++)
            {
                var left = _array[i];
                var right = otherArray[i];
                var combined = left & right;
                if (combined != 0)
                {
                    AppendAllSetBitIndices(result, i, combined);
                }
            }
            return result;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public long GetFirstCommonBitIndex(BitString other)
        {
            EnsureBitStringHasTheSameSize(other, nameof(other));
            GetCommonInnerBorders(this, other, out long from, out long to);
            var otherArray = other._array;
            for (var i = from; i <= to; i++)
            {
                var left = _array[i];
                var right = otherArray[i];
                var combined = left & right;
                if (combined != 0)
                {
                    return GetFirstSetBitForWord(i, combined);
```

```
            }
        }
        return -1;
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    public long GetLastCommonBitIndex(BitString other)
    {
        EnsureBitStringHasTheSameSize(other, nameof(other));
        GetCommonInnerBorders(this, other, out long from, out long to);
        var otherArray = other._array;
        for (var i = to; i >= from; i--)
        {
            var left = _array[i];
            var right = otherArray[i];
            var combined = left & right;
            if (combined != 0)
            {
                return GetLastSetBitForWord(i, combined);
            }
        }
        return -1;
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    public override bool Equals(object obj) => obj is BitString @string ? Equals(@string) :
    ↪  false;

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    public bool Equals(BitString other)
    {
        if (_length != other._length)
        {
            return false;
        }
        var otherArray = other._array;
        if (_array.Length != otherArray.Length)
        {
            return false;
        }
        if (_minPositiveWord != other._minPositiveWord)
        {
            return false;
        }
        if (_maxPositiveWord != other._maxPositiveWord)
        {
            return false;
        }
        GetCommonBorders(this, other, out ulong from, out ulong to);
        for (var i = from; i <= to; i++)
        {
            if (_array[i] != otherArray[i])
            {
                return false;
            }
        }
        return true;
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    private void EnsureBitStringHasTheSameSize(BitString other, string argumentName)
    {
        Ensure.Always.ArgumentNotNull(other, argumentName);
        if (_length != other._length)
        {
            throw new ArgumentException("Bit string must be the same size.", argumentName);
        }
    }

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    private void MarkBordersAsAllBitsReset() => SetBorders(_array.LongLength - 1, 0);

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    private void MarkBordersAsAllBitsSet() => SetBorders(0, _array.LongLength - 1);

    [MethodImpl(MethodImplOptions.AggressiveInlining)]
    private void GetBorders(out long from, out long to)
    {
        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,
                ↪ bits48to63);
956         }
957 
958         [MethodImpl(MethodImplOptions.AggressiveInlining)]
959         private static void AppendAllSetBitIndices(List<long> result, long wordIndex, long
            ↪ wordValue)
960         {
961             GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
                ↪ bits32to47, out byte[] bits48to63);
962             AppendAllSetBitIndices(result, wordIndex, bits00to15, bits16to31, bits32to47,
                ↪ bits48to63);
963         }
964 
965         [MethodImpl(MethodImplOptions.AggressiveInlining)]
966         private static long CountSetBitsForWord(long word)
967         {
968             GetBits(word, out byte[] bits00to15, out byte[] bits16to31, out byte[] bits32to47,
                ↪ out byte[] bits48to63);
969             return bits00to15.LongLength + bits16to31.LongLength + bits32to47.LongLength +
                ↪ bits48to63.LongLength;
970         }
971 
972         [MethodImpl(MethodImplOptions.AggressiveInlining)]
973         private static long GetFirstSetBitForWord(long wordIndex, long wordValue)
974         {
975             GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
                ↪ bits32to47, out byte[] bits48to63);
976             return GetFirstSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
977         }
978 
979         [MethodImpl(MethodImplOptions.AggressiveInlining)]
980         private static long GetLastSetBitForWord(long wordIndex, long wordValue)
981         {
982             GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
                ↪ bits32to47, out byte[] bits48to63);
983             return GetLastSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
984         }
985 
986         [MethodImpl(MethodImplOptions.AggressiveInlining)]
987         private static void AppendAllSetBitIndices(List<long> result, long i, byte[] bits00to15,
            ↪ byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
988         {
989             for (var j = 0; j < bits00to15.Length; j++)
990             {
991                 result.Add(bits00to15[j] + (i * 64));
992             }
993             for (var j = 0; j < bits16to31.Length; j++)
994             {
```

```
                result.Add(bits16to31[j] + 16 + (i * 64));
            }
            for (var j = 0; j < bits32to47.Length; j++)
            {
                result.Add(bits32to47[j] + 32 + (i * 64));
            }
            for (var j = 0; j < bits48to63.Length; j++)
            {
                result.Add(bits48to63[j] + 48 + (i * 64));
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static void AppendAllSetIndices(List<ulong> result, ulong i, byte[] bits00to15, byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
        {
            for (var j = 0; j < bits00to15.Length; j++)
            {
                result.Add(bits00to15[j] + (i * 64));
            }
            for (var j = 0; j < bits16to31.Length; j++)
            {
                result.Add(bits16to31[j] + 16UL + (i * 64));
            }
            for (var j = 0; j < bits32to47.Length; j++)
            {
                result.Add(bits32to47[j] + 32UL + (i * 64));
            }
            for (var j = 0; j < bits48to63.Length; j++)
            {
                result.Add(bits48to63[j] + 48UL + (i * 64));
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static long GetFirstSetBit(long i, byte[] bits00to15, byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
        {
            if (bits00to15.Length > 0)
            {
                return bits00to15[0] + (i * 64);
            }
            if (bits16to31.Length > 0)
            {
                return bits16to31[0] + 16 + (i * 64);
            }
            if (bits32to47.Length > 0)
            {
                return bits32to47[0] + 32 + (i * 64);
            }
            return bits48to63[0] + 48 + (i * 64);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static long GetLastSetBit(long i, byte[] bits00to15, byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
        {
            if (bits48to63.Length > 0)
            {
                return bits48to63[bits48to63.Length - 1] + 48 + (i * 64);
            }
            if (bits32to47.Length > 0)
            {
                return bits32to47[bits32to47.Length - 1] + 32 + (i * 64);
            }
            if (bits16to31.Length > 0)
            {
                return bits16to31[bits16to31.Length - 1] + 16 + (i * 64);
            }
            return bits00to15[bits00to15.Length - 1] + (i * 64);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static void GetBits(long word, out byte[] bits00to15, out byte[] bits16to31, out byte[] bits32to47, out byte[] bits48to63)
        {
            bits00to15 = _bitsSetIn16Bits[word & 0xffffu];
            bits16to31 = _bitsSetIn16Bits[(word >> 16) & 0xffffu];
```

```
            bits32to47 = _bitsSetIn16Bits[(word >> 32) & 0xffffu];
            bits48to63 = _bitsSetIn16Bits[(word >> 48) & 0xffffu];
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void GetCommonInnerBorders(BitString left, BitString right, out long from,
        ↪  out long to)
        {
            from = Math.Max(left._minPositiveWord, right._minPositiveWord);
            to = Math.Min(left._maxPositiveWord, right._maxPositiveWord);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void GetCommonOuterBorders(BitString left, BitString right, out long from,
        ↪  out long to)
        {
            from = Math.Min(left._minPositiveWord, right._minPositiveWord);
            to = Math.Max(left._maxPositiveWord, right._maxPositiveWord);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void GetCommonOuterBorders(BitString left, BitString right, out int from,
        ↪  out int to)
        {
            from = (int)Math.Min(left._minPositiveWord, right._minPositiveWord);
            to = (int)Math.Max(left._maxPositiveWord, right._maxPositiveWord);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void GetCommonBorders(BitString left, BitString right, out ulong from, out
        ↪  ulong to)
        {
            from = (ulong)Math.Max(left._minPositiveWord, right._minPositiveWord);
            to = (ulong)Math.Min(left._maxPositiveWord, right._maxPositiveWord);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static long GetWordsCountFromIndex(long index) => (index + 63) / 64;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static long GetWordIndexFromIndex(long index) => index >> 6;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static long GetBitMaskFromIndex(long index) => 1L << (int)(index & 63);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public override int GetHashCode() => base.GetHashCode();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public override string ToString() => base.ToString();
    }
}
```

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

```
using System.Runtime.CompilerServices;
using Platform.Random;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections
{
    public static class BitStringExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void SetRandomBits(this BitString @string)
        {
            for (var i = 0; i < @string.Length; i++)
            {
                var value = RandomHelpers.Default.NextBoolean();
                @string.Set(i, value);
            }
        }
    }
}
```

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

```
using System.Collections.Concurrent;
using System.Collections.Generic;
```

```
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Concurrent
{
    public static class ConcurrentQueueExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IEnumerable<T> DequeueAll<T>(this ConcurrentQueue<T> queue)
        {
            while (queue.TryDequeue(out T item))
            {
                yield return item;
            }
        }
    }
}
```

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

```
using System.Collections.Concurrent;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Concurrent
{
    public static class ConcurrentStackExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T PopOrDefault<T>(this ConcurrentStack<T> stack) => stack.TryPop(out T
        ↪  value) ? value : default;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T PeekOrDefault<T>(this ConcurrentStack<T> stack) => stack.TryPeek(out T
        ↪  value) ? value : default;
    }
}
```

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

```
using System;
using System.Collections.Generic;
using System.Diagnostics;
using System.Runtime.CompilerServices;
using Platform.Exceptions;
using Platform.Exceptions.ExtensionRoots;

#pragma warning disable IDE0060 // Remove unused parameter
#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections
{
    public static class EnsureExtensions
    {
        #region Always

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void ArgumentNotEmpty<T>(this EnsureAlwaysExtensionRoot root,
        ↪  ICollection<T> argument, string argumentName, string message)
        {
            if (argument.IsNullOrEmpty())
            {
                throw new ArgumentException(message, argumentName);
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void ArgumentNotEmpty<T>(this EnsureAlwaysExtensionRoot root,
        ↪  ICollection<T> argument, string argumentName) => ArgumentNotEmpty(root, argument,
        ↪  argumentName, null);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void ArgumentNotEmpty<T>(this EnsureAlwaysExtensionRoot root,
        ↪  ICollection<T> argument) => ArgumentNotEmpty(root, argument, null, null);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
        ↪  string argument, string argumentName, string message)
        {
```

```
            if (string.IsNullOrWhiteSpace(argument))
            {
                throw new ArgumentException(message, argumentName);
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
        ↪  string argument, string argumentName) => ArgumentNotEmptyAndNotWhiteSpace(root,
        ↪  argument, argumentName, null);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
        ↪  string argument) => ArgumentNotEmptyAndNotWhiteSpace(root, argument, null, null);

        #endregion

        #region OnDebug

        [Conditional("DEBUG")]
        public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
        ↪  ICollection<T> argument, string argumentName, string message) =>
        ↪  Ensure.Always.ArgumentNotEmpty(argument, argumentName, message);

        [Conditional("DEBUG")]
        public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
        ↪  ICollection<T> argument, string argumentName) =>
        ↪  Ensure.Always.ArgumentNotEmpty(argument, argumentName, null);

        [Conditional("DEBUG")]
        public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
        ↪  ICollection<T> argument) => Ensure.Always.ArgumentNotEmpty(argument, null, null);

        [Conditional("DEBUG")]
        public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
        ↪  root, string argument, string argumentName, string message) =>
        ↪  Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument, argumentName, message);

        [Conditional("DEBUG")]
        public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
        ↪  root, string argument, string argumentName) =>
        ↪  Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument, argumentName, null);

        [Conditional("DEBUG")]
        public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
        ↪  root, string argument) => Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument,
        ↪  null, null);

        #endregion
    }
}
```

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

```
using System.Collections.Generic;
using System.Linq;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections
{
    public static class ICollectionExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool IsNullOrEmpty<T>(this ICollection<T> collection) => collection ==
        ↪  null || collection.Count == 0;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool AllEqualToDefault<T>(this ICollection<T> collection)
        {
            var equalityComparer = EqualityComparer<T>.Default;
            return collection.All(item => equalityComparer.Equals(item, default));
        }
    }
}
```

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

```
using System;
using System.Collections.Generic;
```

```
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections
{
    public static class IDictionaryExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TValue GetOrDefault<TKey, TValue>(this IDictionary<TKey, TValue>
        ↪  dictionary, TKey key)
        {
            dictionary.TryGetValue(key, out TValue value);
            return value;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TValue GetOrAdd<TKey, TValue>(this IDictionary<TKey, TValue> dictionary,
        ↪  TKey key, Func<TKey, TValue> valueFactory)
        {
            if (!dictionary.TryGetValue(key, out TValue value))
            {
                value = valueFactory(key);
                dictionary.Add(key, value);
                return value;
            }
            return value;
        }
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

namespace Platform.Collections.Lists
{
    public static class CharIListExtensions
    {
        /// <summary>
        /// <para>Generates a hash code for the entire list based on the values of its
        ↪  elements.</para>
        /// <para>Генерирует хэш-код всего списка, на основе значений его элементов.</para>
        /// </summary>
        /// <param name="list"><para>The list to be hashed.</para><para>Список для
        ↪  хеширования.</para></param>
        /// <returns>
        /// <para>The hash code of the list.</para>
        /// <para>Хэш-код списка.</para>
        /// </returns>
        /// <remarks>
        /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783
        ↪  a3eda37d3d4cd10/mscorlib/system/string.cs#L833
        /// </remarks>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static int GenerateHashCode(this IList<char> list)
        {
            var hashSeed = 5381;
            var hashAccumulator = hashSeed;
            for (var i = 0; i < list.Count; i++)
            {
                hashAccumulator = (hashAccumulator << 5) + hashAccumulator ^ list[i];
            }
            return hashAccumulator + (hashSeed * 1566083941);
        }

        /// <summary>
        /// <para>Compares two lists for equality.</para>
        /// <para>Сравнивает два списка на равенство.</para>
        /// </summary>
        /// <param name="left"><para>The first compared list.</para><para>Первый список для
        ↪  сравнения.</para></param>
        /// <param name="right"><para>The second compared list.</para><para>Второй список для
        ↪  сравнения.</para></param>
        /// <returns>
        /// <para>True, if the passed lists are equal to each other otherwise false.</para>
        /// <para>True, если переданные списки равны друг другу, иначе false.</para>
        /// </returns>
```

```
42          [MethodImpl(MethodImplOptions.AggressiveInlining)]
43          public static bool EqualTo(this IList<char> left, IList<char> right) =>
            ↪  left.EqualTo(right, ContentEqualTo);
44
45          /// <summary>
46          /// <para>Compares each element in the list for equality.</para>
47          /// <para>Сравнивает на равенство каждый элемент списка.</para>
48          /// </summary>
49          /// <param name="left"><para>The first compared list.</para><para>Первый список для
            ↪  сравнения.</para></param>
50          /// <param name="right"><para>The second compared list.</para><para>Второй список для
            ↪  сравнения.</para></param>
51          /// <returns>
52          /// <para>If at least one element of one list is not equal to the corresponding element
            ↪  from another list returns false, otherwise - true.</para>
53          /// <para>Если как минимум один элемент одного списка не равен соответствующему элементу
            ↪  из другого списка возвращает false, иначе - true.</para>
54          /// </returns>
55          [MethodImpl(MethodImplOptions.AggressiveInlining)]
56          public static bool ContentEqualTo(this IList<char> left, IList<char> right)
57          {
58              for (var i = left.Count - 1; i >= 0; --i)
59              {
60                  if (left[i] != right[i])
61                  {
62                      return false;
63                  }
64              }
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
            ↪  списка.</para></typeparam>
13          /// <param name="left"><para>The first compared list.</para><para>Первый список для
            ↪  сравнения.</para></param>
14          /// <param name="right"><para>The second compared list.</para><para>Второй список для
            ↪  сравнения.</para></param>
15          /// <returns>
16          /// <para>
17          ///     A signed integer that indicates the relative values of <paramref name="left" />
            ↪  and <paramref name="right" /> lists' elements, as shown in the following table.
18          ///     <list type="table">
19          ///         <listheader>
20          ///             <term>Value</term>
21          ///             <description>Meaning</description>
22          ///         </listheader>
23          ///         <item>
24          ///             <term>Is less than zero</term>
25          ///             <description>First non equal element of <paramref name="left" /> list is
            ↪  less than first not equal element of <paramref name="right" /> list.</description>
26          ///         </item>
27          ///         <item>
28          ///             <term>Zero</term>
29          ///             <description>All elements of <paramref name="left" /> list equals to all
            ↪  elements of <paramref name="right" /> list.</description>
30          ///         </item>
31          ///         <item>
32          ///             <term>Is greater than zero</term>
33          ///             <description>First non equal element of <paramref name="left" /> list is
            ↪  greater than first not equal element of <paramref name="right" /> list.</description>
34          ///         </item>
35          ///     </list>
36          /// <para>
```

```
37          /// <para>
38          ///     Целое число со знаком, которое указывает относительные значения элементов
            ↪  списков <paramref name="left" /> и <paramref name="right" /> как показано в
            ↪  следующей таблице.
39          ///     <list type="table">
40          ///         <listheader>
41          ///             <term>Значение</term>
42          ///             <description>Смысл</description>
43          ///         </listheader>
44          ///         <item>
45          ///             <term>Меньше нуля</term>
46          ///             <description>Первый не равный элемент <paramref name="left" /> списка
            ↪  меньше первого неравного элемента <paramref name="right" /> списка.</description>
47          ///         </item>
48          ///         <item>
49          ///             <term>Ноль</term>
50          ///             <description>Все элементы <paramref name="left" /> списка равны всем
            ↪  элементам <paramref name="right" /> списка.</description>
51          ///         </item>
52          ///         <item>
53          ///             <term>Больше нуля</term>
54          ///             <description>Первый не равный элемент <paramref name="left" /> списка
            ↪  больше первого неравного элемента <paramref name="right" /> списка.</description>
55          ///         </item>
56          ///     </list>
57          /// </para>
58          /// </returns>
59          [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
            ↪  сравнения.</para></param>
13          /// <param name="right"><para>The second compared list.</para><para>Второй список для
            ↪  сравнения.</para></param>
14          /// <returns>
15          /// <para>If the passed lists are equal to each other, true is returned, otherwise
            ↪  false.</para>
16          /// <para>Если переданные списки равны друг другу, возвращается true, иначе же
            ↪  false.</para>
17          /// </returns>
18          [MethodImpl(MethodImplOptions.AggressiveInlining)]
19          public bool Equals(IList<T> left, IList<T> right) => left.EqualTo(right);
20
21          /// <summary>
22          /// <para>Generates a hash code for the entire list based on the values of its
            ↪  elements.</para>
23          /// <para>Генерирует хэш-код всего списка, на основе значений его элементов.</para>
24          /// </summary>
25          /// <param name="list"><para>Hash list.</para><para>Список для
            ↪  хеширования.</para></param>
26          /// <returns>
27          /// <para>The hash code of the list.</para>
28          /// <para>Хэш-код списка.</para>
29          /// </returns>
30          [MethodImpl(MethodImplOptions.AggressiveInlining)]
31          public int GetHashCode(IList<T> list) => list.GenerateHashCode();
32      }
33  }
```

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
                ↪ within the list's boundaries, otherwise it returns default value of type T.</para>
11          /// <para>Получает элемент из указанного индекса, если список не является null и индекс
                ↪ находится в границах списка, в противном случае он возвращает значение по умолчанию
                ↪ типа T.</para>
12          /// </summary>
13          /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
                ↪ списка.</typeparam>
14          /// <param name="list"><para>The checked list.</para><para>Проверяемый
                ↪ список.</para></param>
15          /// <param name="index"><para>The index of element.</para><para>Индекс
                ↪ элемента.</para></param>
16          /// <returns>
17          /// <para>If the specified index is within list's boundaries, then - list[index],
                ↪ otherwise the default value.</para>
18          /// <para>Если указанный индекс находится в пределах границ списка, тогда - list[index],
                ↪ иначе же значение по умолчанию.</para>
19          /// </returns>
20          [MethodImpl(MethodImplOptions.AggressiveInlining)]
21          public static T GetElementOrDefault<T>(this IList<T> list, int index) => list != null &&
                ↪ list.Count > index ? list[index] : default;
22
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         {
```

```
            for (var i = 0; i < elements.Count; i++)
            {
                list.Add(elements[i]);
            }
        }

        /// <summary>
        /// <para>Adds values to the list skipping the first element.</para>
        /// <para>Добавляет значения в список пропуская первый элемент.</para>
        /// </summary>
        /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
        ↪  списка.</para></typeparam>
        /// <param name="list"><para>The list to add the values to.</para><para>Список в который
        ↪  нужно добавить значения.</para></param>
        /// <param name="elements"><para>The list of values to add.</para><para>Список значений
        ↪  которые необходимо добавить.</para></param>
        /// <returns>
        /// <para>True value in any case.</para>
        /// <para>Значение true в любом случае.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool AddSkipFirstAndReturnTrue<T>(this IList<T> list, IList<T> elements)
        {
            list.AddSkipFirst(elements);
            return true;
        }

        /// <summary>
        /// <para>Adds values to the list skipping the first element.</para>
        /// <para>Добавляет значения в список пропуская первый элемент.</para>
        /// </summary>
        /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
        ↪  списка.</para></typeparam>
        /// <param name="list"><para>The list to add the values to.</para><para>Список в который
        ↪  нужно добавить значения.</para></param>
        /// <param name="elements"><para>List of values to add.</para><para>Список значений
        ↪  которые необходимо добавить.</para></param>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddSkipFirst<T>(this IList<T> list, IList<T> elements) =>
        ↪  list.AddSkipFirst(elements, 1);

        /// <summary>
        /// <para>Adds values to the list skipping a specified number of first elements.</para>
        /// <para>Добавляет в список значения пропуская определенное количество первых
        ↪  элементов.</para>
        /// </summary>
        /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
        ↪  списка.</para></typeparam>
        /// <param name="list"><para>The list to add the values to.</para><para>Список в который
        ↪  нужно добавить значения.</para></param>
        /// <param name="elements"><para>List of values to add.</para><para>Список значений
        ↪  которые необходимо добавить.</para></param>
        /// <param name="skip"><para>Number of elements to skip.</para><para>Количество
        ↪  пропускаемых элементов.</para></param>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddSkipFirst<T>(this IList<T> list, IList<T> elements, int skip)
        {
            for (var i = skip; i < elements.Count; i++)
            {
                list.Add(elements[i]);
            }
        }

        /// <summary>
        /// <para>Reads the number of elements in the list.</para>
        /// <para>Считывает число элементов списка.</para>
        /// </summary>
        /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
        ↪  списка.</para></typeparam>
        /// <param name="list"><para>The checked list.</para><para>Список для
        ↪  проверки.</para></param>
        /// <returns>
        /// <para>The number of items contained in the list or 0.</para>
        /// <para>Число элементов содержащихся в списке или же 0.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        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>
```

```
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool ContentEqualTo<T>(this IList<T> left, IList<T> right)
        {
            var equalityComparer = EqualityComparer<T>.Default;
            for (var i = left.Count - 1; i >= 0; --i)
            {
                if (!equalityComparer.Equals(left[i], right[i]))
                {
                    return false;
                }
            }
            return true;
        }

        /// <summary>
        /// <para>Creates an array by copying all elements from the list that satisfy the
        ↪  predicate. If no list is passed, null is returned.</para>
        /// <para>Создаёт массив, копируя из списка все элементы которые удовлетворяют
        ↪  предикату. Если список не передан, возвращается null.</para>
        /// </summary>
        /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
        ↪  списка.</para></typeparam>
        /// <param name="list">The list to copy from.<para>Список для копирования.</para></param>
        /// <param name="predicate"><para>A function that determines whether an element should
        ↪  be copied.</para><para>Функция определяющая должен ли копироваться
        ↪  элемент.</para></param>
        /// <returns>
        /// <para>An array with copied elements from the list.</para>
        /// <para>Массив с скопированными элементами из списка.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T[] ToArray<T>(this IList<T> list, Func<T, bool> predicate)
        {
            if (list == null)
            {
                return null;
            }
            var result = new List<T>(list.Count);
            for (var i = 0; i < list.Count; i++)
            {
                if (predicate(list[i]))
                {
                    result.Add(list[i]);
                }
            }
            return result.ToArray();
        }

        /// <summary>
        /// <para>Copies all the elements of the list into an array and returns it.</para>
        /// <para>Копирует все элементы списка в массив и возвращает его.</para>
        /// </summary>
        /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
        ↪  списка.</para></typeparam>
        /// <param name="list"><para>The list to copy from.</para><para>Список для
        ↪  копирования.</para></param>
        /// <returns>
        /// <para>An array with all the elements of the passed list.</para>
        /// <para>Массив со всеми элементами переданного списка.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T[] ToArray<T>(this IList<T> list)
        {
            var array = new T[list.Count];
            list.CopyTo(array, 0);
            return array;
        }

        /// <summary>
        /// <para>Executes the passed action for each item in the list.</para>
        /// <para>Выполняет переданное действие для каждого элемента в списке.</para>
        /// </summary>
        /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
        ↪  списка.</para></typeparam>
        /// <param name="list"><para>The list of elements for which the action will be
        ↪  executed.</para><para>Список элементов для которых будет выполняться
        ↪  действие.</para></param>
```

```
312         /// <param name="action"><para>A function that will be called for each element of the
            ↪  list.</para><para>Функция которая будет вызываться для каждого элемента
            ↪  списка.</para></param>
313         [MethodImpl(MethodImplOptions.AggressiveInlining)]
314         public static void ForEach<T>(this IList<T> list, Action<T> action)
315         {
316             for (var i = 0; i < list.Count; i++)
317             {
318                 action(list[i]);
319             }
320         }
321
322         /// <summary>
323         /// <para>Generates a hash code for the entire list based on the values of its
            ↪  elements.</para>
324         /// <para>Генерирует хэш-код всего списка, на основе значений его элементов.</para>
325         /// </summary>
326         /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
            ↪  списка.</para></typeparam>
327         /// <param name="list"><para>Hash list.</para><para>Список для
            ↪  хеширования.</para></param>
328         /// <returns>
329         /// <para>The hash code of the list.</para>
330         /// <para>Хэш-код списка.</para>
331         /// </returns>
332         /// <remarks>
333         /// Based on http://stackoverflow.com/questions/263400/what-is-the-best-algorithm-for-an
            ↪  -overridden-system-object-gethashcode
334         /// </remarks>
335         [MethodImpl(MethodImplOptions.AggressiveInlining)]
336         public static int GenerateHashCode<T>(this IList<T> list)
337         {
338             var hashAccumulator = 17;
339             for (var i = 0; i < list.Count; i++)
340             {
341                 hashAccumulator = unchecked((hashAccumulator * 23) + list[i].GetHashCode());
342             }
343             return hashAccumulator;
344         }
345
346         /// <summary>
347         /// <para>Compares two lists.</para>
348         /// <para>Сравнивает два списка.</para>
349         /// </summary>
350         /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
            ↪  списка.</para></typeparam>
351         /// <param name="left"><para>The first compared list.</para><para>Первый список для
            ↪  сравнения.</para></param>
352         /// <param name="right"><para>The second compared list.</para><para>Второй список для
            ↪  сравнения.</para></param>
353         /// <returns>
354         /// <para>
355         ///     A signed integer that indicates the relative values of <paramref name="left" />
            ↪  and <paramref name="right" /> lists' elements, as shown in the following table.
356         ///     <list type="table">
357         ///         <listheader>
358         ///             <term>Value</term>
359         ///             <description>Meaning</description>
360         ///         </listheader>
361         ///         <item>
362         ///             <term>Is less than zero</term>
363         ///             <description>First non equal element of <paramref name="left" /> list is
            ↪  less than first not equal element of <paramref name="right" /> list.</description>
364         ///         </item>
365         ///         <item>
366         ///             <term>Zero</term>
367         ///             <description>All elements of <paramref name="left" /> list equals to all
            ↪  elements of <paramref name="right" /> list.</description>
368         ///         </item>
369         ///         <item>
370         ///             <term>Is greater than zero</term>
371         ///             <description>First non equal element of <paramref name="left" /> list is
            ↪  greater than first not equal element of <paramref name="right" /> list.</description>
372         ///         </item>
373         ///     </list>
374         /// </para>
375         /// <para>
```

```
///     Целое число со знаком, которое указывает относительные значения элементов списков <paramref name="left" /> и <paramref name="right" /> как показано в следующей таблице.
///     <list type="table">
///         <listheader>
///             <term>Значение</term>
///             <description>Смысл</description>
///         </listheader>
///         <item>
///             <term>Меньше нуля</term>
///             <description>Первый не равный элемент <paramref name="left" /> списка меньше первого неравного элемента <paramref name="right" /> списка.</description>
///         </item>
///         <item>
///             <term>Ноль</term>
///             <description>Все элементы <paramref name="left" /> списка равны всем элементам <paramref name="right" /> списка.</description>
///         </item>
///         <item>
///             <term>Больше нуля</term>
///             <description>Первый не равный элемент <paramref name="left" /> списка больше первого неравного элемента <paramref name="right" /> списка.</description>
///         </item>
///     </list>
/// </para>
/// </returns>
[MethodImpl(MethodImplOptions.AggressiveInlining)]
public static int CompareTo<T>(this IList<T> left, IList<T> right)
{
    var comparer = Comparer<T>.Default;
    var leftCount = left.GetCountOrZero();
    var rightCount = right.GetCountOrZero();
    var intermediateResult = leftCount.CompareTo(rightCount);
    for (var i = 0; intermediateResult == 0 && i < leftCount; i++)
    {
        intermediateResult = comparer.Compare(left[i], right[i]);
    }
    return intermediateResult;
}

/// <summary>
/// <para>Skips one element in the list and builds an array from the remaining elements.</para>
/// <para>Пропускает один элемент списка и составляет из оставшихся элементов массив.</para>
/// </summary>
/// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов списка.</para></typeparam>
/// <param name="list"><para>The list to copy from.</para><para>Список для копирования.</para></param>
/// <returns>
/// <para>If the list is empty, returns an empty array, otherwise - an array with a missing first element.</para>
/// <para>Если список пуст, возвращает пустой массив, иначе - массив с пропущенным первым элементом.</para>
/// </returns>
[MethodImpl(MethodImplOptions.AggressiveInlining)]
public static T[] SkipFirst<T>(this IList<T> list) => list.SkipFirst(1);

/// <summary>
/// <para>Skips the specified number of elements in the list and builds an array from the remaining elements.</para>
/// <para>Пропускает указанное количество элементов списка и составляет из оставшихся элементов массив.</para>
/// </summary>
/// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов списка.</para></typeparam>
/// <param name="list"><para>The list to copy from.</para><para>Список для копирования.</para></param>
/// <param name="skip"><para>The number of items to skip.</para><para>Количество пропускаемых элементов.</para></param>
/// <returns>
/// <para>If the list is empty, or the number of skipped elements is greater than the list, returns an empty array, otherwise - an array with the specified number of missing elements.</para>
```

```
433         /// <para>Если список пуст, или количество пропускаемых элементов больше списка -
            ↪  возвращает пустой массив, иначе - массив с указанным количеством пропущенных
            ↪  элементов.</para>
434         /// </returns>
435         [MethodImpl(MethodImplOptions.AggressiveInlining)]
436         public static T[] SkipFirst<T>(this IList<T> list, int skip)
437         {
438             if (list.IsNullOrEmpty() || list.Count <= skip)
439             {
440                 return Array.Empty<T>();
441             }
442             var result = new T[list.Count - skip];
443             for (int r = skip, w = 0; r < list.Count; r++, w++)
444             {
445                 result[w] = list[r];
446             }
447             return result;
448         }
449 
450         /// <summary>
451         /// <para>Shifts all the elements of the list by one position to the right.</para>
452         /// <para>Сдвигает вправо все элементы списка на одну позицию.</para>
453         /// </summary>
454         /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
            ↪  списка.</para></typeparam>
455         /// <param name="list"><para>The list to copy from.</para><para>Список для
            ↪  копирования.</para></param>
456         /// <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
            ↪  elements.</para>
465         /// <para>Сдвигает вправо все элементы списка на указанное количество элементов.</para>
466         /// </summary>
467         /// <typeparam name="T"><para>The list's item type.</para><para>Тип элементов
            ↪  списка.</para></typeparam>
468         /// <param name="list"><para>The list to copy from.</para><para>Список для
            ↪  копирования.</para></param>
469         /// <param name="skip"><para>The number of items to shift.</para><para>Количество
            ↪  сдвигаемых элементов.</para></param>
470         /// <returns>
471         /// <para>If the value of the shift variable is less than zero - an <see
            ↪  cref="NotImplementedException"/> exception is thrown, but if the value of the shift
            ↪  variable is 0 - an exact copy of the array is returned. Otherwise, an array is
            ↪  returned with the shift of the elements.</para>
472         /// <para>Если значение переменной shift меньше нуля - выбрасывается исключение <see
            ↪  cref="NotImplementedException"/>, если же значение переменной shift равно 0 -
            ↪  возвращается точная копия массива. Иначе возвращается массив со сдвигом
            ↪  элементов.</para>
473         /// </returns>
474         [MethodImpl(MethodImplOptions.AggressiveInlining)]
475         public static IList<T> ShiftRight<T>(this IList<T> list, int shift)
476         {
477             if (shift < 0)
478             {
479                 throw new NotImplementedException();
480             }
481             if (shift == 0)
482             {
483                 return list.ToArray();
484             }
485             else
486             {
487                 var result = new T[list.Count + shift];
488                 for (int r = 0, w = shift; r < list.Count; r++, w++)
489                 {
490                     result[w] = list[r];
491                 }
492                 return result;
493             }
494         }
495     }
```

```
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

namespace Platform.Collections.Lists
{
    public class ListFiller<TElement, TReturnConstant>
    {
        protected readonly List<TElement> _list;
        protected readonly TReturnConstant _returnConstant;

        /// <summary>
        /// <para>Initializes a new instance of the ListFiller class.</para>
        /// <para>Инициализирует новый экземпляр класса ListFiller.</para>
        /// </summary>
        /// <param name="list"><para>The list to be filled.</para><para>Список который будет
        ↪  заполняться.</para></param>
        /// <param name="returnConstant"><para>The value for the constant returned by
        ↪  corresponding methods.</para><para>Значение для константы возвращаемой
        ↪  соответствующими методами.</para></param>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ListFiller(List<TElement> list, TReturnConstant returnConstant)
        {
            _list = list;
            _returnConstant = returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public ListFiller(List<TElement> list) : this(list, default) { }

        /// <summary>
        /// <para>Adds an item to the end of the list.</para>
        /// <para>Добавляет элемент в конец списка.</para>
        /// </summary>
        /// <param name="element"><para>Element to add.</para><para>Добавляемый
        ↪  элемент.</para></param>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Add(TElement element) => _list.Add(element);

        /// <summary>
        /// <para>Adds an item to the end of the list and return true.</para>
        /// <para>Добавляет элемент в конец списка и возвращает true.</para>
        /// </summary>
        /// <param name="element"><para>Element to add.</para><para>Добавляемый
        ↪  элемент.</para></param>
        /// <returns>
        /// <para>True value in any case.</para>
        /// <para>Значение true в любом случае.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddAndReturnTrue(TElement element) => _list.AddAndReturnTrue(element);

        /// <summary>
        /// <para>Adds a value to the list at the first index and return true.</para>
        /// <para>Добавляет значение в список по первому индексу и возвращает true.</para>
        /// </summary>
        /// <param name="element"><para>Element to add.</para><para>Добавляемый
        ↪  элемент.</para></param>
        /// <returns>
        /// <para>True value in any case.</para>
        /// <para>Значение true в любом случае.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddFirstAndReturnTrue(IList<TElement> elements) =>
        ↪  _list.AddFirstAndReturnTrue(elements);

        /// <summary>
        /// <para>Adds all elements from other list to this list and returns true.</para>
        /// <para>Добавляет все элементы из другого списка в этот список и возвращает
        ↪  true.</para>
        /// </summary>
        /// <param name="elements"><para>List of values to add.</para><para>Список значений
        ↪  которые необходимо добавить.</para></param>
        /// <returns>
        /// <para>True value in any case.</para>
        /// <para>Значение true в любом случае.</para>
```

```
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddAllAndReturnTrue(IList<TElement> elements) =>
        ↪  _list.AddAllAndReturnTrue(elements);

        /// <summary>
        /// <para>Adds values to the list skipping the first element.</para>
        /// <para>Добавляет значения в список пропуская первый элемент.</para>
        /// </summary>
        /// <param name="elements"><para>The list of values to add.</para><para>Список значений
        ↪  которые необходимо добавить.</para></param>
        /// <returns>
        /// <para>True value in any case.</para>
        /// <para>Значение true в любом случае.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddSkipFirstAndReturnTrue(IList<TElement> elements) =>
        ↪  _list.AddSkipFirstAndReturnTrue(elements);

        /// <summary>
        /// <para>Adds an item to the end of the list and return constant.</para>
        /// <para>Добавляет элемент в конец списка и возвращает константу.</para>
        /// </summary>
        /// <param name="element"><para>Element to add.</para><para>Добавляемый
        ↪  элемент.</para></param>
        /// <returns>
        /// <para>Constant value in any case.</para>
        /// <para>Значение константы в любом случае.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddAndReturnConstant(TElement element)
        {
            _list.Add(element);
            return _returnConstant;
        }

        /// <summary>
        /// <para>Adds a value to the list at the first index and return constant.</para>
        /// <para>Добавляет значение в список по первому индексу и возвращает константу.</para>
        /// </summary>
        /// <param name="element"><para>Element to add.</para><para>Добавляемый
        ↪  элемент.</para></param>
        /// <returns>
        /// <para>Constant value in any case.</para>
        /// <para>Значение константы в любом случае.</para>
        /// <returns></returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddFirstAndReturnConstant(IList<TElement> elements)
        {
            _list.AddFirst(elements);
            return _returnConstant;
        }

        /// <summary>
        /// <para>Adds all elements from other list to this list and returns constant.</para>
        /// <para>Добавляет все элементы из другого списка в этот список и возвращает
        ↪  константу.</para>
        /// </summary>
        /// <param name="elements"><para>List of values to add.</para><para>Список значений
        ↪  которые необходимо добавить.</para></param>
        /// <returns>
        /// <para>Constant value in any case.</para>
        /// <para>Значение константы в любом случае.</para>
        /// <returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddAllAndReturnConstant(IList<TElement> elements)
        {
            _list.AddAll(elements);
            return _returnConstant;
        }

        /// <summary>
        /// <para>Adds values to the list skipping the first element and return constant
        ↪  value.</para>
        /// <para>Добавляет значения в список пропуская первый элемент и возвращает значение
        ↪  константы.</para>
        /// </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(IList<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;
```

```
    }
}
```

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

```
using System;
using System.Collections;
using System.Collections.Generic;
using System.Runtime.CompilerServices;
using Platform.Collections.Arrays;
using Platform.Collections.Lists;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments
{
    public class Segment<T> : IEquatable<Segment<T>>, IList<T>
    {
        public IList<T> Base
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get;
        }
        public int Offset
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get;
        }
        public int Length
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Segment(IList<T> @base, int offset, int length)
        {
            Base = @base;
            Offset = offset;
            Length = length;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public override int GetHashCode() => this.GenerateHashCode();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public virtual bool Equals(Segment<T> other) => this.EqualTo(other);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public override bool Equals(object obj) => obj is Segment<T> other ? Equals(other) :
        ↪  false;

        #region IList

        public T this[int i]
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => Base[Offset + i];
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            set => Base[Offset + i] = value;
        }

        public int Count
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => Length;
        }

        public bool IsReadOnly
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => true;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public int IndexOf(T item)
        {
            var index = Base.IndexOf(item);
            if (index >= Offset)
            {
                var actualIndex = index - Offset;
                if (actualIndex < Length)
```

```
                {
                    return actualIndex;
                }
            }
            return -1;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Insert(int index, T item) => throw new NotSupportedException();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void RemoveAt(int index) => throw new NotSupportedException();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Add(T item) => throw new NotSupportedException();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Clear() => throw new NotSupportedException();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool Contains(T item) => IndexOf(item) >= 0;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void CopyTo(T[] array, int arrayIndex)
        {
            for (var i = 0; i < Length; i++)
            {
                array.Add(ref arrayIndex, this[i]);
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool Remove(T item) => throw new NotSupportedException();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public IEnumerator<T> GetEnumerator()
        {
            for (var i = 0; i < Length; i++)
            {
                yield return this[i];
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        IEnumerator IEnumerable.GetEnumerator() => GetEnumerator();

        #endregion
    }
}
```

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

```
#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments.Walkers
{
    public abstract class AllSegmentsWalkerBase
    {
        public static readonly int DefaultMinimumStringSegmentLength = 2;
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments.Walkers
{
    public abstract class AllSegmentsWalkerBase<T, TSegment> : AllSegmentsWalkerBase
        where TSegment : Segment<T>
    {
        private readonly int _minimumStringSegmentLength;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected AllSegmentsWalkerBase(int minimumStringSegmentLength) =>
        ↪  _minimumStringSegmentLength = minimumStringSegmentLength;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected AllSegmentsWalkerBase() : this(DefaultMinimumStringSegmentLength) { }
```

```

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public virtual void WalkAll(IList<T> elements)
        {
            for (int offset = 0, maxOffset = elements.Count - _minimumStringSegmentLength;
            ↪  offset <= maxOffset; offset++)
            {
                for (int length = _minimumStringSegmentLength, maxLength = elements.Count -
                ↪  offset; length <= maxLength; length++)
                {
                    Iteration(CreateSegment(elements, offset, length));
                }
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected abstract TSegment CreateSegment(IList<T> elements, int offset, int length);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected abstract void Iteration(TSegment segment);
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments.Walkers
{
    public abstract class AllSegmentsWalkerBase<T> : AllSegmentsWalkerBase<T, Segment<T>>
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected override Segment<T> CreateSegment(IList<T> elements, int offset, int length)
        ↪  => new Segment<T>(elements, offset, length);
    }
}
```

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

```
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments.Walkers
{
    public static class AllSegmentsWalkerExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void WalkAll(this AllSegmentsWalkerBase<char> walker, string @string) =>
        ↪  walker.WalkAll(@string.ToCharArray());

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void WalkAll<TSegment>(this AllSegmentsWalkerBase<char, TSegment> walker,
        ↪  string @string) where TSegment : Segment<char> =>
        ↪  walker.WalkAll(@string.ToCharArray());
    }
}
```

1.26 ./csharp/Platform.Collections/Segments/Walkers/DictionaryBasedDuplicateSegmentsWalkerBase[T, Segment

```
using System;
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments.Walkers
{
    public abstract class DictionaryBasedDuplicateSegmentsWalkerBase<T, TSegment> :
    ↪  DuplicateSegmentsWalkerBase<T, TSegment>
        where TSegment : Segment<T>
    {
        public static readonly bool DefaultResetDictionaryOnEachWalk;

        private readonly bool _resetDictionaryOnEachWalk;
        protected IDictionary<TSegment, long> Dictionary;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
```

```
18          protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
            ↪ dictionary, int minimumStringSegmentLength, bool resetDictionaryOnEachWalk)
19              : base(minimumStringSegmentLength)
20          {
21              Dictionary = dictionary;
22              _resetDictionaryOnEachWalk = resetDictionaryOnEachWalk;
23          }
24
25          [MethodImpl(MethodImplOptions.AggressiveInlining)]
26          protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
            ↪ dictionary, int minimumStringSegmentLength) : this(dictionary,
            ↪ minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
27
28          [MethodImpl(MethodImplOptions.AggressiveInlining)]
29          protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
            ↪ dictionary) : this(dictionary, DefaultMinimumStringSegmentLength,
            ↪ DefaultResetDictionaryOnEachWalk) { }
30
31          [MethodImpl(MethodImplOptions.AggressiveInlining)]
32          protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength,
            ↪ bool resetDictionaryOnEachWalk) : this(resetDictionaryOnEachWalk ? null : new
            ↪ Dictionary<TSegment, long>(), minimumStringSegmentLength, resetDictionaryOnEachWalk)
            ↪ { }
33
34          [MethodImpl(MethodImplOptions.AggressiveInlining)]
35          protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
            ↪ this(minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
36
37          [MethodImpl(MethodImplOptions.AggressiveInlining)]
38          protected DictionaryBasedDuplicateSegmentsWalkerBase() :
            ↪ this(DefaultMinimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
39
40          [MethodImpl(MethodImplOptions.AggressiveInlining)]
41          public override void WalkAll(IList<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) { }
```

```

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength,
        ↪  bool resetDictionaryOnEachWalk) : base(minimumStringSegmentLength,
        ↪  resetDictionaryOnEachWalk) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
        ↪  base(minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase() :
        ↪  base(DefaultMinimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
    }
}
```

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

```
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments.Walkers
{
    public abstract class DuplicateSegmentsWalkerBase<T, TSegment> : AllSegmentsWalkerBase<T,
    ↪  TSegment>
        where TSegment : Segment<T>
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
        ↪  base(minimumStringSegmentLength) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DuplicateSegmentsWalkerBase() : base(DefaultMinimumStringSegmentLength) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected override void Iteration(TSegment segment)
        {
            var frequency = GetSegmentFrequency(segment);
            if (frequency == 1)
            {
                OnDublicateFound(segment);
            }
            SetSegmentFrequency(segment, frequency + 1);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected abstract void OnDublicateFound(TSegment segment);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected abstract long GetSegmentFrequency(TSegment segment);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected abstract void SetSegmentFrequency(TSegment segment, long frequency);
    }
}
```

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

```
#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Segments.Walkers
{
    public abstract class DuplicateSegmentsWalkerBase<T> : DuplicateSegmentsWalkerBase<T,
    ↪  Segment<T>>
    {
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Sets
{
    public static class ISetExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
```

```
        public static void AddAndReturnVoid<T>(this ISet<T> set, T element) => set.Add(element);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void RemoveAndReturnVoid<T>(this ISet<T> set, T element) =>
        ↪  set.Remove(element);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool AddAndReturnTrue<T>(this ISet<T> set, T element)
        {
            set.Add(element);
            return true;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool AddFirstAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
        {
            AddFirst(set, elements);
            return true;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddFirst<T>(this ISet<T> set, IList<T> elements) =>
        ↪  set.Add(elements[0]);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool AddAllAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
        {
            set.AddAll(elements);
            return true;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddAll<T>(this ISet<T> set, IList<T> elements)
        {
            for (var i = 0; i < elements.Count; i++)
            {
                set.Add(elements[i]);
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool AddSkipFirstAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
        {
            set.AddSkipFirst(elements);
            return true;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddSkipFirst<T>(this ISet<T> set, IList<T> elements) =>
        ↪  set.AddSkipFirst(elements, 1);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddSkipFirst<T>(this ISet<T> set, IList<T> elements, int skip)
        {
            for (var i = skip; i < elements.Count; i++)
            {
                set.Add(elements[i]);
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool DoNotContains<T>(this ISet<T> set, T element) =>
        ↪  !set.Contains(element);
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Sets
{
    public class SetFiller<TElement, TReturnConstant>
    {
        protected readonly ISet<TElement> _set;
        protected readonly TReturnConstant _returnConstant;

```

```
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public SetFiller(ISet<TElement> set, TReturnConstant returnConstant)
        {
            _set = set;
            _returnConstant = returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public SetFiller(ISet<TElement> set) : this(set, default) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Add(TElement element) => _set.Add(element);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddAndReturnTrue(TElement element) => _set.AddAndReturnTrue(element);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddFirstAndReturnTrue(IList<TElement> elements) =>
        ↪  _set.AddFirstAndReturnTrue(elements);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddAllAndReturnTrue(IList<TElement> elements) =>
        ↪  _set.AddAllAndReturnTrue(elements);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool AddSkipFirstAndReturnTrue(IList<TElement> elements) =>
        ↪  _set.AddSkipFirstAndReturnTrue(elements);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddAndReturnConstant(TElement element)
        {
            _set.Add(element);
            return _returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddFirstAndReturnConstant(IList<TElement> elements)
        {
            _set.AddFirst(elements);
            return _returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddAllAndReturnConstant(IList<TElement> elements)
        {
            _set.AddAll(elements);
            return _returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public TReturnConstant AddSkipFirstAndReturnConstant(IList<TElement> elements)
        {
            _set.AddSkipFirst(elements);
            return _returnConstant;
        }
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Stacks
{
    public class DefaultStack<TElement> : Stack<TElement>, IStack<TElement>
    {
        public bool IsEmpty
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => Count <= 0;
        }
    }
}
```

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

```
using System.Runtime.CompilerServices;

```

```
#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Stacks
{
    public interface IStack<TElement>
    {
        bool IsEmpty
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        void Push(TElement element);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        TElement Pop();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        TElement Peek();
    }
}
```

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

```
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Stacks
{
    public static class IStackExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void Clear<T>(this IStack<T> stack)
        {
            while (!stack.IsEmpty)
            {
                _ = stack.Pop();
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T PopOrDefault<T>(this IStack<T> stack) => stack.IsEmpty ? default :
        ↪  stack.Pop();

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T PeekOrDefault<T>(this IStack<T> stack) => stack.IsEmpty ? default :
        ↪  stack.Peek();
    }
}
```

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

```
using Platform.Interfaces;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Stacks
{
    public interface IStackFactory<TElement> : IFactory<IStack<TElement>>
    {
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Stacks
{
    public static class StackExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T PopOrDefault<T>(this Stack<T> stack) => stack.Count > 0 ? stack.Pop() :
        ↪  default;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T PeekOrDefault<T>(this Stack<T> stack) => stack.Count > 0 ? stack.Peek()
        ↪  : default;
```

```
    }
}
```

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

```
using System;
using System.Globalization;
using System.Runtime.CompilerServices;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections
{
    public static class StringExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static string CapitalizeFirstLetter(this string @string)
        {
            if (string.IsNullOrWhiteSpace(@string))
            {
                return @string;
            }
            var chars = @string.ToCharArray();
            for (var i = 0; i < chars.Length; i++)
            {
                var category = char.GetUnicodeCategory(chars[i]);
                if (category == UnicodeCategory.UppercaseLetter)
                {
                    return @string;
                }
                if (category == UnicodeCategory.LowercaseLetter)
                {
                    chars[i] = char.ToUpper(chars[i]);
                    return new string(chars);
                }
            }
            return @string;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static string Truncate(this string @string, int maxLength) =>
        ↪  string.IsNullOrEmpty(@string) ? @string : @string.Substring(0,
        ↪  Math.Min(@string.Length, maxLength));

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static string TrimSingle(this string @string, char charToTrim)
        {
            if (!string.IsNullOrEmpty(@string))
            {
                if (@string.Length == 1)
                {
                    if (@string[0] == charToTrim)
                    {
                        return "";
                    }
                    else
                    {
                        return @string;
                    }
                }
                else
                {
                    var left = 0;
                    var right = @string.Length - 1;
                    if (@string[left] == charToTrim)
                    {
                        left++;
                    }
                    if (@string[right] == charToTrim)
                    {
                        right--;
                    }
                    return @string.Substring(left, right - left + 1);
                }
            }
            else
            {
                return @string;
            }
        }
```

```
    }
}
```

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

```
using System.Collections.Generic;
using System.Runtime.CompilerServices;

// ReSharper disable ForCanBeConvertedToForeach
#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.Collections.Trees
{
    public class Node
    {
        private Dictionary<object, Node> _childNodes;

        public object Value
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get;
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            set;
        }

        public Dictionary<object, Node> ChildNodes
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => _childNodes ?? (_childNodes = new Dictionary<object, Node>());
        }

        public Node this[object key]
        {
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            get => GetChild(key) ?? AddChild(key);
            [MethodImpl(MethodImplOptions.AggressiveInlining)]
            set => SetChildValue(value, key);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node(object value) => Value = value;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node() : this(null) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool ContainsChild(params object[] keys) => GetChild(keys) != null;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node GetChild(params object[] keys)
        {
            var node = this;
            for (var i = 0; i < keys.Length; i++)
            {
                node.ChildNodes.TryGetValue(keys[i], out node);
                if (node == null)
                {
                    return null;
                }
            }
            return node;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public object GetChildValue(params object[] keys) => GetChild(keys)?.Value;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node AddChild(object key) => AddChild(key, new Node(null));

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node AddChild(object key, object value) => AddChild(key, new Node(value));

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node AddChild(object key, Node child)
        {
            ChildNodes.Add(key, child);
            return child;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node SetChild(params object[] keys) => SetChildValue(null, keys);
```

```

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node SetChild(object key) => SetChildValue(null, key);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node SetChildValue(object value, params object[] keys)
        {
            var node = this;
            for (var i = 0; i < keys.Length; i++)
            {
                node = SetChildValue(value, keys[i]);
            }
            node.Value = value;
            return node;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public Node SetChildValue(object value, object key)
        {
            if (!ChildNodes.TryGetValue(key, out Node child))
            {
                child = AddChild(key, value);
            }
            child.Value = value;
            return child;
        }
    }
}
```

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

```
using Xunit;
using Platform.Collections.Arrays;

namespace Platform.Collections.Tests
{
    public class ArrayTests
    {
        [Fact]
        public void GetElementTest()
        {
            var nullArray = (int[])null;
            Assert.Equal(0, nullArray.GetElementOrDefault(1));
            Assert.False(nullArray.TryGetElement(1, out int element));
            Assert.Equal(0, element);
            var array = new int[] { 1, 2, 3 };
            Assert.Equal(3, array.GetElementOrDefault(2));
            Assert.True(array.TryGetElement(2, out element));
            Assert.Equal(3, element);
            Assert.Equal(0, array.GetElementOrDefault(10));
            Assert.False(array.TryGetElement(10, out element));
            Assert.Equal(0, element);
        }
    }
}
```

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

```
using System;
using System.Collections;
using Xunit;
using Platform.Random;

namespace Platform.Collections.Tests
{
    public static class BitStringTests
    {
        [Fact]
        public static void BitGetSetTest()
        {
            const int n = 250;
            var bitArray = new BitArray(n);
            var bitString = new BitString(n);
            for (var i = 0; i < n; i++)
            {
                var value = RandomHelpers.Default.NextBoolean();
                bitArray.Set(i, value);
                bitString.Set(i, value);
                Assert.Equal(value, bitArray.Get(i));
                Assert.Equal(value, bitString.Get(i));
            }
```

```
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          [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);
```

```
                w.Or(v);
            });
        }

        [Fact]
        public static void BitParallelVectorOrTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.ParallelVectorOr(y);
                w.Or(v);
            });
        }

        [Fact]
        public static void BitVectorXorTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.VectorXor(y);
                w.Xor(v);
            });
        }

        [Fact]
        public static void BitParallelXorTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.ParallelXor(y);
                w.Xor(v);
            });
        }

        [Fact]
        public static void BitParallelVectorXorTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.ParallelVectorXor(y);
                w.Xor(v);
            });
        }

        private static void TestToOperationsWithSameMeaning(Action<BitString, BitString,
        ↪  BitString, BitString> test)
        {
            const int n = 5654;
            var x = new BitString(n);
            var y = new BitString(n);
            while (x.Equals(y))
            {
                x.SetRandomBits();
                y.SetRandomBits();
            }
            var w = new BitString(x);
            var v = new BitString(y);
            Assert.False(x.Equals(y));
            Assert.False(w.Equals(v));
            Assert.True(x.Equals(w));
            Assert.True(y.Equals(v));
            test(x, y, w, v);
            Assert.True(x.Equals(w));
        }
    }
}
```

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

```
using Xunit;
using Platform.Collections.Segments;

namespace Platform.Collections.Tests
{
    public static class CharsSegmentTests
    {
        [Fact]
        public static void GetHashCodeEqualsTest()
        {
            const string testString = "test test";
```

```
            var testArray = testString.ToCharArray();
            var firstHashCode = new CharSegment(testArray, 0, 4).GetHashCode();
            var secondHashCode = new CharSegment(testArray, 5, 4).GetHashCode();
            Assert.Equal(firstHashCode, secondHashCode);
        }

        [Fact]
        public static void EqualsTest()
        {
            const string testString = "test test";
            var testArray = testString.ToCharArray();
            var first = new CharSegment(testArray, 0, 4);
            var second = new CharSegment(testArray, 5, 4);
            Assert.True(first.Equals(second));
        }
    }
}
```

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

```
using System.Collections.Generic;
using Xunit;
using Platform.Collections.Lists;


namespace Platform.Collections.Tests
{
    public class ListTests
    {
        [Fact]
        public void GetElementTest()
        {
            var nullList = (IList<int>)null;
            Assert.Equal(0, nullList.GetElementOrDefault(1));
            Assert.False(nullList.TryGetElement(1, out int element));
            Assert.Equal(0, element);
            var list = new List<int>() { 1, 2, 3 };
            Assert.Equal(3, list.GetElementOrDefault(2));
            Assert.True(list.TryGetElement(2, out element));
            Assert.Equal(3, element);
            Assert.Equal(0, list.GetElementOrDefault(10));
            Assert.False(list.TryGetElement(10, out element));
            Assert.Equal(0, element);
        }
    }
}
```

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

```
using Xunit;

namespace Platform.Collections.Tests
{
    public static class StringTests
    {
        [Fact]
        public static void CapitalizeFirstLetterTest()
        {
            Assert.Equal("Hello", "hello".CapitalizeFirstLetter());
            Assert.Equal("Hello", "Hello".CapitalizeFirstLetter());
            Assert.Equal("  Hello", "  hello".CapitalizeFirstLetter());
        }

        [Fact]
        public static void TrimSingleTest()
        {
            Assert.Equal("", "''".TrimSingle('\''));
            Assert.Equal("", "''".TrimSingle('\''));
            Assert.Equal("hello", "'hello'".TrimSingle('\''));
            Assert.Equal("hello", "hello'".TrimSingle('\''));
            Assert.Equal("hello", "'hello".TrimSingle('\''));
        }
    }
}
```

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