LinksPlatform's Platform.Collections Class Library

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)]
```

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

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

```csharp
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

```csharp
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;

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

namespace Platform.Collections.Arrays
{
    public static class GenericArrayExtensions
    {
        /// <summary>
        /// <param name="array"><para>Array that will participate in
        ↪  verification.</para><para>Массив который будет учавствовать в
        ↪  проверке.</para></param>
        /// <param name="index"><para>Number type int to compare.</para><para>Число типа int для
        ↪  сравнения.</para></param>
        /// <para>We check whether the array exists, if so, we check the array length using the
        ↪   index variable type int, and if the array length is greater than the index, we
        ↪   return array[index], otherwise-default value.</para>
        /// <para>Мы проверяем, существует ли массив, если да - мы проверяем длину массива с
        ↪   помощью переменной index, и если длина массива больше индекса - возвращаем
        ↪   array[index], иначе - default value.</para>
        /// </summary>
        /// <typeparam name="T"><para>Array variable type.</para><para>Тип переменной
        ↪   массива.</para></typeparam>
        /// <returns><para>Array element or default value.</para><para>Элемент массива или же
        ↪   значение по умолчанию.</para></returns>

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T GetElementOrDefault<T>(this T[] array, int index) => array != null &&
        ↪   array.Length > index ? array[index] : default;

        /// <summary>
        /// <param name="array"><para>Array that will participate in
        ↪   verification.</para><para>Массив который будет учавствовать в
        ↪   проверке.</para></param>
        /// <param name="index"><para>Number type long to compare.</para><para>Число типа long
        ↪   для сравнения.</para></param>
        /// <para>We check whether the array exists, if so, we check the array length using the
        ↪   index variable type long, and if the array length is greater than the index, we
        ↪   return array[index], otherwise-default value.</para>
        /// <para>Мы проверяем, существует ли массив, если да - мы проверяем длину массива с
        ↪   помощью переменной index, и если длина массива больше индекса - возвращаем
        ↪   array[index], иначе - значение по умолчанию.</para>
        /// </summary>
        /// <typeparam name="T"><para>Array variable type.</para><para>Тип переменной
        ↪   массива.</para></typeparam>
        /// <returns><para>Array element or default value.</para><para>Элемент массива или же
        ↪   значение по умолчанию.</para></returns>

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T GetElementOrDefault<T>(this T[] array, long index) => array != null &&
        ↪   array.LongLength > index ? array[index] : default;

        /// <summary>
        /// <param name="array"><para>Array that will participate in
        ↪   verification.</para><para>Массив который будет учавствовать в
        ↪   проверке.</para></param>
        /// <param name="index"><para>Number type int to compare.</para><para>Число типа int для
        ↪   сравнения.</para></param>
        /// <param name="element"><para>Passing the argument by reference, if successful, it
        ↪   will take the value array[index] otherwise default value.</para><para>Передаём
        ↪   аргумент по ссылке, в случае успеха он примет значение array[index] в противном
        ↪   случае значение по умолчанию.</para></param>
        /// <para>We check whether the array exist, if so, we check the array length using the
        ↪   index varible type int, and if the array length is greater than the index, we set
        ↪   the element variable to array[index] and return true.</para>
        /// <para>Мы проверяем, существует ли массив, если да, то мы проверяем длину массива с
        ↪   помощью переменной index  типа int, и если длина массива больше значения index, мы
        ↪   устанавливаем значение переменной element - array[index] и возвращаем true.</para>
        /// </summary>
        /// <typeparam name="T"><para>Array variable type.</para><para>Тип переменной
        ↪   массива.</para></typeparam>
        /// <returns><para>True if successful otherwise false.</para><para>True в случае успеха,
        ↪   в противном случае false</para></returns>

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool TryGetElement<T>(this T[] array, int index, out T element)
        {
            if (array != null && array.Length > index)
            {
                element = array[index];
                return true;
            }
            else
            {
                element = default;
                return false;
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool TryGetElement<T>(this T[] array, long index, out T element)
        {
            if (array != null && array.LongLength > index)
            {
                element = array[index];
                return true;
            }
            else
            {
                element = default;
                return false;
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T[] Clone<T>(this T[] array)
        {
            var copy = new T[array.LongLength];
            Array.Copy(array, 0L, copy, 0L, array.LongLength);
            return copy;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IList<T> ShiftRight<T>(this T[] array) => array.ShiftRight(1L);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IList<T> ShiftRight<T>(this T[] array, long shift)
        {
            if (shift < 0)
            {
                throw new NotImplementedException();
            }
            if (shift == 0)
            {
                return array.Clone<T>();
            }
            else
            {
                var restrictions = new T[array.LongLength + shift];
                Array.Copy(array, 0L, restrictions, shift, array.LongLength);
                return restrictions;
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void Add<T>(this T[] array, ref int position, T element) =>
         ↪  array[position++] = element;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void Add<T>(this T[] array, ref long position, T element) =>
         ↪  array[position++] = element;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TReturnConstant AddAndReturnConstant<TElement, TReturnConstant>(this
         ↪  TElement[] array, ref long position, TElement element, TReturnConstant
         ↪  returnConstant)
        {
            array.Add(ref position, element);
            return returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddFirst<T>(this T[] array, ref long position, IList<T> elements) =>
         ↪  array[position++] = elements[0];

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TReturnConstant AddFirstAndReturnConstant<TElement, TReturnConstant>(this
         ↪  TElement[] array, ref long position, IList<TElement> elements, TReturnConstant
         ↪  returnConstant)
        {
            array.AddFirst(ref position, elements);
            return returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TReturnConstant AddAllAndReturnConstant<TElement, TReturnConstant>(this
         ↪  TElement[] array, ref long position, IList<TElement> elements, TReturnConstant
         ↪  returnConstant)
        {
            array.AddAll(ref position, elements);
            return returnConstant;
        }

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

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static TReturnConstant AddSkipFirstAndReturnConstant<TElement,
         ↪  TReturnConstant>(this TElement[] array, ref long position, IList<TElement> elements,
         ↪  TReturnConstant returnConstant)
        {
            array.AddSkipFirst(ref position, elements);
            return returnConstant;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddSkipFirst<T>(this T[] array, ref long position, IList<T> elements)
         ↪  => array.AddSkipFirst(ref position, elements, 1);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void AddSkipFirst<T>(this T[] array, ref long position, IList<T> elements,
         ↪  int skip)
        {
            for (var i = skip; i < elements.Count; i++)
            {
                array.Add(ref position, elements[i]);
            }
        }
    }
}
```

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

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

        #region Constructors

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        static BitString()
        {
            _bitsSetIn16Bits = new byte[65536][];
            int i, c, k;
            byte bitIndex;
            for (i = 0; i < 65536; i++)
            {
                // Calculating size of array (number of positive bits)
                for (c = 0, k = 1; k <= 65536; k <<= 1)
                {
                    if ((i & k) == k)
                    {
                        c++;
                    }
                }
                var array = new byte[c];
                // Adding positive bits indices into array
                for (bitIndex = 0, c = 0, k = 1; k <= 65536; k <<= 1)
                {
                    if ((i & k) == k)
                    {
                        array[c++] = bitIndex;
                    }
                    bitIndex++;
                }
                _bitsSetIn16Bits[i] = array;
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString(BitString other)
        {
            Ensure.Always.ArgumentNotNull(other, nameof(other));
            _length = other._length;
            _array = new long[GetWordsCountFromIndex(_length)];
            _minPositiveWord = other._minPositiveWord;
            _maxPositiveWord = other._maxPositiveWord;
            Array.Copy(other._array, _array, _array.LongLength);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString(long length)
        {
            Ensure.Always.ArgumentInRange(length, GetValidLengthRange(), nameof(length));
            _length = length;
            _array = new long[GetWordsCountFromIndex(_length)];
            MarkBordersAsAllBitsReset();
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString(long length, bool defaultValue)
            : this(length)
        {
            if (defaultValue)
            {
                SetAll();
            }
        }

        #endregion

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString Not()
        {
            for (var i = 0L; i < _array.LongLength; i++)
            {
                _array[i] = ~_array[i];
                RefreshBordersByWord(i);
            }
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public BitString ParallelNot()
        {
            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);
            }
            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 => VectorAndLoop(_array, other._array,
             ↪  step, range.Item1, range.Item2));
            MarkBordersAsAllBitsSet();
            TryShrinkBorders();
            return this;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        static private void VectorAndLoop(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 Or(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 ParallelOr(BitString other)
        {
            var threads = Environment.ProcessorCount / 2;
            if (threads <= 1)
            {
                return Or(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 VectorOr(BitString other)
        {
            if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
            {
                return Or(other);
            }
            var step = Vector<long>.Count;
            if (_array.Length < step)
            {
                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];
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private void RefreshBordersByWord(long wordIndex)
        {
            if (_array[wordIndex] == 0)
            {
                if (wordIndex == _minPositiveWord && wordIndex != _array.LongLength - 1)
                {
                    _minPositiveWord++;
                }
                if (wordIndex == _maxPositiveWord && wordIndex != 0)
                {
                    _maxPositiveWord--;
                }
            }
            else
            {
                if (wordIndex < _minPositiveWord)
                {
                    _minPositiveWord = wordIndex;
                }
                if (wordIndex > _maxPositiveWord)
                {
                    _maxPositiveWord = wordIndex;
                }
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool TryShrinkBorders()
        {
            GetBorders(out long from, out long to);
            while (from <= to && _array[from] == 0)
            {
                from++;
            }
            if (from > to)
            {
                MarkBordersAsAllBitsReset();
                return true;
            }
            while (to >= from && _array[to] == 0)
            {
                to--;
            }
            if (to < from)
            {
                MarkBordersAsAllBitsReset();
                return true;
            }
            var bordersUpdated = from != _minPositiveWord || to != _maxPositiveWord;
            if (bordersUpdated)
            {
                SetBorders(from, to);
            }
            return bordersUpdated;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool Get(long index)
        {
            Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
            return (_array[GetWordIndexFromIndex(index)] & GetBitMaskFromIndex(index)) != 0;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Set(long index, bool value)
        {
            if (value)
            {
                Set(index);
            }
            else
            {
                Reset(index);
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Set(long index)
        {
            Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
            var wordIndex = GetWordIndexFromIndex(index);
            var mask = GetBitMaskFromIndex(index);
            _array[wordIndex] |= mask;
            RefreshBordersByWord(wordIndex);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void Reset(long index)
        {
            Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
            var wordIndex = GetWordIndexFromIndex(index);
            var mask = GetBitMaskFromIndex(index);
            _array[wordIndex] &= ~mask;
            RefreshBordersByWord(wordIndex);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool Add(long index)
        {
            var wordIndex = GetWordIndexFromIndex(index);
            var mask = GetBitMaskFromIndex(index);
            if ((_array[wordIndex] & mask) == 0)
            {
                _array[wordIndex] |= mask;
                RefreshBordersByWord(wordIndex);
                return true;
            }
            else
            {
                return false;
            }
        }
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void SetAll(bool value)
        {
            if (value)
            {
                SetAll();
            }
            else
            {
                ResetAll();
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void SetAll()
        {
            const long fillValue = unchecked((long)0xffffffffffffffff);
            var words = GetWordsCountFromIndex(_length);
            for (var i = 0; i < words; i++)
            {
                _array[i] = fillValue;
            }
            MarkBordersAsAllBitsSet();
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public void ResetAll()
        {
            const long fillValue = 0;
            GetBorders(out long from, out long to);
            for (var i = from; i <= to; i++)
            {
                _array[i] = fillValue;
            }
            MarkBordersAsAllBitsReset();
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public List<long> GetSetIndices()
        {
            var result = new List<long>();
            GetBorders(out long from, out long 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 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;
            to = _maxPositiveWord;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private void GetBorders(out ulong from, out ulong to)
        {
            from = (ulong)_minPositiveWord;
            to = (ulong)_maxPositiveWord;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private void SetBorders(long from, long to)
        {
            _minPositiveWord = from;
            _maxPositiveWord = to;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private Range<long> GetValidIndexRange() => (0, _length - 1);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Range<long> GetValidLengthRange() => (0, long.MaxValue);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static void AppendAllSetBitIndices(List<ulong> result, ulong wordIndex, long
        ↪   wordValue)
        {
            GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
            ↪   bits32to47, out byte[] bits48to63);
            AppendAllSetIndices(result, wordIndex, bits00to15, bits16to31, bits32to47,
            ↪   bits48to63);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static void AppendAllSetBitIndices(List<long> result, long wordIndex, long
        ↪  wordValue)
        {
            GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
            ↪  bits32to47, out byte[] bits48to63);
            AppendAllSetBitIndices(result, wordIndex, bits00to15, bits16to31, bits32to47,
            ↪  bits48to63);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static long CountSetBitsForWord(long word)
        {
            GetBits(word, out byte[] bits00to15, out byte[] bits16to31, out byte[] bits32to47,
            ↪  out byte[] bits48to63);
            return bits00to15.LongLength + bits16to31.LongLength + bits32to47.LongLength +
            ↪  bits48to63.LongLength;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static long GetFirstSetBitForWord(long wordIndex, long wordValue)
        {
            GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
            ↪  bits32to47, out byte[] bits48to63);
            return GetFirstSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static long GetLastSetBitForWord(long wordIndex, long wordValue)
        {
            GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
            ↪  bits32to47, out byte[] bits48to63);
            return GetLastSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static void AppendAllSetBitIndices(List<long> result, long 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] + 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

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

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

namespace Platform.Collections.Lists
{
    public static class CharIListExtensions
    {
        /// <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);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool EqualTo(this IList<char> left, IList<char> right) =>
        ↪  left.EqualTo(right, ContentEqualTo);

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

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

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

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

namespace Platform.Collections.Lists
{
    public class IListComparer<T> : IComparer<IList<T>>
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public int Compare(IList<T> left, IList<T> right) => left.CompareTo(right);
    }
}
```

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

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

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

namespace Platform.Collections.Lists
{
    public class IListEqualityComparer<T> : IEqualityComparer<IList<T>>
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public bool Equals(IList<T> left, IList<T> right) => left.EqualTo(right);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public int GetHashCode(IList<T> list) => list.GenerateHashCode();
    }
}
```

1.18 ./csharp/Platform.Collections/Lists/IListExtensions.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.Lists
{
    public static class IListExtensions
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T GetElementOrDefault<T>(this IList<T> list, int index) => list != null &&
        ↪  list.Count > index ? list[index] : default;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool TryGetElement<T>(this IList<T> list, int index, out T element)
        {
            if (list != null && list.Count > index)
            {
                element = list[index];
                return true;
            }
            else
            {
                element = default;
                return false;
            }
        }

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

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

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

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

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

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

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

        [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]);
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static int GetCountOrZero<T>(this IList<T> list) => list?.Count ?? 0;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool EqualTo<T>(this IList<T> left, IList<T> right) => EqualTo(left,
        ↪  right, ContentEqualTo);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static bool EqualTo<T>(this IList<T> left, IList<T> right, Func<IList<T>,
        ↪  IList<T>, bool> contentEqualityComparer)
        {
            if (ReferenceEquals(left, right))
            {
                return true;
            }
            var leftCount = left.GetCountOrZero();
            var rightCount = right.GetCountOrZero();
            if (leftCount == 0 && rightCount == 0)
            {
                return true;
            }
            if (leftCount == 0 || rightCount == 0 || leftCount != rightCount)
            {
                return false;
            }
            return contentEqualityComparer(left, right);
        }

        [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;
        }

        [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();
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T[] ToArray<T>(this IList<T> list)
        {
            var array = new T[list.Count];
            list.CopyTo(array, 0);
            return array;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static void ForEach<T>(this IList<T> list, Action<T> action)
        {
            for (var i = 0; i < list.Count; i++)
            {
                action(list[i]);
```

```csharp
            }
        }

        /// <remarks>
        /// Based on http://stackoverflow.com/questions/263400/what-is-the-best-algorithm-for-an
        ↪  -overridden-system-object-gethashcode
        /// </remarks>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static int GenerateHashCode<T>(this IList<T> list)
        {
            var hashAccumulator = 17;
            for (var i = 0; i < list.Count; i++)
            {
                hashAccumulator = unchecked((hashAccumulator * 23) + list[i].GetHashCode());
            }
            return hashAccumulator;
        }

        [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;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T[] SkipFirst<T>(this IList<T> list) => list.SkipFirst(1);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T[] SkipFirst<T>(this IList<T> list, int skip)
        {
            if (list.IsNullOrEmpty() || list.Count <= skip)
            {
                return Array.Empty<T>();
            }
            var result = new T[list.Count - skip];
            for (int r = skip, w = 0; r < list.Count; r++, w++)
            {
                result[w] = list[r];
            }
            return result;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IList<T> ShiftRight<T>(this IList<T> list) => list.ShiftRight(1);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static IList<T> ShiftRight<T>(this IList<T> list, int shift)
        {
            if (shift < 0)
            {
                throw new NotImplementedException();
            }
            if (shift == 0)
            {
                return list.ToArray();
            }
            else
            {
                var result = new T[list.Count + shift];
                for (int r = 0, w = shift; r < list.Count; r++, w++)
                {
                    result[w] = list[r];
                }
                return result;
            }
        }
    }
}
```

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

        [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) { }

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

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

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

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

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

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

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

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

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

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

```
using System.Linq;
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 CharSegment : Segment<char>
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public CharSegment(IList<char> @base, int offset, int length) : base(@base, offset,
         ↪  length) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public override int GetHashCode()
        {
            // Base can be not an array, but still IList<char>
            if (Base is char[] baseArray)
            {
                return baseArray.GenerateHashCode(Offset, Length);
            }
            else
            {
                return this.GenerateHashCode();
            }
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public override bool Equals(Segment<char> other)
        {
            bool contentEqualityComparer(IList<char> left, IList<char> right)
            {
                // Base can be not an array, but still IList<char>
                if (Base is char[] baseArray && other.Base is char[] otherArray)
                {
                    return baseArray.ContentEqualTo(Offset, Length, otherArray, other.Offset);
                }
                else
                {
                    return left.ContentEqualTo(right);
                }
            }
            return this.EqualTo(other, contentEqualityComparer);
        }

        public override bool Equals(object obj) => obj is Segment<char> charSegment ?
         ↪  Equals(charSegment) : false;

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static implicit operator string(CharSegment segment)
        {
            if (!(segment.Base is char[] array))
            {
                array = segment.Base.ToArray();
            }
            return new string(array, segment.Offset, segment.Length);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        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)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
        ↪  dictionary, int minimumStringSegmentLength, bool resetDictionaryOnEachWalk)
            : base(minimumStringSegmentLength)
        {
            Dictionary = dictionary;
            _resetDictionaryOnEachWalk = resetDictionaryOnEachWalk;
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
        ↪  dictionary, int minimumStringSegmentLength) : this(dictionary,
        ↪  minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
        ↪  dictionary) : this(dictionary, DefaultMinimumStringSegmentLength,
        ↪  DefaultResetDictionaryOnEachWalk) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength,
        ↪  bool resetDictionaryOnEachWalk) : this(resetDictionaryOnEachWalk ? null : new
        ↪  Dictionary<TSegment, long>(), minimumStringSegmentLength, resetDictionaryOnEachWalk)
        ↪  { }

```

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

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

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public override void WalkAll(IList<T> elements)
        {
            if (_resetDictionaryOnEachWalk)
            {
                var capacity = Math.Ceiling(Math.Pow(elements.Count, 2) / 2);
                Dictionary = new Dictionary<TSegment, long>((int)capacity);
            }
            base.WalkAll(elements);
        }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected override long GetSegmentFrequency(TSegment segment) =>
        ↪  Dictionary.GetOrDefault(segment);

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected override void SetSegmentFrequency(TSegment segment, long frequency) =>
        ↪  Dictionary[segment] = frequency;
    }
}
```

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

```csharp
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> :
     ↪  DictionaryBasedDuplicateSegmentsWalkerBase<T, Segment<T>>
    {
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<Segment<T>, long>
        ↪  dictionary, int minimumStringSegmentLength, bool resetDictionaryOnEachWalk) :
        ↪  base(dictionary, minimumStringSegmentLength, resetDictionaryOnEachWalk) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<Segment<T>, long>
        ↪  dictionary, int minimumStringSegmentLength) : base(dictionary,
        ↪  minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }

        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        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

```csharp
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

```csharp
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

```csharp
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

```csharp
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

```csharp
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

```csharp
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));
            }
        }

        [Fact]
        public static void BitVectorNotTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.VectorNot();
                w.Not();
            });
        }

        [Fact]
        public static void BitParallelNotTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.ParallelNot();
                w.Not();
            });
        }

        [Fact]
        public static void BitParallelVectorNotTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.ParallelVectorNot();
                w.Not();
            });
        }

        [Fact]
        public static void BitVectorAndTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.VectorAnd(y);
                w.And(v);
            });
        }

        [Fact]
        public static void BitParallelAndTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.ParallelAnd(y);
                w.And(v);
            });
        }

        [Fact]
        public static void BitParallelVectorAndTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                x.ParallelVectorAnd(y);
                w.And(v);
            });
        }

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

        [Fact]
        public static void BitParallelOrTest()
        {
            TestToOperationsWithSameMeaning((x, y, w, v) =>
            {
                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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