

## LinksPlatform's Platform.Collections Class Library

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

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

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

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

```

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

```

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

```

1  using System.Runtime.CompilerServices;
2
3  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5  namespace Platform.Collections.Arrays
6  {
7      public static class ArrayPool
8      {
9          public static readonly int DefaultSizesAmount = 512;
10         public static readonly int DefaultMaxArraysPerSize = 32;
11
12         [MethodImpl(MethodImplOptions.AggressiveInlining)]
13         public static T[] Allocate<T>(long size) => ArrayPool<T>.ThreadInstance.Allocate(size);
14
15         [MethodImpl(MethodImplOptions.AggressiveInlining)]
16         public static void Free<T>(T[] array) => ArrayPool<T>.ThreadInstance.Free(array);
17     }
18 }

```

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

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Disposables;
5  using Platform.Collections.Stacks;
6
7  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9  namespace Platform.Collections.Arrays
10 {
11     /// <remarks>
12     /// Original idea from
13     ↪ http://geekswithblogs.net/blackrob/archive/2014/12/18/array-pooling-in-csharp.aspx
14     /// </remarks>
15     public class ArrayPool<T>
16     {
17         // May be use Default class for that later.
18         [ThreadStatic]
19         private static ArrayPool<T> _threadInstance;
20         internal static ArrayPool<T> ThreadInstance => _threadInstance ?? (_threadInstance = new
           ↪ ArrayPool<T>());
21
22         private readonly int _maxArraysPerSize;
23         private readonly Dictionary<long, Stack<T[]>> _pool = new Dictionary<long,
           ↪ Stack<T[]>>(ArrayPool.DefaultSizesAmount);
24
25         [MethodImpl(MethodImplOptions.AggressiveInlining)]
26         public ArrayPool(int maxArraysPerSize) => _maxArraysPerSize = maxArraysPerSize;
27
28         [MethodImpl(MethodImplOptions.AggressiveInlining)]
29         public ArrayPool() : this(ArrayPool.DefaultMaxArraysPerSize) { }
30
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public Disposable<T[]> AllocateDisposable(long size) => (Allocate(size), Free);
33
34         [MethodImpl(MethodImplOptions.AggressiveInlining)]
35         public Disposable<T[]> Resize(Disposable<T[]> source, long size)
36         {
37             var destination = AllocateDisposable(size);
38             T[] sourceArray = source;
39             if (!sourceArray.IsNullOrEmpty())
40             {
41                 T[] destinationArray = destination;
42                 Array.Copy(sourceArray, destinationArray, size < sourceArray.LongLength ? size :
                   ↪ sourceArray.LongLength);
43                 source.Dispose();
44             }
45             return destination;
46         }
47
48         [MethodImpl(MethodImplOptions.AggressiveInlining)]
49         public virtual void Clear() => _pool.Clear();
50     }
51 }

```

```

50     [MethodImpl(MethodImplOptions.AggressiveInlining)]
51     public virtual T[] Allocate(long size) => size <= 0L ? Array.Empty<T>() :
    ↪     _pool.GetOrDefault(size)?.PopOrDefault() ?? new T[size];
52
53     [MethodImpl(MethodImplOptions.AggressiveInlining)]
54     public virtual void Free(T[] array)
55     {
56         if (array.IsNullOrEmpty())
57         {
58             return;
59         }
60         var stack = _pool.GetOrAdd(array.LongLength, size => new
    ↪         Stack<T[]>(_maxArraysPerSize));
61         if (stack.Count == _maxArraysPerSize) // Stack is full
62         {
63             return;
64         }
65         stack.Push(array);
66     }
67 }
68 }

```

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

```

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

```

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

```

1  using System.Runtime.CompilerServices;
2
3  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5  namespace Platform.Collections.Arrays
6  {
7      public static unsafe class CharArrayExtensions
8      {
9          /// <remarks>
10         /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783\_a3eda37d3d4cd10/mscorlib/system/string.cs#L833
11         ↪     ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L833
12         /// </remarks>
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public static int GenerateHashCode(this char[] array, int offset, int length)
15         {
16             var hashSeed = 5381;
17             var hashAccumulator = hashSeed;
18             fixed (char* arrayPointer = &array[offset])
19             {
20                 for (char* charPointer = arrayPointer, last = charPointer + length; charPointer
21                     ↪     ↪ < last; charPointer++)
22                 {
23                     hashAccumulator = (hashAccumulator << 5) + hashAccumulator ^ *charPointer;
24                 }
25             }
26             return hashAccumulator + (hashSeed * 1566083941);
27         }
28
29         /// <remarks>
30         /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783\_a3eda37d3d4cd10/mscorlib/system/string.cs#L364
31         ↪     ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L364
32         /// </remarks>
33         [MethodImpl(MethodImplOptions.AggressiveInlining)]
34         public static bool ContentEqualTo(this char[] left, int leftOffset, int length, char[]
35             ↪     ↪ right, int rightOffset)

```

```

32 {
33     fixed (char* leftPointer = &left[leftOffset])
34     {
35         fixed (char* rightPointer = &right[rightOffset])
36         {
37             char* leftPointerCopy = leftPointer, rightPointerCopy = rightPointer;
38             if (!CheckArraysMainPartForEquality(ref leftPointerCopy, ref
39                 ↪ rightPointerCopy, ref length))
40             {
41                 return false;
42             }
43             CheckArraysRemainderForEquality(ref leftPointerCopy, ref rightPointerCopy,
44                 ↪ ref length);
45             return length <= 0;
46         }
47     }
48 }
49 [MethodImpl(MethodImplOptions.AggressiveInlining)]
50 private static bool CheckArraysMainPartForEquality(ref char* left, ref char* right, ref
51     ↪ int length)
52 {
53     while (length >= 10)
54     {
55         if ((* (int*)left != *(int*)right)
56             || (*(int*)(left + 2) != *(int*)(right + 2))
57             || (*(int*)(left + 4) != *(int*)(right + 4))
58             || (*(int*)(left + 6) != *(int*)(right + 6))
59             || (*(int*)(left + 8) != *(int*)(right + 8)))
60         {
61             return false;
62         }
63         left += 10;
64         right += 10;
65         length -= 10;
66     }
67     return true;
68 }
69 [MethodImpl(MethodImplOptions.AggressiveInlining)]
70 private static void CheckArraysRemainderForEquality(ref char* left, ref char* right, ref
71     ↪ int length)
72 {
73     // This depends on the fact that the String objects are
74     // always zero terminated and that the terminating zero is not included
75     // in the length. For odd string sizes, the last compare will include
76     // the zero terminator.
77     while (length > 0)
78     {
79         if ((* (int*)left != *(int*)right)
80             {
81                 break;
82             }
83         left += 2;
84         right += 2;
85         length -= 2;
86     }
87 }

```

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

```

1 using System;
2 using System.Collections.Generic;
3 using System.Runtime.CompilerServices;
4
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Collections.Arrays
8 {
9     public static class GenericArrayExtensions
10     {
11         /// <summary>
12         /// <param name="array"><para>Array that will participate in
13         ↪ verification.</para><para>Массив который будет участвовать в
14         ↪ проверке.</para></param>
15         /// <param name="index"><para>Number type int to compare.</para><para>Число типа int для
16         ↪ сравнения.</para></param>

```

```

14  /// <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>
15  /// <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>
16  /// </summary>
17  /// <typeparam name="T"><para>Array variable type.</para><para>Тип переменной
    ↳ массива.</para></typeparam>
18  /// <returns><para>Array element or default value.</para><para>Элемент массива или же
    ↳ значение по умолчанию.</para></returns>
19
20  [MethodImpl(MethodImplOptions.AggressiveInlining)]
21  public static T GetElementOrDefault<T>(this T[] array, int index) => array != null &&
    ↳ array.Length > index ? array[index] : default;
22
23  [MethodImpl(MethodImplOptions.AggressiveInlining)]
24  public static T GetElementOrDefault<T>(this T[] array, long index) => array != null &&
    ↳ array.LongLength > index ? array[index] : default;
25
26  [MethodImpl(MethodImplOptions.AggressiveInlining)]
27  public static bool TryGetElement<T>(this T[] array, int index, out T element)
28  {
29      if (array != null && array.Length > index)
30      {
31          element = array[index];
32          return true;
33      }
34      else
35      {
36          element = default;
37          return false;
38      }
39  }
40
41  [MethodImpl(MethodImplOptions.AggressiveInlining)]
42  public static bool TryGetElement<T>(this T[] array, long index, out T element)
43  {
44      if (array != null && array.LongLength > index)
45      {
46          element = array[index];
47          return true;
48      }
49      else
50      {
51          element = default;
52          return false;
53      }
54  }
55
56  [MethodImpl(MethodImplOptions.AggressiveInlining)]
57  public static T[] Clone<T>(this T[] array)
58  {
59      var copy = new T[array.LongLength];
60      Array.Copy(array, 0L, copy, 0L, array.LongLength);
61      return copy;
62  }
63
64  [MethodImpl(MethodImplOptions.AggressiveInlining)]
65  public static IList<T> ShiftRight<T>(this T[] array) => array.ShiftRight(1L);
66
67  [MethodImpl(MethodImplOptions.AggressiveInlining)]
68  public static IList<T> ShiftRight<T>(this T[] array, long shift)
69  {
70      if (shift < 0)
71      {
72          throw new NotImplementedException();
73      }
74      if (shift == 0)
75      {
76          return array.Clone<T>();
77      }
78      else
79      {
80          var restrictions = new T[array.LongLength + shift];
81          Array.Copy(array, 0L, restrictions, shift, array.LongLength);
82          return restrictions;
83      }
84  }

```

```

85     [MethodImpl(MethodImplOptions.AggressiveInlining)]
86     public static void Add<T>(this T[] array, ref int position, T element) =>
87         ↪ array[position++] = element;
88
89     [MethodImpl(MethodImplOptions.AggressiveInlining)]
90     public static void Add<T>(this T[] array, ref long position, T element) =>
91         ↪ array[position++] = element;
92
93     [MethodImpl(MethodImplOptions.AggressiveInlining)]
94     public static TReturnConstant AddAndReturnConstant<TElement, TReturnConstant>(this
95         ↪ TElement[] array, ref long position, TElement element, TReturnConstant
96         ↪ returnConstant)
97     {
98         array.Add(ref position, element);
99         return returnConstant;
100     }
101
102     [MethodImpl(MethodImplOptions.AggressiveInlining)]
103     public static void AddFirst<T>(this T[] array, ref long position, IList<T> elements) =>
104         ↪ array[position++] = elements[0];
105
106     [MethodImpl(MethodImplOptions.AggressiveInlining)]
107     public static TReturnConstant AddFirstAndReturnConstant<TElement, TReturnConstant>(this
108         ↪ TElement[] array, ref long position, IList<TElement> elements, TReturnConstant
109         ↪ returnConstant)
110     {
111         array.AddFirst(ref position, elements);
112         return returnConstant;
113     }
114
115     [MethodImpl(MethodImplOptions.AggressiveInlining)]
116     public static TReturnConstant AddAllAndReturnConstant<TElement, TReturnConstant>(this
117         ↪ TElement[] array, ref long position, IList<TElement> elements, TReturnConstant
118         ↪ returnConstant)
119     {
120         array.AddAll(ref position, elements);
121         return returnConstant;
122     }
123
124     [MethodImpl(MethodImplOptions.AggressiveInlining)]
125     public static void AddAll<T>(this T[] array, ref long position, IList<T> elements)
126     {
127         for (var i = 0; i < elements.Count; i++)
128         {
129             array.Add(ref position, elements[i]);
130         }
131     }
132
133     [MethodImpl(MethodImplOptions.AggressiveInlining)]
134     public static TReturnConstant AddSkipFirstAndReturnConstant<TElement,
135         ↪ TReturnConstant>(this TElement[] array, ref long position, IList<TElement> elements,
136         ↪ TReturnConstant returnConstant)
137     {
138         array.AddSkipFirst(ref position, elements);
139         return returnConstant;
140     }
141
142     [MethodImpl(MethodImplOptions.AggressiveInlining)]
143     public static void AddSkipFirst<T>(this T[] array, ref long position, IList<T> elements)
144         ↪ => array.AddSkipFirst(ref position, elements, 1);
145
146     [MethodImpl(MethodImplOptions.AggressiveInlining)]
147     public static void AddSkipFirst<T>(this T[] array, ref long position, IList<T> elements,
148         ↪ int skip)
149     {
150         for (var i = skip; i < elements.Count; i++)
151         {
152             array.Add(ref position, elements[i]);
153         }
154     }
155 }

```

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

```

1 using System;
2 using System.Collections.Concurrent;
3 using System.Collections.Generic;

```

```

4 using System.Numerics;
5 using System.Runtime.CompilerServices;
6 using System.Threading.Tasks;
7 using Platform.Exceptions;
8 using Platform.Ranges;
9
10 // ReSharper disable ForCanBeConvertedToForeach
11 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
12
13 namespace Platform.Collections
14 {
15     /// <remarks>
16     /// А что если хранить карту значений, где каждый бит будет означать присутствует ли блок в
17     ///   ↳ 64 бит в массиве значений.
18     /// 64 бита по 0 бит, будут означать отсутствие 64-х блоков по 64 бита. Т.е. упаковка 512
19     ///   ↳ байт в 8 байт.
20     /// Подобный принцип можно применять и к 64-ём блокам и т.п. По сути это карта значений. С
21     ///   ↳ помощью которой можно быстро
22     /// проверять есть ли значения непосредственно далее (ниже по уровню).
23     /// Или как таблица виртуальной памяти где номер блока означает его присутствие и адрес.
24     /// </remarks>
25     public class BitString : IEquatable<BitString>
26     {
27         private static readonly byte[][] _bitsSetIn16Bits;
28         private long[] _array;
29         private long _length;
30         private long _minPositiveWord;
31         private long _maxPositiveWord;
32
33         public bool this[long index]
34         {
35             [MethodImpl(MethodImplOptions.AggressiveInlining)]
36             get => Get(index);
37             [MethodImpl(MethodImplOptions.AggressiveInlining)]
38             set => Set(index, value);
39         }
40
41         public long Length
42         {
43             [MethodImpl(MethodImplOptions.AggressiveInlining)]
44             get => _length;
45             [MethodImpl(MethodImplOptions.AggressiveInlining)]
46             set
47             {
48                 if (_length == value)
49                 {
50                     return;
51                 }
52                 Ensure.Always.ArgumentInRange(value, GetValidLengthRange(), nameof(Length));
53                 // Currently we never shrink the array
54                 if (value > _length)
55                 {
56                     var words = GetWordsCountFromIndex(value);
57                     var oldWords = GetWordsCountFromIndex(_length);
58                     if (words > _array.LongLength)
59                     {
60                         var copy = new long[words];
61                         Array.Copy(_array, copy, _array.LongLength);
62                         _array = copy;
63                     }
64                     else
65                     {
66                         // What is going on here?
67                         Array.Clear(_array, (int)oldWords, (int)(words - oldWords));
68                     }
69                     // What is going on here?
70                     var mask = (int)(_length % 64);
71                     if (mask > 0)
72                     {
73                         _array[oldWords - 1] &= (1L << mask) - 1;
74                     }
75                 }
76                 else
77                 {
78                     // Looks like minimum and maximum positive words are not updated
79                     throw new NotImplementedException();
80                 }
81                 _length = value;
82             }
83         }
84     }
85 }

```

```

80     }
81
82     #region Constructors
83
84     [MethodImpl(MethodImplOptions.AggressiveInlining)]
85     static BitString()
86     {
87         _bitsSetIn16Bits = new byte[65536][];
88         int i, c, k;
89         byte bitIndex;
90         for (i = 0; i < 65536; i++)
91         {
92             // Calculating size of array (number of positive bits)
93             for (c = 0, k = 1; k <= 65536; k <= 1)
94             {
95                 if ((i & k) == k)
96                 {
97                     c++;
98                 }
99             }
100             var array = new byte[c];
101             // Adding positive bits indices into array
102             for (bitIndex = 0, c = 0, k = 1; k <= 65536; k <= 1)
103             {
104                 if ((i & k) == k)
105                 {
106                     array[c++] = bitIndex;
107                 }
108                 bitIndex++;
109             }
110             _bitsSetIn16Bits[i] = array;
111         }
112     }
113
114     [MethodImpl(MethodImplOptions.AggressiveInlining)]
115     public BitString(BitString other)
116     {
117         Ensure.Always.ArgumentNotNull(other, nameof(other));
118         _length = other._length;
119         _array = new long[GetWordsCountFromIndex(_length)];
120         _minPositiveWord = other._minPositiveWord;
121         _maxPositiveWord = other._maxPositiveWord;
122         Array.Copy(other._array, _array, _array.LongLength);
123     }
124
125     [MethodImpl(MethodImplOptions.AggressiveInlining)]
126     public BitString(long length)
127     {
128         Ensure.Always.ArgumentInRange(length, GetValidLengthRange(), nameof(length));
129         _length = length;
130         _array = new long[GetWordsCountFromIndex(_length)];
131         MarkBordersAsAllBitsReset();
132     }
133
134     [MethodImpl(MethodImplOptions.AggressiveInlining)]
135     public BitString(long length, bool defaultValue)
136         : this(length)
137     {
138         if (defaultValue)
139         {
140             SetAll();
141         }
142     }
143
144     #endregion
145
146     [MethodImpl(MethodImplOptions.AggressiveInlining)]
147     public BitString Not()
148     {
149         for (var i = 0L; i < _array.LongLength; i++)
150         {
151             _array[i] = ~_array[i];
152             RefreshBordersByWord(i);
153         }
154         return this;
155     }
156
157     [MethodImpl(MethodImplOptions.AggressiveInlining)]
158     public BitString ParallelNot()

```



```

159 {
160     var threads = Environment.ProcessorCount / 2;
161     if (threads <= 1)
162     {
163         return Not();
164     }
165     var partitioner = Partitioner.Create(0L, _array.LongLength, _array.LongLength /
166     ↪ threads);
167     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
168     ↪ MaxDegreeOfParallelism = threads }, range =>
169     {
170         var maximum = range.Item2;
171         for (var i = range.Item1; i < maximum; i++)
172         {
173             _array[i] = ~_array[i];
174         }
175     });
176     MarkBordersAsAllBitsSet();
177     TryShrinkBorders();
178     return this;
179 }
180
181 [MethodImpl(MethodImplOptions.AggressiveInlining)]
182 public BitString VectorNot()
183 {
184     if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
185     {
186         return Not();
187     }
188     var step = Vector<long>.Count;
189     if (_array.Length < step)
190     {
191         return Not();
192     }
193     VectorNotLoop(_array, step, 0, _array.Length);
194     MarkBordersAsAllBitsSet();
195     TryShrinkBorders();
196     return this;
197 }
198
199 [MethodImpl(MethodImplOptions.AggressiveInlining)]
200 public BitString ParallelVectorNot()
201 {
202     var threads = Environment.ProcessorCount / 2;
203     if (threads <= 1)
204     {
205         return VectorNot();
206     }
207     if (!Vector.IsHardwareAccelerated)
208     {
209         return ParallelNot();
210     }
211     var step = Vector<long>.Count;
212     if (_array.Length < (step * threads))
213     {
214         return VectorNot();
215     }
216     var partitioner = Partitioner.Create(0, _array.Length, _array.Length / threads);
217     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
218     ↪ MaxDegreeOfParallelism = threads }, range => VectorNotLoop(_array, step,
219     ↪ range.Item1, range.Item2));
220     MarkBordersAsAllBitsSet();
221     TryShrinkBorders();
222     return this;
223 }
224
225 [MethodImpl(MethodImplOptions.AggressiveInlining)]
226 static private void VectorNotLoop(long[] array, int step, int start, int maximum)
227 {
228     var i = start;
229     var range = maximum - start - 1;
230     var stop = range - (range % step);
231     for (; i < stop; i += step)
232     {
233         (~new Vector<long>(array, i)).CopyTo(array, i);
234     }
235     for (; i < maximum; i++)
236     {

```

```

233         array[i] = ~array[i];
234     }
235 }
236
237 [MethodImpl(MethodImplOptions.AggressiveInlining)]
238 public BitString And(BitString other)
239 {
240     EnsureBitStringHasTheSameSize(other, nameof(other));
241     GetCommonOuterBorders(this, other, out long from, out long to);
242     var otherArray = other._array;
243     for (var i = from; i <= to; i++)
244     {
245         _array[i] &= otherArray[i];
246         RefreshBordersByWord(i);
247     }
248     return this;
249 }
250
251 [MethodImpl(MethodImplOptions.AggressiveInlining)]
252 public BitString ParallelAnd(BitString other)
253 {
254     var threads = Environment.ProcessorCount / 2;
255     if (threads <= 1)
256     {
257         return And(other);
258     }
259     EnsureBitStringHasTheSameSize(other, nameof(other));
260     GetCommonOuterBorders(this, other, out long from, out long to);
261     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
262     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
263         ↪ MaxDegreeOfParallelism = threads }, range =>
264     {
265         var maximum = range.Item2;
266         for (var i = range.Item1; i < maximum; i++)
267         {
268             _array[i] &= other._array[i];
269         }
270     });
271     MarkBordersAsAllBitsSet();
272     TryShrinkBorders();
273     return this;
274 }
275
276 [MethodImpl(MethodImplOptions.AggressiveInlining)]
277 public BitString VectorAnd(BitString other)
278 {
279     if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
280     {
281         return And(other);
282     }
283     var step = Vector<long>.Count;
284     if (_array.Length < step)
285     {
286         return And(other);
287     }
288     EnsureBitStringHasTheSameSize(other, nameof(other));
289     GetCommonOuterBorders(this, other, out int from, out int to);
290     VectorAndLoop(_array, other._array, step, from, to + 1);
291     MarkBordersAsAllBitsSet();
292     TryShrinkBorders();
293     return this;
294 }
295
296 [MethodImpl(MethodImplOptions.AggressiveInlining)]
297 public BitString ParallelVectorAnd(BitString other)
298 {
299     var threads = Environment.ProcessorCount / 2;
300     if (threads <= 1)
301     {
302         return VectorAnd(other);
303     }
304     if (!Vector.IsHardwareAccelerated)
305     {
306         return ParallelAnd(other);
307     }
308     var step = Vector<long>.Count;
309     if (_array.Length < (step * threads))
310     {

```

```

310         return VectorAnd(other);
311     }
312     EnsureBitStringHasTheSameSize(other, nameof(other));
313     GetCommonOuterBorders(this, other, out int from, out int to);
314     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
315     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
        ↪ MaxDegreeOfParallelism = threads }, range => VectorAndLoop(_array, other._array,
        ↪ step, range.Item1, range.Item2));
316     MarkBordersAsAllBitsSet();
317     TryShrinkBorders();
318     return this;
319 }
320
321 [MethodImpl(MethodImplOptions.AggressiveInlining)]
322 static private void VectorAndLoop(long[] array, long[] otherArray, int step, int start,
    ↪ int maximum)
323 {
324     var i = start;
325     var range = maximum - start - 1;
326     var stop = range - (range % step);
327     for (; i < stop; i += step)
328     {
329         (new Vector<long>(array, i) & new Vector<long>(otherArray, i)).CopyTo(array, i);
330     }
331     for (; i < maximum; i++)
332     {
333         array[i] &= otherArray[i];
334     }
335 }
336
337 [MethodImpl(MethodImplOptions.AggressiveInlining)]
338 public BitString Or(BitString other)
339 {
340     EnsureBitStringHasTheSameSize(other, nameof(other));
341     GetCommonOuterBorders(this, other, out long from, out long to);
342     for (var i = from; i <= to; i++)
343     {
344         _array[i] |= other._array[i];
345         RefreshBordersByWord(i);
346     }
347     return this;
348 }
349
350 [MethodImpl(MethodImplOptions.AggressiveInlining)]
351 public BitString ParallelOr(BitString other)
352 {
353     var threads = Environment.ProcessorCount / 2;
354     if (threads <= 1)
355     {
356         return Or(other);
357     }
358     EnsureBitStringHasTheSameSize(other, nameof(other));
359     GetCommonOuterBorders(this, other, out long from, out long to);
360     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
361     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
        ↪ MaxDegreeOfParallelism = threads }, range =>
362     {
363         var maximum = range.Item2;
364         for (var i = range.Item1; i < maximum; i++)
365         {
366             _array[i] |= other._array[i];
367         }
368     });
369     MarkBordersAsAllBitsSet();
370     TryShrinkBorders();
371     return this;
372 }
373
374 [MethodImpl(MethodImplOptions.AggressiveInlining)]
375 public BitString VectorOr(BitString other)
376 {
377     if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
378     {
379         return Or(other);
380     }
381     var step = Vector<long>.Count;
382     if (_array.Length < step)
383     {

```

```

384         return Or(other);
385     }
386     EnsureBitStringHasTheSameSize(other, nameof(other));
387     GetCommonOuterBorders(this, other, out int from, out int to);
388     VectorOrLoop(_array, other._array, step, from, to + 1);
389     MarkBordersAsAllBitsSet();
390     TryShrinkBorders();
391     return this;
392 }
393
394 [MethodImpl(MethodImplOptions.AggressiveInlining)]
395 public BitString ParallelVectorOr(BitString other)
396 {
397     var threads = Environment.ProcessorCount / 2;
398     if (threads <= 1)
399     {
400         return VectorOr(other);
401     }
402     if (!Vector.IsHardwareAccelerated)
403     {
404         return ParallelOr(other);
405     }
406     var step = Vector<long>.Count;
407     if (_array.Length < (step * threads))
408     {
409         return VectorOr(other);
410     }
411     EnsureBitStringHasTheSameSize(other, nameof(other));
412     GetCommonOuterBorders(this, other, out int from, out int to);
413     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
414     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
415         ↪ MaxDegreeOfParallelism = threads }, range => VectorOrLoop(_array, other._array,
416         ↪ step, range.Item1, range.Item2));
417     MarkBordersAsAllBitsSet();
418     TryShrinkBorders();
419     return this;
420 }
421
422 [MethodImpl(MethodImplOptions.AggressiveInlining)]
423 static private void VectorOrLoop(long[] array, long[] otherArray, int step, int start,
424     ↪ int maximum)
425 {
426     var i = start;
427     var range = maximum - start - 1;
428     var stop = range - (range % step);
429     for (; i < stop; i += step)
430     {
431         (new Vector<long>(array, i) | new Vector<long>(otherArray, i)).CopyTo(array, i);
432     }
433     for (; i < maximum; i++)
434     {
435         array[i] |= otherArray[i];
436     }
437 }
438
439 [MethodImpl(MethodImplOptions.AggressiveInlining)]
440 public BitString Xor(BitString other)
441 {
442     EnsureBitStringHasTheSameSize(other, nameof(other));
443     GetCommonOuterBorders(this, other, out long from, out long to);
444     for (var i = from; i <= to; i++)
445     {
446         _array[i] ^= other._array[i];
447         RefreshBordersByWord(i);
448     }
449     return this;
450 }
451
452 [MethodImpl(MethodImplOptions.AggressiveInlining)]
453 public BitString ParallelXor(BitString other)
454 {
455     var threads = Environment.ProcessorCount / 2;
456     if (threads <= 1)
457     {
458         return Xor(other);
459     }
460     EnsureBitStringHasTheSameSize(other, nameof(other));
461     GetCommonOuterBorders(this, other, out long from, out long to);

```

```

459     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
460     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
461         ↪ MaxDegreeOfParallelism = threads }, range =>
462     {
463         var maximum = range.Item2;
464         for (var i = range.Item1; i < maximum; i++)
465         {
466             _array[i] ^= other._array[i];
467         }
468     });
469     MarkBordersAsAllBitsSet();
470     TryShrinkBorders();
471     return this;
472 }
473
474 [MethodImpl(MethodImplOptions.AggressiveInlining)]
475 public BitString VectorXor(BitString other)
476 {
477     if (!Vector.IsHardwareAccelerated || _array.LongLength >= int.MaxValue)
478     {
479         return Xor(other);
480     }
481     var step = Vector<long>.Count;
482     if (_array.Length < step)
483     {
484         return Xor(other);
485     }
486     EnsureBitStringHasTheSameSize(other, nameof(other));
487     GetCommonOuterBorders(this, other, out int from, out int to);
488     VectorXorLoop(_array, other._array, step, from, to + 1);
489     MarkBordersAsAllBitsSet();
490     TryShrinkBorders();
491     return this;
492 }
493
494 [MethodImpl(MethodImplOptions.AggressiveInlining)]
495 public BitString ParallelVectorXor(BitString other)
496 {
497     var threads = Environment.ProcessorCount / 2;
498     if (threads <= 1)
499     {
500         return VectorXor(other);
501     }
502     if (!Vector.IsHardwareAccelerated)
503     {
504         return ParallelXor(other);
505     }
506     var step = Vector<long>.Count;
507     if (_array.Length < (step * threads))
508     {
509         return VectorXor(other);
510     }
511     EnsureBitStringHasTheSameSize(other, nameof(other));
512     GetCommonOuterBorders(this, other, out int from, out int to);
513     var partitioner = Partitioner.Create(from, to + 1, (to - from) / threads);
514     Parallel.ForEach(partitioner.GetDynamicPartitions(), new ParallelOptions {
515         ↪ MaxDegreeOfParallelism = threads }, range => VectorXorLoop(_array, other._array,
516         ↪ step, range.Item1, range.Item2));
517     MarkBordersAsAllBitsSet();
518     TryShrinkBorders();
519     return this;
520 }
521
522 [MethodImpl(MethodImplOptions.AggressiveInlining)]
523 static private void VectorXorLoop(long[] array, long[] otherArray, int step, int start,
524     ↪ int maximum)
525 {
526     var i = start;
527     var range = maximum - start - 1;
528     var stop = range - (range % step);
529     for (; i < stop; i += step)
530     {
531         (new Vector<long>(array, i) ^ new Vector<long>(otherArray, i)).CopyTo(array, i);
532     }
533     for (; i < maximum; i++)
534     {
535         array[i] ^= otherArray[i];
536     }
537 }

```

```

533     }
534
535     [MethodImpl(MethodImplOptions.AggressiveInlining)]
536     private void RefreshBordersByWord(long wordIndex)
537     {
538         if (_array[wordIndex] == 0)
539         {
540             if (wordIndex == _minPositiveWord && wordIndex != _array.LongLength - 1)
541             {
542                 _minPositiveWord++;
543             }
544             if (wordIndex == _maxPositiveWord && wordIndex != 0)
545             {
546                 _maxPositiveWord--;
547             }
548         }
549         else
550         {
551             if (wordIndex < _minPositiveWord)
552             {
553                 _minPositiveWord = wordIndex;
554             }
555             if (wordIndex > _maxPositiveWord)
556             {
557                 _maxPositiveWord = wordIndex;
558             }
559         }
560     }
561
562     [MethodImpl(MethodImplOptions.AggressiveInlining)]
563     public bool TryShrinkBorders()
564     {
565         GetBorders(out long from, out long to);
566         while (from <= to && _array[from] == 0)
567         {
568             from++;
569         }
570         if (from > to)
571         {
572             MarkBordersAsAllBitsReset();
573             return true;
574         }
575         while (to >= from && _array[to] == 0)
576         {
577             to--;
578         }
579         if (to < from)
580         {
581             MarkBordersAsAllBitsReset();
582             return true;
583         }
584         var bordersUpdated = from != _minPositiveWord || to != _maxPositiveWord;
585         if (bordersUpdated)
586         {
587             SetBorders(from, to);
588         }
589         return bordersUpdated;
590     }
591
592     [MethodImpl(MethodImplOptions.AggressiveInlining)]
593     public bool Get(long index)
594     {
595         Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
596         return (_array[GetWordIndexFromIndex(index)] & GetBitMaskFromIndex(index)) != 0;
597     }
598
599     [MethodImpl(MethodImplOptions.AggressiveInlining)]
600     public void Set(long index, bool value)
601     {
602         if (value)
603         {
604             Set(index);
605         }
606         else
607         {
608             Reset(index);
609         }
610     }
611

```

```

612 [MethodImpl(MethodImplOptions.AggressiveInlining)]
613 public void Set(long index)
614 {
615     Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
616     var wordIndex = GetWordIndexFromIndex(index);
617     var mask = GetBitMaskFromIndex(index);
618     _array[wordIndex] |= mask;
619     RefreshBordersByWord(wordIndex);
620 }
621
622 [MethodImpl(MethodImplOptions.AggressiveInlining)]
623 public void Reset(long index)
624 {
625     Ensure.Always.ArgumentInRange(index, GetValidIndexRange(), nameof(index));
626     var wordIndex = GetWordIndexFromIndex(index);
627     var mask = GetBitMaskFromIndex(index);
628     _array[wordIndex] &= ~mask;
629     RefreshBordersByWord(wordIndex);
630 }
631
632 [MethodImpl(MethodImplOptions.AggressiveInlining)]
633 public bool Add(long index)
634 {
635     var wordIndex = GetWordIndexFromIndex(index);
636     var mask = GetBitMaskFromIndex(index);
637     if ((_array[wordIndex] & mask) == 0)
638     {
639         _array[wordIndex] |= mask;
640         RefreshBordersByWord(wordIndex);
641         return true;
642     }
643     else
644     {
645         return false;
646     }
647 }
648
649 [MethodImpl(MethodImplOptions.AggressiveInlining)]
650 public void SetAll(bool value)
651 {
652     if (value)
653     {
654         SetAll();
655     }
656     else
657     {
658         ResetAll();
659     }
660 }
661
662 [MethodImpl(MethodImplOptions.AggressiveInlining)]
663 public void SetAll()
664 {
665     const long fillValue = unchecked((long)0xffffffffffffffff);
666     var words = GetWordsCountFromIndex(_length);
667     for (var i = 0; i < words; i++)
668     {
669         _array[i] = fillValue;
670     }
671     MarkBordersAsAllBitsSet();
672 }
673
674 [MethodImpl(MethodImplOptions.AggressiveInlining)]
675 public void ResetAll()
676 {
677     const long fillValue = 0;
678     GetBorders(out long from, out long to);
679     for (var i = from; i <= to; i++)
680     {
681         _array[i] = fillValue;
682     }
683     MarkBordersAsAllBitsReset();
684 }
685
686 [MethodImpl(MethodImplOptions.AggressiveInlining)]
687 public List<long> GetSetIndices()
688 {
689     var result = new List<long>();
690     GetBorders(out long from, out long to);

```

```

691     for (var i = from; i <= to; i++)
692     {
693         var word = _array[i];
694         if (word != 0)
695         {
696             AppendAllSetBitIndices(result, i, word);
697         }
698     }
699     return result;
700 }
701
702 [MethodImpl(MethodImplOptions.AggressiveInlining)]
703 public List<ulong> GetSetUInt64Indices()
704 {
705     var result = new List<ulong>();
706     GetBorders(out ulong from, out ulong to);
707     for (var i = from; i <= to; i++)
708     {
709         var word = _array[i];
710         if (word != 0)
711         {
712             AppendAllSetBitIndices(result, i, word);
713         }
714     }
715     return result;
716 }
717
718 [MethodImpl(MethodImplOptions.AggressiveInlining)]
719 public long GetFirstSetBitIndex()
720 {
721     var i = _minPositiveWord;
722     var word = _array[i];
723     if (word != 0)
724     {
725         return GetFirstSetBitForWord(i, word);
726     }
727     return -1;
728 }
729
730 [MethodImpl(MethodImplOptions.AggressiveInlining)]
731 public long GetLastSetBitIndex()
732 {
733     var i = _maxPositiveWord;
734     var word = _array[i];
735     if (word != 0)
736     {
737         return GetLastSetBitForWord(i, word);
738     }
739     return -1;
740 }
741
742 [MethodImpl(MethodImplOptions.AggressiveInlining)]
743 public long CountSetBits()
744 {
745     var total = 0L;
746     GetBorders(out long from, out long to);
747     for (var i = from; i <= to; i++)
748     {
749         var word = _array[i];
750         if (word != 0)
751         {
752             total += CountSetBitsForWord(word);
753         }
754     }
755     return total;
756 }
757
758 [MethodImpl(MethodImplOptions.AggressiveInlining)]
759 public bool HaveCommonBits(BitString other)
760 {
761     EnsureBitStringHasTheSameSize(other, nameof(other));
762     GetCommonInnerBorders(this, other, out long from, out long to);
763     var otherArray = other._array;
764     for (var i = from; i <= to; i++)
765     {
766         var left = _array[i];
767         var right = otherArray[i];
768         if (left != 0 && right != 0 && (left & right) != 0)
769         {

```



```

770         return true;
771     }
772 }
773 return false;
774 }
775
776 [MethodImpl(MethodImplOptions.AggressiveInlining)]
777 public long CountCommonBits(BitString other)
778 {
779     EnsureBitStringHasTheSameSize(other, nameof(other));
780     GetCommonInnerBorders(this, other, out long from, out long to);
781     var total = 0L;
782     var otherArray = other._array;
783     for (var i = from; i <= to; i++)
784     {
785         var left = _array[i];
786         var right = otherArray[i];
787         var combined = left & right;
788         if (combined != 0)
789         {
790             total += CountSetBitsForWord(combined);
791         }
792     }
793     return total;
794 }
795
796 [MethodImpl(MethodImplOptions.AggressiveInlining)]
797 public List<long> GetCommonIndices(BitString other)
798 {
799     EnsureBitStringHasTheSameSize(other, nameof(other));
800     GetCommonInnerBorders(this, other, out long from, out long to);
801     var result = new List<long>();
802     var otherArray = other._array;
803     for (var i = from; i <= to; i++)
804     {
805         var left = _array[i];
806         var right = otherArray[i];
807         var combined = left & right;
808         if (combined != 0)
809         {
810             AppendAllSetBitIndices(result, i, combined);
811         }
812     }
813     return result;
814 }
815
816 [MethodImpl(MethodImplOptions.AggressiveInlining)]
817 public List<ulong> GetCommonUInt64Indices(BitString other)
818 {
819     EnsureBitStringHasTheSameSize(other, nameof(other));
820     GetCommonBorders(this, other, out ulong from, out ulong to);
821     var result = new List<ulong>();
822     var otherArray = other._array;
823     for (var i = from; i <= to; i++)
824     {
825         var left = _array[i];
826         var right = otherArray[i];
827         var combined = left & right;
828         if (combined != 0)
829         {
830             AppendAllSetBitIndices(result, i, combined);
831         }
832     }
833     return result;
834 }
835
836 [MethodImpl(MethodImplOptions.AggressiveInlining)]
837 public long GetFirstCommonBitIndex(BitString other)
838 {
839     EnsureBitStringHasTheSameSize(other, nameof(other));
840     GetCommonInnerBorders(this, other, out long from, out long to);
841     var otherArray = other._array;
842     for (var i = from; i <= to; i++)
843     {
844         var left = _array[i];
845         var right = otherArray[i];
846         var combined = left & right;
847         if (combined != 0)
848         {

```

```

849         return GetFirstSetBitForWord(i, combined);
850     }
851 }
852 return -1;
853 }
854
855 [MethodImpl(MethodImplOptions.AggressiveInlining)]
856 public long GetLastCommonBitIndex(BitString other)
857 {
858     EnsureBitStringHasTheSameSize(other, nameof(other));
859     GetCommonInnerBorders(this, other, out long from, out long to);
860     var otherArray = other._array;
861     for (var i = to; i >= from; i--)
862     {
863         var left = _array[i];
864         var right = otherArray[i];
865         var combined = left & right;
866         if (combined != 0)
867         {
868             return GetLastSetBitForWord(i, combined);
869         }
870     }
871     return -1;
872 }
873
874 [MethodImpl(MethodImplOptions.AggressiveInlining)]
875 public override bool Equals(object obj) => obj is BitString @string ? Equals(@string) :
    ↪ false;
876
877 [MethodImpl(MethodImplOptions.AggressiveInlining)]
878 public bool Equals(BitString other)
879 {
880     if (_length != other._length)
881     {
882         return false;
883     }
884     var otherArray = other._array;
885     if (_array.Length != otherArray.Length)
886     {
887         return false;
888     }
889     if (_minPositiveWord != other._minPositiveWord)
890     {
891         return false;
892     }
893     if (_maxPositiveWord != other._maxPositiveWord)
894     {
895         return false;
896     }
897     GetCommonBorders(this, other, out ulong from, out ulong to);
898     for (var i = from; i <= to; i++)
899     {
900         if (_array[i] != otherArray[i])
901         {
902             return false;
903         }
904     }
905     return true;
906 }
907
908 [MethodImpl(MethodImplOptions.AggressiveInlining)]
909 private void EnsureBitStringHasTheSameSize(BitString other, string argumentName)
910 {
911     Ensure.Always.ArgumentNotNull(other, argumentName);
912     if (_length != other._length)
913     {
914         throw new ArgumentException("Bit string must be the same size.", argumentName);
915     }
916 }
917
918 [MethodImpl(MethodImplOptions.AggressiveInlining)]
919 private void MarkBordersAsAllBitsReset() => SetBorders(_array.LongLength - 1, 0);
920
921 [MethodImpl(MethodImplOptions.AggressiveInlining)]
922 private void MarkBordersAsAllBitsSet() => SetBorders(0, _array.LongLength - 1);
923
924 [MethodImpl(MethodImplOptions.AggressiveInlining)]
925 private void GetBorders(out long from, out long to)
926 {

```

```

927         from = _minPositiveWord;
928         to = _maxPositiveWord;
929     }
930
931     [MethodImpl(MethodImplOptions.AggressiveInlining)]
932     private void GetBorders(out ulong from, out ulong to)
933     {
934         from = (ulong)_minPositiveWord;
935         to = (ulong)_maxPositiveWord;
936     }
937
938     [MethodImpl(MethodImplOptions.AggressiveInlining)]
939     private void SetBorders(long from, long to)
940     {
941         _minPositiveWord = from;
942         _maxPositiveWord = to;
943     }
944
945     [MethodImpl(MethodImplOptions.AggressiveInlining)]
946     private Range<long> GetValidIndexRange() => (0, _length - 1);
947
948     [MethodImpl(MethodImplOptions.AggressiveInlining)]
949     private static Range<long> GetValidLengthRange() => (0, long.MaxValue);
950
951     [MethodImpl(MethodImplOptions.AggressiveInlining)]
952     private static void AppendAllSetBitIndices(List<ulong> result, ulong wordIndex, long
        ↪ wordValue)
953     {
954         GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
        ↪ bits32to47, out byte[] bits48to63);
955         AppendAllSetIndices(result, wordIndex, bits00to15, bits16to31, bits32to47,
        ↪ bits48to63);
956     }
957
958     [MethodImpl(MethodImplOptions.AggressiveInlining)]
959     private static void AppendAllSetBitIndices(List<long> result, long wordIndex, long
        ↪ wordValue)
960     {
961         GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
        ↪ bits32to47, out byte[] bits48to63);
962         AppendAllSetBitIndices(result, wordIndex, bits00to15, bits16to31, bits32to47,
        ↪ bits48to63);
963     }
964
965     [MethodImpl(MethodImplOptions.AggressiveInlining)]
966     private static long CountSetBitsForWord(long word)
967     {
968         GetBits(word, out byte[] bits00to15, out byte[] bits16to31, out byte[] bits32to47,
        ↪ out byte[] bits48to63);
969         return bits00to15.LongLength + bits16to31.LongLength + bits32to47.LongLength +
        ↪ bits48to63.LongLength;
970     }
971
972     [MethodImpl(MethodImplOptions.AggressiveInlining)]
973     private static long GetFirstSetBitForWord(long wordIndex, long wordValue)
974     {
975         GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
        ↪ bits32to47, out byte[] bits48to63);
976         return GetFirstSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
977     }
978
979     [MethodImpl(MethodImplOptions.AggressiveInlining)]
980     private static long GetLastSetBitForWord(long wordIndex, long wordValue)
981     {
982         GetBits(wordValue, out byte[] bits00to15, out byte[] bits16to31, out byte[]
        ↪ bits32to47, out byte[] bits48to63);
983         return GetLastSetBit(wordIndex, bits00to15, bits16to31, bits32to47, bits48to63);
984     }
985
986     [MethodImpl(MethodImplOptions.AggressiveInlining)]
987     private static void AppendAllSetBitIndices(List<long> result, long i, byte[] bits00to15,
        ↪ byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
988     {
989         for (var j = 0; j < bits00to15.Length; j++)
990         {
991             result.Add(bits00to15[j] + (i * 64));
992         }
993         for (var j = 0; j < bits16to31.Length; j++)

```

```

994     {
995         result.Add(bits16to31[j] + 16 + (i * 64));
996     }
997     for (var j = 0; j < bits32to47.Length; j++)
998     {
999         result.Add(bits32to47[j] + 32 + (i * 64));
1000     }
1001     for (var j = 0; j < bits48to63.Length; j++)
1002     {
1003         result.Add(bits48to63[j] + 48 + (i * 64));
1004     }
1005 }
1006
1007 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1008 private static void AppendAllSetIndices(List<ulong> result, ulong i, byte[] bits00to15,
    ↪ byte[] bits16to31, byte[] bits32to47, byte[] bits48to63)
1009 {
1010     for (var j = 0; j < bits00to15.Length; j++)
1011     {
1012         result.Add(bits00to15[j] + (i * 64));
1013     }
1014     for (var j = 0; j < bits16to31.Length; j++)
1015     {
1016         result.Add(bits16to31[j] + 16UL + (i * 64));
1017     }
1018     for (var j = 0; j < bits32to47.Length; j++)
1019     {
1020         result.Add(bits32to47[j] + 32UL + (i * 64));
1021     }
1022     for (var j = 0; j < bits48to63.Length; j++)
1023     {
1024         result.Add(bits48to63[j] + 48UL + (i * 64));
1025     }
1026 }
1027
1028 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1029 private static long GetFirstSetBit(long i, byte[] bits00to15, byte[] bits16to31, byte[]
    ↪ bits32to47, byte[] bits48to63)
1030 {
1031     if (bits00to15.Length > 0)
1032     {
1033         return bits00to15[0] + (i * 64);
1034     }
1035     if (bits16to31.Length > 0)
1036     {
1037         return bits16to31[0] + 16 + (i * 64);
1038     }
1039     if (bits32to47.Length > 0)
1040     {
1041         return bits32to47[0] + 32 + (i * 64);
1042     }
1043     return bits48to63[0] + 48 + (i * 64);
1044 }
1045
1046 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1047 private static long GetLastSetBit(long i, byte[] bits00to15, byte[] bits16to31, byte[]
    ↪ bits32to47, byte[] bits48to63)
1048 {
1049     if (bits48to63.Length > 0)
1050     {
1051         return bits48to63[bits48to63.Length - 1] + 48 + (i * 64);
1052     }
1053     if (bits32to47.Length > 0)
1054     {
1055         return bits32to47[bits32to47.Length - 1] + 32 + (i * 64);
1056     }
1057     if (bits16to31.Length > 0)
1058     {
1059         return bits16to31[bits16to31.Length - 1] + 16 + (i * 64);
1060     }
1061     return bits00to15[bits00to15.Length - 1] + (i * 64);
1062 }
1063
1064 [MethodImpl(MethodImplOptions.AggressiveInlining)]
1065 private static void GetBits(long word, out byte[] bits00to15, out byte[] bits16to31, out
    ↪ byte[] bits32to47, out byte[] bits48to63)
1066 {
1067     bits00to15 = _bitsSetIn16Bits[word & 0xfffff];

```

```

1068         bits16to31 = _bitsSetIn16Bits[(word >> 16) & 0xffffu];
1069         bits32to47 = _bitsSetIn16Bits[(word >> 32) & 0xffffu];
1070         bits48to63 = _bitsSetIn16Bits[(word >> 48) & 0xffffu];
1071     }
1072
1073     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1074     public static void GetCommonInnerBorders(BitString left, BitString right, out long from,
1075         ↪ out long to)
1076     {
1077         from = Math.Max(left._minPositiveWord, right._minPositiveWord);
1078         to = Math.Min(left._maxPositiveWord, right._maxPositiveWord);
1079     }
1080
1081     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1082     public static void GetCommonOuterBorders(BitString left, BitString right, out long from,
1083         ↪ out long to)
1084     {
1085         from = Math.Min(left._minPositiveWord, right._minPositiveWord);
1086         to = Math.Max(left._maxPositiveWord, right._maxPositiveWord);
1087     }
1088
1089     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1090     public static void GetCommonOuterBorders(BitString left, BitString right, out int from,
1091         ↪ out int to)
1092     {
1093         from = (int)Math.Min(left._minPositiveWord, right._minPositiveWord);
1094         to = (int)Math.Max(left._maxPositiveWord, right._maxPositiveWord);
1095     }
1096
1097     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1098     public static void GetCommonBorders(BitString left, BitString right, out ulong from, out
1099         ↪ ulong to)
1100     {
1101         from = (ulong)Math.Max(left._minPositiveWord, right._minPositiveWord);
1102         to = (ulong)Math.Min(left._maxPositiveWord, right._maxPositiveWord);
1103     }
1104
1105     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1106     public static long GetWordsCountFromIndex(long index) => (index + 63) / 64;
1107
1108     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1109     public static long GetWordIndexFromIndex(long index) => index >> 6;
1110
1111     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1112     public static long GetBitMaskFromIndex(long index) => 1L << (int)(index & 63);
1113
1114     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1115     public override int GetHashCode() => base.GetHashCode();
1116
1117     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1118     public override string ToString() => base.ToString();
1119 }
1120 }

```

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

```

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

```

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

```

1 using System.Collections.Concurrent;
2 using System.Collections.Generic;

```

```

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

```

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

```

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

```

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

```

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

```

```

35         if (string.IsNullOrEmpty(argument))
36         {
37             throw new ArgumentException(message, argumentName);
38         }
39     }
40
41     [MethodImpl(MethodImplOptions.AggressiveInlining)]
42     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
43         ↪ string argument, string argumentName) => ArgumentNotEmptyAndNotWhiteSpace(root,
44         ↪ argument, argumentName, null);
45
46     [MethodImpl(MethodImplOptions.AggressiveInlining)]
47     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureAlwaysExtensionRoot root,
48         ↪ string argument) => ArgumentNotEmptyAndNotWhiteSpace(root, argument, null, null);
49
50     #endregion
51
52     #region OnDebug
53
54     [Conditional("DEBUG")]
55     public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
56         ↪ ICollection<T> argument, string argumentName, string message) =>
57         ↪ Ensure.Always.ArgumentNotEmpty(argument, argumentName, message);
58
59     [Conditional("DEBUG")]
60     public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
61         ↪ ICollection<T> argument, string argumentName) =>
62         ↪ Ensure.Always.ArgumentNotEmpty(argument, argumentName, null);
63
64     [Conditional("DEBUG")]
65     public static void ArgumentNotEmpty<T>(this EnsureOnDebugExtensionRoot root,
66         ↪ ICollection<T> argument) => Ensure.Always.ArgumentNotEmpty(argument, null, null);
67
68     [Conditional("DEBUG")]
69     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
70         ↪ root, string argument, string argumentName, string message) =>
71         ↪ Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument, argumentName, message);
72
73     [Conditional("DEBUG")]
74     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
75         ↪ root, string argument, string argumentName) =>
76         ↪ Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument, argumentName, null);
77
78     [Conditional("DEBUG")]
79     public static void ArgumentNotEmptyAndNotWhiteSpace(this EnsureOnDebugExtensionRoot
80         ↪ root, string argument) => Ensure.Always.ArgumentNotEmptyAndNotWhiteSpace(argument,
81         ↪ null, null);
82
83     #endregion
84 }

```

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

```

1  using System.Collections.Generic;
2  using System.Linq;
3  using System.Runtime.CompilerServices;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections
8  {
9      public static class ICollectionExtensions
10     {
11         [MethodImpl(MethodImplOptions.AggressiveInlining)]
12         public static bool IsNullOrEmpty<T>(this ICollection<T> collection) => collection ==
13             ↪ null || collection.Count == 0;
14
15         [MethodImpl(MethodImplOptions.AggressiveInlining)]
16         public static bool AllEqualToDefault<T>(this ICollection<T> collection)
17         {
18             var equalityComparer = EqualityComparer<T>.Default;
19             return collection.All(item => equalityComparer.Equals(item, default));
20         }
21     }
22 }

```

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

```

1  using System;
2  using System.Collections.Generic;

```

```

3 using System.Runtime.CompilerServices;
4
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Collections
8 {
9     public static class IDictionaryExtensions
10    {
11        [MethodImpl(MethodImplOptions.AggressiveInlining)]
12        public static TValue GetOrDefault<TKey, TValue>(this IDictionary<TKey, TValue>
13        ↪ dictionary, TKey key)
14        {
15            dictionary.TryGetValue(key, out TValue value);
16            return value;
17        }
18
19        [MethodImpl(MethodImplOptions.AggressiveInlining)]
20        public static TValue GetOrAdd<TKey, TValue>(this IDictionary<TKey, TValue> dictionary,
21        ↪ TKey key, Func<TKey, TValue> valueFactory)
22        {
23            if (!dictionary.TryGetValue(key, out TValue value))
24            {
25                value = valueFactory(key);
26                dictionary.Add(key, value);
27                return value;
28            }
29            return value;
30        }
31    }
32 }

```

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

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Lists
7 {
8     public static class CharIListExtensions
9     {
10        /// <remarks>
11        /// Based on https://github.com/Microsoft/referencesource/blob/3b1eaf5203992df69de44c783\_
12        ↪ a3eda37d3d4cd10/mscorlib/system/string.cs#L833
13        /// </remarks>
14        [MethodImpl(MethodImplOptions.AggressiveInlining)]
15        public static int GenerateHashCode(this IList<char> list)
16        {
17            var hashSeed = 5381;
18            var hashAccumulator = hashSeed;
19            for (var i = 0; i < list.Count; i++)
20            {
21                hashAccumulator = (hashAccumulator << 5) + hashAccumulator ^ list[i];
22            }
23            return hashAccumulator + (hashSeed * 1566083941);
24        }
25
26        [MethodImpl(MethodImplOptions.AggressiveInlining)]
27        public static bool EqualTo(this IList<char> left, IList<char> right) =>
28        ↪ left.EqualTo(right, ContentEqualTo);
29
30        [MethodImpl(MethodImplOptions.AggressiveInlining)]
31        public static bool ContentEqualTo(this IList<char> left, IList<char> right)
32        {
33            for (var i = left.Count - 1; i >= 0; --i)
34            {
35                if (left[i] != right[i])
36                {
37                    return false;
38                }
39            }
40            return true;
41        }
42    }
43 }

```

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

```

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

```



```

3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Lists
7 {
8     public class IListComparer<T> : IComparer<IList<T>>
9     {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         public int Compare(IList<T> left, IList<T> right) => left.CompareTo(right);
12     }
13 }

```

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

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Lists
7 {
8     public class IListEqualityComparer<T> : IEqualityComparer<IList<T>>
9     {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         public bool Equals(IList<T> left, IList<T> right) => left.EqualTo(right);
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public int GetHashCode(IList<T> list) => list.GenerateHashCode();
15     }
16 }

```

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

```

1 using System;
2 using System.Collections.Generic;
3 using System.Runtime.CompilerServices;
4
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Collections.Lists
8 {
9     public static class IListExtensions
10     {
11         [MethodImpl(MethodImplOptions.AggressiveInlining)]
12         public static T GetElementOrDefault<T>(this IList<T> list, int index) => list != null &&
13             ↪ list.Count > index ? list[index] : default;
14
15         [MethodImpl(MethodImplOptions.AggressiveInlining)]
16         public static bool TryGetElement<T>(this IList<T> list, int index, out T element)
17         {
18             if (list != null && list.Count > index)
19             {
20                 element = list[index];
21                 return true;
22             }
23             else
24             {
25                 element = default;
26                 return false;
27             }
28         }
29
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         public static bool AddAndReturnTrue<T>(this IList<T> list, T element)
32         {
33             list.Add(element);
34             return true;
35         }
36
37         [MethodImpl(MethodImplOptions.AggressiveInlining)]
38         public static bool AddFirstAndReturnTrue<T>(this IList<T> list, IList<T> elements)
39         {
40             list.AddFirst(elements);
41             return true;
42         }
43
44         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45         public static void AddFirst<T>(this IList<T> list, IList<T> elements) =>
46             ↪ list.Add(elements[0]);
47
48         [MethodImpl(MethodImplOptions.AggressiveInlining)]
49         public static bool AddAllAndReturnTrue<T>(this IList<T> list, IList<T> elements)

```

```

48     {
49         list.AddAll(elements);
50         return true;
51     }
52
53     [MethodImpl(MethodImplOptions.AggressiveInlining)]
54     public static void AddAll<T>(this IList<T> list, IList<T> elements)
55     {
56         for (var i = 0; i < elements.Count; i++)
57         {
58             list.Add(elements[i]);
59         }
60     }
61
62     [MethodImpl(MethodImplOptions.AggressiveInlining)]
63     public static bool AddSkipFirstAndReturnTrue<T>(this IList<T> list, IList<T> elements)
64     {
65         list.AddSkipFirst(elements);
66         return true;
67     }
68
69     [MethodImpl(MethodImplOptions.AggressiveInlining)]
70     public static void AddSkipFirst<T>(this IList<T> list, IList<T> elements) =>
71     ↪ list.AddSkipFirst(elements, 1);
72
73     [MethodImpl(MethodImplOptions.AggressiveInlining)]
74     public static void AddSkipFirst<T>(this IList<T> list, IList<T> elements, int skip)
75     {
76         for (var i = skip; i < elements.Count; i++)
77         {
78             list.Add(elements[i]);
79         }
80     }
81
82     [MethodImpl(MethodImplOptions.AggressiveInlining)]
83     public static int GetCountOrZero<T>(this IList<T> list) => list?.Count ?? 0;
84
85     [MethodImpl(MethodImplOptions.AggressiveInlining)]
86     public static bool EqualTo<T>(this IList<T> left, IList<T> right) => EqualTo(left,
87     ↪ right, ContentEqualTo);
88
89     [MethodImpl(MethodImplOptions.AggressiveInlining)]
90     public static bool EqualTo<T>(this IList<T> left, IList<T> right, Func<IList<T>,
91     ↪ IList<T>, bool> contentEqualityComparer)
92     {
93         if (ReferenceEquals(left, right))
94         {
95             return true;
96         }
97         var leftCount = left.GetCountOrZero();
98         var rightCount = right.GetCountOrZero();
99         if (leftCount == 0 && rightCount == 0)
100         {
101             return true;
102         }
103         if (leftCount == 0 || rightCount == 0 || leftCount != rightCount)
104         {
105             return false;
106         }
107         return contentEqualityComparer(left, right);
108     }
109
110     [MethodImpl(MethodImplOptions.AggressiveInlining)]
111     public static bool ContentEqualTo<T>(this IList<T> left, IList<T> right)
112     {
113         var equalityComparer = EqualityComparer<T>.Default;
114         for (var i = left.Count - 1; i >= 0; --i)
115         {
116             if (!equalityComparer.Equals(left[i], right[i]))
117             {
118                 return false;
119             }
120         }
121         return true;
122     }
123
124     [MethodImpl(MethodImplOptions.AggressiveInlining)]
125     public static T[] ToArray<T>(this IList<T> list, Func<T, bool> predicate)
126     {

```

```

124         if (list == null)
125         {
126             return null;
127         }
128         var result = new List<T>(list.Count);
129         for (var i = 0; i < list.Count; i++)
130         {
131             if (predicate(list[i]))
132             {
133                 result.Add(list[i]);
134             }
135         }
136         return result.ToArray();
137     }
138
139     [MethodImpl(MethodImplOptions.AggressiveInlining)]
140     public static T[] ToArray<T>(this IList<T> list)
141     {
142         var array = new T[list.Count];
143         list.CopyTo(array, 0);
144         return array;
145     }
146
147     [MethodImpl(MethodImplOptions.AggressiveInlining)]
148     public static void ForEach<T>(this IList<T> list, Action<T> action)
149     {
150         for (var i = 0; i < list.Count; i++)
151         {
152             action(list[i]);
153         }
154     }
155
156     /// <remarks>
157     /// Based on http://stackoverflow.com/questions/263400/what-is-the-best-algorithm-for-an
158     /// ↪ -overridden-system-object-gethashcode
159     /// </remarks>
160     [MethodImpl(MethodImplOptions.AggressiveInlining)]
161     public static int GenerateHashCode<T>(this IList<T> list)
162     {
163         var hashAccumulator = 17;
164         for (var i = 0; i < list.Count; i++)
165         {
166             hashAccumulator = unchecked((hashAccumulator * 23) + list[i].GetHashCode());
167         }
168         return hashAccumulator;
169     }
170
171     [MethodImpl(MethodImplOptions.AggressiveInlining)]
172     public static int CompareTo<T>(this IList<T> left, IList<T> right)
173     {
174         var comparer = Comparer<T>.Default;
175         var leftCount = left.GetCountOrZero();
176         var rightCount = right.GetCountOrZero();
177         var intermediateResult = leftCount.CompareTo(rightCount);
178         for (var i = 0; intermediateResult == 0 && i < leftCount; i++)
179         {
180             intermediateResult = comparer.Compare(left[i], right[i]);
181         }
182         return intermediateResult;
183     }
184
185     [MethodImpl(MethodImplOptions.AggressiveInlining)]
186     public static T[] SkipFirst<T>(this IList<T> list) => list.SkipFirst(1);
187
188     [MethodImpl(MethodImplOptions.AggressiveInlining)]
189     public static T[] SkipFirst<T>(this IList<T> list, int skip)
190     {
191         if (list.IsNullOrEmpty() || list.Count <= skip)
192         {
193             return Array.Empty<T>();
194         }
195         var result = new T[list.Count - skip];
196         for (int r = skip, w = 0; r < list.Count; r++, w++)
197         {
198             result[w] = list[r];
199         }
200         return result;
201     }

```

```

202 [MethodImpl(MethodImplOptions.AggressiveInlining)]
203 public static IList<T> ShiftRight<T>(this IList<T> list) => list.ShiftRight(1);
204
205 [MethodImpl(MethodImplOptions.AggressiveInlining)]
206 public static IList<T> ShiftRight<T>(this IList<T> list, int shift)
207 {
208     if (shift < 0)
209     {
210         throw new NotImplementedException();
211     }
212     if (shift == 0)
213     {
214         return list.ToArray();
215     }
216     else
217     {
218         var result = new T[list.Count + shift];
219         for (int r = 0, w = shift; r < list.Count; r++, w++)
220         {
221             result[w] = list[r];
222         }
223         return result;
224     }
225 }
226 }
227 }

```

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

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Lists
7 {
8     public class ListFiller<TElement, TReturnConstant>
9     {
10         protected readonly List<TElement> _list;
11         protected readonly TReturnConstant _returnConstant;
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public ListFiller(List<TElement> list, TReturnConstant returnConstant)
15         {
16             _list = list;
17             _returnConstant = returnConstant;
18         }
19
20         [MethodImpl(MethodImplOptions.AggressiveInlining)]
21         public ListFiller(List<TElement> list) : this(list, default) { }
22
23         [MethodImpl(MethodImplOptions.AggressiveInlining)]
24         public void Add(TElement element) => _list.Add(element);
25
26         [MethodImpl(MethodImplOptions.AggressiveInlining)]
27         public bool AddAndReturnTrue(TElement element) => _list.AddAndReturnTrue(element);
28
29         [MethodImpl(MethodImplOptions.AggressiveInlining)]
30         public bool AddFirstAndReturnTrue(IList<TElement> elements) =>
31             ↪ _list.AddFirstAndReturnTrue(elements);
32
33         [MethodImpl(MethodImplOptions.AggressiveInlining)]
34         public bool AddAllAndReturnTrue(IList<TElement> elements) =>
35             ↪ _list.AddAllAndReturnTrue(elements);
36
37         [MethodImpl(MethodImplOptions.AggressiveInlining)]
38         public bool AddSkipFirstAndReturnTrue(IList<TElement> elements) =>
39             ↪ _list.AddSkipFirstAndReturnTrue(elements);
40
41         [MethodImpl(MethodImplOptions.AggressiveInlining)]
42         public TReturnConstant AddAndReturnConstant(TElement element)
43         {
44             _list.Add(element);
45             return _returnConstant;
46         }
47
48         [MethodImpl(MethodImplOptions.AggressiveInlining)]
49         public TReturnConstant AddFirstAndReturnConstant(IList<TElement> elements)
50         {
51             _list.AddFirst(elements);
52         }
53     }
54 }

```

```

49         return _returnConstant;
50     }
51
52     [MethodImpl(MethodImplOptions.AggressiveInlining)]
53     public TReturnConstant AddAllAndReturnConstant(ICollection<TElement> elements)
54     {
55         _list.AddAll(elements);
56         return _returnConstant;
57     }
58
59     [MethodImpl(MethodImplOptions.AggressiveInlining)]
60     public TReturnConstant AddSkipFirstAndReturnConstant(ICollection<TElement> elements)
61     {
62         _list.AddSkipFirst(elements);
63         return _returnConstant;
64     }
65 }
66 }

```

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

```

1  using System.Linq;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Collections.Arrays;
5  using Platform.Collections.Lists;
6
7  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9  namespace Platform.Collections.Segments
10 {
11     public class CharSegment : Segment<char>
12     {
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public CharSegment(ICollection<char> @base, int offset, int length) : base(@base, offset,
15             ↪ length) { }
16
17         [MethodImpl(MethodImplOptions.AggressiveInlining)]
18         public override int GetHashCode()
19         {
20             // Base can be not an array, but still ICollection<char>
21             if (Base is char[] baseArray)
22             {
23                 return baseArray.GenerateHashCode(Offset, Length);
24             }
25             else
26             {
27                 return this.GenerateHashCode();
28             }
29         }
30
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public override bool Equals(Segment<char> other)
33         {
34             bool contentEqualityComparer(ICollection<char> left, ICollection<char> right)
35             {
36                 // Base can be not an array, but still ICollection<char>
37                 if (Base is char[] baseArray && other.Base is char[] otherArray)
38                 {
39                     return baseArray.ContentEqualTo(Offset, Length, otherArray, other.Offset);
40                 }
41                 else
42                 {
43                     return left.ContentEqualTo(right);
44                 }
45             }
46             return this.EqualTo(other, contentEqualityComparer);
47         }
48
49         public override bool Equals(object obj) => obj is Segment<char> charSegment ?
50             ↪ Equals(charSegment) : false;
51
52         [MethodImpl(MethodImplOptions.AggressiveInlining)]
53         public static implicit operator string(CharSegment segment)
54         {
55             if (!(segment.Base is char[] array))
56             {
57                 array = segment.Base.ToArray();
58             }
59             return new string(array, segment.Offset, segment.Length);
60         }
61     }
62 }

```

```

58     }
59
60     [MethodImpl(MethodImplOptions.AggressiveInlining)]
61     public override string ToString() => this;
62 }
63 }

```

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

```

1  using System;
2  using System.Collections;
3  using System.Collections.Generic;
4  using System.Runtime.CompilerServices;
5  using Platform.Collections.Arrays;
6  using Platform.Collections.Lists;
7
8  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
9
10 namespace Platform.Collections.Segments
11 {
12     public class Segment<T> : IEquatable<Segment<T>>, IList<T>
13     {
14         public IList<T> Base
15         {
16             [MethodImpl(MethodImplOptions.AggressiveInlining)]
17             get;
18         }
19         public int Offset
20         {
21             [MethodImpl(MethodImplOptions.AggressiveInlining)]
22             get;
23         }
24         public int Length
25         {
26             [MethodImpl(MethodImplOptions.AggressiveInlining)]
27             get;
28         }
29
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         public Segment(IList<T> @base, int offset, int length)
32         {
33             Base = @base;
34             Offset = offset;
35             Length = length;
36         }
37
38         [MethodImpl(MethodImplOptions.AggressiveInlining)]
39         public override int GetHashCode() => this.GenerateHashCode();
40
41         [MethodImpl(MethodImplOptions.AggressiveInlining)]
42         public virtual bool Equals(Segment<T> other) => this.EqualTo(other);
43
44         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45         public override bool Equals(object obj) => obj is Segment<T> other ? Equals(other) :
46             ↪ false;
47
48         #region IList
49         public T this[int i]
50         {
51             [MethodImpl(MethodImplOptions.AggressiveInlining)]
52             get => Base[Offset + i];
53             [MethodImpl(MethodImplOptions.AggressiveInlining)]
54             set => Base[Offset + i] = value;
55         }
56
57         public int Count
58         {
59             [MethodImpl(MethodImplOptions.AggressiveInlining)]
60             get => Length;
61         }
62
63         public bool IsReadOnly
64         {
65             [MethodImpl(MethodImplOptions.AggressiveInlining)]
66             get => true;
67         }
68
69         [MethodImpl(MethodImplOptions.AggressiveInlining)]
70         public int IndexOf(T item)
71         {
72             var index = Base.IndexOf(item);

```

```

73         if (index >= Offset)
74         {
75             var actualIndex = index - Offset;
76             if (actualIndex < Length)
77             {
78                 return actualIndex;
79             }
80         }
81         return -1;
82     }
83
84     [MethodImpl(MethodImplOptions.AggressiveInlining)]
85     public void Insert(int index, T item) => throw new NotSupportedException();
86
87     [MethodImpl(MethodImplOptions.AggressiveInlining)]
88     public void RemoveAt(int index) => throw new NotSupportedException();
89
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     public void Add(T item) => throw new NotSupportedException();
92
93     [MethodImpl(MethodImplOptions.AggressiveInlining)]
94     public void Clear() => throw new NotSupportedException();
95
96     [MethodImpl(MethodImplOptions.AggressiveInlining)]
97     public bool Contains(T item) => IndexOf(item) >= 0;
98
99     [MethodImpl(MethodImplOptions.AggressiveInlining)]
100    public void CopyTo(T[] array, int arrayIndex)
101    {
102        for (var i = 0; i < Length; i++)
103        {
104            array.Add(ref arrayIndex, this[i]);
105        }
106    }
107
108    [MethodImpl(MethodImplOptions.AggressiveInlining)]
109    public bool Remove(T item) => throw new NotSupportedException();
110
111    [MethodImpl(MethodImplOptions.AggressiveInlining)]
112    public IEnumerator<T> GetEnumerator()
113    {
114        for (var i = 0; i < Length; i++)
115        {
116            yield return this[i];
117        }
118    }
119
120    [MethodImpl(MethodImplOptions.AggressiveInlining)]
121    IEnumerator IEnumerable.GetEnumerator() => GetEnumerator();
122
123    #endregion
124 }
125 }

```

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

```

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

```

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

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Segments.Walkers
7  {
8      public abstract class AllSegmentsWalkerBase<T, TSegment> : AllSegmentsWalkerBase
9          where TSegment : Segment<T>
10     {
11         private readonly int _minimumStringSegmentLength;
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

14     protected AllSegmentsWalkerBase(int minimumStringSegmentLength) =>
15         ↪ _minimumStringSegmentLength = minimumStringSegmentLength;
16
17     [MethodImpl(MethodImplOptions.AggressiveInlining)]
18     protected AllSegmentsWalkerBase() : this(DefaultMinimumStringSegmentLength) { }
19
20     [MethodImpl(MethodImplOptions.AggressiveInlining)]
21     public virtual void WalkAll(ICollection<T> elements)
22     {
23         for (int offset = 0, maxOffset = elements.Count - _minimumStringSegmentLength;
24             ↪ offset <= maxOffset; offset++)
25         {
26             for (int length = _minimumStringSegmentLength, maxLength = elements.Count -
27                 ↪ offset; length <= maxLength; length++)
28             {
29                 Iteration(CreateSegment(elements, offset, length));
30             }
31         }
32
33     [MethodImpl(MethodImplOptions.AggressiveInlining)]
34     protected abstract TSegment CreateSegment(ICollection<T> elements, int offset, int length);
35
36     [MethodImpl(MethodImplOptions.AggressiveInlining)]
37     protected abstract void Iteration(TSegment segment);
38 }

```

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

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Collections.Segments.Walkers
7  {
8      public abstract class AllSegmentsWalkerBase<T> : AllSegmentsWalkerBase<T, Segment<T>>
9      {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         protected override Segment<T> CreateSegment(ICollection<T> elements, int offset, int length)
12             ↪ => new Segment<T>(elements, offset, length);
13     }
14 }

```

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

```

1  using System.Runtime.CompilerServices;
2
3  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5  namespace Platform.Collections.Segments.Walkers
6  {
7      public static class AllSegmentsWalkerExtensions
8      {
9         [MethodImpl(MethodImplOptions.AggressiveInlining)]
10         public static void WalkAll(this AllSegmentsWalkerBase<char> walker, string @string) =>
11             ↪ walker.WalkAll(@string.ToCharArray());
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public static void WalkAll<TSegment>(this AllSegmentsWalkerBase<char>, TSegment walker,
15             ↪ string @string) where TSegment : Segment<char> =>
16             ↪ walker.WalkAll(@string.ToCharArray());
17     }
18 }

```

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

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections.Segments.Walkers
8  {
9      public abstract class DictionaryBasedDuplicateSegmentsWalkerBase<T, TSegment> :
10         ↪ DuplicateSegmentsWalkerBase<T, TSegment>
11         where TSegment : Segment<T>
12     {
13         public static readonly bool DefaultResetDictionaryOnEachWalk;
14     }
15 }

```



```

14 private readonly bool _resetDictionaryOnEachWalk;
15 protected IDictionary<TSegment, long> Dictionary;
16
17 [MethodImpl(MethodImplOptions.AggressiveInlining)]
18 protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
19     ↪ dictionary, int minimumStringSegmentLength, bool resetDictionaryOnEachWalk)
20     : base(minimumStringSegmentLength)
21 {
22     Dictionary = dictionary;
23     _resetDictionaryOnEachWalk = resetDictionaryOnEachWalk;
24 }
25
26 [MethodImpl(MethodImplOptions.AggressiveInlining)]
27 protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
28     ↪ dictionary, int minimumStringSegmentLength) : this(dictionary,
29     ↪ minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
30
31 [MethodImpl(MethodImplOptions.AggressiveInlining)]
32 protected DictionaryBasedDuplicateSegmentsWalkerBase(IDictionary<TSegment, long>
33     ↪ dictionary) : this(dictionary, DefaultMinimumStringSegmentLength,
34     ↪ DefaultResetDictionaryOnEachWalk) { }
35
36 [MethodImpl(MethodImplOptions.AggressiveInlining)]
37 protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength,
38     ↪ bool resetDictionaryOnEachWalk) : this(resetDictionaryOnEachWalk ? null : new
39     ↪ Dictionary<TSegment, long>(), minimumStringSegmentLength, resetDictionaryOnEachWalk)
40     : { }
41
42 [MethodImpl(MethodImplOptions.AggressiveInlining)]
43 protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
44     ↪ this(minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
45
46 [MethodImpl(MethodImplOptions.AggressiveInlining)]
47 protected DictionaryBasedDuplicateSegmentsWalkerBase() :
48     ↪ this(DefaultMinimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }
49
50 [MethodImpl(MethodImplOptions.AggressiveInlining)]
51 public override void WalkAll(ICollection<T> elements)
52 {
53     if (_resetDictionaryOnEachWalk)
54     {
55         var capacity = Math.Ceiling(Math.Pow(elements.Count, 2) / 2);
56         Dictionary = new Dictionary<TSegment, long>((int)capacity);
57     }
58     base.WalkAll(elements);
59 }
60
61 [MethodImpl(MethodImplOptions.AggressiveInlining)]
62 protected override long GetSegmentFrequency(TSegment segment) =>
63     ↪ Dictionary.GetOrDefault(segment);
64
65 [MethodImpl(MethodImplOptions.AggressiveInlining)]
66 protected override void SetSegmentFrequency(TSegment segment, long frequency) =>
67     ↪ Dictionary[segment] = frequency;
68 }
69 }

```

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

```

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

```

```

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

18
19     [MethodImpl(MethodImplOptions.AggressiveInlining)]
20     protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength,
    ↪ bool resetDictionaryOnEachWalk) : base(minimumStringSegmentLength,
    ↪ resetDictionaryOnEachWalk) { }

21
22     [MethodImpl(MethodImplOptions.AggressiveInlining)]
23     protected DictionaryBasedDuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
    ↪ base(minimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }

24
25     [MethodImpl(MethodImplOptions.AggressiveInlining)]
26     protected DictionaryBasedDuplicateSegmentsWalkerBase() :
    ↪ base(DefaultMinimumStringSegmentLength, DefaultResetDictionaryOnEachWalk) { }

27 }
28 }

```

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

```

1 using System.Runtime.CompilerServices;
2
3 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5 namespace Platform.Collections.Segments.Walkers
6 {
7     public abstract class DuplicateSegmentsWalkerBase<T, TSegment> : AllSegmentsWalkerBase<T,
    ↪ TSegment>
8     where TSegment : Segment<T>
9     {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         protected DuplicateSegmentsWalkerBase(int minimumStringSegmentLength) :
    ↪ base(minimumStringSegmentLength) { }
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         protected DuplicateSegmentsWalkerBase() : base(DefaultMinimumStringSegmentLength) { }
15
16         [MethodImpl(MethodImplOptions.AggressiveInlining)]
17         protected override void Iteration(TSegment segment)
18         {
19             var frequency = GetSegmentFrequency(segment);
20             if (frequency == 1)
21             {
22                 OnDuplicateFound(segment);
23             }
24             SetSegmentFrequency(segment, frequency + 1);
25         }
26
27         [MethodImpl(MethodImplOptions.AggressiveInlining)]
28         protected abstract void OnDuplicateFound(TSegment segment);
29
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         protected abstract long GetSegmentFrequency(TSegment segment);
32
33         [MethodImpl(MethodImplOptions.AggressiveInlining)]
34         protected abstract void SetSegmentFrequency(TSegment segment, long frequency);
35     }
36 }

```

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

```

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

```

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

```

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

```

```

7 {
8     public static class ISetExtensions
9     {
10         [MethodImpl(MethodImplOptions.AggressiveInlining)]
11         public static void AddAndReturnVoid<T>(this ISet<T> set, T element) => set.Add(element);
12
13         [MethodImpl(MethodImplOptions.AggressiveInlining)]
14         public static void RemoveAndReturnVoid<T>(this ISet<T> set, T element) =>
15             ↪ set.Remove(element);
16
17         [MethodImpl(MethodImplOptions.AggressiveInlining)]
18         public static bool AddAndReturnTrue<T>(this ISet<T> set, T element)
19         {
20             set.Add(element);
21             return true;
22         }
23
24         [MethodImpl(MethodImplOptions.AggressiveInlining)]
25         public static bool AddFirstAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
26         {
27             AddFirst(set, elements);
28             return true;
29         }
30
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public static void AddFirst<T>(this ISet<T> set, IList<T> elements) =>
33             ↪ set.Add(elements[0]);
34
35         [MethodImpl(MethodImplOptions.AggressiveInlining)]
36         public static bool AddAllAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
37         {
38             set.AddAll(elements);
39             return true;
40         }
41
42         [MethodImpl(MethodImplOptions.AggressiveInlining)]
43         public static void AddAll<T>(this ISet<T> set, IList<T> elements)
44         {
45             for (var i = 0; i < elements.Count; i++)
46             {
47                 set.Add(elements[i]);
48             }
49         }
50
51         [MethodImpl(MethodImplOptions.AggressiveInlining)]
52         public static bool AddSkipFirstAndReturnTrue<T>(this ISet<T> set, IList<T> elements)
53         {
54             set.AddSkipFirst(elements);
55             return true;
56         }
57
58         [MethodImpl(MethodImplOptions.AggressiveInlining)]
59         public static void AddSkipFirst<T>(this ISet<T> set, IList<T> elements) =>
60             ↪ set.AddSkipFirst(elements, 1);
61
62         [MethodImpl(MethodImplOptions.AggressiveInlining)]
63         public static void AddSkipFirst<T>(this ISet<T> set, IList<T> elements, int skip)
64         {
65             for (var i = skip; i < elements.Count; i++)
66             {
67                 set.Add(elements[i]);
68             }
69         }
70
71         [MethodImpl(MethodImplOptions.AggressiveInlining)]
72         public static bool DoNotContains<T>(this ISet<T> set, T element) =>
73             ↪ !set.Contains(element);
74     }
75 }

```

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

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Collections.Sets
7 {
8     public class SetFiller<TElement, TReturnConstant>

```

```

9 {
10     protected readonly ISet<TElement> _set;
11     protected readonly TReturnConstant _returnConstant;
12
13     [MethodImpl(MethodImplOptions.AggressiveInlining)]
14     public SetFiller(ISet<TElement> set, TReturnConstant returnConstant)
15     {
16         _set = set;
17         _returnConstant = returnConstant;
18     }
19
20     [MethodImpl(MethodImplOptions.AggressiveInlining)]
21     public SetFiller(ISet<TElement> set) : this(set, default) { }
22
23     [MethodImpl(MethodImplOptions.AggressiveInlining)]
24     public void Add(TElement element) => _set.Add(element);
25
26     [MethodImpl(MethodImplOptions.AggressiveInlining)]
27     public bool AddAndReturnTrue(TElement element) => _set.AddAndReturnTrue(element);
28
29     [MethodImpl(MethodImplOptions.AggressiveInlining)]
30     public bool AddFirstAndReturnTrue(ICollection<TElement> elements) =>
31         => _set.AddFirstAndReturnTrue(elements);
32
33     [MethodImpl(MethodImplOptions.AggressiveInlining)]
34     public bool AddAllAndReturnTrue(ICollection<TElement> elements) =>
35         => _set.AddAllAndReturnTrue(elements);
36
37     [MethodImpl(MethodImplOptions.AggressiveInlining)]
38     public bool AddSkipFirstAndReturnTrue(ICollection<TElement> elements) =>
39         => _set.AddSkipFirstAndReturnTrue(elements);
40
41     [MethodImpl(MethodImplOptions.AggressiveInlining)]
42     public TReturnConstant AddAndReturnConstant(TElement element)
43     {
44         _set.Add(element);
45         return _returnConstant;
46     }
47
48     [MethodImpl(MethodImplOptions.AggressiveInlining)]
49     public TReturnConstant AddFirstAndReturnConstant(ICollection<TElement> elements)
50     {
51         _set.AddFirst(elements);
52         return _returnConstant;
53     }
54
55     [MethodImpl(MethodImplOptions.AggressiveInlining)]
56     public TReturnConstant AddAllAndReturnConstant(ICollection<TElement> elements)
57     {
58         _set.AddAll(elements);
59         return _returnConstant;
60     }
61
62     [MethodImpl(MethodImplOptions.AggressiveInlining)]
63     public TReturnConstant AddSkipFirstAndReturnConstant(ICollection<TElement> elements)
64     {
65         _set.AddSkipFirst(elements);
66         return _returnConstant;
67     }
68 }

```

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

```

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

```

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

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

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

```
1 using System.Runtime.CompilerServices;
2
3 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5 namespace Platform.Collections.Stacks
6 {
7     public static class IStackExtensions
8     {
9         [MethodImpl(MethodImplOptions.AggressiveInlining)]
10         public static void Clear<T>(this IStack<T> stack)
11         {
12             while (!stack.IsEmpty)
13             {
14                 _ = stack.Pop();
15             }
16         }
17
18         [MethodImpl(MethodImplOptions.AggressiveInlining)]
19         public static T PopOrDefault<T>(this IStack<T> stack) => stack.IsEmpty ? default :
20             ↪ stack.Pop();
21
22         [MethodImpl(MethodImplOptions.AggressiveInlining)]
23         public static T PeekOrDefault<T>(this IStack<T> stack) => stack.IsEmpty ? default :
24             ↪ stack.Peek();
25     }
26 }
```

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

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

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

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

```

12     [MethodImpl(MethodImplOptions.AggressiveInlining)]
13     public static T PeekOrDefault<T>(this Stack<T> stack) => stack.Count > 0 ? stack.Peek()
14     ↪ : default;
15 }
16 }

```

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

```

1  using System;
2  using System.Globalization;
3  using System.Runtime.CompilerServices;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections
8  {
9      public static class StringExtensions
10     {
11         [MethodImpl(MethodImplOptions.AggressiveInlining)]
12         public static string CapitalizeFirstLetter(this string @string)
13         {
14             if (@string.IsNullOrEmpty(@string))
15             {
16                 return @string;
17             }
18             var chars = @string.ToCharArray();
19             for (var i = 0; i < chars.Length; i++)
20             {
21                 var category = char.GetUnicodeCategory(chars[i]);
22                 if (category == UnicodeCategory.UppercaseLetter)
23                 {
24                     return @string;
25                 }
26                 if (category == UnicodeCategory.LowercaseLetter)
27                 {
28                     chars[i] = char.ToUpper(chars[i]);
29                     return new string(chars);
30                 }
31             }
32             return @string;
33         }
34
35         [MethodImpl(MethodImplOptions.AggressiveInlining)]
36         public static string Truncate(this string @string, int maxLength) =>
37         ↪ @string.IsNullOrEmpty(@string) ? @string : @string.Substring(0,
38         ↪ Math.Min(@string.Length, maxLength));
39
40         [MethodImpl(MethodImplOptions.AggressiveInlining)]
41         public static string TrimSingle(this string @string, char charToTrim)
42         {
43             if (!@string.IsNullOrEmpty(@string))
44             {
45                 if (@string.Length == 1)
46                 {
47                     if (@string[0] == charToTrim)
48                     {
49                         return "";
50                     }
51                     else
52                     {
53                         return @string;
54                     }
55                 }
56                 else
57                 {
58                     var left = 0;
59                     var right = @string.Length - 1;
60                     if (@string[left] == charToTrim)
61                     {
62                         left++;
63                     }
64                     if (@string[right] == charToTrim)
65                     {
66                         right--;
67                     }
68                     return @string.Substring(left, right - left + 1);
69                 }
70             }
71             else
72             {
73                 return @string;
74             }
75         }
76     }
77 }

```

```

70         {
71             return @string;
72         }
73     }
74 }
75 }

```

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

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3
4  // ReSharper disable ForCanBeConvertedToForeach
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Collections.Trees
8  {
9      public class Node
10     {
11         private Dictionary<object, Node> _childNodes;
12
13         public object Value
14         {
15             [MethodImpl(MethodImplOptions.AggressiveInlining)]
16             get;
17             [MethodImpl(MethodImplOptions.AggressiveInlining)]
18             set;
19         }
20
21         public Dictionary<object, Node> ChildNodes
22         {
23             [MethodImpl(MethodImplOptions.AggressiveInlining)]
24             get => _childNodes ?? (_childNodes = new Dictionary<object, Node>());
25         }
26
27         public Node this[object key]
28         {
29             [MethodImpl(MethodImplOptions.AggressiveInlining)]
30             get => GetChild(key) ?? AddChild(key);
31             [MethodImpl(MethodImplOptions.AggressiveInlining)]
32             set => SetChildValue(value, key);
33         }
34
35         [MethodImpl(MethodImplOptions.AggressiveInlining)]
36         public Node(object value) => Value = value;
37
38         [MethodImpl(MethodImplOptions.AggressiveInlining)]
39         public Node() : this(null) { }
40
41         [MethodImpl(MethodImplOptions.AggressiveInlining)]
42         public bool ContainsChild(params object[] keys) => GetChild(keys) != null;
43
44         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45         public Node GetChild(params object[] keys)
46         {
47             var node = this;
48             for (var i = 0; i < keys.Length; i++)
49             {
50                 node.ChildNodes.TryGetValue(keys[i], out node);
51                 if (node == null)
52                 {
53                     return null;
54                 }
55             }
56             return node;
57         }
58
59         [MethodImpl(MethodImplOptions.AggressiveInlining)]
60         public object GetChildValue(params object[] keys) => GetChild(keys)?.Value;
61
62         [MethodImpl(MethodImplOptions.AggressiveInlining)]
63         public Node AddChild(object key) => AddChild(key, new Node(null));
64
65         [MethodImpl(MethodImplOptions.AggressiveInlining)]
66         public Node AddChild(object key, object value) => AddChild(key, new Node(value));
67
68         [MethodImpl(MethodImplOptions.AggressiveInlining)]
69         public Node AddChild(object key, Node child)
70         {
71             ChildNodes.Add(key, child);
72             return child;
73         }
74     }
75 }

```

```

73     }
74
75     [MethodImpl(MethodImplOptions.AggressiveInlining)]
76     public Node SetChild(params object[] keys) => SetChildValue(null, keys);
77
78     [MethodImpl(MethodImplOptions.AggressiveInlining)]
79     public Node SetChild(object key) => SetChildValue(null, key);
80
81     [MethodImpl(MethodImplOptions.AggressiveInlining)]
82     public Node SetChildValue(object value, params object[] keys)
83     {
84         var node = this;
85         for (var i = 0; i < keys.Length; i++)
86         {
87             node = SetChildValue(value, keys[i]);
88         }
89         node.Value = value;
90         return node;
91     }
92
93     [MethodImpl(MethodImplOptions.AggressiveInlining)]
94     public Node SetChildValue(object value, object key)
95     {
96         if (!ChildNodes.TryGetValue(key, out Node child))
97         {
98             child = AddChild(key, value);
99         }
100         child.Value = value;
101         return child;
102     }
103 }
104 }

```

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

```

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

```

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

```

1  using System;
2  using System.Collections;
3  using Xunit;
4  using Platform.Random;
5
6  namespace Platform.Collections.Tests
7  {
8      public static class BitStringTests
9      {
10         [Fact]
11         public static void BitGetSetTest()
12         {
13             const int n = 250;
14             var bitArray = new BitArray(n);
15             var bitString = new BitString(n);
16             for (var i = 0; i < n; i++)
17             {
18                 var value = RandomHelpers.Default.NextBoolean();
19                 bitArray.Set(i, value);
20             }
21         }
22     }
23 }

```



```

20         bitString.Set(i, value);
21         Assert.Equal(value, bitArray.Get(i));
22         Assert.Equal(value, bitString.Get(i));
23     }
24 }
25
26 [Fact]
27 public static void BitVectorNotTest()
28 {
29     TestToOperationsWithSameMeaning((x, y, w, v) =>
30     {
31         x.VectorNot();
32         w.Not();
33     });
34 }
35
36 [Fact]
37 public static void BitParallelNotTest()
38 {
39     TestToOperationsWithSameMeaning((x, y, w, v) =>
40     {
41         x.ParallelNot();
42         w.Not();
43     });
44 }
45
46 [Fact]
47 public static void BitParallelVectorNotTest()
48 {
49     TestToOperationsWithSameMeaning((x, y, w, v) =>
50     {
51         x.ParallelVectorNot();
52         w.Not();
53     });
54 }
55
56 [Fact]
57 public static void BitVectorAndTest()
58 {
59     TestToOperationsWithSameMeaning((x, y, w, v) =>
60     {
61         x.VectorAnd(y);
62         w.And(v);
63     });
64 }
65
66 [Fact]
67 public static void BitParallelAndTest()
68 {
69     TestToOperationsWithSameMeaning((x, y, w, v) =>
70     {
71         x.ParallelAnd(y);
72         w.And(v);
73     });
74 }
75
76 [Fact]
77 public static void BitParallelVectorAndTest()
78 {
79     TestToOperationsWithSameMeaning((x, y, w, v) =>
80     {
81         x.ParallelVectorAnd(y);
82         w.And(v);
83     });
84 }
85
86 [Fact]
87 public static void BitVectorOrTest()
88 {
89     TestToOperationsWithSameMeaning((x, y, w, v) =>
90     {
91         x.VectorOr(y);
92         w.Or(v);
93     });
94 }
95
96 [Fact]
97 public static void BitParallelOrTest()

```

```

98     {
99         TestToOperationsWithSameMeaning((x, y, w, v) =>
100         {
101             x.ParallelOr(y);
102             w.Or(v);
103         });
104     }
105
106     [Fact]
107     public static void BitParallelVectorOrTest()
108     {
109         TestToOperationsWithSameMeaning((x, y, w, v) =>
110         {
111             x.ParallelVectorOr(y);
112             w.Or(v);
113         });
114     }
115
116     [Fact]
117     public static void BitVectorXorTest()
118     {
119         TestToOperationsWithSameMeaning((x, y, w, v) =>
120         {
121             x.VectorXor(y);
122             w.Xor(v);
123         });
124     }
125
126     [Fact]
127     public static void BitParallelXorTest()
128     {
129         TestToOperationsWithSameMeaning((x, y, w, v) =>
130         {
131             x.ParallelXor(y);
132             w.Xor(v);
133         });
134     }
135
136     [Fact]
137     public static void BitParallelVectorXorTest()
138     {
139         TestToOperationsWithSameMeaning((x, y, w, v) =>
140         {
141             x.ParallelVectorXor(y);
142             w.Xor(v);
143         });
144     }
145
146     private static void TestToOperationsWithSameMeaning(Action<BitString, BitString,
147     ↪ BitString, BitString> test)
148     {
149         const int n = 5654;
150         var x = new BitString(n);
151         var y = new BitString(n);
152         while (x.Equals(y))
153         {
154             x.SetRandomBits();
155             y.SetRandomBits();
156         }
157         var w = new BitString(x);
158         var v = new BitString(y);
159         Assert.False(x.Equals(y));
160         Assert.False(w.Equals(v));
161         Assert.True(x.Equals(w));
162         Assert.True(y.Equals(v));
163         test(x, y, w, v);
164         Assert.True(x.Equals(w));
165     }
166 }

```

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

```

1  using Xunit;
2  using Platform.Collections.Segments;
3
4  namespace Platform.Collections.Tests
5  {
6      public static class CharsSegmentTests
7      {

```

```

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

```

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

```

1 using System.Collections.Generic;
2 using Xunit;
3 using Platform.Collections.Lists;
4
5
6 namespace Platform.Collections.Tests
7 {
8     public class ListTests
9     {
10         [Fact]
11         public void GetElementTest()
12         {
13             var nullList = (IList<int>)null;
14             Assert.Equal(0, nullList.GetElementOrDefault(1));
15             Assert.False(nullList.TryGetElement(1, out int element));
16             Assert.Equal(0, element);
17             var list = new List<int>() { 1, 2, 3 };
18             Assert.Equal(3, list.GetElementOrDefault(2));
19             Assert.True(list.TryGetElement(2, out element));
20             Assert.Equal(3, element);
21             Assert.Equal(0, list.GetElementOrDefault(10));
22             Assert.False(list.TryGetElement(10, out element));
23             Assert.Equal(0, element);
24         }
25     }
26 }

```

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

```

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

```

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