

# LinksPlatform's Platform.Data.Doublets.Sequences Class Library

## 1.1 ./csharp/Platform.Data.Doublets.Sequences/Converters/BalancedVariantConverter.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.Data.Doublets.Sequences.Converters
7 {
8     /// <summary>
9     /// <para>
10    /// Represents the balanced variant converter.
11    /// </para>
12    /// <para></para>
13    /// </summary>
14    /// <seealso cref="LinkedListToSequenceConverterBase{TLinkAddress}"/>
15    public class BalancedVariantConverter<TLinkAddress> :
16        ↳ LinkedListToSequenceConverterBase<TLinkAddress>
17    {
18        /// <summary>
19        /// <para>
20        /// Initializes a new <see cref="BalancedVariantConverter"/> instance.
21        /// </para>
22        /// <para></para>
23        /// </summary>
24        /// <param name="links">
25        /// <para>A links.</para>
26        /// </param>
27        [MethodImpl(MethodImplOptions.AggressiveInlining)]
28        public BalancedVariantConverter(ILinks<TLinkAddress> links) : base(links) { }
29
30        /// <summary>
31        /// <para>
32        /// Converts the sequence.
33        /// </para>
34        /// <para></para>
35        /// </summary>
36        /// <param name="sequence">
37        /// <para>The sequence.</para>
38        /// </param>
39        /// <returns>
40        /// <para>The link</para>
41        /// <para></para>
42        /// </returns>
43        [MethodImpl(MethodImplOptions.AggressiveInlining)]
44        public override TLinkAddress Convert(ICollection<TLinkAddress>? sequence)
45        {
46            var length = sequence.Count;
47            if (length < 1)
48            {
49                return default;
50            }
51            if (length == 1)
52            {
53                return sequence[0];
54            }
55            // Make copy of next layer
56            if (length > 2)
57            {
58                // TODO: Try to use stackalloc (which at the moment is not working with
59                ↳ generics) but will be possible with Sigil
60                var halvedSequence = new TLinkAddress[(length / 2) + (length % 2)];
61                HalveSequence(halvedSequence, sequence, length);
62                sequence = halvedSequence;
63                length = halvedSequence.Length;
64            }
65            // Keep creating layer after layer
66            while (length > 2)
67            {
68                HalveSequence(sequence, sequence, length);
69                length = (length / 2) + (length % 2);
70            }
71            return _links.GetOrCreate(sequence[0], sequence[1]);
72        }
73        [MethodImpl(MethodImplOptions.AggressiveInlining)]
```

```

74     private void HalveSequence(ICollection<TLinkAddress>? destination, ICollection<TLinkAddress>?
    ↪ source, int length)
75     {
76         var loopedLength = length - (length % 2);
77         for (var i = 0; i < loopedLength; i += 2)
78         {
79             destination[i / 2] = _links.GetOrCreate(source[i], source[i + 1]);
80         }
81         if (length > loopedLength)
82         {
83             destination[length / 2] = source[length - 1];
84         }
85     }
86 }
87 }

```

## 1.2 ./csharp/Platform.Data.Doublets.Sequences/Converters/CompressingConverter.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Collections;
5  using Platform.Converters;
6  using Platform.Singletons;
7  using Platform.Numbers;
8  using Platform.Data.Doublets.Sequences.Frequencies.Cache;
9
10 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
11
12 namespace Platform.Data.Doublets.Sequences.Converters
13 {
14     /// <remarks>
15     /// TODO: Возможно будет лучше если алгоритм будет выполняться полностью изолированно от
    ↪ Links на этапе сжатия.
16     /// А именно будет создаваться временный список пар необходимых для выполнения сжатия, в
    ↪ таком случае тип значения элемента массива может быть любым, как char так и ulong.
17     /// Как только список/словарь пар был выявлен можно разом выполнить создание всех этих
    ↪ пар, а так же разом выполнить замену.
18     /// </remarks>
19     public class CompressingConverter<TLinkAddress> :
    ↪ LinkedListToSequenceConverterBase<TLinkAddress>
20     {
21         private static readonly LinksConstants<TLinkAddress> _constants =
    ↪ Default<LinksConstants<TLinkAddress>>.Instance;
22         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↪ EqualityComparer<TLinkAddress>.Default;
23         private static readonly Comparer<TLinkAddress> _comparer =
    ↪ Comparer<TLinkAddress>.Default;
24         private static readonly TLinkAddress _zero = default;
25         private static readonly TLinkAddress _one = Arithmetic.Increment(_zero);
26         private readonly IConverter<ICollection<TLinkAddress>, TLinkAddress> _baseConverter;
27         private readonly LinkFrequenciesCache<TLinkAddress> _doubletFrequenciesCache;
28         private readonly TLinkAddress _minFrequencyToCompress;
29         private readonly bool _doInitialFrequenciesIncrement;
30         private Doublet<TLinkAddress> _maxDoublet;
31         private LinkFrequency<TLinkAddress> _maxDoubletData;
32         private struct HalfDoublet
33         {
34             /// <summary>
35             /// <para>
36             /// The element.
37             /// </para>
38             /// <para></para>
39             /// </summary>
40             public TLinkAddress Element;
41             /// <summary>
42             /// <para>
43             /// The doublet data.
44             /// </para>
45             /// <para></para>
46             /// </summary>
47             public LinkFrequency<TLinkAddress> DoubletData;
48
49             /// <summary>
50             /// <para>
51             /// Initializes a new <see cref="HalfDoublet"/> instance.
52             /// </para>
53             /// <para></para>
54             /// </summary>
55             /// <param name="element">
56             /// <para>A element.</para>

```

```

57     /// <para></para>
58     /// </param>
59     /// <param name="doubletData">
60     /// <para>A doublet data.</para>
61     /// <para></para>
62     /// </param>
63     [MethodImpl(MethodImplOptions.AggressiveInlining)]
64     public HalfDoublet(TLinkAddress element, LinkFrequency<TLinkAddress> doubletData)
65     {
66         Element = element;
67         DoubletData = doubletData;
68     }
69
70     /// <summary>
71     /// <para>
72     /// Returns the string.
73     /// </para>
74     /// <para></para>
75     /// </summary>
76     /// <returns>
77     /// <para>The string</para>
78     /// <para></para>
79     /// </returns>
80     public override string ToString() => $"{Element}: ({DoubletData})";
81 }
82
83 /// <summary>
84 /// <para>
85 /// Initializes a new <see cref="CompressingConverter"/> instance.
86 /// </para>
87 /// <para></para>
88 /// </summary>
89 /// <param name="links">
90 /// <para>A links.</para>
91 /// <para></para>
92 /// </param>
93 /// <param name="baseConverter">
94 /// <para>A base converter.</para>
95 /// <para></para>
96 /// </param>
97 /// <param name="doubletFrequenciesCache">
98 /// <para>A doublet frequencies cache.</para>
99 /// <para></para>
100 /// </param>
101 [MethodImpl(MethodImplOptions.AggressiveInlining)]
102 public CompressingConverter(ILinks<TLinkAddress> links, IConverter<IList<TLinkAddress>,
    ↪ TLinkAddress> baseConverter, LinkFrequenciesCache<TLinkAddress>
    ↪ doubletFrequenciesCache)
    : this(links, baseConverter, doubletFrequenciesCache, _one, true) { }
103
104 /// <summary>
105 /// <para>
106 /// Initializes a new <see cref="CompressingConverter"/> instance.
107 /// </para>
108 /// <para></para>
109 /// </summary>
110 /// <param name="links">
111 /// <para>A links.</para>
112 /// <para></para>
113 /// </param>
114 /// <param name="baseConverter">
115 /// <para>A base converter.</para>
116 /// <para></para>
117 /// </param>
118 /// <param name="doubletFrequenciesCache">
119 /// <para>A doublet frequencies cache.</para>
120 /// <para></para>
121 /// </param>
122 /// <param name="doInitialFrequenciesIncrement">
123 /// <para>A do initial frequencies increment.</para>
124 /// <para></para>
125 /// </param>
126 [MethodImpl(MethodImplOptions.AggressiveInlining)]
127 public CompressingConverter(ILinks<TLinkAddress> links, IConverter<IList<TLinkAddress>,
    ↪ TLinkAddress> baseConverter, LinkFrequenciesCache<TLinkAddress>
    ↪ doubletFrequenciesCache, bool doInitialFrequenciesIncrement)
    : this(links, baseConverter, doubletFrequenciesCache, _one,
    ↪ doInitialFrequenciesIncrement) { }
128
129

```

```

130
131     /// <summary>
132     /// <para>
133     /// Initializes a new <see cref="CompressingConverter"/> instance.
134     /// </para>
135     /// </summary>
136     /// <param name="links">
137     /// <para>A links.</para>
138     /// </param>
139     /// <param name="baseConverter">
140     /// <para>A base converter.</para>
141     /// </param>
142     /// <param name="doubletFrequenciesCache">
143     /// <para>A doublet frequencies cache.</para>
144     /// </param>
145     /// <param name="minFrequencyToCompress">
146     /// <para>A min frequency to compress.</para>
147     /// </param>
148     /// <param name="doInitialFrequenciesIncrement">
149     /// <para>A do initial frequencies increment.</para>
150     /// </param>
151     [MethodImpl(MethodImplOptions.AggressiveInlining)]
152     public CompressingConverter(ILinks<TLinkAddress> links, IConverter<IList<TLinkAddress>,
153     ↪ TLinkAddress> baseConverter, LinkFrequenciesCache<TLinkAddress>
154     ↪ doubletFrequenciesCache, TLinkAddress minFrequencyToCompress, bool
155     ↪ doInitialFrequenciesIncrement)
156     : base(links)
157     {
158         _baseConverter = baseConverter;
159         _doubletFrequenciesCache = doubletFrequenciesCache;
160         if (_comparer.Compare(minFrequencyToCompress, _one) < 0)
161         {
162             minFrequencyToCompress = _one;
163         }
164         _minFrequencyToCompress = minFrequencyToCompress;
165         _doInitialFrequenciesIncrement = doInitialFrequenciesIncrement;
166         ResetMaxDoublet();
167     }
168
169     /// <summary>
170     /// <para>
171     /// Converts the source.
172     /// </para>
173     /// </summary>
174     /// <param name="source">
175     /// <para>The source.</para>
176     /// </param>
177     /// <returns>
178     /// <para>The link</para>
179     /// </returns>
180     [MethodImpl(MethodImplOptions.AggressiveInlining)]
181     public override TLinkAddress Convert(IList<TLinkAddress>? source) =>
182     ↪ _baseConverter.Convert(Compress(source));
183     [MethodImpl(MethodImplOptions.AggressiveInlining)]
184     private IList<TLinkAddress>? Compress(IList<TLinkAddress>? sequence)
185     {
186         if (sequence.IsNullOrEmpty())
187         {
188             return null;
189         }
190         if (sequence.Count == 1)
191         {
192             return sequence;
193         }
194         if (sequence.Count == 2)
195         {
196             return new[] { _links.GetOrCreate(sequence[0], sequence[1]) };
197         }
198         // TODO: arraypool with min size (to improve cache locality) or stackalloc with Sigil

```

```

204 var copy = new HalfDoublet[sequence.Count];
205 Doublet<TLinkAddress> doublet = default;
206 for (var i = 1; i < sequence.Count; i++)
207 {
208     doublet = new Doublet<TLinkAddress>(sequence[i - 1], sequence[i]);
209     LinkFrequency<TLinkAddress> data;
210     if (_doInitialFrequenciesIncrement)
211     {
212         data = _doubletFrequenciesCache.IncrementFrequency(ref doublet);
213     }
214     else
215     {
216         data = _doubletFrequenciesCache.GetFrequency(ref doublet);
217         if (data == null)
218         {
219             throw new NotSupportedException("If you ask not to increment
220                 ↪ frequencies, it is expected that all frequencies for the sequence
221                 ↪ are prepared.");
222         }
223     }
224     copy[i - 1].Element = sequence[i - 1];
225     copy[i - 1].DoubletData = data;
226     UpdateMaxDoublet(ref doublet, data);
227 }
228 copy[sequence.Count - 1].Element = sequence[sequence.Count - 1];
229 copy[sequence.Count - 1].DoubletData = new LinkFrequency<TLinkAddress>();
230 if (_comparer.Compare(_maxDoubletData.Frequency, default) > 0)
231 {
232     var newLength = ReplaceDoublets(copy);
233     sequence = new TLinkAddress[newLength];
234     for (int i = 0; i < newLength; i++)
235     {
236         sequence[i] = copy[i].Element;
237     }
238     return sequence;
239 }
240 [MethodImpl(MethodImplOptions.AggressiveInlining)]
241 private int ReplaceDoublets(HalfDoublet[] copy)
242 {
243     var oldLength = copy.Length;
244     var newLength = copy.Length;
245     while (_comparer.Compare(_maxDoubletData.Frequency, default) > 0)
246     {
247         var maxDoubletSource = _maxDoublet.Source;
248         var maxDoubletTarget = _maxDoublet.Target;
249         if (_equalityComparer.Equals(_maxDoubletData.Link, _constants.Null))
250         {
251             _maxDoubletData.Link = _links.GetOrCreate(maxDoubletSource,
252                 ↪ maxDoubletTarget);
253         }
254         var maxDoubletReplacementLink = _maxDoubletData.Link;
255         oldLength--;
256         var oldLengthMinusTwo = oldLength - 1;
257         // Substitute all usages
258         int w = 0, r = 0; // (r == read, w == write)
259         for (; r < oldLength; r++)
260         {
261             if (_equalityComparer.Equals(copy[r].Element, maxDoubletSource) &&
262                 ↪ _equalityComparer.Equals(copy[r + 1].Element, maxDoubletTarget))
263             {
264                 if (r > 0)
265                 {
266                     var previous = copy[w - 1].Element;
267                     copy[w - 1].DoubletData.DecrementFrequency();
268                     copy[w - 1].DoubletData =
269                         ↪ _doubletFrequenciesCache.IncrementFrequency(previous,
270                             ↪ maxDoubletReplacementLink);
271                 }
272                 if (r < oldLengthMinusTwo)
273                 {
274                     var next = copy[r + 2].Element;
275                     copy[r + 1].DoubletData.DecrementFrequency();
276                     copy[w].DoubletData = _doubletFrequenciesCache.IncrementFrequency(max
277                         ↪ xDoubletReplacementLink,
278                         ↪ next);
279                 }
280                 copy[w++].Element = maxDoubletReplacementLink;

```

```

274         r++;
275         newLength--;
276     }
277     else
278     {
279         copy[w++] = copy[r];
280     }
281 }
282 if (w < newLength)
283 {
284     copy[w] = copy[r];
285 }
286 oldLength = newLength;
287 ResetMaxDoublet();
288 UpdateMaxDoublet(copy, newLength);
289 }
290 return newLength;
291 }
292 [MethodImpl(MethodImplOptions.AggressiveInlining)]
293 private void ResetMaxDoublet()
294 {
295     _maxDoublet = new Doublet<TLinkAddress>();
296     _maxDoubletData = new LinkFrequency<TLinkAddress>();
297 }
298 [MethodImpl(MethodImplOptions.AggressiveInlining)]
299 private void UpdateMaxDoublet(HalfDoublet[] copy, int length)
300 {
301     Doublet<TLinkAddress> doublet = default;
302     for (var i = 1; i < length; i++)
303     {
304         doublet = new Doublet<TLinkAddress>(copy[i - 1].Element, copy[i].Element);
305         UpdateMaxDoublet(ref doublet, copy[i - 1].DoubletData);
306     }
307 }
308 [MethodImpl(MethodImplOptions.AggressiveInlining)]
309 private void UpdateMaxDoublet(ref Doublet<TLinkAddress> doublet,
310     ↪ LinkFrequency<TLinkAddress> data)
311 {
312     var frequency = data.Frequency;
313     var maxFrequency = _maxDoubletData.Frequency;
314     //if (frequency > _minFrequencyToCompress && (maxFrequency < frequency ||
315     ↪ (maxFrequency == frequency && doublet.Source + doublet.Target < /* gives better
316     ↪ compression string data (and gives collisions quickly) */ _maxDoublet.Source +
317     ↪ _maxDoublet.Target)))
318     if (_comparer.Compare(frequency, _minFrequencyToCompress) > 0 &&
319     ↪ (_comparer.Compare(maxFrequency, frequency) < 0 ||
320     ↪ (_equalityComparer.Equals(maxFrequency, frequency) &&
321     ↪ _comparer.Compare(Arithmetic.Add(doublet.Source, doublet.Target),
322     ↪ Arithmetic.Add(_maxDoublet.Source, _maxDoublet.Target)) > 0))) /* gives
323     ↪ better stability and better compression on sequent data and even on runderm
324     ↪ numbers data (but gives collisions anyway) */
325     {
326         _maxDoublet = doublet;
327         _maxDoubletData = data;
328     }
329 }
330 }
331 }
332 }

```

### 1.3 ./csharp/Platform.Data.Doublets.Sequences/Converters/LinksListToSequenceConverterBase.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Converters;
4
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Data.Doublets.Sequences.Converters
8 {
9     /// <summary>
10     /// <para>
11     /// Represents the links list to sequence converter base.
12     /// </para>
13     /// <para></para>
14     /// </summary>
15     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
16     /// <seealso cref="IConverter{IList{TLinkAddress}, TLinkAddress}"/>
17     public abstract class LinksListToSequenceConverterBase<TLinkAddress> :
18     ↪ LinksOperatorBase<TLinkAddress>, IConverter<IList<TLinkAddress>, TLinkAddress>
19     {

```

```

19     /// <summary>
20     /// <para>
21     /// Initializes a new <see cref="LinksListToSequenceConverterBase"/> instance.
22     /// </para>
23     /// <para></para>
24     /// </summary>
25     /// <param name="links">
26     /// <para>A links.</para>
27     /// <para></para>
28     /// </param>
29     [MethodImpl(MethodImplOptions.AggressiveInlining)]
30     protected LinksListToSequenceConverterBase(ILinks<TLinkAddress> links) : base(links) { }
31
32     /// <summary>
33     /// <para>
34     /// Converts the source.
35     /// </para>
36     /// <para></para>
37     /// </summary>
38     /// <param name="source">
39     /// <para>The source.</para>
40     /// <para></para>
41     /// </param>
42     /// <returns>
43     /// <para>The link</para>
44     /// <para></para>
45     /// </returns>
46     [MethodImpl(MethodImplOptions.AggressiveInlining)]
47     public abstract TLinkAddress Convert(IList<TLinkAddress>? source);
48 }
49 }

```

#### 1.4 ./csharp/Platform.Data.Doublets.Sequences/Converters/OptimalVariantConverter.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Collections.Lists;
4 using Platform.Converters;
5 using Platform.Data.Doublets.Sequences.Frequencies.Cache;
6 using Platform.Data.Doublets.Sequences.Frequencies.Counters;
7
8 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
9
10 namespace Platform.Data.Doublets.Sequences.Converters
11 {
12     /// <summary>
13     /// <para>
14     /// Represents the optimal variant converter.
15     /// </para>
16     /// <para></para>
17     /// </summary>
18     /// <seealso cref="LinksListToSequenceConverterBase{TLinkAddress}"/>
19     public class OptimalVariantConverter<TLinkAddress> :
20         ↳ LinksListToSequenceConverterBase<TLinkAddress>
21     {
22         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
23             ↳ EqualityComparer<TLinkAddress>.Default;
24         private static readonly Comparer<TLinkAddress> _comparer =
25             ↳ Comparer<TLinkAddress>.Default;
26         private readonly IConverter<IList<TLinkAddress>>
27             ↳ _sequenceToItsLocalElementLevelsConverter;
28
29         /// <summary>
30         /// <para>
31         /// Initializes a new <see cref="OptimalVariantConverter"/> instance.
32         /// </para>
33         /// <para></para>
34         /// </summary>
35         /// <param name="links">
36         /// <para>A links.</para>
37         /// <para></para>
38         /// </param>
39         /// <param name="sequenceToItsLocalElementLevelsConverter">
40         /// <para>A sequence to its local element levels converter.</para>
41         /// <para></para>
42         /// </param>
43         [MethodImpl(MethodImplOptions.AggressiveInlining)]
44         public OptimalVariantConverter(ILinks<TLinkAddress> links,
45             ↳ IConverter<IList<TLinkAddress>> sequenceToItsLocalElementLevelsConverter) :
46             ↳ base(links)

```

```

41     => _sequenceToItsLocalElementLevelsConverter =
42         ↳ sequenceToItsLocalElementLevelsConverter;
43
44     /// <summary>
45     /// <para>
46     /// Initializes a new <see cref="OptimalVariantConverter"/> instance.
47     /// </para>
48     /// </summary>
49     /// <param name="links">
50     /// <para>A links.</para>
51     /// </para>
52     /// </param>
53     /// <param name="linkFrequenciesCache">
54     /// <para>A link frequencies cache.</para>
55     /// </param>
56     [MethodImpl(MethodImplOptions.AggressiveInlining)]
57     public OptimalVariantConverter(ILinks<TLinkAddress> links,
58         ↳ LinkFrequenciesCache<TLinkAddress> linkFrequenciesCache)
59         : this(links, new SequenceToItsLocalElementLevelsConverter<TLinkAddress>(links, new
60             ↳ FrequenciesCacheBasedLinkToItsFrequencyNumberConverter<TLinkAddress>(linkFrequen
61             ↳ ciesCache))) {
62         ↳ }
63
64     /// <summary>
65     /// <para>
66     /// Initializes a new <see cref="OptimalVariantConverter"/> instance.
67     /// </para>
68     /// </summary>
69     /// <param name="links">
70     /// <para>A links.</para>
71     /// </para>
72     /// </param>
73     [MethodImpl(MethodImplOptions.AggressiveInlining)]
74     public OptimalVariantConverter(ILinks<TLinkAddress> links)
75         : this(links, new LinkFrequenciesCache<TLinkAddress>(links, new
76             ↳ TotalSequenceSymbolFrequencyCounter<TLinkAddress>(links))) { }
77
78     /// <summary>
79     /// <para>
80     /// Converts the sequence.
81     /// </para>
82     /// </summary>
83     /// <param name="sequence">
84     /// <para>The sequence.</para>
85     /// </para>
86     /// </param>
87     /// <returns>
88     /// <para>The link</para>
89     /// </returns>
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     public override TLinkAddress Convert(IList<TLinkAddress>? sequence)
92     {
93         var length = sequence.Count;
94         if (length == 1)
95         {
96             return sequence[0];
97         }
98         if (length == 2)
99         {
100             return _links.GetOrCreate(sequence[0], sequence[1]);
101         }
102         sequence = sequence.ToArray();
103         var levels = _sequenceToItsLocalElementLevelsConverter.Convert(sequence);
104         while (length > 2)
105         {
106             var levelRepeat = 1;
107             var currentLevel = levels[0];
108             var previousLevel = levels[0];
109             var skipOnce = false;
110             var w = 0;
111             for (var i = 1; i < length; i++)
112             {
113                 if (_equalityComparer.Equals(currentLevel, levels[i]))

```



```

113     {
114         levelRepeat++;
115         skipOnce = false;
116         if (levelRepeat == 2)
117         {
118             sequence[w] = _links.GetOrCreate(sequence[i - 1], sequence[i]);
119             var newLevel = i >= length - 1 ?
120                 GetPreviousLowerThanCurrentOrCurrent(previousLevel,
121                     ↪ currentLevel) :
122                 i < 2 ?
123                 GetNextLowerThanCurrentOrCurrent(currentLevel, levels[i + 1]) :
124                 GetGreatestNeighbourLowerThanCurrentOrCurrent(previousLevel,
125                     ↪ currentLevel, levels[i + 1]);
126             levels[w] = newLevel;
127             previousLevel = currentLevel;
128             w++;
129             levelRepeat = 0;
130             skipOnce = true;
131         }
132         else if (i == length - 1)
133         {
134             sequence[w] = sequence[i];
135             levels[w] = levels[i];
136             w++;
137         }
138     }
139     else
140     {
141         currentLevel = levels[i];
142         levelRepeat = 1;
143         if (skipOnce)
144         {
145             skipOnce = false;
146         }
147         else
148         {
149             sequence[w] = sequence[i - 1];
150             levels[w] = levels[i - 1];
151             previousLevel = levels[w];
152             w++;
153         }
154         if (i == length - 1)
155         {
156             sequence[w] = sequence[i];
157             levels[w] = levels[i];
158             w++;
159         }
160     }
161     }
162     length = w;
163     return _links.GetOrCreate(sequence[0], sequence[1]);
164 }
165 [MethodImpl(MethodImplOptions.AggressiveInlining)]
166 private static TLinkAddress GetGreatestNeighbourLowerThanCurrentOrCurrent(TLinkAddress
167     ↪ previous, TLinkAddress current, TLinkAddress next)
168 {
169     return _comparer.Compare(previous, next) > 0
170         ? _comparer.Compare(previous, current) < 0 ? previous : current
171         : _comparer.Compare(next, current) < 0 ? next : current;
172 }
173 [MethodImpl(MethodImplOptions.AggressiveInlining)]
174 private static TLinkAddress GetNextLowerThanCurrentOrCurrent(TLinkAddress current,
175     ↪ TLinkAddress next) => _comparer.Compare(next, current) < 0 ? next : current;
176 [MethodImpl(MethodImplOptions.AggressiveInlining)]
177 private static TLinkAddress GetPreviousLowerThanCurrentOrCurrent(TLinkAddress previous,
178     ↪ TLinkAddress current) => _comparer.Compare(previous, current) < 0 ? previous :
179     ↪ current;
180 }
181 }

```

## 1.5 ./csharp/Platform.Data.Doublets.Sequences/Converters/SequenceToltsLocalElementLevelsConverter.cs

```

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

```

```

8 {
9     /// <summary>
10    /// <para>
11    /// Represents the sequence to its local element levels converter.
12    /// </para>
13    /// <para></para>
14    /// </summary>
15    /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
16    /// <seealso cref="IConverter{IList{TLinkAddress}}"/>
17    public class SequenceToItsLocalElementLevelsConverter<TLinkAddress> :
18    ↪ LinksOperatorBase<TLinkAddress>, IConverter<IList<TLinkAddress>>
19    {
20        private static readonly Comparer<TLinkAddress> _comparer =
21        ↪ Comparer<TLinkAddress>.Default;
22        private readonly IConverter<Doublet<TLinkAddress>, TLinkAddress>
23        ↪ _linkToItsFrequencyToNumberConveter;
24
25        /// <summary>
26        /// <para>
27        /// Initializes a new <see cref="SequenceToItsLocalElementLevelsConverter"/> instance.
28        /// </para>
29        /// <para></para>
30        /// </summary>
31        /// <param name="links">
32        /// <para>A links.</para>
33        /// <para></para>
34        /// </param>
35        /// <param name="linkToItsFrequencyToNumberConveter">
36        /// <para>A link to its frequency to number conveter.</para>
37        /// <para></para>
38        /// </param>
39        [MethodImpl(MethodImplOptions.AggressiveInlining)]
40        public SequenceToItsLocalElementLevelsConverter(ILinks<TLinkAddress> links,
41        ↪ IConverter<Doublet<TLinkAddress>, TLinkAddress> linkToItsFrequencyToNumberConveter)
42        ↪ : base(links) => _linkToItsFrequencyToNumberConveter =
43        ↪ linkToItsFrequencyToNumberConveter;
44
45        /// <summary>
46        /// <para>
47        /// Converts the sequence.
48        /// </para>
49        /// <para></para>
50        /// </summary>
51        /// <param name="sequence">
52        /// <para>The sequence.</para>
53        /// <para></para>
54        /// </param>
55        /// <returns>
56        /// <para>The levels.</para>
57        /// <para></para>
58        /// </returns>
59        [MethodImpl(MethodImplOptions.AggressiveInlining)]
60        public IList<TLinkAddress>? Convert(IList<TLinkAddress>? sequence)
61        {
62            var levels = new TLinkAddress[sequence.Count];
63            levels[0] = GetFrequencyNumber(sequence[0], sequence[1]);
64            for (var i = 1; i < sequence.Count - 1; i++)
65            {
66                var previous = GetFrequencyNumber(sequence[i - 1], sequence[i]);
67                var next = GetFrequencyNumber(sequence[i], sequence[i + 1]);
68                levels[i] = _comparer.Compare(previous, next) > 0 ? previous : next;
69            }
70            levels[levels.Length - 1] = GetFrequencyNumber(sequence[sequence.Count - 2],
71            ↪ sequence[sequence.Count - 1]);
72            return levels;
73        }
74
75        /// <summary>
76        /// <para>
77        /// Gets the frequency number using the specified source.
78        /// </para>
79        /// <para></para>
80        /// </summary>
81        /// <param name="source">
82        /// <para>The source.</para>
83        /// <para></para>
84        /// </param>
85        /// <param name="target">

```

```

79     /// <para>The target.</para>
80     /// <para></para>
81     /// </param>
82     /// <returns>
83     /// <para>The link</para>
84     /// <para></para>
85     /// </returns>
86     [MethodImpl(MethodImplOptions.AggressiveInlining)]
87     public TLinkAddress GetFrequencyNumber(TLinkAddress source, TLinkAddress target) =>
88         ↪ _linkToItsFrequencyToNumberConveter.Convert(new Doublet<TLinkAddress>(source,
89         ↪ target));
88 }
89 }

```

## 1.6 ./csharp/Platform.Data.Doublets.Sequences/CriterionMatchers/DefaultSequenceElementCriterionMatcher.cs

```

1  using System.Runtime.CompilerServices;
2  using Platform.Interfaces;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Data.Doublets.Sequences.CriterionMatchers
7  {
8      /// <summary>
9      /// <para>
10     /// Represents the default sequence element criterion matcher.
11     /// </para>
12     /// <para></para>
13     /// </summary>
14     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
15     /// <seealso cref="ICriterionMatcher{TLinkAddress}"/>
16     public class DefaultSequenceElementCriterionMatcher<TLinkAddress> :
17         ↪ LinksOperatorBase<TLinkAddress>, ICriterionMatcher<TLinkAddress>
18     {
19         /// <summary>
20         /// <para>
21         /// Initializes a new <see cref="DefaultSequenceElementCriterionMatcher"/> instance.
22         /// </para>
23         /// <para></para>
24         /// </summary>
25         /// <param name="links">
26         /// <para>A links.</para>
27         /// <para></para>
28         /// </param>
29         [MethodImpl(MethodImplOptions.AggressiveInlining)]
30         public DefaultSequenceElementCriterionMatcher(ILinks<TLinkAddress> links) : base(links)
31             ↪ { }
32
33         /// <summary>
34         /// <para>
35         /// Determines whether this instance is matched.
36         /// </para>
37         /// <para></para>
38         /// </summary>
39         /// <param name="argument">
40         /// <para>The argument.</para>
41         /// <para></para>
42         /// </param>
43         /// <returns>
44         /// <para>The bool</para>
45         /// <para></para>
46         /// </returns>
47         [MethodImpl(MethodImplOptions.AggressiveInlining)]
48         public bool IsMatched(TLinkAddress argument) => _links.IsPartialPoint(argument);
49     }
50 }

```

## 1.7 ./csharp/Platform.Data.Doublets.Sequences/CriterionMatchers/MarkedSequenceCriterionMatcher.cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3  using Platform.Interfaces;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Data.Doublets.Sequences.CriterionMatchers
8  {
9      /// <summary>
10     /// <para>
11     /// Represents the marked sequence criterion matcher.

```

```

12  /// </para>
13  /// <para></para>
14  /// </summary>
15  /// <seealso cref="ICriterionMatcher{TLinkAddress}"/>
16  public class MarkedSequenceCriterionMatcher<TLinkAddress> : ICriterionMatcher<TLinkAddress>
17  {
18      private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
19          ↪ EqualityComparer<TLinkAddress>.Default;
20      private readonly ILinks<TLinkAddress> _links;
21      private readonly TLinkAddress _sequenceMarkerLink;
22
23      /// <summary>
24      /// <para>
25      /// Initializes a new <see cref="MarkedSequenceCriterionMatcher"/> instance.
26      /// </para>
27      /// <para></para>
28      /// </summary>
29      /// <param name="links">
30      /// <para>A links.</para>
31      /// </param>
32      /// <param name="sequenceMarkerLink">
33      /// <para>A sequence marker link.</para>
34      /// </param>
35      [MethodImpl(MethodImplOptions.AggressiveInlining)]
36      public MarkedSequenceCriterionMatcher(ILinks<TLinkAddress> links, TLinkAddress
37          ↪ sequenceMarkerLink)
38      {
39          _links = links;
40          _sequenceMarkerLink = sequenceMarkerLink;
41      }
42
43      /// <summary>
44      /// <para>
45      /// Determines whether this instance is matched.
46      /// </para>
47      /// <para></para>
48      /// </summary>
49      /// <param name="sequenceCandidate">
50      /// <para>The sequence candidate.</para>
51      /// </param>
52      /// <returns>
53      /// <para>The bool</para>
54      /// <para></para>
55      /// </returns>
56      [MethodImpl(MethodImplOptions.AggressiveInlining)]
57      public bool IsMatched(TLinkAddress sequenceCandidate)
58          => _equalityComparer.Equals(_links.GetSource(sequenceCandidate), _sequenceMarkerLink)
59          || !_equalityComparer.Equals(_links.SearchOrDefault(_sequenceMarkerLink,
60          ↪ sequenceCandidate), _links.Constants.Null);
61  }
62  }

```

## 1.8 ./csharp/Platform.Data.Doublets.Sequences/CriterionMatchers/UnicodeSequenceMatcher.cs

```

1  using System.Collections.Generic;
2  using Platform.Interfaces;
3
4  namespace Platform.Data.Doublets.Sequences.CriterionMatchers;
5
6  public class UnicodeSequenceMatcher<TLinkAddress> : ICriterionMatcher<TLinkAddress>
7  {
8      public readonly ILinks<TLinkAddress> Storage;
9      public readonly TLinkAddress UnicodeSequenceMarker;
10     public readonly EqualityComparer<TLinkAddress> EqualityComparer =
11         ↪ EqualityComparer<TLinkAddress>.Default;
12     public UnicodeSequenceMatcher(ILinks<TLinkAddress> storage, TLinkAddress
13         ↪ unicodeSequenceMarker)
14     {
15         Storage = storage;
16         UnicodeSequenceMarker = unicodeSequenceMarker;
17     }
18     public bool IsMatched(TLinkAddress argument)
19     {
20         var target = Storage.GetTarget(argument);
21         return EqualityComparer.Equals(UnicodeSequenceMarker, argument) ||
22             ↪ EqualityComparer.Equals(UnicodeSequenceMarker, target);
23     }
24 }

```

21 }

## 1.9 ./csharp/Platform.Data.Doublets.Sequences/DefaultSequenceAppender.cs

```
1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Collections.Stacks;
4 using Platform.Data.Doublets.Sequences.HeightProviders;
5 using Platform.Data.Sequences;
6
7 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9 namespace Platform.Data.Doublets.Sequences
10 {
11     /// <summary>
12     /// <para>
13     /// Represents the default sequence appender.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
18     /// <seealso cref="ISequenceAppender{TLinkAddress}"/>
19     public class DefaultSequenceAppender<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
20         ↳ ISequenceAppender<TLinkAddress>
21     {
22         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
23             ↳ EqualityComparer<TLinkAddress>.Default;
24         private readonly IStack<TLinkAddress> _stack;
25         private readonly ISequenceHeightProvider<TLinkAddress> _heightProvider;
26
27         /// <summary>
28         /// <para>
29         /// Initializes a new <see cref="DefaultSequenceAppender"/> instance.
30         /// </para>
31         /// <para></para>
32         /// </summary>
33         /// <param name="links">
34         /// <para>A links.</para>
35         /// <para></para>
36         /// </param>
37         /// <param name="stack">
38         /// <para>A stack.</para>
39         /// <para></para>
40         /// </param>
41         /// <param name="heightProvider">
42         /// <para>A height provider.</para>
43         /// <para></para>
44         /// </param>
45         [MethodImpl(MethodImplOptions.AggressiveInlining)]
46         public DefaultSequenceAppender(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack,
47             ↳ ISequenceHeightProvider<TLinkAddress> heightProvider)
48             : base(links)
49         {
50             _stack = stack;
51             _heightProvider = heightProvider;
52         }
53
54         /// <summary>
55         /// <para>
56         /// Appends the sequence.
57         /// </para>
58         /// <para></para>
59         /// </summary>
60         /// <param name="sequence">
61         /// <para>The sequence.</para>
62         /// <para></para>
63         /// </param>
64         /// <param name="appendant">
65         /// <para>The appendant.</para>
66         /// <para></para>
67         /// </param>
68         /// <returns>
69         /// <para>The link</para>
70         /// <para></para>
71         /// </returns>
72         [MethodImpl(MethodImplOptions.AggressiveInlining)]
73         public TLinkAddress Append(TLinkAddress sequence, TLinkAddress appendant)
74         {
75             var cursor = sequence;
76             var links = _links;
```

```

74     while (!_equalityComparer.Equals(_heightProvider.Get(cursor), default))
75     {
76         var source = links.GetSource(cursor);
77         var target = links.GetTarget(cursor);
78         if (_equalityComparer.Equals(_heightProvider.Get(source),
79             ↪ _heightProvider.Get(target)))
80         {
81             break;
82         }
83         else
84         {
85             _stack.Push(source);
86             cursor = target;
87         }
88     }
89     var left = cursor;
90     var right = appendant;
91     while (!_equalityComparer.Equals(cursor = _stack.PopOrDefault(),
92         ↪ links.Constants.Null))
93     {
94         right = links.GetOrCreate(left, right);
95         left = cursor;
96     }
97     return links.GetOrCreate(left, right);
98 }

```

#### 1.10 ./csharp/Platform.Data.Doublets.Sequences/DuplicateSegmentsCounter.cs

```

1  using System.Collections.Generic;
2  using System.Linq;
3  using System.Runtime.CompilerServices;
4  using Platform.Interfaces;
5
6  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8  namespace Platform.Data.Doublets.Sequences
9  {
10     /// <summary>
11     /// <para>
12     /// Represents the duplicate segments counter.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="ICounter{int}"/>
17     public class DuplicateSegmentsCounter<TLinkAddress> : ICounter<int>
18     {
19         private readonly IProvider<IList<KeyValuePair<IList<TLinkAddress>?,
20             ↪ IList<TLinkAddress>?>>> _duplicateFragmentsProvider;
21
22         /// <summary>
23         /// <para>
24         /// Initializes a new <see cref="DuplicateSegmentsCounter"/> instance.
25         /// </para>
26         /// <para></para>
27         /// </summary>
28         /// <param name="duplicateFragmentsProvider">
29         /// <para>A duplicate fragments provider.</para>
30         /// <para></para>
31         /// </param>
32         [MethodImpl(MethodImplOptions.AggressiveInlining)]
33         public DuplicateSegmentsCounter(IProvider<IList<KeyValuePair<IList<TLinkAddress>?,
34             ↪ IList<TLinkAddress>?>>> duplicateFragmentsProvider) => _duplicateFragmentsProvider =
35             ↪ duplicateFragmentsProvider;
36
37         /// <summary>
38         /// <para>
39         /// Counts this instance.
40         /// </para>
41         /// <para></para>
42         /// </summary>
43         /// <returns>
44         /// <para>The int</para>
45         /// <para></para>
46         /// </returns>
47         [MethodImpl(MethodImplOptions.AggressiveInlining)]
48         public int Count() => _duplicateFragmentsProvider.Get().Sum(x => x.Value.Count);
49     }
50 }

```

## 1.11 ./csharp/Platform.Data.Doublets.Sequences/DuplicateSegmentsProvider.cs

```

1  // using System;
2  // using System.Linq;
3  // using System.Collections.Generic;
4  // using System.Runtime.CompilerServices;
5  // using Platform.Interfaces;
6  // using Platform.Collections;
7  // using Platform.Collections.Lists;
8  // using Platform.Collections.Segments;
9  // using Platform.Collections.Segments.Walkers;
10 // using Platform.Singletons;
11 // using Platform.Converters;
12 // using Platform.Data.Doublets.Unicode;
13 //
14 // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
15 //
16 // namespace Platform.Data.Doublets.Sequences
17 // {
18 //     /// <summary>
19 //     /// <para>
20 //     /// Represents the duplicate segments provider.
21 //     /// </para>
22 //     /// <para></para>
23 //     /// </summary>
24 //     /// <seealso cref="DictionaryBasedDuplicateSegmentsWalkerBase{TLinkAddress}"/>
25 //     /// <seealso cref="IProvider{IList{KeyValuePair{IList{TLinkAddress},
    ↪ IList{TLinkAddress}}}" />
26 //     public class DuplicateSegmentsProvider<TLinkAddress> :
    ↪ DictionaryBasedDuplicateSegmentsWalkerBase<TLinkAddress>,
    ↪ IProvider<IList<KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?>>>
27 //     {
28 //         private static readonly UncheckedConverter<TLinkAddress, long>
    ↪ _addressToInt64Converter = UncheckedConverter<TLinkAddress, long>.Default;
29 //         private static readonly UncheckedConverter<TLinkAddress, ulong>
    ↪ _addressToUInt64Converter = UncheckedConverter<TLinkAddress, ulong>.Default;
30 //         private static readonly UncheckedConverter<ulong, TLinkAddress>
    ↪ _uInt64ToAddressConverter = UncheckedConverter<ulong, TLinkAddress>.Default;
31 //         private readonly IList<TLinkAddress> _links;
32 //         private readonly IList<TLinkAddress> _sequences;
33 //         private HashSet<KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?>> _groups;
34 //         private BitString _visited;
35 //         private class ItemEquilityComparer :
    ↪ IEqualityComparer<KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?>>
36 //         {
37 //             private readonly IListEqualityComparer<TLinkAddress> _listComparer;
38 //
39 //             /// <summary>
40 //             /// <para>
41 //             /// Initializes a new <see cref="ItemEquilityComparer"/> instance.
42 //             /// </para>
43 //             /// <para></para>
44 //             /// </summary>
45 //             public ItemEquilityComparer() => _listComparer =
    ↪ Default<IListEqualityComparer<TLinkAddress>>.Instance;
46 //
47 //             /// <summary>
48 //             /// <para>
49 //             /// Determines whether this instance equals.
50 //             /// </para>
51 //             /// <para></para>
52 //             /// </summary>
53 //             /// <param name="left">
54 //             /// <para>The left.</para>
55 //             /// <para></para>
56 //             /// </param>
57 //             /// <param name="right">
58 //             /// <para>The right.</para>
59 //             /// <para></para>
60 //             /// </param>
61 //             /// <returns>
62 //             /// <para>The bool</para>
63 //             /// <para></para>
64 //             /// </returns>
65 //             [MethodImpl(MethodImplOptions.AggressiveInlining)]
66 //             public bool Equals(KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?> left,
    ↪ KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?> right) =>
    ↪ _listComparer.Equals(left.Key, right.Key) && _listComparer.Equals(left.Value, right.Value);

```

```

67 //
68 //          /// <summary>
69 //          /// <para>
70 //          /// Gets the hash code using the specified pair.
71 //          /// </para>
72 //          /// <para></para>
73 //          /// </summary>
74 //          /// <param name="pair">
75 //          /// <para>The pair.</para>
76 //          /// <para></para>
77 //          /// </param>
78 //          /// <returns>
79 //          /// <para>The int</para>
80 //          /// <para></para>
81 //          /// </returns>
82 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
83 //          public int GetHashCode(KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?>
↵ pair) => (_listComparer.GetHashCode(pair.Key),
↵ _listComparer.GetHashCode(pair.Value)).GetHashCode();
84 //          }
85 //          private class ItemComparer : IComparer<KeyValuePair<IList<TLinkAddress>?,
↵ IList<TLinkAddress>?>>
86 //          {
87 //              private readonly IListComparer<TLinkAddress> _listComparer;
88 //
89 //              /// <summary>
90 //              /// <para>
91 //              /// Initializes a new <see cref="ItemComparer"/> instance.
92 //              /// </para>
93 //              /// <para></para>
94 //              /// </summary>
95 //              [MethodImpl(MethodImplOptions.AggressiveInlining)]
96 //              public ItemComparer() => _listComparer =
↵ Default<IListComparer<TLinkAddress>>.Instance;
97 //
98 //              /// <summary>
99 //              /// <para>
100 //              /// Compares the left.
101 //              /// </para>
102 //              /// <para></para>
103 //              /// </summary>
104 //              /// <param name="left">
105 //              /// <para>The left.</para>
106 //              /// <para></para>
107 //              /// </param>
108 //              /// <param name="right">
109 //              /// <para>The right.</para>
110 //              /// <para></para>
111 //              /// </param>
112 //              /// <returns>
113 //              /// <para>The intermediate result.</para>
114 //              /// <para></para>
115 //              /// </returns>
116 //              [MethodImpl(MethodImplOptions.AggressiveInlining)]
117 //              public int Compare(KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?> left,
↵ KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?> right)
118 //              {
119 //                  var intermediateResult = _listComparer.Compare(left.Key, right.Key);
120 //                  if (intermediateResult == 0)
121 //                  {
122 //                      intermediateResult = _listComparer.Compare(left.Value, right.Value);
123 //                  }
124 //                  return intermediateResult;
125 //              }
126 //          }
127 //
128 //          /// <summary>
129 //          /// <para>
130 //          /// Initializes a new <see cref="DuplicateSegmentsProvider"/> instance.
131 //          /// </para>
132 //          /// <para></para>
133 //          /// </summary>
134 //          /// <param name="links">
135 //          /// <para>A links.</para>
136 //          /// <para></para>
137 //          /// </param>
138 //          /// <param name="sequences">

```



```

139 //      /// <para>A sequences.</para>
140 //      /// <para></para>
141 //      /// </param>
142 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
143 //      public DuplicateSegmentsProvider(ILinks<TLinkAddress> links, ILinks<TLinkAddress>
↵ sequences)
144 //          : base(minimumStringSegmentLength: 2)
145 //      {
146 //          _links = links;
147 //          _sequences = sequences;
148 //      }
149 //
150 //      /// <summary>
151 //      /// <para>
152 //      /// Gets this instance.
153 //      /// </para>
154 //      /// <para></para>
155 //      /// </summary>
156 //      /// <returns>
157 //      /// <para>The result list.</para>
158 //      /// <para></para>
159 //      /// </returns>
160 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
161 //      public IList<KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?>> Get()
162 //      {
163 //          _groups = new HashSet<KeyValuePair<IList<TLinkAddress>?,
↵ IList<TLinkAddress>?>>(Default<ItemEquilityComparer>.Instance);
164 //          var links = _links;
165 //          var count = links.Count();
166 //          _visited = new BitString(_addressToInt64Converter.Convert(count) + 1L);
167 //          links.Each(link =>
168 //          {
169 //              var linkIndex = links.GetIndex(link);
170 //              var linkBitIndex = _addressToInt64Converter.Convert(linkIndex);
171 //              var constants = links.Constants;
172 //              if (!_visited.Get(linkBitIndex))
173 //              {
174 //                  var sequenceElements = new List<TLinkAddress>();
175 //                  var filler = new ListFiller<TLinkAddress, TLinkAddress>(sequenceElements,
↵ constants.Break);
176 //                  _sequences.Each(filler.AddSkipFirstAndReturnConstant, new
↵ LinkAddress<TLinkAddress>(linkIndex));
177 //                  if (sequenceElements.Count > 2)
178 //                  {
179 //                      WalkAll(sequenceElements);
180 //                  }
181 //                  return constants.Continue;
182 //              });
183 //              var resultList = _groups.ToList();
184 //              var comparer = Default<ItemComparer>.Instance;
185 //              resultList.Sort(comparer);
186 //              #if DEBUG
187 //              foreach (var item in resultList)
188 //              {
189 //                  PrintDuplicates(item);
190 //              }
191 //              #endif
192 //              return resultList;
193 //          }
194 //
195 //      /// <summary>
196 //      /// <para>
197 //      /// Creates the segment using the specified elements.
198 //      /// </para>
199 //      /// <para></para>
200 //      /// </summary>
201 //      /// <param name="elements">
202 //      /// <para>The elements.</para>
203 //      /// <para></para>
204 //      /// </param>
205 //      /// <param name="offset">
206 //      /// <para>The offset.</para>
207 //      /// <para></para>
208 //      /// </param>
209 //      /// <param name="length">
210 //      /// <para>The length.</para>
211 //

```

```

212 //          /// <para></para>
213 //          /// </param>
214 //          /// <returns>
215 //          /// <para>A segment of t link</para>
216 //          /// <para></para>
217 //          /// </returns>
218 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
219 //          protected override Segment<TLinkAddress> CreateSegment(IList<TLinkAddress>? elements,
↵ int offset, int length) => new Segment<TLinkAddress>(elements, offset, length);
220 //
221 //          /// <summary>
222 //          /// <para>
223 //          /// Ons the dubuplicate found using the specified segment.
224 //          /// </para>
225 //          /// <para></para>
226 //          /// </summary>
227 //          /// <param name="segment">
228 //          /// <para>The segment.</para>
229 //          /// <para></para>
230 //          /// </param>
231 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
232 //          protected override void OnDubuplicateFound(Segment<TLinkAddress> segment)
233 //          {
234 //              var duplicates = CollectDuplicatesForSegment(segment);
235 //              if (duplicates.Count > 1)
236 //              {
237 //                  _groups.Add(new KeyValuePair<IList<TLinkAddress>?,
↵ IList<TLinkAddress>?>(segment.ToArray(), duplicates));
238 //              }
239 //          }
240 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
241 //          private List<TLinkAddress> CollectDuplicatesForSegment(Segment<TLinkAddress> segment)
242 //          {
243 //              var duplicates = new List<TLinkAddress>();
244 //              var readAsElement = new HashSet<TLinkAddress>();
245 //              var restrictions = segment.ShiftRight();
246 //              var constants = _links.Constants;
247 //              restrictions[0] = constants.Any;
248 //              _sequences.Each(restrictions, sequence =>
249 //              {
250 //                  var sequenceIndex = sequence[constants.IndexPart];
251 //                  duplicates.Add(sequenceIndex);
252 //                  readAsElement.Add(sequenceIndex);
253 //                  return constants.Continue;
254 //              });
255 //              if (duplicates.Any(x => _visited.Get(_addressToInt64Converter.Convert(x))))
256 //              {
257 //                  return new List<TLinkAddress>();
258 //              }
259 //              foreach (var duplicate in duplicates)
260 //              {
261 //                  var duplicateBitIndex = _addressToInt64Converter.Convert(duplicate);
262 //                  _visited.Set(duplicateBitIndex);
263 //              }
264 //              if (_sequences is Sequences sequencesExperiments)
265 //              {
266 //                  var partiallyMatched = sequencesExperiments.GetAllPartiallyMatchingSequences4_1
↵ ((HashSet<ulong>)(object)readAsElement,
↵ (IList<ulong>)segment);
267 //                  foreach (var partiallyMatchedSequence in partiallyMatched)
268 //                  {
269 //                      var sequenceIndex =
↵ _uInt64ToAddressConverter.Convert(partiallyMatchedSequence);
270 //                      duplicates.Add(sequenceIndex);
271 //                  }
272 //              }
273 //              duplicates.Sort();
274 //              return duplicates;
275 //          }
276 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
277 //          private void PrintDuplicates(KeyValuePair<IList<TLinkAddress>?, IList<TLinkAddress>?>
↵ duplicatesItem)
278 //          {
279 //              if (!(_links is ILinks<ulong> ulongLinks))
280 //              {
281 //                  return;
282 //              }

```

```

283 //         var duplicatesKey = duplicatesItem.Key;
284 //         var keyString = UnicodeMap.FromLinksToString((IList<ulong>)duplicatesKey);
285 //         Console.WriteLine($"> {keyString} ({string.Join(", ", duplicatesKey)})");
286 //         var duplicatesList = duplicatesItem.Value;
287 //         for (int i = 0; i < duplicatesList.Count; i++)
288 //         {
289 //             var sequenceIndex = _addressToUInt64Converter.Convert(duplicatesList[i]);
290 //             var formattedSequenceStructure = ulongLinks.FormatStructure(sequenceIndex, x
↳ => Point<ulong>.IsPartialPoint(x), (sb, link) => _ = UnicodeMap.IsCharLink(link.Index) ?
↳ sb.Append(UnicodeMap.FromLinkToChar(link.Index)) : sb.Append(link.Index));
291 //             Console.WriteLine(formattedSequenceStructure);
292 //             var sequenceString = UnicodeMap.FromSequenceLinkToString(sequenceIndex,
↳ ulongLinks);
293 //             Console.WriteLine(sequenceString);
294 //         }
295 //         Console.WriteLine();
296 //     }
297 // }
298 // }

```

## 1.12 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Cache/LinkFrequenciesCache.cs

```

1 using System;
2 using System.Collections.Generic;
3 using System.Runtime.CompilerServices;
4 using Platform.Interfaces;
5 using Platform.Numbers;
6
7 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9 namespace Platform.Data.Doublets.Sequences.Frequencies.Cache
10 {
11     /// <remarks>
12     /// Can be used to operate with many CompressingConverters (to keep global frequencies data
↳ between them).
13     /// TODO: Extract interface to implement frequencies storage inside Links storage
14     /// </remarks>
15     public class LinkFrequenciesCache<TLinkAddress> : LinksOperatorBase<TLinkAddress>
16     {
17         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
↳ EqualityComparer<TLinkAddress>.Default;
18         private static readonly Comparer<TLinkAddress> _comparer =
↳ Comparer<TLinkAddress>.Default;
19         private static readonly TLinkAddress _zero = default;
20         private static readonly TLinkAddress _one = Arithmetic.Increment(_zero);
21         private readonly Dictionary<Doublet<TLinkAddress>, LinkFrequency<TLinkAddress>>
↳ _doubletsCache;
22         private readonly ICounter<TLinkAddress, TLinkAddress> _frequencyCounter;
23
24         /// <summary>
25         /// <para>
26         /// Initializes a new <see cref="LinkFrequenciesCache"/> instance.
27         /// </para>
28         /// <para></para>
29         /// </summary>
30         /// <param name="links">
31         /// <para>A links.</para>
32         /// <para></para>
33         /// </param>
34         /// <param name="frequencyCounter">
35         /// <para>A frequency counter.</para>
36         /// <para></para>
37         /// </param>
38         [MethodImpl(MethodImplOptions.AggressiveInlining)]
39         public LinkFrequenciesCache(ILinks<TLinkAddress> links, ICounter<TLinkAddress,
↳ TLinkAddress> frequencyCounter)
40             : base(links)
41         {
42             _doubletsCache = new Dictionary<Doublet<TLinkAddress>,
↳ LinkFrequency<TLinkAddress>>(4096, DoubletComparer<TLinkAddress>.Default);
43             _frequencyCounter = frequencyCounter;
44         }
45
46         /// <summary>
47         /// <para>
48         /// Gets the frequency using the specified source.
49         /// </para>
50         /// <para></para>
51         /// </summary>
52         /// <param name="source">

```

```

53     /// <para>The source.</para>
54     /// <para></para>
55     /// </param>
56     /// <param name="target">
57     /// <para>The target.</para>
58     /// <para></para>
59     /// </param>
60     /// <returns>
61     /// <para>A link frequency of t link</para>
62     /// <para></para>
63     /// </returns>
64     [MethodImpl(MethodImplOptions.AggressiveInlining)]
65     public LinkFrequency<TLinkAddress> GetFrequency(TLinkAddress source, TLinkAddress target)
66     {
67         var doublet = new Doublet<TLinkAddress>(source, target);
68         return GetFrequency(ref doublet);
69     }
70
71     /// <summary>
72     /// <para>
73     /// Gets the frequency using the specified doublet.
74     /// </para>
75     /// <para></para>
76     /// </summary>
77     /// <param name="doublet">
78     /// <para>The doublet.</para>
79     /// <para></para>
80     /// </param>
81     /// <returns>
82     /// <para>The data.</para>
83     /// <para></para>
84     /// </returns>
85     [MethodImpl(MethodImplOptions.AggressiveInlining)]
86     public LinkFrequency<TLinkAddress> GetFrequency(ref Doublet<TLinkAddress> doublet)
87     {
88         _doubletsCache.TryGetValue(doublet, out LinkFrequency<TLinkAddress> data);
89         return data;
90     }
91
92     /// <summary>
93     /// <para>
94     /// Increments the frequencies using the specified sequence.
95     /// </para>
96     /// <para></para>
97     /// </summary>
98     /// <param name="sequence">
99     /// <para>The sequence.</para>
100    /// <para></para>
101    /// </param>
102    [MethodImpl(MethodImplOptions.AggressiveInlining)]
103    public void IncrementFrequencies(ICollection<TLinkAddress>? sequence)
104    {
105        for (var i = 1; i < sequence.Count; i++)
106        {
107            IncrementFrequency(sequence[i - 1], sequence[i]);
108        }
109    }
110
111    /// <summary>
112    /// <para>
113    /// Increments the frequency using the specified source.
114    /// </para>
115    /// <para></para>
116    /// </summary>
117    /// <param name="source">
118    /// <para>The source.</para>
119    /// <para></para>
120    /// </param>
121    /// <param name="target">
122    /// <para>The target.</para>
123    /// <para></para>
124    /// </param>
125    /// <returns>
126    /// <para>A link frequency of t link</para>
127    /// <para></para>
128    /// </returns>
129    [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

130 public LinkFrequency<TLinkAddress> IncrementFrequency(TLinkAddress source, TLinkAddress
    ↪ target)
131 {
132     var doublet = new Doublet<TLinkAddress>(source, target);
133     return IncrementFrequency(ref doublet);
134 }
135
136 /// <summary>
137 /// <para>
138 /// Prints the frequencies using the specified sequence.
139 /// </para>
140 /// <para></para>
141 /// </summary>
142 /// <param name="sequence">
143 /// <para>The sequence.</para>
144 /// <para></para>
145 /// </param>
146 [MethodImpl(MethodImplOptions.AggressiveInlining)]
147 public void PrintFrequencies(ICollection<TLinkAddress>? sequence)
148 {
149     for (var i = 1; i < sequence.Count; i++)
150     {
151         PrintFrequency(sequence[i - 1], sequence[i]);
152     }
153 }
154
155 /// <summary>
156 /// <para>
157 /// Prints the frequency using the specified source.
158 /// </para>
159 /// <para></para>
160 /// </summary>
161 /// <param name="source">
162 /// <para>The source.</para>
163 /// <para></para>
164 /// </param>
165 /// <param name="target">
166 /// <para>The target.</para>
167 /// <para></para>
168 /// </param>
169 [MethodImpl(MethodImplOptions.AggressiveInlining)]
170 public void PrintFrequency(TLinkAddress source, TLinkAddress target)
171 {
172     var number = GetFrequency(source, target).Frequency;
173     Console.WriteLine("{0},{1} - {2}", source, target, number);
174 }
175
176 /// <summary>
177 /// <para>
178 /// Increments the frequency using the specified doublet.
179 /// </para>
180 /// <para></para>
181 /// </summary>
182 /// <param name="doublet">
183 /// <para>The doublet.</para>
184 /// <para></para>
185 /// </param>
186 /// <returns>
187 /// <para>The data.</para>
188 /// <para></para>
189 /// </returns>
190 [MethodImpl(MethodImplOptions.AggressiveInlining)]
191 public LinkFrequency<TLinkAddress> IncrementFrequency(ref Doublet<TLinkAddress> doublet)
192 {
193     if (_doubletsCache.TryGetValue(doublet, out LinkFrequency<TLinkAddress> data))
194     {
195         data.IncrementFrequency();
196     }
197     else
198     {
199         var link = _links.SearchOrDefault(doublet.Source, doublet.Target);
200         data = new LinkFrequency<TLinkAddress>(_one, link);
201         if (!_equalityComparer.Equals(link, default))
202         {
203             data.Frequency = Arithmetic.Add(data.Frequency,
                ↪ _frequencyCounter.Count(link));
204         }
205         _doubletsCache.Add(doublet, data);

```

```

206     }
207     return data;
208 }
209
210 /// <summary>
211 /// <para>
212 /// Validates the frequencies.
213 /// </para>
214 /// <para></para>
215 /// </summary>
216 /// <exception cref="InvalidOperationException">
217 /// <para>Frequencies validation failed.</para>
218 /// <para></para>
219 /// </exception>
220 [MethodImpl(MethodImplOptions.AggressiveInlining)]
221 public void ValidateFrequencies()
222 {
223     foreach (var entry in _doubletsCache)
224     {
225         var value = entry.Value;
226         var linkIndex = value.Link;
227         if (!_equalityComparer.Equals(linkIndex, default))
228         {
229             var frequency = value.Frequency;
230             var count = _frequencyCounter.Count(linkIndex);
231             // TODO: Why `frequency` always greater than `count` by 1?
232             if (((_comparer.Compare(frequency, count) > 0) &&
233                 ↪ (_comparer.Compare(Arithmetic.Subtract(frequency, count), _one) > 0))
234                 || ((_comparer.Compare(count, frequency) > 0) &&
235                 ↪ (_comparer.Compare(Arithmetic.Subtract(count, frequency), _one) > 0)))
236             {
237                 throw new InvalidOperationException("Frequencies validation failed.");
238             }
239             //else
240             // {
241             //     if (value.Frequency > 0)
242             //     {
243             //         var frequency = value.Frequency;
244             //         linkIndex = _createLink(entry.Key.Source, entry.Key.Target);
245             //         var count = _countLinkFrequency(linkIndex);
246             //         if ((frequency > count && frequency - count > 1) || (count > frequency
247             //             ↪ && count - frequency > 1))
248             //             throw new InvalidOperationException("Frequencies validation
249             //             ↪ failed.");
250             //     }
251             // }
252         }
253     }
254 }

```

### 1.13 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Cache/LinkFrequency.cs

```

1 using System.Runtime.CompilerServices;
2 using Platform.Numbers;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Data.Doublets.Sequences.Frequencies.Cache
7 {
8     /// <summary>
9     /// <para>
10    /// Represents the link frequency.
11    /// </para>
12    /// <para></para>
13    /// </summary>
14    public class LinkFrequency<TLinkAddress>
15    {
16        /// <summary>
17        /// <para>
18        /// Gets or sets the frequency value.
19        /// </para>
20        /// <para></para>
21        /// </summary>
22        public TLinkAddress Frequency { get; set; }
23        /// <summary>
24        /// <para>

```

```

25     /// Gets or sets the link value.
26     /// </para>
27     /// <para></para>
28     /// </summary>
29     public TLinkAddress Link { get; set; }
30
31     /// <summary>
32     /// <para>
33     /// Initializes a new <see cref="LinkFrequency"/> instance.
34     /// </para>
35     /// <para></para>
36     /// </summary>
37     /// <param name="frequency">
38     /// <para>A frequency.</para>
39     /// <para></para>
40     /// </param>
41     /// <param name="link">
42     /// <para>A link.</para>
43     /// <para></para>
44     /// </param>
45     [MethodImpl(MethodImplOptions.AggressiveInlining)]
46     public LinkFrequency(TLinkAddress frequency, TLinkAddress link)
47     {
48         Frequency = frequency;
49         Link = link;
50     }
51
52     /// <summary>
53     /// <para>
54     /// Initializes a new <see cref="LinkFrequency"/> instance.
55     /// </para>
56     /// <para></para>
57     /// </summary>
58     [MethodImpl(MethodImplOptions.AggressiveInlining)]
59     public LinkFrequency() { }
60
61     /// <summary>
62     /// <para>
63     /// Increments the frequency.
64     /// </para>
65     /// <para></para>
66     /// </summary>
67     [MethodImpl(MethodImplOptions.AggressiveInlining)]
68     public void IncrementFrequency() => Frequency =
        ↪ Arithmetic<TLinkAddress>.Increment(Frequency);
69
70     /// <summary>
71     /// <para>
72     /// Decrements the frequency.
73     /// </para>
74     /// <para></para>
75     /// </summary>
76     [MethodImpl(MethodImplOptions.AggressiveInlining)]
77     public void DecrementFrequency() => Frequency =
        ↪ Arithmetic<TLinkAddress>.Decrement(Frequency);
78
79     /// <summary>
80     /// <para>
81     /// Returns the string.
82     /// </para>
83     /// <para></para>
84     /// </summary>
85     /// <returns>
86     /// <para>The string</para>
87     /// <para></para>
88     /// </returns>
89     [MethodImpl(MethodImplOptions.AggressiveInlining)]
90     public override string ToString() => $"F: {Frequency}, L: {Link}";
91 }
92 }

```

#### 1.14 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Cache/LinkToltsFrequencyValueConverter.cs

```

1 using System.Runtime.CompilerServices;
2 using Platform.Converters;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Data.Doublets.Sequences.Frequencies.Cache

```

```

7 {
8     /// <summary>
9     /// <para>
10    /// Represents the frequencies cache based link to its frequency number converter.
11    /// </para>
12    /// <para></para>
13    /// </summary>
14    /// <seealso cref="IConverter{Doublet{TLinkAddress}, TLinkAddress}"/>
15    public class FrequenciesCacheBasedLinkToItsFrequencyNumberConverter<TLinkAddress> :
        ↳ IConverter<Doublet<TLinkAddress>, TLinkAddress>
16    {
17        private readonly LinkFrequenciesCache<TLinkAddress> _cache;
18
19        /// <summary>
20        /// <para>
21        /// Initializes a new <see
22        ↳ cref="FrequenciesCacheBasedLinkToItsFrequencyNumberConverter"/> instance.
23        /// </para>
24        /// <para></para>
25        /// </summary>
26        /// <param name="cache">
27        /// <para>A cache.</para>
28        /// <para></para>
29        /// </param>
30        [MethodImpl(MethodImplOptions.AggressiveInlining)]
31        public FrequenciesCacheBasedLinkToItsFrequencyNumberConverter(LinkFrequenciesCache<TLink
32        ↳ Address> cache) => _cache =
33        ↳ cache;
34
35        /// <summary>
36        /// <para>
37        /// Converts the source.
38        /// </para>
39        /// <para></para>
40        /// </summary>
41        /// <param name="source">
42        /// <para>The source.</para>
43        /// <para></para>
44        /// </param>
45        /// <returns>
46        /// <para>The link</para>
47        /// <para></para>
48        /// </returns>
49        [MethodImpl(MethodImplOptions.AggressiveInlining)]
50        public TLinkAddress Convert(Doublet<TLinkAddress> source) => _cache.GetFrequency(ref
51        ↳ source).Frequency;
52    }
53 }

```

### 1.15 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Counters/MarkedSequenceSymbolFrequencyOneOff

```

1 using System.Runtime.CompilerServices;
2 using Platform.Interfaces;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Data.Doublets.Sequences.Frequencies.Counters
7 {
8     /// <summary>
9     /// <para>
10    /// Represents the marked sequence symbol frequency one off counter.
11    /// </para>
12    /// <para></para>
13    /// </summary>
14    /// <seealso cref="SequenceSymbolFrequencyOneOffCounter{TLinkAddress}"/>
15    public class MarkedSequenceSymbolFrequencyOneOffCounter<TLinkAddress> :
        ↳ SequenceSymbolFrequencyOneOffCounter<TLinkAddress>
16    {
17        private readonly ICriterionMatcher<TLinkAddress> _markedSequenceMatcher;
18
19        /// <summary>
20        /// <para>
21        /// Initializes a new <see cref="MarkedSequenceSymbolFrequencyOneOffCounter"/> instance.
22        /// </para>
23        /// <para></para>
24        /// </summary>
25        /// <param name="links">
26        /// <para>A links.</para>
27        /// <para></para>

```



```

28     /// </param>
29     /// <param name="markedSequenceMatcher">
30     /// <para>A marked sequence matcher.</para>
31     /// <para></para>
32     /// </param>
33     /// <param name="sequenceLink">
34     /// <para>A sequence link.</para>
35     /// <para></para>
36     /// </param>
37     /// <param name="symbol">
38     /// <para>A symbol.</para>
39     /// <para></para>
40     /// </param>
41     [MethodImpl(MethodImplOptions.AggressiveInlining)]
42     public MarkedSequenceSymbolFrequencyOneOffCounter(ILinks<TLinkAddress> links,
43         ↳ ICriterionMatcher<TLinkAddress> markedSequenceMatcher, TLinkAddress sequenceLink,
44         ↳ TLinkAddress symbol)
45         : base(links, sequenceLink, symbol)
46         => _markedSequenceMatcher = markedSequenceMatcher;
47
48     /// <summary>
49     /// <para>
50     /// Counts this instance.
51     /// </para>
52     /// <para></para>
53     /// </summary>
54     /// <returns>
55     /// <para>The link</para>
56     /// <para></para>
57     /// </returns>
58     [MethodImpl(MethodImplOptions.AggressiveInlining)]
59     public override TLinkAddress Count()
60     {
61         if (!_markedSequenceMatcher.IsMatched(_sequenceLink))
62         {
63             return default;
64         }
65         return base.Count();
66     }
67 }

```

## 1.16 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Counters/SequenceSymbolFrequencyOneOffCounter

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Interfaces;
4 using Platform.Numbers;
5 using Platform.Data.Sequences;
6
7 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9 namespace Platform.Data.Doublets.Sequences.Frequencies.Counters
10 {
11     /// <summary>
12     /// <para>
13     /// Represents the sequence symbol frequency one off counter.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="ICounter{TLinkAddress}"/>
18     public class SequenceSymbolFrequencyOneOffCounter<TLinkAddress> : ICounter<TLinkAddress>
19     {
20         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
21             ↳ EqualityComparer<TLinkAddress>.Default;
22         private static readonly Comparer<TLinkAddress> _comparer =
23             ↳ Comparer<TLinkAddress>.Default;
24
25         /// <summary>
26         /// <para>
27         /// The links.
28         /// </para>
29         /// <para></para>
30         /// </summary>
31         protected readonly ILinks<TLinkAddress> _links;
32
33         /// <summary>
34         /// <para>
35         /// The sequence link.
36         /// </para>
37         /// <para></para>
38         /// </summary>

```

```

35     /// </summary>
36     protected readonly TLinkAddress _sequenceLink;
37     /// <summary>
38     /// <para>
39     /// The symbol.
40     /// </para>
41     /// <para></para>
42     /// </summary>
43     protected readonly TLinkAddress _symbol;
44     /// <summary>
45     /// <para>
46     /// The total.
47     /// </para>
48     /// <para></para>
49     /// </summary>
50     protected TLinkAddress _total;
51
52     /// <summary>
53     /// <para>
54     /// Initializes a new <see cref="SequenceSymbolFrequencyOneOffCounter"/> instance.
55     /// </para>
56     /// <para></para>
57     /// </summary>
58     /// <param name="links">
59     /// <para>A links.</para>
60     /// <para></para>
61     /// </param>
62     /// <param name="sequenceLink">
63     /// <para>A sequence link.</para>
64     /// <para></para>
65     /// </param>
66     /// <param name="symbol">
67     /// <para>A symbol.</para>
68     /// <para></para>
69     /// </param>
70     [MethodImpl(MethodImplOptions.AggressiveInlining)]
71     public SequenceSymbolFrequencyOneOffCounter(ILinks<TLinkAddress> links, TLinkAddress
72     ↪ sequenceLink, TLinkAddress symbol)
73     {
74         _links = links;
75         _sequenceLink = sequenceLink;
76         _symbol = symbol;
77         _total = default;
78     }
79
80     /// <summary>
81     /// <para>
82     /// Counts this instance.
83     /// </para>
84     /// <para></para>
85     /// </summary>
86     /// <returns>
87     /// <para>The total.</para>
88     /// <para></para>
89     /// </returns>
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     public virtual TLinkAddress Count()
92     {
93         if (_comparer.Compare(_total, default) > 0)
94         {
95             return _total;
96         }
97         StopableSequenceWalker.WalkRight(_sequenceLink, _links.GetSource, _links.GetTarget,
98         ↪ IsElement, VisitElement);
99         return _total;
100     }
101     [MethodImpl(MethodImplOptions.AggressiveInlining)]
102     private bool IsElement(TLinkAddress x) => _equalityComparer.Equals(x, _symbol) ||
103     ↪ _links.IsPartialPoint(x); // TODO: Use SequenceElementCriteriaMatcher instead of
104     ↪ IsPartialPoint
105     [MethodImpl(MethodImplOptions.AggressiveInlining)]
106     private bool VisitElement(TLinkAddress element)
107     {
108         if (_equalityComparer.Equals(element, _symbol))
109         {
110             _total = Arithmetic.Increment(_total);
111         }
112         return true;
113     }

```

```

109     }
110 }
111 }

```

### 1.17 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Counters/TotalMarkedSequenceSymbolFrequencyC

```

1  using System.Runtime.CompilerServices;
2  using Platform.Interfaces;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Data.Doublets.Sequences.Frequencies.Counters
7  {
8      /// <summary>
9      /// <para>
10     /// Represents the total marked sequence symbol frequency counter.
11     /// </para>
12     /// <para></para>
13     /// </summary>
14     /// <seealso cref="ICounter{TLinkAddress, TLinkAddress}"/>
15     public class TotalMarkedSequenceSymbolFrequencyCounter<TLinkAddress> :
16         ↪ ICounter<TLinkAddress, TLinkAddress>
17     {
18         private readonly ILinks<TLinkAddress> _links;
19         private readonly ICriterionMatcher<TLinkAddress> _markedSequenceMatcher;
20
21         /// <summary>
22         /// <para>
23         /// Initializes a new <see cref="TotalMarkedSequenceSymbolFrequencyCounter"/> instance.
24         /// </para>
25         /// <para></para>
26         /// </summary>
27         /// <param name="links">
28         /// <para>A links.</para>
29         /// </param>
30         /// <param name="markedSequenceMatcher">
31         /// <para>A marked sequence matcher.</para>
32         /// </param>
33         /// </summary>
34         [MethodImpl(MethodImplOptions.AggressiveInlining)]
35         public TotalMarkedSequenceSymbolFrequencyCounter(ILinks<TLinkAddress> links,
36             ↪ ICriterionMatcher<TLinkAddress> markedSequenceMatcher)
37         {
38             _links = links;
39             _markedSequenceMatcher = markedSequenceMatcher;
40
41             /// <summary>
42             /// <para>
43             /// Counts the argument.
44             /// </para>
45             /// <para></para>
46             /// </summary>
47             /// <param name="argument">
48             /// <para>The argument.</para>
49             /// </param>
50             /// </summary>
51             /// <returns>
52             /// <para>The link</para>
53             /// </returns>
54             [MethodImpl(MethodImplOptions.AggressiveInlining)]
55             public TLinkAddress Count(TLinkAddress argument) => new
56                 ↪ TotalMarkedSequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links,
57                 ↪ _markedSequenceMatcher, argument).Count();
58     }
59 }

```

### 1.18 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Counters/TotalMarkedSequenceSymbolFrequencyO

```

1  using System.Runtime.CompilerServices;
2  using Platform.Interfaces;
3  using Platform.Numbers;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Data.Doublets.Sequences.Frequencies.Counters
8  {
9      /// <summary>
10     /// <para>

```

```

11     /// Represents the total marked sequence symbol frequency one off counter.
12     /// </para>
13     /// <para></para>
14     /// </summary>
15     /// <seealso cref="TotalSequenceSymbolFrequencyOneOffCounter{TLinkAddress}"/>
16     public class TotalMarkedSequenceSymbolFrequencyOneOffCounter<TLinkAddress> :
17         ↳ TotalSequenceSymbolFrequencyOneOffCounter<TLinkAddress>
18     {
19         private readonly ICriterionMatcher<TLinkAddress> _markedSequenceMatcher;
20
21         /// <summary>
22         /// <para>
23         ///     Initializes a new <see cref="TotalMarkedSequenceSymbolFrequencyOneOffCounter"/>
24         ///     ↳ instance.
25         /// </para>
26         /// <para></para>
27         /// </summary>
28         /// <param name="links">
29         /// <para>A links.</para>
30         /// <para></para>
31         /// </param>
32         /// <param name="markedSequenceMatcher">
33         /// <para>A marked sequence matcher.</para>
34         /// <para></para>
35         /// </param>
36         /// <param name="symbol">
37         /// <para>A symbol.</para>
38         /// <para></para>
39         /// </param>
40         [MethodImpl(MethodImplOptions.AggressiveInlining)]
41         public TotalMarkedSequenceSymbolFrequencyOneOffCounter(ILinks<TLinkAddress> links,
42             ↳ ICriterionMatcher<TLinkAddress> markedSequenceMatcher, TLinkAddress symbol)
43             : base(links, symbol)
44             => _markedSequenceMatcher = markedSequenceMatcher;
45
46         /// <summary>
47         /// <para>
48         ///     Counts the sequence symbol frequency using the specified link.
49         /// </para>
50         /// <para></para>
51         /// </summary>
52         /// <param name="link">
53         /// <para>The link.</para>
54         /// <para></para>
55         /// </param>
56         [MethodImpl(MethodImplOptions.AggressiveInlining)]
57         protected override void CountSequenceSymbolFrequency(TLinkAddress link)
58         {
59             var symbolFrequencyCounter = new
60                 ↳ MarkedSequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links,
61                 ↳ _markedSequenceMatcher, link, _symbol);
62             _total = Arithmetic.Add(_total, symbolFrequencyCounter.Count());
63         }
64     }
65 }

```

## 1.19 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Counters/TotalSequenceSymbolFrequencyCounter.

```

1 using System.Runtime.CompilerServices;
2 using Platform.Interfaces;
3
4 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6 namespace Platform.Data.Doublets.Sequences.Frequencies.Counters
7 {
8     /// <summary>
9     /// <para>
10     ///     Represents the total sequence symbol frequency counter.
11     /// </para>
12     /// <para></para>
13     /// </summary>
14     /// <seealso cref="ICounter{TLinkAddress, TLinkAddress}"/>
15     public class TotalSequenceSymbolFrequencyCounter<TLinkAddress> : ICounter<TLinkAddress,
16         ↳ TLinkAddress>
17     {
18         private readonly ILinks<TLinkAddress> _links;
19
20         /// <summary>
21         /// <para>
22         ///     Initializes a new <see cref="TotalSequenceSymbolFrequencyCounter"/> instance.

```

```

22     /// </para>
23     /// <para></para>
24     /// </summary>
25     /// <param name="links">
26     /// <para>A links.</para>
27     /// <para></para>
28     /// </param>
29     [MethodImpl(MethodImplOptions.AggressiveInlining)]
30     public TotalSequenceSymbolFrequencyCounter(ILinks<TLinkAddress> links) => _links = links;
31
32     /// <summary>
33     /// <para>
34     /// Counts the symbol.
35     /// </para>
36     /// <para></para>
37     /// </summary>
38     /// <param name="symbol">
39     /// <para>The symbol.</para>
40     /// <para></para>
41     /// </param>
42     /// <returns>
43     /// <para>The link</para>
44     /// <para></para>
45     /// </returns>
46     [MethodImpl(MethodImplOptions.AggressiveInlining)]
47     public TLinkAddress Count(TLinkAddress symbol) => new
48     ↪ TotalSequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links, symbol).Count();
49 }

```

## 1.20 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Counters/TotalSequenceSymbolFrequencyOneOffCounter.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Interfaces;
4 using Platform.Numbers;
5
6 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8 namespace Platform.Data.Doublets.Sequences.Frequencies.Counters
9 {
10     /// <summary>
11     /// <para>
12     /// Represents the total sequence symbol frequency one off counter.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="ICounter{TLinkAddress}"/>
17     public class TotalSequenceSymbolFrequencyOneOffCounter<TLinkAddress> : ICounter<TLinkAddress>
18     {
19         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
20         ↪ EqualityComparer<TLinkAddress>.Default;
21         private static readonly Comparer<TLinkAddress> _comparer =
22         ↪ Comparer<TLinkAddress>.Default;
23
24         /// <summary>
25         /// <para>
26         /// The links.
27         /// </para>
28         /// <para></para>
29         /// </summary>
30         protected readonly ILinks<TLinkAddress> _links;
31
32         /// <summary>
33         /// <para>
34         /// The symbol.
35         /// </para>
36         /// <para></para>
37         /// </summary>
38         protected readonly TLinkAddress _symbol;
39
40         /// <summary>
41         /// <para>
42         /// The visits.
43         /// </para>
44         /// <para></para>
45         /// </summary>
46         protected readonly HashSet<TLinkAddress> _visits;

```

```

47     /// <para></para>
48     /// </summary>
49     protected TLinkAddress _total;
50
51     /// <summary>
52     /// <para>
53     /// Initializes a new <see cref="TotalSequenceSymbolFrequencyOneOffCounter"/> instance.
54     /// </para>
55     /// <para></para>
56     /// </summary>
57     /// <param name="links">
58     /// <para>A links.</para>
59     /// <para></para>
60     /// </param>
61     /// <param name="symbol">
62     /// <para>A symbol.</para>
63     /// <para></para>
64     /// </param>
65     [MethodImpl(MethodImplOptions.AggressiveInlining)]
66     public TotalSequenceSymbolFrequencyOneOffCounter(ILinks<TLinkAddress> links,
67     ↪ TLinkAddress symbol)
68     {
69         _links = links;
70         _symbol = symbol;
71         _visits = new HashSet<TLinkAddress>();
72         _total = default;
73     }
74
75     /// <summary>
76     /// <para>
77     /// Counts this instance.
78     /// </para>
79     /// <para></para>
80     /// </summary>
81     /// <returns>
82     /// <para>The total.</para>
83     /// <para></para>
84     /// </returns>
85     [MethodImpl(MethodImplOptions.AggressiveInlining)]
86     public TLinkAddress Count()
87     {
88         if (_comparer.Compare(_total, default) > 0 || _visits.Count > 0)
89         {
90             return _total;
91         }
92         CountCore(_symbol);
93         return _total;
94     }
95     [MethodImpl(MethodImplOptions.AggressiveInlining)]
96     private void CountCore(TLinkAddress link)
97     {
98         var any = _links.Constants.Any;
99         if (_equalityComparer.Equals(_links.Count(any, link), default))
100         {
101             CountSequenceSymbolFrequency(link);
102         }
103         else
104         {
105             _links.Each(EachElementHandler, any, link);
106         }
107     }
108
109     /// <summary>
110     /// <para>
111     /// Counts the sequence symbol frequency using the specified link.
112     /// </para>
113     /// <para></para>
114     /// </summary>
115     /// <param name="link">
116     /// <para>The link.</para>
117     /// <para></para>
118     /// </param>
119     [MethodImpl(MethodImplOptions.AggressiveInlining)]
120     protected virtual void CountSequenceSymbolFrequency(TLinkAddress link)
121     {
122         var symbolFrequencyCounter = new
123         ↪ SequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links, link, _symbol);
124         _total = Arithmetic.Add(_total, symbolFrequencyCounter.Count());

```

```

123     }
124     [MethodImpl(MethodImplOptions.AggressiveInlining)]
125     private TLinkAddress EachElementHandler(ICollection<TLinkAddress>? doublet)
126     {
127         var constants = _links.Constants;
128         var doubletIndex = doublet[constants.IndexPart];
129         if (_visits.Add(doubletIndex))
130         {
131             CountCore(doubletIndex);
132         }
133         return constants.Continue;
134     }
135 }
136 }

```

## 1.21 ./csharp/Platform.Data.Doublets.Sequences/HeightProviders/CachedSequenceHeightProvider.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Interfaces;
4 using Platform.Converters;
5
6 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8 namespace Platform.Data.Doublets.Sequences.HeightProviders
9 {
10     /// <summary>
11     /// <para>
12     /// Represents the cached sequence height provider.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="ISequenceHeightProvider{TLinkAddress}"/>
17     public class CachedSequenceHeightProvider<TLinkAddress> :
18         ↳ ISequenceHeightProvider<TLinkAddress>
19     {
20         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
21             ↳ EqualityComparer<TLinkAddress>.Default;
22         private readonly TLinkAddress _heightPropertyMarker;
23         private readonly ISequenceHeightProvider<TLinkAddress> _baseHeightProvider;
24         private readonly IConverter<TLinkAddress> _addressToUnaryNumberConverter;
25         private readonly IConverter<TLinkAddress> _unaryNumberToAddressConverter;
26         private readonly IProperties<TLinkAddress, TLinkAddress, TLinkAddress> _propertyOperator;
27
28         /// <summary>
29         /// <para>
30         /// Initializes a new <see cref="CachedSequenceHeightProvider"/> instance.
31         /// </para>
32         /// <para></para>
33         /// </summary>
34         /// <param name="baseHeightProvider">
35         /// <para>A base height provider.</para>
36         /// <para></para>
37         /// </param>
38         /// <param name="addressToUnaryNumberConverter">
39         /// <para>A address to unary number converter.</para>
40         /// <para></para>
41         /// </param>
42         /// <param name="unaryNumberToAddressConverter">
43         /// <para>A unary number to address converter.</para>
44         /// <para></para>
45         /// </param>
46         /// <param name="heightPropertyMarker">
47         /// <para>A height property marker.</para>
48         /// <para></para>
49         /// </param>
50         /// <param name="propertyOperator">
51         /// <para>A property operator.</para>
52         /// <para></para>
53         /// </param>
54         [MethodImpl(MethodImplOptions.AggressiveInlining)]
55         public CachedSequenceHeightProvider(
56             ISequenceHeightProvider<TLinkAddress> baseHeightProvider,
57             IConverter<TLinkAddress> addressToUnaryNumberConverter,
58             IConverter<TLinkAddress> unaryNumberToAddressConverter,
59             TLinkAddress heightPropertyMarker,
60             IProperties<TLinkAddress, TLinkAddress, TLinkAddress> propertyOperator)
61         {
62             _heightPropertyMarker = heightPropertyMarker;
63             _baseHeightProvider = baseHeightProvider;
64             _addressToUnaryNumberConverter = addressToUnaryNumberConverter;

```

```

63         _unaryNumberToAddressConverter = unaryNumberToAddressConverter;
64         _propertyOperator = propertyOperator;
65     }
66
67     /// <summary>
68     /// <para>
69     /// Gets the sequence.
70     /// </para>
71     /// <para></para>
72     /// </summary>
73     /// <param name="sequence">
74     /// <para>The sequence.</para>
75     /// <para></para>
76     /// </param>
77     /// <returns>
78     /// <para>The height.</para>
79     /// <para></para>
80     /// </returns>
81     [MethodImpl(MethodImplOptions.AggressiveInlining)]
82     public TLinkAddress Get(TLinkAddress sequence)
83     {
84         TLinkAddress height;
85         var heightValue = _propertyOperator.GetValue(sequence, _heightPropertyMarker);
86         if (_equalityComparer.Equals(heightValue, default))
87         {
88             height = _baseHeightProvider.Get(sequence);
89             heightValue = _addressToUnaryNumberConverter.Convert(height);
90             _propertyOperator.SetValue(sequence, _heightPropertyMarker, heightValue);
91         }
92         else
93         {
94             height = _unaryNumberToAddressConverter.Convert(heightValue);
95         }
96         return height;
97     }
98 }
99 }

```

## 1.22 ./csharp/Platform.Data.Doublets.Sequences/HeightProviders/DefaultSequenceRightHeightProvider.cs

```

1  using System.Runtime.CompilerServices;
2  using Platform.Interfaces;
3  using Platform.Numbers;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Data.Doublets.Sequences.HeightProviders
8  {
9      /// <summary>
10     /// <para>
11     /// Represents the default sequence right height provider.
12     /// </para>
13     /// <para></para>
14     /// </summary>
15     /// <seealso cref="LinksOperatorBase{TLinkAddress}">
16     /// <seealso cref="ISequenceHeightProvider{TLinkAddress}">
17     public class DefaultSequenceRightHeightProvider<TLinkAddress> :
18     ↪ LinksOperatorBase<TLinkAddress>, ISequenceHeightProvider<TLinkAddress>
19     {
20         private readonly ICriterionMatcher<TLinkAddress> _elementMatcher;
21
22         /// <summary>
23         /// <para>
24         /// Initializes a new <see cref="DefaultSequenceRightHeightProvider"/> instance.
25         /// </para>
26         /// <para></para>
27         /// </summary>
28         /// <param name="links">
29         /// <para>A links.</para>
30         /// <para></para>
31         /// </param>
32         /// <param name="elementMatcher">
33         /// <para>A element matcher.</para>
34         /// <para></para>
35         /// </param>
36         [MethodImpl(MethodImplOptions.AggressiveInlining)]
37         public DefaultSequenceRightHeightProvider(ILinks<TLinkAddress> links,
38         ↪ ICriterionMatcher<TLinkAddress> elementMatcher) : base(links) => _elementMatcher =
39         ↪ elementMatcher;

```



```

38     /// <summary>
39     /// <para>
40     /// Gets the sequence.
41     /// </para>
42     /// <para></para>
43     /// </summary>
44     /// <param name="sequence">
45     /// <para>The sequence.</para>
46     /// <para></para>
47     /// </param>
48     /// <returns>
49     /// <para>The height.</para>
50     /// <para></para>
51     /// </returns>
52     [MethodImpl(MethodImplOptions.AggressiveInlining)]
53     public TLinkAddress Get(TLinkAddress sequence)
54     {
55         var height = default(TLinkAddress);
56         var pairOrElement = sequence;
57         while (!_elementMatcher.IsMatched(pairOrElement))
58         {
59             pairOrElement = _links.GetTarget(pairOrElement);
60             height = Arithmetic.Increment(height);
61         }
62         return height;
63     }
64 }
65 }

```

### 1.23 ./csharp/Platform.Data.Doublets.Sequences/HeightProviders/ISequenceHeightProvider.cs

```

1 using Platform.Interfaces;
2
3 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5 namespace Platform.Data.Doublets.Sequences.HeightProviders
6 {
7     /// <summary>
8     /// <para>
9     /// Defines the sequence height provider.
10    /// </para>
11    /// <para></para>
12    /// </summary>
13    /// <seealso cref="IProvider{TLinkAddress, TLinkAddress}"/>
14    public interface ISequenceHeightProvider<TLinkAddress> : IProvider<TLinkAddress,
15        ↪ TLinkAddress>
16    {
17    }
18 }

```

### 1.24 ./csharp/Platform.Data.Doublets.Sequences/Incrementers/FrequencyIncrementer.cs

```

1 // using System.Collections.Generic;
2 // using System.Runtime.CompilerServices;
3 // using Platform.Incrementers;
4 //
5 // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6 //
7 // namespace Platform.Data.Doublets.Incrementers
8 // {
9 //     /// <summary>
10 //     /// <para>
11 //     /// Represents the frequency incrementer.
12 //     /// </para>
13 //     /// <para></para>
14 //     /// </summary>
15 //     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
16 //     /// <seealso cref="IIncrementer{TLinkAddress}"/>
17 //     public class FrequencyIncrementer<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
18 //         ↪ IIncrementer<TLinkAddress>
19 //     {
20 //         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
21 //         ↪ EqualityComparer<TLinkAddress>.Default;
22 //         private readonly TLinkAddress _frequencyMarker;
23 //         private readonly TLinkAddress _unaryOne;
24 //         private readonly IIncrementer<TLinkAddress> _unaryNumberIncrementer;
25 //
26 //         /// <summary>
27 //         /// <para>
28 //         /// Initializes a new <see cref="FrequencyIncrementer"/> instance.

```

```

27 //          /// </para>
28 //          /// <para></para>
29 //          /// </summary>
30 //          /// <param name="links">
31 //          /// <para>A links.</para>
32 //          /// <para></para>
33 //          /// </param>
34 //          /// <param name="frequencyMarker">
35 //          /// <para>A frequency marker.</para>
36 //          /// <para></para>
37 //          /// </param>
38 //          /// <param name="unaryOne">
39 //          /// <para>A unary one.</para>
40 //          /// <para></para>
41 //          /// </param>
42 //          /// <param name="unaryNumberIncrementer">
43 //          /// <para>A unary number incrementer.</para>
44 //          /// <para></para>
45 //          /// </param>
46 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
47 //          public FrequencyIncrementer(ILinks<TLinkAddress> links, TLinkAddress frequencyMarker,
↪ TLinkAddress unaryOne, IIncrementer<TLinkAddress> unaryNumberIncrementer)
48 //              : base(links)
49 //          {
50 //              _frequencyMarker = frequencyMarker;
51 //              _unaryOne = unaryOne;
52 //              _unaryNumberIncrementer = unaryNumberIncrementer;
53 //          }
54 //
55 //          /// <summary>
56 //          /// <para>
57 //          /// Increments the frequency.
58 //          /// </para>
59 //          /// <para></para>
60 //          /// </summary>
61 //          /// <param name="frequency">
62 //          /// <para>The frequency.</para>
63 //          /// <para></para>
64 //          /// </param>
65 //          /// <returns>
66 //          /// <para>The link</para>
67 //          /// <para></para>
68 //          /// </returns>
69 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
70 //          public TLinkAddress Increment(TLinkAddress frequency)
71 //          {
72 //              var links = _links;
73 //              if (_equalityComparer.Equals(frequency, default))
74 //              {
75 //                  return links.GetOrCreate(_unaryOne, _frequencyMarker);
76 //              }
77 //              var incrementedSource =
↪ _unaryNumberIncrementer.Increment(links.GetSource(frequency));
78 //              return links.GetOrCreate(incrementedSource, _frequencyMarker);
79 //          }
80 //      }
81 // }

```

## 1.25 ./csharp/Platform.Data.Doublets.Sequences/Incrementers/UnaryNumberIncrementer.cs

```

1 // using System.Collections.Generic;
2 // using System.Runtime.CompilerServices;
3 // using Platform.Incrementers;
4 //
5 // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6 //
7 // namespace Platform.Data.Doublets.Incrementers
8 // {
9 //     /// <summary>
10 //     /// <para>
11 //     /// Represents the unary number incrementer.
12 //     /// </para>
13 //     /// <para></para>
14 //     /// </summary>
15 //     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
16 //     /// <seealso cref="IIncrementer{TLinkAddress}"/>
17 //     public class UnaryNumberIncrementer<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
↪ IIncrementer<TLinkAddress>
18 //     {

```

```

19 //         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↪ EqualityComparer<TLinkAddress>.Default;
20 //         private readonly TLinkAddress _unaryOne;
21 //
22 //         /// <summary>
23 //         /// <para>
24 //         /// Initializes a new <see cref="UnaryNumberIncrementer"/> instance.
25 //         /// </para>
26 //         /// <para></para>
27 //         /// </summary>
28 //         /// <param name="links">
29 //         /// <para>A links.</para>
30 //         /// <para></para>
31 //         /// </param>
32 //         /// <param name="unaryOne">
33 //         /// <para>A unary one.</para>
34 //         /// <para></para>
35 //         /// </param>
36 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
37 //         public UnaryNumberIncrementer(ILinks<TLinkAddress> links, TLinkAddress unaryOne) :
    ↪ base(links) => _unaryOne = unaryOne;
38 //
39 //         /// <summary>
40 //         /// <para>
41 //         /// Increments the unary number.
42 //         /// </para>
43 //         /// <para></para>
44 //         /// </summary>
45 //         /// <param name="unaryNumber">
46 //         /// <para>The unary number.</para>
47 //         /// <para></para>
48 //         /// </param>
49 //         /// <returns>
50 //         /// <para>The link</para>
51 //         /// <para></para>
52 //         /// </returns>
53 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
54 //         public TLinkAddress Increment(TLinkAddress unaryNumber)
55 //         {
56 //             var links = _links;
57 //             if (_equalityComparer.Equals(unaryNumber, _unaryOne))
58 //             {
59 //                 return links.GetOrCreate(_unaryOne, _unaryOne);
60 //             }
61 //             var source = links.GetSource(unaryNumber);
62 //             var target = links.GetTarget(unaryNumber);
63 //             if (_equalityComparer.Equals(source, target))
64 //             {
65 //                 return links.GetOrCreate(unaryNumber, _unaryOne);
66 //             }
67 //             else
68 //             {
69 //                 return links.GetOrCreate(source, Increment(target));
70 //             }
71 //         }
72 //     }
73 // }

```

## 1.26 ./csharp/Platform.Data.Doublets.Sequences/Indexes/CachedFrequencyIncrementingSequenceIndex.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Data.Doublets.Sequences.Frequencies.Cache;
4
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Data.Doublets.Sequences.Indexes
8 {
9     /// <summary>
10    /// <para>
11    /// Represents the cached frequency incrementing sequence index.
12    /// </para>
13    /// <para></para>
14    /// </summary>
15    /// <seealso cref="ISequenceIndex{TLinkAddress}"/>
16    public class CachedFrequencyIncrementingSequenceIndex<TLinkAddress> :
    ↪ ISequenceIndex<TLinkAddress>
17    {
18        private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↪ EqualityComparer<TLinkAddress>.Default;

```

```

19 private readonly LinkFrequenciesCache<TLinkAddress> _cache;
20
21 /// <summary>
22 /// <para>
23 /// Initializes a new <see cref="CachedFrequencyIncrementingSequenceIndex"/> instance.
24 /// </para>
25 /// <para></para>
26 /// </summary>
27 /// <param name="cache">
28 /// <para>A cache.</para>
29 /// <para></para>
30 /// </param>
31 [MethodImpl(MethodImplOptions.AggressiveInlining)]
32 public CachedFrequencyIncrementingSequenceIndex(LinkFrequenciesCache<TLinkAddress>
    ↪ cache) => _cache = cache;
33
34 /// <summary>
35 /// <para>
36 /// Determines whether this instance add.
37 /// </para>
38 /// <para></para>
39 /// </summary>
40 /// <param name="sequence">
41 /// <para>The sequence.</para>
42 /// <para></para>
43 /// </param>
44 /// <returns>
45 /// <para>The indexed.</para>
46 /// <para></para>
47 /// </returns>
48 [MethodImpl(MethodImplOptions.AggressiveInlining)]
49 public bool Add(IList<TLinkAddress>? sequence)
50 {
51     var indexed = true;
52     var i = sequence.Count;
53     while (--i >= 1 && (indexed = IsIndexedWithIncrement(sequence[i - 1], sequence[i])))
54         ↪ { }
55     for (; i >= 1; i--)
56     {
57         _cache.IncrementFrequency(sequence[i - 1], sequence[i]);
58     }
59     return indexed;
60 }
61 [MethodImpl(MethodImplOptions.AggressiveInlining)]
62 private bool IsIndexedWithIncrement(TLinkAddress source, TLinkAddress target)
63 {
64     var frequency = _cache.GetFrequency(source, target);
65     if (frequency == null)
66     {
67         return false;
68     }
69     var indexed = !_equalityComparer.Equals(frequency.Frequency, default);
70     if (indexed)
71     {
72         _cache.IncrementFrequency(source, target);
73     }
74     return indexed;
75 }
76
77 /// <summary>
78 /// <para>
79 /// Determines whether this instance might contain.
80 /// </para>
81 /// <para></para>
82 /// </summary>
83 /// <param name="sequence">
84 /// <para>The sequence.</para>
85 /// <para></para>
86 /// </param>
87 /// <returns>
88 /// <para>The indexed.</para>
89 /// <para></para>
90 /// </returns>
91 [MethodImpl(MethodImplOptions.AggressiveInlining)]
92 public bool MightContain(IList<TLinkAddress>? sequence)
93 {
94     var indexed = true;
95     var i = sequence.Count;

```

```

95         while (--i >= 1 && (indexed = IsIndexed(sequence[i - 1], sequence[i]))) { }
96         return indexed;
97     }
98     [MethodImpl(MethodImplOptions.AggressiveInlining)]
99     private bool IsIndexed(TLinkAddress source, TLinkAddress target)
100     {
101         var frequency = _cache.GetFrequency(source, target);
102         if (frequency == null)
103         {
104             return false;
105         }
106         return !_equalityComparer.Equals(frequency.Frequency, default);
107     }
108 }
109 }

```

## 1.27 ./csharp/Platform.Data.Doublets.Sequences/Indexes/FrequencyIncrementingSequenceIndex.cs

```

1  // using System.Collections.Generic;
2  // using System.Runtime.CompilerServices;
3  // using Platform.Interfaces;
4  // using Platform.Incremeters;
5  //
6  // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7  //
8  // namespace Platform.Data.Doublets.Sequences.Indexes
9  // {
10 //     /// <summary>
11 //     /// <para>
12 //     /// Represents the frequency incrementing sequence index.
13 //     /// </para>
14 //     /// <para></para>
15 //     /// </summary>
16 //     /// <seealso cref="SequenceIndex{TLinkAddress}"/>
17 //     /// <seealso cref="ISequenceIndex{TLinkAddress}"/>
18 //     public class FrequencyIncrementingSequenceIndex<TLinkAddress> :
19 //     ↪ SequenceIndex<TLinkAddress>, ISequenceIndex<TLinkAddress>
20 //     {
21 //         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
22 //         ↪ EqualityComparer<TLinkAddress>.Default;
23 //         private readonly IProperty<TLinkAddress, TLinkAddress> _frequencyPropertyOperator;
24 //         private readonly IIncrementer<TLinkAddress> _frequencyIncrementer;
25 //
26 //         /// <summary>
27 //         /// <para>
28 //         /// Initializes a new <see cref="FrequencyIncrementingSequenceIndex"/> instance.
29 //         /// </para>
30 //         /// <para></para>
31 //         /// </summary>
32 //         /// <param name="links">
33 //         /// <para>A links.</para>
34 //         /// <para></para>
35 //         /// </param>
36 //         /// <param name="frequencyPropertyOperator">
37 //         /// <para>A frequency property operator.</para>
38 //         /// <para></para>
39 //         /// </param>
40 //         /// <param name="frequencyIncrementer">
41 //         /// <para>A frequency incrementer.</para>
42 //         /// <para></para>
43 //         /// </param>
44 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45 //         public FrequencyIncrementingSequenceIndex(ILinks<TLinkAddress> links,
46 //         ↪ IProperty<TLinkAddress, TLinkAddress> frequencyPropertyOperator, IIncrementer<TLinkAddress>
47 //         ↪ frequencyIncrementer)
48 //         : base(links)
49 //         {
50 //             _frequencyPropertyOperator = frequencyPropertyOperator;
51 //             _frequencyIncrementer = frequencyIncrementer;
52 //         }
53 //
54 //         /// <summary>
55 //         /// <para>
56 //         /// Determines whether this instance add.
57 //         /// </para>
58 //         /// <para></para>
59 //         /// </summary>
60 //         /// <param name="sequence">
61 //         /// <para>The sequence.</para>

```

```

58 //          /// <para></para>
59 //          /// </param>
60 //          /// <returns>
61 //          /// <para>The indexed.</para>
62 //          /// <para></para>
63 //          /// </returns>
64 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
65 //          public override bool Add(ICollection<TLinkAddress>? sequence)
66 //          {
67 //              var indexed = true;
68 //              var i = sequence.Count;
69 //              while (--i >= 1 && (indexed = IsIndexedWithIncrement(sequence[i - 1],
↵ sequence[i]))) { }
70 //              for (; i >= 1; i--)
71 //              {
72 //                  Increment(_links.GetOrCreate(sequence[i - 1], sequence[i]));
73 //              }
74 //              return indexed;
75 //          }
76 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
77 //          private bool IsIndexedWithIncrement(TLinkAddress source, TLinkAddress target)
78 //          {
79 //              var link = _links.SearchOrCreate(source, target);
80 //              var indexed = !_equalityComparer.Equals(link, default);
81 //              if (indexed)
82 //              {
83 //                  Increment(link);
84 //              }
85 //              return indexed;
86 //          }
87 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
88 //          private void Increment(TLinkAddress link)
89 //          {
90 //              var previousFrequency = _frequencyPropertyOperator.Get(link);
91 //              var frequency = _frequencyIncrementer.Increment(previousFrequency);
92 //              _frequencyPropertyOperator.Set(link, frequency);
93 //          }
94 //      }
95 // }

```

## 1.28 ./csharp/Platform.Data.Doublets.Sequences/Indexes/ISequenceIndex.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.Data.Doublets.Sequences.Indexes
7 {
8     /// <summary>
9     /// <para>
10     /// Defines the sequence index.
11     /// </para>
12     /// <para></para>
13     /// </summary>
14     public interface ISequenceIndex<TLinkAddress>
15     {
16         /// <summary>
17         /// Индексирует последовательность глобально, и возвращает значение,
18         /// определяющие была ли запрошенная последовательность проиндексирована ранее.
19         /// </summary>
20         /// <param name="sequence">Последовательность для индексации.</param>
21         [MethodImpl(MethodImplOptions.AggressiveInlining)]
22         bool Add(ICollection<TLinkAddress>? sequence);
23
24         /// <summary>
25         /// <para>
26         /// Determines whether this instance might contain.
27         /// </para>
28         /// <para></para>
29         /// </summary>
30         /// <param name="sequence">
31         /// <para>The sequence.</para>
32         /// <para></para>
33         /// </param>
34         /// <returns>
35         /// <para>The bool</para>
36         /// <para></para>
37         /// </returns>

```

```

38     [MethodImpl(MethodImplOptions.AggressiveInlining)]
39     bool MightContain(IList<TLinkAddress>? sequence);
40 }
41 }

```

## 1.29 ./csharp/Platform.Data.Doublets.Sequences/Indexes/SequenceIndex.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.Data.Doublets.Sequences.Indexes
7  {
8      /// <summary>
9      /// <para>
10     /// Represents the sequence index.
11     /// </para>
12     /// <para></para>
13     /// </summary>
14     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
15     /// <seealso cref="ISequenceIndex{TLinkAddress}"/>
16     public class SequenceIndex<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
17     ↪ ISequenceIndex<TLinkAddress>
18     {
19         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
20         ↪ EqualityComparer<TLinkAddress>.Default;
21
22         /// <summary>
23         /// <para>
24         /// Initializes a new <see cref="SequenceIndex"/> instance.
25         /// </para>
26         /// <para></para>
27         /// </summary>
28         /// <param name="links">
29         /// <para>A links.</para>
30         /// <para></para>
31         /// </param>
32         [MethodImpl(MethodImplOptions.AggressiveInlining)]
33         public SequenceIndex(ILinks<TLinkAddress> links) : base(links) { }
34
35         /// <summary>
36         /// <para>
37         /// Determines whether this instance add.
38         /// </para>
39         /// <para></para>
40         /// </summary>
41         /// <param name="sequence">
42         /// <para>The sequence.</para>
43         /// <para></para>
44         /// </param>
45         /// <returns>
46         /// <para>The indexed.</para>
47         /// <para></para>
48         /// </returns>
49         [MethodImpl(MethodImplOptions.AggressiveInlining)]
50         public virtual bool Add(IList<TLinkAddress>? sequence)
51         {
52             var indexed = true;
53             var i = sequence.Count;
54             while (--i >= 1 && (indexed =
55             ↪ !_equalityComparer.Equals(_links.SearchOrDefault(sequence[i - 1], sequence[i]),
56             ↪ default))) { }
57             for (; i >= 1; i--)
58             {
59                 _links.GetOrCreate(sequence[i - 1], sequence[i]);
60             }
61             return indexed;
62         }
63
64         /// <summary>
65         /// <para>
66         /// Determines whether this instance might contain.
67         /// </para>
68         /// <para></para>
69         /// </summary>
70         /// <param name="sequence">
71         /// <para>The sequence.</para>
72         /// <para></para>
73         /// </param>

```

```

70     /// <returns>
71     /// <para>The indexed.</para>
72     /// <para></para>
73     /// </returns>
74     [MethodImpl(MethodImplOptions.AggressiveInlining)]
75     public virtual bool MightContain(IList<TLinkAddress>? sequence)
76     {
77         var indexed = true;
78         var i = sequence.Count;
79         while (--i >= 1 && (indexed =
            ↪ !_equalityComparer.Equals(_links.SearchOrDefault(sequence[i - 1], sequence[i]),
            ↪ default))) { }
80         return indexed;
81     }
82 }
83 }

```

### 1.30 ./csharp/Platform.Data.Doublets.Sequences/Indexes/SynchronizedSequenceIndex.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.Data.Doublets.Sequences.Indexes
7  {
8      /// <summary>
9      /// <para>
10         /// Represents the synchronized sequence index.
11         /// </para>
12         /// <para></para>
13         /// </summary>
14         /// <seealso cref="ISequenceIndex{TLinkAddress}"/>
15         public class SynchronizedSequenceIndex<TLinkAddress> : ISequenceIndex<TLinkAddress>
16         {
17             private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
18                 ↪ EqualityComparer<TLinkAddress>.Default;
19             private readonly ISynchronizedLinks<TLinkAddress> _links;
20
21             /// <summary>
22             /// <para>
23             /// Initializes a new <see cref="SynchronizedSequenceIndex"/> instance.
24             /// </para>
25             /// <para></para>
26             /// </summary>
27             /// <param name="links">
28             /// <para>A links.</para>
29             /// </param>
30             [MethodImpl(MethodImplOptions.AggressiveInlining)]
31             public SynchronizedSequenceIndex(ISynchronizedLinks<TLinkAddress> links) => _links =
32                 ↪ links;
33
34             /// <summary>
35             /// <para>
36             /// Determines whether this instance add.
37             /// </para>
38             /// <para></para>
39             /// </summary>
40             /// <param name="sequence">
41             /// <para>The sequence.</para>
42             /// </param>
43             /// <returns>
44             /// <para>The indexed.</para>
45             /// <para></para>
46             /// </returns>
47             [MethodImpl(MethodImplOptions.AggressiveInlining)]
48             public bool Add(IList<TLinkAddress>? sequence)
49             {
50                 var indexed = true;
51                 var i = sequence.Count;
52                 var links = _links.Unsync;
53                 _links.SyncRoot.DoRead(() =>
54                 {
55                     while (--i >= 1 && (indexed =
56                         ↪ !_equalityComparer.Equals(links.SearchOrDefault(sequence[i - 1],
57                         ↪ sequence[i]), default))) { }
58                     if (!indexed)

```



```

58     {
59         _links.SyncRoot.DoWrite(() =>
60         {
61             for (; i >= 1; i--)
62             {
63                 links.GetOrCreate(sequence[i - 1], sequence[i]);
64             }
65         });
66     }
67     return indexed;
68 }
69
70 /// <summary>
71 /// <para>
72 /// Determines whether this instance might contain.
73 /// </para>
74 /// <para></para>
75 /// </summary>
76 /// <param name="sequence">
77 /// <para>The sequence.</para>
78 /// <para></para>
79 /// </param>
80 /// <returns>
81 /// <para>The bool</para>
82 /// <para></para>
83 /// </returns>
84 [MethodImpl(MethodImplOptions.AggressiveInlining)]
85 public bool MightContain(ICollection<TLinkAddress>? sequence)
86 {
87     var links = _links.Unsync;
88     return _links.SyncRoot.DoRead(() =>
89     {
90         var indexed = true;
91         var i = sequence.Count;
92         while (--i >= 1 && (indexed =
93             ↪ !_equalityComparer.Equals(links.SearchOrDefault(sequence[i - 1],
94             ↪ sequence[i]), default))) { }
95         return indexed;
96     });
97 }

```

### 1.31 ./csharp/Platform.Data.Doublets.Sequences/Indexes/Unindex.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.Data.Doublets.Sequences.Indexes
7 {
8     /// <summary>
9     /// <para>
10    /// Represents the unindex.
11    /// </para>
12    /// <para></para>
13    /// </summary>
14    /// <seealso cref="ISequenceIndex{TLinkAddress}"/>
15    public class Unindex<TLinkAddress> : ISequenceIndex<TLinkAddress>
16    {
17        /// <summary>
18        /// <para>
19        /// Determines whether this instance add.
20        /// </para>
21        /// <para></para>
22        /// </summary>
23        /// <param name="sequence">
24        /// <para>The sequence.</para>
25        /// <para></para>
26        /// </param>
27        /// <returns>
28        /// <para>The bool</para>
29        /// <para></para>
30        /// </returns>
31        [MethodImpl(MethodImplOptions.AggressiveInlining)]
32        public virtual bool Add(ICollection<TLinkAddress>? sequence) => false;
33
34        /// <summary>
35        /// <para>

```

```

36     /// Determines whether this instance might contain.
37     /// </para>
38     /// <para></para>
39     /// </summary>
40     /// <param name="sequence">
41     /// <para>The sequence.</para>
42     /// <para></para>
43     /// </param>
44     /// <returns>
45     /// <para>The bool</para>
46     /// <para></para>
47     /// </returns>
48     [MethodImpl(MethodImplOptions.AggressiveInlining)]
49     public virtual bool MightContain(ICollection<TLinkAddress>? sequence) => true;
50 }
51 }

```

### 1.32 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Rational/DecimalToRationalConverter.cs

```

1  using System.Numerics;
2  using Platform.Converters;
3  using Platform.Data.Doublets.Decorators;
4  using System.Globalization;
5  using Platform.Data.Doublets.Numbers.Raw;
6
7  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9  namespace Platform.Data.Doublets.Numbers.Rational
10 {
11     /// <summary>
12     /// <para>
13     /// Represents the decimal to rational converter.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="LinksDecoratorBase{TLinkAddress}"/>
18     /// <seealso cref="IConverter{decimal, TLinkAddress}"/>
19     public class DecimalToRationalConverter<TLinkAddress> : LinksDecoratorBase<TLinkAddress>,
20     ↪ IConverter<decimal, TLinkAddress>
21     where TLinkAddress: struct
22     {
23         /// <summary>
24         /// <para>
25         /// The big integer to raw number sequence converter.
26         /// </para>
27         /// <para></para>
28         /// </summary>
29         public readonly BigIntegerToRawNumberSequenceConverter<TLinkAddress>
30         ↪ BigIntegerToRawNumberSequenceConverter;
31
32         /// <summary>
33         /// <para>
34         /// Initializes a new <see cref="DecimalToRationalConverter"/> instance.
35         /// </para>
36         /// <para></para>
37         /// </summary>
38         /// <param name="links">
39         /// <para>A links.</para>
40         /// <para></para>
41         /// </param>
42         /// <param name="bigIntegerToRawNumberSequenceConverter">
43         /// <para>A big integer to raw number sequence converter.</para>
44         /// <para></para>
45         /// </param>
46         public DecimalToRationalConverter(ILinks<TLinkAddress> links,
47         ↪ BigIntegerToRawNumberSequenceConverter<TLinkAddress>
48         ↪ bigIntegerToRawNumberSequenceConverter) : base(links)
49         {
50             BigIntegerToRawNumberSequenceConverter = bigIntegerToRawNumberSequenceConverter;
51         }
52
53         /// <summary>
54         /// <para>
55         /// Converts the decimal.
56         /// </para>
57         /// <para></para>
58         /// </summary>
59         /// <param name="@decimal">
60         /// <para>The decimal.</para>
61         /// <para></para>
62         /// </param>

```

```

58     /// </param>
59     /// <returns>
60     /// <para>The link</para>
61     /// <para></para>
62     /// </returns>
63     public TLinkAddress Convert(decimal @decimal)
64     {
65         var decimalAsString = @decimal.ToString(CultureInfo.InvariantCulture);
66         var dotPosition = decimalAsString.IndexOf('.');
67         var decimalWithoutDots = decimalAsString;
68         int digitsAfterDot = 0;
69         if (dotPosition != -1)
70         {
71             decimalWithoutDots = decimalWithoutDots.Remove(dotPosition, 1);
72             digitsAfterDot = decimalAsString.Length - 1 - dotPosition;
73         }
74         BigInteger denominator = new(System.Math.Pow(10, digitsAfterDot));
75         BigInteger numerator = BigInteger.Parse(decimalWithoutDots);
76         BigInteger greatestCommonDivisor;
77         do
78         {
79             greatestCommonDivisor = BigInteger.GreatestCommonDivisor(numerator, denominator);
80             numerator /= greatestCommonDivisor;
81             denominator /= greatestCommonDivisor;
82         }
83         while (greatestCommonDivisor > 1);
84         var numeratorLink = BigIntegerToRawNumberSequenceConverter.Convert(numerator);
85         var denominatorLink = BigIntegerToRawNumberSequenceConverter.Convert(denominator);
86         return _links.GetOrCreate(numeratorLink, denominatorLink);
87     }
88 }
89 }

```

### 1.33 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Rational/RationalToDecimalConverter.cs

```

1  using Platform.Converters;
2  using Platform.Data.Doublets.Decorators;
3  using Platform.Data.Doublets.Numbers.Raw;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Data.Doublets.Numbers.Rational
8  {
9      /// <summary>
10     /// <para>
11     /// Represents the rational to decimal converter.
12     /// </para>
13     /// <para></para>
14     /// </summary>
15     /// <seealso cref="LinksDecoratorBase{TLinkAddress}"/>
16     /// <seealso cref="IConverter{TLinkAddress, decimal}"/>
17     public class RationalToDecimalConverter<TLinkAddress> : LinksDecoratorBase<TLinkAddress>,
18     ↪ IConverter<TLinkAddress, decimal>
19     where TLinkAddress: struct
20     {
21         /// <summary>
22         /// <para>
23         /// The raw number sequence to big integer converter.
24         /// </para>
25         /// <para></para>
26         /// </summary>
27         public readonly RawNumberSequenceToBigIntegerConverter<TLinkAddress>
28         ↪ RawNumberSequenceToBigIntegerConverter;
29
30         /// <summary>
31         /// <para>
32         /// Initializes a new <see cref="RationalToDecimalConverter"/> instance.
33         /// </para>
34         /// <para></para>
35         /// </summary>
36         /// <param name="links">
37         /// <para>A links.</para>
38         /// <para></para>
39         /// </param>
40         /// <param name="rawNumberSequenceToBigIntegerConverter">
41         /// <para>A raw number sequence to big integer converter.</para>
42         /// <para></para>
43         /// </param>

```

```

42     public RationalToDecimalConverter(ILinks<TLinkAddress> links,
    ↪     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
    ↪     rawNumberSequenceToBigIntegerConverter) : base(links)
43     {
44         RawNumberSequenceToBigIntegerConverter = rawNumberSequenceToBigIntegerConverter;
45     }
46
47     /// <summary>
48     /// <para>
49     /// Converts the rational number.
50     /// </para>
51     /// <para></para>
52     /// </summary>
53     /// <param name="rationalNumber">
54     /// <para>The rational number.</para>
55     /// <para></para>
56     /// </param>
57     /// <returns>
58     /// <para>The decimal</para>
59     /// <para></para>
60     /// </returns>
61     public decimal Convert(TLinkAddress rationalNumber)
62     {
63         var numerator = (decimal)RawNumberSequenceToBigIntegerConverter.Convert(_links.GetSo
    ↪         ↪     urce(rationalNumber));
64         var denominator = (decimal)RawNumberSequenceToBigIntegerConverter.Convert(_links.Get
    ↪         ↪     Target(rationalNumber));
65         return numerator / denominator;
66     }
67 }
68 }

```

### 1.34 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Raw/BigIntegerToRawNumberSequenceConverter.cs

```

1  using System.Collections.Generic;
2  using System.Numerics;
3  using System.Runtime.InteropServices;
4  using Platform.Converters;
5  using Platform.Data.Doublets.Decorators;
6  using Platform.Numbers;
7  using Platform.Reflection;
8  using Platform.Unsafe;
9
10 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
11
12 namespace Platform.Data.Doublets.Numbers.Raw
13 {
14     /// <summary>
15     /// <para>
16     /// Represents the big integer to raw number sequence converter.
17     /// </para>
18     /// <para></para>
19     /// </summary>
20     /// <seealso cref="LinksDecoratorBase{TLinkAddress}"/>
21     /// <seealso cref="IConverter{BigInteger, TLinkAddress}"/>
22     public class BigIntegerToRawNumberSequenceConverter<TLinkAddress> :
    ↪     LinksDecoratorBase<TLinkAddress>, IConverter<BigInteger, TLinkAddress>
23     where TLinkAddress : struct
24     {
25         /// <summary>
26         /// <para>
27         /// The max value.
28         /// </para>
29         /// <para></para>
30         /// </summary>
31         public static readonly TLinkAddress MaximumValue = NumericType<TLinkAddress>.MaxValue;
32         /// <summary>
33         /// <para>
34         /// The maximum value.
35         /// </para>
36         /// <para></para>
37         /// </summary>
38         public static readonly TLinkAddress BitMask = Bit.ShiftRight(MaximumValue, 1);
39         /// <summary>
40         /// <para>
41         /// The address to number converter.
42         /// </para>
43         /// <para></para>
44         /// </summary>
45         public readonly IConverter<TLinkAddress> AddressToNumberConverter;

```

```

46     /// <summary>
47     /// <para>
48     /// The list to sequence converter.
49     /// </para>
50     /// <para></para>
51     /// </summary>
52     public readonly IConverter<IList<TLinkAddress>, TLinkAddress> ListToSequenceConverter;
53     /// <summary>
54     /// <para>
55     /// The negative number marker.
56     /// </para>
57     /// <para></para>
58     /// </summary>
59     public readonly TLinkAddress NegativeNumberMarker;
60
61     /// <summary>
62     /// <para>
63     /// Initializes a new <see cref="BigIntegerToRawNumberSequenceConverter"/> instance.
64     /// </para>
65     /// <para></para>
66     /// </summary>
67     /// <param name="links">
68     /// <para>A links.</para>
69     /// <para></para>
70     /// </param>
71     /// <param name="addressToNumberConverter">
72     /// <para>A address to number converter.</para>
73     /// <para></para>
74     /// </param>
75     /// <param name="listToSequenceConverter">
76     /// <para>A list to sequence converter.</para>
77     /// <para></para>
78     /// </param>
79     /// <param name="negativeNumberMarker">
80     /// <para>A negative number marker.</para>
81     /// <para></para>
82     /// </param>
83     public BigIntegerToRawNumberSequenceConverter(ILinks<TLinkAddress> links,
84     ↪ IConverter<TLinkAddress> addressToNumberConverter,
85     ↪ IConverter<IList<TLinkAddress>,TLinkAddress> listToSequenceConverter, TLinkAddress
86     ↪ negativeNumberMarker) : base(links)
87     {
88         AddressToNumberConverter = addressToNumberConverter;
89         ListToSequenceConverter = listToSequenceConverter;
90         NegativeNumberMarker = negativeNumberMarker;
91     }
92     private List<TLinkAddress> GetRawNumberParts(BigInteger bigInteger)
93     {
94         List<TLinkAddress> rawNumbers = new();
95         BigInteger currentBigInt = bigInteger;
96         do
97         {
98             var bigIntBytes = currentBigInt.ToByteArray();
99             var bigIntWithBitMask = Bit.And(bigIntBytes.ToStructure<TLinkAddress>(),
100             ↪ BitMask);
101             var rawNumber = AddressToNumberConverter.Convert(bigIntWithBitMask);
102             rawNumbers.Add(rawNumber);
103             currentBigInt >>= (NumericType<TLinkAddress>.BitsSize - 1);
104         }
105         while (currentBigInt > 0);
106         return rawNumbers;
107     }
108
109     /// <summary>
110     /// <para>
111     /// Converts the big integer.
112     /// </para>
113     /// <para></para>
114     /// </summary>
115     /// <param name="bigInteger">
116     /// <para>The big integer.</para>
117     /// <para></para>
118     /// </param>
119     /// <returns>
120     /// <para>The link</para>
121     /// <para></para>
122     /// </returns>
123     public TLinkAddress Convert(BigInteger bigInteger)

```

```

120     {
121         var sign = bigInteger.Sign;
122         var number = GetRawNumberParts(sign == -1 ? BigInteger.Negate(bigInteger) :
            ↳ bigInteger);
123         var numberSequence = ListToSequenceConverter.Convert(number);
124         return sign == -1 ? _links.GetOrCreate(NegativeNumberMarker, numberSequence) :
            ↳ numberSequence;
125     }
126 }
127 }

```

### 1.35 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Raw/LongRawNumberSequenceToNumberConverter.cs

```

1  using System.Runtime.CompilerServices;
2  using Platform.Collections.Stacks;
3  using Platform.Converters;
4  using Platform.Numbers;
5  using Platform.Reflection;
6  using Platform.Data.Doublets.Decorators;
7  using Platform.Data.Doublets.Sequences.Walkers;
8
9  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
10
11 namespace Platform.Data.Doublets.Numbers.Raw
12 {
13     /// <summary>
14     /// <para>
15     /// Represents the long raw number sequence to number converter.
16     /// </para>
17     /// <para></para>
18     /// </summary>
19     /// <seealso cref="LinksDecoratorBase{TSource}"/>
20     /// <seealso cref="IConverter{TSource, TTarget}"/>
21     public class LongRawNumberSequenceToNumberConverter<TSource, TTarget> :
        ↳ LinksDecoratorBase<TSource>, IConverter<TSource, TTarget>
22     {
23         private static readonly int _bitsPerRawNumber = NumericType<TSource>.BitsSize - 1;
24         private static readonly UncheckedConverter<TSource, TTarget> _sourceToTargetConverter =
            ↳ UncheckedConverter<TSource, TTarget>.Default;
25         private readonly IConverter<TSource> _numberToAddressConverter;
26
27         /// <summary>
28         /// <para>
29         /// Initializes a new <see cref="LongRawNumberSequenceToNumberConverter"/> instance.
30         /// </para>
31         /// <para></para>
32         /// </summary>
33         /// <param name="links">
34         /// <para>A links.</para>
35         /// <para></para>
36         /// </param>
37         /// <param name="numberToAddressConverter">
38         /// <para>A number to address converter.</para>
39         /// <para></para>
40         /// </param>
41         [MethodImpl(MethodImplOptions.AggressiveInlining)]
42         public LongRawNumberSequenceToNumberConverter(ILinks<TSource> links, IConverter<TSource>
            ↳ numberToAddressConverter) : base(links) => _numberToAddressConverter =
            ↳ numberToAddressConverter;
43
44         /// <summary>
45         /// <para>
46         /// Converts the source.
47         /// </para>
48         /// <para></para>
49         /// </summary>
50         /// <param name="source">
51         /// <para>The source.</para>
52         /// <para></para>
53         /// </param>
54         /// <returns>
55         /// <para>The target</para>
56         /// <para></para>
57         /// </returns>
58         [MethodImpl(MethodImplOptions.AggressiveInlining)]
59         public TTarget Convert(TSource source)
60         {
61             var constants = Links.Constants;
62             var externalReferencesRange = constants.ExternalReferencesRange;

```

```

63         if (externalReferencesRange.HasValue &&
        ↪ externalReferencesRange.Value.Contains(source))
64     {
65         return
        ↪ _sourceToTargetConverter.Convert(_numberToAddressConverter.Convert(source));
66     }
67     else
68     {
69         var pair = Links.GetLink(source);
70         var walker = new LeftSequenceWalker<TSource>(Links, new DefaultStack<TSource>(),
        ↪ (link) => externalReferencesRange.HasValue &&
        ↪ externalReferencesRange.Value.Contains(link));
71         TTarget result = default;
72         foreach (var element in walker.Walk(source))
73         {
74             result = Bit.Or(Bit.ShiftLeft(result, _bitsPerRawNumber), Convert(element));
75         }
76         return result;
77     }
78 }
79 }
80 }

```

### 1.36 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Raw/NumberToLongRawNumberSequenceConverter.cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3  using Platform.Converters;
4  using Platform.Numbers;
5  using Platform.Reflection;
6  using Platform.Data.Doublets.Decorators;
7
8  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
9
10 namespace Platform.Data.Doublets.Numbers.Raw
11 {
12     /// <summary>
13     /// <para>
14     /// Represents the number to long raw number sequence converter.
15     /// </para>
16     /// <para></para>
17     /// </summary>
18     /// <seealso cref="LinksDecoratorBase{TTarget}">
19     /// <seealso cref="IConverter{TSource, TTarget}">
20     public class NumberToLongRawNumberSequenceConverter<TSource, TTarget> :
        ↪ LinksDecoratorBase<TTarget>, IConverter<TSource, TTarget>
21     {
22         private static readonly Comparer<TSource> _comparer = Comparer<TSource>.Default;
23         private static readonly TSource _maximumValue = NumericType<TSource>.MaxValue;
24         private static readonly int _bitsPerRawNumber = NumericType<TTarget>.BitsSize - 1;
25         private static readonly TSource _bitMask = Bit.ShiftRight(_maximumValue,
        ↪ NumericType<TTarget>.BitsSize + 1);
26         private static readonly TSource _maximumConvertibleAddress = CheckedConverter<TTarget,
        ↪ TSource>.Default.Convert(Arithmetic.Decrement(Hybrid<TTarget>.ExternalZero));
27         private static readonly UncheckedConverter<TSource, TTarget> _sourceToTargetConverter =
        ↪ UncheckedConverter<TSource, TTarget>.Default;
28         private readonly IConverter<TTarget> _addressToNumberConverter;
29
30         /// <summary>
31         /// <para>
32         /// Initializes a new <see cref="NumberToLongRawNumberSequenceConverter" /> instance.
33         /// </para>
34         /// <para></para>
35         /// </summary>
36         /// <param name="links">
37         /// <para>A links.</para>
38         /// <para></para>
39         /// </param>
40         /// <param name="addressToNumberConverter">
41         /// <para>A address to number converter.</para>
42         /// <para></para>
43         /// </param>
44         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45         public NumberToLongRawNumberSequenceConverter(ILinks<TTarget> links, IConverter<TTarget>
        ↪ addressToNumberConverter) : base(links) => _addressToNumberConverter =
        ↪ addressToNumberConverter;
46
47         /// <summary>
48         /// <para>
49         /// Converts the source.

```

```

50     /// </para>
51     /// <para></para>
52     /// </summary>
53     /// <param name="source">
54     /// <para>The source.</para>
55     /// <para></para>
56     /// </param>
57     /// <returns>
58     /// <para>The target</para>
59     /// <para></para>
60     /// </returns>
61     [MethodImpl(MethodImplOptions.AggressiveInlining)]
62     public TTarget Convert(TSource source)
63     {
64         if (_comparer.Compare(source, _maximumConvertibleAddress) > 0)
65         {
66             var numberPart = Bit.And(source, _bitMask);
67             var convertedNumber = _addressToNumberConverter.Convert(_sourceToTargetConverter
        ↪ .Convert(numberPart));
68             return Links.GetOrCreate(convertedNumber, Convert(Bit.ShiftRight(source,
        ↪ _bitsPerRawNumber)));
69         }
70         else
71         {
72             return
73             ↪ _addressToNumberConverter.Convert(_sourceToTargetConverter.Convert(source));
74         }
75     }
76 }

```

### 1.37 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Raw/RawNumberSequenceToBigIntegerConverter.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Numerics;
4  using Platform.Collections.Stacks;
5  using Platform.Converters;
6  using Platform.Data.Doublets.Decorators;
7  using Platform.Data.Doublets.Sequences.Walkers;
8  using Platform.Reflection;
9  using Platform.Unsafe;
10
11 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
12
13 namespace Platform.Data.Doublets.Numbers.Raw
14 {
15     /// <summary>
16     /// <para>
17     /// Represents the raw number sequence to big integer converter.
18     /// </para>
19     /// <para></para>
20     /// </summary>
21     /// <seealso cref="LinksDecoratorBase{TLinkAddress}"/>
22     /// <seealso cref="IConverter{TLinkAddress, BigInteger}"/>
23     public class RawNumberSequenceToBigIntegerConverter<TLinkAddress> :
24     ↪ LinksDecoratorBase<TLinkAddress>, IConverter<TLinkAddress, BigInteger>
25     where TLinkAddress : struct
26     {
27         /// <summary>
28         /// <para>
29         /// The default.
30         /// </para>
31         /// <para></para>
32         /// </summary>
33         public readonly EqualityComparer<TLinkAddress> EqualityComparer =
34         ↪ EqualityComparer<TLinkAddress>.Default;
35         /// <summary>
36         /// <para>
37         /// The number to address converter.
38         /// </para>
39         /// <para></para>
40         /// </summary>
41         public readonly IConverter<TLinkAddress, TLinkAddress> NumberToAddressConverter;
42         /// <summary>
43         /// <para>
44         /// The left sequence walker.
45         /// </para>
46         /// <para></para>
47         /// </summary>

```



```

46 public readonly LeftSequenceWalker<TLinkAddress> LeftSequenceWalker;
47 /// <summary>
48 /// <para>
49 /// The negative number marker.
50 /// </para>
51 /// <para></para>
52 /// </summary>
53 public readonly TLinkAddress NegativeNumberMarker;
54
55 /// <summary>
56 /// <para>
57 /// Initializes a new <see cref="RawNumberSequenceToBigIntegerConverter"/> instance.
58 /// </para>
59 /// <para></para>
60 /// </summary>
61 /// <param name="links">
62 /// <para>A links.</para>
63 /// <para></para>
64 /// </param>
65 /// <param name="numberToAddressConverter">
66 /// <para>A number to address converter.</para>
67 /// <para></para>
68 /// </param>
69 /// <param name="negativeNumberMarker">
70 /// <para>A negative number marker.</para>
71 /// <para></para>
72 /// </param>
73 public RawNumberSequenceToBigIntegerConverter(ILinks<TLinkAddress> links,
74     ↳ IConverter<TLinkAddress, TLinkAddress> numberToAddressConverter, TLinkAddress
75     ↳ negativeNumberMarker) : base(links)
76 {
77     NumberToAddressConverter = numberToAddressConverter;
78     LeftSequenceWalker = new(links, new DefaultStack<TLinkAddress>());
79     NegativeNumberMarker = negativeNumberMarker;
80 }
81
82 /// <summary>
83 /// <para>
84 /// Converts the big integer.
85 /// </para>
86 /// <para></para>
87 /// </summary>
88 /// <param name="bigInteger">
89 /// <para>The big integer.</para>
90 /// <para></para>
91 /// </param>
92 /// <exception cref="Exception">
93 /// <para>Raw number sequence cannot be empty.</para>
94 /// <para></para>
95 /// </exception>
96 /// <returns>
97 /// <para>The big integer</para>
98 /// <para></para>
99 /// </returns>
100 public BigInteger Convert(TLinkAddress bigInteger)
101 {
102     var sign = 1;
103     var bigIntegerSequence = bigInteger;
104     if (EqualityComparer.Equals(_links.GetSource(bigIntegerSequence),
105         ↳ NegativeNumberMarker))
106     {
107         sign = -1;
108         bigIntegerSequence = _links.GetTarget(bigInteger);
109     }
110     using var enumerator = LeftSequenceWalker.Walk(bigIntegerSequence).GetEnumerator();
111     if (!enumerator.MoveNext())
112     {
113         throw new Exception("Raw number sequence cannot be empty.");
114     }
115     var nextPart = NumberToAddressConverter.Convert(enumerator.Current);
116     BigInteger currentBigInt = new(nextPart.ToBytes());
117     while (enumerator.MoveNext())
118     {
119         currentBigInt <= (NumericType<TLinkAddress>.BitsSize - 1);
120         nextPart = NumberToAddressConverter.Convert(enumerator.Current);
121         currentBigInt |= new BigInteger(nextPart.ToBytes());
122     }
123     return sign == -1 ? BigInteger.Negate(currentBigInt) : currentBigInt;

```

```

121     }
122 }
123 }

```

### 1.38 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Unary/AddressToUnaryNumberConverter.cs

```

1  using System.Collections.Generic;
2  using Platform.Reflection;
3  using Platform.Converters;
4  using Platform.Numbers;
5  using System.Runtime.CompilerServices;
6
7  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9  namespace Platform.Data.Doublets.Numbers.Unary
10 {
11     /// <summary>
12     /// <para>
13     /// Represents the address to unary number converter.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="LinksOperatorBase{TLinkAddress}" />
18     /// <seealso cref="IConverter{TLinkAddress}" />
19     public class AddressToUnaryNumberConverter<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
20         IConverter<TLinkAddress>
21     {
22         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
23             EqualityComparer<TLinkAddress>.Default;
24         private static readonly TLinkAddress _zero = default;
25         private static readonly TLinkAddress _one = Arithmetic.Increment(_zero);
26         private readonly IConverter<int, TLinkAddress> _powerOf2ToUnaryNumberConverter;
27
28         /// <summary>
29         /// <para>
30         /// Initializes a new <see cref="AddressToUnaryNumberConverter" /> instance.
31         /// </para>
32         /// <para></para>
33         /// </summary>
34         /// <param name="links">
35         /// <para>A links.</para>
36         /// <para></para>
37         /// </param>
38         /// <param name="powerOf2ToUnaryNumberConverter">
39         /// <para>A power of 2 to unary number converter.</para>
40         /// <para></para>
41         /// </param>
42         [MethodImpl(MethodImplOptions.AggressiveInlining)]
43         public AddressToUnaryNumberConverter(ILinks<TLinkAddress> links, IConverter<int,
44             TLinkAddress> powerOf2ToUnaryNumberConverter) : base(links) =>
45             _powerOf2ToUnaryNumberConverter = powerOf2ToUnaryNumberConverter;
46
47         /// <summary>
48         /// <para>
49         /// Converts the number.
50         /// </para>
51         /// <para></para>
52         /// </summary>
53         /// <param name="number">
54         /// <para>The number.</para>
55         /// <para></para>
56         /// </param>
57         /// <returns>
58         /// <para>The target.</para>
59         /// <para></para>
60         /// </returns>
61         [MethodImpl(MethodImplOptions.AggressiveInlining)]
62         public TLinkAddress Convert(TLinkAddress number)
63         {
64             var links = _links;
65             var nullConstant = links.Constants.Null;
66             var target = nullConstant;
67             for (var i = 0; !_equalityComparer.Equals(number, _zero) && i <
68                 NumericType<TLinkAddress>.BitsSize; i++)
69             {
70                 if (_equalityComparer.Equals(Bit.And(number, _one), _one))
71                 {
72                     target = _equalityComparer.Equals(target, nullConstant)
73                         ? _powerOf2ToUnaryNumberConverter.Convert(i)
74                         : links.GetOrCreate(_powerOf2ToUnaryNumberConverter.Convert(i), target);
75                 }
76             }
77         }
78     }
79 }

```

```

70         }
71         number = Bit.ShiftRight(number, 1);
72     }
73     return target;
74 }
75 }
76 }

```

### 1.39 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Unary/LinkToItsFrequencyNumberConverter.cs

```

1  using System;
2  using System.Collections.Generic;
3  using Platform.Interfaces;
4  using Platform.Converters;
5  using System.Runtime.CompilerServices;
6
7  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9  namespace Platform.Data.Doublets.Numbers.Unary
10 {
11     /// <summary>
12     /// <para>
13     /// Represents the link to its frequency number converter.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
18     /// <seealso cref="IConverter{Doublet{TLinkAddress}, TLinkAddress}"/>
19     public class LinkToItsFrequencyNumberConverter<TLinkAddress> :
20         ↳ LinksOperatorBase<TLinkAddress>, IConverter<Doublet<TLinkAddress>, TLinkAddress>
21     {
22         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
23             ↳ EqualityComparer<TLinkAddress>.Default;
24         private readonly IProperty<TLinkAddress, TLinkAddress> _frequencyPropertyOperator;
25         private readonly IConverter<TLinkAddress> _unaryNumberToAddressConverter;
26
27         /// <summary>
28         /// <para>
29         /// Initializes a new <see cref="LinkToItsFrequencyNumberConverter"/> instance.
30         /// </para>
31         /// <para></para>
32         /// </summary>
33         /// <param name="links">
34         /// <para>A links.</para>
35         /// <para></para>
36         /// </param>
37         /// <param name="frequencyPropertyOperator">
38         /// <para>A frequency property operator.</para>
39         /// <para></para>
40         /// </param>
41         /// <param name="unaryNumberToAddressConverter">
42         /// <para>A unary number to address converter.</para>
43         /// <para></para>
44         /// </param>
45         [MethodImpl(MethodImplOptions.AggressiveInlining)]
46         public LinkToItsFrequencyNumberConverter(
47             ILinks<TLinkAddress> links,
48             IProperty<TLinkAddress, TLinkAddress> frequencyPropertyOperator,
49             IConverter<TLinkAddress> unaryNumberToAddressConverter)
50             : base(links)
51         {
52             _frequencyPropertyOperator = frequencyPropertyOperator;
53             _unaryNumberToAddressConverter = unaryNumberToAddressConverter;
54         }
55
56         /// <summary>
57         /// <para>
58         /// Converts the doublet.
59         /// </para>
60         /// <para></para>
61         /// </summary>
62         /// <param name="doublet">
63         /// <para>The doublet.</para>
64         /// <para></para>
65         /// </param>
66         /// <exception cref="ArgumentException">
67         /// <para>Link ({doublet}) not found. </para>
68         /// <para></para>
69         /// </exception>
70         /// </returns>

```

```

69     /// <para>The link</para>
70     /// <para></para>
71     /// </returns>
72     [MethodImpl(MethodImplOptions.AggressiveInlining)]
73     public TLinkAddress Convert(Doublet<TLinkAddress> doublet)
74     {
75         var links = _links;
76         var link = links.SearchOrDefault(doublet.Source, doublet.Target);
77         if (_equalityComparer.Equals(link, default))
78         {
79             throw new ArgumentException($"Link ({doublet}) not found.", nameof(doublet));
80         }
81         var frequency = _frequencyPropertyOperator.Get(link);
82         if (_equalityComparer.Equals(frequency, default))
83         {
84             return default;
85         }
86         var frequencyNumber = links.GetSource(frequency);
87         return _unaryNumberToAddressConverter.Convert(frequencyNumber);
88     }
89 }
90 }

```

#### 1.40 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Unary/PowerOf2ToUnaryNumberConverter.cs

```

1  using System.Collections.Generic;
2  using Platform.Exceptions;
3  using Platform.Ranges;
4  using Platform.Converters;
5  using System.Runtime.CompilerServices;
6
7  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9  namespace Platform.Data.Doublets.Numbers.Unary
10 {
11     /// <summary>
12     /// <para>
13     /// Represents the power of to unary number converter.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
18     /// <seealso cref="IConverter{int, TLinkAddress}"/>
19     public class PowerOf2ToUnaryNumberConverter<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
20     ↪ IConverter<int, TLinkAddress>
21     {
22         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
23         ↪ EqualityComparer<TLinkAddress>.Default;
24         private readonly TLinkAddress[] _unaryNumberPowersOf2;
25
26         /// <summary>
27         /// <para>
28         /// Initializes a new <see cref="PowerOf2ToUnaryNumberConverter"/> instance.
29         /// </para>
30         /// <para></para>
31         /// </summary>
32         /// <param name="links">
33         /// <para>A links.</para>
34         /// <para></para>
35         /// </param>
36         /// <param name="one">
37         /// <para>A one.</para>
38         /// <para></para>
39         /// </param>
40         [MethodImpl(MethodImplOptions.AggressiveInlining)]
41         public PowerOf2ToUnaryNumberConverter(ILinks<TLinkAddress> links, TLinkAddress one) :
42         ↪ base(links)
43         {
44             _unaryNumberPowersOf2 = new TLinkAddress[64];
45             _unaryNumberPowersOf2[0] = one;
46         }
47
48         /// <summary>
49         /// <para>
50         /// Converts the power.
51         /// </para>
52         /// <para></para>
53         /// </summary>
54         /// <param name="power">
55         /// <para>The power.</para>
56         /// </param>

```

```

53     /// <para></para>
54     /// </param>
55     /// <returns>
56     /// <para>The power of.</para>
57     /// <para></para>
58     /// </returns>
59     [MethodImpl(MethodImplOptions.AggressiveInlining)]
60     public TLinkAddress Convert(int power)
61     {
62         Ensure.Always.ArgumentInRange(power, new Range<int>(0, _unaryNumberPowersOf2.Length
        ↪ - 1), nameof(power));
63         if (!_equalityComparer.Equals(_unaryNumberPowersOf2[power], default))
64         {
65             return _unaryNumberPowersOf2[power];
66         }
67         var previousPowerOf2 = Convert(power - 1);
68         var powerOf2 = _links.GetOrCreate(previousPowerOf2, previousPowerOf2);
69         _unaryNumberPowersOf2[power] = powerOf2;
70         return powerOf2;
71     }
72 }
73 }

```

#### 1.41 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Unary/UnaryNumberToAddressAddOperationConverter

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3  using Platform.Converters;
4  using Platform.Numbers;
5
6  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8  namespace Platform.Data.Doublets.Numbers.Unary
9  {
10     /// <summary>
11     /// <para>
12     /// Represents the unary number to address add operation converter.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
17     /// <seealso cref="IConverter{TLinkAddress}"/>
18     public class UnaryNumberToAddressAddOperationConverter<TLinkAddress> :
19     ↪ LinksOperatorBase<TLinkAddress>, IConverter<TLinkAddress>
20     {
21         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
22         ↪ EqualityComparer<TLinkAddress>.Default;
23         private static readonly UncheckedConverter<TLinkAddress, ulong>
24         ↪ _addressToUInt64Converter = UncheckedConverter<TLinkAddress, ulong>.Default;
25         private static readonly UncheckedConverter<ulong, TLinkAddress>
26         ↪ _uint64ToAddressConverter = UncheckedConverter<ulong, TLinkAddress>.Default;
27         private static readonly TLinkAddress _zero = default;
28         private static readonly TLinkAddress _one = Arithmetic.Increment(_zero);
29         private readonly Dictionary<TLinkAddress, TLinkAddress> _unaryToUInt64;
30         private readonly TLinkAddress _unaryOne;
31
32         /// <summary>
33         /// <para>
34         /// Initializes a new <see cref="UnaryNumberToAddressAddOperationConverter"/> instance.
35         /// </para>
36         /// <para></para>
37         /// </summary>
38         /// <param name="links">
39         /// <para>A links.</para>
40         /// <para></para>
41         /// </param>
42         /// <param name="unaryOne">
43         /// <para>A unary one.</para>
44         /// <para></para>
45         /// </param>
46         [MethodImpl(MethodImplOptions.AggressiveInlining)]
47         public UnaryNumberToAddressAddOperationConverter(ILinks<TLinkAddress> links,
48         ↪ TLinkAddress unaryOne)
49         : base(links)
50         {
51             _unaryOne = unaryOne;
52             _unaryToUInt64 = CreateUnaryToUInt64Dictionary(links, unaryOne);
53         }
54
55         /// <summary>

```

```

51     /// <para>
52     /// Converts the unary number.
53     /// </para>
54     /// <para></para>
55     /// </summary>
56     /// <param name="unaryNumber">
57     /// <para>The unary number.</para>
58     /// <para></para>
59     /// </param>
60     /// <returns>
61     /// <para>The link</para>
62     /// <para></para>
63     /// </returns>
64     [MethodImpl(MethodImplOptions.AggressiveInlining)]
65     public TLinkAddress Convert(TLinkAddress unaryNumber)
66     {
67         if (_equalityComparer.Equals(unaryNumber, default))
68         {
69             return default;
70         }
71         if (_equalityComparer.Equals(unaryNumber, _unaryOne))
72         {
73             return _one;
74         }
75         var links = _links;
76         var source = links.GetSource(unaryNumber);
77         var target = links.GetTarget(unaryNumber);
78         if (_equalityComparer.Equals(source, target))
79         {
80             return _unaryToUInt64[unaryNumber];
81         }
82         else
83         {
84             var result = _unaryToUInt64[source];
85             TLinkAddress lastValue;
86             while (!_unaryToUInt64.TryGetValue(target, out lastValue))
87             {
88                 source = links.GetSource(target);
89                 result = Arithmetic<TLinkAddress>.Add(result, _unaryToUInt64[source]);
90                 target = links.GetTarget(target);
91             }
92             result = Arithmetic<TLinkAddress>.Add(result, lastValue);
93             return result;
94         }
95     }
96     [MethodImpl(MethodImplOptions.AggressiveInlining)]
97     private static Dictionary<TLinkAddress, TLinkAddress>
98     ↪ CreateUnaryToUInt64Dictionary(ILinks<TLinkAddress> links, TLinkAddress unaryOne)
99     {
100         var unaryToUInt64 = new Dictionary<TLinkAddress, TLinkAddress>
101         {
102             { unaryOne, _one }
103         };
104         var unary = unaryOne;
105         var number = _one;
106         for (var i = 1; i < 64; i++)
107         {
108             unary = links.GetOrCreate(unary, unary);
109             number = Double(number);
110             unaryToUInt64.Add(unary, number);
111         }
112         return unaryToUInt64;
113     }
114     [MethodImpl(MethodImplOptions.AggressiveInlining)]
115     private static TLinkAddress Double(TLinkAddress number) =>
116     ↪ _uInt64ToAddressConverter.Convert(_addressToUInt64Converter.Convert(number) * 2UL);

```

#### 1.42 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Unary/UnaryNumberToAddressOrOperationConverter

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Reflection;
4 using Platform.Converters;
5 using Platform.Numbers;
6
7 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9 namespace Platform.Data.Doublets.Numbers.Unary

```

```

10 {
11     /// <summary>
12     /// <para>
13     /// Represents the unary number to address or operation converter.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
18     /// <seealso cref="IConverter{TLinkAddress}"/>
19     public class UnaryNumberToAddressOrOperationConverter<TLinkAddress> :
20     ↪ LinksOperatorBase<TLinkAddress>, IConverter<TLinkAddress>
21     {
22         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
23         ↪ EqualityComparer<TLinkAddress>.Default;
24         private static readonly TLinkAddress _zero = default;
25         private static readonly TLinkAddress _one = Arithmetic.Increment(_zero);
26         private static readonly IDictionary<TLinkAddress, int> _unaryNumberPowerOf2Indicies;
27
28         /// <summary>
29         /// <para>
30         /// Initializes a new <see cref="UnaryNumberToAddressOrOperationConverter"/> instance.
31         /// </para>
32         /// <para></para>
33         /// </summary>
34         /// <param name="links">
35         /// <para>A links.</para>
36         /// </param>
37         /// <param name="powerOf2ToUnaryNumberConverter">
38         /// <para>A power of 2 to unary number converter.</para>
39         /// </param>
40         [MethodImpl(MethodImplOptions.AggressiveInlining)]
41         public UnaryNumberToAddressOrOperationConverter(ILinks<TLinkAddress> links,
42         ↪ IConverter<int, TLinkAddress> powerOf2ToUnaryNumberConverter) : base(links) =>
43         ↪ _unaryNumberPowerOf2Indicies =
44         ↪ CreateUnaryNumberPowerOf2IndiciesDictionary(powerOf2ToUnaryNumberConverter);
45
46         /// <summary>
47         /// <para>
48         /// Converts the source number.
49         /// </para>
50         /// <para></para>
51         /// </summary>
52         /// <param name="sourceNumber">
53         /// <para>The source number.</para>
54         /// </param>
55         /// <returns>
56         /// <para>The target.</para>
57         /// </returns>
58         [MethodImpl(MethodImplOptions.AggressiveInlining)]
59         public TLinkAddress Convert(TLinkAddress sourceNumber)
60         {
61             var links = _links;
62             var nullConstant = links.Constants.Null;
63             var source = sourceNumber;
64             var target = nullConstant;
65             if (!_equalityComparer.Equals(source, nullConstant))
66             {
67                 while (true)
68                 {
69                     if (_unaryNumberPowerOf2Indicies.TryGetValue(source, out int powerOf2Index))
70                     {
71                         SetBit(ref target, powerOf2Index);
72                         break;
73                     }
74                     else
75                     {
76                         powerOf2Index = _unaryNumberPowerOf2Indicies[links.GetSource(source)];
77                         SetBit(ref target, powerOf2Index);
78                         source = links.GetTarget(source);
79                     }
80                 }
81             }
82             return target;
83         }
84     }
85     [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

84     private static Dictionary<TLinkAddress, int>
        ↪ CreateUnaryNumberPowerOf2Indices(Dictionary<int, TLinkAddress>
        ↪ powerOf2ToUnaryNumberConverter)
85     {
86         var unaryNumberPowerOf2Indices = new Dictionary<TLinkAddress, int>();
87         for (int i = 0; i < NumericType<TLinkAddress>.BitsSize; i++)
88         {
89             unaryNumberPowerOf2Indices.Add(powerOf2ToUnaryNumberConverter.Convert(i), i);
90         }
91         return unaryNumberPowerOf2Indices;
92     }
93     [MethodImpl(MethodImplOptions.AggressiveInlining)]
94     private static void SetBit(ref TLinkAddress target, int powerOf2Index) => target =
        ↪ Bit.Or(target, Bit.ShiftLeft(_one, powerOf2Index));
95 }
96 }

```

#### 1.43 ./csharp/Platform.Data.Doublets.Sequences/Sequences.Experiments.cs

```

1  // using System;
2  // using System.Collections.Generic;
3  // using System.Runtime.CompilerServices;
4  // using System.Linq;
5  // using System.Text;
6  // using Platform.Collections;
7  // using Platform.Collections.Sets;
8  // using Platform.Collections.Stacks;
9  // using Platform.Data.Exceptions;
10 // using Platform.Data.Sequences;
11 // using Platform.Data.Doublets.Sequences.Frequencies.Counters;
12 // using Platform.Data.Doublets.Sequences.Walkers;
13 // using LinkIndex = System.UInt64;
14 // using Stack = System.Collections.Generic.Stack<ulong>;
15 //
16 // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
17 //
18 // namespace Platform.Data.Doublets.Sequences
19 // {
20 //     /// <summary>
21 //     /// <para>
22 //     /// Represents the sequences.
23 //     /// </para>
24 //     /// <para></para>
25 //     /// </summary>
26 //     partial class Sequences
27 //     {
28 //         #region Create All Variants (Not Practical)
29 //
30 //         /// <remarks>
31 //         /// Number of links that is needed to generate all variants for
32 //         /// sequence of length N corresponds to https://oeis.org/A014143/list sequence.
33 //         /// </remarks>
34 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
35 //         public ulong[] CreateAllVariants2(ulong[] sequence)
36 //         {
37 //             return _sync.DoWrite(() =>
38 //             {
39 //                 if (sequence.IsNullOrEmpty())
40 //                 {
41 //                     return Array.Empty<ulong>();
42 //                 }
43 //                 Links.EnsureLinkExists(sequence);
44 //                 if (sequence.Length == 1)
45 //                 {
46 //                     return sequence;
47 //                 }
48 //                 return CreateAllVariants2Core(sequence, 0, (ulong)sequence.Length - 1);
49 //             });
50 //         }
51 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
52 //         private ulong[] CreateAllVariants2Core(ulong[] sequence, ulong startAt, ulong stopAt)
53 //         {
54 //             if ((stopAt - startAt) == 0)
55 //             {
56 //                 return new[] { sequence[startAt] };
57 //             }
58 //             if ((stopAt - startAt) == 1)
59 //             {

```



```

60 //         return new[] { Links.Unsync.GetOrCreate(sequence[startAt], sequence[stopAt])
61 //     };
62 //     }
63 //     var variants = new ulong[Platform.Numbers.Math.Catalan(stopAt - startAt)];
64 //     var last = 0;
65 //     for (var splitter = startAt; splitter < stopAt; splitter++)
66 //     {
67 //         var left = CreateAllVariants2Core(sequence, startAt, splitter);
68 //         var right = CreateAllVariants2Core(sequence, splitter + 1, stopAt);
69 //         for (var i = 0; i < left.Length; i++)
70 //         {
71 //             for (var j = 0; j < right.Length; j++)
72 //             {
73 //                 var variant = Links.Unsync.GetOrCreate(left[i], right[j]);
74 //                 if (variant == Constants.Null)
75 //                 {
76 //                     throw new NotImplementedException("Creation cancellation is not
77 //                 implemented.");
78 //                 }
79 //                 variants[last++] = variant;
80 //             }
81 //         }
82 //     }
83 //     return variants;
84 // }
85 //
86 // /// <summary>
87 // /// <para>
88 // /// Creates the all variants 1 using the specified sequence.
89 // /// </para>
90 // /// <para></para>
91 // /// </summary>
92 // /// <param name="sequence">
93 // /// <para>The sequence.</para>
94 // /// </param>
95 // /// <returns>
96 // /// <para>A list of ulong</para>
97 // /// <para></para>
98 // /// </returns>
99 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
100 // public List<ulong> CreateAllVariants1(params ulong[] sequence)
101 // {
102 //     return _sync.DoWrite(() =>
103 //     {
104 //         if (sequence.IsNullOrEmpty())
105 //         {
106 //             return new List<ulong>();
107 //         }
108 //         Links.Unsync.EnsureLinkExists(sequence);
109 //         if (sequence.Length == 1)
110 //         {
111 //             return new List<ulong> { sequence[0] };
112 //         }
113 //         var results = new
114 //         List<ulong>((int)Platform.Numbers.Math.Catalan((ulong)sequence.Length));
115 //         return CreateAllVariants1Core(sequence, results);
116 //     });
117 // }
118 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
119 // private List<ulong> CreateAllVariants1Core(ulong[] sequence, List<ulong> results)
120 // {
121 //     if (sequence.Length == 2)
122 //     {
123 //         var link = Links.Unsync.GetOrCreate(sequence[0], sequence[1]);
124 //         if (link == Constants.Null)
125 //         {
126 //             throw new NotImplementedException("Creation cancellation is not
127 //         implemented.");
128 //         }
129 //         results.Add(link);
130 //         return results;
131 //     }
132 //     var innerSequenceLength = sequence.Length - 1;
133 //     var innerSequence = new ulong[innerSequenceLength];
134 //     for (var li = 0; li < innerSequenceLength; li++)
135 //     {

```

```

133 //                var link = Links.Unsync.GetOrCreate(sequence[li], sequence[li + 1]);
134 //                if (link == Constants.Null)
135 //                {
136 //                    throw new NotImplementedException("Creation cancellation is not
↳ implemented.");
137 //                }
138 //                for (var isi = 0; isi < li; isi++)
139 //                {
140 //                    innerSequence[isi] = sequence[isi];
141 //                }
142 //                innerSequence[li] = link;
143 //                for (var isi = li + 1; isi < innerSequenceLength; isi++)
144 //                {
145 //                    innerSequence[isi] = sequence[isi + 1];
146 //                }
147 //                CreateAllVariants1Core(innerSequence, results);
148 //            }
149 //            return results;
150 //        }
151 //
152 //        #endregion
153 //
154 //        /// <summary>
155 //        /// <para>
156 //        /// Eaches the 1 using the specified sequence.
157 //        /// </para>
158 //        /// <para></para>
159 //        /// </summary>
160 //        /// <param name="sequence">
161 //        /// <para>The sequence.</para>
162 //        /// <para></para>
163 //        /// </param>
164 //        /// <returns>
165 //        /// <para>The visited links.</para>
166 //        /// <para></para>
167 //        /// </returns>
168 //        [MethodImpl(MethodImplOptions.AggressiveInlining)]
169 //        public HashSet<ulong> Each1(params ulong[] sequence)
170 //        {
171 //            var visitedLinks = new HashSet<ulong>(); // Заменить на bitstring
172 //            Each1(link =>
173 //            {
174 //                if (!visitedLinks.Contains(link))
175 //                {
176 //                    visitedLinks.Add(link); // изучить почему случаются повторы
177 //                }
178 //                return true;
179 //            }, sequence);
180 //            return visitedLinks;
181 //        }
182 //        [MethodImpl(MethodImplOptions.AggressiveInlining)]
183 //        private void Each1(Func<ulong, bool> handler, params ulong[] sequence)
184 //        {
185 //            if (sequence.Length == 2)
186 //            {
187 //                Links.Unsync.Each(sequence[0], sequence[1], handler);
188 //            }
189 //            else
190 //            {
191 //                var innerSequenceLength = sequence.Length - 1;
192 //                for (var li = 0; li < innerSequenceLength; li++)
193 //                {
194 //                    var left = sequence[li];
195 //                    var right = sequence[li + 1];
196 //                    if (left == 0 && right == 0)
197 //                    {
198 //                        continue;
199 //                    }
200 //                    var linkIndex = li;
201 //                    ulong[] innerSequence = null;
202 //                    Links.Unsync.Each(doublet =>
203 //                    {
204 //                        if (innerSequence == null)
205 //                        {
206 //                            innerSequence = new ulong[innerSequenceLength];
207 //                            for (var isi = 0; isi < linkIndex; isi++)
208 //                                {

```

```

209 //                                     innerSequence[isi] = sequence[isi];
210 //                                     }
211 //                                     for (var isi = linkIndex + 1; isi < innerSequenceLength; isi++)
212 //                                     {
213 //                                         innerSequence[isi] = sequence[isi + 1];
214 //                                     }
215 //                                     }
216 //                                     innerSequence[linkIndex] = doublet[Constants.IndexPart];
217 //                                     Each1(handler, innerSequence);
218 //                                     return Constants.Continue;
219 //                                     }, Constants.Any, left, right);
220 //                                     }
221 //                                     }
222 //                                     }
223 //
224 //                                     /// <summary>
225 //                                     /// <para>
226 //                                     /// Eaches the part using the specified sequence.
227 //                                     /// </para>
228 //                                     /// <para></para>
229 //                                     /// </summary>
230 //                                     /// <param name="sequence">
231 //                                     /// <para>The sequence.</para>
232 //                                     /// <para></para>
233 //                                     /// </param>
234 //                                     /// <returns>
235 //                                     /// <para>The visited links.</para>
236 //                                     /// <para></para>
237 //                                     /// </returns>
238 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
239 //                                     public HashSet<ulong> EachPart(params ulong[] sequence)
240 //                                     {
241 //                                         var visitedLinks = new HashSet<ulong>(); // Заменить на bitstring
242 //                                         EachPartCore(link =>
243 //                                         {
244 //                                             var linkIndex = link[Constants.IndexPart];
245 //                                             if (!visitedLinks.Contains(linkIndex))
246 //                                             {
247 //                                                 visitedLinks.Add(linkIndex); // изучить почему случаются повторы
248 //                                             }
249 //                                             return Constants.Continue;
250 //                                         }, sequence);
251 //                                         return visitedLinks;
252 //                                     }
253 //
254 //                                     /// <summary>
255 //                                     /// <para>
256 //                                     /// Eaches the part using the specified handler.
257 //                                     /// </para>
258 //                                     /// <para></para>
259 //                                     /// </summary>
260 //                                     /// <param name="handler">
261 //                                     /// <para>The handler.</para>
262 //                                     /// <para></para>
263 //                                     /// </param>
264 //                                     /// <param name="sequence">
265 //                                     /// <para>The sequence.</para>
266 //                                     /// <para></para>
267 //                                     /// </param>
268 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
269 //                                     public void EachPart(Func<IList<LinkIndex>, LinkIndex> handler, params ulong[]
↵ sequence)
270 //                                     {
271 //                                         var visitedLinks = new HashSet<ulong>(); // Заменить на bitstring
272 //                                         EachPartCore(link =>
273 //                                         {
274 //                                             var linkIndex = link[Constants.IndexPart];
275 //                                             if (!visitedLinks.Contains(linkIndex))
276 //                                             {
277 //                                                 visitedLinks.Add(linkIndex); // изучить почему случаются повторы
278 //                                                 return handler(new LinkAddress<LinkIndex>(linkIndex));
279 //                                             }
280 //                                             return Constants.Continue;
281 //                                         }, sequence);
282 //                                     }
283 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
284 //                                     private void EachPartCore(Func<IList<LinkIndex>, LinkIndex> handler, params ulong[]
↵ sequence)

```

```

285 // {
286 //     if (sequence.IsNullOrEmpty())
287 //     {
288 //         return;
289 //     }
290 //     Links.EnsureLinkIsAnyOrExists(sequence);
291 //     if (sequence.Length == 1)
292 //     {
293 //         var link = sequence[0];
294 //         if (link > 0)
295 //         {
296 //             handler(new LinkAddress<LinkIndex>(link));
297 //         }
298 //         else
299 //         {
300 //             Links.Each(Constants.Any, Constants.Any, handler);
301 //         }
302 //     }
303 //     else if (sequence.Length == 2)
304 //     {
305 //         //_links.Each(sequence[0], sequence[1], handler);
306 //         // o_|          x_o ...
307 //         // x_|          |___|
308 //         Links.Each(sequence[1], Constants.Any, doublet =>
309 //         {
310 //             var match = Links.SearchOrDefault(sequence[0], doublet);
311 //             if (match != Constants.Null)
312 //             {
313 //                 handler(new LinkAddress<LinkIndex>(match));
314 //             }
315 //             return true;
316 //         });
317 //         //_x          ... x_o
318 //         // |_o          |___|
319 //         Links.Each(Constants.Any, sequence[0], doublet =>
320 //         {
321 //             var match = Links.SearchOrDefault(doublet, sequence[1]);
322 //             if (match != 0)
323 //             {
324 //                 handler(new LinkAddress<LinkIndex>(match));
325 //             }
326 //             return true;
327 //         });
328 //         //          .x o_.
329 //         //          |___|
330 //         PartialStepRight(x => handler(x), sequence[0], sequence[1]);
331 //     }
332 //     else
333 //     {
334 //         throw new NotImplementedException();
335 //     }
336 // }
337 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
338 // private void PartialStepRight(Action<IList<LinkIndex>> handler, ulong left, ulong
↵ right)
339 // {
340 //     Links.Unsync.Each(Constants.Any, left, doublet =>
341 //     {
342 //         StepRight(handler, doublet, right);
343 //         if (left != doublet)
344 //         {
345 //             PartialStepRight(handler, doublet, right);
346 //         }
347 //         return true;
348 //     });
349 // }
350 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
351 // private void StepRight(Action<IList<LinkIndex>> handler, ulong left, ulong right)
352 // {
353 //     Links.Unsync.Each(left, Constants.Any, rightStep =>
354 //     {
355 //         TryStepRightUp(handler, right, rightStep);
356 //         return true;
357 //     });
358 // }
359 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
360 // private void TryStepRightUp(Action<IList<LinkIndex>> handler, ulong right, ulong
↵ stepFrom)

```

```

361 //      {
362 //          var upStep = stepFrom;
363 //          var firstSource = Links.Unsync.GetTarget(upStep);
364 //          while (firstSource != right && firstSource != upStep)
365 //          {
366 //              upStep = firstSource;
367 //              firstSource = Links.Unsync.GetSource(upStep);
368 //          }
369 //          if (firstSource == right)
370 //          {
371 //              handler(new LinkAddress<LinkIndex>(stepFrom));
372 //          }
373 //      }
374 //
375 //      // TODO: Test
376 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
377 //      private void PartialStepLeft(Action<IList<LinkIndex>> handler, ulong left, ulong
↵ right)
378 //      {
379 //          Links.Unsync.Each(right, Constants.Any, doublet =>
380 //          {
381 //              StepLeft(handler, left, doublet);
382 //              if (right != doublet)
383 //              {
384 //                  PartialStepLeft(handler, left, doublet);
385 //              }
386 //              return true;
387 //          });
388 //      }
389 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
390 //      private void StepLeft(Action<IList<LinkIndex>> handler, ulong left, ulong right)
391 //      {
392 //          Links.Unsync.Each(Constants.Any, right, leftStep =>
393 //          {
394 //              TryStepLeftUp(handler, left, leftStep);
395 //              return true;
396 //          });
397 //      }
398 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
399 //      private void TryStepLeftUp(Action<IList<LinkIndex>> handler, ulong left, ulong
↵ stepFrom)
400 //      {
401 //          var upStep = stepFrom;
402 //          var firstTarget = Links.Unsync.GetSource(upStep);
403 //          while (firstTarget != left && firstTarget != upStep)
404 //          {
405 //              upStep = firstTarget;
406 //              firstTarget = Links.Unsync.GetTarget(upStep);
407 //          }
408 //          if (firstTarget == left)
409 //          {
410 //              handler(new LinkAddress<LinkIndex>(stepFrom));
411 //          }
412 //      }
413 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
414 //      private bool StartsWith(ulong sequence, ulong link)
415 //      {
416 //          var upStep = sequence;
417 //          var firstSource = Links.Unsync.GetSource(upStep);
418 //          while (firstSource != link && firstSource != upStep)
419 //          {
420 //              upStep = firstSource;
421 //              firstSource = Links.Unsync.GetSource(upStep);
422 //          }
423 //          return firstSource == link;
424 //      }
425 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
426 //      private bool EndsWith(ulong sequence, ulong link)
427 //      {
428 //          var upStep = sequence;
429 //          var lastTarget = Links.Unsync.GetTarget(upStep);
430 //          while (lastTarget != link && lastTarget != upStep)
431 //          {
432 //              upStep = lastTarget;
433 //              lastTarget = Links.Unsync.GetTarget(upStep);
434 //          }
435 //          return lastTarget == link;

```

```

436 // }
437 //
438 // /// <summary>
439 // /// <para>
440 // /// Gets the all matching sequences 0 using the specified sequence.
441 // /// </para>
442 // /// <para></para>
443 // /// </summary>
444 // /// <param name="sequence">
445 // /// <para>The sequence.</para>
446 // /// <para></para>
447 // /// </param>
448 // /// <returns>
449 // /// <para>A list of ulong</para>
450 // /// <para></para>
451 // /// </returns>
452 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
453 // public List<ulong> GetAllMatchingSequences0(params ulong[] sequence)
454 // {
455 //     return _sync.DoRead(() =>
456 //     {
457 //         var results = new List<ulong>();
458 //         if (sequence.Length > 0)
459 //         {
460 //             Links.EnsureLinkExists(sequence);
461 //             var firstElement = sequence[0];
462 //             if (sequence.Length == 1)
463 //             {
464 //                 results.Add(firstElement);
465 //                 return results;
466 //             }
467 //             if (sequence.Length == 2)
468 //             {
469 //                 var doublet = Links.SearchOrDefault(firstElement, sequence[1]);
470 //                 if (doublet != Constants.Null)
471 //                 {
472 //                     results.Add(doublet);
473 //                 }
474 //                 return results;
475 //             }
476 //             var linksInSequence = new HashSet<ulong>(sequence);
477 //             void handler(ICollection<LinkIndex> result)
478 //             {
479 //                 var resultIndex = result[Links.Constants.IndexPart];
480 //                 var filterPosition = 0;
481 //                 StopableSequenceWalker.WalkRight(resultIndex, Links.Unsync.GetSource,
↳ Links.Unsync.GetTarget,
482 //                 x => linksInSequence.Contains(x) || Links.Unsync.GetTarget(x) ==
↳ x, x =>
483 //                 {
484 //                     if (filterPosition == sequence.Length)
485 //                     {
486 //                         filterPosition = -2; // Длиннее чем нужно
487 //                         return false;
488 //                     }
489 //                     if (x != sequence[filterPosition])
490 //                     {
491 //                         filterPosition = -1;
492 //                         return false; // Начинается иначе
493 //                     }
494 //                     filterPosition++;
495 //
496 //                     return true;
497 //                 });
498 //             if (filterPosition == sequence.Length)
499 //             {
500 //                 results.Add(resultIndex);
501 //             }
502 //         }
503 //         if (sequence.Length >= 2)
504 //         {
505 //             StepRight(handler, sequence[0], sequence[1]);
506 //         }
507 //         var last = sequence.Length - 2;
508 //         for (var i = 1; i < last; i++)
509 //         {
510 //             PartialStepRight(handler, sequence[i], sequence[i + 1]);
511 //         }

```

```

512 //         if (sequence.Length >= 3)
513 //         {
514 //             StepLeft(handler, sequence[sequence.Length - 2],
↵ sequence[sequence.Length - 1]);
515 //         }
516 //     }
517 //     return results;
518 // });
519 // }
520 //
521 //     /// <summary>
522 //     /// <para>
523 //     /// Gets the all matching sequences 1 using the specified sequence.
524 //     /// </para>
525 //     /// <para></para>
526 //     /// </summary>
527 //     /// <param name="sequence">
528 //     /// <para>The sequence.</para>
529 //     /// <para></para>
530 //     /// </param>
531 //     /// <returns>
532 //     /// <para>A hash set of ulong</para>
533 //     /// <para></para>
534 //     /// </returns>
535 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
536 //     public HashSet<ulong> GetAllMatchingSequences1(params ulong[] sequence)
537 //     {
538 //         return _sync.DoRead(() =>
539 //         {
540 //             var results = new HashSet<ulong>();
541 //             if (sequence.Length > 0)
542 //             {
543 //                 Links.EnsureLinkExists(sequence);
544 //                 var firstElement = sequence[0];
545 //                 if (sequence.Length == 1)
546 //                 {
547 //                     results.Add(firstElement);
548 //                     return results;
549 //                 }
550 //                 if (sequence.Length == 2)
551 //                 {
552 //                     var doublet = Links.SearchOrDefault(firstElement, sequence[1]);
553 //                     if (doublet != Constants.Null)
554 //                     {
555 //                         results.Add(doublet);
556 //                     }
557 //                     return results;
558 //                 }
559 //                 var matcher = new Matcher(this, sequence, results, null);
560 //                 if (sequence.Length >= 2)
561 //                 {
562 //                     StepRight(matcher.AddFullMatchedToResults, sequence[0], sequence[1]);
563 //                 }
564 //                 var last = sequence.Length - 2;
565 //                 for (var i = 1; i < last; i++)
566 //                 {
567 //                     PartialStepRight(matcher.AddFullMatchedToResults, sequence[i],
↵ sequence[i + 1]);
568 //                 }
569 //                 if (sequence.Length >= 3)
570 //                 {
571 //                     StepLeft(matcher.AddFullMatchedToResults, sequence[sequence.Length -
↵ 2], sequence[sequence.Length - 1]);
572 //                 }
573 //             }
574 //             return results;
575 //         });
576 //     }
577 //
578 //     /// <summary>
579 //     /// <para>
580 //     /// The max sequence format size.
581 //     /// </para>
582 //     /// <para></para>
583 //     /// </summary>
584 //     public const int MaxSequenceFormatSize = 200;
585 //

```

```

586 //      /// <summary>
587 //      /// <para>
588 //      /// Formats the sequence using the specified sequence link.
589 //      /// </para>
590 //      /// <para></para>
591 //      /// </summary>
592 //      /// <param name="sequenceLink">
593 //      /// <para>The sequence link.</para>
594 //      /// <para></para>
595 //      /// </param>
596 //      /// <param name="knownElements">
597 //      /// <para>The known elements.</para>
598 //      /// <para></para>
599 //      /// </param>
600 //      /// <returns>
601 //      /// <para>The string</para>
602 //      /// <para></para>
603 //      /// </returns>
604 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
605 //      public string FormatSequence(LinkIndex sequenceLink, params LinkIndex[]
↵ knownElements) => FormatSequence(sequenceLink, (sb, x) => sb.Append(x), true, knownElements);
606 //
607 //      /// <summary>
608 //      /// <para>
609 //      /// Formats the sequence using the specified sequence link.
610 //      /// </para>
611 //      /// <para></para>
612 //      /// </summary>
613 //      /// <param name="sequenceLink">
614 //      /// <para>The sequence link.</para>
615 //      /// <para></para>
616 //      /// </param>
617 //      /// <param name="elementToString">
618 //      /// <para>The element to string.</para>
619 //      /// <para></para>
620 //      /// </param>
621 //      /// <param name="insertComma">
622 //      /// <para>The insert comma.</para>
623 //      /// <para></para>
624 //      /// </param>
625 //      /// <param name="knownElements">
626 //      /// <para>The known elements.</para>
627 //      /// <para></para>
628 //      /// </param>
629 //      /// <returns>
630 //      /// <para>The string</para>
631 //      /// <para></para>
632 //      /// </returns>
633 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
634 //      public string FormatSequence(LinkIndex sequenceLink, Action<StringBuilder, LinkIndex>
↵ elementToString, bool insertComma, params LinkIndex[] knownElements) =>
↵ Links.SyncRoot.DoRead(() => FormatSequence(Links.Unsync, sequenceLink, elementToString,
↵ insertComma, knownElements));
635 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
636 //      private string FormatSequence(ILinks<LinkIndex> links, LinkIndex sequenceLink,
↵ Action<StringBuilder, LinkIndex> elementToString, bool insertComma, params LinkIndex[]
↵ knownElements)
637 //      {
638 //          var linksInSequence = new HashSet<ulong>(knownElements);
639 //          //var entered = new HashSet<ulong>();
640 //          var sb = new StringBuilder();
641 //          sb.Append('{');
642 //          if (links.Exists(sequenceLink))
643 //          {
644 //              StopableSequenceWalker.WalkRight(sequenceLink, links.GetSource,
↵ links.GetTarget,
645 //              x => linksInSequence.Contains(x) || links.IsPartialPoint(x), element =>
↵ // entered.AddAndReturnVoid, x => { }, entered.DoNotContains
646 //              {
647 //                  if (insertComma && sb.Length > 1)
648 //                  {
649 //                      sb.Append(',');
650 //                  }
651 //                  //if (entered.Contains(element))
652 //                  //{
653 //                      sb.Append('{');
654 //                      elementToString(sb, element);

```



```

655 //                                     // sb.Append('}');
656 //                                     //}
657 //                                     //else
658 //                                     elementToString(sb, element);
659 //                                     if (sb.Length < MaxSequenceFormatSize)
660 //                                     {
661 //                                     return true;
662 //                                     }
663 //                                     sb.Append(insertComma ? ", ..." : "...");
664 //                                     return false;
665 //                                     });
666 //                                     }
667 //                                     sb.Append('}');
668 //                                     return sb.ToString();
669 //                                     }
670 //
671 //                                     /// <summary>
672 //                                     /// <para>
673 //                                     /// Safes the format sequence using the specified sequence link.
674 //                                     /// </para>
675 //                                     /// <para></para>
676 //                                     /// </summary>
677 //                                     /// <param name="sequenceLink">
678 //                                     /// <para>The sequence link.</para>
679 //                                     /// <para></para>
680 //                                     /// </param>
681 //                                     /// <param name="knownElements">
682 //                                     /// <para>The known elements.</para>
683 //                                     /// <para></para>
684 //                                     /// </param>
685 //                                     /// <returns>
686 //                                     /// <para>The string</para>
687 //                                     /// <para></para>
688 //                                     /// </returns>
689 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
690 //                                     public string SafeFormatSequence(LinkIndex sequenceLink, params LinkIndex[]
↳ knownElements) => SafeFormatSequence(sequenceLink, (sb, x) => sb.Append(x), true,
↳ knownElements);
691 //
692 //                                     /// <summary>
693 //                                     /// <para>
694 //                                     /// Safes the format sequence using the specified sequence link.
695 //                                     /// </para>
696 //                                     /// <para></para>
697 //                                     /// </summary>
698 //                                     /// <param name="sequenceLink">
699 //                                     /// <para>The sequence link.</para>
700 //                                     /// <para></para>
701 //                                     /// </param>
702 //                                     /// <param name="elementToString">
703 //                                     /// <para>The element to string.</para>
704 //                                     /// <para></para>
705 //                                     /// </param>
706 //                                     /// <param name="insertComma">
707 //                                     /// <para>The insert comma.</para>
708 //                                     /// <para></para>
709 //                                     /// </param>
710 //                                     /// <param name="knownElements">
711 //                                     /// <para>The known elements.</para>
712 //                                     /// <para></para>
713 //                                     /// </param>
714 //                                     /// <returns>
715 //                                     /// <para>The string</para>
716 //                                     /// <para></para>
717 //                                     /// </returns>
718 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
719 //                                     public string SafeFormatSequence(LinkIndex sequenceLink, Action<StringBuilder,
↳ LinkIndex> elementToString, bool insertComma, params LinkIndex[] knownElements) =>
↳ Links.SyncRoot.DoRead(() => SafeFormatSequence(Links.Unsync, sequenceLink, elementToString,
↳ insertComma, knownElements));
720 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
721 //                                     private string SafeFormatSequence(ILinks<LinkIndex> links, LinkIndex sequenceLink,
↳ Action<StringBuilder, LinkIndex> elementToString, bool insertComma, params LinkIndex[]
↳ knownElements)
722 //                                     {
723 //                                     var linksInSequence = new HashSet<ulong>(knownElements);
724 //                                     var entered = new HashSet<ulong>();

```

```

725 //         var sb = new StringBuilder();
726 //         sb.Append('{');
727 //         if (links.Exists(sequenceLink))
728 //         {
729 //             StopableSequenceWalker.WalkRight(sequenceLink, links.GetSource,
↳ links.GetTarget,
730 //             x => linksInSequence.Contains(x) || links.IsFullPoint(x),
↳ entered.AddAndReturnVoid, x => { }, entered.DoNotContains, element =>
731 //             {
732 //                 if (insertComma && sb.Length > 1)
733 //                 {
734 //                     sb.Append(',');
735 //                 }
736 //                 if (entered.Contains(element))
737 //                 {
738 //                     sb.Append('{');
739 //                     elementToString(sb, element);
740 //                     sb.Append('}');
741 //                 }
742 //                 else
743 //                 {
744 //                     elementToString(sb, element);
745 //                 }
746 //                 if (sb.Length < MaxSequenceFormatSize)
747 //                 {
748 //                     return true;
749 //                 }
750 //                 sb.Append(insertComma ? ", ..." : "...");
751 //                 return false;
752 //             });
753 //         }
754 //         sb.Append('}');
755 //         return sb.ToString();
756 //     }
757 //
758 //     /// <summary>
759 //     /// <para>
760 //     /// Gets the all partially matching sequences 0 using the specified sequence.
761 //     /// </para>
762 //     /// <para></para>
763 //     /// </summary>
764 //     /// <param name="sequence">
765 //     /// <para>The sequence.</para>
766 //     /// <para></para>
767 //     /// </param>
768 //     /// <returns>
769 //     /// <para>A list of ulong</para>
770 //     /// <para></para>
771 //     /// </returns>
772 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
773 //     public List<ulong> GetAllPartiallyMatchingSequences0(params ulong[] sequence)
774 //     {
775 //         return _sync.DoRead(() =>
776 //         {
777 //             if (sequence.Length > 0)
778 //             {
779 //                 Links.EnsureLinkExists(sequence);
780 //                 var results = new HashSet<ulong>();
781 //                 for (var i = 0; i < sequence.Length; i++)
782 //                 {
783 //                     AllUsagesCore(sequence[i], results);
784 //                 }
785 //                 var filteredResults = new List<ulong>();
786 //                 var linksInSequence = new HashSet<ulong>(sequence);
787 //                 foreach (var result in results)
788 //                 {
789 //                     var filterPosition = -1;
790 //                     StopableSequenceWalker.WalkRight(result, Links.Unsync.GetSource,
↳ Links.Unsync.GetTarget,
791 //                     x => linksInSequence.Contains(x) || Links.Unsync.GetTarget(x) ==
↳ x, x =>
792 //                     {
793 //                         if (filterPosition == (sequence.Length - 1))
794 //                         {
795 //                             return false;
796 //                         }
797 //                         if (filterPosition >= 0)
798 //                         {

```

```

799     //         if (x == sequence[filterPosition + 1])
800     //         {
801     //             filterPosition++;
802     //         }
803     //         else
804     //         {
805     //             return false;
806     //         }
807     //     }
808     //     if (filterPosition < 0)
809     //     {
810     //         if (x == sequence[0])
811     //         {
812     //             filterPosition = 0;
813     //         }
814     //     }
815     //     return true;
816     // });
817     //     if (filterPosition == (sequence.Length - 1))
818     //     {
819     //         filteredResults.Add(result);
820     //     }
821     //     }
822     //     return filteredResults;
823     // }
824     //     return new List<ulong>();
825     // });
826     // }
827     //
828     //     /// <summary>
829     //     /// <para>
830     //     /// Gets the all partially matching sequences 1 using the specified sequence.
831     //     /// </para>
832     //     /// <para></para>
833     //     /// </summary>
834     //     /// <param name="sequence">
835     //     /// <para>The sequence.</para>
836     //     /// <para></para>
837     //     /// </param>
838     //     /// <returns>
839     //     /// <para>A hash set of ulong</para>
840     //     /// <para></para>
841     //     /// </returns>
842     //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
843     //     public HashSet<ulong> GetAllPartiallyMatchingSequences1(params ulong[] sequence)
844     //     {
845     //         return _sync.DoRead(() =>
846     //         {
847     //             if (sequence.Length > 0)
848     //             {
849     //                 Links.EnsureLinkExists(sequence);
850     //                 var results = new HashSet<ulong>();
851     //                 for (var i = 0; i < sequence.Length; i++)
852     //                 {
853     //                     AllUsagesCore(sequence[i], results);
854     //                 }
855     //                 var filteredResults = new HashSet<ulong>();
856     //                 var matcher = new Matcher(this, sequence, filteredResults, null);
857     //                 matcher.AddAllPartialMatchedToResults(results);
858     //                 return filteredResults;
859     //             }
860     //             return new HashSet<ulong>();
861     //         });
862     //     }
863     //
864     //     /// <summary>
865     //     /// <para>
866     //     /// Determines whether this instance get all partially matching sequences 2.
867     //     /// </para>
868     //     /// <para></para>
869     //     /// </summary>
870     //     /// <param name="handler">
871     //     /// <para>The handler.</para>
872     //     /// <para></para>
873     //     /// </param>
874     //     /// <param name="sequence">
875     //     /// <para>The sequence.</para>
876     //     /// <para></para>

```

```

877 //      /// </param>
878 //      /// <returns>
879 //      /// <para>The bool</para>
880 //      /// <para></para>
881 //      /// </returns>
882 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
883 //      public bool GetAllPartiallyMatchingSequences2(Func<IList<LinkIndex>, LinkIndex>
↵ handler, params ulong[] sequence)
884 //      {
885 //          return _sync.DoRead(() =>
886 //          {
887 //              if (sequence.Length > 0)
888 //              {
889 //                  Links.EnsureLinkExists(sequence);
890 //
891 //                  var results = new HashSet<ulong>();
892 //                  var filteredResults = new HashSet<ulong>();
893 //                  var matcher = new Matcher(this, sequence, filteredResults, handler);
894 //                  for (var i = 0; i < sequence.Length; i++)
895 //                  {
896 //                      if (!AllUsagesCore1(sequence[i], results,
↵ matcher.HandlePartialMatched))
897 //                      {
898 //                          return false;
899 //                      }
900 //                  }
901 //                  return true;
902 //              }
903 //              return true;
904 //          });
905 //      }
906 //
907 //      ///public HashSet<ulong> GetAllPartiallyMatchingSequences3(params ulong[] sequence)
908 //      ///{
909 //          return Sync.DoRead(() =>
910 //          {
911 //              if (sequence.Length > 0)
912 //              {
913 //                  _links.EnsureEachLinkIsAnyOrExists(sequence);
914 //
915 //                  var firstResults = new HashSet<ulong>();
916 //                  var lastResults = new HashSet<ulong>();
917 //
918 //                  var first = sequence.First(x => x != LinksConstants.Any);
919 //                  var last = sequence.Last(x => x != LinksConstants.Any);
920 //
921 //                  AllUsagesCore(first, firstResults);
922 //                  AllUsagesCore(last, lastResults);
923 //
924 //                  firstResults.IntersectWith(lastResults);
925 //
926 //                  //for (var i = 0; i < sequence.Length; i++)
927 //                  //    AllUsagesCore(sequence[i], results);
928 //
929 //                  var filteredResults = new HashSet<ulong>();
930 //                  var matcher = new Matcher(this, sequence, filteredResults, null);
931 //                  matcher.AddAllPartialMatchedToResults(firstResults);
932 //                  return filteredResults;
933 //              }
934 //
935 //              return new HashSet<ulong>();
936 //          });
937 //      }
938 //
939 //      /// <summary>
940 //      /// <para>
941 //      /// Gets the all partially matching sequences 3 using the specified sequence.
942 //      /// </para>
943 //      /// <para></para>
944 //      /// </summary>
945 //      /// <param name="sequence">
946 //      /// <para>The sequence.</para>
947 //      /// <para></para>
948 //      /// </param>
949 //      /// <returns>
950 //      /// <para>A hash set of ulong</para>
951 //      /// <para></para>

```

```

952 //      /// </returns>
953 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
954 //      public HashSet<ulong> GetAllPartiallyMatchingSequences3(params ulong[] sequence)
955 //      {
956 //          return _sync.DoRead(() =>
957 //          {
958 //              if (sequence.Length > 0)
959 //              {
960 //                  ILinksExtensions.EnsureLinkIsAnyOrExists(Links, sequence);
961 //                  var firstResults = new HashSet<ulong>();
962 //                  var lastResults = new HashSet<ulong>();
963 //                  var first = sequence.First(x => x != Constants.Any);
964 //                  var last = sequence.Last(x => x != Constants.Any);
965 //                  AllUsagesCore(first, firstResults);
966 //                  AllUsagesCore(last, lastResults);
967 //                  firstResults.IntersectWith(lastResults);
968 //                  //for (var i = 0; i < sequence.Length; i++)
969 //                  //    AllUsagesCore(sequence[i], results);
970 //                  var filteredResults = new HashSet<ulong>();
971 //                  var matcher = new Matcher(this, sequence, filteredResults, null);
972 //                  matcher.AddAllPartialMatchedToResults(firstResults);
973 //                  return filteredResults;
974 //              }
975 //              return new HashSet<ulong>();
976 //          });
977 //      }
978 //
979 //      /// <summary>
980 //      /// <para>
981 //      /// Gets the all partially matching sequences 4 using the specified read as elements.
982 //      /// </para>
983 //      /// <para></para>
984 //      /// </summary>
985 //      /// <param name="readAsElements">
986 //      /// <para>The read as elements.</para>
987 //      /// <para></para>
988 //      /// </param>
989 //      /// <param name="sequence">
990 //      /// <para>The sequence.</para>
991 //      /// <para></para>
992 //      /// </param>
993 //      /// <returns>
994 //      /// <para>A hash set of ulong</para>
995 //      /// <para></para>
996 //      /// </returns>
997 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
998 //      public HashSet<ulong> GetAllPartiallyMatchingSequences4(HashSet<ulong>
↵ readAsElements, IList<ulong> sequence)
999 //      {
1000 //          return _sync.DoRead(() =>
1001 //          {
1002 //              if (sequence.Count > 0)
1003 //              {
1004 //                  Links.EnsureLinkExists(sequence);
1005 //                  var results = new HashSet<LinkIndex>();
1006 //                  //var nextResults = new HashSet<ulong>();
1007 //                  //for (var i = 0; i < sequence.Length; i++)
1008 //                  //{
1009 //                      AllUsagesCore(sequence[i], nextResults);
1010 //                      if (results.IsNullOrEmpty())
1011 //                      {
1012 //                          results = nextResults;
1013 //                          nextResults = new HashSet<ulong>();
1014 //                      }
1015 //                      else
1016 //                      {
1017 //                          results.IntersectWith(nextResults);
1018 //                          nextResults.Clear();
1019 //                      }
1020 //                  }
1021 //                  var collector1 = new AllUsagesCollector1(Links.Unsync, results);
1022 //                  collector1.Collect(Links.Unsync.GetLink(sequence[0]));
1023 //                  var next = new HashSet<ulong>();
1024 //                  for (var i = 1; i < sequence.Count; i++)
1025 //                  {
1026 //                      var collector = new AllUsagesCollector1(Links.Unsync, next);
1027 //                      collector.Collect(Links.Unsync.GetLink(sequence[i]));

```

```

1028 //
1029 //             results.IntersectWith(next);
1030 //             next.Clear();
1031 //         }
1032 //         var filteredResults = new HashSet<ulong>();
1033 //         var matcher = new Matcher(this, sequence, filteredResults, null,
↳ readAsElements);
1034 //         matcher.AddAllPartialMatchedToResultsAndReadAsElements(results.OrderBy(x
↳ => x)); // OrderBy is a Hack
1035 //         return filteredResults;
1036 //     }
1037 //     return new HashSet<ulong>();
1038 // }
1039 // }
1040 //
1041 // // Does not work
1042 // //public HashSet<ulong> GetAllPartiallyMatchingSequences5(HashSet<ulong>
↳ readAsElements, params ulong[] sequence)
1043 // // {
1044 // //     var visited = new HashSet<ulong>();
1045 // //     var results = new HashSet<ulong>();
1046 // //     var matcher = new Matcher(this, sequence, visited, x => { results.Add(x);
↳ return true; }, readAsElements);
1047 // //     var last = sequence.Length - 1;
1048 // //     for (var i = 0; i < last; i++)
1049 // //     {
1050 // //         PartialStepRight(matcher.PartialMatch, sequence[i], sequence[i + 1]);
1051 // //     }
1052 // //     return results;
1053 // // }
1054 //
1055 // /// <summary>
1056 // /// <para>
1057 // /// Gets the all partially matching sequences using the specified sequence.
1058 // /// </para>
1059 // /// <para></para>
1060 // /// </summary>
1061 // /// <param name="sequence">
1062 // /// <para>The sequence.</para>
1063 // /// <para></para>
1064 // /// </param>
1065 // /// <returns>
1066 // /// <para>A list of ulong</para>
1067 // /// <para></para>
1068 // /// </returns>
1069 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1070 // public List<ulong> GetAllPartiallyMatchingSequences(params ulong[] sequence)
1071 // {
1072 //     return _sync.DoRead(() =>
1073 //     {
1074 //         if (sequence.Length > 0)
1075 //         {
1076 //             Links.EnsureLinkExists(sequence);
1077 //             //var firstElement = sequence[0];
1078 //             //if (sequence.Length == 1)
1079 //             // {
1080 //                 //results.Add(firstElement);
1081 //                 //return results;
1082 //             // }
1083 //             //if (sequence.Length == 2)
1084 //             // {
1085 //                 //var doublet = _links.SearchCore(firstElement, sequence[1]);
1086 //                 //if (doublet != Doublets.Links.Null)
1087 //                 //    results.Add(doublet);
1088 //                 //return results;
1089 //             // }
1090 //             //var lastElement = sequence[sequence.Length - 1];
1091 //             //Func<ulong, bool> handler = x =>
1092 //             // {
1093 //                 // if (StartsWith(x, firstElement) && EndsWith(x, lastElement))
1094 //                 //     results.Add(x);
1095 //                 // return true;
1096 //             // };
1097 //             //if (sequence.Length >= 2)
1098 //             //    StepRight(handler, sequence[0], sequence[1]);
1099 //             //var last = sequence.Length - 2;
1100 //             //for (var i = 1; i < last; i++)

```

```

1100 //                //    PartialStepRight(handler, sequence[i], sequence[i + 1]);
1101 //                //if (sequence.Length >= 3)
1102 //                //    StepLeft(handler, sequence[sequence.Length - 2],
↪ sequence[sequence.Length - 1]);
1103 //                //if (sequence.Length == 1)
1104 //                //if (sequence.Length == 1)
1105 //                //if (sequence.Length == 1)
↪ containing this element?
1106 //                //if (sequence.Length == 1)
1107 //                //if (sequence.Length == 2)
1108 //                //if (sequence.Length == 2)
1109 //                //if (sequence.Length == 2)
1110 //                //if (sequence.Length == 2)
1111 //                //if (sequence.Length == 2)
1112 //                //if (sequence.Length == 2)
1113 //                //if (sequence.Length == 2)
1114 //                //if (sequence.Length == 2)
1115 //                //if (sequence.Length == 2)
1116 //                //if (sequence.Length == 2)
1117 //                //if (sequence.Length == 2)
1118 //                //if (sequence.Length == 2)
1119 //                //if (sequence.Length == 2)
1120 //                //if (sequence.Length == 2)
1121 //                //if (sequence.Length == 2)
1122 //                //if (sequence.Length == 2)
1123 //                //if (sequence.Length == 2)
1124 //                //if (sequence.Length == 2)
1125 //                //if (sequence.Length == 2)
1126 //                //if (sequence.Length == 2)
1127 //                //if (sequence.Length == 2)
1128 //                //if (sequence.Length == 2)
1129 //                //if (sequence.Length == 2)
↪ matches[1][k]);
1130 //                //if (sequence.Length == 2)
1131 //                //if (sequence.Length == 2)
1132 //                //if (sequence.Length == 2)
1133 //                //if (sequence.Length == 2)
1134 //                //if (sequence.Length == 2)
1135 //                //if (sequence.Length == 2)
1136 //                //if (sequence.Length == 2)
1137 //                //if (sequence.Length == 2)
1138 //                //if (sequence.Length == 2)
1139 //                //if (sequence.Length == 2)
1140 //                //if (sequence.Length == 2)
1141 //                //if (sequence.Length == 2)
1142 //                //if (sequence.Length == 2)
1143 //                //if (sequence.Length == 2)
1144 //                //if (sequence.Length == 2)
1145 //                //if (sequence.Length == 2)
1146 //                //if (sequence.Length == 2)
1147 //                //if (sequence.Length == 2)
1148 //                //if (sequence.Length == 2)
1149 //                //if (sequence.Length == 2)
1150 //                //if (sequence.Length == 2)
1151 //                //if (sequence.Length == 2)
↪ sequence[0] }; // or all sequences, containing this element?
1152 //                //if (sequence.Length == 2)
↪ 1).ToList();
1153 //                //if (sequence.Length == 2)
1154 //                //if (sequence.Length == 2)
↪ firstLinkUsages, 1))
1155 //                //if (sequence.Length == 2)
1156 //                //if (sequence.Length == 2)
1157 //                //if (sequence.Length == 2)
1158 //                //if (sequence.Length == 2)
1159 //                //if (sequence.Length == 2)
1160 //                //if (sequence.Length == 2)
1161 //                //if (sequence.Length == 2)
1162 //                //if (sequence.Length == 2)
1163 //                //if (sequence.Length == 2)
1164 //                //if (sequence.Length == 2)
1165 //                //if (sequence.Length == 2)
1166 //                //if (sequence.Length == 2)
1167 //                //if (sequence.Length == 2)
1168 //                //if (sequence.Length == 2)
1169 //                //if (sequence.Length == 2)
1170 //                //if (sequence.Length == 2)

```

```

1171 //      {
1172 //          var usages = new HashSet<ulong>();
1173 //          AllUsagesCore(link, usages);
1174 //          return usages;
1175 //      });
1176 //  }
1177 //
1178 //      // При сборе всех использований (последовательностей) можно сохранять обратный путь к
↪ той связи с которой начинался поиск (STTTSSSTT),
1179 //      // причём достаточно одного бита для хранения перехода влево или вправо
1180 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
1181 //      private void AllUsagesCore(ulong link, HashSet<ulong> usages)
1182 //      {
1183 //          bool handler(ulong doublet)
1184 //          {
1185 //              if (usages.Add(doublet))
1186 //              {
1187 //                  AllUsagesCore(doublet, usages);
1188 //              }
1189 //              return true;
1190 //          }
1191 //          Links.Unsync.Each(link, Constants.Any, handler);
1192 //          Links.Unsync.Each(Constants.Any, link, handler);
1193 //      }
1194 //
1195 //      /// <summary>
1196 //      /// <para>
1197 //      /// Alls the bottom usages using the specified link.
1198 //      /// </para>
1199 //      /// <para></para>
1200 //      /// </summary>
1201 //      /// <param name="link">
1202 //      /// <para>The link.</para>
1203 //      /// <para></para>
1204 //      /// </param>
1205 //      /// <returns>
1206 //      /// <para>A hash set of ulong</para>
1207 //      /// <para></para>
1208 //      /// </returns>
1209 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
1210 //      public HashSet<ulong> AllBottomUsages(ulong link)
1211 //      {
1212 //          return _sync.DoRead(() =>
1213 //          {
1214 //              var visits = new HashSet<ulong>();
1215 //              var usages = new HashSet<ulong>();
1216 //              AllBottomUsagesCore(link, visits, usages);
1217 //              return usages;
1218 //          });
1219 //      }
1220 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
1221 //      private void AllBottomUsagesCore(ulong link, HashSet<ulong> visits, HashSet<ulong>
↪ usages)
1222 //      {
1223 //          bool handler(ulong doublet)
1224 //          {
1225 //              if (visits.Add(doublet))
1226 //              {
1227 //                  AllBottomUsagesCore(doublet, visits, usages);
1228 //              }
1229 //              return true;
1230 //          }
1231 //          if (Links.Unsync.Count(Constants.Any, link) == 0)
1232 //          {
1233 //              usages.Add(link);
1234 //          }
1235 //          else
1236 //          {
1237 //              Links.Unsync.Each(link, Constants.Any, handler);
1238 //              Links.Unsync.Each(Constants.Any, link, handler);
1239 //          }
1240 //      }
1241 //
1242 //      /// <summary>
1243 //      /// <para>
1244 //      /// Calculates the total symbol frequency core using the specified symbol.
1245 //      /// </para>

```



```

1246 //          /// <para></para>
1247 //          /// </summary>
1248 //          /// <param name="symbol">
1249 //          /// <para>The symbol.</para>
1250 //          /// <para></para>
1251 //          /// </param>
1252 //          /// <returns>
1253 //          /// <para>The ulong</para>
1254 //          /// <para></para>
1255 //          /// </returns>
1256 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1257 //          public ulong CalculateTotalSymbolFrequencyCore(ulong symbol)
1258 //          {
1259 //              if (Options.UseSequenceMarker)
1260 //              {
1261 //                  var counter = new
1262 //                  ↪ TotalMarkedSequenceSymbolFrequencyOneOffCounter<ulong>(Links, Options.MarkedSequenceMatcher,
1263 //                  ↪ symbol);
1264 //                  return counter.Count();
1265 //              }
1266 //              else
1267 //              {
1268 //                  var counter = new TotalSequenceSymbolFrequencyOneOffCounter<ulong>(Links,
1269 //                  ↪ symbol);
1270 //                  return counter.Count();
1271 //              }
1272 //          }
1273 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1274 //          private bool AllUsagesCore1(ulong link, HashSet<ulong> usages, Func<IList<LinkIndex>,
1275 //          ↪ LinkIndex> outerHandler)
1276 //          {
1277 //              bool handler(ulong doublet)
1278 //              {
1279 //                  if (usages.Add(doublet))
1280 //                  {
1281 //                      if (outerHandler(new LinkAddress<LinkIndex>(doublet)) !=
1282 //                      ↪ Constants.Continue)
1283 //                      {
1284 //                          return false;
1285 //                      }
1286 //                      if (!AllUsagesCore1(doublet, usages, outerHandler))
1287 //                      {
1288 //                          return false;
1289 //                      }
1290 //                  }
1291 //                  return true;
1292 //              }
1293 //              return Links.Unsync.Each(link, Constants.Any, handler)
1294 //              && Links.Unsync.Each(Constants.Any, link, handler);
1295 //          }
1296 //          /// <summary>
1297 //          /// <para>
1298 //          /// Calculates the all usages using the specified totals.
1299 //          /// </para>
1300 //          /// <para></para>
1301 //          /// </summary>
1302 //          /// <param name="totals">
1303 //          /// <para>The totals.</para>
1304 //          /// <para></para>
1305 //          /// </param>
1306 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1307 //          public void CalculateAllUsages(ulong[] totals)
1308 //          {
1309 //              var calculator = new AllUsagesCalculator(Links, totals);
1310 //              calculator.Calculate();
1311 //          }
1312 //          /// <summary>
1313 //          /// <para>
1314 //          /// Calculates the all usages 2 using the specified totals.
1315 //          /// </para>
1316 //          /// <para></para>
1317 //          /// </summary>
1318 //          /// <param name="totals">
1319 //          /// <para>The totals.</para>
1320 //          /// <para></para>
1321 //          /// </param>

```

```

1318 //      /// </param>
1319 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
1320 //      public void CalculateAllUsages2(ulong[] totals)
1321 //      {
1322 //          var calculator = new AllUsagesCalculator2(Links, totals);
1323 //          calculator.Calculate();
1324 //      }
1325 //      private class AllUsagesCalculator
1326 //      {
1327 //          private readonly SynchronizedLinks<ulong> _links;
1328 //          private readonly ulong[] _totals;
1329 //
1330 //          /// <summary>
1331 //          /// <para>
1332 //          ///     Initializes a new <see cref="AllUsagesCalculator"/> instance.
1333 //          /// </para>
1334 //          /// <para></para>
1335 //          /// </summary>
1336 //          /// <param name="links">
1337 //          /// <para>A links.</para>
1338 //          /// <para></para>
1339 //          /// </param>
1340 //          /// <param name="totals">
1341 //          /// <para>A totals.</para>
1342 //          /// <para></para>
1343 //          /// </param>
1344 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1345 //          public AllUsagesCalculator(SynchronizedLinks<ulong> links, ulong[] totals)
1346 //          {
1347 //              _links = links;
1348 //              _totals = totals;
1349 //          }
1350 //
1351 //          /// <summary>
1352 //          /// <para>
1353 //          ///     Calculates this instance.
1354 //          /// </para>
1355 //          /// <para></para>
1356 //          /// </summary>
1357 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1358 //          public void Calculate() => _links.Each(_links.Constants.Any,
↵      _links.Constants.Any, CalculateCore);
1359 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1360 //          private bool CalculateCore(ulong link)
1361 //          {
1362 //              if (_totals[link] == 0)
1363 //              {
1364 //                  var total = 1UL;
1365 //                  _totals[link] = total;
1366 //                  var visitedChildren = new HashSet<ulong>();
1367 //                  bool linkCalculator(ulong child)
1368 //                  {
1369 //                      if (link != child && visitedChildren.Add(child))
1370 //                      {
1371 //                          total += _totals[child] == 0 ? 1 : _totals[child];
1372 //                      }
1373 //                      return true;
1374 //                  }
1375 //                  _links.Unsync.Each(link, _links.Constants.Any, linkCalculator);
1376 //                  _links.Unsync.Each(_links.Constants.Any, link, linkCalculator);
1377 //                  _totals[link] = total;
1378 //              }
1379 //              return true;
1380 //          }
1381 //      }
1382 //      private class AllUsagesCalculator2
1383 //      {
1384 //          private readonly SynchronizedLinks<ulong> _links;
1385 //          private readonly ulong[] _totals;
1386 //
1387 //          /// <summary>
1388 //          /// <para>
1389 //          ///     Initializes a new <see cref="AllUsagesCalculator2"/> instance.
1390 //          /// </para>
1391 //          /// <para></para>
1392 //          /// </summary>
1393 //          /// <param name="links">

```

```

1394 //          /// <para>A links.</para>
1395 //          /// <para></para>
1396 //          /// </param>
1397 //          /// <param name="totals">
1398 //          /// <para>A totals.</para>
1399 //          /// <para></para>
1400 //          /// </param>
1401 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1402 //          public AllUsagesCalculator2(SynchronizedLinks<ulong> links, ulong[] totals)
1403 //          {
1404 //              _links = links;
1405 //              _totals = totals;
1406 //          }
1407 //
1408 //          /// <summary>
1409 //          /// <para>
1410 //          /// Calculates this instance.
1411 //          /// </para>
1412 //          /// <para></para>
1413 //          /// </summary>
1414 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1415 //          public void Calculate() => _links.Each(_links.Constants.Any,
↵          _links.Constants.Any, CalculateCore);
1416 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1417 //          private bool IsElement(ulong link)
1418 //          {
1419 //              //_linksInSequence.Contains(link) ||
1420 //              return _links.Unsync.GetTarget(link) == link || _links.Unsync.GetSource(link)
↵          == link;
1421 //          }
1422 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1423 //          private bool CalculateCore(ulong link)
1424 //          {
1425 //              // TODO: Проработать защиту от заикливания
1426 //              // Основано на SequenceWalker.WalkLeft
1427 //              Func<ulong, ulong> getSource = _links.Unsync.GetSource;
1428 //              Func<ulong, ulong> getTarget = _links.Unsync.GetTarget;
1429 //              Func<ulong, bool> isElement = IsElement;
1430 //              void visitLeaf(ulong parent)
1431 //              {
1432 //                  if (link != parent)
1433 //                  {
1434 //                      _totals[parent]++;
1435 //                  }
1436 //              }
1437 //              void visitNode(ulong parent)
1438 //              {
1439 //                  if (link != parent)
1440 //                  {
1441 //                      _totals[parent]++;
1442 //                  }
1443 //              }
1444 //              var stack = new Stack();
1445 //              var element = link;
1446 //              if (isElement(element))
1447 //              {
1448 //                  visitLeaf(element);
1449 //              }
1450 //              else
1451 //              {
1452 //                  while (true)
1453 //                  {
1454 //                      if (isElement(element))
1455 //                      {
1456 //                          if (stack.Count == 0)
1457 //                          {
1458 //                              break;
1459 //                          }
1460 //                          element = stack.Pop();
1461 //                          var source = getSource(element);
1462 //                          var target = getTarget(element);
1463 //                          // Обработка элемента
1464 //                          if (isElement(target))
1465 //                          {
1466 //                              visitLeaf(target);
1467 //                          }
1468 //                          if (isElement(source))

```

```

1469 //                                     {
1470 //                                     visitLeaf(source);
1471 //                                     }
1472 //                                     element = source;
1473 //                                     }
1474 //                                     else
1475 //                                     {
1476 //                                     stack.Push(element);
1477 //                                     visitNode(element);
1478 //                                     element = getTarget(element);
1479 //                                     }
1480 //                                     }
1481 //                                     }
1482 //                                     _totals[link]++;
1483 //                                     return true;
1484 //                                     }
1485 //                                     }
1486 // private class AllUsagesCollector
1487 // {
1488 //     private readonly ILinks<ulong> _links;
1489 //     private readonly HashSet<ulong> _usages;
1490 //
1491 //     /// <summary>
1492 //     /// <para>
1493 //     /// Initializes a new <see cref="AllUsagesCollector"/> instance.
1494 //     /// </para>
1495 //     /// <para></para>
1496 //     /// </summary>
1497 //     /// <param name="links">
1498 //     /// <para>A links.</para>
1499 //     /// <para></para>
1500 //     /// </param>
1501 //     /// <param name="usages">
1502 //     /// <para>A usages.</para>
1503 //     /// <para></para>
1504 //     /// </param>
1505 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1506 //     public AllUsagesCollector(ILinks<ulong> links, HashSet<ulong> usages)
1507 //     {
1508 //         _links = links;
1509 //         _usages = usages;
1510 //     }
1511 //
1512 //     /// <summary>
1513 //     /// <para>
1514 //     /// Determines whether this instance collect.
1515 //     /// </para>
1516 //     /// <para></para>
1517 //     /// </summary>
1518 //     /// <param name="link">
1519 //     /// <para>The link.</para>
1520 //     /// <para></para>
1521 //     /// </param>
1522 //     /// <returns>
1523 //     /// <para>The bool</para>
1524 //     /// <para></para>
1525 //     /// </returns>
1526 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1527 //     public bool Collect(ulong link)
1528 //     {
1529 //         if (_usages.Add(link))
1530 //         {
1531 //             _links.Each(link, _links.Constants.Any, Collect);
1532 //             _links.Each(_links.Constants.Any, link, Collect);
1533 //         }
1534 //         return true;
1535 //     }
1536 // }
1537 // private class AllUsagesCollector1
1538 // {
1539 //     private readonly ILinks<ulong> _links;
1540 //     private readonly HashSet<ulong> _usages;
1541 //     private readonly ulong _continue;
1542 //
1543 //     /// <summary>
1544 //     /// <para>
1545 //     /// Initializes a new <see cref="AllUsagesCollector1"/> instance.
1546 //     /// </para>

```

```

1547 //          /// <para></para>
1548 //          /// </summary>
1549 //          /// <param name="links">
1550 //          /// <para>A links.</para>
1551 //          /// <para></para>
1552 //          /// </param>
1553 //          /// <param name="usages">
1554 //          /// <para>A usages.</para>
1555 //          /// <para></para>
1556 //          /// </param>
1557 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1558 //          public AllUsagesCollector1(ILinks<ulong> links, HashSet<ulong> usages)
1559 //          {
1560 //              _links = links;
1561 //              _usages = usages;
1562 //              _continue = _links.Constants.Continue;
1563 //          }
1564 //
1565 //          /// <summary>
1566 //          /// <para>
1567 //          /// Collects the link.
1568 //          /// </para>
1569 //          /// <para></para>
1570 //          /// </summary>
1571 //          /// <param name="link">
1572 //          /// <para>The link.</para>
1573 //          /// <para></para>
1574 //          /// </param>
1575 //          /// <returns>
1576 //          /// <para>The continue.</para>
1577 //          /// <para></para>
1578 //          /// </returns>
1579 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1580 //          public ulong Collect(IList<ulong> link)
1581 //          {
1582 //              var linkIndex = _links.GetIndex(link);
1583 //              if (_usages.Add(linkIndex))
1584 //              {
1585 //                  _links.Each(Collect, _links.Constants.Any, linkIndex);
1586 //              }
1587 //              return _continue;
1588 //          }
1589 //      }
1590 //      private class AllUsagesCollector2
1591 //      {
1592 //          private readonly ILinks<ulong> _links;
1593 //          private readonly BitString _usages;
1594 //
1595 //          /// <summary>
1596 //          /// <para>
1597 //          /// Initializes a new <see cref="AllUsagesCollector2"/> instance.
1598 //          /// </para>
1599 //          /// <para></para>
1600 //          /// </summary>
1601 //          /// <param name="links">
1602 //          /// <para>A links.</para>
1603 //          /// <para></para>
1604 //          /// </param>
1605 //          /// <param name="usages">
1606 //          /// <para>A usages.</para>
1607 //          /// <para></para>
1608 //          /// </param>
1609 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1610 //          public AllUsagesCollector2(ILinks<ulong> links, BitString usages)
1611 //          {
1612 //              _links = links;
1613 //              _usages = usages;
1614 //          }
1615 //
1616 //          /// <summary>
1617 //          /// <para>
1618 //          /// Determines whether this instance collect.
1619 //          /// </para>
1620 //          /// <para></para>
1621 //          /// </summary>
1622 //          /// <param name="link">
1623 //          /// <para>The link.</para>
1624 //          /// <para></para>

```

```

1625 //          /// </param>
1626 //          /// <returns>
1627 //          /// <para>The bool</para>
1628 //          /// <para></para>
1629 //          /// </returns>
1630 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1631 //          public bool Collect(ulong link)
1632 //          {
1633 //              if (_usages.Add((long)link))
1634 //              {
1635 //                  _links.Each(link, _links.Constants.Any, Collect);
1636 //                  _links.Each(_links.Constants.Any, link, Collect);
1637 //              }
1638 //              return true;
1639 //          }
1640 //      }
1641 //      private class AllUsagesIntersectingCollector
1642 //      {
1643 //          private readonly SynchronizedLinks<ulong> _links;
1644 //          private readonly HashSet<ulong> _intersectWith;
1645 //          private readonly HashSet<ulong> _usages;
1646 //          private readonly HashSet<ulong> _enter;
1647 //
1648 //          /// <summary>
1649 //          /// <para>
1650 //          /// Initializes a new <see cref="AllUsagesIntersectingCollector"/> instance.
1651 //          /// </para>
1652 //          /// <para></para>
1653 //          /// </summary>
1654 //          /// <param name="links">
1655 //          /// <para>A links.</para>
1656 //          /// <para></para>
1657 //          /// </param>
1658 //          /// <param name="intersectWith">
1659 //          /// <para>A intersect with.</para>
1660 //          /// <para></para>
1661 //          /// </param>
1662 //          /// <param name="usages">
1663 //          /// <para>A usages.</para>
1664 //          /// <para></para>
1665 //          /// </param>
1666 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1667 //          public AllUsagesIntersectingCollector(SynchronizedLinks<ulong> links,
1668 //          ↪ HashSet<ulong> intersectWith, HashSet<ulong> usages)
1669 //          {
1670 //              _links = links;
1671 //              _intersectWith = intersectWith;
1672 //              _usages = usages;
1673 //              _enter = new HashSet<ulong>(); // защита от заикливания
1674 //          }
1675 //
1676 //          /// <summary>
1677 //          /// <para>
1678 //          /// Determines whether this instance collect.
1679 //          /// </para>
1680 //          /// <para></para>
1681 //          /// </summary>
1682 //          /// <param name="link">
1683 //          /// <para>The link.</para>
1684 //          /// <para></para>
1685 //          /// </param>
1686 //          /// <returns>
1687 //          /// <para>The bool</para>
1688 //          /// <para></para>
1689 //          /// </returns>
1690 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1691 //          public bool Collect(ulong link)
1692 //          {
1693 //              if (_enter.Add(link))
1694 //              {
1695 //                  if (_intersectWith.Contains(link))
1696 //                  {
1697 //                      _usages.Add(link);
1698 //                  }
1699 //                  _links.Unsync.Each(link, _links.Constants.Any, Collect);
1700 //                  _links.Unsync.Each(_links.Constants.Any, link, Collect);

```

```

1701 //         return true;
1702 //     }
1703 // }
1704 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1705 // private void CloseInnerConnections(Action<IList<LinkIndex>> handler, ulong left,
↵ ulong right)
1706 // {
1707 //     TryStepLeftUp(handler, left, right);
1708 //     TryStepRightUp(handler, right, left);
1709 // }
1710 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1711 // private void AllCloseConnections(Action<IList<LinkIndex>> handler, ulong left, ulong
↵ right)
1712 // {
1713 //     // Direct
1714 //     if (left == right)
1715 //     {
1716 //         handler(new LinkAddress<LinkIndex>(left));
1717 //     }
1718 //     var doublet = Links.Unsync.SearchOrDefault(left, right);
1719 //     if (doublet != Constants.Null)
1720 //     {
1721 //         handler(new LinkAddress<LinkIndex>(doublet));
1722 //     }
1723 //     // Inner
1724 //     CloseInnerConnections(handler, left, right);
1725 //     // Outer
1726 //     StepLeft(handler, left, right);
1727 //     StepRight(handler, left, right);
1728 //     PartialStepRight(handler, left, right);
1729 //     PartialStepLeft(handler, left, right);
1730 // }
1731 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1732 // private HashSet<ulong> GetAllPartiallyMatchingSequencesCore(ulong[] sequence,
↵ HashSet<ulong> previousMatchings, long startAt)
1733 // {
1734 //     if (startAt >= sequence.Length) // ?
1735 //     {
1736 //         return previousMatchings;
1737 //     }
1738 //     var secondLinkUsages = new HashSet<ulong>();
1739 //     AllUsagesCore(sequence[startAt], secondLinkUsages);
1740 //     secondLinkUsages.Add(sequence[startAt]);
1741 //     var matchings = new HashSet<ulong>();
1742 //     var filler = new SetFiller<LinkIndex, LinkIndex>(matchings, Constants.Continue);
1743 //     //for (var i = 0; i < previousMatchings.Count; i++)
1744 //     foreach (var secondLinkUsage in secondLinkUsages)
1745 //     {
1746 //         foreach (var previousMatching in previousMatchings)
1747 //         {
1748 //             //AllCloseConnections(matchings.AddAndReturnVoid, previousMatching,
↵ secondLinkUsage);
1749 //             StepRight(filler.AddFirstAndReturnConstant, previousMatching,
↵ secondLinkUsage);
1750 //             TryStepRightUp(filler.AddFirstAndReturnConstant, secondLinkUsage,
↵ previousMatching);
1751 //             //PartialStepRight(matchings.AddAndReturnVoid, secondLinkUsage,
↵ sequence[startAt]); // почему-то эта ошибочная запись приводит к желаемым результатам.
1752 //             PartialStepRight(filler.AddFirstAndReturnConstant, previousMatching,
↵ secondLinkUsage);
1753 //         }
1754 //     }
1755 //     if (matchings.Count == 0)
1756 //     {
1757 //         return matchings;
1758 //     }
1759 //     return GetAllPartiallyMatchingSequencesCore(sequence, matchings, startAt + 1); //
↵ ??
1760 // }
1761 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1762 // private static void EnsureEachLinkIsAnyOrZeroOrManyOrExists(SynchronizedLinks<ulong>
↵ links, params ulong[] sequence)
1763 // {
1764 //     if (sequence == null)
1765 //     {
1766 //         return;
1767 //     }

```

```

1768 //         for (var i = 0; i < sequence.Length; i++)
1769 //         {
1770 //             if (sequence[i] != links.Constants.Any && sequence[i] != ZeroOrMany &&
↵ !links.Exists(sequence[i]))
1771 //                 {
1772 //                     throw new ArgumentLinkDoesNotExistsException<ulong>(sequence[i],
↵ $"patternSequence[{i}]");
1773 //                 }
1774 //             }
1775 //         }
1776 //
1777 //         // Pattern Matching -> Key To Triggers
1778 //         /// <summary>
1779 //         /// <para>
1780 //         /// Matches the pattern using the specified pattern sequence.
1781 //         /// </para>
1782 //         /// <para></para>
1783 //         /// </summary>
1784 //         /// <param name="patternSequence">
1785 //         /// <para>The pattern sequence.</para>
1786 //         /// <para></para>
1787 //         /// </param>
1788 //         /// <returns>
1789 //         /// <para>A hash set of ulong</para>
1790 //         /// <para></para>
1791 //         /// </returns>
1792 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
1793 //         public HashSet<ulong> MatchPattern(params ulong[] patternSequence)
1794 //         {
1795 //             return _sync.DoRead(() =>
1796 //             {
1797 //                 patternSequence = Simplify(patternSequence);
1798 //                 if (patternSequence.Length > 0)
1799 //                 {
1800 //                     EnsureEachLinkIsAnyOrZeroOrManyOrExists(Links, patternSequence);
1801 //                     var uniqueSequenceElements = new HashSet<ulong>();
1802 //                     for (var i = 0; i < patternSequence.Length; i++)
1803 //                     {
1804 //                         if (patternSequence[i] != Constants.Any && patternSequence[i] !=
↵ ZeroOrMany)
1805 //                         {
1806 //                             uniqueSequenceElements.Add(patternSequence[i]);
1807 //                         }
1808 //                     }
1809 //                     var results = new HashSet<ulong>();
1810 //                     foreach (var uniqueSequenceElement in uniqueSequenceElements)
1811 //                     {
1812 //                         AllUsagesCore(uniqueSequenceElement, results);
1813 //                     }
1814 //                     var filteredResults = new HashSet<ulong>();
1815 //                     var matcher = new PatternMatcher(this, patternSequence, filteredResults);
1816 //                     matcher.AddAllPatternMatchedToResults(results);
1817 //                     return filteredResults;
1818 //                 }
1819 //                 return new HashSet<ulong>();
1820 //             });
1821 //         }
1822 //
1823 //         // Найти все возможные связи между указанным списком связей.
1824 //         // Находит связи между всеми указанными связями в любом порядке.
1825 //         // TODO: решить что делать с повторами (когда одни и те же элементы встречаются
↵ несколько раз в последовательности)
1826 //         /// <summary>
1827 //         /// <para>
1828 //         /// Gets the all connections using the specified links to connect.
1829 //         /// </para>
1830 //         /// <para></para>
1831 //         /// </summary>
1832 //         /// <param name="linksToConnect">
1833 //         /// <para>The links to connect.</para>
1834 //         /// <para></para>
1835 //         /// </param>
1836 //         /// <returns>
1837 //         /// <para>A hash set of ulong</para>
1838 //         /// <para></para>
1839 //         /// </returns>
1840 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]

```



```

1841 // public HashSet<ulong> GetAllConnections(params ulong[] linksToConnect)
1842 // {
1843 //     return _sync.DoRead(() =>
1844 //     {
1845 //         var results = new HashSet<ulong>();
1846 //         if (linksToConnect.Length > 0)
1847 //         {
1848 //             Links.EnsureLinkExists(linksToConnect);
1849 //             AllUsagesCore(linksToConnect[0], results);
1850 //             for (var i = 1; i < linksToConnect.Length; i++)
1851 //             {
1852 //                 var next = new HashSet<ulong>();
1853 //                 AllUsagesCore(linksToConnect[i], next);
1854 //                 results.IntersectWith(next);
1855 //             }
1856 //         }
1857 //         return results;
1858 //     });
1859 // }
1860 //
1861 // /// <summary>
1862 // /// <para>
1863 // /// Gets the all connections 1 using the specified links to connect.
1864 // /// </para>
1865 // /// <para></para>
1866 // /// </summary>
1867 // /// <param name="linksToConnect">
1868 // /// <para>The links to connect.</para>
1869 // /// <para></para>
1870 // /// </param>
1871 // /// <returns>
1872 // /// <para>A hash set of ulong</para>
1873 // /// <para></para>
1874 // /// </returns>
1875 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1876 // public HashSet<ulong> GetAllConnections1(params ulong[] linksToConnect)
1877 // {
1878 //     return _sync.DoRead(() =>
1879 //     {
1880 //         var results = new HashSet<ulong>();
1881 //         if (linksToConnect.Length > 0)
1882 //         {
1883 //             Links.EnsureLinkExists(linksToConnect);
1884 //             var collector1 = new AllUsagesCollector(Links.Unsync, results);
1885 //             collector1.Collect(linksToConnect[0]);
1886 //             var next = new HashSet<ulong>();
1887 //             for (var i = 1; i < linksToConnect.Length; i++)
1888 //             {
1889 //                 var collector = new AllUsagesCollector(Links.Unsync, next);
1890 //                 collector.Collect(linksToConnect[i]);
1891 //                 results.IntersectWith(next);
1892 //                 next.Clear();
1893 //             }
1894 //         }
1895 //         return results;
1896 //     });
1897 // }
1898 //
1899 // /// <summary>
1900 // /// <para>
1901 // /// Gets the all connections 2 using the specified links to connect.
1902 // /// </para>
1903 // /// <para></para>
1904 // /// </summary>
1905 // /// <param name="linksToConnect">
1906 // /// <para>The links to connect.</para>
1907 // /// <para></para>
1908 // /// </param>
1909 // /// <returns>
1910 // /// <para>A hash set of ulong</para>
1911 // /// <para></para>
1912 // /// </returns>
1913 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1914 // public HashSet<ulong> GetAllConnections2(params ulong[] linksToConnect)
1915 // {
1916 //     return _sync.DoRead(() =>
1917 //     {
1918 //         var results = new HashSet<ulong>();

```

```

1919 //         if (linksToConnect.Length > 0)
1920 //         {
1921 //             Links.EnsureLinkExists(linksToConnect);
1922 //             var collector1 = new AllUsagesCollector(Links, results);
1923 //             collector1.Collect(linksToConnect[0]);
1924 //             //AllUsagesCore(linksToConnect[0], results);
1925 //             for (var i = 1; i < linksToConnect.Length; i++)
1926 //             {
1927 //                 var next = new HashSet<ulong>();
1928 //                 var collector = new AllUsagesIntersectingCollector(Links, results,
↵ next);
1929 //                 collector.Collect(linksToConnect[i]);
1930 //                 //AllUsagesCore(linksToConnect[i], next);
1931 //                 //results.IntersectWith(next);
1932 //                 results = next;
1933 //             }
1934 //         }
1935 //         return results;
1936 //     });
1937 // }
1938 //
1939 //     /// <summary>
1940 //     /// <para>
1941 //     /// Gets the all connections 3 using the specified links to connect.
1942 //     /// </para>
1943 //     /// <para></para>
1944 //     /// </summary>
1945 //     /// <param name="linksToConnect">
1946 //     /// <para>The links to connect.</para>
1947 //     /// <para></para>
1948 //     /// </param>
1949 //     /// <returns>
1950 //     /// <para>A list of ulong</para>
1951 //     /// <para></para>
1952 //     /// </returns>
1953 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1954 //     public List<ulong> GetAllConnections3(params ulong[] linksToConnect)
1955 //     {
1956 //         return _sync.DoRead(() =>
1957 //         {
1958 //             var results = new BitString((long)Links.Unsync.Count() + 1); // new
↵ BitArray((int)_links.Total + 1);
1959 //             if (linksToConnect.Length > 0)
1960 //             {
1961 //                 Links.EnsureLinkExists(linksToConnect);
1962 //                 var collector1 = new AllUsagesCollector2(Links.Unsync, results);
1963 //                 collector1.Collect(linksToConnect[0]);
1964 //                 for (var i = 1; i < linksToConnect.Length; i++)
1965 //                 {
1966 //                     var next = new BitString((long)Links.Unsync.Count() + 1); //new
↵ BitArray((int)_links.Total + 1);
1967 //                     var collector = new AllUsagesCollector2(Links.Unsync, next);
1968 //                     collector.Collect(linksToConnect[i]);
1969 //                     results = results.And(next);
1970 //                 }
1971 //             }
1972 //             return results.GetSetUInt64Indices();
1973 //         });
1974 //     }
1975 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1976 //     private static ulong[] Simplify(ulong[] sequence)
1977 //     {
1978 //         // Считаем новый размер последовательности
1979 //         long newLength = 0;
1980 //         var zeroOrManyStepped = false;
1981 //         for (var i = 0; i < sequence.Length; i++)
1982 //         {
1983 //             if (sequence[i] == ZeroOrMany)
1984 //             {
1985 //                 if (zeroOrManyStepped)
1986 //                 {
1987 //                     continue;
1988 //                 }
1989 //                 zeroOrManyStepped = true;
1990 //             }
1991 //             else
1992 //             {

```

```

1993 // //if (zeroOrManyStepped) Is it efficient?
1994 // zeroOrManyStepped = false;
1995 // }
1996 // newLength++;
1997 // }
1998 // // Строим новую последовательность
1999 // zeroOrManyStepped = false;
2000 // var newSequence = new ulong[newLength];
2001 // long j = 0;
2002 // for (var i = 0; i < sequence.Length; i++)
2003 // {
2004 //     //var current = zeroOrManyStepped;
2005 //     //zeroOrManyStepped = patternSequence[i] == zeroOrMany;
2006 //     //if (current && zeroOrManyStepped)
2007 //     //     continue;
2008 //     //var newZeroOrManyStepped = patternSequence[i] == zeroOrMany;
2009 //     //if (zeroOrManyStepped && newZeroOrManyStepped)
2010 //     //     continue;
2011 //     //zeroOrManyStepped = newZeroOrManyStepped;
2012 //     if (sequence[i] == ZeroOrMany)
2013 //     {
2014 //         if (zeroOrManyStepped)
2015 //         {
2016 //             continue;
2017 //         }
2018 //         zeroOrManyStepped = true;
2019 //     }
2020 //     else
2021 //     {
2022 //         //if (zeroOrManyStepped) Is it efficient?
2023 //         zeroOrManyStepped = false;
2024 //     }
2025 //     newSequence[j++] = sequence[i];
2026 // }
2027 // return newSequence;
2028 // }
2029 //
2030 // /// <summary>
2031 // /// <para>
2032 // /// Tests the simplify.
2033 // /// </para>
2034 // /// <para></para>
2035 // /// </summary>
2036 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
2037 // public static void TestSimplify()
2038 // {
2039 //     var sequence = new ulong[] { ZeroOrMany, ZeroOrMany, 2, 3, 4, ZeroOrMany,
↵ ZeroOrMany, ZeroOrMany, 4, ZeroOrMany, ZeroOrMany, ZeroOrMany };
2040 //     var simplifiedSequence = Simplify(sequence);
2041 // }
2042 //
2043 // /// <summary>
2044 // /// <para>
2045 // /// Gets the similar sequences.
2046 // /// </para>
2047 // /// <para></para>
2048 // /// </summary>
2049 // /// <returns>
2050 // /// <para>A list of ulong</para>
2051 // /// <para></para>
2052 // /// </returns>
2053 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
2054 // public List<ulong> GetSimilarSequences() => new List<ulong>();
2055 //
2056 // /// <summary>
2057 // /// <para>
2058 // /// Predictions this instance.
2059 // /// </para>
2060 // /// <para></para>
2061 // /// </summary>
2062 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
2063 // public void Prediction()
2064 // {
2065 //     //_links
2066 //     //sequences
2067 // }
2068 //

```

```

2069 // #region From Triplets
2070 //
2071 // //public static void DeleteSequence(Link sequence)
2072 // //{
2073 // //}
2074 //
2075 // /// <summary>
2076 // /// <para>
2077 // /// Collects the matching sequences using the specified links.
2078 // /// </para>
2079 // /// <para></para>
2080 // /// </summary>
2081 // /// <param name="links">
2082 // /// <para>The links.</para>
2083 // /// <para></para>
2084 // /// </param>
2085 // /// <exception cref="InvalidOperationException">
2086 // /// <para>Подпоследовательности с одним элементом не поддерживаются.</para>
2087 // /// <para></para>
2088 // /// </exception>
2089 // /// <returns>
2090 // /// <para>The results.</para>
2091 // /// <para></para>
2092 // /// </returns>
2093 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
2094 // public List<ulong> CollectMatchingSequences(ulong[] links)
2095 // {
2096 //     if (links.Length == 1)
2097 //     {
2098 //         throw new InvalidOperationException("Подпоследовательности с одним элементом
↵ не поддерживаются.");
2099 //     }
2100 //     var leftBound = 0;
2101 //     var rightBound = links.Length - 1;
2102 //     var left = links[leftBound++];
2103 //     var right = links[rightBound--];
2104 //     var results = new List<ulong>();
2105 //     CollectMatchingSequences(left, leftBound, links, right, rightBound, ref results);
2106 //     return results;
2107 // }
2108 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
2109 // private void CollectMatchingSequences(ulong leftLink, int leftBound, ulong[]
↵ middleLinks, ulong rightLink, int rightBound, ref List<ulong> results)
2110 // {
2111 //     var leftLinkTotalReferers = Links.Unsync.Count(leftLink);
2112 //     var rightLinkTotalReferers = Links.Unsync.Count(rightLink);
2113 //     if (leftLinkTotalReferers <= rightLinkTotalReferers)
2114 //     {
2115 //         var nextLeftLink = middleLinks[leftBound];
2116 //         var elements = GetRightElements(leftLink, nextLeftLink);
2117 //         if (leftBound <= rightBound)
2118 //         {
2119 //             for (var i = elements.Length - 1; i >= 0; i--)
2120 //             {
2121 //                 var element = elements[i];
2122 //                 if (element != 0)
2123 //                 {
2124 //                     CollectMatchingSequences(element, leftBound + 1, middleLinks,
↵ rightLink, rightBound, ref results);
2125 //                 }
2126 //             }
2127 //         }
2128 //         else
2129 //         {
2130 //             for (var i = elements.Length - 1; i >= 0; i--)
2131 //             {
2132 //                 var element = elements[i];
2133 //                 if (element != 0)
2134 //                 {
2135 //                     results.Add(element);
2136 //                 }
2137 //             }
2138 //         }
2139 //     }
2140 //     else
2141 //     {
2142 //         var nextRightLink = middleLinks[rightBound];

```

```

2143 //         var elements = GetLeftElements(rightLink, nextRightLink);
2144 //         if (leftBound <= rightBound)
2145 //         {
2146 //             for (var i = elements.Length - 1; i >= 0; i--)
2147 //             {
2148 //                 var element = elements[i];
2149 //                 if (element != 0)
2150 //                 {
2151 //                     CollectMatchingSequences(leftLink, leftBound, middleLinks,
↵ elements[i], rightBound - 1, ref results);
2152 //                 }
2153 //             }
2154 //         }
2155 //         else
2156 //         {
2157 //             for (var i = elements.Length - 1; i >= 0; i--)
2158 //             {
2159 //                 var element = elements[i];
2160 //                 if (element != 0)
2161 //                 {
2162 //                     results.Add(element);
2163 //                 }
2164 //             }
2165 //         }
2166 //     }
2167 // }
2168 //
2169 //     /// <summary>
2170 //     /// <para>
2171 //     /// Gets the right elements using the specified start link.
2172 //     /// </para>
2173 //     /// <para></para>
2174 //     /// </summary>
2175 //     /// <param name="startLink">
2176 //     /// <para>The start link.</para>
2177 //     /// <para></para>
2178 //     /// </param>
2179 //     /// <param name="rightLink">
2180 //     /// <para>The right link.</para>
2181 //     /// <para></para>
2182 //     /// </param>
2183 //     /// <returns>
2184 //     /// <para>The result.</para>
2185 //     /// <para></para>
2186 //     /// </returns>
2187 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
2188 //     public ulong[] GetRightElements(ulong startLink, ulong rightLink)
2189 //     {
2190 //         var result = new ulong[5];
2191 //         TryStepRight(startLink, rightLink, result, 0);
2192 //         Links.Each(Constants.Any, startLink, couple =>
2193 //         {
2194 //             if (couple != startLink)
2195 //             {
2196 //                 if (TryStepRight(couple, rightLink, result, 2))
2197 //                 {
2198 //                     return false;
2199 //                 }
2200 //             }
2201 //             return true;
2202 //         });
2203 //         if (Links.GetTarget(Links.GetTarget(startLink)) == rightLink)
2204 //         {
2205 //             result[4] = startLink;
2206 //         }
2207 //         return result;
2208 //     }
2209 //
2210 //     /// <summary>
2211 //     /// <para>
2212 //     /// Determines whether this instance try step right.
2213 //     /// </para>
2214 //     /// <para></para>
2215 //     /// </summary>
2216 //     /// <param name="startLink">
2217 //     /// <para>The start link.</para>
2218 //     /// <para></para>

```

```

2219 //      /// </param>
2220 //      /// <param name="rightLink">
2221 //      /// <para>The right link.</para>
2222 //      /// <para></para>
2223 //      /// </param>
2224 //      /// <param name="result">
2225 //      /// <para>The result.</para>
2226 //      /// <para></para>
2227 //      /// </param>
2228 //      /// <param name="offset">
2229 //      /// <para>The offset.</para>
2230 //      /// <para></para>
2231 //      /// </param>
2232 //      /// <returns>
2233 //      /// <para>The bool</para>
2234 //      /// <para></para>
2235 //      /// </returns>
2236 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
2237 //      public bool TryStepRight(ulong startLink, ulong rightLink, ulong[] result, int offset)
2238 //      {
2239 //          var added = 0;
2240 //          Links.Each(startLink, Constants.Any, couple =>
2241 //          {
2242 //              if (couple != startLink)
2243 //              {
2244 //                  var coupleTarget = Links.GetTarget(couple);
2245 //                  if (coupleTarget == rightLink)
2246 //                  {
2247 //                      result[offset] = couple;
2248 //                      if (++added == 2)
2249 //                      {
2250 //                          return false;
2251 //                      }
2252 //                  }
2253 //                  else if (Links.GetSource(coupleTarget) == rightLink) //
2254 //                      ↪ coupleTarget.Linker == Net.And &&
2255 //                  {
2256 //                      result[offset + 1] = couple;
2257 //                      if (++added == 2)
2258 //                      {
2259 //                          return false;
2260 //                      }
2261 //                  }
2262 //                  return true;
2263 //              });
2264 //          return added > 0;
2265 //      }
2266 //
2267 //      /// <summary>
2268 //      /// <para>
2269 //      /// Gets the left elements using the specified start link.
2270 //      /// </para>
2271 //      /// <para></para>
2272 //      /// </summary>
2273 //      /// <param name="startLink">
2274 //      /// <para>The start link.</para>
2275 //      /// <para></para>
2276 //      /// </param>
2277 //      /// <param name="leftLink">
2278 //      /// <para>The left link.</para>
2279 //      /// <para></para>
2280 //      /// </param>
2281 //      /// <returns>
2282 //      /// <para>The result.</para>
2283 //      /// <para></para>
2284 //      /// </returns>
2285 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
2286 //      public ulong[] GetLeftElements(ulong startLink, ulong leftLink)
2287 //      {
2288 //          var result = new ulong[5];
2289 //          TryStepLeft(startLink, leftLink, result, 0);
2290 //          Links.Each(startLink, Constants.Any, couple =>
2291 //          {
2292 //              if (couple != startLink)
2293 //              {
2294 //                  if (TryStepLeft(couple, leftLink, result, 2))
2295 //                  {

```

```

2296 //         return false;
2297 //     }
2298 // }
2299 //     return true;
2300 // });
2301 // if (Links.GetSource(Links.GetSource(leftLink)) == startLink)
2302 // {
2303 //     result[4] = leftLink;
2304 // }
2305 // return result;
2306 // }
2307 //
2308 // /// <summary>
2309 // /// <para>
2310 // /// Determines whether this instance try step left.
2311 // /// </para>
2312 // /// <para></para>
2313 // /// </summary>
2314 // /// <param name="startLink">
2315 // /// <para>The start link.</para>
2316 // /// <para></para>
2317 // /// </param>
2318 // /// <param name="leftLink">
2319 // /// <para>The left link.</para>
2320 // /// <para></para>
2321 // /// </param>
2322 // /// <param name="result">
2323 // /// <para>The result.</para>
2324 // /// <para></para>
2325 // /// </param>
2326 // /// <param name="offset">
2327 // /// <para>The offset.</para>
2328 // /// <para></para>
2329 // /// </param>
2330 // /// <returns>
2331 // /// <para>The bool</para>
2332 // /// <para></para>
2333 // /// </returns>
2334 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
2335 // public bool TryStepLeft(ulong startLink, ulong leftLink, ulong[] result, int offset)
2336 // {
2337 //     var added = 0;
2338 //     Links.Each(Constants.Any, startLink, couple =>
2339 //     {
2340 //         if (couple != startLink)
2341 //         {
2342 //             var coupleSource = Links.GetSource(couple);
2343 //             if (coupleSource == leftLink)
2344 //             {
2345 //                 result[offset] = couple;
2346 //                 if (++added == 2)
2347 //                 {
2348 //                     return false;
2349 //                 }
2350 //             }
2351 //             else if (Links.GetTarget(coupleSource) == leftLink) //
2352 // ↵ coupleSource.Linker == Net.And &&
2353 //             {
2354 //                 result[offset + 1] = couple;
2355 //                 if (++added == 2)
2356 //                 {
2357 //                     return false;
2358 //                 }
2359 //             }
2360 //         }
2361 //         return true;
2362 //     });
2363 //     return added > 0;
2364 // }
2365 //
2366 // #endregion
2367 //
2368 // #region Walkers
2369 //
2370 // /// <summary>
2371 // /// <para>
2372 // /// Represents the pattern matcher.
2373 // /// </para>

```

```

2373 //      /// <para></para>
2374 //      /// </summary>
2375 //      /// <seealso cref="RightSequenceWalker{ulong}" />
2376 //      public class PatternMatcher : RightSequenceWalker<ulong>
2377 //      {
2378 //          private readonly Sequences _sequences;
2379 //          private readonly ulong[] _patternSequence;
2380 //          private readonly HashSet<LinkIndex> _linksInSequence;
2381 //          private readonly HashSet<LinkIndex> _results;
2382 //
2383 //          #region Pattern Match
2384 //
2385 //          /// <summary>
2386 //          /// <para>
2387 //          /// The pattern block type enum.
2388 //          /// </para>
2389 //          /// <para></para>
2390 //          /// </summary>
2391 //          enum PatternBlockType
2392 //          {
2393 //              /// <summary>
2394 //              /// <para>
2395 //              /// The undefined pattern block type.
2396 //              /// </para>
2397 //              /// <para></para>
2398 //              /// </summary>
2399 //              Undefined,
2400 //              /// <summary>
2401 //              /// <para>
2402 //              /// The gap pattern block type.
2403 //              /// </para>
2404 //              /// <para></para>
2405 //              /// </summary>
2406 //              Gap,
2407 //              /// <summary>
2408 //              /// <para>
2409 //              /// The elements pattern block type.
2410 //              /// </para>
2411 //              /// <para></para>
2412 //              /// </summary>
2413 //              Elements
2414 //          }
2415 //
2416 //          /// <summary>
2417 //          /// <para>
2418 //          /// The pattern block.
2419 //          /// </para>
2420 //          /// <para></para>
2421 //          /// </summary>
2422 //          struct PatternBlock
2423 //          {
2424 //              /// <summary>
2425 //              /// <para>
2426 //              /// The type.
2427 //              /// </para>
2428 //              /// <para></para>
2429 //              /// </summary>
2430 //              public PatternBlockType Type;
2431 //              /// <summary>
2432 //              /// <para>
2433 //              /// The start.
2434 //              /// </para>
2435 //              /// <para></para>
2436 //              /// </summary>
2437 //              public long Start;
2438 //              /// <summary>
2439 //              /// <para>
2440 //              /// The stop.
2441 //              /// </para>
2442 //              /// <para></para>
2443 //              /// </summary>
2444 //              public long Stop;
2445 //          }
2446 //          private readonly List<PatternBlock> _pattern;
2447 //          private int _patternPosition;
2448 //          private long _sequencePosition;
2449 //
2450 //          #endregion

```



```

2451 //
2452 //      /// <summary>
2453 //      /// <para>
2454 //      /// Initializes a new <see cref="PatternMatcher"/> instance.
2455 //      /// </para>
2456 //      /// <para></para>
2457 //      /// </summary>
2458 //      /// <param name="sequences">
2459 //      /// <para>A sequences.</para>
2460 //      /// <para></para>
2461 //      /// </param>
2462 //      /// <param name="patternSequence">
2463 //      /// <para>A pattern sequence.</para>
2464 //      /// <para></para>
2465 //      /// </param>
2466 //      /// <param name="results">
2467 //      /// <para>A results.</para>
2468 //      /// <para></para>
2469 //      /// </param>
2470 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
2471 //      public PatternMatcher(Sequences sequences, LinkIndex[] patternSequence,
↵      HashSet<LinkIndex> results)
2472 //          : base(sequences.Links.Unsync, new DefaultStack<ulong>())
2473 //      {
2474 //          _sequences = sequences;
2475 //          _patternSequence = patternSequence;
2476 //          _linksInSequence = new HashSet<LinkIndex>(patternSequence.Where(x => x !=
↵      _sequences.Constants.Any && x != ZeroOrMany));
2477 //          _results = results;
2478 //          _pattern = CreateDetailedPattern();
2479 //      }
2480 //
2481 //      /// <summary>
2482 //      /// <para>
2483 //      /// Determines whether this instance is element.
2484 //      /// </para>
2485 //      /// <para></para>
2486 //      /// </summary>
2487 //      /// <param name="link">
2488 //      /// <para>The link.</para>
2489 //      /// <para></para>
2490 //      /// </param>
2491 //      /// <returns>
2492 //      /// <para>The bool</para>
2493 //      /// <para></para>
2494 //      /// </returns>
2495 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
2496 //      protected override bool IsElement(ulong link) => _linksInSequence.Contains(link)
↵      || base.IsElement(link);
2497 //
2498 //      /// <summary>
2499 //      /// <para>
2500 //      /// Determines whether this instance pattern match.
2501 //      /// </para>
2502 //      /// <para></para>
2503 //      /// </summary>
2504 //      /// <param name="sequenceToMatch">
2505 //      /// <para>The sequence to match.</para>
2506 //      /// <para></para>
2507 //      /// </param>
2508 //      /// <returns>
2509 //      /// <para>The bool</para>
2510 //      /// <para></para>
2511 //      /// </returns>
2512 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
2513 //      public bool PatternMatch(LinkIndex sequenceToMatch)
2514 //      {
2515 //          _patternPosition = 0;
2516 //          _sequencePosition = 0;
2517 //          foreach (var part in Walk(sequenceToMatch))
2518 //          {
2519 //              if (!PatternMatchCore(part))
2520 //              {
2521 //                  break;
2522 //              }
2523 //          }

```

```

2524 //         return _patternPosition == _pattern.Count || (_patternPosition ==
↵ _pattern.Count - 1 && _pattern[_patternPosition].Start == 0);
2525 //     }
2526 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
2527 //     private List<PatternBlock> CreateDetailedPattern()
2528 //     {
2529 //         var pattern = new List<PatternBlock>();
2530 //         var patternBlock = new PatternBlock();
2531 //         for (var i = 0; i < _patternSequence.Length; i++)
2532 //         {
2533 //             if (patternBlock.Type == PatternBlockType.Undefined)
2534 //             {
2535 //                 if (_patternSequence[i] == _sequences.Constants.Any)
2536 //                 {
2537 //                     patternBlock.Type = PatternBlockType.Gap;
2538 //                     patternBlock.Start = 1;
2539 //                     patternBlock.Stop = 1;
2540 //                 }
2541 //                 else if (_patternSequence[i] == ZeroOrMany)
2542 //                 {
2543 //                     patternBlock.Type = PatternBlockType.Gap;
2544 //                     patternBlock.Start = 0;
2545 //                     patternBlock.Stop = long.MaxValue;
2546 //                 }
2547 //                 else
2548 //                 {
2549 //                     patternBlock.Type = PatternBlockType.Elements;
2550 //                     patternBlock.Start = i;
2551 //                     patternBlock.Stop = i;
2552 //                 }
2553 //             }
2554 //             else if (patternBlock.Type == PatternBlockType.Elements)
2555 //             {
2556 //                 if (_patternSequence[i] == _sequences.Constants.Any)
2557 //                 {
2558 //                     pattern.Add(patternBlock);
2559 //                     patternBlock = new PatternBlock
2560 //                     {
2561 //                         Type = PatternBlockType.Gap,
2562 //                         Start = 1,
2563 //                         Stop = 1
2564 //                     };
2565 //                 }
2566 //                 else if (_patternSequence[i] == ZeroOrMany)
2567 //                 {
2568 //                     pattern.Add(patternBlock);
2569 //                     patternBlock = new PatternBlock
2570 //                     {
2571 //                         Type = PatternBlockType.Gap,
2572 //                         Start = 0,
2573 //                         Stop = long.MaxValue
2574 //                     };
2575 //                 }
2576 //                 else
2577 //                 {
2578 //                     patternBlock.Stop = i;
2579 //                 }
2580 //             }
2581 //             else // patternBlock.Type == PatternBlockType.Gap
2582 //             {
2583 //                 if (_patternSequence[i] == _sequences.Constants.Any)
2584 //                 {
2585 //                     patternBlock.Start++;
2586 //                     if (patternBlock.Stop < patternBlock.Start)
2587 //                     {
2588 //                         patternBlock.Stop = patternBlock.Start;
2589 //                     }
2590 //                 }
2591 //                 else if (_patternSequence[i] == ZeroOrMany)
2592 //                 {
2593 //                     patternBlock.Stop = long.MaxValue;
2594 //                 }
2595 //                 else
2596 //                 {
2597 //                     pattern.Add(patternBlock);
2598 //                     patternBlock = new PatternBlock
2599 //                     {

```

```

2600 //                                     Type = PatternBlockType.Elements,
2601 //                                     Start = i,
2602 //                                     Stop = i
2603 //                                     };
2604 //                                     }
2605 //                                     }
2606 //                                     }
2607 //                                     if (patternBlock.Type != PatternBlockType.Undefined)
2608 //                                     {
2609 //                                         pattern.Add(patternBlock);
2610 //                                     }
2611 //                                     return pattern;
2612 //                                     }
2613 //
2614 //                                     // match: search for regexp anywhere in text
2615 //                                     //int match(char* regexp, char* text)
2616 //                                     //{
2617 //                                     //    do
2618 //                                     //    {
2619 //                                     //        } while (*text++ != '\0');
2620 //                                     //    return 0;
2621 //                                     //}
2622 //
2623 //                                     // matchhere: search for regexp at beginning of text
2624 //                                     //int matchhere(char* regexp, char* text)
2625 //                                     //{
2626 //                                     //    if (regexp[0] == '\0')
2627 //                                     //        return 1;
2628 //                                     //    if (regexp[1] == '*')
2629 //                                     //        return matchstar(regexp[0], regexp + 2, text);
2630 //                                     //    if (regexp[0] == '$' && regexp[1] == '\0')
2631 //                                     //        return *text == '\0';
2632 //                                     //    if (*text != '\0' && (regexp[0] == '.' || regexp[0] == *text))
2633 //                                     //        return matchhere(regexp + 1, text + 1);
2634 //                                     //    return 0;
2635 //                                     //}
2636 //
2637 //                                     // matchstar: search for c*regexp at beginning of text
2638 //                                     //int matchstar(int c, char* regexp, char* text)
2639 //                                     //{
2640 //                                     //    do
2641 //                                     //    {
2642 //                                     //        /* a * matches zero or more instances */
2643 //                                     //        if (matchhere(regexp, text))
2644 //                                     //            return 1;
2645 //                                     //    } while (*text != '\0' && (*text++ == c || c == '.'));
2646 //                                     //    return 0;
2647 //                                     //}
2648 //                                     //private void GetNextPatternElement(out LinkIndex element, out long mininumGap,
2649 //                                     ↪ out long maximumGap)
2650 //                                     //{
2651 //                                     //    mininumGap = 0;
2652 //                                     //    maximumGap = 0;
2653 //                                     //    element = 0;
2654 //                                     //    for (; _patternPosition < _patternSequence.Length; _patternPosition++)
2655 //                                     //    {
2656 //                                     //        if (_patternSequence[_patternPosition] == Doublets.Links.Null)
2657 //                                     //            mininumGap++;
2658 //                                     //        else if (_patternSequence[_patternPosition] == ZeroOrMany)
2659 //                                     //            maximumGap = long.MaxValue;
2660 //                                     //        else
2661 //                                     //            break;
2662 //                                     //    }
2663 //                                     //    if (maximumGap < mininumGap)
2664 //                                     //        maximumGap = mininumGap;
2665 //                                     //}
2666 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
2667 //                                     private bool PatternMatchCore(LinkIndex element)
2668 //                                     {
2669 //                                     //    if (_patternPosition >= _pattern.Count)
2670 //                                     //    {
2671 //                                     //        _patternPosition = -2;
2672 //                                     //        return false;
2673 //                                     //    }
2674 //                                     //    var currentPatternBlock = _pattern[_patternPosition];
2675 //                                     //    if (currentPatternBlock.Type == PatternBlockType.Gap)

```

```

2676 // {
2677 //     //var currentMatchingBlockLength = (_sequencePosition -
↵  _lastMatchedBlockPosition);
2678 //     if (_sequencePosition < currentPatternBlock.Start)
2679 //     {
2680 //         _sequencePosition++;
2681 //         return true; // Двигаемся дальше
2682 //     }
2683 //     // Это последний блок
2684 //     if (_pattern.Count == _patternPosition + 1)
2685 //     {
2686 //         _patternPosition++;
2687 //         _sequencePosition = 0;
2688 //         return false; // Полное соответствие
2689 //     }
2690 //     else
2691 //     {
2692 //         if (_sequencePosition > currentPatternBlock.Stop)
2693 //         {
2694 //             return false; // Соответствие невозможно
2695 //         }
2696 //         var nextPatternBlock = _pattern[_patternPosition + 1];
2697 //         if (_patternSequence[nextPatternBlock.Start] == element)
2698 //         {
2699 //             if (nextPatternBlock.Start < nextPatternBlock.Stop)
2700 //             {
2701 //                 _patternPosition++;
2702 //                 _sequencePosition = 1;
2703 //             }
2704 //             else
2705 //             {
2706 //                 _patternPosition += 2;
2707 //                 _sequencePosition = 0;
2708 //             }
2709 //         }
2710 //     }
2711 // }
2712 // else // currentPatternBlock.Type == PatternBlockType.Elements
2713 // {
2714 //     var patternElementPosition = currentPatternBlock.Start +
↵  _sequencePosition;
2715 //     if (_patternSequence[patternElementPosition] != element)
2716 //     {
2717 //         return false; // Соответствие невозможно
2718 //     }
2719 //     if (patternElementPosition == currentPatternBlock.Stop)
2720 //     {
2721 //         _patternPosition++;
2722 //         _sequencePosition = 0;
2723 //     }
2724 //     else
2725 //     {
2726 //         _sequencePosition++;
2727 //     }
2728 // }
2729 // return true;
2730 // //if (_patternSequence[_patternPosition] != element)
2731 // //    return false;
2732 // //else
2733 // //{
2734 // //    _sequencePosition++;
2735 // //    _patternPosition++;
2736 // //    return true;
2737 // //}
2738 // ///////
2739 // //if (_filterPosition == _patternSequence.Length)
2740 // //{
2741 // //    _filterPosition = -2; // Длиннее чем нужно
2742 // //    return false;
2743 // //}
2744 // //if (element != _patternSequence[_filterPosition])
2745 // //{
2746 // //    _filterPosition = -1;
2747 // //    return false; // Начинается иначе
2748 // //}
2749 // //__filterPosition++;
2750 // //if (_filterPosition == (_patternSequence.Length - 1))

```

```

2751 //                //    return false;
2752 //                //if (_filterPosition >= 0)
2753 //                //{
2754 //                //    if (element == _patternSequence[_filterPosition + 1])
2755 //                //        _filterPosition++;
2756 //                //    else
2757 //                //        return false;
2758 //                //}
2759 //                //if (_filterPosition < 0)
2760 //                //{
2761 //                //    if (element == _patternSequence[0])
2762 //                //        _filterPosition = 0;
2763 //                //}
2764 //            }
2765 //
2766 //            /// <summary>
2767 //            /// <para>
2768 //            /// Adds the all pattern matched to results using the specified sequences to
2769 //            match.
2770 //            /// </para>
2771 //            /// <para></para>
2772 //            /// </summary>
2773 //            /// <param name="sequencesToMatch">
2774 //            /// <para>The sequences to match.</para>
2775 //            /// <para></para>
2776 //            /// </param>
2777 //            [MethodImpl(MethodImplOptions.AggressiveInlining)]
2778 //            public void AddAllPatternMatchedToResults(IEnumerable<ulong> sequencesToMatch)
2779 //            {
2780 //                foreach (var sequenceToMatch in sequencesToMatch)
2781 //                {
2782 //                    if (PatternMatch(sequenceToMatch))
2783 //                    {
2784 //                        _results.Add(sequenceToMatch);
2785 //                    }
2786 //                }
2787 //            }
2788 //
2789 //            #endregion
2790 //        }
2791 //    }

```

#### 1.44 ./csharp/Platform.Data.Doublets.Sequences/Sequences.cs

```

1  // using System;
2  // using System.Collections.Generic;
3  // using System.Linq;
4  // using System.Runtime.CompilerServices;
5  // using Platform.Collections;
6  // using Platform.Collections.Lists;
7  // using Platform.Collections.Stacks;
8  // using Platform.Threading.Synchronization;
9  // using Platform.Data.Doublets.Sequences.Walkers;
10 // using Platform.Delegates;
11 // using LinkIndex = System.UInt64;
12 //
13 // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
14 //
15 // namespace Platform.Data.Doublets.Sequences
16 // {
17 //     /// <summary>
18 //     /// Представляет коллекцию последовательностей связей.
19 //     /// </summary>
20 //     /// <remarks>
21 //     /// Обязательно реализовать атомарность каждого публичного метода.
22 //     ///
23 //     /// TODO:
24 //     ///
25 //     /// !!! Повышение вероятности повторного использования групп (подпоследовательностей),
26 //     /// через естественную группировку по unicode типам, все whitespace вместе, все символы
27 //     /// вместе, все числа вместе и т.п.
28 //     /// + использовать ровно сбалансированный вариант, чтобы уменьшать вложенность (глубину
29 //     /// графа)
30 //     ///
31 //     /// х*у - найти все связи между, в последовательностях любой формы, если не стоит
32 //     /// ограничитель на то, что является последовательностью, а что нет,
33 //     /// то находятся любые структуры связей, которые содержат эти элементы именно в таком
34 //     /// порядке.

```

```

31 //      ///
32 //      /// Рост последовательности слева и справа.
33 //      /// Поиск со звёздочкой.
34 //      /// URL, PURL - реестр используемых во вне ссылок на ресурсы,
35 //      /// так же проблема может быть решена при реализации дистанционных триггеров.
36 //      /// Нужны ли уникальные указатели вообще?
37 //      /// Что если обращение к информации будет происходить через содержимое всегда?
38 //      ///
39 //      /// Писать тесты.
40 //      ///
41 //      ///
42 //      /// Можно убрать зависимость от конкретной реализации Links,
43 //      /// на зависимость от абстрактного элемента, который может быть представлен несколькими
    ↪ способами.
44 //      ///
45 //      /// Можно ли как-то сделать один общий интерфейс
46 //      ///
47 //      ///
48 //      /// Блокчейн и/или гит для распределённой записи транзакций.
49 //      ///
50 //      /// </remarks>
51 //      public partial class Sequences : ILinks<LinkIndex> // IList<string>, IList<LinkIndex[]>
    ↪ (после завершения реализации Sequences)
52 //      {
53 //          /// <summary>Возвращает значение LinkIndex, обозначающее любое количество
    ↪ связей.</summary>
54 //          public const LinkIndex ZeroOrMany = LinkIndex.MaxValue;
55 //
56 //          /// <summary>
57 //          /// <para>
58 //          /// Gets the options value.
59 //          /// </para>
60 //          /// <para></para>
61 //          /// </summary>
62 //          public SequencesOptions<LinkIndex> Options { get; }
63 //          /// <summary>
64 //          /// <para>
65 //          /// Gets the links value.
66 //          /// </para>
67 //          /// <para></para>
68 //          /// </summary>
69 //          public SynchronizedLinks<LinkIndex> Links { get; }
70 //          private readonly ISynchronization _sync;
71 //
72 //          /// <summary>
73 //          /// <para>
74 //          /// Gets the constants value.
75 //          /// </para>
76 //          /// <para></para>
77 //          /// </summary>
78 //          public LinksConstants<LinkIndex> Constants { get; }
79 //
80 //          /// <summary>
81 //          /// <para>
82 //          /// Initializes a new <see cref="Sequences"/> instance.
83 //          /// </para>
84 //          /// <para></para>
85 //          /// </summary>
86 //          /// <param name="links">
87 //          /// <para>A links.</para>
88 //          /// <para></para>
89 //          /// </param>
90 //          /// <param name="options">
91 //          /// <para>A options.</para>
92 //          /// <para></para>
93 //          /// </param>
94 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
95 //          public Sequences(SynchronizedLinks<LinkIndex> links, SequencesOptions<LinkIndex>
    ↪ options)
96 //          {
97 //              Links = links;
98 //              _sync = links.SyncRoot;
99 //              Options = options;
100 //              Options.ValidateOptions();
101 //              Options.InitOptions(Links);
102 //              Constants = links.Constants;
103 //          }

```

```

104 //
105 //      /// <summary>
106 //      /// <para>
107 //      /// Initializes a new <see cref="Sequences"/> instance.
108 //      /// </para>
109 //      /// <para></para>
110 //      /// </summary>
111 //      /// <param name="links">
112 //      /// <para>A links.</para>
113 //      /// <para></para>
114 //      /// </param>
115 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
116 //      public Sequences(SynchronizedLinks<LinkIndex> links) : this(links, new
↵ SequencesOptions<LinkIndex>()) { }
117 //
118 //      /// <summary>
119 //      /// <para>
120 //      /// Determines whether this instance is sequence.
121 //      /// </para>
122 //      /// <para></para>
123 //      /// </summary>
124 //      /// <param name="sequence">
125 //      /// <para>The sequence.</para>
126 //      /// <para></para>
127 //      /// </param>
128 //      /// <returns>
129 //      /// <para>The bool</para>
130 //      /// <para></para>
131 //      /// </returns>
132 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
133 //      public bool IsSequence(LinkIndex sequence)
134 //      {
135 //          return _sync.DoRead(() =>
136 //          {
137 //              if (Options.UseSequenceMarker)
138 //              {
139 //                  return Options.MarkedSequenceMatcher.IsMatched(sequence);
140 //              }
141 //              return !Links.Unsync.IsPartialPoint(sequence);
142 //          });
143 //      }
144 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
145 //      private LinkIndex GetSequenceByElements(LinkIndex sequence)
146 //      {
147 //          if (Options.UseSequenceMarker)
148 //          {
149 //              return Links.SearchOrDefault(Options.SequenceMarkerLink, sequence);
150 //          }
151 //          return sequence;
152 //      }
153 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
154 //      private LinkIndex GetSequenceElements(LinkIndex sequence)
155 //      {
156 //          if (Options.UseSequenceMarker)
157 //          {
158 //              var linkContents = new Link<ulong>(Links.GetLink(sequence));
159 //              if (linkContents.Source == Options.SequenceMarkerLink)
160 //              {
161 //                  return linkContents.Target;
162 //              }
163 //              if (linkContents.Target == Options.SequenceMarkerLink)
164 //              {
165 //                  return linkContents.Source;
166 //              }
167 //          }
168 //          return sequence;
169 //      }
170 //
171 //      #region Count
172 //
173 //      /// <summary>
174 //      /// <para>
175 //      /// Counts the restriction.
176 //      /// </para>
177 //      /// <para></para>
178 //      /// </summary>
179 //      /// <param name="restriction">

```

```

180 //      /// <para>The restriction.</para>
181 //      /// <para></para>
182 //      /// </param>
183 //      /// <exception cref="NotImplementedException">
184 //      /// <para></para>
185 //      /// <para></para>
186 //      /// </exception>
187 //      /// <returns>
188 //      /// <para>The link index</para>
189 //      /// <para></para>
190 //      /// </returns>
191 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
192 //      public LinkIndex Count(IList<LinkIndex>? restriction)
193 //      {
194 //          if (restriction.IsNullOrEmpty())
195 //          {
196 //              return Links.Count(Constants.Any, Options.SequenceMarkerLink, Constants.Any);
197 //          }
198 //          if (restriction.Count == 1) // Первая связь это адрес
199 //          {
200 //              var sequenceIndex = restriction[0];
201 //              if (sequenceIndex == Constants.Null)
202 //              {
203 //                  return 0;
204 //              }
205 //              if (sequenceIndex == Constants.Any)
206 //              {
207 //                  return Count(null);
208 //              }
209 //              if (Options.UseSequenceMarker)
210 //              {
211 //                  return Links.Count(Constants.Any, Options.SequenceMarkerLink,
↵ sequenceIndex);
212 //              }
213 //              return Links.Exists(sequenceIndex) ? 1UL : 0;
214 //          }
215 //          throw new NotImplementedException();
216 //      }
217 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
218 //      private LinkIndex CountUsages(params LinkIndex[] restriction)
219 //      {
220 //          if (restriction.Length == 0)
221 //          {
222 //              return 0;
223 //          }
224 //          if (restriction.Length == 1) // Первая связь это адрес
225 //          {
226 //              if (restriction[0] == Constants.Null)
227 //              {
228 //                  return 0;
229 //              }
230 //              var any = Constants.Any;
231 //              if (Options.UseSequenceMarker)
232 //              {
233 //                  var elementsLink = GetSequenceElements(restriction[0]);
234 //                  var sequenceLink = GetSequenceByElements(elementsLink);
235 //                  if (sequenceLink != Constants.Null)
236 //                  {
237 //                      return Links.Count(any, sequenceLink) + Links.Count(any,
↵ elementsLink) - 1;
238 //                  }
239 //                  return Links.Count(any, elementsLink);
240 //              }
241 //              return Links.Count(any, restriction[0]);
242 //          }
243 //          throw new NotImplementedException();
244 //      }
245 //
246 //      #endregion
247 //
248 //      #region Create
249 //
250 //      /// <summary>
251 //      /// <para>
252 //      /// Creates the restriction.
253 //      /// </para>
254 //      /// <para></para>

```



```

255 //      /// </summary>
256 //      /// <param name="restriction">
257 //      /// <para>The restriction.</para>
258 //      /// <para></para>
259 //      /// </param>
260 //      /// <returns>
261 //      /// <para>The link index</para>
262 //      /// <para></para>
263 //      /// </returns>
264 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
265 //      public LinkIndex Create(IList<LinkIndex>? restriction)
266 //      {
267 //          return _sync.DoWrite(() =>
268 //          {
269 //              if (restriction.IsNullOrEmpty())
270 //              {
271 //                  return Constants.Null;
272 //              }
273 //              Links.EnsureInnerReferenceExists(restriction, nameof(restriction));
274 //              return CreateCore(restriction);
275 //          });
276 //      }
277 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
278 //      private LinkIndex CreateCore(IList<LinkIndex>? restriction)
279 //      {
280 //          LinkIndex[] sequence = restriction.SkipFirst();
281 //          if (Options.UseIndex)
282 //          {
283 //              Options.Index.Add(sequence);
284 //          }
285 //          var sequenceRoot = default(LinkIndex);
286 //          if (Options.EnforceSingleSequenceVersionOnWriteBasedOnExisting)
287 //          {
288 //              var matches = Each(restriction);
289 //              if (matches.Count > 0)
290 //              {
291 //                  sequenceRoot = matches[0];
292 //              }
293 //          }
294 //          else if (Options.EnforceSingleSequenceVersionOnWriteBasedOnNew)
295 //          {
296 //              return CompactCore(sequence);
297 //          }
298 //          if (sequenceRoot == default)
299 //          {
300 //              sequenceRoot = Options.LinksToSequenceConverter.Convert(sequence);
301 //          }
302 //          if (Options.UseSequenceMarker)
303 //          {
304 //              return Links.Unsync.GetOrCreate(Options.SequenceMarkerLink, sequenceRoot);
305 //          }
306 //          return sequenceRoot; // Возвращаем корень последовательности (т.е. сами элементы)
307 //      }
308 //
309 //      #endregion
310 //
311 //      #region Each
312 //
313 //      /// <summary>
314 //      /// <para>
315 //      /// Eaches the sequence.
316 //      /// </para>
317 //      /// <para></para>
318 //      /// </summary>
319 //      /// <param name="sequence">
320 //      /// <para>The sequence.</para>
321 //      /// <para></para>
322 //      /// </param>
323 //      /// <returns>
324 //      /// <para>The results.</para>
325 //      /// <para></para>
326 //      /// </returns>
327 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
328 //      public List<LinkIndex> Each(IList<LinkIndex> sequence)
329 //      {
330 //          var results = new List<LinkIndex>();
331 //          var filler = new ListFiller<LinkIndex, LinkIndex>(results, Constants.Continue);
332 //          Each(filler.AddFirstAndReturnConstant, sequence);

```

```

333 //         return results;
334 //     }
335 //
336 //         /// <summary>
337 //         /// <para>
338 //         /// Eaches the handler.
339 //         /// </para>
340 //         /// <para></para>
341 //         /// </summary>
342 //         /// <param name="handler">
343 //         /// <para>The handler.</para>
344 //         /// <para></para>
345 //         /// </param>
346 //         /// <param name="restriction">
347 //         /// <para>The restriction.</para>
348 //         /// <para></para>
349 //         /// </param>
350 //         /// <exception cref="NotImplementedException">
351 //         /// <para></para>
352 //         /// <para></para>
353 //         /// </exception>
354 //         /// <returns>
355 //         /// <para>The link index</para>
356 //         /// <para></para>
357 //         /// </returns>
358 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
359 //         public LinkIndex Each(ReadHandler<LinkIndex> handler, IList<LinkIndex>? restriction)
360 //         {
361 //             return _sync.DoRead(() =>
362 //             {
363 //                 if (restriction.IsNullOrEmpty())
364 //                 {
365 //                     return Constants.Continue;
366 //                 }
367 //                 Links.EnsureInnerReferenceExists(restriction, nameof(restriction));
368 //                 if (restriction.Count == 1)
369 //                 {
370 //                     var link = restriction[0];
371 //                     var any = Constants.Any;
372 //                     if (link == any)
373 //                     {
374 //                         if (Options.UseSequenceMarker)
375 //                         {
376 //                             return Links.Unsync.Each(new Link<LinkIndex>(any,
↵ Options.SequenceMarkerLink, any), handler);
377 //                         }
378 //                         else
379 //                         {
380 //                             return Links.Unsync.Each(handler, new Link<LinkIndex>(any, any,
↵ any));
381 //                         }
382 //                     }
383 //                     if (Options.UseSequenceMarker)
384 //                     {
385 //                         var sequenceLinkValues = Links.Unsync.GetLink(link);
386 //                         if (sequenceLinkValues[Constants.SourcePart] ==
↵ Options.SequenceMarkerLink)
387 //                         {
388 //                             link = sequenceLinkValues[Constants.TargetPart];
389 //                         }
390 //                     }
391 //                     var sequence = Options.Walker.Walk(link).ToArray().ShiftRight();
392 //                     sequence[0] = link;
393 //                     return handler(sequence);
394 //                 }
395 //                 else if (restriction.Count == 2)
396 //                 {
397 //                     throw new NotImplementedException();
398 //                 }
399 //                 else if (restriction.Count == 3)
400 //                 {
401 //                     return Links.Unsync.Each(restriction, handler);
402 //                 }
403 //                 else
404 //                 {
405 //                     var sequence = restriction.SkipFirst();
406 //                     if (Options.UseIndex && !Options.Index.MightContain(sequence))

```

```

407 // {
408 //     return Constants.Break;
409 // }
410 // return EachCore(sequence, handler);
411 // }
412 // });
413 // }
414 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
415 // private LinkIndex EachCore(ICollection<LinkIndex> values, ReadHandler<LinkIndex> handler)
416 // {
417 //     var matcher = new Matcher(this, values, new HashSet<LinkIndex>(), handler);
418 //     // TODO: Find out why matcher.HandleFullMatched executed twice for the same
419 //     sequence Id.
420 //     Func<ICollection<LinkIndex>, LinkIndex> innerHandler = Options.UseSequenceMarker ?
421 //     (Func<ICollection<LinkIndex>, LinkIndex>)matcher.HandleFullMatchedSequence :
422 //     matcher.HandleFullMatched;
423 //     //if (sequence.Length >= 2)
424 //     if (StepRight(innerHandler, values[0], values[1]) != Constants.Continue)
425 //     {
426 //         return Constants.Break;
427 //     }
428 //     var last = values.Count - 2;
429 //     for (var i = 1; i < last; i++)
430 //     {
431 //         if (PartialStepRight(innerHandler, values[i], values[i + 1]) !=
432 //         Constants.Continue)
433 //         {
434 //             return Constants.Break;
435 //         }
436 //     }
437 //     if (values.Count >= 3)
438 //     {
439 //         if (StepLeft(innerHandler, values[values.Count - 2], values[values.Count -
440 //         1]) != Constants.Continue)
441 //         {
442 //             return Constants.Break;
443 //         }
444 //     }
445 //     return Constants.Continue;
446 // }
447 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
448 // private LinkIndex PartialStepRight(Func<ICollection<LinkIndex>, LinkIndex> handler,
449 // LinkIndex left, LinkIndex right)
450 // {
451 //     return Links.Unsync.Each(doublet =>
452 //     {
453 //         var doubletIndex = doublet[Constants.IndexPart];
454 //         if (StepRight(handler, doubletIndex, right) != Constants.Continue)
455 //         {
456 //             return Constants.Break;
457 //         }
458 //         if (left != doubletIndex)
459 //         {
460 //             return PartialStepRight(handler, doubletIndex, right);
461 //         }
462 //         return Constants.Continue;
463 //     }, new Link<LinkIndex>(Constants.Any, Constants.Any, left));
464 // }
465 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
466 // private LinkIndex StepRight(Func<ICollection<LinkIndex>, LinkIndex> handler, LinkIndex
467 // left, LinkIndex right) => Links.Unsync.Each(rightStep => TryStepRightUp(handler, right,
468 // rightStep[Constants.IndexPart]), new Link<LinkIndex>(Constants.Any, left, Constants.Any));
469 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
470 // private LinkIndex TryStepRightUp(Func<ICollection<LinkIndex>, LinkIndex> handler, LinkIndex
471 // right, LinkIndex stepFrom)
472 // {
473 //     var upStep = stepFrom;
474 //     var firstSource = Links.Unsync.GetTarget(upStep);
475 //     while (firstSource != right && firstSource != upStep)
476 //     {
477 //         upStep = firstSource;
478 //         firstSource = Links.Unsync.GetSource(upStep);
479 //     }
480 //     if (firstSource == right)
481 //     {
482 //         return handler(new LinkAddress<LinkIndex>(stepFrom));
483 //     }

```

```

475 //         return Constants.Continue;
476 //     }
477 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
478 //     private LinkIndex StepLeft(Func<IList<LinkIndex>, LinkIndex> handler, LinkIndex left,
↳ LinkIndex right) => Links.Unsync.Each(leftStep => TryStepLeftUp(handler, left,
↳ leftStep[Constants.IndexPart]), new Link<LinkIndex>(Constants.Any, Constants.Any, right));
479 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
480 //     private LinkIndex TryStepLeftUp(Func<IList<LinkIndex>, LinkIndex> handler, LinkIndex
↳ left, LinkIndex stepFrom)
481 //     {
482 //         var upStep = stepFrom;
483 //         var firstTarget = Links.Unsync.GetSource(upStep);
484 //         while (firstTarget != left && firstTarget != upStep)
485 //         {
486 //             upStep = firstTarget;
487 //             firstTarget = Links.Unsync.GetTarget(upStep);
488 //         }
489 //         if (firstTarget == left)
490 //         {
491 //             return handler(new LinkAddress<LinkIndex>(stepFrom));
492 //         }
493 //         return Constants.Continue;
494 //     }
495 //
496 //     #endregion
497 //
498 //     #region Update
499 //
500 //     /// <summary>
501 //     /// <para>
502 //     /// Updates the restriction.
503 //     /// </para>
504 //     /// <para></para>
505 //     /// </summary>
506 //     /// <param name="restriction">
507 //     /// <para>The restriction.</para>
508 //     /// <para></para>
509 //     /// </param>
510 //     /// <param name="substitution">
511 //     /// <para>The substitution.</para>
512 //     /// <para></para>
513 //     /// </param>
514 //     /// <returns>
515 //     /// <para>The link index</para>
516 //     /// <para></para>
517 //     /// </returns>
518 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
519 //     public LinkIndex Update(IList<LinkIndex>? restriction, IList<LinkIndex>?
↳ substitution, WriteHandler<LinkIndex> handler)
520 //     {
521 //         var sequence = restriction.SkipFirst();
522 //         var newSequence = substitution.SkipFirst();
523 //         if (sequence.IsNullOrEmpty() && newSequence.IsNullOrEmpty())
524 //         {
525 //             return Constants.Null;
526 //         }
527 //         if (sequence.IsNullOrEmpty())
528 //         {
529 //             return Create(substitution);
530 //         }
531 //         if (newSequence.IsNullOrEmpty())
532 //         {
533 //             Delete(restriction);
534 //             return Constants.Null;
535 //         }
536 //         return _sync.DoWrite((Func<ulong>)((() =>
537 //         {
538 //             ILinksExtensions.EnsureLinkIsAnyOrExists<ulong>(Links,
↳ (IList<ulong>)sequence);
539 //             Links.EnsureLinkExists(newSequence);
540 //             return UpdateCore(sequence, newSequence);
541 //         })));
542 //     }
543 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
544 //     private LinkIndex UpdateCore(IList<LinkIndex> sequence, IList<LinkIndex> newSequence,
↳ WriteHandler<LinkIndex> handler)
545 //     {

```

```

546 //         LinkIndex bestVariant;
547 //         if (Options.EnforceSingleSequenceVersionOnWriteBasedOnNew &&
↵ !sequence.EqualTo(newSequence))
548 //         {
549 //             bestVariant = CompactCore(newSequence);
550 //         }
551 //         else
552 //         {
553 //             bestVariant = CreateCore(newSequence);
554 //         }
555 //         // TODO: Check all options only ones before loop execution
556 //         // Возможно нужно две версии Each, возвращающий фактические последовательности и
↵ с маркером,
557 //         // или возможно даже возвращать и тот и тот вариант. С другой стороны все
↵ варианты можно получить имея только фактические последовательности.
558 //         foreach (var variant in Each(sequence))
559 //         {
560 //             if (variant != bestVariant)
561 //             {
562 //                 UpdateOneCore(variant, bestVariant);
563 //             }
564 //         }
565 //         return bestVariant;
566 //     }
567 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
568 //     private void UpdateOneCore(LinkIndex sequence, LinkIndex newSequence,
↵ WriteHandler<LinkIndex> handler)
569 //     {
570 //         if (Options.UseGarbageCollection)
571 //         {
572 //             var sequenceElements = GetSequenceElements(sequence);
573 //             var sequenceElementsContents = new
↵ Link<ulong>(Links.GetLink(sequenceElements));
574 //             var sequenceLink = GetSequenceByElements(sequenceElements);
575 //             var newSequenceElements = GetSequenceElements(newSequence);
576 //             var newSequenceLink = GetSequenceByElements(newSequenceElements);
577 //             if (Options.UseCascadeUpdate || CountUsages(sequence) == 0)
578 //             {
579 //                 if (sequenceLink != Constants.Null)
580 //                 {
581 //                     Links.Unsync.MergeAndDelete(sequenceLink, newSequenceLink);
582 //                 }
583 //                 Links.Unsync.MergeAndDelete(sequenceElements, newSequenceElements);
584 //             }
585 //             ClearGarbage(sequenceElementsContents.Source);
586 //             ClearGarbage(sequenceElementsContents.Target);
587 //         }
588 //         else
589 //         {
590 //             if (Options.UseSequenceMarker)
591 //             {
592 //                 var sequenceElements = GetSequenceElements(sequence);
593 //                 var sequenceLink = GetSequenceByElements(sequenceElements);
594 //                 var newSequenceElements = GetSequenceElements(newSequence);
595 //                 var newSequenceLink = GetSequenceByElements(newSequenceElements);
596 //                 if (Options.UseCascadeUpdate || CountUsages(sequence) == 0)
597 //                 {
598 //                     if (sequenceLink != Constants.Null)
599 //                     {
600 //                         Links.Unsync.MergeAndDelete(sequenceLink, newSequenceLink);
601 //                     }
602 //                     Links.Unsync.MergeAndDelete(sequenceElements, newSequenceElements);
603 //                 }
604 //             }
605 //             else
606 //             {
607 //                 if (Options.UseCascadeUpdate || CountUsages(sequence) == 0)
608 //                 {
609 //                     Links.Unsync.MergeAndDelete(sequence, newSequence);
610 //                 }
611 //             }
612 //         }
613 //     }
614 //
615 //     #endregion
616 //
617 //     #region Delete

```

```

618 //
619 //      /// <summary>
620 //      /// <para>
621 //      /// Deletes the restriction.
622 //      /// </para>
623 //      /// </summary>
624 //      /// <param name="restriction">
625 //      /// <para>The restriction.</para>
626 //      /// </param>
627 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
628 //      public void Delete(ICollection<LinkIndex>? restriction)
629 //      {
630 //          _sync.DoWrite(() =>
631 //          {
632 //              var sequence = restriction.SkipFirst();
633 //              // TODO: Check all options only ones before loop execution
634 //              foreach (var linkToDelete in Each(sequence))
635 //              {
636 //                  DeleteOneCore(linkToDelete);
637 //              }
638 //          });
639 //      }
640 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
641 //      private void DeleteOneCore(LinkIndex link)
642 //      {
643 //          if (Options.UseGarbageCollection)
644 //          {
645 //              var sequenceElements = GetSequenceElements(link);
646 //              var sequenceElementsContents = new
647 //              ↪ Link<ulong>(Links.GetLink(sequenceElements));
648 //              var sequenceLink = GetSequenceByElements(sequenceElements);
649 //              if (Options.UseCascadeDelete || CountUsages(link) == 0)
650 //              {
651 //                  if (sequenceLink != Constants.Null)
652 //                  {
653 //                      Links.Unsync.Delete(sequenceLink);
654 //                  }
655 //                  Links.Unsync.Delete(link);
656 //              }
657 //              ClearGarbage(sequenceElementsContents.Source);
658 //              ClearGarbage(sequenceElementsContents.Target);
659 //          }
660 //          else
661 //          {
662 //              if (Options.UseSequenceMarker)
663 //              {
664 //                  var sequenceElements = GetSequenceElements(link);
665 //                  var sequenceLink = GetSequenceByElements(sequenceElements);
666 //                  if (Options.UseCascadeDelete || CountUsages(link) == 0)
667 //                  {
668 //                      if (sequenceLink != Constants.Null)
669 //                      {
670 //                          Links.Unsync.Delete(sequenceLink);
671 //                      }
672 //                      Links.Unsync.Delete(link);
673 //                  }
674 //              }
675 //              else
676 //              {
677 //                  if (Options.UseCascadeDelete || CountUsages(link) == 0)
678 //                  {
679 //                      Links.Unsync.Delete(link);
680 //                  }
681 //              }
682 //          }
683 //      }
684 //  }
685 //
686 //  #endregion
687 //
688 //  #region Compactification
689 //
690 //      /// <summary>
691 //      /// <para>
692 //      /// Compacts the all.
693 //      /// </para>

```

```

694 //      /// <para></para>
695 //      /// </summary>
696 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
697 //      public void CompactAll()
698 //      {
699 //          _sync.DoWrite(() =>
700 //          {
701 //              var sequences = Each((LinkAddress<LinkIndex>)Constants.Any);
702 //              for (int i = 0; i < sequences.Count; i++)
703 //              {
704 //                  var sequence = this.ToList(sequences[i]);
705 //                  Compact(sequence.ShiftRight());
706 //              }
707 //          });
708 //      }
709 //
710 //      /// <remarks>
711 //      /// bestVariant можно выбирать по максимальному числу использований,
712 //      /// но балансированный позволяет гарантировать уникальность (если есть возможность,
713 //      /// гарантировать его использование в других местах).
714 //      ///
715 //      /// Получается этот метод должен игнорировать
↪ Options.EnforceSingleSequenceVersionOnWrite
716 //      /// </remarks>
717 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
718 //      public LinkIndex Compact(ICollection<LinkIndex> sequence)
719 //      {
720 //          return _sync.DoWrite(() =>
721 //          {
722 //              if (sequence.IsNullOrEmpty())
723 //              {
724 //                  return Constants.Null;
725 //              }
726 //              Links.EnsureInnerReferenceExists(sequence, nameof(sequence));
727 //              return CompactCore(sequence);
728 //          });
729 //      }
730 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
731 //      private LinkIndex CompactCore(ICollection<LinkIndex> sequence) => UpdateCore(sequence,
↪ sequence);
732 //
733 //      #endregion
734 //
735 //      #region Garbage Collection
736 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
737 //      private bool IsGarbage(LinkIndex link) => link != Options.SequenceMarkerLink &&
↪ !Links.Unsync.IsPartialPoint(link) && Links.Count(Constants.Any, link) == 0;
738 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
739 //      private void ClearGarbage(LinkIndex link)
740 //      {
741 //          if (IsGarbage(link))
742 //          {
743 //              var contents = new Link<ulong>(Links.GetLink(link));
744 //              Links.Unsync.Delete(link);
745 //              ClearGarbage(contents.Source);
746 //              ClearGarbage(contents.Target);
747 //          }
748 //      }
749 //
750 //      #endregion
751 //
752 //      #region Walkers
753 //
754 //      /// <summary>
755 //      /// <para>
756 //      /// Determines whether this instance each part.
757 //      /// </para>
758 //      /// <para></para>
759 //      /// </summary>
760 //      /// <param name="handler">
761 //      /// <para>The handler.</para>
762 //      /// <para></para>
763 //      /// </param>
764 //      /// <param name="sequence">
765 //      /// <para>The sequence.</para>
766 //      /// <para></para>
767 //      /// </param>

```

```

768 //      /// <returns>
769 //      /// <para>The bool</para>
770 //      /// <para></para>
771 //      /// </returns>
772 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
773 //      public bool EachPart(Func<LinkIndex, bool> handler, LinkIndex sequence)
774 //      {
775 //          return _sync.DoRead(() =>
776 //          {
777 //              var links = Links.Unsync;
778 //              foreach (var part in Options.Walker.Walk(sequence))
779 //              {
780 //                  if (!handler(part))
781 //                  {
782 //                      return false;
783 //                  }
784 //              }
785 //              return true;
786 //          });
787 //      }
788 //
789 //      /// <summary>
790 //      /// <para>
791 //      /// Represents the matcher.
792 //      /// </para>
793 //      /// <para></para>
794 //      /// </summary>
795 //      /// <seealso cref="RightSequenceWalker{LinkIndex}" />
796 //      public class Matcher : RightSequenceWalker<LinkIndex>
797 //      {
798 //          private readonly Sequences _sequences;
799 //          private readonly IList<LinkIndex> _patternSequence;
800 //          private readonly HashSet<LinkIndex> _linksInSequence;
801 //          private readonly HashSet<LinkIndex> _results;
802 //          private readonly ReadHandler<LinkIndex> _stopableHandler;
803 //          private readonly HashSet<LinkIndex> _readAsElements;
804 //          private int _filterPosition;
805 //
806 //          /// <summary>
807 //          /// <para>
808 //          /// Initializes a new <see cref="Matcher" /> instance.
809 //          /// </para>
810 //          /// <para></para>
811 //          /// </summary>
812 //          /// <param name="sequences">
813 //          /// <para>A sequences.</para>
814 //          /// <para></para>
815 //          /// </param>
816 //          /// <param name="patternSequence">
817 //          /// <para>A pattern sequence.</para>
818 //          /// <para></para>
819 //          /// </param>
820 //          /// <param name="results">
821 //          /// <para>A results.</para>
822 //          /// <para></para>
823 //          /// </param>
824 //          /// <param name="stopableHandler">
825 //          /// <para>A stopable handler.</para>
826 //          /// <para></para>
827 //          /// </param>
828 //          /// <param name="readAsElements">
829 //          /// <para>A read as elements.</para>
830 //          /// <para></para>
831 //          /// </param>
832 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
833 //          public Matcher(Sequences sequences, IList<LinkIndex> patternSequence,
834 //          ↪ HashSet<LinkIndex> results, ReadHandler<LinkIndex> stopableHandler, HashSet<LinkIndex>
835 //          ↪ readAsElements = null)
836 //              : base(sequences.Links.Unsync, new DefaultStack<LinkIndex>())
837 //          {
838 //              _sequences = sequences;
839 //              _patternSequence = patternSequence;
840 //              _linksInSequence = new HashSet<LinkIndex>(patternSequence.Where(x => x !=
841 //          ↪ _links.Constants.Any && x != ZeroOrMany));
842 //              _results = results;
843 //              _stopableHandler = stopableHandler;
844 //              _readAsElements = readAsElements;

```



```

842 // }
843 //
844 // /// <summary>
845 // /// <para>
846 // /// Determines whether this instance is element.
847 // /// </para>
848 // /// <para></para>
849 // /// </summary>
850 // /// <param name="link">
851 // /// <para>The link.</para>
852 // /// <para></para>
853 // /// </param>
854 // /// <returns>
855 // /// <para>The bool</para>
856 // /// <para></para>
857 // /// </returns>
858 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
859 // protected override bool IsElement(LinkIndex link) => base.IsElement(link) ||
↵  (_readAsElements != null && _readAsElements.Contains(link)) ||
↵  _linksInSequence.Contains(link);
860 //
861 // /// <summary>
862 // /// <para>
863 // /// Determines whether this instance full match.
864 // /// </para>
865 // /// <para></para>
866 // /// </summary>
867 // /// <param name="sequenceToMatch">
868 // /// <para>The sequence to match.</para>
869 // /// <para></para>
870 // /// </param>
871 // /// <returns>
872 // /// <para>The bool</para>
873 // /// <para></para>
874 // /// </returns>
875 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
876 // public bool FullMatch(LinkIndex sequenceToMatch)
877 // {
878 //     _filterPosition = 0;
879 //     foreach (var part in Walk(sequenceToMatch))
880 //     {
881 //         if (!FullMatchCore(part))
882 //         {
883 //             break;
884 //         }
885 //     }
886 //     return _filterPosition == _patternSequence.Count;
887 // }
888 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
889 // private bool FullMatchCore(LinkIndex element)
890 // {
891 //     if (_filterPosition == _patternSequence.Count)
892 //     {
893 //         _filterPosition = -2; // Длиннее чем нужно
894 //         return false;
895 //     }
896 //     if (_patternSequence[_filterPosition] != _links.Constants.Any
897 //         && element != _patternSequence[_filterPosition])
898 //     {
899 //         _filterPosition = -1;
900 //         return false; // Начинается/Продолжается иначе
901 //     }
902 //     _filterPosition++;
903 //     return true;
904 // }
905 //
906 // /// <summary>
907 // /// <para>
908 // /// Adds the full matched to results using the specified restriction.
909 // /// </para>
910 // /// <para></para>
911 // /// </summary>
912 // /// <param name="restriction">
913 // /// <para>The restriction.</para>
914 // /// <para></para>
915 // /// </param>
916 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
917 // public void AddFullMatchedToResults(ICollection<LinkIndex>? restriction)

```

```

918 // {
919 //     var sequenceToMatch = restriction[_links.Constants.IndexPart];
920 //     if (FullMatch(sequenceToMatch))
921 //     {
922 //         _results.Add(sequenceToMatch);
923 //     }
924 // }
925 //
926 // /// <summary>
927 // /// <para>
928 // /// Handles the full matched using the specified restriction.
929 // /// </para>
930 // /// <para></para>
931 // /// </summary>
932 // /// <param name="restriction">
933 // /// <para>The restriction.</para>
934 // /// <para></para>
935 // /// </param>
936 // /// <returns>
937 // /// <para>The link index</para>
938 // /// <para></para>
939 // /// </returns>
940 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
941 // public LinkIndex HandleFullMatched(IList<LinkIndex>? restriction)
942 // {
943 //     var sequenceToMatch = restriction[_links.Constants.IndexPart];
944 //     if (FullMatch(sequenceToMatch) && _results.Add(sequenceToMatch))
945 //     {
946 //         return _stopableHandler(new LinkAddress<LinkIndex>(sequenceToMatch));
947 //     }
948 //     return _links.Constants.Continue;
949 // }
950 //
951 // /// <summary>
952 // /// <para>
953 // /// Handles the full matched sequence using the specified restriction.
954 // /// </para>
955 // /// <para></para>
956 // /// </summary>
957 // /// <param name="restriction">
958 // /// <para>The restriction.</para>
959 // /// <para></para>
960 // /// </param>
961 // /// <returns>
962 // /// <para>The link index</para>
963 // /// <para></para>
964 // /// </returns>
965 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
966 // public LinkIndex HandleFullMatchedSequence(IList<LinkIndex>? restriction)
967 // {
968 //     var sequenceToMatch = restriction[_links.Constants.IndexPart];
969 //     var sequence = _sequences.GetSequenceByElements(sequenceToMatch);
970 //     if (sequence != _links.Constants.Null && FullMatch(sequenceToMatch) &&
↵ _results.Add(sequenceToMatch))
971 //     {
972 //         return _stopableHandler(new LinkAddress<LinkIndex>(sequence));
973 //     }
974 //     return _links.Constants.Continue;
975 // }
976 //
977 // /// <remarks>
978 // /// TODO: Add support for LinksConstants.Any
979 // /// </remarks>
980 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
981 // public bool PartialMatch(LinkIndex sequenceToMatch)
982 // {
983 //     _filterPosition = -1;
984 //     foreach (var part in Walk(sequenceToMatch))
985 //     {
986 //         if (!PartialMatchCore(part))
987 //         {
988 //             break;
989 //         }
990 //     }
991 //     return _filterPosition == _patternSequence.Count - 1;
992 // }
993 // [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

994 // private bool PartialMatchCore(LinkIndex element)
995 // {
996 //     if (_filterPosition == (_patternSequence.Count - 1))
997 //     {
998 //         return false; // Нашлось
999 //     }
1000 //     if (_filterPosition >= 0)
1001 //     {
1002 //         if (element == _patternSequence[_filterPosition + 1])
1003 //         {
1004 //             _filterPosition++;
1005 //         }
1006 //         else
1007 //         {
1008 //             _filterPosition = -1;
1009 //         }
1010 //     }
1011 //     if (_filterPosition < 0)
1012 //     {
1013 //         if (element == _patternSequence[0])
1014 //         {
1015 //             _filterPosition = 0;
1016 //         }
1017 //     }
1018 //     return true; // Ищем дальше
1019 // }
1020 //
1021 // /// <summary>
1022 // /// <para>
1023 // /// Adds the partial matched to results using the specified sequence to match.
1024 // /// </para>
1025 // /// <para></para>
1026 // /// </summary>
1027 // /// <param name="sequenceToMatch">
1028 // /// <para>The sequence to match.</para>
1029 // /// <para></para>
1030 // /// </param>
1031 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1032 // public void AddPartialMatchedToResults(LinkIndex sequenceToMatch)
1033 // {
1034 //     if (PartialMatch(sequenceToMatch))
1035 //     {
1036 //         _results.Add(sequenceToMatch);
1037 //     }
1038 // }
1039 //
1040 // /// <summary>
1041 // /// <para>
1042 // /// Handles the partial matched using the specified restriction.
1043 // /// </para>
1044 // /// <para></para>
1045 // /// </summary>
1046 // /// <param name="restriction">
1047 // /// <para>The restriction.</para>
1048 // /// <para></para>
1049 // /// </param>
1050 // /// <returns>
1051 // /// <para>The link index</para>
1052 // /// <para></para>
1053 // /// </returns>
1054 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1055 // public LinkIndex HandlePartialMatched(IList<LinkIndex>? restriction)
1056 // {
1057 //     var sequenceToMatch = restriction[_links.Constants.IndexPart];
1058 //     if (PartialMatch(sequenceToMatch))
1059 //     {
1060 //         return _stopableHandler(new LinkAddress<LinkIndex>(sequenceToMatch));
1061 //     }
1062 //     return _links.Constants.Continue;
1063 // }
1064 //
1065 // /// <summary>
1066 // /// <para>
1067 // /// Adds the all partial matched to results using the specified sequences to
1068 // ↪ match.
1069 // /// </para>
1070 // /// <para></para>
1071 // /// </summary>

```

```

1071 //          /// <param name="sequencesToMatch">
1072 //          /// <para>The sequences to match.</para>
1073 //          /// </para>
1074 //          /// </param>
1075 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1076 //          public void AddAllPartialMatchedToResults(IEnumerable<LinkIndex> sequencesToMatch)
1077 //          {
1078 //              foreach (var sequenceToMatch in sequencesToMatch)
1079 //              {
1080 //                  if (PartialMatch(sequenceToMatch))
1081 //                  {
1082 //                      _results.Add(sequenceToMatch);
1083 //                  }
1084 //              }
1085 //          }
1086 //
1087 //          /// <summary>
1088 //          /// <para>
1089 //          /// Adds the all partial matched to results and read as elements using the
1090 //          ↪ specified sequences to match.
1091 //          /// </para>
1092 //          /// <para></para>
1093 //          /// </summary>
1094 //          /// <param name="sequencesToMatch">
1095 //          /// <para>The sequences to match.</para>
1096 //          /// <para></para>
1097 //          /// </param>
1098 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
1099 //          public void AddAllPartialMatchedToResultsAndReadAsElements(IEnumerable<LinkIndex>
1100 //          ↪ sequencesToMatch)
1101 //          {
1102 //              foreach (var sequenceToMatch in sequencesToMatch)
1103 //              {
1104 //                  if (PartialMatch(sequenceToMatch))
1105 //                  {
1106 //                      _readAsElements.Add(sequenceToMatch);
1107 //                      _results.Add(sequenceToMatch);
1108 //                  }
1109 //              }
1110 //          }
1111 //          #endregion
1112 //      }
1113 // }

```

#### 1.45 ./csharp/Platform.Data.Doublets.Sequences/SequencesExtensions.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Collections.Lists;
4
5 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7 namespace Platform.Data.Doublets.Sequences
8 {
9     /// <summary>
10     /// <para>
11     /// Represents the sequences extensions.
12     /// </para>
13     /// <para></para>
14     /// </summary>
15     public static class SequencesExtensions
16     {
17         /// <summary>
18         /// <para>
19         /// Creates the sequences.
20         /// </para>
21         /// <para></para>
22         /// </summary>
23         /// <typeparam name="TLinkAddress">
24         /// <para>The link.</para>
25         /// <para></para>
26         /// </typeparam>
27         /// <param name="sequences">
28         /// <para>The sequences.</para>
29         /// <para></para>
30         /// </param>
31         /// <param name="groupedSequence">

```

```

32     /// <para>The grouped sequence.</para>
33     /// <para></para>
34     /// </param>
35     /// <returns>
36     /// <para>The link</para>
37     /// <para></para>
38     /// </returns>
39     [MethodImpl(MethodImplOptions.AggressiveInlining)]
40     public static TLinkAddress Create<TLinkAddress>(this ILinks<TLinkAddress> sequences,
41     ↪ IList<TLinkAddress[]> groupedSequence)
42     {
43         var finalSequence = new TLinkAddress[groupedSequence.Count];
44         for (var i = 0; i < finalSequence.Length; i++)
45         {
46             var part = groupedSequence[i];
47             finalSequence[i] = part.Length == 1 ? part[0] :
48             ↪ sequences.Create(part.ShiftRight());
49         }
50         return sequences.Create(finalSequence.ShiftRight());
51     }
52     /// <summary>
53     /// <para>
54     /// Returns the list using the specified sequences.
55     /// </para>
56     /// <para></para>
57     /// </summary>
58     /// <typeparam name="TLinkAddress">
59     /// <para>The link.</para>
60     /// <para></para>
61     /// </typeparam>
62     /// <param name="sequences">
63     /// <para>The sequences.</para>
64     /// <para></para>
65     /// </param>
66     /// <param name="sequence">
67     /// <para>The sequence.</para>
68     /// <para></para>
69     /// </param>
70     /// <returns>
71     /// <para>The list.</para>
72     /// <para></para>
73     /// </returns>
74     [MethodImpl(MethodImplOptions.AggressiveInlining)]
75     public static IList<TLinkAddress>? ToList<TLinkAddress>(this ILinks<TLinkAddress>
76     ↪ sequences, TLinkAddress sequence)
77     {
78         var list = new List<TLinkAddress>();
79         var filler = new ListFiller<TLinkAddress, TLinkAddress>(list,
80         ↪ sequences.Constants.Break);
81         sequences.Each(filler.AddSkipFirstAndReturnConstant, new
82         ↪ LinkAddress<TLinkAddress>(sequence));
83         return list;
84     }
85 }

```

#### 1.46 ./csharp/Platform.Data.Doublets.Sequences/SequencesOptions.cs

```

1  using System;
2  using System.Collections.Generic;
3  using Platform.Interfaces;
4  using Platform.Collections.Stacks;
5  using Platform.Converters;
6  using Platform.Data.Doublets.Sequences.Frequencies.Cache;
7  using Platform.Data.Doublets.Sequences.Frequencies.Counters;
8  using Platform.Data.Doublets.Sequences.Converters;
9  using Platform.Data.Doublets.Sequences.Walkers;
10 using Platform.Data.Doublets.Sequences.Indexes;
11 using Platform.Data.Doublets.Sequences.CriterionMatchers;
12 using System.Runtime.CompilerServices;
13
14 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
15
16 namespace Platform.Data.Doublets.Sequences
17 {
18     /// <summary>
19     /// <para>
20     /// Represents the sequences options.
21     /// </para>

```

```

22  /// <para></para>
23  /// </summary>
24  public class SequencesOptions<TLinkAddress> // TODO: To use type parameter <TLinkAddress>
    ↪ the ILinks<TLinkAddress> must contain GetConstants function.
25  {
26      private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↪ EqualityComparer<TLinkAddress>.Default;
27
28      /// <summary>
29      /// <para>
30      /// Gets or sets the sequence marker link value.
31      /// </para>
32      /// <para></para>
33      /// </summary>
34      public TLinkAddress SequenceMarkerLink
35      {
36          [MethodImpl(MethodImplOptions.AggressiveInlining)]
37          get;
38          [MethodImpl(MethodImplOptions.AggressiveInlining)]
39          set;
40      }
41
42      /// <summary>
43      /// <para>
44      /// Gets or sets the use cascade update value.
45      /// </para>
46      /// <para></para>
47      /// </summary>
48      public bool UseCascadeUpdate
49      {
50          [MethodImpl(MethodImplOptions.AggressiveInlining)]
51          get;
52          [MethodImpl(MethodImplOptions.AggressiveInlining)]
53          set;
54      }
55
56      /// <summary>
57      /// <para>
58      /// Gets or sets the use cascade delete value.
59      /// </para>
60      /// <para></para>
61      /// </summary>
62      public bool UseCascadeDelete
63      {
64          [MethodImpl(MethodImplOptions.AggressiveInlining)]
65          get;
66          [MethodImpl(MethodImplOptions.AggressiveInlining)]
67          set;
68      }
69
70      /// <summary>
71      /// <para>
72      /// Gets or sets the use index value.
73      /// </para>
74      /// <para></para>
75      /// </summary>
76      public bool UseIndex
77      {
78          [MethodImpl(MethodImplOptions.AggressiveInlining)]
79          get;
80          [MethodImpl(MethodImplOptions.AggressiveInlining)]
81          set;
82      } // TODO: Update Index on sequence update/delete.
83
84      /// <summary>
85      /// <para>
86      /// Gets or sets the use sequence marker value.
87      /// </para>
88      /// <para></para>
89      /// </summary>
90      public bool UseSequenceMarker
91      {
92          [MethodImpl(MethodImplOptions.AggressiveInlining)]
93          get;
94          [MethodImpl(MethodImplOptions.AggressiveInlining)]
95          set;
96      }
97
98      /// <summary>

```

```

99     /// <para>
100     /// Gets or sets the use compression value.
101     /// </para>
102     /// <para></para>
103     /// </summary>
104     public bool UseCompression
105     {
106         [MethodImpl(MethodImplOptions.AggressiveInlining)]
107         get;
108         [MethodImpl(MethodImplOptions.AggressiveInlining)]
109         set;
110     }
111
112     /// <summary>
113     /// <para>
114     /// Gets or sets the use garbage collection value.
115     /// </para>
116     /// <para></para>
117     /// </summary>
118     public bool UseGarbageCollection
119     {
120         [MethodImpl(MethodImplOptions.AggressiveInlining)]
121         get;
122         [MethodImpl(MethodImplOptions.AggressiveInlining)]
123         set;
124     }
125
126     /// <summary>
127     /// <para>
128     /// Gets or sets the enforce single sequence version on write based on existing value.
129     /// </para>
130     /// <para></para>
131     /// </summary>
132     public bool EnforceSingleSequenceVersionOnWriteBasedOnExisting
133     {
134         [MethodImpl(MethodImplOptions.AggressiveInlining)]
135         get;
136         [MethodImpl(MethodImplOptions.AggressiveInlining)]
137         set;
138     }
139
140     /// <summary>
141     /// <para>
142     /// Gets or sets the enforce single sequence version on write based on new value.
143     /// </para>
144     /// <para></para>
145     /// </summary>
146     public bool EnforceSingleSequenceVersionOnWriteBasedOnNew
147     {
148         [MethodImpl(MethodImplOptions.AggressiveInlining)]
149         get;
150         [MethodImpl(MethodImplOptions.AggressiveInlining)]
151         set;
152     }
153
154     /// <summary>
155     /// <para>
156     /// Gets or sets the marked sequence matcher value.
157     /// </para>
158     /// <para></para>
159     /// </summary>
160     public MarkedSequenceCriterionMatcher<TLinkAddress> MarkedSequenceMatcher
161     {
162         [MethodImpl(MethodImplOptions.AggressiveInlining)]
163         get;
164         [MethodImpl(MethodImplOptions.AggressiveInlining)]
165         set;
166     }
167
168     /// <summary>
169     /// <para>
170     /// Gets or sets the links to sequence converter value.
171     /// </para>
172     /// <para></para>
173     /// </summary>
174     public IConverter<IList<TLinkAddress>, TLinkAddress> LinksToSequenceConverter
175     {
176         [MethodImpl(MethodImplOptions.AggressiveInlining)]
177         get;

```

```

178         [MethodImpl(MethodImplOptions.AggressiveInlining)]
179         set;
180     }
181
182     /// <summary>
183     /// <para>
184     /// Gets or sets the index value.
185     /// </para>
186     /// <para></para>
187     /// </summary>
188     public ISequenceIndex<TLinkAddress> Index
189     {
190         [MethodImpl(MethodImplOptions.AggressiveInlining)]
191         get;
192         [MethodImpl(MethodImplOptions.AggressiveInlining)]
193         set;
194     }
195
196     /// <summary>
197     /// <para>
198     /// Gets or sets the walker value.
199     /// </para>
200     /// <para></para>
201     /// </summary>
202     public ISequenceWalker<TLinkAddress> Walker
203     {
204         [MethodImpl(MethodImplOptions.AggressiveInlining)]
205         get;
206         [MethodImpl(MethodImplOptions.AggressiveInlining)]
207         set;
208     }
209
210     /// <summary>
211     /// <para>
212     /// Gets or sets the read full sequence value.
213     /// </para>
214     /// <para></para>
215     /// </summary>
216     public bool ReadFullSequence
217     {
218         [MethodImpl(MethodImplOptions.AggressiveInlining)]
219         get;
220         [MethodImpl(MethodImplOptions.AggressiveInlining)]
221         set;
222     }
223
224     // TODO: Реализовать компактификацию при чтении
225     //public bool EnforceSingleSequenceVersionOnRead { get; set; }
226     //public bool UseRequestMarker { get; set; }
227     //public bool StoreRequestResults { get; set; }
228
229     /// <summary>
230     /// <para>
231     /// Inits the options using the specified links.
232     /// </para>
233     /// <para></para>
234     /// </summary>
235     /// <param name="links">
236     /// <para>The links.</para>
237     /// <para></para>
238     /// </param>
239     /// <exception cref="InvalidOperationException">
240     /// <para>Cannot recreate sequence marker link.</para>
241     /// <para></para>
242     /// </exception>
243     [MethodImpl(MethodImplOptions.AggressiveInlining)]
244     public void InitOptions(ISynchronizedLinks<TLinkAddress> links)
245     {
246         if (UseSequenceMarker)
247         {
248             if (_equalityComparer.Equals(SequenceMarkerLink, links.Constants.Null))
249             {
250                 SequenceMarkerLink = links.CreatePoint();
251             }
252             else
253             {
254                 if (!links.Exists(SequenceMarkerLink))
255                 {
256                     var link = links.CreatePoint();

```



```

257         if (!_equalityComparer.Equals(link, SequenceMarkerLink))
258         {
259             throw new InvalidOperationException("Cannot recreate sequence marker
                ↳ link.");
260         }
261     }
262 }
263 if (MarkedSequenceMatcher == null)
264 {
265     MarkedSequenceMatcher = new
        ↳ MarkedSequenceCriterionMatcher<TLinkAddress>(links, SequenceMarkerLink);
266 }
267
268 var balancedVariantConverter = new BalancedVariantConverter<TLinkAddress>(links);
269 if (UseCompression)
270 {
271     if (LinksToSequenceConverter == null)
272     {
273         ICounter<TLinkAddress, TLinkAddress> totalSequenceSymbolFrequencyCounter;
274         if (UseSequenceMarker)
275         {
276             totalSequenceSymbolFrequencyCounter = new
                ↳ TotalMarkedSequenceSymbolFrequencyCounter<TLinkAddress>(links,
                ↳ MarkedSequenceMatcher);
277         }
278         else
279         {
280             totalSequenceSymbolFrequencyCounter = new
                ↳ TotalSequenceSymbolFrequencyCounter<TLinkAddress>(links);
281         }
282         var doubletFrequenciesCache = new LinkFrequenciesCache<TLinkAddress>(links,
            ↳ totalSequenceSymbolFrequencyCounter);
283         var compressingConverter = new CompressingConverter<TLinkAddress>(links,
            ↳ balancedVariantConverter, doubletFrequenciesCache);
284         LinksToSequenceConverter = compressingConverter;
285     }
286 }
287 else
288 {
289     if (LinksToSequenceConverter == null)
290     {
291         LinksToSequenceConverter = balancedVariantConverter;
292     }
293 }
294 if (UseIndex && Index == null)
295 {
296     Index = new SequenceIndex<TLinkAddress>(links);
297 }
298 if (Walker == null)
299 {
300     Walker = new RightSequenceWalker<TLinkAddress>(links, new
        ↳ DefaultStack<TLinkAddress>());
301 }
302 }
303
304 /// <summary>
305 /// <para>
306 /// Validates the options.
307 /// </para>
308 /// <para></para>
309 /// </summary>
310 /// <exception cref="NotSupportedException">
311 /// <para>To use garbage collection UseSequenceMarker option must be on.</para>
312 /// <para></para>
313 /// </exception>
314 [MethodImpl(MethodImplOptions.AggressiveInlining)]
315 public void ValidateOptions()
316 {
317     if (UseGarbageCollection && !UseSequenceMarker)
318     {
319         throw new NotSupportedException("To use garbage collection UseSequenceMarker
            ↳ option must be on.");
320     }
321 }
322 }
323 }

```

## 1.47 ./csharp/Platform.Data.Doublets.Sequences/Time/DateTimeToLongRawNumberSequenceConverter.cs

```

1  using System;
2  using System.Runtime.CompilerServices;
3  using Platform.Converters;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Data.Doublets.Time
8  {
9      /// <summary>
10     /// <para>
11     /// Represents the date time to long raw number sequence converter.
12     /// </para>
13     /// <para></para>
14     /// </summary>
15     /// <seealso cref="IConverter{DateTime, TLinkAddress}"/>
16     public class DateTimeToLongRawNumberSequenceConverter<TLinkAddress> : IConverter<DateTime,
17     ↪ TLinkAddress>
18     {
19         private readonly IConverter<long, TLinkAddress> _int64ToLongRawNumberConverter;
20
21         /// <summary>
22         /// <para>
23         /// Initializes a new <see cref="DateTimeToLongRawNumberSequenceConverter"/> instance.
24         /// </para>
25         /// <para></para>
26         /// </summary>
27         /// <param name="int64ToLongRawNumberConverter">
28         /// <para>A int 64 to long raw number converter.</para>
29         /// <para></para>
30         /// </param>
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public DateTimeToLongRawNumberSequenceConverter(IConverter<long, TLinkAddress>
33         ↪ int64ToLongRawNumberConverter) => _int64ToLongRawNumberConverter =
34         ↪ int64ToLongRawNumberConverter;
35
36         /// <summary>
37         /// <para>
38         /// Converts the source.
39         /// </para>
40         /// <para></para>
41         /// </summary>
42         /// <param name="source">
43         /// <para>The source.</para>
44         /// <para></para>
45         /// </param>
46         /// <returns>
47         /// <para>The link</para>
48         /// <para></para>
49         /// </returns>
50         [MethodImpl(MethodImplOptions.AggressiveInlining)]
51         public TLinkAddress Convert(DateTime source) =>
52         ↪ _int64ToLongRawNumberConverter.Convert(source.ToFileTimeUtc());
53     }
54 }

```

## 1.48 ./csharp/Platform.Data.Doublets.Sequences/Time/LongRawNumberSequenceToDateTimeConverter.cs

```

1  using System;
2  using System.Runtime.CompilerServices;
3  using Platform.Converters;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Data.Doublets.Time
8  {
9      /// <summary>
10     /// <para>
11     /// Represents the long raw number sequence to date time converter.
12     /// </para>
13     /// <para></para>
14     /// </summary>
15     /// <seealso cref="IConverter{TLinkAddress, DateTime}"/>
16     public class LongRawNumberSequenceToDateTimeConverter<TLinkAddress> :
17     ↪ IConverter<TLinkAddress, DateTime>
18     {
19         private readonly IConverter<TLinkAddress, long> _longRawNumberConverterToInt64;
20
21         /// <summary>
22         /// <para>

```

```

22     /// Initializes a new <see cref="LongRawNumberSequenceToDateTimeConverter"/> instance.
23     /// </para>
24     /// <para></para>
25     /// </summary>
26     /// <param name="longRawNumberConverterToInt64">
27     /// <para>A long raw number converter to int 64.</para>
28     /// <para></para>
29     /// </param>
30     [MethodImpl(MethodImplOptions.AggressiveInlining)]
31     public LongRawNumberSequenceToDateTimeConverter(IConverter<TLinkAddress, long>
        ↳ longRawNumberConverterToInt64) => _longRawNumberConverterToInt64 =
        ↳ longRawNumberConverterToInt64;
32
33     /// <summary>
34     /// <para>
35     /// Converts the source.
36     /// </para>
37     /// <para></para>
38     /// </summary>
39     /// <param name="source">
40     /// <para>The source.</para>
41     /// <para></para>
42     /// </param>
43     /// <returns>
44     /// <para>The date time</para>
45     /// <para></para>
46     /// </returns>
47     [MethodImpl(MethodImplOptions.AggressiveInlining)]
48     public DateTime Convert(TLinkAddress source) =>
        ↳ DateTime.FromFileTimeUtc(_longRawNumberConverterToInt64.Convert(source));
49 }
50 }

```

#### 1.49 ./csharp/Platform.Data.Doublets.Sequences/UInt64LinksExtensions.cs

```

1  using System;
2  using System.Text;
3  using System.Collections.Generic;
4  using System.Runtime.CompilerServices;
5  using Platform.Singletons;
6  using Platform.Data.Doublets.Unicode;
7
8  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
9
10 namespace Platform.Data.Doublets
11 {
12     /// <summary>
13     /// <para>
14     /// Represents the int 64 links extensions.
15     /// </para>
16     /// <para></para>
17     /// </summary>
18     public static class UInt64LinksExtensions
19     {
20         /// <summary>
21         /// <para>
22         /// Uses the unicode using the specified links.
23         /// </para>
24         /// <para></para>
25         /// </summary>
26         /// <param name="links">
27         /// <para>The links.</para>
28         /// <para></para>
29         /// </param>
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         public static void UseUnicode(this ILinks<ulong> links) => UnicodeMap.InitNew(links);
32     }
33 }

```

#### 1.50 ./csharp/Platform.Data.Doublets.Sequences/Unicode/CharToUnicodeSymbolConverter.cs

```

1  using System.Runtime.CompilerServices;
2  using Platform.Converters;
3
4  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
5
6  namespace Platform.Data.Doublets.Unicode
7  {
8     /// <summary>
9     /// <para>
10     /// Represents the char to unicode symbol converter.

```

```

11     /// </para>
12     /// <para></para>
13     /// </summary>
14     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
15     /// <seealso cref="IConverter<char, TLinkAddress>"/>
16     public class CharToUnicodeSymbolConverter<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
17     ↪ IConverter<char, TLinkAddress>
18     {
19         private static readonly UncheckedConverter<char, TLinkAddress> _charToAddressConverter =
20         ↪ UncheckedConverter<char, TLinkAddress>.Default;
21         private readonly IConverter<TLinkAddress> _addressToNumberConverter;
22         private readonly TLinkAddress _unicodeSymbolMarker;
23
24         /// <summary>
25         /// <para>
26         /// Initializes a new <see cref="CharToUnicodeSymbolConverter"/> instance.
27         /// </para>
28         /// <para></para>
29         /// </summary>
30         /// <param name="links">
31         /// <para>A links.</para>
32         /// <para></para>
33         /// </param>
34         /// <param name="addressToNumberConverter">
35         /// <para>A address to number converter.</para>
36         /// <para></para>
37         /// </param>
38         /// <param name="unicodeSymbolMarker">
39         /// <para>A unicode symbol marker.</para>
40         /// <para></para>
41         /// </param>
42         [MethodImpl(MethodImplOptions.AggressiveInlining)]
43         public CharToUnicodeSymbolConverter(ILinks<TLinkAddress> links, IConverter<TLinkAddress>
44         ↪ addressToNumberConverter, TLinkAddress unicodeSymbolMarker) : base(links)
45         {
46             _addressToNumberConverter = addressToNumberConverter;
47             _unicodeSymbolMarker = unicodeSymbolMarker;
48         }
49
50         /// <summary>
51         /// <para>
52         /// Converts the source.
53         /// </para>
54         /// <para></para>
55         /// </summary>
56         /// <param name="source">
57         /// <para>The source.</para>
58         /// <para></para>
59         /// </param>
60         /// <returns>
61         /// <para>The link</para>
62         /// <para></para>
63         /// </returns>
64         [MethodImpl(MethodImplOptions.AggressiveInlining)]
65         public TLinkAddress Convert(char source)
66         {
67             var unaryNumber =
68             ↪ _addressToNumberConverter.Convert(_charToAddressConverter.Convert(source));
69             return _links.GetOrCreate(unaryNumber, _unicodeSymbolMarker);
70         }
71     }
72 }

```

## 1.51 ./csharp/Platform.Data.Doublets.Sequences/Unicode/StringToUnicodeSequenceConverter.cs

```

1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Converters;
4 using Platform.Data.Doublets.Sequences.Indexes;
5
6 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8 namespace Platform.Data.Doublets.Unicode
9 {
10     /// <summary>
11     /// <para>
12     /// Represents the string to unicode sequence converter.
13     /// </para>
14     /// <para></para>
15     /// </summary>

```

```

16  /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
17  /// <seealso cref="IConverter{string, TLinkAddress}"/>
18  public class StringToUnicodeSequenceConverter<TLinkAddress> :
    ↳ LinksOperatorBase<TLinkAddress>, IConverter<string, TLinkAddress>
19  {
20      private readonly IConverter<string, IList<TLinkAddress>?>
    ↳ _stringToUnicodeSymbolListConverter;
21      private readonly IConverter<IList<TLinkAddress>, TLinkAddress>
    ↳ _unicodeSymbolListToSequenceConverter;
22
23      /// <summary>
24      /// <para>
25      /// Initializes a new <see cref="StringToUnicodeSequenceConverter"/> instance.
26      /// </para>
27      /// <para></para>
28      /// </summary>
29      /// <param name="links">
30      /// <para>A links.</para>
31      /// <para></para>
32      /// </param>
33      /// <param name="stringToUnicodeSymbolListConverter">
34      /// <para>A string to unicode symbol list converter.</para>
35      /// <para></para>
36      /// </param>
37      /// <param name="unicodeSymbolListToSequenceConverter">
38      /// <para>A unicode symbol list to sequence converter.</para>
39      /// <para></para>
40      /// </param>
41      [MethodImpl(MethodImplOptions.AggressiveInlining)]
42      public StringToUnicodeSequenceConverter(ILinks<TLinkAddress> links, IConverter<string,
    ↳ IList<TLinkAddress>?> stringToUnicodeSymbolListConverter,
    ↳ IConverter<IList<TLinkAddress>, TLinkAddress> unicodeSymbolListToSequenceConverter)
    ↳ : base(links)
43      {
44          _stringToUnicodeSymbolListConverter = stringToUnicodeSymbolListConverter;
45          _unicodeSymbolListToSequenceConverter = unicodeSymbolListToSequenceConverter;
46      }
47
48      /// <summary>
49      /// <para>
50      /// Initializes a new <see cref="StringToUnicodeSequenceConverter"/> instance.
51      /// </para>
52      /// <para></para>
53      /// </summary>
54      /// <param name="links">
55      /// <para>A links.</para>
56      /// <para></para>
57      /// </param>
58      /// <param name="stringToUnicodeSymbolListConverter">
59      /// <para>A string to unicode symbol list converter.</para>
60      /// <para></para>
61      /// </param>
62      /// <param name="index">
63      /// <para>A index.</para>
64      /// <para></para>
65      /// </param>
66      /// <param name="listToSequenceLinkConverter">
67      /// <para>A list to sequence link converter.</para>
68      /// <para></para>
69      /// </param>
70      /// <param name="unicodeSequenceMarker">
71      /// <para>A unicode sequence marker.</para>
72      /// <para></para>
73      /// </param>
74      [MethodImpl(MethodImplOptions.AggressiveInlining)]
75      public StringToUnicodeSequenceConverter(ILinks<TLinkAddress> links, IConverter<string,
    ↳ IList<TLinkAddress>?> stringToUnicodeSymbolListConverter,
    ↳ ISequenceIndex<TLinkAddress> index, IConverter<IList<TLinkAddress>, TLinkAddress>
    ↳ listToSequenceLinkConverter, TLinkAddress unicodeSequenceMarker)
76      : this(links, stringToUnicodeSymbolListConverter, new
    ↳ UnicodeSymbolsListToUnicodeSequenceConverter<TLinkAddress>(links, index,
    ↳ listToSequenceLinkConverter, unicodeSequenceMarker)) { }
77
78      /// <summary>
79      /// <para>
80      /// Initializes a new <see cref="StringToUnicodeSequenceConverter"/> instance.
81      /// </para>
82      /// <para></para>

```

```

83     /// </summary>
84     /// <param name="links">
85     /// <para>A links.</para>
86     /// <para></para>
87     /// </param>
88     /// <param name="charToUnicodeSymbolConverter">
89     /// <para>A char to unicode symbol converter.</para>
90     /// <para></para>
91     /// </param>
92     /// <param name="index">
93     /// <para>A index.</para>
94     /// <para></para>
95     /// </param>
96     /// <param name="listToSequenceLinkConverter">
97     /// <para>A list to sequence link converter.</para>
98     /// <para></para>
99     /// </param>
100    /// <param name="unicodeSequenceMarker">
101    /// <para>A unicode sequence marker.</para>
102    /// <para></para>
103    /// </param>
104    [MethodImpl(MethodImplOptions.AggressiveInlining)]
105    public StringToUnicodeSequenceConverter(ILinks<TLinkAddress> links, IConverter<char,
    ↪ TLinkAddress> charToUnicodeSymbolConverter, ISequenceIndex<TLinkAddress> index,
    ↪ IConverter<IList<TLinkAddress>, TLinkAddress> listToSequenceLinkConverter,
    ↪ TLinkAddress unicodeSequenceMarker)
106    : this(links, new
    ↪ StringToUnicodeSymbolsListConverter<TLinkAddress>(charToUnicodeSymbolConverter),
    ↪ index, listToSequenceLinkConverter, unicodeSequenceMarker) { }

107
108    /// <summary>
109    /// <para>
110    /// Initializes a new <see cref="StringToUnicodeSequenceConverter"/> instance.
111    /// </para>
112    /// <para></para>
113    /// </summary>
114    /// <param name="links">
115    /// <para>A links.</para>
116    /// <para></para>
117    /// </param>
118    /// <param name="charToUnicodeSymbolConverter">
119    /// <para>A char to unicode symbol converter.</para>
120    /// <para></para>
121    /// </param>
122    /// <param name="listToSequenceLinkConverter">
123    /// <para>A list to sequence link converter.</para>
124    /// <para></para>
125    /// </param>
126    /// <param name="unicodeSequenceMarker">
127    /// <para>A unicode sequence marker.</para>
128    /// <para></para>
129    /// </param>
130    [MethodImpl(MethodImplOptions.AggressiveInlining)]
131    public StringToUnicodeSequenceConverter(ILinks<TLinkAddress> links, IConverter<char,
    ↪ TLinkAddress> charToUnicodeSymbolConverter, IConverter<IList<TLinkAddress>,
    ↪ TLinkAddress> listToSequenceLinkConverter, TLinkAddress unicodeSequenceMarker)
132    : this(links, charToUnicodeSymbolConverter, new Unindex<TLinkAddress>(),
    ↪ listToSequenceLinkConverter, unicodeSequenceMarker) { }

133
134    /// <summary>
135    /// <para>
136    /// Initializes a new <see cref="StringToUnicodeSequenceConverter"/> instance.
137    /// </para>
138    /// <para></para>
139    /// </summary>
140    /// <param name="links">
141    /// <para>A links.</para>
142    /// <para></para>
143    /// </param>
144    /// <param name="stringToUnicodeSymbolListConverter">
145    /// <para>A string to unicode symbol list converter.</para>
146    /// <para></para>
147    /// </param>
148    /// <param name="listToSequenceLinkConverter">
149    /// <para>A list to sequence link converter.</para>
150    /// <para></para>
151    /// </param>

```

```

152     /// <param name="unicodeSequenceMarker">
153     /// <para>A unicode sequence marker.</para>
154     /// </para>
155     /// </param>
156     [MethodImpl(MethodImplOptions.AggressiveInlining)]
157     public StringToUnicodeSequenceConverter(ILinks<TLinkAddress> links, IConverter<string,
    ↪ IList<TLinkAddress>?> stringToUnicodeSymbolListConverter,
    ↪ IConverter<IList<TLinkAddress>, TLinkAddress> listToSequenceLinkConverter,
    ↪ TLinkAddress unicodeSequenceMarker)
158     : this(links, stringToUnicodeSymbolListConverter, new Unindex<TLinkAddress>(),
    ↪ listToSequenceLinkConverter, unicodeSequenceMarker) { }
159
160     /// <summary>
161     /// <para>
162     /// Converts the source.
163     /// </para>
164     /// </para>
165     /// </summary>
166     /// <param name="source">
167     /// <para>The source.</para>
168     /// </para>
169     /// </param>
170     /// <returns>
171     /// <para>The link</para>
172     /// </para>
173     /// </returns>
174     [MethodImpl(MethodImplOptions.AggressiveInlining)]
175     public TLinkAddress Convert(string source)
176     {
177         var elements = _stringToUnicodeSymbolListConverter.Convert(source);
178         return _unicodeSymbolListToSequenceConverter.Convert(elements);
179     }
180 }
181 }

```

## 1.52 ./csharp/Platform.Data.Doublets.Sequences/Unicode/StringToUnicodeSymbolsListConverter.cs

```

1  using System.Collections.Generic;
2  using System.Runtime.CompilerServices;
3  using Platform.Converters;
4
5  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
6
7  namespace Platform.Data.Doublets.Unicode
8  {
9      /// <summary>
10     /// <para>
11     /// Represents the string to unicode symbols list converter.
12     /// </para>
13     /// </para>
14     /// </summary>
15     /// <seealso cref="IConverter{string, IList{TLinkAddress}}"/>
16     public class StringToUnicodeSymbolsListConverter<TLinkAddress> : IConverter<string,
    ↪ IList<TLinkAddress>?>
17     {
18         private readonly IConverter<char, TLinkAddress> _charToUnicodeSymbolConverter;
19
20         /// <summary>
21         /// <para>
22         /// Initializes a new <see cref="StringToUnicodeSymbolsListConverter"/> instance.
23         /// </para>
24         /// </para>
25         /// </summary>
26         /// <param name="charToUnicodeSymbolConverter">
27         /// <para>A char to unicode symbol converter.</para>
28         /// </para>
29         /// </param>
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         public StringToUnicodeSymbolsListConverter(IConverter<char, TLinkAddress>
    ↪ charToUnicodeSymbolConverter) => _charToUnicodeSymbolConverter =
    ↪ charToUnicodeSymbolConverter;
32
33         /// <summary>
34         /// <para>
35         /// Converts the source.
36         /// </para>
37         /// </para>
38         /// </summary>
39         /// <param name="source">
40         /// <para>The source.</para>

```

```

41     /// <para></para>
42     /// </param>
43     /// <returns>
44     /// <para>The elements.</para>
45     /// <para></para>
46     /// </returns>
47     [MethodImpl(MethodImplOptions.AggressiveInlining)]
48     public IList<TLinkAddress>? Convert(string source)
49     {
50         var elements = new TLinkAddress[source.Length];
51         for (var i = 0; i < elements.Length; i++)
52         {
53             elements[i] = _charToUnicodeSymbolConverter.Convert(source[i]);
54         }
55         return elements;
56     }
57 }
58 }

```

### 1.53 ./csharp/Platform.Data.Doublets.Sequences/Unicode/UnicodeMap.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Globalization;
4  using System.Runtime.CompilerServices;
5  using System.Text;
6  using Platform.Data.Sequences;
7
8  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
9
10 namespace Platform.Data.Doublets.Unicode
11 {
12     /// <summary>
13     /// <para>
14     /// Represents the unicode map.
15     /// </para>
16     /// <para></para>
17     /// </summary>
18     public class UnicodeMap
19     {
20         /// <summary>
21         /// <para>
22         /// The first char link.
23         /// </para>
24         /// <para></para>
25         /// </summary>
26         public static readonly ulong FirstCharLink = 1;
27         /// <summary>
28         /// <para>
29         /// The max value.
30         /// </para>
31         /// <para></para>
32         /// </summary>
33         public static readonly ulong LastCharLink = FirstCharLink + char.MaxValue;
34         /// <summary>
35         /// <para>
36         /// The max value.
37         /// </para>
38         /// <para></para>
39         /// </summary>
40         public static readonly ulong MapSize = 1 + char.MaxValue;
41         private readonly ILinks<ulong> _links;
42         private bool _initialized;
43
44         /// <summary>
45         /// <para>
46         /// Initializes a new <see cref="UnicodeMap"/> instance.
47         /// </para>
48         /// <para></para>
49         /// </summary>
50         /// <param name="links">
51         /// <para>A links.</para>
52         /// <para></para>
53         /// </param>
54         [MethodImpl(MethodImplOptions.AggressiveInlining)]
55         public UnicodeMap(ILinks<ulong> links) => _links = links;
56
57         /// <summary>
58         /// <para>
59         /// Inits the new using the specified links.

```



```

60    /// </para>
61    /// <para></para>
62    /// </summary>
63    /// <param name="links">
64    /// <para>The links.</para>
65    /// <para></para>
66    /// </param>
67    /// <returns>
68    /// <para>The map.</para>
69    /// <para></para>
70    /// </returns>
71    [MethodImpl(MethodImplOptions.AggressiveInlining)]
72    public static UnicodeMap InitNew(ILinks<ulong> links)
73    {
74        var map = new UnicodeMap(links);
75        map.Init();
76        return map;
77    }
78
79    /// <summary>
80    /// <para>
81    ///     Inits this instance.
82    /// </para>
83    /// <para></para>
84    /// </summary>
85    /// <exception cref="InvalidOperationException">
86    /// <para>Unable to initialize UTF 16 table.</para>
87    /// <para></para>
88    /// </exception>
89    [MethodImpl(MethodImplOptions.AggressiveInlining)]
90    public void Init()
91    {
92        if (_initialized)
93        {
94            return;
95        }
96        _initialized = true;
97        var firstLink = _links.CreatePoint();
98        if (firstLink != FirstCharLink)
99        {
100            _links.Delete(firstLink);
101        }
102        else
103        {
104            for (var i = FirstCharLink + 1; i <= LastCharLink; i++)
105            {
106                // From NIL to It (NIL -> Character) transformation meaning, (or infinite
107                // ↪ amount of NIL characters before actual Character)
108                var createdLink = _links.CreatePoint();
109                _links.Update(createdLink, firstLink, createdLink);
110                if (createdLink != i)
111                {
112                    throw new InvalidOperationException("Unable to initialize UTF 16
113                    ↪ table.");
114                }
115            }
116        }
117    }
118
119    /// 0 - null link
120    /// 1 - nil character (0 character)
121    /// ...
122    /// 65536 (0(1) + 65535 = 65536 possible values)
123
124    /// <summary>
125    /// <para>
126    ///     Creates the char to link using the specified character.
127    /// </para>
128    /// <para></para>
129    /// </summary>
130    /// <param name="character">
131    /// <para>The character.</para>
132    /// <para></para>
133    /// </param>
134    /// <returns>
135    /// <para>The ulong</para>
136    /// <para></para>
137    /// </returns>

```

```

136 [MethodImpl(MethodImplOptions.AggressiveInlining)]
137 public static ulong FromCharToLink(char character) => (ulong)character + 1;
138
139 /// <summary>
140 /// <para>
141 /// Creates the link to char using the specified link.
142 /// </para>
143 /// <para></para>
144 /// </summary>
145 /// <param name="link">
146 /// <para>The link.</para>
147 /// <para></para>
148 /// </param>
149 /// <returns>
150 /// <para>The char</para>
151 /// <para></para>
152 /// </returns>
153 [MethodImpl(MethodImplOptions.AggressiveInlining)]
154 public static char FromLinkToChar(ulong link) => (char)(link - 1);
155
156 /// <summary>
157 /// <para>
158 /// Determines whether is char link.
159 /// </para>
160 /// <para></para>
161 /// </summary>
162 /// <param name="link">
163 /// <para>The link.</para>
164 /// <para></para>
165 /// </param>
166 /// <returns>
167 /// <para>The bool</para>
168 /// <para></para>
169 /// </returns>
170 [MethodImpl(MethodImplOptions.AggressiveInlining)]
171 public static bool IsCharLink(ulong link) => link <= MapSize;
172
173 /// <summary>
174 /// <para>
175 /// Creates the links to string using the specified links list.
176 /// </para>
177 /// <para></para>
178 /// </summary>
179 /// <param name="linksList">
180 /// <para>The links list.</para>
181 /// <para></para>
182 /// </param>
183 /// <returns>
184 /// <para>The string</para>
185 /// <para></para>
186 /// </returns>
187 [MethodImpl(MethodImplOptions.AggressiveInlining)]
188 public static string FromLinksToString(ICollection<ulong> linksList)
189 {
190     var sb = new StringBuilder();
191     for (int i = 0; i < linksList.Count; i++)
192     {
193         sb.Append(FromLinkToChar(linksList[i]));
194     }
195     return sb.ToString();
196 }
197
198 /// <summary>
199 /// <para>
200 /// Creates the sequence link to string using the specified link.
201 /// </para>
202 /// <para></para>
203 /// </summary>
204 /// <param name="link">
205 /// <para>The link.</para>
206 /// <para></para>
207 /// </param>
208 /// <param name="links">
209 /// <para>The links.</para>
210 /// <para></para>
211 /// </param>
212 /// <returns>
213 /// <para>The string</para>

```

```

214 /// <para></para>
215 /// </returns>
216 [MethodImpl(MethodImplOptions.AggressiveInlining)]
217 public static string FromSequenceLinkToString(ulong link, ILinks<ulong> links)
218 {
219     var sb = new StringBuilder();
220     if (links.Exists(link))
221     {
222         StopableSequenceWalker.WalkRight(link, links.GetSource, links.GetTarget,
223             x => x <= MapSize || links.GetSource(x) == x || links.GetTarget(x) == x,
224             element =>
225             {
226                 sb.Append(FromLinkToChar(element));
227                 return true;
228             });
229     }
230     return sb.ToString();
231 }
232
233 /// <summary>
234 /// <para>
235 /// Creates the chars to link array using the specified chars.
236 /// </para>
237 /// </summary>
238 /// <param name="chars">
239 /// <para>The chars.</para>
240 /// </param>
241 /// <returns>
242 /// <para>The ulong array</para>
243 /// </returns>
244 [MethodImpl(MethodImplOptions.AggressiveInlining)]
245 public static ulong[] FromCharsToLinkArray(char[] chars) => FromCharsToLinkArray(chars,
246     ↪ chars.Length);
247
248
249 /// <summary>
250 /// <para>
251 /// Creates the chars to link array using the specified chars.
252 /// </para>
253 /// </summary>
254 /// <param name="chars">
255 /// <para>The chars.</para>
256 /// </param>
257 /// <param name="count">
258 /// <para>The count.</para>
259 /// </param>
260 /// <returns>
261 /// <para>The links sequence.</para>
262 /// </returns>
263 [MethodImpl(MethodImplOptions.AggressiveInlining)]
264 public static ulong[] FromCharsToLinkArray(char[] chars, int count)
265 {
266     // char array to ulong array
267     var linksSequence = new ulong[count];
268     for (var i = 0; i < count; i++)
269     {
270         linksSequence[i] = FromCharToLink(chars[i]);
271     }
272     return linksSequence;
273 }
274
275
276 /// <summary>
277 /// <para>
278 /// Creates the string to link array using the specified sequence.
279 /// </para>
280 /// </summary>
281 /// <param name="sequence">
282 /// <para>The sequence.</para>
283 /// </param>
284 /// <returns>

```

```

290 /// <para>The links sequence.</para>
291 /// <para></para>
292 /// </returns>
293 [MethodImpl(MethodImplOptions.AggressiveInlining)]
294 public static ulong[] FromStringToLinkArray(string sequence)
295 {
296     // char array to ulong array
297     var linksSequence = new ulong[sequence.Length];
298     for (var i = 0; i < sequence.Length; i++)
299     {
300         linksSequence[i] = FromCharToLink(sequence[i]);
301     }
302     return linksSequence;
303 }
304
305 /// <summary>
306 /// <para>
307 /// Creates the string to link array groups using the specified sequence.
308 /// </para>
309 /// <para></para>
310 /// </summary>
311 /// <param name="sequence">
312 /// <para>The sequence.</para>
313 /// <para></para>
314 /// </param>
315 /// <returns>
316 /// <para>The result.</para>
317 /// <para></para>
318 /// </returns>
319 [MethodImpl(MethodImplOptions.AggressiveInlining)]
320 public static List<ulong[]> FromStringToLinkArrayGroups(string sequence)
321 {
322     var result = new List<ulong[]>();
323     var offset = 0;
324     while (offset < sequence.Length)
325     {
326         var currentCategory = CharUnicodeInfo.GetUnicodeCategory(sequence[offset]);
327         var relativeLength = 1;
328         var absoluteLength = offset + relativeLength;
329         while (absoluteLength < sequence.Length &&
330             currentCategory ==
331                 CharUnicodeInfo.GetUnicodeCategory(sequence[absoluteLength]))
332         {
333             relativeLength++;
334             absoluteLength++;
335         }
336         // char array to ulong array
337         var innerSequence = new ulong[relativeLength];
338         var maxLength = offset + relativeLength;
339         for (var i = offset; i < maxLength; i++)
340         {
341             innerSequence[i - offset] = FromCharToLink(sequence[i]);
342         }
343         result.Add(innerSequence);
344         offset += relativeLength;
345     }
346     return result;
347
348 /// <summary>
349 /// <para>
350 /// Creates the link array to link array groups using the specified array.
351 /// </para>
352 /// <para></para>
353 /// </summary>
354 /// <param name="array">
355 /// <para>The array.</para>
356 /// <para></para>
357 /// </param>
358 /// <returns>
359 /// <para>The result.</para>
360 /// <para></para>
361 /// </returns>
362 [MethodImpl(MethodImplOptions.AggressiveInlining)]
363 public static List<ulong[]> FromLinkArrayToLinkArrayGroups(ulong[] array)
364 {
365     var result = new List<ulong[]>();
366     var offset = 0;
367     while (offset < array.Length)

```

```

368     {
369         var relativeLength = 1;
370         if (array[offset] <= LastCharLink)
371         {
372             var currentCategory =
373                 ↪ CharUnicodeInfo.GetUnicodeCategory(FromLinkToChar(array[offset]));
374             var absoluteLength = offset + relativeLength;
375             while (absoluteLength < array.Length &&
376                 array[absoluteLength] <= LastCharLink &&
377                 currentCategory == CharUnicodeInfo.GetUnicodeCategory(FromLinkToChar(
378                     ↪ array[absoluteLength])))
379             {
380                 relativeLength++;
381                 absoluteLength++;
382             }
383         }
384         else
385         {
386             var absoluteLength = offset + relativeLength;
387             while (absoluteLength < array.Length && array[absoluteLength] > LastCharLink)
388             {
389                 relativeLength++;
390                 absoluteLength++;
391             }
392             // copy array
393             var innerSequence = new ulong[relativeLength];
394             var maxLength = offset + relativeLength;
395             for (var i = offset; i < maxLength; i++)
396             {
397                 innerSequence[i - offset] = array[i];
398             }
399             result.Add(innerSequence);
400             offset += relativeLength;
401         }
402     }
403     return result;
404 }

```

#### 1.54 ./csharp/Platform.Data.Doublets.Sequences/Unicode/UnicodeSequenceToStringConverter.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Interfaces;
5  using Platform.Converters;
6  using Platform.Data.Doublets.Sequences.Walkers;
7  using System.Text;
8  using Platform.Data.Doublets.Sequences.CriterionMatchers;
9
10 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
11
12 namespace Platform.Data.Doublets.Unicode
13 {
14     /// <summary>
15     /// <para>
16     /// Represents the unicode sequence to string converter.
17     /// </para>
18     /// <para></para>
19     /// </summary>
20     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
21     /// <seealso cref="IConverter{TLinkAddress, string}"/>
22     public class UnicodeSequenceToStringConverter<TLinkAddress> :
23         ↪ LinksOperatorBase<TLinkAddress>, IConverter<TLinkAddress, string>
24     {
25         private readonly ICriterionMatcher<TLinkAddress> _unicodeSequenceCriterionMatcher;
26         private readonly ISequenceWalker<TLinkAddress> _sequenceWalker;
27         private readonly IConverter<TLinkAddress, char> _unicodeSymbolToCharConverter;
28         private readonly TLinkAddress _unicodeSequenceMarker;
29
30         /// <summary>
31         /// <para>
32         /// Initializes a new <see cref="UnicodeSequenceToStringConverter"/> instance.
33         /// </para>
34         /// <para></para>
35         /// </summary>
36         /// <param name="links">
37         /// <para>A links.</para>
38         /// <para></para>

```

```

39     /// </param>
40     /// <param name="unicodeSequenceCriterionMatcher">
41     /// <para>A unicode sequence criterion matcher.</para>
42     /// </param>
43     /// <param name="sequenceWalker">
44     /// <para>A sequence walker.</para>
45     /// </param>
46     /// <param name="unicodeSymbolToCharConverter">
47     /// <para>A unicode symbol to char converter.</para>
48     /// </param>
49     [MethodImpl(MethodImplOptions.AggressiveInlining)]
50     public UnicodeSequenceToStringConverter(ILinks<TLinkAddress> links,
51     ↪ ICriterionMatcher<TLinkAddress> unicodeSequenceCriterionMatcher,
52     ↪ ISequenceWalker<TLinkAddress> sequenceWalker, IConverter<TLinkAddress, char>
53     ↪ unicodeSymbolToCharConverter, TLinkAddress unicodeSequenceMarker) : base(links)
54     {
55         _unicodeSequenceCriterionMatcher = unicodeSequenceCriterionMatcher;
56         _sequenceWalker = sequenceWalker;
57         _unicodeSymbolToCharConverter = unicodeSymbolToCharConverter;
58         _unicodeSequenceMarker = unicodeSequenceMarker;
59     }
60
61     public UnicodeSequenceToStringConverter(ILinks<TLinkAddress> links,
62     ↪ ISequenceWalker<TLinkAddress> sequenceWalker, IConverter<TLinkAddress, char>
63     ↪ unicodeSymbolToCharConverter, TLinkAddress unicodeSequenceMarker): this(links, new
64     ↪ UnicodeSequenceMatcher<TLinkAddress>(links, unicodeSequenceMarker), sequenceWalker,
65     ↪ unicodeSymbolToCharConverter, unicodeSequenceMarker){}
66
67     /// <summary>
68     /// <para>
69     /// Converts the source.
70     /// </para>
71     /// </summary>
72     /// <param name="source">
73     /// <para>The source.</para>
74     /// </param>
75     /// <exception cref="ArgumentOutOfRangeException">
76     /// <para>Specified link is not a unicode sequence.</para>
77     /// </exception>
78     /// <returns>
79     /// <para>The string</para>
80     /// </returns>
81     [MethodImpl(MethodImplOptions.AggressiveInlining)]
82     public string Convert(TLinkAddress source)
83     {
84         if (!_unicodeSequenceCriterionMatcher.IsMatched(source))
85         {
86             throw new ArgumentOutOfRangeException(nameof(source), source, "Specified link is
87             ↪ not a unicode sequence.");
88         }
89         if (EqualityComparer<TLinkAddress>.Default.Equals(_unicodeSequenceMarker, source))
90         {
91             return String.Empty;
92         }
93         var sequence = _links.GetSource(source);
94         var sb = new StringBuilder();
95         foreach (var character in _sequenceWalker.Walk(sequence))
96         {
97             sb.Append(_unicodeSymbolToCharConverter.Convert(character));
98         }
99         return sb.ToString();
100     }
101 }
102 }

```

## 1.55 ./csharp/Platform.Data.Doublets.Sequences/Unicode/UnicodeSymbolToCharConverter.cs

```

1 using System;
2 using System.Runtime.CompilerServices;
3 using Platform.Interfaces;
4 using Platform.Converters;

```

```

5
6 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8 namespace Platform.Data.Doublets.Unicode
9 {
10     /// <summary>
11     /// <para>
12     /// Represents the unicode symbol to char converter.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
17     /// <seealso cref="IConverter{TLinkAddress, char}"/>
18     public class UnicodeSymbolToCharConverter<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
19         ↳ IConverter<TLinkAddress, char>
20     {
21         private static readonly UncheckedConverter<TLinkAddress, char> _addressToCharConverter =
22             ↳ UncheckedConverter<TLinkAddress, char>.Default;
23         private readonly IConverter<TLinkAddress> _numberToAddressConverter;
24         private readonly ICriterionMatcher<TLinkAddress> _unicodeSymbolCriterionMatcher;
25
26         /// <summary>
27         /// <para>
28         /// Initializes a new <see cref="UnicodeSymbolToCharConverter"/> instance.
29         /// </para>
30         /// <para></para>
31         /// </summary>
32         /// <param name="links">
33         /// <para>A links.</para>
34         /// <para></para>
35         /// </param>
36         /// <param name="numberToAddressConverter">
37         /// <para>A number to address converter.</para>
38         /// <para></para>
39         /// </param>
40         /// <param name="unicodeSymbolCriterionMatcher">
41         /// <para>A unicode symbol criterion matcher.</para>
42         /// <para></para>
43         /// </param>
44         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45         public UnicodeSymbolToCharConverter(ILinks<TLinkAddress> links, IConverter<TLinkAddress>
46             ↳ numberToAddressConverter, ICriterionMatcher<TLinkAddress>
47             ↳ unicodeSymbolCriterionMatcher) : base(links)
48         {
49             _numberToAddressConverter = numberToAddressConverter;
50             _unicodeSymbolCriterionMatcher = unicodeSymbolCriterionMatcher;
51         }
52
53         /// <summary>
54         /// <para>
55         /// Converts the source.
56         /// </para>
57         /// <para></para>
58         /// </summary>
59         /// <param name="source">
60         /// <para>The source.</para>
61         /// <para></para>
62         /// </param>
63         /// <exception cref="ArgumentOutOfRangeException">
64         /// <para>Specified link is not a unicode symbol.</para>
65         /// <para></para>
66         /// </exception>
67         /// <returns>
68         /// <para>The char</para>
69         /// <para></para>
70         /// </returns>
71         [MethodImpl(MethodImplOptions.AggressiveInlining)]
72         public char Convert(TLinkAddress source)
73         {
74             if (!_unicodeSymbolCriterionMatcher.IsMatched(source))
75             {
76                 throw new ArgumentOutOfRangeException(nameof(source), source, "Specified link is
77                 ↳ not a unicode symbol.");
78             }
79             return _addressToCharConverter.Convert(_numberToAddressConverter.Convert(_links.GetS
80             ↳ ource(source)));
81         }
82     }
83 }

```

77 }

## 1.56 ./csharp/Platform.Data.Doublets.Sequences/Unicode/UnicodeSymbolsListToUnicodeSequenceConverter.cs

```
1 using System.Collections.Generic;
2 using System.Runtime.CompilerServices;
3 using Platform.Collections;
4 using Platform.Converters;
5 using Platform.Data.Doublets.Sequences.Indexes;
6
7 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
8
9 namespace Platform.Data.Doublets.Unicode
10 {
11     /// <summary>
12     /// <para>
13     /// Represents the unicode symbols list to unicode sequence converter.
14     /// </para>
15     /// <para></para>
16     /// </summary>
17     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
18     /// <seealso cref="IConverter<IList{TLinkAddress}, TLinkAddress>"/>
19     public class UnicodeSymbolsListToUnicodeSequenceConverter<TLinkAddress> :
20         ↳ LinksOperatorBase<TLinkAddress>, IConverter<IList<TLinkAddress>, TLinkAddress>
21     {
22         private readonly ISequenceIndex<TLinkAddress> _index;
23         private readonly IConverter<IList<TLinkAddress>, TLinkAddress>
24             ↳ _listToSequenceLinkConverter;
25         private readonly TLinkAddress _unicodeSequenceMarker;
26
27         /// <summary>
28         /// <para>
29         /// Initializes a new <see cref="UnicodeSymbolsListToUnicodeSequenceConverter"/>
30         ↳ instance.
31         /// </para>
32         /// <para></para>
33         /// </summary>
34         /// <param name="links">
35         /// <para>A links.</para>
36         /// <para></para>
37         /// </param>
38         /// <param name="index">
39         /// <para>A index.</para>
40         /// <para></para>
41         /// </param>
42         /// <param name="listToSequenceLinkConverter">
43         /// <para>A list to sequence link converter.</para>
44         /// <para></para>
45         /// </param>
46         /// <param name="unicodeSequenceMarker">
47         /// <para>A unicode sequence marker.</para>
48         /// <para></para>
49         /// </param>
50         [MethodImpl(MethodImplOptions.AggressiveInlining)]
51         public UnicodeSymbolsListToUnicodeSequenceConverter(ILinks<TLinkAddress> links,
52             ↳ ISequenceIndex<TLinkAddress> index, IConverter<IList<TLinkAddress>, TLinkAddress>
53             ↳ listToSequenceLinkConverter, TLinkAddress unicodeSequenceMarker) : base(links)
54         {
55             _index = index;
56             _listToSequenceLinkConverter = listToSequenceLinkConverter;
57             _unicodeSequenceMarker = unicodeSequenceMarker;
58         }
59
60         /// <summary>
61         /// <para>
62         /// Initializes a new <see cref="UnicodeSymbolsListToUnicodeSequenceConverter"/>
63         ↳ instance.
64         /// </para>
65         /// <para></para>
66         /// </summary>
67         /// <param name="links">
68         /// <para>A links.</para>
69         /// <para></para>
70         /// </param>
71         /// <param name="listToSequenceLinkConverter">
72         /// <para>A list to sequence link converter.</para>
73         /// <para></para>
74         /// </param>
75         /// <param name="unicodeSequenceMarker">
76         /// <para>A unicode sequence marker.</para>
77         /// <para></para>
78         /// </param>
```



```

71     /// <para></para>
72     /// </param>
73     [MethodImpl(MethodImplOptions.AggressiveInlining)]
74     public UnicodeSymbolsListToUnicodeSequenceConverter(ILinks<TLinkAddress> links,
75         ↪ IConverter<IList<TLinkAddress>, TLinkAddress> listToSequenceLinkConverter,
76         ↪ TLinkAddress unicodeSequenceMarker)
77         : this(links, new Unindex<TLinkAddress>(), listToSequenceLinkConverter,
78             ↪ unicodeSequenceMarker) { }
79
80     /// <summary>
81     /// <para>
82     /// Converts the list.
83     /// </para>
84     /// <para></para>
85     /// </summary>
86     /// <param name="list">
87     /// <para>The list.</para>
88     /// <para></para>
89     /// </param>
90     /// <returns>
91     /// <para>The link</para>
92     /// <para></para>
93     /// </returns>
94     [MethodImpl(MethodImplOptions.AggressiveInlining)]
95     public TLinkAddress Convert(IList<TLinkAddress>? list)
96     {
97         if (list.IsNullOrEmpty())
98         {
99             return _unicodeSequenceMarker;
100         }
101         _index.Add(list);
102         var sequence = _listToSequenceLinkConverter.Convert(list);
103         return _links.GetOrCreate(sequence, _unicodeSequenceMarker);
104     }
105 }

```

### 1.57 ./csharp/Platform.Data.Doublets.Sequences/Walkers/ISequenceWalker.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.Data.Doublets.Sequences.Walkers
7  {
8      /// <summary>
9      /// <para>
10     /// Defines the sequence walker.
11     /// </para>
12     /// <para></para>
13     /// </summary>
14     public interface ISequenceWalker<TLinkAddress>
15     {
16         /// <summary>
17         /// <para>
18         /// Walks the sequence.
19         /// </para>
20         /// <para></para>
21         /// </summary>
22         /// <param name="sequence">
23         /// <para>The sequence.</para>
24         /// <para></para>
25         /// </param>
26         /// <returns>
27         /// <para>An enumerable of t link</para>
28         /// <para></para>
29         /// </returns>
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         IEnumerable<TLinkAddress> Walk(TLinkAddress sequence);
32     }
33 }

```

### 1.58 ./csharp/Platform.Data.Doublets.Sequences/Walkers/LeftSequenceWalker.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Collections.Stacks;
5

```

```

6 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8 namespace Platform.Data.Doublets.Sequences.Walkers
9 {
10     /// <summary>
11     /// <para>
12     /// Represents the left sequence walker.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="SequenceWalkerBase{TLinkAddress}"/>
17     public class LeftSequenceWalker<TLinkAddress> : SequenceWalkerBase<TLinkAddress>
18     {
19         /// <summary>
20         /// <para>
21         /// Initializes a new <see cref="LeftSequenceWalker"/> instance.
22         /// </para>
23         /// <para></para>
24         /// </summary>
25         /// <param name="links">
26         /// <para>A links.</para>
27         /// <para></para>
28         /// </param>
29         /// <param name="stack">
30         /// <para>A stack.</para>
31         /// <para></para>
32         /// </param>
33         /// <param name="isElement">
34         /// <para>A is element.</para>
35         /// <para></para>
36         /// </param>
37         [MethodImpl(MethodImplOptions.AggressiveInlining)]
38         public LeftSequenceWalker(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack,
39             ↪ Func<TLinkAddress, bool> isElement) : base(links, stack, isElement) { }
40
41         /// <summary>
42         /// <para>
43         /// Initializes a new <see cref="LeftSequenceWalker"/> instance.
44         /// </para>
45         /// <para></para>
46         /// </summary>
47         /// <param name="links">
48         /// <para>A links.</para>
49         /// <para></para>
50         /// </param>
51         /// <param name="stack">
52         /// <para>A stack.</para>
53         /// <para></para>
54         /// </param>
55         [MethodImpl(MethodImplOptions.AggressiveInlining)]
56         public LeftSequenceWalker(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack) :
57             ↪ base(links, stack, links.IsPartialPoint) { }
58
59         /// <summary>
60         /// <para>
61         /// Gets the next element after pop using the specified element.
62         /// </para>
63         /// <para></para>
64         /// </summary>
65         /// <param name="element">
66         /// <para>The element.</para>
67         /// <para></para>
68         /// </param>
69         /// <returns>
70         /// <para>The link</para>
71         /// <para></para>
72         /// </returns>
73         [MethodImpl(MethodImplOptions.AggressiveInlining)]
74         protected override TLinkAddress GetNextElementAfterPop(TLinkAddress element) =>
75             ↪ _links.GetSource(element);
76
77         /// <summary>
78         /// <para>
79         /// Gets the next element after push using the specified element.
80         /// </para>
81         /// <para></para>
82         /// </summary>
83         /// <param name="element">

```

```

81     /// <para>The element.</para>
82     /// <para></para>
83     /// </param>
84     /// <returns>
85     /// <para>The link</para>
86     /// <para></para>
87     /// </returns>
88     [MethodImpl(MethodImplOptions.AggressiveInlining)]
89     protected override TLinkAddress GetNextElementAfterPush(TLinkAddress element) =>
90         ↪ _links.GetTarget(element);
91
92     /// <summary>
93     /// <para>
94     /// Walks the contents using the specified element.
95     /// </para>
96     /// <para></para>
97     /// </summary>
98     /// <param name="element">
99     /// <para>The element.</para>
100    /// <para></para>
101    /// </param>
102    /// <returns>
103    /// <para>An enumerable of t link</para>
104    /// <para></para>
105    /// </returns>
106    [MethodImpl(MethodImplOptions.AggressiveInlining)]
107    protected override IEnumerable<TLinkAddress> WalkContents(TLinkAddress element)
108    {
109        var links = _links;
110        var parts = links.GetLink(element);
111        var start = links.Constants.SourcePart;
112        for (var i = parts.Count - 1; i >= start; i--)
113        {
114            var part = parts[i];
115            if (IsElement(part))
116            {
117                yield return part;
118            }
119        }
120    }
121 }

```

## 1.59 ./csharp/Platform.Data.Doublets.Sequences/Walkers/LeveledSequenceWalker.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  // #define USEARRAYPOOL
8  #if USEARRAYPOOL
9  using Platform.Collections;
10 #endif
11
12 namespace Platform.Data.Doublets.Sequences.Walkers
13 {
14     /// <summary>
15     /// <para>
16     /// Represents the leveled sequence walker.
17     /// </para>
18     /// <para></para>
19     /// </summary>
20     /// <seealso cref="LinksOperatorBase{TLinkAddress}">
21     /// <seealso cref="ISequenceWalker{TLinkAddress}">
22     public class LeveledSequenceWalker<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
23         ↪ ISequenceWalker<TLinkAddress>
24     {
25         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
26             ↪ EqualityComparer<TLinkAddress>.Default;
27         private readonly Func<TLinkAddress, bool> _isElement;
28
29         /// <summary>
30         /// <para>
31         /// Initializes a new <see cref="LeveledSequenceWalker"/> instance.
32         /// </para>
33         /// <para></para>
34         /// </summary>
35         /// <param name="links">

```

```

34     /// <para>A links.</para>
35     /// <para></para>
36     /// </param>
37     /// <param name="isElement">
38     /// <para>A is element.</para>
39     /// <para></para>
40     /// </param>
41     [MethodImpl(MethodImplOptions.AggressiveInlining)]
42     public LeveledSequenceWalker(ILinks<TLinkAddress> links, Func<TLinkAddress, bool>
43         ↪ isElement) : base(links) => _isElement = isElement;
44
45     /// <summary>
46     /// <para>
47     /// Initializes a new <see cref="LeveledSequenceWalker"/> instance.
48     /// </para>
49     /// <para></para>
50     /// </summary>
51     /// <param name="links">
52     /// <para>A links.</para>
53     /// <para></para>
54     /// </param>
55     [MethodImpl(MethodImplOptions.AggressiveInlining)]
56     public LeveledSequenceWalker(ILinks<TLinkAddress> links) : base(links) => _isElement =
57         ↪ _links.IsPartialPoint;
58
59     /// <summary>
60     /// <para>
61     /// Walks the sequence.
62     /// </para>
63     /// <para></para>
64     /// </summary>
65     /// <param name="sequence">
66     /// <para>The sequence.</para>
67     /// <para></para>
68     /// </param>
69     /// <returns>
70     /// <para>An enumerable of t link</para>
71     /// <para></para>
72     /// </returns>
73     [MethodImpl(MethodImplOptions.AggressiveInlining)]
74     public IEnumerable<TLinkAddress> Walk(TLinkAddress sequence) => ToArray(sequence);
75
76     /// <summary>
77     /// <para>
78     /// Returns the array using the specified sequence.
79     /// </para>
80     /// <para></para>
81     /// </summary>
82     /// <param name="sequence">
83     /// <para>The sequence.</para>
84     /// <para></para>
85     /// </param>
86     /// <returns>
87     /// <para>The link array</para>
88     /// <para></para>
89     /// </returns>
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     public TLinkAddress[] ToArray(TLinkAddress sequence)
92     {
93         var length = 1;
94         var array = new TLinkAddress[length];
95         array[0] = sequence;
96         if (_isElement(sequence))
97         {
98             return array;
99         }
100         bool hasElements;
101         do
102         {
103             length *= 2;
104             #if USEARRAYPOOL
105             var nextArray = ArrayPool.Allocate<ulong>(length);
106             #else
107             var nextArray = new TLinkAddress[length];
108             #endif
109             hasElements = false;
110             for (var i = 0; i < array.Length; i++)
111             {

```

```

110         var candidate = array[i];
111         if (_equalityComparer.Equals(array[i], default))
112         {
113             continue;
114         }
115         var doubletOffset = i * 2;
116         if (!_isElement(candidate))
117         {
118             nextArray[doubletOffset] = candidate;
119         }
120         else
121         {
122             var links = _links;
123             var link = links.GetLink(candidate);
124             var linkSource = links.GetSource(link);
125             var linkTarget = links.GetTarget(link);
126             nextArray[doubletOffset] = linkSource;
127             nextArray[doubletOffset + 1] = linkTarget;
128             if (!hasElements)
129             {
130                 hasElements = !(_isElement(linkSource) && _isElement(linkTarget));
131             }
132         }
133     }
134     #if USEARRAYPOOL
135     if (array.Length > 1)
136     {
137         ArrayPool.Free(array);
138     }
139     #endif
140     array = nextArray;
141 }
142 while (hasElements);
143 var filledElementsCount = CountFilledElements(array);
144 if (filledElementsCount == array.Length)
145 {
146     return array;
147 }
148 else
149 {
150     return CopyFilledElements(array, filledElementsCount);
151 }
152 }
153 [MethodImpl(MethodImplOptions.AggressiveInlining)]
154 private static TLinkAddress[] CopyFilledElements(TLinkAddress[] array, int
↪ filledElementsCount)
155 {
156     var finalArray = new TLinkAddress[filledElementsCount];
157     for (int i = 0, j = 0; i < array.Length; i++)
158     {
159         if (!_equalityComparer.Equals(array[i], default))
160         {
161             finalArray[j] = array[i];
162             j++;
163         }
164     }
165     #if USEARRAYPOOL
166     ArrayPool.Free(array);
167     #endif
168     return finalArray;
169 }
170 [MethodImpl(MethodImplOptions.AggressiveInlining)]
171 private static int CountFilledElements(TLinkAddress[] array)
172 {
173     var count = 0;
174     for (var i = 0; i < array.Length; i++)
175     {
176         if (!_equalityComparer.Equals(array[i], default))
177         {
178             count++;
179         }
180     }
181     return count;
182 }
183 }
184 }

```

## 1.60 ./csharp/Platform.Data.Doublets.Sequences/Walkers/RightSequenceWalker.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Collections.Stacks;
5
6  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8  namespace Platform.Data.Doublets.Sequences.Walkers
9  {
10     /// <summary>
11     /// <para>
12     /// Represents the right sequence walker.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="SequenceWalkerBase{TLinkAddress}"/>
17     public class RightSequenceWalker<TLinkAddress> : SequenceWalkerBase<TLinkAddress>
18     {
19         /// <summary>
20         /// <para>
21         /// Initializes a new <see cref="RightSequenceWalker"/> instance.
22         /// </para>
23         /// <para></para>
24         /// </summary>
25         /// <param name="links">
26         /// <para>A links.</para>
27         /// <para></para>
28         /// </param>
29         /// <param name="stack">
30         /// <para>A stack.</para>
31         /// <para></para>
32         /// </param>
33         /// <param name="isElement">
34         /// <para>A is element.</para>
35         /// <para></para>
36         /// </param>
37         [MethodImpl(MethodImplOptions.AggressiveInlining)]
38         public RightSequenceWalker(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack,
39             ↪ Func<TLinkAddress, bool> isElement) : base(links, stack, isElement) { }
40
41         /// <summary>
42         /// <para>
43         /// Initializes a new <see cref="RightSequenceWalker"/> instance.
44         /// </para>
45         /// <para></para>
46         /// </summary>
47         /// <param name="links">
48         /// <para>A links.</para>
49         /// <para></para>
50         /// </param>
51         /// <param name="stack">
52         /// <para>A stack.</para>
53         /// <para></para>
54         /// </param>
55         [MethodImpl(MethodImplOptions.AggressiveInlining)]
56         public RightSequenceWalker(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack) :
57             ↪ base(links, stack, links.IsPartialPoint) { }
58
59         /// <summary>
60         /// <para>
61         /// Gets the next element after pop using the specified element.
62         /// </para>
63         /// <para></para>
64         /// </summary>
65         /// <param name="element">
66         /// <para>The element.</para>
67         /// <para></para>
68         /// </param>
69         /// <returns>
70         /// <para>The link</para>
71         /// <para></para>
72         /// </returns>
73         [MethodImpl(MethodImplOptions.AggressiveInlining)]
74         protected override TLinkAddress GetNextElementAfterPop(TLinkAddress element) =>
75             ↪ _links.GetTarget(element);
76
77         /// <summary>

```

```

75     /// <para>
76     /// Gets the next element after push using the specified element.
77     /// </para>
78     /// <para></para>
79     /// </summary>
80     /// <param name="element">
81     /// <para>The element.</para>
82     /// <para></para>
83     /// </param>
84     /// <returns>
85     /// <para>The link</para>
86     /// <para></para>
87     /// </returns>
88     [MethodImpl(MethodImplOptions.AggressiveInlining)]
89     protected override TLinkAddress GetNextElementAfterPush(TLinkAddress element) =>
90         ↪ _links.GetSource(element);
91
92     /// <summary>
93     /// <para>
94     /// Walks the contents using the specified element.
95     /// </para>
96     /// <para></para>
97     /// </summary>
98     /// <param name="element">
99     /// <para>The element.</para>
100    /// <para></para>
101    /// </param>
102    /// <returns>
103    /// <para>An enumerable of t link</para>
104    /// <para></para>
105    /// </returns>
106    [MethodImpl(MethodImplOptions.AggressiveInlining)]
107    protected override IEnumerable<TLinkAddress> WalkContents(TLinkAddress element)
108    {
109        var parts = _links.GetLink(element);
110        for (var i = _links.Constants.SourcePart; i < parts.Count; i++)
111        {
112            var part = parts[i];
113            if (IsElement(part))
114            {
115                yield return part;
116            }
117        }
118    }
119 }

```

## 1.61 ./csharp/Platform.Data.Doublets.Sequences/Walkers/SequenceWalkerBase.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Runtime.CompilerServices;
4  using Platform.Collections.Stacks;
5
6  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8  namespace Platform.Data.Doublets.Sequences.Walkers
9  {
10     /// <summary>
11     /// <para>
12     /// Represents the sequence walker base.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
17     /// <seealso cref="ISequenceWalker{TLinkAddress}"/>
18     public abstract class SequenceWalkerBase<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
19         ↪ ISequenceWalker<TLinkAddress>
20     {
21         private readonly IStack<TLinkAddress> _stack;
22         private readonly Func<TLinkAddress, bool> _isElement;
23
24         /// <summary>
25         /// <para>
26         /// Initializes a new <see cref="SequenceWalkerBase"/> instance.
27         /// </para>
28         /// <para></para>
29         /// </summary>
30         /// <param name="links">
31         /// <para>A links.</para>

```

```

31     /// <para></para>
32     /// </param>
33     /// <param name="stack">
34     /// <para>A stack.</para>
35     /// <para></para>
36     /// </param>
37     /// <param name="isElement">
38     /// <para>A is element.</para>
39     /// <para></para>
40     /// </param>
41     [MethodImpl(MethodImplOptions.AggressiveInlining)]
42     protected SequenceWalkerBase(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack,
43     ↪ Func<TLinkAddress, bool> isElement) : base(links)
44     {
45         _stack = stack;
46         _isElement = isElement;
47     }
48     /// <summary>
49     /// <para>
50     /// Initializes a new <see cref="SequenceWalkerBase"/> instance.
51     /// </para>
52     /// <para></para>
53     /// </summary>
54     /// <param name="links">
55     /// <para>A links.</para>
56     /// <para></para>
57     /// </param>
58     /// <param name="stack">
59     /// <para>A stack.</para>
60     /// <para></para>
61     /// </param>
62     [MethodImpl(MethodImplOptions.AggressiveInlining)]
63     protected SequenceWalkerBase(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack) :
64     ↪ this(links, stack, links.IsPartialPoint) { }
65     /// <summary>
66     /// <para>
67     /// Walks the sequence.
68     /// </para>
69     /// <para></para>
70     /// </summary>
71     /// <param name="sequence">
72     /// <para>The sequence.</para>
73     /// <para></para>
74     /// </param>
75     /// <returns>
76     /// <para>An enumerable of t link</para>
77     /// <para></para>
78     /// </returns>
79     [MethodImpl(MethodImplOptions.AggressiveInlining)]
80     public IEnumerable<TLinkAddress> Walk(TLinkAddress sequence)
81     {
82         _stack.Clear();
83         var element = sequence;
84         if (IsElement(element))
85         {
86             yield return element;
87         }
88         else
89         {
90             while (true)
91             {
92                 if (IsElement(element))
93                 {
94                     if (_stack.IsEmpty)
95                     {
96                         break;
97                     }
98                     element = _stack.Pop();
99                     foreach (var output in WalkContents(element))
100                     {
101                         yield return output;
102                     }
103                     element = GetNextElementAfterPop(element);
104                 }
105                 else
106                 {

```



```

107         _stack.Push(element);
108         element = GetNextElementAfterPush(element);
109     }
110 }
111 }
112 }
113
114 /// <summary>
115 /// <para>
116 /// Determines whether this instance is element.
117 /// </para>
118 /// <para></para>
119 /// </summary>
120 /// <param name="elementLink">
121 /// <para>The element link.</para>
122 /// <para></para>
123 /// </param>
124 /// <returns>
125 /// <para>The bool</para>
126 /// <para></para>
127 /// </returns>
128 [MethodImpl(MethodImplOptions.AggressiveInlining)]
129 protected virtual bool IsElement(TLinkAddress elementLink) => _isElement(elementLink);
130
131 /// <summary>
132 /// <para>
133 /// Gets the next element after pop using the specified element.
134 /// </para>
135 /// <para></para>
136 /// </summary>
137 /// <param name="element">
138 /// <para>The element.</para>
139 /// <para></para>
140 /// </param>
141 /// <returns>
142 /// <para>The link</para>
143 /// <para></para>
144 /// </returns>
145 [MethodImpl(MethodImplOptions.AggressiveInlining)]
146 protected abstract TLinkAddress GetNextElementAfterPop(TLinkAddress element);
147
148 /// <summary>
149 /// <para>
150 /// Gets the next element after push using the specified element.
151 /// </para>
152 /// <para></para>
153 /// </summary>
154 /// <param name="element">
155 /// <para>The element.</para>
156 /// <para></para>
157 /// </param>
158 /// <returns>
159 /// <para>The link</para>
160 /// <para></para>
161 /// </returns>
162 [MethodImpl(MethodImplOptions.AggressiveInlining)]
163 protected abstract TLinkAddress GetNextElementAfterPush(TLinkAddress element);
164
165 /// <summary>
166 /// <para>
167 /// Walks the contents using the specified element.
168 /// </para>
169 /// <para></para>
170 /// </summary>
171 /// <param name="element">
172 /// <para>The element.</para>
173 /// <para></para>
174 /// </param>
175 /// <returns>
176 /// <para>An enumerable of t link</para>
177 /// <para></para>
178 /// </returns>
179 [MethodImpl(MethodImplOptions.AggressiveInlining)]
180 protected abstract IEnumerable<TLinkAddress> WalkContents(TLinkAddress element);
181 }
182 }

```

## 1.62 ./csharp/Platform.Data.Doublets.Sequences.Tests/BigIntegerConvertersTests.cs

```

1  using System.Collections.Generic;
2  using System.Numerics;
3  using Platform.Data.Doublets.Memory;
4  using Platform.Data.Doublets.Memory.United.Generic;
5  using Platform.Data.Doublets.Numbers.Raw;
6  using Platform.Data.Doublets.Sequences.Converters;
7  using Platform.Data.Numbers.Raw;
8  using Platform.Memory;
9  using Xunit;
10 using TLinkAddress = System.UInt64;
11
12 namespace Platform.Data.Doublets.Sequences.Tests
13 {
14     public class BigIntegerConvertersTests
15     {
16         public ILinks<TLinkAddress> CreateLinks() => CreateLinks<TLinkAddress>(new
            ↳ IO.TemporaryFile());
17
18         public ILinks<TLinkAddress> CreateLinks<TLinkAddress>(string dataDbFilename)
19         {
20             var linksConstants = new
                ↳ LinksConstants<TLinkAddress>(enableExternalReferencesSupport: true);
21             return new UnitedMemoryLinks<TLinkAddress>(new
                ↳ FileMappedResizableDirectMemory(dataDbFilename),
                ↳ UnitedMemoryLinks<TLinkAddress>.DefaultLinksSizeStep, linksConstants,
                ↳ IndexTreeType.Default);
22         }
23
24         [Fact]
25         public void DecimalMaxValueTest()
26         {
27             var links = CreateLinks();
28             BigInteger bigInteger = new(decimal.MaxValue);
29             TLinkAddress negativeNumberMarker = links.Create();
30             AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
31             RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
32             BalancedVariantConverter<TLinkAddress> listToSequenceConverter = new(links);
33             BigIntegerToRawNumberSequenceConverter<TLinkAddress>
                ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
                ↳ listToSequenceConverter, negativeNumberMarker);
34             RawNumberSequenceToBigIntegerConverter<TLinkAddress>
                ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
                ↳ negativeNumberMarker);
35             var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
36             var bigIntFromSequence =
                ↳ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
37             Assert.Equal(bigInteger, bigIntFromSequence);
38         }
39
40         [Fact]
41         public void DecimalMinValueTest()
42         {
43             var links = CreateLinks();
44             BigInteger bigInteger = new(decimal.MinValue);
45             TLinkAddress negativeNumberMarker = links.Create();
46             AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
47             RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
48             BalancedVariantConverter<TLinkAddress> listToSequenceConverter = new(links);
49             BigIntegerToRawNumberSequenceConverter<TLinkAddress>
                ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
                ↳ listToSequenceConverter, negativeNumberMarker);
50             RawNumberSequenceToBigIntegerConverter<TLinkAddress>
                ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
                ↳ negativeNumberMarker);
51             var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
52             var bigIntFromSequence =
                ↳ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
53             Assert.Equal(bigInteger, bigIntFromSequence);
54         }
55
56         [Fact]
57         public void ZeroValueTest()
58         {
59             var links = CreateLinks();
60             BigInteger bigInteger = new(0);
61             TLinkAddress negativeNumberMarker = links.Create();
62             AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();

```

```

63     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
64     BalancedVariantConverter<TLinkAddress> listToSequenceConverter = new(links);
65     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
        ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
        ↳ listToSequenceConverter, negativeNumberMarker);
66     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
        ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
        ↳ negativeNumberMarker);
67     var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
68     var bigIntFromSequence =
        ↳ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
69     Assert.Equal(bigInteger, bigIntFromSequence);
70 }
71
72 [Fact]
73 public void OneValueTest()
74 {
75     var links = CreateLinks();
76     BigInteger bigInteger = new(1);
77     TLinkAddress negativeNumberMarker = links.Create();
78     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
79     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
80     BalancedVariantConverter<TLinkAddress> listToSequenceConverter = new(links);
81     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
        ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
        ↳ listToSequenceConverter, negativeNumberMarker);
82     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
        ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
        ↳ negativeNumberMarker);
83     var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
84     var bigIntFromSequence =
        ↳ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
85     Assert.Equal(bigInteger, bigIntFromSequence);
86 }
87 }
88 }

```

### 1.63 ./csharp/Platform.Data.Doublets.Sequences.Tests/DefaultSequenceAppenderTests.cs

```

1  using System.Collections.Generic;
2  using Platform.Collections.Stacks;
3  using Platform.Data.Doublets.Memory;
4  using Platform.Data.Doublets.Memory.United.Generic;
5  using Platform.Data.Doublets.Sequences;
6  using Platform.Data.Doublets.Sequences.HeightProviders;
7  using Platform.Data.Numbers.Raw;
8  using Platform.Interfaces;
9  using Platform.Memory;
10 using Platform.Numbers;
11 using Xunit;
12 using Xunit.Abstractions;
13 using TLinkAddress = System.UInt64;
14
15 namespace Platform.Data.Doublets.Sequences.Tests
16 {
17     public class DefaultSequenceAppenderTests
18     {
19         private readonly ITestOutputHelper _output;
20
21         public DefaultSequenceAppenderTests(ITestOutputHelper output)
22         {
23             _output = output;
24         }
25         public static ILinks<TLinkAddress> CreateLinks() => CreateLinks<TLinkAddress>(new
        ↳ IO.TemporaryFile());
26
27         public static ILinks<TLinkAddress> CreateLinks<TLinkAddress>(string dataDBFilename)
28         {
29             var linksConstants = new
        ↳ LinksConstants<TLinkAddress>(enableExternalReferencesSupport: true);
30             return new UnitedMemoryLinks<TLinkAddress>(new
        ↳ FileMappedResizableDirectMemory(dataDBFilename),
        ↳ UnitedMemoryLinks<TLinkAddress>.DefaultLinksSizeStep, linksConstants,
        ↳ IndexTreeType.Default);
31         }
32
33         public class ValueCriterionMatcher<TLinkAddress> : ICriterionMatcher<TLinkAddress>
34         {
35             public readonly ILinks<TLinkAddress> Links;
36             public readonly TLinkAddress Marker;

```

```

37     public ValueCriterionMatcher(ILinks<TLinkAddress> links, TLinkAddress marker)
38     {
39         Links = links;
40         Marker = marker;
41     }
42
43     public bool IsMatched(TLinkAddress link) =>
44     ↪ EqualityComparer<TLinkAddress>.Default.Equals(Links.GetSource(link), Marker);
45
46     [Fact]
47     public void AppendArrayBug()
48     {
49         ILinks<TLinkAddress> links = CreateLinks();
50         TLinkAddress zero = default;
51         var markerIndex = Arithmetic.Increment(zero);
52         var meaningRoot = links.GetOrCreate(markerIndex, markerIndex);
53         var sequence = links.Create();
54         sequence = links.Update(sequence, meaningRoot, sequence);
55         var appendant = links.Create();
56         appendant = links.Update(appendant, meaningRoot, appendant);
57         ValueCriterionMatcher<TLinkAddress> valueCriterionMatcher = new(links, meaningRoot);
58         DefaultSequenceRightHeightProvider<ulong> defaultSequenceRightHeightProvider =
59         ↪ new(links, valueCriterionMatcher);
60         DefaultSequenceAppender<TLinkAddress> defaultSequenceAppender = new(links, new
61         ↪ DefaultStack<ulong>(), defaultSequenceRightHeightProvider);
62         var newArray = defaultSequenceAppender.Append(sequence, appendant);
63         var output = links.FormatStructure(newArray, link => link.IsFullPoint(), true);
64         Assert.Equal("(4:(2:1 2) (3:1 3))", output);
65     }
66 }

```

#### 1.64 ./csharp/Platform.Data.Doublets.Sequences.Tests/ILinksExtensionsTests.cs

```

1  // using Xunit;
2  //
3  // namespace Platform.Data.Doublets.Sequences.Tests
4  // {
5  //     public class ILinksExtensionsTests
6  //     {
7  //         [Fact]
8  //         public void FormatTest()
9  //         {
10         //             using (var scope = new TempLinksTestScope())
11         //             {
12         //                 var links = scope.Links;
13         //                 var link = links.Create();
14         //                 var linkString = links.Format(link);
15         //                 Assert.Equal("(1: 1 1)", linkString);
16         //             }
17         //         }
18         //     }
19     // }

```

#### 1.65 ./csharp/Platform.Data.Doublets.Sequences.Tests/OptimalVariantSequenceTests.cs

```

1  // using System;
2  // using System.Linq;
3  // using Xunit;
4  // using Platform.Collections.Stacks;
5  // using Platform.Collections.Arrays;
6  // using Platform.Memory;
7  // using Platform.Data.Numbers.Raw;
8  // using Platform.Data.Doublets.Sequences;
9  // using Platform.Data.Doublets.Sequences.Frequencies.Cache;
10 // using Platform.Data.Doublets.Sequences.Frequencies.Counters;
11 // using Platform.Data.Doublets.Sequences.Converters;
12 // using Platform.Data.Doublets.PropertyOperators;
13 // using Platform.Data.Doublets.Incrementers;
14 // using Platform.Data.Doublets.Sequences.Walkers;
15 // using Platform.Data.Doublets.Sequences.Indexes;
16 // using Platform.Data.Doublets.Unicode;
17 // using Platform.Data.Doublets.Numbers.Unary;
18 // using Platform.Data.Doublets.Decorators;
19 // using Platform.Data.Doublets.Memory.United.Specific;
20 // using Platform.Data.Doublets.Memory;
21 //
22 // namespace Platform.Data.Doublets.Sequences.Tests

```

```

23 // {
24 //     public static class OptimalVariantSequenceTests
25 //     {
26 //         private static readonly string _sequenceExample = "зеленела зелёная зелень";
27 //         private static readonly string _loremIpsumExample = @"Lorem ipsum dolor sit amet,
↳ consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna
↳ aliqua.
28 // Facilisi nullam vehicula ipsum a arcu cursus vitae congue mauris.
29 // Et malesuada fames ac turpis egestas sed.
30 // Eget velit aliquet sagittis id consectetur purus.
31 // Dignissim cras tincidunt lobortis feugiat vivamus.
32 // Vitae aliquet nec ullamcorper sit.
33 // Lectus quam id leo in vitae.
34 // Tortor dignissim convallis aenean et tortor at risus viverra adipiscing.
35 // Sed risus ultricies tristique nulla aliquet enim tortor at auctor.
36 // Integer eget aliquet nibh praesent tristique.
37 // Vitae congue eu consequat ac felis donec et odio.
38 // Tristique et egestas quis ipsum suspendisse.
39 // Suspendisse potenti nullam ac tortor vitae purus faucibus ornare.
40 // Nulla facilisi etiam dignissim diam quis enim lobortis scelerisque.
41 // Imperdiet proin fermentum leo vel orci.
42 // In ante metus dictum at tempor commodo.
43 // Nisi lacus sed viverra tellus in.
44 // Quam vulputate dignissim suspendisse in.
45 // Elit scelerisque mauris pellentesque pulvinar pellentesque habitant morbi tristique senectus.
46 // Gravida cum sociis natoque penatibus et magnis dis parturient.
47 // Risus quis varius quam quisque id diam.
48 // Congue nisi vitae suscipit tellus mauris a diam maecenas.
49 // Eget nunc scelerisque viverra mauris in aliquam sem fringilla.
50 // Pharetra vel turpis nunc eget lorem dolor sed viverra.
51 // Mattis pellentesque id nibh tortor id aliquet.
52 // Purus non enim praesent elementum facilisis leo vel.
53 // Etiam sit amet nisl purus in mollis nunc sed.
54 // Tortor at auctor urna nunc id cursus metus aliquam.
55 // Volutpat odio facilisis mauris sit amet.
56 // Turpis egestas pretium aenean pharetra magna ac placerat.
57 // Fermentum dui faucibus in ornare quam viverra orci sagittis eu.
58 // Porttitor leo a diam sollicitudin tempor id eu.
59 // Volutpat sed cras ornare arcu dui.
60 // Ut aliquam purus sit amet luctus venenatis lectus magna.
61 // Aliquet risus feugiat in ante metus dictum at.
62 // Mattis nunc sed blandit libero.
63 // Elit pellentesque habitant morbi tristique senectus et netus.
64 // Nibh sit amet commodo nulla facilisi nullam vehicula ipsum a.
65 // Enim sit amet venenatis urna cursus eget nunc scelerisque viverra.
66 // Amet venenatis urna cursus eget nunc scelerisque viverra mauris in.
67 // Diam donec adipiscing tristique risus nec feugiat.
68 // Pulvinar mattis nunc sed blandit libero volutpat.
69 // Cras fermentum odio eu feugiat pretium nibh ipsum.
70 // In nulla posuere sollicitudin aliquam ultrices sagittis orci a.
71 // Mauris pellentesque pulvinar pellentesque habitant morbi tristique senectus et.
72 // A iaculis at erat pellentesque.
73 // Morbi blandit cursus risus at ultrices mi tempus imperdiet nulla.
74 // Eget lorem dolor sed viverra ipsum nunc.
75 // Leo a diam sollicitudin tempor id eu.
76 // Interdum consectetur libero id faucibus nisl tincidunt eget nullam non.";
77 //
78 //     [Fact]
79 //     public static void LinksBasedFrequencyStoredOptimalVariantSequenceTest()
80 //     {
81 //         using (var scope = new TempLinksTestScope(useSequences: false))
82 //         {
83 //             var links = scope.Links;
84 //             var constants = links.Constants;
85 //
86 //             links.UseUnicode();
87 //
88 //             var sequence = UnicodeMap.FromStringToLinkArray(_sequenceExample);
89 //
90 //             var meaningRoot = links.CreatePoint();
91 //             var unaryOne = links.CreateAndUpdate(meaningRoot, constants.Itself);
92 //             var frequencyMarker = links.CreateAndUpdate(meaningRoot, constants.Itself);
93 //             var frequencyPropertyMarker = links.CreateAndUpdate(meaningRoot,
↳ constants.Itself);
94 //
95 //             var unaryNumberToAddressConverter = new
↳ UnaryNumberToAddressAddOperationConverter<ulong>(links, unaryOne);

```

```

96 //          var unaryNumberIncrementer = new UnaryNumberIncrementer<ulong>(links,
    ↳ unaryOne);
97 //          var frequencyIncrementer = new FrequencyIncrementer<ulong>(links,
    ↳ frequencyMarker, unaryOne, unaryNumberIncrementer);
98 //          var frequencyPropertyOperator = new PropertyOperator<ulong>(links,
    ↳ frequencyPropertyMarker, frequencyMarker);
99 //          var index = new FrequencyIncrementingSequenceIndex<ulong>(links,
    ↳ frequencyPropertyOperator, frequencyIncrementer);
100 //          var linkToItsFrequencyNumberConverter = new
    ↳ LinkToItsFrequencyNumberConverter<ulong>(links, frequencyPropertyOperator,
    ↳ unaryNumberToAddressConverter);
101 //          var sequenceToItsLocalElementLevelsConverter = new
    ↳ SequenceToItsLocalElementLevelsConverter<ulong>(links, linkToItsFrequencyNumberConverter);
102 //          var optimalVariantConverter = new OptimalVariantConverter<ulong>(links,
    ↳ sequenceToItsLocalElementLevelsConverter);
103 //
104 //          var sequences = new Sequences(links, new SequencesOptions<ulong>() { Walker =
    ↳ new LeveledSequenceWalker<ulong>(links) });
105 //
106 //          ExecuteTest(sequences, sequence, sequenceToItsLocalElementLevelsConverter,
    ↳ index, optimalVariantConverter);
107 //      }
108 //  }
109 //
110 //  [Fact]
111 //  public static void DictionaryBasedFrequencyStoredOptimalVariantSequenceTest()
112 //  {
113 //      using (var scope = new TempLinksTestScope(useSequences: false))
114 //      {
115 //          var links = scope.Links;
116 //
117 //          links.UseUnicode();
118 //
119 //          var sequence = UnicodeMap.FromStringToLinkArray(_sequenceExample);
120 //
121 //          var totalSequenceSymbolFrequencyCounter = new
    ↳ TotalSequenceSymbolFrequencyCounter<ulong>(links);
122 //
123 //          var linkFrequenciesCache = new LinkFrequenciesCache<ulong>(links,
    ↳ totalSequenceSymbolFrequencyCounter);
124 //
125 //          var index = new
    ↳ CachedFrequencyIncrementingSequenceIndex<ulong>(linkFrequenciesCache);
126 //          var linkToItsFrequencyNumberConverter = new
    ↳ FrequenciesCacheBasedLinkToItsFrequencyNumberConverter<ulong>(linkFrequenciesCache);
127 //
128 //          var sequenceToItsLocalElementLevelsConverter = new
    ↳ SequenceToItsLocalElementLevelsConverter<ulong>(links, linkToItsFrequencyNumberConverter);
129 //          var optimalVariantConverter = new OptimalVariantConverter<ulong>(links,
    ↳ sequenceToItsLocalElementLevelsConverter);
130 //
131 //          var sequences = new Sequences(links, new SequencesOptions<ulong>() { Walker =
    ↳ new LeveledSequenceWalker<ulong>(links) });
132 //
133 //          ExecuteTest(sequences, sequence, sequenceToItsLocalElementLevelsConverter,
    ↳ index, optimalVariantConverter);
134 //      }
135 //  }
136 //  private static void ExecuteTest(Sequences sequences, ulong[] sequence,
    ↳ SequenceToItsLocalElementLevelsConverter<ulong> sequenceToItsLocalElementLevelsConverter,
    ↳ ISequenceIndex<ulong> index, OptimalVariantConverter<ulong> optimalVariantConverter)
137 //  {
138 //      index.Add(sequence);
139 //
140 //      var optimalVariant = optimalVariantConverter.Convert(sequence);
141 //
142 //      var readSequence1 = sequences.ToList(optimalVariant);
143 //
144 //      Assert.True(sequence.SequenceEqual(readSequence1));
145 //  }
146 //
147 //  [Fact]
148 //  public static void SavedSequencesOptimizationTest()
149 //  {
150 //      LinksConstants<ulong> constants = new LinksConstants<ulong>((1, long.MaxValue),
    ↳ (long.MaxValue + 1UL, ulong.MaxValue));

```

```

151 //
152 //         using (var memory = new HeapResizableDirectMemory())
153 //         using (var disposableLinks = new UInt64UnitedMemoryLinks(memory,
↳ UInt64UnitedMemoryLinks.DefaultLinksSizeStep, constants, IndexTreeType.Default))
154 //         {
155 //             var links = new UInt64Links(disposableLinks);
156 //
157 //             var root = links.CreatePoint();
158 //
159 //             //var numberToAddressConverter = new RawNumberToAddressConverter<ulong>();
160 //             var addressToNumberConverter = new AddressToRawNumberConverter<ulong>();
161 //
162 //             var unicodeSymbolMarker = links.GetOrCreate(root,
↳ addressToNumberConverter.Convert(1));
163 //             var unicodeSequenceMarker = links.GetOrCreate(root,
↳ addressToNumberConverter.Convert(2));
164 //
165 //             var totalSequenceSymbolFrequencyCounter = new
↳ TotalSequenceSymbolFrequencyCounter<ulong>(links);
166 //             var linkFrequenciesCache = new LinkFrequenciesCache<ulong>(links,
↳ totalSequenceSymbolFrequencyCounter);
167 //             var index = new
↳ CachedFrequencyIncrementingSequenceIndex<ulong>(linkFrequenciesCache);
168 //             var linkToItsFrequencyNumberConverter = new
↳ FrequenciesCacheBasedLinkToItsFrequencyNumberConverter<ulong>(linkFrequenciesCache);
169 //             var sequenceToItsLocalElementLevelsConverter = new
↳ SequenceToItsLocalElementLevelsConverter<ulong>(links, linkToItsFrequencyNumberConverter);
170 //             var optimalVariantConverter = new OptimalVariantConverter<ulong>(links,
↳ sequenceToItsLocalElementLevelsConverter);
171 //
172 //             var walker = new RightSequenceWalker<ulong>(links, new DefaultStack<ulong>(),
↳ (link) => constants.IsExternalReference(link) || links.IsPartialPoint(link));
173 //
174 //             var unicodeSequencesOptions = new SequencesOptions<ulong>()
175 //             {
176 //                 UseSequenceMarker = true,
177 //                 SequenceMarkerLink = unicodeSequenceMarker,
178 //                 UseIndex = true,
179 //                 Index = index,
180 //                 LinksToSequenceConverter = optimalVariantConverter,
181 //                 Walker = walker,
182 //                 UseGarbageCollection = true
183 //             };
184 //
185 //             var unicodeSequences = new Sequences(new SynchronizedLinks<ulong>(links),
↳ unicodeSequencesOptions);
186 //
187 //             // Create some sequences
188 //             var strings = _loremIpsumExample.Split(new[] { '\n', '\r' },
↳ StringSplitOptions.RemoveEmptyEntries);
189 //             var arrays = strings.Select(x => x.Select(y =>
↳ addressToNumberConverter.Convert(y)).ToArray()).ToArray();
190 //             for (int i = 0; i < arrays.Length; i++)
191 //             {
192 //                 unicodeSequences.Create(arrays[i].ShiftRight());
193 //             }
194 //
195 //             var linksCountAfterCreation = links.Count();
196 //
197 //             // get list of sequences links
198 //             // for each sequence link
199 //             //     create new sequence version
200 //             //     if new sequence is not the same as sequence link
201 //             //         delete sequence link
202 //             //         collect garbadge
203 //             unicodeSequences.CompactAll();
204 //
205 //             var linksCountAfterCompactification = links.Count();
206 //
207 //             Assert.True(linksCountAfterCompactification < linksCountAfterCreation);
208 //         }
209 //     }
210 // }
211 // }

```

## 1.66 ./csharp/Platform.Data.Doublets.Sequences.Tests/RationalNumbersTests.cs

```

1  using Platform.Data.Doublets.Memory;
2  using Platform.Data.Doublets.Memory.United.Generic;
3  using Platform.Data.Doublets.Numbers.Rational;
4  using Platform.Data.Doublets.Numbers.Raw;
5  using Platform.Data.Doublets.Sequences.Converters;
6  using Platform.Data.Numbers.Raw;
7  using Platform.Memory;
8  using Xunit;
9  using TLinkAddress = System.UInt64;
10
11 namespace Platform.Data.Doublets.Sequences.Tests
12 {
13     public class RationalNumbersTests
14     {
15         public ILinks<TLinkAddress> CreateLinks() => CreateLinks<TLinkAddress>(new
            ↳ IO.TemporaryFile());
16
17         public ILinks<TLinkAddress> CreateLinks<TLinkAddress>(string dataDbFilename)
18         {
19             var linksConstants = new
                ↳ LinksConstants<TLinkAddress>(enableExternalReferencesSupport: true);
20             return new UnitedMemoryLinks<TLinkAddress>(new
                ↳ FileMappedResizableDirectMemory(dataDbFilename),
                ↳ UnitedMemoryLinks<TLinkAddress>.DefaultLinksSizeStep, linksConstants,
                ↳ IndexTreeType.Default);
21         }
22
23         [Fact]
24         public void DecimalMinValueTest()
25         {
26             const decimal @decimal = decimal.MinValue;
27             var links = CreateLinks();
28             TLinkAddress negativeNumberMarker = links.Create();
29             AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
30             RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
31             BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
32             BigIntegerToRawNumberSequenceConverter<TLinkAddress>
                ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
                ↳ balancedVariantConverter, negativeNumberMarker);
33             RawNumberSequenceToBigIntegerConverter<TLinkAddress>
                ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
                ↳ negativeNumberMarker);
34             DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
                ↳ bigIntegerToRawNumberSequenceConverter);
35             RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
                ↳ rawNumberSequenceToBigIntegerConverter);
36             var rationalNumber = decimalToRationalConverter.Convert(@decimal);
37             var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
38             Assert.Equal(@decimal, decimalFromRational);
39         }
40
41         [Fact]
42         public void DecimalMaxValueTest()
43         {
44             const decimal @decimal = decimal.MaxValue;
45             var links = CreateLinks();
46             TLinkAddress negativeNumberMarker = links.Create();
47             AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
48             RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
49             BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
50             BigIntegerToRawNumberSequenceConverter<TLinkAddress>
                ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
                ↳ balancedVariantConverter, negativeNumberMarker);
51             RawNumberSequenceToBigIntegerConverter<TLinkAddress>
                ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
                ↳ negativeNumberMarker);
52             DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
                ↳ bigIntegerToRawNumberSequenceConverter);
53             RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
                ↳ rawNumberSequenceToBigIntegerConverter);
54             var rationalNumber = decimalToRationalConverter.Convert(@decimal);
55             var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
56             Assert.Equal(@decimal, decimalFromRational);
57         }
58
59         [Fact]
60         public void DecimalPositiveHalfTest()

```



```

61 {
62     const decimal @decimal = 0.5M;
63     var links = CreateLinks();
64     TLinkAddress negativeNumberMarker = links.Create();
65     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
66     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
67     BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
68     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
        ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
        ↳ balancedVariantConverter, negativeNumberMarker);
69     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
        ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
        ↳ negativeNumberMarker);
70     DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
        ↳ bigIntegerToRawNumberSequenceConverter);
71     RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
        ↳ rawNumberSequenceToBigIntegerConverter);
72     var rationalNumber = decimalToRationalConverter.Convert(@decimal);
73     var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
74     Assert.Equal(@decimal, decimalFromRational);
75 }
76
77 [Fact]
78 public void DecimalNegativeHalfTest()
79 {
80     const decimal @decimal = -0.5M;
81     var links = CreateLinks();
82     TLinkAddress negativeNumberMarker = links.Create();
83     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
84     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
85     BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
86     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
        ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
        ↳ balancedVariantConverter, negativeNumberMarker);
87     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
        ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
        ↳ negativeNumberMarker);
88     DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
        ↳ bigIntegerToRawNumberSequenceConverter);
89     RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
        ↳ rawNumberSequenceToBigIntegerConverter);
90     var rationalNumber = decimalToRationalConverter.Convert(@decimal);
91     var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
92     Assert.Equal(@decimal, decimalFromRational);
93 }
94
95 [Fact]
96 public void DecimalOneTest()
97 {
98     const decimal @decimal = 1;
99     var links = CreateLinks();
100    TLinkAddress negativeNumberMarker = links.Create();
101    AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
102    RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
103    BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
104    BigIntegerToRawNumberSequenceConverter<TLinkAddress>
        ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
        ↳ balancedVariantConverter, negativeNumberMarker);
105    RawNumberSequenceToBigIntegerConverter<TLinkAddress>
        ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
        ↳ negativeNumberMarker);
106    DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
        ↳ bigIntegerToRawNumberSequenceConverter);
107    RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
        ↳ rawNumberSequenceToBigIntegerConverter);
108    var rationalNumber = decimalToRationalConverter.Convert(@decimal);
109    var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
110    Assert.Equal(@decimal, decimalFromRational);
111 }
112
113 [Fact]
114 public void DecimalMinusOneTest()
115 {
116     const decimal @decimal = -1;
117     var links = CreateLinks();
118     TLinkAddress negativeNumberMarker = links.Create();
119     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();

```

```

120     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
121     BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
122     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
        ↳ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
        ↳ balancedVariantConverter, negativeNumberMarker);
123     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
        ↳ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
        ↳ negativeNumberMarker);
124     DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
        ↳ bigIntegerToRawNumberSequenceConverter);
125     RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
        ↳ rawNumberSequenceToBigIntegerConverter);
126     var rationalNumber = decimalToRationalConverter.Convert(@decimal);
127     var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
128     Assert.Equal(@decimal, decimalFromRational);
129 }
130 }
131 }

```

## 1.67 ./csharp/Platform.Data.Doublets.Sequences.Tests/ReadSequenceTests.cs

```

1  // using System;
2  // using System.Collections.Generic;
3  // using System.Diagnostics;
4  // using System.Linq;
5  // using Xunit;
6  // using Platform.Data.Sequences;
7  // using Platform.Data.Doublets.Sequences.Converters;
8  // using Platform.Data.Doublets.Sequences.Walkers;
9  // using Platform.Data.Doublets.Sequences;
10 //
11 // namespace Platform.Data.Doublets.Sequences.Tests
12 // {
13 //     public static class ReadSequenceTests
14 //     {
15 //         [Fact]
16 //         public static void ReadSequenceTest()
17 //         {
18 //             const long sequenceLength = 2000;
19 //
20 //             using (var scope = new TempLinksTestScope(useSequences: false))
21 //             {
22 //                 var links = scope.Links;
23 //                 var sequences = new SequencesOptions<ulong> { Walker =
        ↳ new LevelledSequenceWalker<ulong>(links) };
24 //
25 //                 var sequence = new ulong[sequenceLength];
26 //                 for (var i = 0; i < sequenceLength; i++)
27 //                 {
28 //                     sequence[i] = links.Create();
29 //                 }
30 //
31 //                 var balancedVariantConverter = new BalancedVariantConverter<ulong>(links);
32 //
33 //                 var sw1 = Stopwatch.StartNew();
34 //                 var balancedVariant = balancedVariantConverter.Convert(sequence); sw1.Stop();
35 //
36 //                 var sw2 = Stopwatch.StartNew();
37 //                 var readSequence1 = sequences.ToList(balancedVariant); sw2.Stop();
38 //
39 //                 var sw3 = Stopwatch.StartNew();
40 //                 var readSequence2 = new List<ulong>();
41 //                 SequenceWalker.WalkRight(balancedVariant,
42 //                                         links.GetSource,
43 //                                         links.GetTarget,
44 //                                         links.IsPartialPoint,
45 //                                         readSequence2.Add);
46 //                 sw3.Stop();
47 //
48 //                 Assert.True(sequence.SequenceEqual(readSequence1));
49 //
50 //                 Assert.True(sequence.SequenceEqual(readSequence2));
51 //
52 //                 // Assert.True(sw2.Elapsed < sw3.Elapsed);
53 //
54 //                 Console.WriteLine($"Stack-based walker: {sw3.Elapsed}, Level-based reader:
        ↳ {sw2.Elapsed}");
55 //

```

```

56 //         for (var i = 0; i < sequenceLength; i++)
57 //         {
58 //             links.Delete(sequence[i]);
59 //         }
60 //     }
61 // }
62 // }
63 // }

```

## 1.68 ./csharp/Platform.Data.Doublets.Sequences.Tests/SequencesTests.cs

```

1  // using System;
2  // using System.Collections.Generic;
3  // using System.Diagnostics;
4  // using System.Linq;
5  // using Xunit;
6  // using Platform.Collections;
7  // using Platform.Collections.Arrays;
8  // using Platform.Random;
9  // using Platform.IO;
10 // using Platform.Singletons;
11 // using Platform.Data.Doublets.Sequences;
12 // using Platform.Data.Doublets.Sequences.Frequencies.Cache;
13 // using Platform.Data.Doublets.Sequences.Frequencies.Counters;
14 // using Platform.Data.Doublets.Sequences.Converters;
15 // using Platform.Data.Doublets.Unicode;
16 //
17 // namespace Platform.Data.Doublets.Sequences.Tests
18 // {
19 //     public static class SequencesTests
20 //     {
21 //         private static readonly LinksConstants<ulong> _constants =
↵ Default<LinksConstants<ulong>>.Instance;
22 //
23 //         static SequencesTests()
24 //         {
25 //             // Trigger static constructor to not mess with performance measurements
26 //             _ = BitString.GetBitMaskFromIndex(1);
27 //         }
28 //
29 //         [Fact]
30 //         public static void CreateAllVariantsTest()
31 //         {
32 //             const long sequenceLength = 8;
33 //
34 //             using (var scope = new TempLinksTestScope(useSequences: true))
35 //             {
36 //                 var links = scope.Links;
37 //                 var sequences = scope.Sequences;
38 //
39 //                 var sequence = new ulong[sequenceLength];
40 //                 for (var i = 0; i < sequenceLength; i++)
41 //                 {
42 //                     sequence[i] = links.Create();
43 //                 }
44 //
45 //                 var sw1 = Stopwatch.StartNew();
46 //                 var results1 = sequences.CreateAllVariants1(sequence); sw1.Stop();
47 //
48 //                 var sw2 = Stopwatch.StartNew();
49 //                 var results2 = sequences.CreateAllVariants2(sequence); sw2.Stop();
50 //
51 //                 Assert.True(results1.Count > results2.Length);
52 //                 Assert.True(sw1.Elapsed > sw2.Elapsed);
53 //
54 //                 for (var i = 0; i < sequenceLength; i++)
55 //                 {
56 //                     links.Delete(sequence[i]);
57 //                 }
58 //
59 //                 Assert.True(links.Count() == 0);
60 //             }
61 //         }
62 //
63 //         //[Fact]
64 //         //public void CUDTest()
65 //         //{
66 //             var tempFilename = Path.GetTempFileName();
67 //

```

```

68 //          //      const long sequenceLength = 8;
69 //
70 //          //      const ulong itself = LinksConstants.Itself;
71 //
72 //          //      using (var memoryAdapter = new ResizableDirectMemoryLinks(tempFilename,
↵ DefaultLinksSizeStep))
73 //          //      using (var links = new Links(memoryAdapter))
74 //          //      {
75 //          //          var sequence = new ulong[sequenceLength];
76 //          //          for (var i = 0; i < sequenceLength; i++)
77 //          //              sequence[i] = links.Create(itself, itself);
78 //
79 //          //          SequencesOptions o = new SequencesOptions();
80 //
81 //          //      TODO: Из числа в bool значения o.UseSequenceMarker = ((value & 1) != 0)
82 //          //          o.
83 //
84 //          //          var sequences = new Sequences(links);
85 //
86 //          //          var sw1 = Stopwatch.StartNew();
87 //          //          var results1 = sequences.CreateAllVariants1(sequence); sw1.Stop();
88 //
89 //          //          var sw2 = Stopwatch.StartNew();
90 //          //          var results2 = sequences.CreateAllVariants2(sequence); sw2.Stop();
91 //
92 //          //          Assert.True(results1.Count > results2.Length);
93 //          //          Assert.True(sw1.Elapsed > sw2.Elapsed);
94 //
95 //          //          for (var i = 0; i < sequenceLength; i++)
96 //          //              links.Delete(sequence[i]);
97 //          //      }
98 //
99 //          //      File.Delete(tempFilename);
100 //          //}
101 //
102 //      [Fact]
103 //      public static void AllVariantsSearchTest()
104 //      {
105 //          const long sequenceLength = 8;
106 //
107 //          using (var scope = new TempLinksTestScope(useSequences: true))
108 //          {
109 //              var links = scope.Links;
110 //              var sequences = scope.Sequences;
111 //
112 //              var sequence = new ulong[sequenceLength];
113 //              for (var i = 0; i < sequenceLength; i++)
114 //              {
115 //                  sequence[i] = links.Create();
116 //              }
117 //
118 //              var createResults =
↵ sequences.CreateAllVariants2(sequence).Distinct().ToArray();
119 //
120 //              //for (int i = 0; i < createResults.Length; i++)
121 //              //    sequences.Create(createResults[i]);
122 //
123 //              var sw0 = Stopwatch.StartNew();
124 //              var searchResults0 = sequences.GetAllMatchingSequences0(sequence); sw0.Stop();
125 //
126 //              var sw1 = Stopwatch.StartNew();
127 //              var searchResults1 = sequences.GetAllMatchingSequences1(sequence); sw1.Stop();
128 //
129 //              var sw2 = Stopwatch.StartNew();
130 //              var searchResults2 = sequences.Each1(sequence); sw2.Stop();
131 //
132 //              var sw3 = Stopwatch.StartNew();
133 //              var searchResults3 = sequences.Each(sequence.ShiftRight()); sw3.Stop();
134 //
135 //              var intersection0 = createResults.Intersect(searchResults0).ToList();
136 //              Assert.True(intersection0.Count == searchResults0.Count);
137 //              Assert.True(intersection0.Count == createResults.Length);
138 //
139 //              var intersection1 = createResults.Intersect(searchResults1).ToList();
140 //              Assert.True(intersection1.Count == searchResults1.Count);
141 //              Assert.True(intersection1.Count == createResults.Length);
142 //

```

```

143 //         var intersection2 = createResults.Intersect(searchResults2).ToList();
144 //         Assert.True(intersection2.Count == searchResults2.Count);
145 //         Assert.True(intersection2.Count == createResults.Length);
146 //
147 //         var intersection3 = createResults.Intersect(searchResults3).ToList();
148 //         Assert.True(intersection3.Count == searchResults3.Count);
149 //         Assert.True(intersection3.Count == createResults.Length);
150 //
151 //         for (var i = 0; i < sequenceLength; i++)
152 //         {
153 //             links.Delete(sequence[i]);
154 //         }
155 //     }
156 // }
157 //
158 // [Fact]
159 // public static void BalancedVariantSearchTest()
160 // {
161 //     const long sequenceLength = 200;
162 //
163 //     using (var scope = new TempLinksTestScope(useSequences: true))
164 //     {
165 //         var links = scope.Links;
166 //         var sequences = scope.Sequences;
167 //
168 //         var sequence = new ulong[sequenceLength];
169 //         for (var i = 0; i < sequenceLength; i++)
170 //         {
171 //             sequence[i] = links.Create();
172 //         }
173 //
174 //         var balancedVariantConverter = new BalancedVariantConverter<ulong>(links);
175 //
176 //         var sw1 = Stopwatch.StartNew();
177 //         var balancedVariant = balancedVariantConverter.Convert(sequence); sw1.Stop();
178 //
179 //         var sw2 = Stopwatch.StartNew();
180 //         var searchResults2 = sequences.GetAllMatchingSequences0(sequence); sw2.Stop();
181 //
182 //         var sw3 = Stopwatch.StartNew();
183 //         var searchResults3 = sequences.GetAllMatchingSequences1(sequence); sw3.Stop();
184 //
185 //         // На количестве в 200 элементов это будет занимать вечность
186 //         //var sw4 = Stopwatch.StartNew();
187 //         //var searchResults4 = sequences.Each(sequence); sw4.Stop();
188 //
189 //         Assert.True(searchResults2.Count == 1 && balancedVariant ==
↵ searchResults2[0]);
190 //
191 //         Assert.True(searchResults3.Count == 1 && balancedVariant ==
↵ searchResults3.First());
192 //
193 //         //Assert.True(sw1.Elapsed < sw2.Elapsed);
194 //
195 //         for (var i = 0; i < sequenceLength; i++)
196 //         {
197 //             links.Delete(sequence[i]);
198 //         }
199 //     }
200 // }
201 //
202 // [Fact]
203 // public static void AllPartialVariantsSearchTest()
204 // {
205 //     const long sequenceLength = 8;
206 //
207 //     using (var scope = new TempLinksTestScope(useSequences: true))
208 //     {
209 //         var links = scope.Links;
210 //         var sequences = scope.Sequences;
211 //
212 //         var sequence = new ulong[sequenceLength];
213 //         for (var i = 0; i < sequenceLength; i++)
214 //         {
215 //             sequence[i] = links.Create();
216 //         }
217 //

```

```

218 //                var createResults = sequences.CreateAllVariants2(sequence);
219 //
220 //                //var createResultsStrings = createResults.Select(x => x + ": " +
↵ sequences.FormatSequence(x)).ToList();
221 //                //Global.Trash = createResultsStrings;
222 //
223 //                var partialSequence = new ulong[sequenceLength - 2];
224 //
225 //                Array.Copy(sequence, 1, partialSequence, 0, (int)sequenceLength - 2);
226 //
227 //                var sw1 = Stopwatch.StartNew();
228 //                var searchResults1 =
↵ sequences.GetAllPartiallyMatchingSequences0(partialSequence); sw1.Stop();
229 //
230 //                var sw2 = Stopwatch.StartNew();
231 //                var searchResults2 =
↵ sequences.GetAllPartiallyMatchingSequences1(partialSequence); sw2.Stop();
232 //
233 //                //var sw3 = Stopwatch.StartNew();
234 //                //var searchResults3 =
↵ sequences.GetAllPartiallyMatchingSequences2(partialSequence); sw3.Stop();
235 //
236 //                var sw4 = Stopwatch.StartNew();
237 //                var searchResults4 =
↵ sequences.GetAllPartiallyMatchingSequences3(partialSequence); sw4.Stop();
238 //
239 //                //Global.Trash = searchResults3;
240 //
241 //                //var searchResults1Strings = searchResults1.Select(x => x + ": " +
↵ sequences.FormatSequence(x)).ToList();
242 //                //Global.Trash = searchResults1Strings;
243 //
244 //                var intersection1 = createResults.Intersect(searchResults1).ToList();
245 //                Assert.True(intersection1.Count == createResults.Length);
246 //
247 //                var intersection2 = createResults.Intersect(searchResults2).ToList();
248 //                Assert.True(intersection2.Count == createResults.Length);
249 //
250 //                var intersection4 = createResults.Intersect(searchResults4).ToList();
251 //                Assert.True(intersection4.Count == createResults.Length);
252 //
253 //                for (var i = 0; i < sequenceLength; i++)
254 //                {
255 //                    links.Delete(sequence[i]);
256 //                }
257 //            }
258 //        }
259 //
260 //        [Fact]
261 //        public static void BalancedPartialVariantsSearchTest()
262 //        {
263 //            const long sequenceLength = 200;
264 //
265 //            using (var scope = new TempLinksTestScope(useSequences: true))
266 //            {
267 //                var links = scope.Links;
268 //                var sequences = scope.Sequences;
269 //
270 //                var sequence = new ulong[sequenceLength];
271 //                for (var i = 0; i < sequenceLength; i++)
272 //                {
273 //                    sequence[i] = links.Create();
274 //                }
275 //
276 //                var balancedVariantConverter = new BalancedVariantConverter<ulong>(links);
277 //
278 //                var balancedVariant = balancedVariantConverter.Convert(sequence);
279 //
280 //                var partialSequence = new ulong[sequenceLength - 2];
281 //
282 //                Array.Copy(sequence, 1, partialSequence, 0, (int)sequenceLength - 2);
283 //
284 //                var sw1 = Stopwatch.StartNew();
285 //                var searchResults1 =
↵ sequences.GetAllPartiallyMatchingSequences0(partialSequence); sw1.Stop();
286 //
287 //                var sw2 = Stopwatch.StartNew();

```

```

288 //                var searchResults2 =
↪ sequences.GetAllPartiallyMatchingSequences1(partialSequence); sw2.Stop();
289 //
290 //                Assert.True(searchResults1.Count == 1 && balancedVariant ==
↪ searchResults1[0]);
291 //
292 //                Assert.True(searchResults2.Count == 1 && balancedVariant ==
↪ searchResults2.First());
293 //
294 //                for (var i = 0; i < sequenceLength; i++)
295 //                {
296 //                    links.Delete(sequence[i]);
297 //                }
298 //            }
299 //        }
300 //
301 //        [Fact(Skip = "Correct implementation is pending")]
302 //        public static void PatternMatchTest()
303 //        {
304 //            var zeroOrMany = Sequences.ZeroOrMany;
305 //
306 //            using (var scope = new TempLinksTestScope(useSequences: true))
307 //            {
308 //                var links = scope.Links;
309 //                var sequences = scope.Sequences;
310 //
311 //                var e1 = links.Create();
312 //                var e2 = links.Create();
313 //
314 //                var sequence = new[]
315 //                {
316 //                    e1, e2, e1, e2 // mama / papa
317 //                };
318 //
319 //                var balancedVariantConverter = new BalancedVariantConverter<ulong>(links);
320 //
321 //                var balancedVariant = balancedVariantConverter.Convert(sequence);
322 //
323 //                // 1: [1]
324 //                // 2: [2]
325 //                // 3: [1,2]
326 //                // 4: [1,2,1,2]
327 //
328 //                var doublet = links.GetSource(balancedVariant);
329 //
330 //                var matchedSequences1 = sequences.MatchPattern(e2, e1, zeroOrMany);
331 //
332 //                Assert.True(matchedSequences1.Count == 0);
333 //
334 //                var matchedSequences2 = sequences.MatchPattern(zeroOrMany, e2, e1);
335 //
336 //                Assert.True(matchedSequences2.Count == 0);
337 //
338 //                var matchedSequences3 = sequences.MatchPattern(e1, zeroOrMany, e1);
339 //
340 //                Assert.True(matchedSequences3.Count == 0);
341 //
342 //                var matchedSequences4 = sequences.MatchPattern(e1, zeroOrMany, e2);
343 //
344 //                Assert.Contains(doublet, matchedSequences4);
345 //                Assert.Contains(balancedVariant, matchedSequences4);
346 //
347 //                for (var i = 0; i < sequence.Length; i++)
348 //                {
349 //                    links.Delete(sequence[i]);
350 //                }
351 //            }
352 //        }
353 //
354 //        [Fact]
355 //        public static void IndexTest()
356 //        {
357 //            using (var scope = new TempLinksTestScope(new SequencesOptions<ulong> { UseIndex
↪ = true }, useSequences: true))
358 //            {
359 //                var links = scope.Links;
360 //                var sequences = scope.Sequences;

```

```

361 //          var index = sequences.Options.Index;
362 //
363 //          var e1 = links.Create();
364 //          var e2 = links.Create();
365 //
366 //          var sequence = new[]
367 //          {
368 //              e1, e2, e1, e2 // mama / papa
369 //          };
370 //
371 //          Assert.False(index.MightContain(sequence));
372 //
373 //          index.Add(sequence);
374 //
375 //          Assert.True(index.MightContain(sequence));
376 //      }
377 //  }
378 //  private static readonly string _exampleText =
379 //      @"([english
↳ version](https://github.com/Konard/LinksPlatform/wiki/About-the-beginning))
380 //
381 // Обозначение пустоты, какое оно? Темнота ли это? Там где отсутствие света, отсутствие фотонов
↳ (носителей света)? Или это то, что полностью отражает свет? Пустой белый лист бумаги? Там
↳ где есть место для нового начала? Разве пустота это не характеристика пространства?
↳ Пространство это то, что можно чем-то наполнить?
382 //
383 // ![чёрное пространство, белое
↳ пространство](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/1.png
↳ "чёрное пространство, белое пространство")](https://raw.githubusercontent.com/Konard/Links
↳ Platform/master/doc/Intro/1.png)
384 //
385 // Что может быть минимальным рисунком, образом, графикой? Может быть это точка? Это ли
↳ простейшая форма? Но есть ли у точки размер? Цвет? Масса? Координаты? Время существования?
386 //
387 // ![чёрное пространство, чёрная
↳ точка](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/2.png
↳ "чёрное пространство, чёрная
↳ точка")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/2.png)
388 //
389 // А что если повторить? Сделать копию? Создать дубликат? Из одного сделать два? Может это быть
↳ так? Инверсия? Отражение? Сумма?
390 //
391 // ![белая точка, чёрная
↳ точка](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/3.png "белая
↳ точка, чёрная
↳ точка")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/3.png)
392 //
393 // А что если мы вообразим движение? Нужно ли время? Каким самым коротким будет путь? Что будет
↳ если этот путь зафиксировать? Запомнить след? Как две точки становятся линией? Чертой?
↳ Гранью? Разделителем? Единицей?
394 //
395 // ![две белые точки, чёрная вертикальная
↳ линия](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/4.png "две
↳ белые точки, чёрная вертикальная
↳ линия")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/4.png)
396 //
397 // Можно ли замкнуть движение? Может ли это быть кругом? Можно ли замкнуть время? Или остаётся
↳ только спираль? Но что если замкнуть предел? Создать ограничение, разделение? Получится
↳ замкнутая область? Полностью отделённая от всего остального? Но что это всё остальное? Что
↳ можно делить? В каком направлении? Ничего или всё? Пустота или полнота? Начало или конец?
↳ Или может быть это единица и ноль? Дуальность? Противоположность? А что будет с кругом если
↳ у него нет размера? Будет ли круг точкой? Точка состоящая из точек?
398 //
399 // ![белая вертикальная линия, чёрный
↳ круг](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/5.png "белая
↳ вертикальная линия, чёрный
↳ круг")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/5.png)
400 //
401 // Как ещё можно использовать грань, черту, линию? А что если она может что-то соединять, может
↳ тогда её нужно повернуть? Почему то, что перпендикулярно вертикальному горизонтально?
↳ Горизонт? Инвертирует ли это смысл? Что такое смысл? Из чего состоит смысл? Существует ли
↳ элементарная единица смысла?
402 //
403 // ![белый круг, чёрная горизонтальная
↳ линия](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/6.png "белый
↳ круг, чёрная горизонтальная
↳ линия")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/6.png)

```



```

404 //
405 // Соединять, допустим, а какой смысл в этом есть ещё? Что если помимо смысла ""соединить,
    ↳ связать"", есть ещё и смысл направления ""от начала к концу""? От предка к потомку? От
    ↳ родителя к ребёнку? От общего к частному?
406 //
407 // ![белая горизонтальная линия, чёрная горизонтальная
    ↳ стрелка](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/7.png
    ↳ ""белая горизонтальная линия, чёрная горизонтальная
    ↳ стрелка"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/7.png)
408 //
409 // Шаг назад. Возьмём опять отделённую область, которая лишь та же замкнутая линия, что ещё она
    ↳ может представлять собой? Объект? Но в чём его суть? Разве не в том, что у него есть
    ↳ граница, разделяющая внутреннее и внешнее? Допустим связь, стрелка, линия соединяет два
    ↳ объекта, как бы это выглядело?
410 //
411 // ![белая связь, чёрная направленная
    ↳ связь](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/8.png ""белая
    ↳ связь, чёрная направленная
    ↳ связь"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/8.png)
412 //
413 // Допустим у нас есть смысл ""связать"" и смысл ""направления"", много ли это нам даёт? Много
    ↳ ли вариантов интерпретации? А что если уточнить, каким именно образом выполнена связь? Что
    ↳ если можно задать ей чёткий, конкретный смысл? Что это будет? Тип? Глагол? Связка? Действие?
    ↳ Трансформация? Переход из состояния в состояние? Или всё это и есть объект, суть которого в
    ↳ его конечном состоянии, если конечно конец определён направлением?
414 //
415 // ![белая обычная и направленная связи, чёрная типизированная
    ↳ связь](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/9.png ""белая
    ↳ обычная и направленная связи, чёрная типизированная
    ↳ связь"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/9.png)
416 //
417 // А что если всё это время, мы смотрели на суть как бы снаружи? Можно ли взглянуть на это
    ↳ изнутри? Что будет внутри объектов? Объекты ли это? Или это связи? Может ли эта структура
    ↳ описать сама себя? Но что тогда получится, разве это не рекурсия? Может это фрактал?
418 //
419 // ![белая обычная и направленная связи с рекурсивной внутренней структурой, чёрная
    ↳ типизированная связь с рекурсивной внутренней
    ↳ структурой](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/10.png
    ↳ ""белая обычная и направленная связи с рекурсивной внутренней структурой, чёрная
    ↳ типизированная связь с рекурсивной внутренней структурой"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/10.png)
420 //
421 // На один уровень внутрь (вниз)? Или на один уровень во вне (вверх)? Или это можно назвать
    ↳ шагом рекурсии или фрактала?
422 //
423 // ![белая обычная и направленная связи с двойной рекурсивной внутренней структурой, чёрная
    ↳ типизированная связь с двойной рекурсивной внутренней
    ↳ структурой](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/11.png
    ↳ ""белая обычная и направленная связи с двойной рекурсивной внутренней структурой, чёрная
    ↳ типизированная связь с двойной рекурсивной внутренней структурой"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/11.png)
424 //
425 // Последовательность? Массив? Список? Множество? Объект? Таблица? Элементы? Цвета? Символы?
    ↳ Буквы? Слово? Цифры? Число? Алфавит? Дерево? Сеть? Граф? Гиперграф?
426 //
427 // ![белая обычная и направленная связи со структурой из 8 цветных элементов
    ↳ последовательности, чёрная типизированная связь со структурой из 8 цветных элементов последо-
    ↳ вательности](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/12.png
    ↳ ""белая обычная и направленная связи со структурой из 8 цветных элементов
    ↳ последовательности, чёрная типизированная связь со структурой из 8 цветных элементов
    ↳ последовательности"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/12.png)
428 //
429 // ...
430 //
431 // ![анимация](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/intro-an
    ↳ imation-500.gif
    ↳ ""анимация"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/intro-
    ↳ -animation-500.gif");
432 //     private static readonly string _exampleLoremIpsumText =
433 //         @"Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor
    ↳ incididunt ut labore et dolore magna aliqua.
434 // Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea
    ↳ commodo consequat.";
435 //
436 //     [Fact]
437 //     public static void CompressionTest()

```

```

438 //      {
439 //          using (var scope = new TempLinksTestScope(useSequences: true))
440 //          {
441 //              var links = scope.Links;
442 //              var sequences = scope.Sequences;
443 //
444 //              var e1 = links.Create();
445 //              var e2 = links.Create();
446 //
447 //              var sequence = new[]
448 //              {
449 //                  e1, e2, e1, e2 // mama / papa / template [(m/p), a] { [1] [2] [1] [2] }
450 //              };
451 //
452 //              var balancedVariantConverter = new
↳ BalancedVariantConverter<ulong>(links.Unsync);
453 //              var totalSequenceSymbolFrequencyCounter = new
↳ TotalSequenceSymbolFrequencyCounter<ulong>(links.Unsync);
454 //              var doubletFrequenciesCache = new LinkFrequenciesCache<ulong>(links.Unsync,
↳ totalSequenceSymbolFrequencyCounter);
455 //              var compressingConverter = new CompressingConverter<ulong>(links.Unsync,
↳ balancedVariantConverter, doubletFrequenciesCache);
456 //
457 //              var compressedVariant = compressingConverter.Convert(sequence);
458 //
459 //              // 1: [1]          (1->1) point
460 //              // 2: [2]          (2->2) point
461 //              // 3: [1,2]        (1->2) doublet
462 //              // 4: [1,2,1,2]    (3->3) doublet
463 //
464 //              Assert.True(links.GetSource(links.GetSource(compressedVariant)) ==
↳ sequence[0]);
465 //              Assert.True(links.GetTarget(links.GetSource(compressedVariant)) ==
↳ sequence[1]);
466 //              Assert.True(links.GetSource(links.GetTarget(compressedVariant)) ==
↳ sequence[2]);
467 //              Assert.True(links.GetTarget(links.GetTarget(compressedVariant)) ==
↳ sequence[3]);
468 //
469 //              var source = _constants.SourcePart;
470 //              var target = _constants.TargetPart;
471 //
472 //              Assert.True(links.GetByKey(compressedVariant, source, source) ==
↳ sequence[0]);
473 //              Assert.True(links.GetByKey(compressedVariant, source, target) ==
↳ sequence[1]);
474 //              Assert.True(links.GetByKey(compressedVariant, target, source) ==
↳ sequence[2]);
475 //              Assert.True(links.GetByKey(compressedVariant, target, target) ==
↳ sequence[3]);
476 //
477 //              // 4 - length of sequence
478 //              Assert.True(links.GetSquareMatrixSequenceElementByIndex(compressedVariant, 4,
↳ 0) == sequence[0]);
479 //              Assert.True(links.GetSquareMatrixSequenceElementByIndex(compressedVariant, 4,
↳ 1) == sequence[1]);
480 //              Assert.True(links.GetSquareMatrixSequenceElementByIndex(compressedVariant, 4,
↳ 2) == sequence[2]);
481 //              Assert.True(links.GetSquareMatrixSequenceElementByIndex(compressedVariant, 4,
↳ 3) == sequence[3]);
482 //          }
483 //      }
484 //
485 //      [Fact]
486 //      public static void CompressionEfficiencyTest()
487 //      {
488 //          var strings = _exampleLoremIpsumText.Split(new[] { '\n', '\r' },
↳ StringSplitOptions.RemoveEmptyEntries);
489 //          var arrays = strings.Select(UnicodeMap.FromStringToLinkArray).ToArray();
490 //          var totalCharacters = arrays.Select(x => x.Length).Sum();
491 //
492 //          using (var scope1 = new TempLinksTestScope(useSequences: true))
493 //          using (var scope2 = new TempLinksTestScope(useSequences: true))
494 //          using (var scope3 = new TempLinksTestScope(useSequences: true))
495 //          {
496 //              scope1.Links.Unsync.UseUnicode();

```

```

497 // scope2.Links.Unsync.UseUnicode();
498 // scope3.Links.Unsync.UseUnicode();
499 //
500 // var balancedVariantConverter1 = new
↳ BalancedVariantConverter<ulong>(scope1.Links.Unsync);
501 // var totalSequenceSymbolFrequencyCounter = new
↳ TotalSequenceSymbolFrequencyCounter<ulong>(scope1.Links.Unsync);
502 // var linkFrequenciesCache1 = new
↳ LinkFrequenciesCache<ulong>(scope1.Links.Unsync, totalSequenceSymbolFrequencyCounter);
503 // var compressor1 = new CompressingConverter<ulong>(scope1.Links.Unsync,
↳ balancedVariantConverter1, linkFrequenciesCache1, doInitialFrequenciesIncrement: false);
504 //
505 // //var compressor2 = scope2.Sequences;
506 // var compressor3 = scope3.Sequences;
507 //
508 // var constants = Default<LinksConstants<ulong>>.Instance;
509 //
510 // var sequences = compressor3;
511 // //var meaningRoot = links.CreatePoint();
512 // //var unaryOne = links.CreateAndUpdate(meaningRoot, constants.Itself);
513 // //var frequencyMarker = links.CreateAndUpdate(meaningRoot, constants.Itself);
514 // //var frequencyPropertyMarker = links.CreateAndUpdate(meaningRoot,
↳ constants.Itself);
515 //
516 // //var unaryNumberToAddressConverter = new
↳ UnaryNumberToAddressAddOperationConverter<ulong>(links, unaryOne);
517 // //var unaryNumberIncrementer = new UnaryNumberIncrementer<ulong>(links,
↳ unaryOne);
518 // //var frequencyIncrementer = new FrequencyIncrementer<ulong>(links,
↳ frequencyMarker, unaryOne, unaryNumberIncrementer);
519 // //var frequencyPropertyOperator = new FrequencyPropertyOperator<ulong>(links,
↳ frequencyPropertyMarker, frequencyMarker);
520 // //var linkFrequencyIncrementer = new LinkFrequencyIncrementer<ulong>(links,
↳ frequencyPropertyOperator, frequencyIncrementer);
521 // //var linkToItsFrequencyNumberConverter = new
↳ LinkToItsFrequencyNumberConveter<ulong>(links, frequencyPropertyOperator,
↳ unaryNumberToAddressConverter);
522 //
523 // var linkFrequenciesCache3 = new
↳ LinkFrequenciesCache<ulong>(scope3.Links.Unsync, totalSequenceSymbolFrequencyCounter);
524 //
525 // var linkToItsFrequencyNumberConverter = new
↳ FrequenciesCacheBasedLinkToItsFrequencyNumberConverter<ulong>(linkFrequenciesCache3);
526 //
527 // var sequenceToItsLocalElementLevelsConverter = new
↳ SequenceToItsLocalElementLevelsConverter<ulong>(scope3.Links.Unsync,
↳ linkToItsFrequencyNumberConverter);
528 // var optimalVariantConverter = new
↳ OptimalVariantConverter<ulong>(scope3.Links.Unsync,
↳ sequenceToItsLocalElementLevelsConverter);
529 //
530 // var compressed1 = new ulong[arrays.Length];
531 // var compressed2 = new ulong[arrays.Length];
532 // var compressed3 = new ulong[arrays.Length];
533 //
534 // var START = 0;
535 // var END = arrays.Length;
536 //
537 // //for (int i = START; i < END; i++)
538 // // linkFrequenciesCache1.IncrementFrequencies(arrays[i]);
539 //
540 // var initialCount1 = scope2.Links.Unsync.Count();
541 //
542 // var sw1 = Stopwatch.StartNew();
543 //
544 // for (int i = START; i < END; i++)
545 // {
546 // linkFrequenciesCache1.IncrementFrequencies(arrays[i]);
547 // compressed1[i] = compressor1.Convert(arrays[i]);
548 // }
549 //
550 // var elapsed1 = sw1.Elapsed;
551 //
552 // var balancedVariantConverter2 = new
↳ BalancedVariantConverter<ulong>(scope2.Links.Unsync);
553 //

```

```

554 //                var initialCount2 = scope2.Links.Unsync.Count();
555 //
556 //                var sw2 = Stopwatch.StartNew();
557 //
558 //                for (int i = START; i < END; i++)
559 //                {
560 //                    compressed2[i] = balancedVariantConverter2.Convert(arrays[i]);
561 //                }
562 //
563 //                var elapsed2 = sw2.Elapsed;
564 //
565 //                for (int i = START; i < END; i++)
566 //                {
567 //                    linkFrequenciesCache3.IncrementFrequencies(arrays[i]);
568 //                }
569 //
570 //                var initialCount3 = scope3.Links.Unsync.Count();
571 //
572 //                var sw3 = Stopwatch.StartNew();
573 //
574 //                for (int i = START; i < END; i++)
575 //                {
576 //                    //linkFrequenciesCache3.IncrementFrequencies(arrays[i]);
577 //                    compressed3[i] = optimalVariantConverter.Convert(arrays[i]);
578 //                }
579 //
580 //                var elapsed3 = sw3.Elapsed;
581 //
582 //                Console.WriteLine($"Compressor: {elapsed1}, Balanced variant: {elapsed2},
↵ Optimal variant: {elapsed3}");
583 //
584 //                // Assert.True(elapsed1 > elapsed2);
585 //
586 //                // Checks
587 //                for (int i = START; i < END; i++)
588 //                {
589 //                    var sequence1 = compressed1[i];
590 //                    var sequence2 = compressed2[i];
591 //                    var sequence3 = compressed3[i];
592 //
593 //                    var decompress1 = UnicodeMap.FromSequenceLinkToString(sequence1,
↵ scope1.Links.Unsync);
594 //
595 //                    var decompress2 = UnicodeMap.FromSequenceLinkToString(sequence2,
↵ scope2.Links.Unsync);
596 //
597 //                    var decompress3 = UnicodeMap.FromSequenceLinkToString(sequence3,
↵ scope3.Links.Unsync);
598 //
599 //                    var structure1 = scope1.Links.Unsync.FormatStructure(sequence1, link =>
↵ link.IsPartialPoint());
600 //                    var structure2 = scope2.Links.Unsync.FormatStructure(sequence2, link =>
↵ link.IsPartialPoint());
601 //                    var structure3 = scope3.Links.Unsync.FormatStructure(sequence3, link =>
↵ link.IsPartialPoint());
602 //
603 //                    //if (sequence1 != Constants.Null && sequence2 != Constants.Null &&
↵ arrays[i].Length > 3)
604 //                    //    Assert.False(structure1 == structure2);
605 //                    //if (sequence3 != Constants.Null && sequence2 != Constants.Null &&
↵ arrays[i].Length > 3)
606 //                    //    Assert.False(structure3 == structure2);
607 //
608 //                    Assert.True(strings[i] == decompress1 && decompress1 == decompress2);
609 //                    Assert.True(strings[i] == decompress3 && decompress3 == decompress2);
610 //                }
611 //
612 //                Assert.True((int)(scope1.Links.Unsync.Count() - initialCount1) <
↵ totalCharacters);
613 //                Assert.True((int)(scope2.Links.Unsync.Count() - initialCount2) <
↵ totalCharacters);
614 //                Assert.True((int)(scope3.Links.Unsync.Count() - initialCount3) <
↵ totalCharacters);
615 //

```

```

616 // Console.WriteLine($"{(double)(scope1.Links.Unsync.Count() - initialCount1) /
↳ totalCharacters} | {(double)(scope2.Links.Unsync.Count() - initialCount2) / totalCharacters}
↳ | {(double)(scope3.Links.Unsync.Count() - initialCount3) / totalCharacters}");
617 //
618 // Assert.True(scope1.Links.Unsync.Count() - initialCount1 <
↳ scope2.Links.Unsync.Count() - initialCount2);
619 // Assert.True(scope3.Links.Unsync.Count() - initialCount3 <
↳ scope2.Links.Unsync.Count() - initialCount2);
620 //
621 // var duplicateProvider1 = new
↳ DuplicateSegmentsProvider<ulong>(scope1.Links.Unsync, scope1.Sequences);
622 // var duplicateProvider2 = new
↳ DuplicateSegmentsProvider<ulong>(scope2.Links.Unsync, scope2.Sequences);
623 // var duplicateProvider3 = new
↳ DuplicateSegmentsProvider<ulong>(scope3.Links.Unsync, scope3.Sequences);
624 //
625 // var duplicateCounter1 = new
↳ DuplicateSegmentsCounter<ulong>(duplicateProvider1);
626 // var duplicateCounter2 = new
↳ DuplicateSegmentsCounter<ulong>(duplicateProvider2);
627 // var duplicateCounter3 = new
↳ DuplicateSegmentsCounter<ulong>(duplicateProvider3);
628 //
629 // var duplicates1 = duplicateCounter1.Count();
630 //
631 // ConsoleHelpers.Debug("-----");
632 //
633 // var duplicates2 = duplicateCounter2.Count();
634 //
635 // ConsoleHelpers.Debug("-----");
636 //
637 // var duplicates3 = duplicateCounter3.Count();
638 //
639 // Console.WriteLine($"{duplicates1} | {duplicates2} | {duplicates3}");
640 //
641 // linkFrequenciesCache1.ValidateFrequencies();
642 // linkFrequenciesCache3.ValidateFrequencies();
643 // }
644 // }
645 //
646 // [Fact]
647 // public static void CompressionStabilityTest()
648 // {
649 //     // TODO: Fix bug (do a separate test)
650 //     //const ulong minNumbers = 0;
651 //     //const ulong maxNumbers = 1000;
652 //
653 //     const ulong minNumbers = 10000;
654 //     const ulong maxNumbers = 12500;
655 //
656 //     var strings = new List<string>();
657 //
658 //     for (ulong i = minNumbers; i < maxNumbers; i++)
659 //     {
660 //         strings.Add(i.ToString());
661 //     }
662 //
663 //     var arrays = strings.Select(UnicodeMap.FromStringToLinkArray).ToArray();
664 //     var totalCharacters = arrays.Select(x => x.Length).Sum();
665 //
666 //     using (var scope1 = new TempLinksTestScope(useSequences: true, sequencesOptions:
↳ new SequencesOptions<ulong> { UseCompression = true,
↳ EnforceSingleSequenceVersionOnWriteBasedOnExisting = true })))
667 //     using (var scope2 = new TempLinksTestScope(useSequences: true))
668 //     {
669 //         scope1.Links.UseUnicode();
670 //         scope2.Links.UseUnicode();
671 //
672 //         //var compressor1 = new Compressor(scope1.Links.Unsync, scope1.Sequences);
673 //         var compressor1 = scope1.Sequences;
674 //         var compressor2 = scope2.Sequences;
675 //
676 //         var compressed1 = new ulong[arrays.Length];
677 //         var compressed2 = new ulong[arrays.Length];
678 //
679 //         var sw1 = Stopwatch.StartNew();

```

```

680 //
681 //
682 //
683 //
684 //
↪ rule)
685 //
686 //
687 //
688 //
689 //
690 //
691 //
692 //
693 //
694 //
695 //
696 //
697 //
698 //
699 //
700 //
701 //
702 //
703 //
704 //
705 //
706 //
707 //
708 //
709 //
710 //
711 //
712 //
713 //
714 //
715 //
716 //
↪ BalancedVariantConverter<ulong>(scope2.Links);
717 //
718 //
719 //
720 //
721 //
722 //
723 //
724 //
725 //
726 //
727 //
728 //
729 //
730 //
731 //
732 //
733 //
↪ {elapsed2}");
734 //
735 //
736 //
737 //
738 //
739 //
740 //
741 //
742 //
743 //
744 //
745 //
↪ scope1.Links);
746 //
747 //
↪ scope2.Links);
748 //
749 //
↪ link.IsPartialPoint());

```

```

var START = 0;
var END = arrays.Length;

// Collisions proved (cannot be solved by max doublet comparison, no stable

// Stability issue starts at 10001 or 11000
//for (int i = START; i < END; i++)
//{
//    var first = compressor1.Compress(arrays[i]);
//    var second = compressor1.Compress(arrays[i]);

//    if (first == second)
//        compressed1[i] = first;
//    else
//    {
//        // TODO: Find a solution for this case
//    }
//}

for (int i = START; i < END; i++)
{
    var first = compressor1.Create(arrays[i].ShiftRight());
    var second = compressor1.Create(arrays[i].ShiftRight());

    if (first == second)
    {
        compressed1[i] = first;
    }
    else
    {
        // TODO: Find a solution for this case
    }
}

var elapsed1 = sw1.Elapsed;

var balancedVariantConverter = new
BalancedVariantConverter<ulong>(scope2.Links);

var sw2 = Stopwatch.StartNew();

for (int i = START; i < END; i++)
{
    var first = balancedVariantConverter.Convert(arrays[i]);
    var second = balancedVariantConverter.Convert(arrays[i]);

    if (first == second)
    {
        compressed2[i] = first;
    }
}

var elapsed2 = sw2.Elapsed;

Debug.WriteLine($"Compressor: {elapsed1}, Balanced sequence creator:
{elapsed2}");

Assert.True(elapsed1 > elapsed2);

// Checks
for (int i = START; i < END; i++)
{
    var sequence1 = compressed1[i];
    var sequence2 = compressed2[i];

    if (sequence1 != _constants.Null && sequence2 != _constants.Null)
    {
        var decompress1 = UnicodeMap.FromSequenceLinkToString(sequence1,
scope1.Links);

        var decompress2 = UnicodeMap.FromSequenceLinkToString(sequence2,
scope2.Links);

        //var structure1 = scope1.Links.FormatStructure(sequence1, link =>
link.IsPartialPoint());

```

```

750 //                                     //var structure2 = scope2.Links.FormatStructure(sequence2, link =>
↵ link.IsPartialPoint());
751 //
752 //                                     //if (sequence1 != Constants.Null && sequence2 != Constants.Null &&
↵ arrays[i].Length > 3)
753 //                                     //    Assert.False(structure1 == structure2);
754 //
755 //                                     Assert.True(strings[i] == decompress1 && decompress1 == decompress2);
756 //                                     }
757 //                                     }
758 //
759 //                                     Assert.True((int)(scope1.Links.Count() - UnicodeMap.MapSize) <
↵ totalCharacters);
760 //                                     Assert.True((int)(scope2.Links.Count() - UnicodeMap.MapSize) <
↵ totalCharacters);
761 //
762 //                                     Debug.WriteLine($"{(double)(scope1.Links.Count() - UnicodeMap.MapSize) /
↵ totalCharacters} | {(double)(scope2.Links.Count() - UnicodeMap.MapSize) / totalCharacters}");
763 //
764 //                                     Assert.True(scope1.Links.Count() <= scope2.Links.Count());
765 //
766 //                                     //compressor1.ValidateFrequencies();
767 //                                     }
768 //                                     }
769 //
770 // [Fact]
771 // public static void RandomNumbersCompressionQualityTest()
772 // {
773 //     const ulong N = 500;
774 //
775 //     //const ulong minNumbers = 10000;
776 //     //const ulong maxNumbers = 20000;
777 //
778 //     //var strings = new List<string>();
779 //
780 //     //for (ulong i = 0; i < N; i++)
781 //     //    strings.Add(RandomHelpers.DefaultFactory.NextUInt64(minNumbers,
↵ maxNumbers).ToString());
782 //
783 //     var strings = new List<string>();
784 //
785 //     for (ulong i = 0; i < N; i++)
786 //     {
787 //         strings.Add(RandomHelpers.Default.NextUInt64().ToString());
788 //     }
789 //
790 //     strings = strings.Distinct().ToList();
791 //
792 //     var arrays = strings.Select(UnicodeMap.FromStringToLinkArray).ToArray();
793 //     var totalCharacters = arrays.Select(x => x.Length).Sum();
794 //
795 //     using (var scope1 = new TempLinksTestScope(useSequences: true, sequencesOptions:
↵ new SequencesOptions<ulong> { UseCompression = true,
↵ EnforceSingleSequenceVersionOnWriteBasedOnExisting = true }))
796 //     using (var scope2 = new TempLinksTestScope(useSequences: true))
797 //     {
798 //         scope1.Links.UseUnicode();
799 //         scope2.Links.UseUnicode();
800 //
801 //         var compressor1 = scope1.Sequences;
802 //         var compressor2 = scope2.Sequences;
803 //
804 //         var compressed1 = new ulong[arrays.Length];
805 //         var compressed2 = new ulong[arrays.Length];
806 //
807 //         var sw1 = Stopwatch.StartNew();
808 //
809 //         var START = 0;
810 //         var END = arrays.Length;
811 //
812 //         for (int i = START; i < END; i++)
813 //         {
814 //             compressed1[i] = compressor1.Create(arrays[i].ShiftRight());
815 //         }
816 //
817 //         var elapsed1 = sw1.Elapsed;
818 //

```

```

819 //          var balancedVariantConverter = new
↵ BalancedVariantConverter<ulong>(scope2.Links);
820 //
821 //          var sw2 = Stopwatch.StartNew();
822 //
823 //          for (int i = START; i < END; i++)
824 //          {
825 //              compressed2[i] = balancedVariantConverter.Convert(arrays[i]);
826 //          }
827 //
828 //          var elapsed2 = sw2.Elapsed;
829 //
830 //          Debug.WriteLine($"Compressor: {elapsed1}, Balanced sequence creator:
↵ {elapsed2}");
831 //
832 //          Assert.True(elapsed1 > elapsed2);
833 //
834 //          // Checks
835 //          for (int i = START; i < END; i++)
836 //          {
837 //              var sequence1 = compressed1[i];
838 //              var sequence2 = compressed2[i];
839 //
840 //              if (sequence1 != _constants.Null && sequence2 != _constants.Null)
841 //              {
842 //                  var decompress1 = UnicodeMap.FromSequenceLinkToString(sequence1,
↵ scope1.Links);
843 //
844 //                  var decompress2 = UnicodeMap.FromSequenceLinkToString(sequence2,
↵ scope2.Links);
845 //
846 //                  Assert.True(strings[i] == decompress1 && decompress1 == decompress2);
847 //              }
848 //          }
849 //
850 //          Assert.True((int)(scope1.Links.Count() - UnicodeMap.MapSize) <
↵ totalCharacters);
851 //          Assert.True((int)(scope2.Links.Count() - UnicodeMap.MapSize) <
↵ totalCharacters);
852 //
853 //          Debug.WriteLine($"{{(double)(scope1.Links.Count() - UnicodeMap.MapSize) /
↵ totalCharacters}} | {{(double)(scope2.Links.Count() - UnicodeMap.MapSize) / totalCharacters}}");
854 //
855 //          // Can be worse than balanced variant
856 //          //Assert.True(scope1.Links.Count() <= scope2.Links.Count());
857 //
858 //          //compressor1.ValidateFrequencies();
859 //      }
860 //  }
861 //
862 //  [Fact]
863 //  public static void AllTreeBreakDownAtSequencesCreationBugTest()
864 //  {
865 //      // Made out of AllPossibleConnectionsTest test.
866 //
867 //      //const long sequenceLength = 5; //100% bug
868 //      const long sequenceLength = 4; //100% bug
869 //      //const long sequenceLength = 3; //100% _no_bug (ok)
870 //
871 //      using (var scope = new TempLinksTestScope(useSequences: true))
872 //      {
873 //          var links = scope.Links;
874 //          var sequences = scope.Sequences;
875 //
876 //          var sequence = new ulong[sequenceLength];
877 //          for (var i = 0; i < sequenceLength; i++)
878 //          {
879 //              sequence[i] = links.Create();
880 //          }
881 //
882 //          var createResults = sequences.CreateAllVariants2(sequence);
883 //
884 //          Global.Trash = createResults;
885 //
886 //          for (var i = 0; i < sequenceLength; i++)
887 //          {
888 //              links.Delete(sequence[i]);

```



```

889 //     }
890 // }
891 // }
892 //
893 // [Fact]
894 // public static void AllPossibleConnectionsTest()
895 // {
896 //     const long sequenceLength = 5;
897 //
898 //     using (var scope = new TempLinksTestScope(useSequences: true))
899 //     {
900 //         var links = scope.Links;
901 //         var sequences = scope.Sequences;
902 //
903 //         var sequence = new ulong[sequenceLength];
904 //         for (var i = 0; i < sequenceLength; i++)
905 //         {
906 //             sequence[i] = links.Create();
907 //         }
908 //
909 //         var createResults = sequences.CreateAllVariants2(sequence);
910 //         var reverseResults =
↵ sequences.CreateAllVariants2(sequence.Reverse().ToArray());
911 //
912 //         for (var i = 0; i < 1; i++)
913 //         {
914 //             var sw1 = Stopwatch.StartNew();
915 //             var searchResults1 = sequences.GetAllConnections(sequence); sw1.Stop();
916 //
917 //             var sw2 = Stopwatch.StartNew();
918 //             var searchResults2 = sequences.GetAllConnections1(sequence); sw2.Stop();
919 //
920 //             var sw3 = Stopwatch.StartNew();
921 //             var searchResults3 = sequences.GetAllConnections2(sequence); sw3.Stop();
922 //
923 //             var sw4 = Stopwatch.StartNew();
924 //             var searchResults4 = sequences.GetAllConnections3(sequence); sw4.Stop();
925 //
926 //             Global.Trash = searchResults3;
927 //             Global.Trash = searchResults4; //-V3008
928 //
929 //             var intersection1 = createResults.Intersect(searchResults1).ToList();
930 //             Assert.True(intersection1.Count == createResults.Length);
931 //
932 //             var intersection2 = reverseResults.Intersect(searchResults1).ToList();
933 //             Assert.True(intersection2.Count == reverseResults.Length);
934 //
935 //             var intersection0 = searchResults1.Intersect(searchResults2).ToList();
936 //             Assert.True(intersection0.Count == searchResults2.Count);
937 //
938 //             var intersection3 = searchResults2.Intersect(searchResults3).ToList();
939 //             Assert.True(intersection3.Count == searchResults3.Count);
940 //
941 //             var intersection4 = searchResults3.Intersect(searchResults4).ToList();
942 //             Assert.True(intersection4.Count == searchResults4.Count);
943 //         }
944 //
945 //         for (var i = 0; i < sequenceLength; i++)
946 //         {
947 //             links.Delete(sequence[i]);
948 //         }
949 //     }
950 // }
951 //
952 // [Fact(Skip = "Correct implementation is pending")]
953 // public static void CalculateAllUsagesTest()
954 // {
955 //     const long sequenceLength = 3;
956 //
957 //     using (var scope = new TempLinksTestScope(useSequences: true))
958 //     {
959 //         var links = scope.Links;
960 //         var sequences = scope.Sequences;
961 //
962 //         var sequence = new ulong[sequenceLength];
963 //         for (var i = 0; i < sequenceLength; i++)
964 //         {

```

```

965 //         sequence[i] = links.Create();
966 //     }
967 //
968 //         var createResults = sequences.CreateAllVariants2(sequence);
969 //
970 //         //var reverseResults =
↵ sequences.CreateAllVariants2(sequence.Reverse().ToArray());
971 //
972 //         for (var i = 0; i < 1; i++)
973 //         {
974 //             var linksTotalUsages1 = new ulong[links.Count() + 1];
975 //
976 //             sequences.CalculateAllUsages(linksTotalUsages1);
977 //
978 //             var linksTotalUsages2 = new ulong[links.Count() + 1];
979 //
980 //             sequences.CalculateAllUsages2(linksTotalUsages2);
981 //
982 //             var intersection1 =
↵ linksTotalUsages1.Intersect(linksTotalUsages2).ToList();
983 //             Assert.True(intersection1.Count == linksTotalUsages2.Length);
984 //         }
985 //
986 //         for (var i = 0; i < sequenceLength; i++)
987 //         {
988 //             links.Delete(sequence[i]);
989 //         }
990 //     }
991 // }
992 //
993 // }

```

#### 1.69 ./csharp/Platform.Data.Doublets.Sequences.Tests/TempLinksTestScope.cs

```

1 // using System.IO;
2 // using Platform.Disposables;
3 // using Platform.Data.Doublets.Sequences;
4 // using Platform.Data.Doublets.Decorators;
5 // using Platform.Data.Doublets.Memory.United.Specific;
6 // using Platform.Data.Doublets.Memory.Split.Specific;
7 // using Platform.Memory;
8 //
9 namespace Platform.Data.Doublets.Sequences.Tests
10 // {
11 //     public class TempLinksTestScope : DisposableBase
12 //     {
13 //         public ILinks<ulong> MemoryAdapter { get; }
14 //         public SynchronizedLinks<ulong> Links { get; }
15 //         public Sequences Sequences { get; }
16 //         public string TempFilename { get; }
17 //         public string TempTransactionLogFilename { get; }
18 //         private readonly bool _deleteFiles;
19 //
20 //         public TempLinksTestScope(bool deleteFiles = true, bool useSequences = false, bool
↵ useLog = false) : this(new SequencesOptions<ulong>(), deleteFiles, useSequences, useLog) { }
21 //
22 //         public TempLinksTestScope(SequencesOptions<ulong> sequencesOptions, bool deleteFiles
↵ = true, bool useSequences = false, bool useLog = false)
23 //         {
24 //             _deleteFiles = deleteFiles;
25 //             TempFilename = Path.GetTempFileName();
26 //             TempTransactionLogFilename = Path.GetTempFileName();
27 //             //var coreMemoryAdapter = new UInt64UnitedMemoryLinks(TempFilename);
28 //             var coreMemoryAdapter = new UInt64SplitMemoryLinks(new
↵ FileMappedResizableDirectMemory(TempFilename), new
↵ FileMappedResizableDirectMemory(Path.ChangeExtension(TempFilename, "indexes")),
↵ UInt64SplitMemoryLinks.DefaultLinksSizeStep, new LinksConstants<ulong>(),
↵ Memory.IndexTreeType.Default, useLinkedList: true);
29 //             MemoryAdapter = useLog ? (ILinks<ulong>)new
↵ UInt64LinksTransactionsLayer(coreMemoryAdapter, TempTransactionLogFilename) :
↵ coreMemoryAdapter;
30 //             Links = new SynchronizedLinks<ulong>(new UInt64Links(MemoryAdapter));
31 //             if (useSequences)
32 //             {
33 //                 Sequences = new Sequences(Links, sequencesOptions);
34 //             }
35 //         }
36 //     }

```

```

37 //         protected override void Dispose(bool manual, bool wasDisposed)
38 //         {
39 //             if (!wasDisposed)
40 //             {
41 //                 Links.Unsync.DisposeIfPossible();
42 //                 if (_deleteFiles)
43 //                 {
44 //                     DeleteFiles();
45 //                 }
46 //             }
47 //         }
48 //
49 //         public void DeleteFiles()
50 //         {
51 //             File.Delete(TempFilename);
52 //             File.Delete(TempTransactionLogFilename);
53 //         }
54 //     }
55 // }

```

## 1.70 ./csharp/Platform.Data.Doublets.Sequences.Tests/TestExtensions.cs

```

1 // using System.Collections.Generic;
2 // using Xunit;
3 // using Platform.Ranges;
4 // using Platform.Numbers;
5 // using Platform.Random;
6 // using Platform.Setters;
7 // using Platform.Converters;
8 //
9 // namespace Platform.Data.Doublets.Sequences.Tests
10 // {
11 //     public static class TestExtensions
12 //     {
13 //         public static void TestCRUDOperations<T>(this ILinks<T> links)
14 //         {
15 //             var constants = links.Constants;
16 //
17 //             var equalityComparer = EqualityComparer<T>.Default;
18 //
19 //             var zero = default(T);
20 //             var one = Arithmetic.Increment(zero);
21 //
22 //             // Create Link
23 //             Assert.True(equalityComparer.Equals(links.Count(), zero));
24 //
25 //             var setter = new Setter<T>(constants.Null);
26 //             links.Each(constants.Any, constants.Any, setter.SetAndReturnTrue);
27 //
28 //             Assert.True(equalityComparer.Equals(setter.Result, constants.Null));
29 //
30 //             var linkAddress = links.Create();
31 //
32 //             var link = new Link<T>(links.GetLink(linkAddress));
33 //
34 //             Assert.True(link.Count == 3);
35 //             Assert.True(equalityComparer.Equals(link.Index, linkAddress));
36 //             Assert.True(equalityComparer.Equals(link.Source, constants.Null));
37 //             Assert.True(equalityComparer.Equals(link.Target, constants.Null));
38 //
39 //             Assert.True(equalityComparer.Equals(links.Count(), one));
40 //
41 //             // Get first link
42 //             setter = new Setter<T>(constants.Null);
43 //             links.Each(constants.Any, constants.Any, setter.SetAndReturnFalse);
44 //
45 //             Assert.True(equalityComparer.Equals(setter.Result, linkAddress));
46 //
47 //             // Update link to reference itself
48 //             links.Update(linkAddress, linkAddress, linkAddress);
49 //
50 //             link = new Link<T>(links.GetLink(linkAddress));
51 //
52 //             Assert.True(equalityComparer.Equals(link.Source, linkAddress));
53 //             Assert.True(equalityComparer.Equals(link.Target, linkAddress));
54 //
55 //             // Update link to reference null (prepare for delete)
56 //             var updated = links.Update(linkAddress, constants.Null, constants.Null);
57 //

```

```

58 // Assert.True(equalityComparer.Equals(updated, linkAddress));
59 //
60 // link = new Link<T>(links.GetLink(linkAddress));
61 //
62 // Assert.True(equalityComparer.Equals(link.Source, constants.Null));
63 // Assert.True(equalityComparer.Equals(link.Target, constants.Null));
64 //
65 // // Delete link
66 // links.Delete(linkAddress);
67 //
68 // Assert.True(equalityComparer.Equals(links.Count(), zero));
69 //
70 // setter = new Setter<T>(constants.Null);
71 // links.Each(constants.Any, constants.Any, setter.SetAndReturnTrue);
72 //
73 // Assert.True(equalityComparer.Equals(setter.Result, constants.Null));
74 // }
75 //
76 // public static void TestRawNumbersCRUDOperations<T>(this ILinks<T> links)
77 // {
78 //     // Constants
79 //     var constants = links.Constants;
80 //     var equalityComparer = EqualityComparer<T>.Default;
81 //
82 //     var zero = default(T);
83 //     var one = Arithmetic.Increment(zero);
84 //     var two = Arithmetic.Increment(one);
85 //
86 //     var h106E = new Hybrid<T>(106L, isExternal: true);
87 //     var h107E = new Hybrid<T>(-char.ConvertFromUtf32(107)[0]);
88 //     var h108E = new Hybrid<T>(-108L);
89 //
90 //     Assert.Equal(106L, h106E.AbsoluteValue);
91 //     Assert.Equal(107L, h107E.AbsoluteValue);
92 //     Assert.Equal(108L, h108E.AbsoluteValue);
93 //
94 //     // Create Link (External -> External)
95 //     var linkAddress1 = links.Create();
96 //
97 //     links.Update(linkAddress1, h106E, h108E);
98 //
99 //     var link1 = new Link<T>(links.GetLink(linkAddress1));
100 //
101 //     Assert.True(equalityComparer.Equals(link1.Source, h106E));
102 //     Assert.True(equalityComparer.Equals(link1.Target, h108E));
103 //
104 //     // Create Link (Internal -> External)
105 //     var linkAddress2 = links.Create();
106 //
107 //     links.Update(linkAddress2, linkAddress1, h108E);
108 //
109 //     var link2 = new Link<T>(links.GetLink(linkAddress2));
110 //
111 //     Assert.True(equalityComparer.Equals(link2.Source, linkAddress1));
112 //     Assert.True(equalityComparer.Equals(link2.Target, h108E));
113 //
114 //     // Create Link (Internal -> Internal)
115 //     var linkAddress3 = links.Create();
116 //
117 //     links.Update(linkAddress3, linkAddress1, linkAddress2);
118 //
119 //     var link3 = new Link<T>(links.GetLink(linkAddress3));
120 //
121 //     Assert.True(equalityComparer.Equals(link3.Source, linkAddress1));
122 //     Assert.True(equalityComparer.Equals(link3.Target, linkAddress2));
123 //
124 //     // Search for created link
125 //     var setter1 = new Setter<T>(constants.Null);
126 //     links.Each(h106E, h108E, setter1.SetAndReturnFalse);
127 //
128 //     Assert.True(equalityComparer.Equals(setter1.Result, linkAddress1));
129 //
130 //     // Search for nonexistent link
131 //     var setter2 = new Setter<T>(constants.Null);
132 //     links.Each(h106E, h107E, setter2.SetAndReturnFalse);
133 //
134 //     Assert.True(equalityComparer.Equals(setter2.Result, constants.Null));
135 // }

```

```

136 // // Update link to reference null (prepare for delete)
137 // var updated = links.Update(linkAddress3, constants.Null, constants.Null);
138 //
139 // Assert.True(equalityComparer.Equals(updated, linkAddress3));
140 //
141 // link3 = new Link<T>(links.GetLink(linkAddress3));
142 //
143 // Assert.True(equalityComparer.Equals(link3.Source, constants.Null));
144 // Assert.True(equalityComparer.Equals(link3.Target, constants.Null));
145 //
146 // // Delete link
147 // links.Delete(linkAddress3);
148 //
149 // Assert.True(equalityComparer.Equals(links.Count(), two));
150 //
151 // var setter3 = new Setter<T>(constants.Null);
152 // links.Each(constants.Any, constants.Any, setter3.SetAndReturnTrue);
153 //
154 // Assert.True(equalityComparer.Equals(setter3.Result, linkAddress2));
155 // }
156 //
157 // public static void TestMultipleRandomCreationsAndDeletions<TLinkAddress>(this
    ↪ ILinks<TLinkAddress> links, int maximumOperationsPerCycle)
158 // {
159 //     var comparer = Comparer<TLinkAddress>.Default;
160 //     var addressToUInt64Converter = CheckedConverter<TLinkAddress, ulong>.Default;
161 //     var uint64ToAddressConverter = CheckedConverter<ulong, TLinkAddress>.Default;
162 //     for (var N = 1; N < maximumOperationsPerCycle; N++)
163 //     {
164 //         var random = new System.Random(N);
165 //         var created = 0UL;
166 //         var deleted = 0UL;
167 //         for (var i = 0; i < N; i++)
168 //         {
169 //             var linksCount = addressToUInt64Converter.Convert(links.Count());
170 //             var createPoint = random.NextBoolean();
171 //             if (linksCount >= 2 && createPoint)
172 //             {
173 //                 var linksAddressRange = new Range<ulong>(1, linksCount);
174 //                 TLinkAddress source =
    ↪ uint64ToAddressConverter.Convert(random.NextUInt64(linksAddressRange));
175 //                 TLinkAddress target =
    ↪ uint64ToAddressConverter.Convert(random.NextUInt64(linksAddressRange)); //-V3086
176 //                 var resultLink = links.GetOrCreate(source, target);
177 //                 if (comparer.Compare(resultLink,
    ↪ uint64ToAddressConverter.Convert(linksCount)) > 0)
178 //                 {
179 //                     created++;
180 //                 }
181 //             }
182 //             else
183 //             {
184 //                 links.Create();
185 //                 created++;
186 //             }
187 //         }
188 //         Assert.True(created == addressToUInt64Converter.Convert(links.Count()));
189 //         for (var i = 0; i < N; i++)
190 //         {
191 //             TLinkAddress link = uint64ToAddressConverter.Convert((ulong)i + 1UL);
192 //             if (links.Exists(link))
193 //             {
194 //                 links.Delete(link);
195 //                 deleted++;
196 //             }
197 //         }
198 //         Assert.True(addressToUInt64Converter.Convert(links.Count()) == 0L);
199 //     }
200 // }
201 // }
202 // }

```

## 1.71 ./csharp/Platform.Data.Doublets.Sequences.Tests/UInt64LinksTests.cs

```

1 // using System;
2 // using System.Collections.Generic;
3 // using System.Diagnostics;
4 // using System.IO;

```

```

5  // using System.Text;
6  // using System.Threading;
7  // using System.Threading.Tasks;
8  // using Xunit;
9  // using Platform.Disposables;
10 // using Platform.Ranges;
11 // using Platform.Random;
12 // using Platform.Timestamps;
13 // using Platform.Reflection;
14 // using Platform.Singletons;
15 // using Platform.Scopes;
16 // using Platform.Counters;
17 // using Platform.Diagnostics;
18 // using Platform.IO;
19 // using Platform.Memory;
20 // using Platform.Data.Doublets.Decorators;
21 // using Platform.Data.Doublets.Memory.United.Specific;
22 //
23 // namespace Platform.Data.Doublets.Sequences.Tests
24 // {
25 //     public static class UInt64LinksTests
26 //     {
27 //         private static readonly LinksConstants<ulong> _constants =
28 ↵ Default<LinksConstants<ulong>>.Instance;
29 //         private const long Iterations = 10 * 1024;
30 //
31 //         #region Concept
32 //
33 //         [Fact]
34 //         public static void MultipleCreateAndDeleteTest()
35 //         {
36 ↵         using (var scope = new Scope<Types<HeapResizableDirectMemory,
37 ↵ UInt64UnitedMemoryLinks>>())
38 //         {
39 //             new
40 ↵ UInt64Links(scope.Use<ILinks<ulong>>()).TestMultipleRandomCreationsAndDeletions(100);
41 //         }
42 //
43 //         [Fact]
44 //         public static void CascadeUpdateTest()
45 //         {
46 //             var itself = _constants.Itself;
47 //             using (var scope = new TempLinksTestScope(useLog: true))
48 //             {
49 //                 var links = scope.Links;
50 //
51 //                 var l1 = links.Create();
52 //                 var l2 = links.Create();
53 //
54 //                 l2 = links.Update(l2, l2, l1, l2);
55 //
56 //                 links.CreateAndUpdate(l2, itself);
57 //                 links.CreateAndUpdate(l2, itself);
58 //
59 //                 l2 = links.Update(l2, l1);
60 //
61 //                 links.Delete(l2);
62 //
63 //                 Global.Trash = links.Count();
64 //
65 //                 links.Unsync.DisposeIfPossible(); // Close links to access log
66 //
67 //                 Global.Trash = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(scope.TempTransactionLogFilename);
68 //             }
69 //         }
70 //
71 //         [Fact]
72 //         public static void BasicTransactionLogTest()
73 //         {
74 //             using (var scope = new TempLinksTestScope(useLog: true))
75 //             {
76 //                 var links = scope.Links;
77 //                 var l1 = links.Create();
78 //                 var l2 = links.Create();

```

```

78 // Global.Trash = links.Update(l2, l2, l1, l2);
79 //
80 // links.Delete(l1);
81 //
82 // links.Unsync.DisposeIfPossible(); // Close links to access log
83 //
84 // Global.Trash = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(scope.TempTransactionLogFilename);
85 // }
86 // }
87 //
88 // [Fact]
89 // public static void TransactionAutoRevertedTest()
90 // {
91 //     // Auto Reverted (Because no commit at transaction)
92 //     using (var scope = new TempLinksTestScope(useLog: true))
93 //     {
94 //         var links = scope.Links;
95 //         var transactionsLayer = (UInt64LinksTransactionsLayer)scope.MemoryAdapter;
96 //         using (var transaction = transactionsLayer.BeginTransaction())
97 //         {
98 //             var l1 = links.Create();
99 //             var l2 = links.Create();
100 //
101 //             links.Update(l2, l2, l1, l2);
102 //         }
103 //
104 //         Assert.Equal(0UL, links.Count());
105 //
106 //         links.Unsync.DisposeIfPossible();
107 //
108 //         var transitions = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(scope.TempTransactionLogFilename);
109 //         Assert.Single(transitions);
110 //     }
111 // }
112 //
113 // [Fact]
114 // public static void TransactionUserCodeErrorNoDataSavedTest()
115 // {
116 //     // User Code Error (Autoreverted), no data saved
117 //     var itself = _constants.Itself;
118 //
119 //     TempLinksTestScope lastScope = null;
120 //     try
121 //     {
122 //         using (var scope = lastScope = new TempLinksTestScope(deleteFiles: false, useLog: true))
123 //         {
124 //             var links = scope.Links;
125 //             var transactionsLayer =
126 //                 (UInt64LinksTransactionsLayer)((LinksDisposableDecoratorBase<ulong>)links.Unsync).Links;
127 //             using (var transaction = transactionsLayer.BeginTransaction())
128 //             {
129 //                 var l1 = links.CreateAndUpdate(itself, itself);
130 //                 var l2 = links.CreateAndUpdate(itself, itself);
131 //
132 //                 l2 = links.Update(l2, l2, l1, l2);
133 //
134 //                 links.CreateAndUpdate(l2, itself);
135 //                 links.CreateAndUpdate(l2, itself);
136 //
137 //                 //Global.Trash = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(scope.TempTransactionLogFilename);
138 //
139 //                 l2 = links.Update(l2, l1);
140 //
141 //                 links.Delete(l2);
142 //
143 //                 ExceptionThrower();
144 //
145 //                 transaction.Commit();
146 //             }
147 //
148 //             Global.Trash = links.Count();
149 //         }
150 //     }
151 // }

```

```

150 //      catch
151 //      {
152 //          Assert.False(lastScope == null);
153 //
154 //          var transitions = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>
↳ >(lastScope.TempTransactionLogFilename);
155 //
156 //          Assert.True(transitions.Length == 1 && transitions[0].Before.IsNull() &&
↳ transitions[0].After.IsNull());
157 //
158 //          lastScope.DeleteFiles();
159 //      }
160 //  }
161 //
162 //  [Fact]
163 //  public static void TransactionUserCodeErrorSomeDataSavedTest()
164 //  {
165 //      // User Code Error (Autoreverted), some data saved
166 //      var itself = _constants.Itself;
167 //
168 //      TempLinksTestScope lastScope = null;
169 //      try
170 //      {
171 //          ulong l1;
172 //          ulong l2;
173 //
174 //          using (var scope = new TempLinksTestScope(useLog: true))
175 //          {
176 //              var links = scope.Links;
177 //              l1 = links.CreateAndUpdate(itself, itself);
178 //              l2 = links.CreateAndUpdate(itself, itself);
179 //
180 //              l2 = links.Update(l2, l2, l1, l2);
181 //
182 //              links.CreateAndUpdate(l2, itself);
183 //              links.CreateAndUpdate(l2, itself);
184 //
185 //              links.Unsync.DisposeIfPossible();
186 //
187 //              Global.Trash = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transitio
↳ n>(scope.TempTransactionLogFilename);
188 //          }
189 //
190 //          using (var scope = lastScope = new TempLinksTestScope(deleteFiles: false,
↳ useLog: true))
191 //          {
192 //              var links = scope.Links;
193 //              var transactionsLayer = (UInt64LinksTransactionsLayer)links.Unsync;
194 //              using (var transaction = transactionsLayer.BeginTransaction())
195 //              {
196 //                  l2 = links.Update(l2, l1);
197 //
198 //                  links.Delete(l2);
199 //
200 //                  ExceptionThrower();
201 //
202 //                  transaction.Commit();
203 //              }
204 //
205 //              Global.Trash = links.Count();
206 //          }
207 //      }
208 //      catch
209 //      {
210 //          Assert.False(lastScope == null);
211 //
212 //          Global.Trash = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(l
↳ astScope.TempTransactionLogFilename);
213 //
214 //          lastScope.DeleteFiles();
215 //      }
216 //  }
217 //
218 //  [Fact]
219 //  public static void TransactionCommit()
220 //  {
221 //      var itself = _constants.Itself;

```



```

222 //
223 //         var tempDatabaseFilename = Path.GetTempFileName();
224 //         var tempTransactionLogFilename = Path.GetTempFileName();
225 //
226 //         // Commit
227 //         using (var memoryAdapter = new UInt64LinksTransactionsLayer(new
↳ UInt64UnitedMemoryLinks(tempDatabaseFilename), tempTransactionLogFilename))
228 //         using (var links = new UInt64Links(memoryAdapter))
229 //         {
230 //             using (var transaction = memoryAdapter.BeginTransaction())
231 //             {
232 //                 var l1 = links.CreateAndUpdate(itself, itself);
233 //                 var l2 = links.CreateAndUpdate(itself, itself);
234 //
235 //                 Global.Trash = links.Update(l2, l2, l1, l2);
236 //
237 //                 links.Delete(l1);
238 //
239 //                 transaction.Commit();
240 //             }
241 //
242 //             Global.Trash = links.Count();
243 //         }
244 //
245 //         Global.Trash =
↳ FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(tempTransactionLogFilename);
246 //     }
247 //
248 //     [Fact]
249 //     public static void TransactionDamage()
250 //     {
251 //         var itself = _constants.Itself;
252 //
253 //         var tempDatabaseFilename = Path.GetTempFileName();
254 //         var tempTransactionLogFilename = Path.GetTempFileName();
255 //
256 //         // Commit
257 //         using (var memoryAdapter = new UInt64LinksTransactionsLayer(new
↳ UInt64UnitedMemoryLinks(tempDatabaseFilename), tempTransactionLogFilename))
258 //         using (var links = new UInt64Links(memoryAdapter))
259 //         {
260 //             using (var transaction = memoryAdapter.BeginTransaction())
261 //             {
262 //                 var l1 = links.CreateAndUpdate(itself, itself);
263 //                 var l2 = links.CreateAndUpdate(itself, itself);
264 //
265 //                 Global.Trash = links.Update(l2, l2, l1, l2);
266 //
267 //                 links.Delete(l1);
268 //
269 //                 transaction.Commit();
270 //             }
271 //
272 //             Global.Trash = links.Count();
273 //         }
274 //
275 //         Global.Trash =
↳ FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(tempTransactionLogFilename);
276 //
277 //         // Damage database
278 //
279 //         FileHelpers.WriteFirst(tempTransactionLogFilename, new
↳ UInt64LinksTransactionsLayer.Transition(new UniqueTimestampFactory(), 555));
280 //
281 //         // Try load damaged database
282 //         try
283 //         {
284 //             // TODO: Fix
285 //             using (var memoryAdapter = new UInt64LinksTransactionsLayer(new
↳ UInt64UnitedMemoryLinks(tempDatabaseFilename), tempTransactionLogFilename))
286 //             using (var links = new UInt64Links(memoryAdapter))
287 //             {
288 //                 Global.Trash = links.Count();
289 //             }
290 //         }
291 //         catch (NotSupportedException ex)
292 //         {

```

```

293 //                Assert.True(ex.Message == "Database is damaged, autorecovery is not supported
↵ yet.");
294 //            }
295 //
296 //            Global.Trash =
↵ FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(tempTransactionLogFilename);
297 //
298 //            File.Delete(tempDatabaseFilename);
299 //            File.Delete(tempTransactionLogFilename);
300 //        }
301 //
302 //        [Fact]
303 //        public static void Bug1Test()
304 //        {
305 //            var tempDatabaseFilename = Path.GetTempFileName();
306 //            var tempTransactionLogFilename = Path.GetTempFileName();
307 //
308 //            var itself = _constants.Itself;
309 //
310 //            // User Code Error (Autoreverted), some data saved
311 //            try
312 //            {
313 //                ulong l1;
314 //                ulong l2;
315 //
316 //                using (var memory = new UInt64UnitedMemoryLinks(tempDatabaseFilename))
317 //                using (var memoryAdapter = new UInt64LinksTransactionsLayer(memory,
↵ tempTransactionLogFilename))
318 //                using (var links = new UInt64Links(memoryAdapter))
319 //                {
320 //                    l1 = links.CreateAndUpdate(itself, itself);
321 //                    l2 = links.CreateAndUpdate(itself, itself);
322 //
323 //                    l2 = links.Update(l2, l2, l1, l2);
324 //
325 //                    links.CreateAndUpdate(l2, itself);
326 //                    links.CreateAndUpdate(l2, itself);
327 //                }
328 //
329 //                Global.Trash =
↵ FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(tempTransactionLogFilename);
330 //
331 //                using (var memory = new UInt64UnitedMemoryLinks(tempDatabaseFilename))
332 //                using (var memoryAdapter = new UInt64LinksTransactionsLayer(memory,
↵ tempTransactionLogFilename))
333 //                using (var links = new UInt64Links(memoryAdapter))
334 //                {
335 //                    using (var transaction = memoryAdapter.BeginTransaction())
336 //                    {
337 //                        l2 = links.Update(l2, l1);
338 //
339 //                        links.Delete(l2);
340 //
341 //                        ExceptionThrower();
342 //
343 //                        transaction.Commit();
344 //                    }
345 //
346 //                    Global.Trash = links.Count();
347 //                }
348 //            }
349 //            catch
350 //            {
351 //                Global.Trash =
↵ FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(tempTransactionLogFilename);
352 //            }
353 //
354 //            File.Delete(tempDatabaseFilename);
355 //            File.Delete(tempTransactionLogFilename);
356 //        }
357 //        private static void ExceptionThrower() => throw new InvalidOperationException();
358 //
359 //        [Fact]
360 //        public static void PathsTest()
361 //        {
362 //            var source = _constants.SourcePart;
363 //            var target = _constants.TargetPart;

```

```

364 //
365 //         using (var scope = new TempLinksTestScope())
366 //         {
367 //             var links = scope.Links;
368 //             var l1 = links.CreatePoint();
369 //             var l2 = links.CreatePoint();
370 //
371 //             var r1 = links.GetByKeys(l1, source, target, source);
372 //             var r2 = links.CheckPathExistance(l2, l2, l2, l2);
373 //         }
374 //     }
375 //
376 //     [Fact]
377 //     public static void RecursiveStringFormattingTest()
378 //     {
379 //         using (var scope = new TempLinksTestScope(useSequences: true))
380 //         {
381 //             var links = scope.Links;
382 //             var sequences = scope.Sequences; // TODO: Auto use sequences on Sequences
383 //
384 //             var a = links.CreatePoint();
385 //             var b = links.CreatePoint();
386 //             var c = links.CreatePoint();
387 //
388 //             var ab = links.GetOrCreate(a, b);
389 //             var cb = links.GetOrCreate(c, b);
390 //             var ac = links.GetOrCreate(a, c);
391 //
392 //             a = links.Update(a, c, b);
393 //             b = links.Update(b, a, c);
394 //             c = links.Update(c, a, b);
395 //
396 //             Debug.WriteLine(links.FormatStructure(ab, link => link.IsFullPoint(), true));
397 //             Debug.WriteLine(links.FormatStructure(cb, link => link.IsFullPoint(), true));
398 //             Debug.WriteLine(links.FormatStructure(ac, link => link.IsFullPoint(), true));
399 //
400 //             Assert.True(links.FormatStructure(cb, link => link.IsFullPoint(), true) ==
401 // ↪ "5:(4:5 (6:5 4)) 6");
402 //             Assert.True(links.FormatStructure(ac, link => link.IsFullPoint(), true) ==
403 // ↪ "6:(5:(4:5 6) 6) 4");
404 //             Assert.True(links.FormatStructure(ab, link => link.IsFullPoint(), true) ==
405 // ↪ "4:(5:4 (6:5 4)) 6");
406 //
407 //             // TODO: Think how to build balanced syntax tree while formatting structure
408 //             // (eg. "4:(5:4 6) (6:5 4)" instead of "4:(5:4 (6:5 4)) 6")
409 //
410 //             Assert.True(sequences.SafeFormatSequence(cb, DefaultFormatter, false) ==
411 // ↪ "{5}{5}{4}{6}");
412 //             Assert.True(sequences.SafeFormatSequence(ac, DefaultFormatter, false) ==
413 // ↪ "{5}{6}{6}{4}");
414 //             Assert.True(sequences.SafeFormatSequence(ab, DefaultFormatter, false) ==
415 // ↪ "{4}{5}{4}{6}");
416 //         }
417 //     }
418 //
419 //     private static void DefaultFormatter(StringBuilder sb, ulong link)
420 //     {
421 //         sb.Append(link.ToString());
422 //     }
423 //
424 //     #endregion
425 //
426 //     #region Performance
427 //
428 //     /*
429 //     public static void RunAllPerformanceTests()
430 //     {
431 //         try
432 //         {
433 //             links.TestLinksInSteps();
434 //         }
435 //         catch (Exception ex)
436 //         {
437 //             ex.WriteToConsole();
438 //         }
439 //     }
440 //
441 //     return;

```

```

433 //
434 //
435 //
436 //
437 //
438 //
↪ на результат
439 //
440 //
441 //
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471 //
472 //
473 //
474 //
↪ Platform.Links.Data.Core.Doublets.Links.LinkSizeInBytes;
475 //
↪ Platform.Links.Data.Core.Doublets.Links.LinkSizeInBytes;
476 //
477 //
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479 //
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505 //
506 //
507 //

```

```

try
{
    //ThreadPool.SetMaxThreads(2, 2);

    // Запускаем все тесты дважды, чтобы первоначальная инициализация не повлияла
    // Также это дополнительно помогает в отладке
    // Увеличивает вероятность попадания информации в кэши
    for (var i = 0; i < 10; i++)
    {
        //0 - 10 ГБ
        //Каждые 100 МБ срез цифр

        //links.TestGetSourceFunction();
        //links.TestGetSourceFunctionInParallel();
        //links.TestGetTargetFunction();
        //links.TestGetTargetFunctionInParallel();
        links.Create64BillionLinks();

        links.TestRandomSearchFixed();
        //links.Create64BillionLinksInParallel();
        links.TestEachFunction();
        //links.TestForeach();
        //links.TestParallelForeach();
    }

    links.TestDeletionOfAllLinks();
}
catch (Exception ex)
{
    ex.WriteToConsole();
}
}*/

/*
public static void TestLinksInSteps()
{
    const long gibibyte = 1024 * 1024 * 1024;
    const long mebibyte = 1024 * 1024;

    var totalLinksToCreate = gibibyte /
Platform.Links.Data.Core.Doublets.Links.LinkSizeInBytes;
    var linksStep = 102 * mebibyte /
Platform.Links.Data.Core.Doublets.Links.LinkSizeInBytes;

    var creationMeasurements = new List<TimeSpan>();
    var searchMeasurements = new List<TimeSpan>();
    var deletionMeasurements = new List<TimeSpan>();

    GetBaseRandomLoopOverhead(linksStep);
    GetBaseRandomLoopOverhead(linksStep);

    var stepLoopOverhead = GetBaseRandomLoopOverhead(linksStep);

    ConsoleHelpers.Debug("Step loop overhead: {0}.", stepLoopOverhead);

    var loops = totalLinksToCreate / linksStep;

    for (int i = 0; i < loops; i++)
    {
        creationMeasurements.Add(Measure(() => links.RunRandomCreations(linksStep)));
        searchMeasurements.Add(Measure(() => links.RunRandomSearches(linksStep)));

        Console.Write("\rC + S {0}/{1}", i + 1, loops);
    }

    ConsoleHelpers.Debug();

    for (int i = 0; i < loops; i++)
    {
        deletionMeasurements.Add(Measure(() => links.RunRandomDeletions(linksStep)));

        Console.Write("\rD {0}/{1}", i + 1, loops);
    }

    ConsoleHelpers.Debug();
}

```

```

508 //
509 //         ConsoleHelpers.Debug("C S D");
510 //
511 //         for (int i = 0; i < loops; i++)
512 //         {
513 //             ConsoleHelpers.Debug("{0} {1} {2}", creationMeasurements[i],
↵ searchMeasurements[i], deletionMeasurements[i]);
514 //         }
515 //
516 //         ConsoleHelpers.Debug("C S D (no overhead)");
517 //
518 //         for (int i = 0; i < loops; i++)
519 //         {
520 //             ConsoleHelpers.Debug("{0} {1} {2}", creationMeasurements[i] -
↵ stepLoopOverhead, searchMeasurements[i] - stepLoopOverhead, deletionMeasurements[i] -
↵ stepLoopOverhead);
521 //         }
522 //
523 //         ConsoleHelpers.Debug("All tests done. Total links left in database: {0}.",
↵ links.Total);
524 //     }
525 //
526 //     private static void CreatePoints(this Platform.Links.Data.Core.Doublets.Links links,
↵ long amountToCreate)
527 //     {
528 //         for (long i = 0; i < amountToCreate; i++)
529 //             links.Create(0, 0);
530 //     }
531 //
532 //     private static TimeSpan GetBaseRandomLoopOverhead(long loops)
533 //     {
534 //         return Measure(() =>
535 //         {
536 //             ulong maxValue = RandomHelpers.DefaultFactory.NextUInt64();
537 //             ulong result = 0;
538 //             for (long i = 0; i < loops; i++)
539 //             {
540 //                 var source = RandomHelpers.DefaultFactory.NextUInt64(maxValue);
541 //                 var target = RandomHelpers.DefaultFactory.NextUInt64(maxValue);
542 //
543 //                 result += maxValue + source + target;
544 //             }
545 //             Global.Trash = result;
546 //         });
547 //     }
548 //     */
549 //
550 //     [Fact(Skip = "performance test")]
551 //     public static void GetSourceTest()
552 //     {
553 //         using (var scope = new TempLinksTestScope())
554 //         {
555 //             var links = scope.Links;
556 //             ConsoleHelpers.Debug("Testing GetSource function with {0} Iterations.",
↵ Iterations);
557 //
558 //             ulong counter = 0;
559 //
560 //             //var firstLink = links.First();
561 //             // Создаём одну связь, из которой будет производить считывание
562 //             var firstLink = links.Create();
563 //
564 //             var sw = Stopwatch.StartNew();
565 //
566 //             // Тестируем саму функцию
567 //             for (ulong i = 0; i < Iterations; i++)
568 //             {
569 //                 counter += links.GetSource(firstLink);
570 //             }
571 //
572 //             var elapsedTime = sw.Elapsed;
573 //
574 //             var iterationsPerSecond = Iterations / elapsedTime.TotalSeconds;
575 //
576 //             // Удаляем связь, из которой производилось считывание
577 //             links.Delete(firstLink);
578 //

```

```

579 //         ConsoleHelpers.Debug(
580 //             "{0} Iterations of GetSource function done in {1} ({2} Iterations per
↵ second), counter result: {3}",
581 //                 Iterations, elapsedTime, (long)iterationsPerSecond, counter);
582 //         }
583 //     }
584 //
585 //     [Fact(Skip = "performance test")]
586 //     public static void GetSourceInParallel()
587 //     {
588 //         using (var scope = new TempLinksTestScope())
589 //         {
590 //             var links = scope.Links;
591 //             ConsoleHelpers.Debug("Testing GetSource function with {0} Iterations in
↵ parallel.", Iterations);
592 //
593 //             long counter = 0;
594 //
595 //             //var firstLink = links.First();
596 //             var firstLink = links.Create();
597 //
598 //             var sw = Stopwatch.StartNew();
599 //
600 //             // Тестируем саму функцию
601 //             Parallel.For(0, Iterations, x =>
602 //             {
603 //                 Interlocked.Add(ref counter, (long)links.GetSource(firstLink));
604 //                 //Interlocked.Increment(ref counter);
605 //             });
606 //
607 //             var elapsedTime = sw.Elapsed;
608 //
609 //             var iterationsPerSecond = Iterations / elapsedTime.TotalSeconds;
610 //
611 //             links.Delete(firstLink);
612 //
613 //             ConsoleHelpers.Debug(
614 //                 "{0} Iterations of GetSource function done in {1} ({2} Iterations per
↵ second), counter result: {3}",
615 //                     Iterations, elapsedTime, (long)iterationsPerSecond, counter);
616 //             }
617 //         }
618 //
619 //     [Fact(Skip = "performance test")]
620 //     public static void TestGetTarget()
621 //     {
622 //         using (var scope = new TempLinksTestScope())
623 //         {
624 //             var links = scope.Links;
625 //             ConsoleHelpers.Debug("Testing GetTarget function with {0} Iterations.",
↵ Iterations);
626 //
627 //             ulong counter = 0;
628 //
629 //             //var firstLink = links.First();
630 //             var firstLink = links.Create();
631 //
632 //             var sw = Stopwatch.StartNew();
633 //
634 //             for (ulong i = 0; i < Iterations; i++)
635 //             {
636 //                 counter += links.GetTarget(firstLink);
637 //             }
638 //
639 //             var elapsedTime = sw.Elapsed;
640 //
641 //             var iterationsPerSecond = Iterations / elapsedTime.TotalSeconds;
642 //
643 //             links.Delete(firstLink);
644 //
645 //             ConsoleHelpers.Debug(
646 //                 "{0} Iterations of GetTarget function done in {1} ({2} Iterations per
↵ second), counter result: {3}",
647 //                     Iterations, elapsedTime, (long)iterationsPerSecond, counter);
648 //             }
649 //         }
650 //     }

```

```

651 // [Fact(Skip = "performance test")]
652 // public static void TestGetTargetInParallel()
653 // {
654 //     using (var scope = new TempLinksTestScope())
655 //     {
656 //         var links = scope.Links;
657 //         ConsoleHelpers.Debug("Testing GetTarget function with {0} Iterations in
↵ parallel.", Iterations);
658 //
659 //         long counter = 0;
660 //
661 //         //var firstLink = links.First();
662 //         var firstLink = links.Create();
663 //
664 //         var sw = Stopwatch.StartNew();
665 //
666 //         Parallel.For(0, Iterations, x =>
667 //         {
668 //             Interlocked.Add(ref counter, (long)links.GetTarget(firstLink));
669 //             //Interlocked.Increment(ref counter);
670 //         });
671 //
672 //         var elapsedTime = sw.Elapsed;
673 //
674 //         var iterationsPerSecond = Iterations / elapsedTime.TotalSeconds;
675 //
676 //         links.Delete(firstLink);
677 //
678 //         ConsoleHelpers.Debug(
679 //             "{0} Iterations of GetTarget function done in {1} ({2} Iterations per
↵ second), counter result: {3}",
680 //             Iterations, elapsedTime, (long)iterationsPerSecond, counter);
681 //         }
682 //     }
683 //
684 //     // TODO: Заполнить базу данных перед тестом
685 //     /*
686 //     [Fact]
687 //     public void TestRandomSearchFixed()
688 //     {
689 //         var tempFilename = Path.GetTempFileName();
690 //
691 //         using (var links = new Platform.Links.Data.Core.Doublets.Links(tempFilename,
↵ DefaultLinksSizeStep))
692 //         {
693 //             long iterations = 64 * 1024 * 1024 /
↵ Platform.Links.Data.Core.Doublets.Links.LinkSizeInBytes;
694 //
695 //             ulong counter = 0;
696 //             var maxLink = links.Total;
697 //
698 //             ConsoleHelpers.Debug("Testing Random Search with {0} Iterations.",
↵ iterations);
699 //
700 //             var sw = Stopwatch.StartNew();
701 //
702 //             for (var i = iterations; i > 0; i--)
703 //             {
704 //                 var source =
↵ RandomHelpers.DefaultFactory.NextUInt64(LinksConstants.MinPossibleIndex, maxLink);
705 //                 var target =
↵ RandomHelpers.DefaultFactory.NextUInt64(LinksConstants.MinPossibleIndex, maxLink);
706 //
707 //                 counter += links.Search(source, target);
708 //             }
709 //
710 //             var elapsedTime = sw.Elapsed;
711 //
712 //             var iterationsPerSecond = iterations / elapsedTime.TotalSeconds;
713 //
714 //             ConsoleHelpers.Debug("{0} Iterations of Random Search done in {1} ({2}
↵ Iterations per second), c: {3}", iterations, elapsedTime, (long)iterationsPerSecond,
715 //                 counter);
716 //         }
717 //
718 //         File.Delete(tempFilename);
719 //     }*/

```

```

719 //
720 // [Fact(Skip = "useless: 0(0), was dependent on creation tests")]
721 // public static void TestRandomSearchAll()
722 // {
723 //     using (var scope = new TempLinksTestScope())
724 //     {
725 //         var links = scope.Links;
726 //         ulong counter = 0;
727 //
728 //         var maxLink = links.Count();
729 //
730 //         var iterations = links.Count();
731 //
732 //         ConsoleHelpers.Debug("Testing Random Search with {0} Iterations.",
↵ links.Count());
733 //
734 //         var sw = Stopwatch.StartNew();
735 //
736 //         for (var i = iterations; i > 0; i--)
737 //         {
738 //             var linksAddressRange = new
↵ Range<ulong>(_constants.InternalReferencesRange.Minimum, maxLink);
739 //
740 //             var source = RandomHelpers.Default.NextUInt64(linksAddressRange);
741 //             var target = RandomHelpers.Default.NextUInt64(linksAddressRange);
742 //
743 //             counter += links.SearchOrDefault(source, target);
744 //         }
745 //
746 //         var elapsedTime = sw.Elapsed;
747 //
748 //         var iterationsPerSecond = iterations / elapsedTime.TotalSeconds;
749 //
750 //         ConsoleHelpers.Debug("{0} Iterations of Random Search done in {1} ({2}
↵ Iterations per second), c: {3}",
751 //             iterations, elapsedTime, (long)iterationsPerSecond, counter);
752 //         }
753 //     }
754 //
755 // [Fact(Skip = "useless: 0(0), was dependent on creation tests")]
756 // public static void TestEach()
757 // {
758 //     using (var scope = new TempLinksTestScope())
759 //     {
760 //         var links = scope.Links;
761 //
762 //         var counter = new Counter<IList<ulong>, ulong>(links.Constants.Continue);
763 //
764 //         ConsoleHelpers.Debug("Testing Each function.");
765 //
766 //         var sw = Stopwatch.StartNew();
767 //
768 //         links.Each(counter.IncrementAndReturnTrue);
769 //
770 //         var elapsedTime = sw.Elapsed;
771 //
772 //         var linksPerSecond = counter.Count / elapsedTime.TotalSeconds;
773 //
774 //         ConsoleHelpers.Debug("{0} Iterations of Each's handler function done in {1}
↵ ({2} links per second)",
775 //             counter, elapsedTime, (long)linksPerSecond);
776 //     }
777 // }
778 //
779 // /*
780 // [Fact]
781 // public static void TestForeach()
782 // {
783 //     var tempFilename = Path.GetTempFileName();
784 //
785 //     using (var links = new Platform.Links.Data.Core.Doublets.Links(tempFilename,
↵ DefaultLinksSizeStep))
786 //     {
787 //         ulong counter = 0;
788 //
789 //         ConsoleHelpers.Debug("Testing foreach through links.");
790 //     }

```



```

791 //         var sw = Stopwatch.StartNew();
792 //
793 //         //foreach (var link in links)
794 //         //{
795 //             counter++;
796 //         //}
797 //
798 //         var elapsedTime = sw.Elapsed;
799 //
800 //         var linksPerSecond = (double)counter / elapsedTime.TotalSeconds;
801 //
802 //         ConsoleHelpers.Debug("{0} Iterations of Foreach's handler block done in {1}
↵ ({2} links per second)", counter, elapsedTime, (long)linksPerSecond);
803 //     }
804 //
805 //     File.Delete(tempFilename);
806 // }
807 // */
808 //
809 // /*
810 // [Fact]
811 // public static void TestParallelForeach()
812 // {
813 //     var tempFilename = Path.GetTempFileName();
814 //
815 //     using (var links = new Platform.Links.Data.Core.Doublets.Links(tempFilename,
↵ DefaultLinksSizeStep))
816 //     {
817 //
818 //         long counter = 0;
819 //
820 //         ConsoleHelpers.Debug("Testing parallel foreach through links.");
821 //
822 //         var sw = Stopwatch.StartNew();
823 //
824 //         //Parallel.ForEach((IEnumerable<ulong>)links, x =>
825 //         //{
826 //             Interlocked.Increment(ref counter);
827 //         //});
828 //
829 //         var elapsedTime = sw.Elapsed;
830 //
831 //         var linksPerSecond = (double)counter / elapsedTime.TotalSeconds;
832 //
833 //         ConsoleHelpers.Debug("{0} Iterations of Parallel Foreach's handler block done
↵ in {1} ({2} links per second)", counter, elapsedTime, (long)linksPerSecond);
834 //     }
835 //
836 //     File.Delete(tempFilename);
837 // }
838 // */
839 //
840 // [Fact(Skip = "performance test")]
841 // public static void Create64BillionLinks()
842 // {
843 //     using (var scope = new TempLinksTestScope())
844 //     {
845 //         var links = scope.Links;
846 //         var linksBeforeTest = links.Count();
847 //
848 //         long linksToCreate = 64 * 1024 * 1024 /
↵ UInt64UnitedMemoryLinks.LinkSizeInBytes;
849 //
850 //         ConsoleHelpers.Debug("Creating {0} links.", linksToCreate);
851 //
852 //         var elapsedTime = Performance.Measure(() =>
853 //         {
854 //             for (long i = 0; i < linksToCreate; i++)
855 //             {
856 //                 links.Create();
857 //             }
858 //         });
859 //
860 //         var linksCreated = links.Count() - linksBeforeTest;
861 //         var linksPerSecond = linksCreated / elapsedTime.TotalSeconds;
862 //
863 //         ConsoleHelpers.Debug("Current links count: {0}.", links.Count());

```

```

864 //
865 //         ConsoleHelpers.Debug("{0} links created in {1} ({2} links per second)",
↪ linksCreated, elapsedTime,
866 //             (long)linksPerSecond);
867 //     }
868 // }
869 //
870 // [Fact(Skip = "performance test")]
871 // public static void Create64BillionLinksInParallel()
872 // {
873 //     using (var scope = new TempLinksTestScope())
874 //     {
875 //         var links = scope.Links;
876 //         var linksBeforeTest = links.Count();
877 //
878 //         var sw = Stopwatch.StartNew();
879 //
880 //         long linksToCreate = 64 * 1024 * 1024 /
↪ UInt64UnitedMemoryLinks.LinkSizeInBytes;
881 //
882 //         ConsoleHelpers.Debug("Creating {0} links in parallel.", linksToCreate);
883 //
884 //         Parallel.For(0, linksToCreate, x => links.Create());
885 //
886 //         var elapsedTime = sw.Elapsed;
887 //
888 //         var linksCreated = links.Count() - linksBeforeTest;
889 //         var linksPerSecond = linksCreated / elapsedTime.TotalSeconds;
890 //
891 //         ConsoleHelpers.Debug("{0} links created in {1} ({2} links per second)",
↪ linksCreated, elapsedTime,
892 //             (long)linksPerSecond);
893 //     }
894 // }
895 //
896 // [Fact(Skip = "useless: 0(0), was dependent on creation tests")]
897 // public static void TestDeletionOfAllLinks()
898 // {
899 //     using (var scope = new TempLinksTestScope())
900 //     {
901 //         var links = scope.Links;
902 //         var linksBeforeTest = links.Count();
903 //
904 //         ConsoleHelpers.Debug("Deleting all links");
905 //
906 //         var elapsedTime = Performance.Measure(links.DeleteAll);
907 //
908 //         var linksDeleted = linksBeforeTest - links.Count();
909 //         var linksPerSecond = linksDeleted / elapsedTime.TotalSeconds;
910 //
911 //         ConsoleHelpers.Debug("{0} links deleted in {1} ({2} links per second)",
↪ linksDeleted, elapsedTime,
912 //             (long)linksPerSecond);
913 //     }
914 // }
915 //
916 // #endregion
917 // }
918 // }

```

## 1.72 ./csharp/Platform.Data.Doublets.Sequences.Tests/UInt64LinksExtensionsTests.cs

```

1 using Platform.Data.Doublets.Memory;
2 using Platform.Data.Doublets.Memory.United.Generic;
3 using Platform.Data.Numbers.Raw;
4 using Platform.Memory;
5 using Platform.Numbers;
6 using Xunit;
7 using Xunit.Abstractions;
8 using TLinkAddress = System.UInt64;
9
10 namespace Platform.Data.Doublets.Sequences.Tests
11 {
12     public class UInt64LinksExtensionsTests
13     {
14         public static ILinks<TLinkAddress> CreateLinks() => CreateLinks<TLinkAddress>(new
↪ Platform.IO.TemporaryFile());
15
16         public static ILinks<TLinkAddress> CreateLinks<TLinkAddress>(string dataDBFilename)
17     {

```

```

18     var linksConstants = new
19     ↪ LinksConstants<TLinkAddress>(enableExternalReferencesSupport: true);
20     return new UnitedMemoryLinks<TLinkAddress>(new
21     ↪ FileMappedResizableDirectMemory(dataDBFilename),
22     ↪ UnitedMemoryLinks<TLinkAddress>.DefaultLinksSizeStep, linksConstants,
23     ↪ IndexTreeType.Default);
24 }
25 [Fact]
26 public void FormatStructureWithExternalReferenceTest()
27 {
28     ILinks<TLinkAddress> links = CreateLinks();
29     TLinkAddress zero = default;
30     var one = Arithmetic.Increment(zero);
31     var markerIndex = one;
32     var meaningRoot = links.GetOrCreate(markerIndex, markerIndex);
33     var numberMarker = links.GetOrCreate(meaningRoot, Arithmetic.Increment(ref
34     ↪ markerIndex));
35     AddressToRawNumberConverter<TLinkAddress> addressToNumberConverter = new();
36     var numberAddress = addressToNumberConverter.Convert(1);
37     var numberLink = links.GetOrCreate(numberMarker, numberAddress);
38     var linkNotation = links.FormatStructure(numberLink, link => link.IsFullPoint(),
39     ↪ true);
40     Assert.Equal("(3:(2:1 2) 18446744073709551615)", linkNotation);
41 }
42 }
43 }

```

### 1.73 ./csharp/Platform.Data.Doublets.Sequences.Tests/UnaryNumberConvertersTests.cs

```

1  // using Xunit;
2  // using Platform.Random;
3  // using Platform.Data.Doublets.Numbers.Unary;
4  //
5  // namespace Platform.Data.Doublets.Sequences.Tests
6  // {
7  //     public static class UnaryNumberConvertersTests
8  //     {
9  //         [Fact]
10 //         public static void ConvertersTest()
11 //         {
12 //             using (var scope = new TempLinksTestScope())
13 //             {
14 //                 const int N = 10;
15 //                 var links = scope.Links;
16 //                 var meaningRoot = links.CreatePoint();
17 //                 var one = links.CreateAndUpdate(meaningRoot, links.Constants.Itself);
18 //                 var powerOf2ToUnaryNumberConverter = new
19 ↪ PowerOf2ToUnaryNumberConverter<ulong>(links, one);
20 //                 var toUnaryNumberConverter = new AddressToUnaryNumberConverter<ulong>(links,
21 ↪ powerOf2ToUnaryNumberConverter);
22 //                 var random = new System.Random(0);
23 //                 ulong[] numbers = new ulong[N];
24 //                 ulong[] unaryNumbers = new ulong[N];
25 //                 for (int i = 0; i < N; i++)
26 //                 {
27 //                     numbers[i] = random.NextUInt64();
28 //                     unaryNumbers[i] = toUnaryNumberConverter.Convert(numbers[i]);
29 //                 }
30 //                 var fromUnaryNumberConverterUsingOrOperation = new
31 ↪ UnaryNumberToAddressOrOperationConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
32 //                 var fromUnaryNumberConverterUsingAddOperation = new
33 ↪ UnaryNumberToAddressAddOperationConverter<ulong>(links, one);
34 //                 for (int i = 0; i < N; i++)
35 //                 {
36 //                     Assert.Equal(numbers[i],
37 ↪ fromUnaryNumberConverterUsingOrOperation.Convert(unaryNumbers[i]));
38 //                     Assert.Equal(numbers[i],
39 ↪ fromUnaryNumberConverterUsingAddOperation.Convert(unaryNumbers[i]));
40 //                 }
41 //             }
42 //         }
43 //     }
44 // }

```

### 1.74 ./csharp/Platform.Data.Doublets.Sequences.Tests/UnicodeConvertersTests.cs

```

1  // using Xunit;
2  // using Platform.Converters;

```

```

3  // using Platform.Memory;
4  // using Platform.Reflection;
5  // using Platform.Scopes;
6  // using Platform.Data.Numbers.Raw;
7  // using Platform.Data.Doublets.Incrementers;
8  // using Platform.Data.Doublets.Numbers.Unary;
9  // using Platform.Data.Doublets.PropertyOperators;
10 // using Platform.Data.Doublets.Sequences.Converters;
11 // using Platform.Data.Doublets.Sequences.Indexes;
12 // using Platform.Data.Doublets.Sequences.Walkers;
13 // using Platform.Data.Doublets.Unicode;
14 // using Platform.Data.Doublets.Memory.United.Generic;
15 // using Platform.Data.Doublets.CriterionMatchers;
16 //
17 namespace Platform.Data.Doublets.Sequences.Tests
18 {
19     public static class UnicodeConvertersTests
20     {
21         [Fact]
22         public static void CharAndUnaryNumberUnicodeSymbolConvertersTest()
23         {
24             using (var scope = new TempLinksTestScope())
25             {
26                 var links = scope.Links;
27                 var meaningRoot = links.CreatePoint();
28                 var one = links.CreateAndUpdate(meaningRoot, links.Constants.Itself);
29                 var powerOf2ToUnaryNumberConverter = new
30                 ↵ PowerOf2ToUnaryNumberConverter<ulong>(links, one);
31                 var addressToUnaryNumberConverter = new
32                 ↵ AddressToUnaryNumberConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
33                 var unaryNumberToAddressConverter = new
34                 ↵ UnaryNumberToAddressOrOperationConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
35                 TestCharAndUnicodeSymbolConverters(links, meaningRoot,
36                 ↵ addressToUnaryNumberConverter, unaryNumberToAddressConverter);
37             }
38         }
39
40         [Fact]
41         public static void CharAndRawNumberUnicodeSymbolConvertersTest()
42         {
43             using (var scope = new Scope<Types<HeapResizableDirectMemory,
44             ↵ UnitedMemoryLinks<ulong>>>())
45             {
46                 var links = scope.Use<ILinks<ulong>>>();
47                 var meaningRoot = links.CreatePoint();
48                 var addressToRawNumberConverter = new AddressToRawNumberConverter<ulong>();
49                 var rawNumberToAddressConverter = new RawNumberToAddressConverter<ulong>();
50                 TestCharAndUnicodeSymbolConverters(links, meaningRoot,
51                 ↵ addressToRawNumberConverter, rawNumberToAddressConverter);
52             }
53         }
54
55         private static void TestCharAndUnicodeSymbolConverters(ILinks<ulong> links, ulong
56         ↵ meaningRoot, IConverter<ulong> addressToNumberConverter, IConverter<ulong>
57         ↵ numberToAddressConverter)
58         {
59             var unicodeSymbolMarker = links.CreateAndUpdate(meaningRoot,
60             ↵ links.Constants.Itself);
61             var charToUnicodeSymbolConverter = new CharToUnicodeSymbolConverter<ulong>(links,
62             ↵ addressToNumberConverter, unicodeSymbolMarker);
63             var originalCharacter = 'H';
64             var characterLink = charToUnicodeSymbolConverter.Convert(originalCharacter);
65             var unicodeSymbolCriterionMatcher = new TargetMatcher<ulong>(links,
66             ↵ unicodeSymbolMarker);
67             var unicodeSymbolToCharConverter = new UnicodeSymbolToCharConverter<ulong>(links,
68             ↵ numberToAddressConverter, unicodeSymbolCriterionMatcher);
69             var resultingCharacter = unicodeSymbolToCharConverter.Convert(characterLink);
70             Assert.Equal(originalCharacter, resultingCharacter);
71         }
72     }
73
74     [Fact]
75     public static void StringAndUnicodeSequenceConvertersTest()
76     {
77         using (var scope = new TempLinksTestScope())
78         {
79             var links = scope.Links;
80
81             var itself = links.Constants.Itself;

```

```

68 //
69 //         var meaningRoot = links.CreatePoint();
70 //         var unaryOne = links.CreateAndUpdate(meaningRoot, itself);
71 //         var unicodeSymbolMarker = links.CreateAndUpdate(meaningRoot, itself);
72 //         var unicodeSequenceMarker = links.CreateAndUpdate(meaningRoot, itself);
73 //         var frequencyMarker = links.CreateAndUpdate(meaningRoot, itself);
74 //         var frequencyPropertyMarker = links.CreateAndUpdate(meaningRoot, itself);
75 //
76 //         var powerOf2ToUnaryNumberConverter = new
↳ PowerOf2ToUnaryNumberConverter<ulong>(links, unaryOne);
77 //         var addressToUnaryNumberConverter = new
↳ AddressToUnaryNumberConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
78 //         var charToUnicodeSymbolConverter = new
↳ CharToUnicodeSymbolConverter<ulong>(links, addressToUnaryNumberConverter,
↳ unicodeSymbolMarker);
79 //
80 //         var unaryNumberToAddressConverter = new
↳ UnaryNumberToAddressOrOperationConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
81 //         var unaryNumberIncrementer = new UnaryNumberIncrementer<ulong>(links,
↳ unaryOne);
82 //         var frequencyIncrementer = new FrequencyIncrementer<ulong>(links,
↳ frequencyMarker, unaryOne, unaryNumberIncrementer);
83 //         var frequencyPropertyOperator = new PropertyOperator<ulong>(links,
↳ frequencyPropertyMarker, frequencyMarker);
84 //         var index = new FrequencyIncrementingSequenceIndex<ulong>(links,
↳ frequencyPropertyOperator, frequencyIncrementer);
85 //         var linkToItsFrequencyNumberConverter = new
↳ LinkToItsFrequencyNumberConverter<ulong>(links, frequencyPropertyOperator,
↳ unaryNumberToAddressConverter);
86 //         var sequenceToItsLocalElementLevelsConverter = new
↳ SequenceToItsLocalElementLevelsConverter<ulong>(links, linkToItsFrequencyNumberConverter);
87 //         var optimalVariantConverter = new OptimalVariantConverter<ulong>(links,
↳ sequenceToItsLocalElementLevelsConverter);
88 //
89 //         var stringToUnicodeSequenceConverter = new
↳ StringToUnicodeSequenceConverter<ulong>(links, charToUnicodeSymbolConverter, index,
↳ optimalVariantConverter, unicodeSequenceMarker);
90 //
91 //         var originalString = "Hello";
92 //
93 //         var unicodeSequenceLink =
↳ stringToUnicodeSequenceConverter.Convert(originalString);
94 //
95 //         var unicodeSymbolCriterionMatcher = new TargetMatcher<ulong>(links,
↳ unicodeSymbolMarker);
96 //         var unicodeSymbolToCharConverter = new
↳ UnicodeSymbolToCharConverter<ulong>(links, unaryNumberToAddressConverter,
↳ unicodeSymbolCriterionMatcher);
97 //
98 //         var unicodeSequenceCriterionMatcher = new TargetMatcher<ulong>(links,
↳ unicodeSequenceMarker);
99 //
100 //         var sequenceWalker = new LeveledSequenceWalker<ulong>(links,
↳ unicodeSymbolCriterionMatcher.IsMatched);
101 //
102 //         var unicodeSequenceToStringConverter = new
↳ UnicodeSequenceToStringConverter<ulong>(links, unicodeSequenceCriterionMatcher,
↳ sequenceWalker, unicodeSymbolToCharConverter);
103 //
104 //         var resultingString =
↳ unicodeSequenceToStringConverter.Convert(unicodeSequenceLink);
105 //
106 //         Assert.Equal(originalString, resultingString);
107 //     }
108 // }
109 // }
110 // }

```

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