

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         /// <para></para>
27         /// </param>
28         [MethodImpl(MethodImplOptions.AggressiveInlining)]
29         public BalancedVariantConverter(ILinks<TLinkAddress> links) : base(links) { }
30
31         /// <summary>
32         /// <para>
33         /// Converts the sequence.
34         /// </para>
35         /// <para></para>
36         /// </summary>
37         /// <param name="sequence">
38         /// <para>The sequence.</para>
39         /// <para></para>
40         /// </param>
41         /// <returns>
42         /// <para>The link</para>
43         /// <para></para>
44         /// </returns>
45         [MethodImpl(MethodImplOptions.AggressiveInlining)]
46         public override TLinkAddress Convert(ICollection<TLinkAddress>? sequence)
47         {
48             var length = sequence.Count;
49             if (length < 1)
50             {
51                 return default;
52             }
53             if (length == 1)
54             {
55                 return sequence[0];
56             }
57             // Make copy of next layer
58             if (length > 2)
59             {
60                 // TODO: Try to use stackalloc (which at the moment is not working with
61                 ↳ generics) but will be possible with Sigil
62                 var halvedSequence = new TLinkAddress[(length / 2) + (length % 2)];
63                 HalveSequence(halvedSequence, sequence, length);
64                 sequence = halvedSequence;
65                 length = halvedSequence.Length;
66             }
67             // Keep creating layer after layer
68             while (length > 2)
69             {
70                 HalveSequence(sequence, sequence, length);
71                 length = (length / 2) + (length % 2);
72             }
73             return _links.GetOrCreate(sequence[0], sequence[1]);
74         }
75     }
76     [MethodImpl(MethodImplOptions.AggressiveInlining)]

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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>

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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<ILinkAddress>,
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(ILinkAddress? 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 stackallow with Sigil

```

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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 }
239 return sequence;
240 }
241 [MethodImpl(MethodImplOptions.AggressiveInlining)]
242 private int ReplaceDoublets(HalfDoublet[] copy)
243 {
244     var oldLength = copy.Length;
245     var newLength = copy.Length;
246     while (_comparer.Compare(_maxDoubletData.Frequency, default) > 0)
247     {
248         var maxDoubletSource = _maxDoublet.Source;
249         var maxDoubletTarget = _maxDoublet.Target;
250         if (_equalityComparer.Equals(_maxDoubletData.Link, _constants.Null))
251         {
252             _maxDoubletData.Link = _links.GetOrCreate(maxDoubletSource,
253                 ↪ maxDoubletTarget);
254         }
255         var maxDoubletReplacementLink = _maxDoubletData.Link;
256         oldLength--;
257         var oldLengthMinusTwo = oldLength - 1;
258         // Substitute all usages
259         int w = 0, r = 0; // (r == read, w == write)
260         for (; r < oldLength; r++)
261         {
262             if (_equalityComparer.Equals(copy[r].Element, maxDoubletSource) &&
263                 ↪ _equalityComparer.Equals(copy[r + 1].Element, maxDoubletTarget))
264             {
265                 if (r > 0)
266                 {
267                     var previous = copy[w - 1].Element;
268                     copy[w - 1].DoubletData.DecrementFrequency();
269                     copy[w - 1].DoubletData =
270                         ↪ _doubletFrequenciesCache.IncrementFrequency(previous,
271                         ↪ maxDoubletReplacementLink);
272                 }
273                 if (r < oldLengthMinusTwo)
274                 {
275                     var next = copy[r + 2].Element;
276                     copy[r + 1].DoubletData.DecrementFrequency();
277                     copy[w].DoubletData = _doubletFrequenciesCache.IncrementFrequency(max
278                         ↪ xDoubletReplacementLink,
279                         ↪ next);
280                 }
281                 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 random
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     /// </param>
52     /// <param name="linkFrequenciesCache">
53     /// <para>A link frequencies cache.</para>
54     /// </param>
55     [MethodImpl(MethodImplOptions.AggressiveInlining)]
56     public OptimalVariantConverter(ILinks<TLinkAddress> links,
57         ↳ LinkFrequenciesCache<TLinkAddress> linkFrequenciesCache)
58         : this(links, new SequenceToItsLocalElementLevelsConverter<TLinkAddress>(links, new
59             ↳ FrequenciesCacheBasedLinkToItsFrequencyNumberConverter<TLinkAddress>(linkFrequen
60             ↳ ciesCache))) {
61
62     /// <summary>
63     /// <para>
64     /// Initializes a new <see cref="OptimalVariantConverter"/> instance.
65     /// </para>
66     /// </summary>
67     /// <param name="links">
68     /// <para>A links.</para>
69     /// </param>
70     [MethodImpl(MethodImplOptions.AggressiveInlining)]
71     public OptimalVariantConverter(ILinks<TLinkAddress> links)
72         : this(links, new LinkFrequenciesCache<TLinkAddress>(links, new
73             ↳ TotalSequenceSymbolFrequencyCounter<TLinkAddress>(links))) { }
74
75     /// <summary>
76     /// <para>
77     /// Converts the sequence.
78     /// </para>
79     /// </summary>
80     /// <param name="sequence">
81     /// <para>The sequence.</para>
82     /// </param>
83     /// <returns>
84     /// <para>The link</para>
85     /// </returns>
86     [MethodImpl(MethodImplOptions.AggressiveInlining)]
87     public override TLinkAddress Convert(IList<TLinkAddress>? sequence)
88     {
89         var length = sequence.Count;
90         if (length == 1)
91         {
92             return sequence[0];
93         }
94         if (length == 2)
95         {
96             return _links.GetOrCreate(sequence[0], sequence[1]);
97         }
98         sequence = sequence.ToArray();
99         var levels = _sequenceToItsLocalElementLevelsConverter.Convert(sequence);
100         while (length > 2)
101         {
102             var levelRepeat = 1;
103             var currentLevel = levels[0];
104             var previousLevel = levels[0];
105             var skipOnce = false;
106             var w = 0;
107             for (var i = 1; i < length; i++)
108             {
109                 if (_equalityComparer.Equals(currentLevel, levels[i]))
110

```



```

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;
19      private readonly ILinks<TLinkAddress> _links;
20      private readonly TLinkAddress _sequenceMarkerLink;
21
22      /// <summary>
23      /// <para>
24      /// Initializes a new <see cref="MarkedSequenceCriterionMatcher"/> 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="sequenceMarkerLink">
33      /// <para>A sequence marker link.</para>
34      /// <para></para>
35      /// </param>
36      [MethodImpl(MethodImplOptions.AggressiveInlining)]
37      public MarkedSequenceCriterionMatcher(ILinks<TLinkAddress> links, TLinkAddress
38          ↪ sequenceMarkerLink)
39      {
40          _links = links;
41          _sequenceMarkerLink = sequenceMarkerLink;
42      }
43
44      /// <summary>
45      /// <para>
46      /// Determines whether this instance is matched.
47      /// </para>
48      /// <para></para>
49      /// </summary>
50      /// <param name="sequenceCandidate">
51      /// <para>The sequence candidate.</para>
52      /// <para></para>
53      /// </param>
54      /// <returns>
55      /// <para>The bool</para>
56      /// <para></para>
57      /// </returns>
58      [MethodImpl(MethodImplOptions.AggressiveInlining)]
59      public bool IsMatched(TLinkAddress sequenceCandidate)
60      => _equalityComparer.Equals(_links.GetSource(sequenceCandidate), _sequenceMarkerLink)
61      || !_equalityComparer.Equals(_links.SearchOrDefault(_sequenceMarkerLink,
62          ↪ sequenceCandidate), _links.Constants.Null);
63  }
64 }

```

1.8 ./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;

```

```

22 private readonly IStack<TLinkAddress> _stack;
23 private readonly ISequenceHeightProvider<TLinkAddress> _heightProvider;
24
25 /// <summary>
26 /// <para>
27 /// Initializes a new <see cref="DefaultSequenceAppender"/> 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="stack">
36 /// <para>A stack.</para>
37 /// <para></para>
38 /// </param>
39 /// <param name="heightProvider">
40 /// <para>A height provider.</para>
41 /// <para></para>
42 /// </param>
43 [MethodImpl(MethodImplOptions.AggressiveInlining)]
44 public DefaultSequenceAppender(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack,
45     ↪ ISequenceHeightProvider<TLinkAddress> heightProvider)
46     : base(links)
47 {
48     _stack = stack;
49     _heightProvider = heightProvider;
50 }
51
52 /// <summary>
53 /// <para>
54 /// Appends the sequence.
55 /// </para>
56 /// <para></para>
57 /// </summary>
58 /// <param name="sequence">
59 /// <para>The sequence.</para>
60 /// <para></para>
61 /// </param>
62 /// <param name="appendant">
63 /// <para>The appendant.</para>
64 /// <para></para>
65 /// </param>
66 /// <returns>
67 /// <para>The link</para>
68 /// <para></para>
69 /// </returns>
70 [MethodImpl(MethodImplOptions.AggressiveInlining)]
71 public TLinkAddress Append(TLinkAddress sequence, TLinkAddress appendant)
72 {
73     var cursor = sequence;
74     var links = _links;
75     while (!_equalityComparer.Equals(_heightProvider.Get(cursor), default))
76     {
77         var source = links.GetSource(cursor);
78         var target = links.GetTarget(cursor);
79         if (_equalityComparer.Equals(_heightProvider.Get(source),
80             ↪ _heightProvider.Get(target)))
81         {
82             break;
83         }
84         else
85         {
86             _stack.Push(source);
87             cursor = target;
88         }
89     }
90     var left = cursor;
91     var right = appendant;
92     while (!_equalityComparer.Equals(cursor = _stack.PopOrDefault(),
93         ↪ links.Constants.Null))
94     {
95         right = links.GetOrCreate(left, right);
96         left = cursor;
97     }
98     return links.GetOrCreate(left, right);
99 }

```

```

97     }
98 }

```

1.9 ./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         /// </param>
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public DuplicateSegmentsCounter(IProvider<IList<KeyValuePair<IList<TLinkAddress>?,
33             ↳ IList<TLinkAddress>?>>> duplicateFragmentsProvider) => _duplicateFragmentsProvider =
34             ↳ duplicateFragmentsProvider;
35
36         /// <summary>
37         /// <para>
38         /// Counts this instance.
39         /// </para>
40         /// <para></para>
41         /// </summary>
42         /// <returns>
43         /// <para>The int</para>
44         /// <para></para>
45         /// </returns>
46         [MethodImpl(MethodImplOptions.AggressiveInlining)]
47         public int Count() => _duplicateFragmentsProvider.Get().Sum(x => x.Value.Count);
48     }
49 }

```

1.10 ./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 //                 }
182 //                 return constants.Continue;
183 //             });
184 //             var resultList = _groups.ToList();
185 //             var comparer = Default<ItemComparer>.Instance;
186 //             resultList.Sort(comparer);
187 // #if DEBUG
188 //             foreach (var item in resultList)
189 //             {
190 //                 PrintDuplicates(item);
191 //             }
192 // #endif
193 //             return resultList;
194 //         }
195 //
196 //         /// <summary>
197 //         /// <para>
198 //         /// Creates the segment using the specified elements.
199 //         /// </para>
200 //         /// <para></para>
201 //         /// </summary>
202 //         /// <param name="elements">
203 //         /// <para>The elements.</para>
204 //         /// <para></para>
205 //         /// </param>
206 //         /// <param name="offset">
207 //         /// <para>The offset.</para>
208 //         /// <para></para>
209 //         /// </param>
210 //         /// <param name="length">
211 //         /// <para>The length.</para>
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 duplicate 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 OnDuplicateFound(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 // }

```

1.11 ./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
13     /// ↪ between them).
14     /// TODO: Extract interface to implement frequencies storage inside Links storage
15     /// </remarks>
16     public class LinkFrequenciesCache<TLinkAddress> : LinksOperatorBase<TLinkAddress>
17     {
18         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
19             ↪ EqualityComparer<TLinkAddress>.Default;
20         private static readonly Comparer<TLinkAddress> _comparer =
21             ↪ Comparer<TLinkAddress>.Default;
22         private static readonly TLinkAddress _zero = default;
23         private static readonly TLinkAddress _one = Arithmetic.Increment(_zero);
24         private readonly Dictionary<Doublet<TLinkAddress>, LinkFrequency<TLinkAddress>>
25             ↪ _doubletsCache;
26         private readonly ICounter<TLinkAddress, TLinkAddress> _frequencyCounter;
27
28         /// <summary>
29         /// <para>
30         /// Initializes a new <see cref="LinkFrequenciesCache"/> 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="frequencyCounter">
39         /// <para>A frequency counter.</para>
40         /// <para></para>
41         /// </param>
42         [MethodImpl(MethodImplOptions.AggressiveInlining)]
43         public LinkFrequenciesCache(ILinks<TLinkAddress> links, ICounter<TLinkAddress,
44             ↪ TLinkAddress> frequencyCounter)
45             : base(links)
46         {
47             _doubletsCache = new Dictionary<Doublet<TLinkAddress>,
48                 ↪ LinkFrequency<TLinkAddress>>(4096, DoubletComparer<TLinkAddress>.Default);
49             _frequencyCounter = frequencyCounter;
50         }
51
52         /// <summary>
53         /// <para>
54         /// Gets the frequency using the specified source.
55         /// </para>
56         /// <para></para>
57         /// </summary>
58         /// <param name="source">
59         /// <para>The source.</para>
60         /// <para></para>
61         /// </param>
62         /// <param name="target">
63         /// <para>The target.</para>
64         /// <para></para>
65         /// </param>
66         /// <returns>
67         /// <para>A link frequency of t link</para>
68         /// <para></para>
69         /// </returns>
70         [MethodImpl(MethodImplOptions.AggressiveInlining)]
71         public LinkFrequency<TLinkAddress> GetFrequency(TLinkAddress source, TLinkAddress target)
72         {
73             var doublet = new Doublet<TLinkAddress>(source, target);
74             return GetFrequency(ref doublet);
75         }
76
77         /// <summary>
78         /// <para>
79         /// Gets the frequency using the specified doublet.
80         /// </para>
81         /// <para></para>
82         /// </summary>
83         /// <para></para>
84     }
85 }

```

```

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
131    → target)
132    {
133        var doublet = new Doublet<TLinkAddress>(source, target);
134        return IncrementFrequency(ref doublet);
135    }
136
137    /// <summary>
138    /// <para>
139    /// Prints the frequencies using the specified sequence.
140    /// </para>
141    /// <para></para>
142    /// </summary>
143    /// <param name="sequence">
144    /// <para>The sequence.</para>
145    /// <para></para>
146    /// </param>
147    [MethodImpl(MethodImplOptions.AggressiveInlining)]
148    public void PrintFrequencies(ICollection<TLinkAddress>? sequence)
149    {
150        for (var i = 1; i < sequence.Count; i++)
151        {
152            PrintFrequency(sequence[i - 1], sequence[i]);
153        }
154    }

```

```

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,
204                     ↪ _frequencyCounter.Count(link));
205             }
206             _doubletsCache.Add(doublet, data);
207         }
208         return data;
209     }
210
211     /// <summary>
212     /// <para>
213     /// Validates the frequencies.
214     /// </para>
215     /// <para></para>
216     /// </summary>
217     /// <exception cref="InvalidOperationException">
218     /// <para>Frequencies validation failed.</para>
219     /// <para></para>
220     /// </exception>
221     [MethodImpl(MethodImplOptions.AggressiveInlining)]
222     public void ValidateFrequencies()
223     {
224         foreach (var entry in _doubletsCache)
225         {
226             var value = entry.Value;
227             var linkIndex = value.Link;
228             if (!_equalityComparer.Equals(linkIndex, default))
229             {
230                 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 }

```

1.12 ./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 }

```

1.13 ./csharp/Platform.Data.Doublets.Sequences/Frequencies/Cache/LinkToItsFrequencyValueConverter.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>

```

```

29     [MethodImpl(MethodImplOptions.AggressiveInlining)]
30     public FrequenciesCacheBasedLinkToItsFrequencyNumberConverter(LinkFrequenciesCache<TLink_
    ↪ Address> cache) => _cache =
    ↪ cache;

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 TLinkAddress Convert(Doublet<TLinkAddress> source) => _cache.GetFrequency(ref
    ↪ source).Frequency;

48 }
49 }

```

1.14 ./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,
    ↪ ICriterionMatcher<TLinkAddress> markedSequenceMatcher, TLinkAddress sequenceLink,
    ↪ TLinkAddress symbol)
43            : base(links, sequenceLink, symbol)
44            => _markedSequenceMatcher = markedSequenceMatcher;
45
46        /// <summary>
47        /// <para>
48        /// Counts this instance.
49        /// </para>

```



```

50     /// <para></para>
51     /// </summary>
52     /// <returns>
53     /// <para>The link</para>
54     /// <para></para>
55     /// </returns>
56     [MethodImpl(MethodImplOptions.AggressiveInlining)]
57     public override TLinkAddress Count()
58     {
59         if (!_markedSequenceMatcher.IsMatched(_sequenceLink))
60         {
61             return default;
62         }
63         return base.Count();
64     }
65 }
66 }

```

1.15 ./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>
39         protected readonly TLinkAddress _sequenceLink;
40
41         /// <summary>
42         /// <para>
43         /// The symbol.
44         /// </para>
45         /// <para></para>
46         /// </summary>
47         protected readonly TLinkAddress _symbol;
48
49         /// <summary>
50         /// <para>
51         /// The total.
52         /// </para>
53         /// <para></para>
54         /// </summary>
55         protected TLinkAddress _total;
56
57         /// <summary>
58         /// <para>
59         /// Initializes a new <see cref="SequenceSymbolFrequencyOneOffCounter" /> instance.
60         /// </para>
61         /// <para></para>
62         /// </summary>
63         /// <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
    ↪ sequenceLink, TLinkAddress symbol)
72     {
73         _links = links;
74         _sequenceLink = sequenceLink;
75         _symbol = symbol;
76         _total = default;
77     }
78
79     /// <summary>
80     /// <para>
81     /// Counts this instance.
82     /// </para>
83     /// <para></para>
84     /// </summary>
85     /// <returns>
86     /// <para>The total.</para>
87     /// <para></para>
88     /// </returns>
89     [MethodImpl(MethodImplOptions.AggressiveInlining)]
90     public virtual TLinkAddress Count()
91     {
92         if (_comparer.Compare(_total, default) > 0)
93         {
94             return _total;
95         }
96         StopableSequenceWalker.WalkRight(_sequenceLink, _links.GetSource, _links.GetTarget,
    ↪ IsElement, VisitElement);
97         return _total;
98     }
99     [MethodImpl(MethodImplOptions.AggressiveInlining)]
100    private bool IsElement(TLinkAddress x) => _equalityComparer.Equals(x, _symbol) ||
    ↪ _links.IsPartialPoint(x); // TODO: Use SequenceElementCriteriaMatcher instead of
    ↪ IsPartialPoint
101    [MethodImpl(MethodImplOptions.AggressiveInlining)]
102    private bool VisitElement(TLinkAddress element)
103    {
104        if (_equalityComparer.Equals(element, _symbol))
105        {
106            _total = Arithmetic.Increment(_total);
107        }
108        return true;
109    }
110 }
111 }

```

1.16 ./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> :
    ↪ ICounter<TLinkAddress, TLinkAddress>
16     {
17         private readonly ILinks<TLinkAddress> _links;
18         private readonly ICriterionMatcher<TLinkAddress> _markedSequenceMatcher;
19

```

```

20     /// <summary>
21     /// <para>
22     /// Initializes a new <see cref="TotalMarkedSequenceSymbolFrequencyCounter"/> instance.
23     /// </para>
24     /// <para></para>
25     /// </summary>
26     /// <param name="links">
27     /// <para>A links.</para>
28     /// <para></para>
29     /// </param>
30     /// <param name="markedSequenceMatcher">
31     /// <para>A marked sequence matcher.</para>
32     /// <para></para>
33     /// </param>
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     /// <para></para>
50     /// </param>
51     /// <returns>
52     /// <para>The link</para>
53     /// <para></para>
54     /// </returns>
55     [MethodImpl(MethodImplOptions.AggressiveInlining)]
56     public TLinkAddress Count(TLinkAddress argument) => new
57         ↪ TotalMarkedSequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links,
58         ↪ _markedSequenceMatcher, argument).Count();
59 }
60 }

```

1.17 ./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>

```

```

33     /// </param>
34     /// <param name="symbol">
35     /// <para>A symbol.</para>
36     /// <para></para>
37     /// </param>
38     [MethodImpl(MethodImplOptions.AggressiveInlining)]
39     public TotalMarkedSequenceSymbolFrequencyOneOffCounter(ILinks<TLinkAddress> links,
40         ↪ ICriterionMatcher<TLinkAddress> markedSequenceMatcher, TLinkAddress symbol)
41         : base(links, symbol)
42         => _markedSequenceMatcher = markedSequenceMatcher;
43
44     /// <summary>
45     /// <para>
46     /// Counts the sequence symbol frequency using the specified link.
47     /// </para>
48     /// <para></para>
49     /// </summary>
50     /// <param name="link">
51     /// <para>The link.</para>
52     /// <para></para>
53     /// </param>
54     [MethodImpl(MethodImplOptions.AggressiveInlining)]
55     protected override void CountSequenceSymbolFrequency(TLinkAddress link)
56     {
57         var symbolFrequencyCounter = new
58             ↪ MarkedSequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links,
59             ↪ _markedSequenceMatcher, link, _symbol);
60         _total = Arithmetic.Add(_total, symbolFrequencyCounter.Count());
61     }
62 }

```

1.18 ./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.
23         /// </para>
24         /// <para></para>
25         /// </summary>
26         /// <param name="links">
27         /// <para>A links.</para>
28         /// <para></para>
29         /// </param>
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         public TotalSequenceSymbolFrequencyCounter(ILinks<TLinkAddress> links) => _links = links;
32
33         /// <summary>
34         /// <para>
35         /// Counts the symbol.
36         /// </para>
37         /// <para></para>
38         /// </summary>
39         /// <param name="symbol">
40         /// <para>The symbol.</para>
41         /// <para></para>
42         /// </param>
43         /// <returns>
44         /// <para>The link</para>
45         /// <para></para>

```

```

45     /// </returns>
46     [MethodImpl(MethodImplOptions.AggressiveInlining)]
47     public TLinkAddress Count(TLinkAddress symbol) => new
        ↳ TotalSequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links, symbol).Count();
48 }
49 }

```

1.19 ./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
48         /// <summary>
49         /// <para>
50         /// The total.
51         /// </para>
52         /// <para></para>
53         /// </summary>
54         protected TLinkAddress _total;
55
56         /// <summary>
57         /// <para>
58         /// Initializes a new <see cref="TotalSequenceSymbolFrequencyOneOffCounter" /> instance.
59         /// </para>
60         /// <para></para>
61         /// </summary>
62         /// <param name="links">
63         /// <para>A links.</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 TotalSequenceSymbolFrequencyOneOffCounter(ILinks<TLinkAddress> links,
72             ↳ TLinkAddress symbol)
73         {
74             _links = links;

```

```

69     _symbol = symbol;
70     _visits = new HashSet<TLinkAddress>();
71     _total = default;
72 }
73
74 /// <summary>
75 /// <para>
76 /// Counts this instance.
77 /// </para>
78 /// <para></para>
79 /// </summary>
80 /// <returns>
81 /// <para>The total.</para>
82 /// <para></para>
83 /// </returns>
84 [MethodImpl(MethodImplOptions.AggressiveInlining)]
85 public TLinkAddress Count()
86 {
87     if (_comparer.Compare(_total, default) > 0 || _visits.Count > 0)
88     {
89         return _total;
90     }
91     CountCore(_symbol);
92     return _total;
93 }
94 [MethodImpl(MethodImplOptions.AggressiveInlining)]
95 private void CountCore(TLinkAddress link)
96 {
97     var any = _links.Constants.Any;
98     if (_equalityComparer.Equals(_links.Count(any, link), default))
99     {
100         CountSequenceSymbolFrequency(link);
101     }
102     else
103     {
104         _links.Each(EachElementHandler, any, link);
105     }
106 }
107
108 /// <summary>
109 /// <para>
110 /// Counts the sequence symbol frequency using the specified link.
111 /// </para>
112 /// <para></para>
113 /// </summary>
114 /// <param name="link">
115 /// <para>The link.</para>
116 /// <para></para>
117 /// </param>
118 [MethodImpl(MethodImplOptions.AggressiveInlining)]
119 protected virtual void CountSequenceSymbolFrequency(TLinkAddress link)
120 {
121     var symbolFrequencyCounter = new
122         ↪ SequenceSymbolFrequencyOneOffCounter<TLinkAddress>(_links, link, _symbol);
123     _total = Arithmetic.Add(_total, symbolFrequencyCounter.Count());
124 }
125 [MethodImpl(MethodImplOptions.AggressiveInlining)]
126 private TLinkAddress EachElementHandler(IList<TLinkAddress>? doublet)
127 {
128     var constants = _links.Constants;
129     var doubletIndex = doublet[constants.IndexPart];
130     if (_visits.Add(doubletIndex))
131     {
132         CountCore(doubletIndex);
133     }
134     return constants.Continue;
135 }
136 }

```

1.20 ./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> :
    ↳ ISequenceHeightProvider<TLinkAddress>
18  {
19      private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↳ EqualityComparer<TLinkAddress>.Default;
20      private readonly TLinkAddress _heightPropertyMarker;
21      private readonly ISequenceHeightProvider<TLinkAddress> _baseHeightProvider;
22      private readonly IConverter<TLinkAddress> _addressToUnaryNumberConverter;
23      private readonly IConverter<TLinkAddress> _unaryNumberToAddressConverter;
24      private readonly IProperties<TLinkAddress, TLinkAddress, TLinkAddress> _propertyOperator;
25
26      /// <summary>
27      /// <para>
28      /// Initializes a new <see cref="CachedSequenceHeightProvider"/> instance.
29      /// </para>
30      /// <para></para>
31      /// </summary>
32      /// <param name="baseHeightProvider">
33      /// <para>A base height provider.</para>
34      /// <para></para>
35      /// </param>
36      /// <param name="addressToUnaryNumberConverter">
37      /// <para>A address to unary number converter.</para>
38      /// <para></para>
39      /// </param>
40      /// <param name="unaryNumberToAddressConverter">
41      /// <para>A unary number to address converter.</para>
42      /// <para></para>
43      /// </param>
44      /// <param name="heightPropertyMarker">
45      /// <para>A height property marker.</para>
46      /// <para></para>
47      /// </param>
48      /// <param name="propertyOperator">
49      /// <para>A property operator.</para>
50      /// <para></para>
51      /// </param>
52      [MethodImpl(MethodImplOptions.AggressiveInlining)]
53      public CachedSequenceHeightProvider(
54          ISequenceHeightProvider<TLinkAddress> baseHeightProvider,
55          IConverter<TLinkAddress> addressToUnaryNumberConverter,
56          IConverter<TLinkAddress> unaryNumberToAddressConverter,
57          TLinkAddress heightPropertyMarker,
58          IProperties<TLinkAddress, TLinkAddress, TLinkAddress> propertyOperator)
59      {
60          _heightPropertyMarker = heightPropertyMarker;
61          _baseHeightProvider = baseHeightProvider;
62          _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 }

```

1.21 ./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;
40
41         /// <summary>
42         /// <para>
43         /// Gets the sequence.
44         /// </para>
45         /// <para></para>
46         /// </summary>
47         /// <param name="sequence">
48         /// <para>The sequence.</para>
49         /// <para></para>
50         /// </param>
51         /// <returns>
52         /// <para>The height.</para>
53         /// <para></para>
54         /// </returns>
55         [MethodImpl(MethodImplOptions.AggressiveInlining)]
56         public TLinkAddress Get(TLinkAddress sequence)
57         {
58             var height = default(TLinkAddress);
59             var pairOrElement = sequence;
60             while (!_elementMatcher.IsMatched(pairOrElement))
61             {
62                 pairOrElement = _links.GetTarget(pairOrElement);
63                 height = Arithmetic.Increment(height);
64             }
65         }
66     }
67 }

```



```

61     }
62     return height;
63 }
64 }
65 }

```

1.22 ./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     }

```

1.23 ./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.
29 //         /// </para>
30 //         /// <para></para>
31 //         /// </summary>
32 //         /// <param name="links">
33 //         /// <para>A links.</para>
34 //         /// <para></para>
35 //         /// </param>
36 //         /// <param name="frequencyMarker">
37 //         /// <para>A frequency marker.</para>
38 //         /// <para></para>
39 //         /// </param>
40 //         /// <param name="unaryOne">
41 //         /// <para>A unary one.</para>
42 //         /// <para></para>
43 //         /// </param>
44 //         /// <param name="unaryNumberIncrementer">
45 //         /// <para>A unary number incrementer.</para>
46 //         /// <para></para>
47 //         /// </param>
48 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
49 //         public FrequencyIncrementer(ILinks<TLinkAddress> links, TLinkAddress frequencyMarker,
50 //         ↪ TLinkAddress unaryOne, IIncrementer<TLinkAddress> unaryNumberIncrementer)
51 //         : 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 =
78 //          ↪ _unaryNumberIncrementer.Increment(links.GetSource(frequency));
79 //          return links.GetOrCreate(incrementedSource, _frequencyMarker);
80 //      }
81 // }

```

1.24 ./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>,
18 //     ↪ IIncrementer<TLinkAddress>
19 //     {
20 //         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
21 //         ↪ EqualityComparer<TLinkAddress>.Default;
22 //         private readonly TLinkAddress _unaryOne;
23 //
24 //         /// <summary>
25 //         /// <para>
26 //         /// Initializes a new <see cref="UnaryNumberIncrementer"/> 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="unaryOne">
35 //         /// <para>A unary one.</para>
36 //         /// <para></para>
37 //         /// </param>
38 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
39 //         public UnaryNumberIncrementer(ILinks<TLinkAddress> links, TLinkAddress unaryOne) :
40 //         ↪ base(links) => _unaryOne = unaryOne;
41 //     }

```

```

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  //  }

```

1.25 ./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> :
17         ↳ ISequenceIndex<TLinkAddress>
18     {
19         private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
20             ↳ EqualityComparer<TLinkAddress>.Default;
21         private readonly LinkFrequenciesCache<TLinkAddress> _cache;
22
23         /// <summary>
24         /// <para>
25         /// Initializes a new <see cref="CachedFrequencyIncrementingSequenceIndex"/> instance.
26         /// </para>
27         /// <para></para>
28         /// </summary>
29         /// <param name="cache">
30         /// <para>A cache.</para>
31         /// <para></para>
32         /// </param>
33         [MethodImpl(MethodImplOptions.AggressiveInlining)]
34         public CachedFrequencyIncrementingSequenceIndex(LinkFrequenciesCache<TLinkAddress>
35             ↳ cache) => _cache = cache;
36
37         /// <summary>
38         /// <para>
39         /// Determines whether this instance add.
40         /// </para>
41         /// <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(ICollection<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     /// <summary>
77     /// <para>
78     /// Determines whether this instance might contain.
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 indexed.</para>
88     /// <para></para>
89     /// </returns>
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     public bool MightContain(ICollection<TLinkAddress>? sequence)
92     {
93         var indexed = true;
94         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 }

```

1.26 ./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.Incrementers;

```

```

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 //         /// </param>
35 //         /// <param name="frequencyPropertyOperator">
36 //         /// <para>A frequency property operator.</para>
37 //         /// </param>
38 //         /// <param name="frequencyIncrementer">
39 //         /// <para>A frequency incrementer.</para>
40 //         /// </param>
41 //         /// </param>
42 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
43 //         public FrequencyIncrementingSequenceIndex(ILinks<TLinkAddress> links,
44 //             IProperty<TLinkAddress, TLinkAddress> frequencyPropertyOperator, IIncrementer<TLinkAddress>
45 //             frequencyIncrementer)
46 //             : base(links)
47 //         {
48 //             _frequencyPropertyOperator = frequencyPropertyOperator;
49 //             _frequencyIncrementer = frequencyIncrementer;
50 //         }
51 //
52 //         /// <summary>
53 //         /// <para>
54 //         /// Determines whether this instance add.
55 //         /// </para>
56 //         /// <para></para>
57 //         /// </summary>
58 //         /// <param name="sequence">
59 //         /// <para>The sequence.</para>
60 //         /// </param>
61 //         /// <returns>
62 //         /// <para>The indexed.</para>
63 //         /// <para></para>
64 //         /// </returns>
65 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]
66 //         public override bool Add(IList<TLinkAddress>? sequence)
67 //         {
68 //             var indexed = true;
69 //             var i = sequence.Count;
70 //             while (--i >= 1 && (indexed = IsIndexedWithIncrement(sequence[i - 1],
71 //                 sequence[i]))) { }
72 //             for (; i >= 1; i--)
73 //             {
74 //                 Increment(_links.GetOrCreate(sequence[i - 1], sequence[i]));
75 //             }
76 //             return indexed;
77 //         }
78 //         [MethodImpl(MethodImplOptions.AggressiveInlining)]

```

```

77 //         private bool IsIndexedWithIncrement(TLinkAddress source, TLinkAddress target)
78 //         {
79 //             var link = _links.SearchOrDefault(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 // }

```

1.27 ./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(ICollection<TLinkAddress>? sequence);
40    }
41 }

```

1.28 ./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>,
    ↳ ISequenceIndex<TLinkAddress>
17  {
18      private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↳ EqualityComparer<TLinkAddress>.Default;
19
20      /// <summary>
21      /// <para>
22      /// Initializes a new <see cref="SequenceIndex"/> instance.
23      /// </para>
24      /// <para></para>
25      /// </summary>
26      /// <param name="links">
27      /// <para>A links.</para>
28      /// <para></para>
29      /// </param>
30      [MethodImpl(MethodImplOptions.AggressiveInlining)]
31      public SequenceIndex(ILinks<TLinkAddress> links) : base(links) { }
32
33      /// <summary>
34      /// <para>
35      /// Determines whether this instance add.
36      /// </para>
37      /// <para></para>
38      /// </summary>
39      /// <param name="sequence">
40      /// <para>The sequence.</para>
41      /// <para></para>
42      /// </param>
43      /// <returns>
44      /// <para>The indexed.</para>
45      /// <para></para>
46      /// </returns>
47      [MethodImpl(MethodImplOptions.AggressiveInlining)]
48      public virtual bool Add(IList<TLinkAddress>? sequence)
49      {
50          var indexed = true;
51          var i = sequence.Count;
52          while (--i >= 1 && (indexed =
    ↳ !_equalityComparer.Equals(_links.SearchOrDefault(sequence[i - 1], sequence[i]),
    ↳ default))) { }
53          for (; i >= 1; i--)
54          {
55              _links.GetOrCreate(sequence[i - 1], sequence[i]);
56          }
57          return indexed;
58      }
59
60      /// <summary>
61      /// <para>
62      /// Determines whether this instance might contain.
63      /// </para>
64      /// <para></para>
65      /// </summary>
66      /// <param name="sequence">
67      /// <para>The sequence.</para>
68      /// <para></para>
69      /// </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  }

```

1.29 ./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(ICollection<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            });
59            if (!indexed)
60            {
61                _links.SyncRoot.DoWrite(() =>
62                {
63                    for (; i >= 1; i--)
64                    {
65                        links.GetOrCreate(sequence[i - 1], sequence[i]);
66                    }
67                });
68                return indexed;
69            }
70
71            /// <summary>
72            /// <para>
73            /// Determines whether this instance might contain.
74            /// </para>
75            /// <para></para>
76            /// </summary>
77            /// <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(IList<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     }

```

1.30 ./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(IList<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(IList<TLinkAddress>? sequence) => true;
50     }
51 }

```

1.31 ./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     {
22         where TLinkAddress: struct
23
24         /// <summary>
25         /// <para>
26         /// The big integer to raw number sequence converter.
27         /// </para>
28         /// <para></para>
29         /// </summary>
30         public readonly BigIntegerToRawNumberSequenceConverter<TLinkAddress>
31         ↳ BigIntegerToRawNumberSequenceConverter;
32
33         /// <summary>
34         /// <para>
35         /// Initializes a new <see cref="DecimalToRationalConverter"/> instance.
36         /// </para>
37         /// <para></para>
38         /// </summary>
39         /// <param name="links">
40         /// <para>A links.</para>
41         /// <para></para>
42         /// </param>
43         /// <param name="bigIntegerToRawNumberSequenceConverter">
44         /// <para>A big integer to raw number sequence converter.</para>
45         /// <para></para>
46         /// </param>
47         public DecimalToRationalConverter(ILinks<TLinkAddress> links,
48         ↳ BigIntegerToRawNumberSequenceConverter<TLinkAddress>
49         ↳ bigIntegerToRawNumberSequenceConverter) : base(links)
50     {
51         BigIntegerToRawNumberSequenceConverter = bigIntegerToRawNumberSequenceConverter;
52     }
53
54     /// <summary>
55     /// <para>
56     /// Converts the decimal.
57     /// </para>
58     /// <para></para>
59     /// </summary>
60     /// <param name="@decimal">
61     /// <para>The decimal.</para>
62     /// <para></para>
63     /// </param>
64     /// <returns>
65     /// <para>The link</para>
66     /// <para></para>
67     /// </returns>
68     public TLinkAddress Convert(decimal @decimal)
69     {
70         var decimalAsString = @decimal.ToString(CultureInfo.InvariantCulture);
71         var dotPosition = decimalAsString.IndexOf('.');
72         var decimalWithoutDots = decimalAsString;
73         int digitsAfterDot = 0;
74         if (dotPosition != -1)
75         {
76             decimalWithoutDots = decimalWithoutDots.Remove(dotPosition, 1);
77             digitsAfterDot = decimalAsString.Length - 1 - dotPosition;
78         }
79         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 }

```

1.32 ./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>
44         public RationalToDecimalConverter(ILinks<TLinkAddress> links,
45         ↪ RawNumberSequenceToBigIntegerConverter<TLinkAddress>
46         ↪ rawNumberSequenceToBigIntegerConverter) : base(links)
47     {
48         RawNumberSequenceToBigIntegerConverter = rawNumberSequenceToBigIntegerConverter;
49     }
50
51     /// <summary>
52     /// <para>
53     /// Converts the rational number.
54     /// </para>
55     /// <para></para>
56     /// </summary>
57     /// <param name="rationalNumber">
58     /// <para>The rational number.</para>
59     /// <para></para>
60     /// </param>
61     /// <returns>
62     /// <para>The decimal</para>
63     /// </returns>

```

```

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 }

```

1.33 ./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> :
23     ↪ LinksDecoratorBase<TLinkAddress>, IConverter<BigInteger, TLinkAddress>
24     where TLinkAddress : struct
25     {
26         /// <summary>
27         /// <para>
28         /// The max value.
29         /// </para>
30         /// <para></para>
31         /// </summary>
32         public static readonly TLinkAddress MaximumValue = NumericType<TLinkAddress>.MaxValue;
33         /// <summary>
34         /// <para>
35         /// The maximum value.
36         /// </para>
37         /// <para></para>
38         /// </summary>
39         public static readonly TLinkAddress BitMask = Bit.ShiftRight(MaximumValue, 1);
40         /// <summary>
41         /// <para>
42         /// The address to number converter.
43         /// </para>
44         /// <para></para>
45         /// </summary>
46         public readonly IConverter<TLinkAddress> AddressToNumberConverter;
47         /// <summary>
48         /// <para>
49         /// The list to sequence converter.
50         /// </para>
51         /// <para></para>
52         /// </summary>
53         public readonly IConverter<IList<TLinkAddress>, TLinkAddress> ListToSequenceConverter;
54         /// <summary>
55         /// <para>
56         /// The negative number marker.
57         /// </para>
58         /// <para></para>
59         /// </summary>
60         public readonly TLinkAddress NegativeNumberMarker;
61
62         /// <summary>
63         /// <para>
64         /// Initializes a new <see cref="BigIntegerToRawNumberSequenceConverter"/> instance.
65         /// </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     /// <summary>
109     /// <para>
110     /// Converts the big integer.
111     /// </para>
112     /// <para></para>
113     /// </summary>
114     /// <param name="bigInteger">
115     /// <para>The big integer.</para>
116     /// <para></para>
117     /// </param>
118     /// <returns>
119     /// <para>The link</para>
120     /// <para></para>
121     /// </returns>
122     public TLinkAddress Convert(BigInteger bigInteger)
123     {
124         var sign = bigInteger.Sign;
125         var number = GetRawNumberParts(sign == -1 ? BigInteger.Negate(bigInteger) :
126             ↪ bigInteger);
127         var numberSequence = ListToSequenceConverter.Convert(number);
128         return sign == -1 ? _links.GetOrCreate(NegativeNumberMarker, numberSequence) :
129             ↪ numberSequence;
130     }
131 }
132 }

```

1.34 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Raw/LongRawNumberSequenceToNumberConverter.c

```

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> :
22         ↳ LinksDecoratorBase<TSource>, IConverter<TSource, TTarget>
23     {
24         private static readonly int _bitsPerRawNumber = NumericType<TSource>.BitsSize - 1;
25         private static readonly UncheckedConverter<TSource, TTarget> _sourceToTargetConverter =
26             ↳ UncheckedConverter<TSource, TTarget>.Default;
27         private readonly IConverter<TSource> _numberToAddressConverter;
28
29         /// <summary>
30         /// <para>
31         /// Initializes a new <see cref="LongRawNumberSequenceToNumberConverter"/> 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="numberToAddressConverter">
40         /// <para>A number to address converter.</para>
41         /// <para></para>
42         /// </param>
43         [MethodImpl(MethodImplOptions.AggressiveInlining)]
44         public LongRawNumberSequenceToNumberConverter(ILinks<TSource> links, IConverter<TSource>
45             ↳ numberToAddressConverter) : base(links) => _numberToAddressConverter =
46             ↳ numberToAddressConverter;
47
48         /// <summary>
49         /// <para>
50         /// Converts the source.
51         /// </para>
52         /// <para></para>
53         /// </summary>
54         /// <param name="source">
55         /// <para>The source.</para>
56         /// <para></para>
57         /// </param>
58         /// <returns>
59         /// <para>The target</para>
60         /// <para></para>
61         /// </returns>
62         [MethodImpl(MethodImplOptions.AggressiveInlining)]
63         public TTarget Convert(TSource source)
64         {
65             var constants = Links.Constants;
66             var externalReferencesRange = constants.ExternalReferencesRange;
67             if (externalReferencesRange.HasValue &&
68                 ↳ externalReferencesRange.Value.Contains(source))
69             {
70                 return
71                 ↳ _sourceToTargetConverter.Convert(_numberToAddressConverter.Convert(source));
72             }
73             else
74             {
75                 var pair = Links.GetLink(source);
76                 var walker = new LeftSequenceWalker<TSource>(Links, new DefaultStack<TSource>(),
77                     ↳ (link) => externalReferencesRange.HasValue &&
78                     ↳ externalReferencesRange.Value.Contains(link));
79                 TTarget result = default;
80                 foreach (var element in walker.Walk(source))
81                 {
82                     result = Bit.Or(Bit.ShiftLeft(result, _bitsPerRawNumber), Convert(element));
83                 }
84                 return result;
85             }
86         }
87     }
88 }

```

```

79     }
80 }

```

1.35 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Row/NumberToLongRawNumberSequenceConverter.c

```

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.Row
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> :
21         ↳ LinksDecoratorBase<TTarget>, IConverter<TSource, TTarget>
22     {
23         private static readonly Comparer<TSource> _comparer = Comparer<TSource>.Default;
24         private static readonly TSource _maximumValue = NumericType<TSource>.MaxValue;
25         private static readonly int _bitsPerRawNumber = NumericType<TTarget>.BitsSize - 1;
26         private static readonly TSource _bitMask = Bit.ShiftRight(_maximumValue,
27             ↳ NumericType<TTarget>.BitsSize + 1);
28         private static readonly TSource _maximumConvertibleAddress = CheckedConverter<TTarget,
29             ↳ TSource>.Default.Convert(Arithmetic.Decrement(Hybrid<TTarget>.ExternalZero));
30         private static readonly UncheckedConverter<TSource, TTarget> _sourceToTargetConverter =
31             ↳ UncheckedConverter<TSource, TTarget>.Default;
32         private readonly IConverter<TTarget> _addressToNumberConverter;
33
34         /// <summary>
35         /// <para>
36         /// Initializes a new <see cref="NumberToLongRawNumberSequenceConverter"/> instance.
37         /// </para>
38         /// <para></para>
39         /// </summary>
40         /// <param name="links">
41         /// <para>A links.</para>
42         /// <para></para>
43         /// </param>
44         /// <param name="addressToNumberConverter">
45         /// <para>A address to number converter.</para>
46         /// <para></para>
47         /// </param>
48         [MethodImpl(MethodImplOptions.AggressiveInlining)]
49         public NumberToLongRawNumberSequenceConverter(ILinks<TTarget> links, IConverter<TTarget>
50             ↳ addressToNumberConverter) : base(links) => _addressToNumberConverter =
51             ↳ addressToNumberConverter;
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         /// <returns>
64         /// <para>The target</para>
65         /// <para></para>
66         /// </returns>
67         [MethodImpl(MethodImplOptions.AggressiveInlining)]
68         public TTarget Convert(TSource source)
69         {
70             if (_comparer.Compare(source, _maximumConvertibleAddress) > 0)
71             {
72                 var numberPart = Bit.And(source, _bitMask);
73                 var convertedNumber = _addressToNumberConverter.Convert(_sourceToTargetConverter
74                     ↳ .Convert(numberPart));

```

```

68         return Links.GetOrCreate(convertedNumber, Convert(Bit.ShiftRight(source,
        ↪ _bitsPerRowNumber)));
69     }
70     else
71     {
72         return
        ↪ _addressToNumberConverter.Convert(_sourceToTargetConverter.Convert(source));
73     }
74 }
75 }
76 }

```

1.36 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Row/RowNumberSequenceToBigIntegerConverter.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.Row
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 RowNumberSequenceToBigIntegerConverter<TLinkAddress> :
        ↪ LinksDecoratorBase<TLinkAddress>, IConverter<TLinkAddress, BigInteger>
24     where TLinkAddress : struct
25     {
26         /// <summary>
27         /// <para>
28         /// The default.
29         /// </para>
30         /// <para></para>
31         /// </summary>
32         public readonly EqualityComparer<TLinkAddress> EqualityComparer =
            ↪ EqualityComparer<TLinkAddress>.Default;
33         /// <summary>
34         /// <para>
35         /// The number to address converter.
36         /// </para>
37         /// <para></para>
38         /// </summary>
39         public readonly IConverter<TLinkAddress, TLinkAddress> NumberToAddressConverter;
40         /// <summary>
41         /// <para>
42         /// The left sequence walker.
43         /// </para>
44         /// <para></para>
45         /// </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="RowNumberSequenceToBigIntegerConverter"/> 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>
68     /// </param>
69     /// <param name="negativeNumberMarker">
70     /// <para>A negative number marker.</para>
71     /// </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     /// <summary>
82     /// <para>
83     /// Converts the big integer.
84     /// </para>
85     /// </summary>
86     /// <param name="bigInteger">
87     /// <para>The big integer.</para>
88     /// </para>
89     /// </param>
90     /// <exception cref="Exception">
91     /// <para>Raw number sequence cannot be empty.</para>
92     /// </para>
93     /// </exception>
94     /// <returns>
95     /// <para>The big integer</para>
96     /// </para>
97     /// </returns>
98     public BigInteger Convert(TLinkAddress bigInteger)
99     {
100         var sign = 1;
101         var bigIntegerSequence = bigInteger;
102         if (EqualityComparer.Equals(_links.GetSource(bigIntegerSequence),
103             ↪ NegativeNumberMarker))
104         {
105             sign = -1;
106             bigIntegerSequence = _links.GetTarget(bigInteger);
107         }
108         using var enumerator = LeftSequenceWalker.Walk(bigIntegerSequence).GetEnumerator();
109         if (!enumerator.MoveNext())
110         {
111             throw new Exception("Raw number sequence cannot be empty.");
112         }
113         var nextPart = NumberToAddressConverter.Convert(enumerator.Current);
114         BigInteger currentBigInt = new(nextPart.ToBytes());
115         while (enumerator.MoveNext())
116         {
117             currentBigInt <= (NumericType<TLinkAddress>.BitsSize - 1);
118             nextPart = NumberToAddressConverter.Convert(enumerator.Current);
119             currentBigInt |= new BigInteger(nextPart.ToBytes());
120         }
121         return sign == -1 ? BigInteger.Negate(currentBigInt) : currentBigInt;
122     }
123 }

```

1.37 ./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     /// </summary>

```

```

16  /// </summary>
17  /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
18  /// <seealso cref="IConverter{TLinkAddress}"/>
19  public class AddressToUnaryNumberConverter<TLinkAddress> : LinksOperatorBase<TLinkAddress>,
    ↪ IConverter<TLinkAddress>
20  {
21      private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↪ EqualityComparer<TLinkAddress>.Default;
22      private static readonly TLinkAddress _zero = default;
23      private static readonly TLinkAddress _one = Arithmetic.Increment(_zero);
24      private readonly IConverter<int, TLinkAddress> _powerOf2ToUnaryNumberConverter;
25
26      /// <summary>
27      /// <para>
28      /// Initializes a new <see cref="AddressToUnaryNumberConverter"/> 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="powerOf2ToUnaryNumberConverter">
37      /// <para>A power of 2 to unary number converter.</para>
38      /// <para></para>
39      /// </param>
40      [MethodImpl(MethodImplOptions.AggressiveInlining)]
41      public AddressToUnaryNumberConverter(ILinks<TLinkAddress> links, IConverter<int,
    ↪ TLinkAddress> powerOf2ToUnaryNumberConverter) : base(links) =>
    ↪ _powerOf2ToUnaryNumberConverter = powerOf2ToUnaryNumberConverter;
42
43      /// <summary>
44      /// <para>
45      /// Converts the number.
46      /// </para>
47      /// <para></para>
48      /// </summary>
49      /// <param name="number">
50      /// <para>The number.</para>
51      /// <para></para>
52      /// </param>
53      /// <returns>
54      /// <para>The target.</para>
55      /// <para></para>
56      /// </returns>
57      [MethodImpl(MethodImplOptions.AggressiveInlining)]
58      public TLinkAddress Convert(TLinkAddress number)
59      {
60          var links = _links;
61          var nullConstant = links.Constants.Null;
62          var target = nullConstant;
63          for (var i = 0; !_equalityComparer.Equals(number, _zero) && i <
    ↪ NumericType<TLinkAddress>.BitsSize; i++)
64          {
65              if (_equalityComparer.Equals(Bit.And(number, _one), _one))
66              {
67                  target = _equalityComparer.Equals(target, nullConstant)
    ↪ ? _powerOf2ToUnaryNumberConverter.Convert(i)
    ↪ : links.GetOrCreate(_powerOf2ToUnaryNumberConverter.Convert(i), target);
68              }
69              number = Bit.ShiftRight(number, 1);
70          }
71          return target;
72      }
73  }
74
75  }
76  }

```

1.38 ./csharp/Platform.Data.Doublets.Sequences/Numbers/Unary/LinkToltsFrequencyNumberConveter.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 conveter.
14  /// </para>
15  /// <para></para>
16  /// </summary>
17  /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
18  /// <seealso cref="IConverter{Doublet{TLinkAddress}, TLinkAddress}"/>
19  public class LinkToItsFrequencyNumberConveter<TLinkAddress> :
    ↳ LinksOperatorBase<TLinkAddress>, IConverter<Doublet<TLinkAddress>, TLinkAddress>
20  {
21      private static readonly EqualityComparer<TLinkAddress> _equalityComparer =
    ↳ EqualityComparer<TLinkAddress>.Default;
22      private readonly IProperty<TLinkAddress, TLinkAddress> _frequencyPropertyOperator;
23      private readonly IConverter<TLinkAddress> _unaryNumberToAddressConverter;
24
25      /// <summary>
26      /// <para>
27      /// Initializes a new <see cref="LinkToItsFrequencyNumberConveter"/> 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="frequencyPropertyOperator">
36      /// <para>A frequency property operator.</para>
37      /// <para></para>
38      /// </param>
39      /// <param name="unaryNumberToAddressConverter">
40      /// <para>A unary number to address converter.</para>
41      /// <para></para>
42      /// </param>
43      [MethodImpl(MethodImplOptions.AggressiveInlining)]
44      public LinkToItsFrequencyNumberConveter(
45          ILinks<TLinkAddress> links,
46          IProperty<TLinkAddress, TLinkAddress> frequencyPropertyOperator,
47          IConverter<TLinkAddress> unaryNumberToAddressConverter)
48          : base(links)
49      {
50          _frequencyPropertyOperator = frequencyPropertyOperator;
51          _unaryNumberToAddressConverter = unaryNumberToAddressConverter;
52      }
53
54      /// <summary>
55      /// <para>
56      /// Converts the doublet.
57      /// </para>
58      /// <para></para>
59      /// </summary>
60      /// <param name="doublet">
61      /// <para>The doublet.</para>
62      /// <para></para>
63      /// </param>
64      /// <exception cref="ArgumentException">
65      /// <para>Link ({doublet}) not found. </para>
66      /// <para></para>
67      /// </exception>
68      /// <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 }

```

1.39 ./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         /// </param>
35         /// <param name="one">
36         /// <para>A one.</para>
37         /// </param>
38         [MethodImpl(MethodImplOptions.AggressiveInlining)]
39         public PowerOf2ToUnaryNumberConverter(ILinks<TLinkAddress> links, TLinkAddress one) :
40         ↪ base(links)
41         {
42             _unaryNumberPowersOf2 = new TLinkAddress[64];
43             _unaryNumberPowersOf2[0] = one;
44         }
45
46         /// <summary>
47         /// <para>
48         /// Converts the power.
49         /// </para>
50         /// <para></para>
51         /// </summary>
52         /// <param name="power">
53         /// <para>The power.</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
63             ↪ - 1), nameof(power));
64             if (!_equalityComparer.Equals(_unaryNumberPowersOf2[power], default))
65             {
66                 return _unaryNumberPowersOf2[power];
67             }
68             var previousPowerOf2 = Convert(power - 1);
69             var powerOf2 = _links.GetOrCreate(previousPowerOf2, previousPowerOf2);
70             unaryNumberPowersOf2[power] = powerOf2;
71             return powerOf2;

```

```

71     }
72 }
73 }

```

1.40 ./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>
56         /// <para>
57         /// Converts the unary number.
58         /// </para>
59         /// <para></para>
60         /// </summary>
61         /// <param name="unaryNumber">
62         /// <para>The unary number.</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 Convert(TLinkAddress unaryNumber)
71         {
72             if (_equalityComparer.Equals(unaryNumber, default))
73             {
74                 return default;
75             }
76         }
77     }
78 }

```

```

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);

```

1.41 ./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>

```

```

27     /// <para>
28     /// Initializes a new <see cref="UnaryNumberToAddressOrOperationConverter"/> instance.
29     /// </para>
30     /// </para></para>
31     /// </summary>
32     /// <param name="links">
33     /// <para>A links.</para>
34     /// </para></param>
35     /// <param name="powerOf2ToUnaryNumberConverter">
36     /// <para>A power of 2 to unary number converter.</para>
37     /// </param></param>
38     /// </summary>
39     [MethodImpl(MethodImplOptions.AggressiveInlining)]
40     public UnaryNumberToAddressOrOperationConverter(ILinks<TLinkAddress> links,
41         ↳ IConverter<int, TLinkAddress> powerOf2ToUnaryNumberConverter) : base(links) =>
42         ↳ _unaryNumberPowerOf2Indicies =
43         ↳ CreateUnaryNumberPowerOf2IndiciesDictionary(powerOf2ToUnaryNumberConverter);
44
45     /// <summary>
46     /// <para>
47     /// Converts the source number.
48     /// </para>
49     /// </summary>
50     /// <param name="sourceNumber">
51     /// <para>The source number.</para>
52     /// </param>
53     /// <returns>
54     /// <para>The target.</para>
55     /// </returns>
56     [MethodImpl(MethodImplOptions.AggressiveInlining)]
57     public TLinkAddress Convert(TLinkAddress sourceNumber)
58     {
59         var links = _links;
60         var nullConstant = links.Constants.Null;
61         var source = sourceNumber;
62         var target = nullConstant;
63         if (!_equalityComparer.Equals(source, nullConstant))
64         {
65             while (true)
66             {
67                 if (_unaryNumberPowerOf2Indicies.TryGetValue(source, out int powerOf2Index))
68                 {
69                     SetBit(ref target, powerOf2Index);
70                     break;
71                 }
72                 else
73                 {
74                     powerOf2Index = _unaryNumberPowerOf2Indicies[links.GetSource(source)];
75                     SetBit(ref target, powerOf2Index);
76                     source = links.GetTarget(source);
77                 }
78             }
79         }
80         return target;
81     }
82
83     [MethodImpl(MethodImplOptions.AggressiveInlining)]
84     private static Dictionary<TLinkAddress, int>
85     ↳ CreateUnaryNumberPowerOf2IndiciesDictionary(IConverter<int, TLinkAddress>
86     ↳ powerOf2ToUnaryNumberConverter)
87     {
88         var unaryNumberPowerOf2Indicies = new Dictionary<TLinkAddress, int>();
89         for (int i = 0; i < NumericType<TLinkAddress>.BitsSize; i++)
90         {
91             unaryNumberPowerOf2Indicies.Add(powerOf2ToUnaryNumberConverter.Convert(i), i);
92         }
93         return unaryNumberPowerOf2Indicies;
94     }
95
96     [MethodImpl(MethodImplOptions.AggressiveInlining)]
97     private static void SetBit(ref TLinkAddress target, int powerOf2Index) => target =
98     ↳ Bit.Or(target, Bit.ShiftLeft(_one, powerOf2Index));
99 }

```

1.42 ./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 //                         {

```



```

75 //                                     throw new NotImplementedException("Creation cancellation is not
    ↳ implemented.");
76 //                                     }
77 //                                     variants[last++] = variant;
78 //                                     }
79 //                                     }
80 //                                     }
81 //                                     return variants;
82 //                                     }
83 //
84 //                                     /// <summary>
85 //                                     /// <para>
86 //                                     /// Creates the all variants 1 using the specified sequence.
87 //                                     /// </para>
88 //                                     /// <para></para>
89 //                                     /// </summary>
90 //                                     /// <param name="sequence">
91 //                                     /// <para>The sequence.</para>
92 //                                     /// <para></para>
93 //                                     /// </param>
94 //                                     /// <returns>
95 //                                     /// <para>A list of ulong</para>
96 //                                     /// <para></para>
97 //                                     /// </returns>
98 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
99 //                                     public List<ulong> CreateAllVariants1(params ulong[] sequence)
100 //                                     {
101 //                                     return _sync.DoWrite(() =>
102 //                                     {
103 //                                     if (sequence.IsNullOrEmpty())
104 //                                     {
105 //                                     return new List<ulong>();
106 //                                     }
107 //                                     Links.Unsync.EnsureLinkExists(sequence);
108 //                                     if (sequence.Length == 1)
109 //                                     {
110 //                                     return new List<ulong> { sequence[0] };
111 //                                     }
112 //                                     var results = new
    ↳ List<ulong>((int)Platform.Numbers.Math.Catalan((ulong)sequence.Length));
113 //                                     return CreateAllVariants1Core(sequence, results);
114 //                                     });
115 //                                     }
116 //                                     [MethodImpl(MethodImplOptions.AggressiveInlining)]
117 //                                     private List<ulong> CreateAllVariants1Core(ulong[] sequence, List<ulong> results)
118 //                                     {
119 //                                     if (sequence.Length == 2)
120 //                                     {
121 //                                     var link = Links.Unsync.GetOrCreate(sequence[0], sequence[1]);
122 //                                     if (link == Constants.Null)
123 //                                     {
124 //                                     throw new NotImplementedException("Creation cancellation is not
    ↳ implemented.");
125 //                                     }
126 //                                     results.Add(link);
127 //                                     return results;
128 //                                     }
129 //                                     var innerSequenceLength = sequence.Length - 1;
130 //                                     var innerSequence = new ulong[innerSequenceLength];
131 //                                     for (var li = 0; li < innerSequenceLength; li++)
132 //                                     {
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(IList<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],
568 //                      ↪ sequence[i + 1]);
569 //                  }
570 //                  if (sequence.Length >= 3)
571 //                  {
572 //                      StepLeft(matcher.AddFullMatchedToResults, sequence[sequence.Length -
573 //                      ↪ 2], sequence[sequence.Length - 1]);
574 //                  }
575 //                  return results;
576 //              });
577 //          }
578 //      }
579 //      /// <summary>
580 //      /// <para>
581 //      /// The max sequence format size.
582 //      /// </para>
583 //      /// <para></para>
584 //      /// </summary>
585 //      public const int MaxSequenceFormatSize = 200;
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 //              StoppableSequenceWalker.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 //              StoppableSequenceWalker.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,
791 // ↵ Links.Unsync.GetTarget,
792 // ↵ x, x =>
793 //                     {
794 //                         if (filterPosition == (sequence.Length - 1))
795 //                         {
796 //                             return false;
797 //                         }
798 //                         if (filterPosition >= 0)
799 //                         {
800 //                             if (x == sequence[filterPosition + 1])
801 //                             {
802 //                                 filterPosition++;
803 //                             }
804 //                             else
805 //                             {
806 //                                 return false;
807 //                             }
808 //                         }
809 //                         if (filterPosition < 0)
810 //                         {
811 //                             if (x == sequence[0])
812 //                             {
813 //                                 filterPosition = 0;

```

```

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>
884 // ↪ handler, params ulong[] sequence)
885 // {
886 //     return _sync.DoRead(() =>
887 //     {
888 //         if (sequence.Length > 0)
889 //         {
890 //             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))
↪ results.Add(x);
1094 //                      //      return true;
1095 //                  //};
1096 //                  //if (sequence.Length >= 2)
1097 //                      StepRight(handler, sequence[0], sequence[1]);
1098 //                  //var last = sequence.Length - 2;
1099 //                  //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)
↪ throw new NotImplementedException(); // all sequences,
1106 //                  //if (sequence.Length == 1)
1107 //                  //if (sequence.Length == 1)
1108 //                  //if (sequence.Length == 1)
1109 //                  //if (sequence.Length == 1)
1110 //                  //if (sequence.Length == 1)
1111 //                  //if (sequence.Length == 1)
↪ return results;

```

```

1112 //                //}
1113 //                //var matches = new List<List<ulong>>();
1114 //                //var last = sequence.Length - 1;
1115 //                //for (var i = 0; i < last; i++)
1116 //                //{
1117 //                //    var results = new List<ulong>();
1118 //                //    //StepRight(results.Add, sequence[i], sequence[i + 1]);
1119 //                //    PartialStepRight(results.Add, sequence[i], sequence[i + 1]);
1120 //                //    if (results.Count > 0)
1121 //                //        matches.Add(results);
1122 //                //    else
1123 //                //        return results;
1124 //                //    if (matches.Count == 2)
1125 //                //    {
1126 //                //        var merged = new List<ulong>();
1127 //                //        for (var j = 0; j < matches[0].Count; j++)
1128 //                //            for (var k = 0; k < matches[1].Count; k++)
1129 //                //                CloseInnerConnections(merged.Add, matches[0][j],
1130 //                //                matches[1][k]);
1131 //                //        if (merged.Count > 0)
1132 //                //            matches = new List<List<ulong>> { merged };
1133 //                //        else
1134 //                //            return new List<ulong>();
1135 //                //    }
1136 //                //}
1137 //                //if (matches.Count > 0)
1138 //                //{
1139 //                //    var usages = new HashSet<ulong>();
1140 //                //    for (int i = 0; i < sequence.Length; i++)
1141 //                //    {
1142 //                //        AllUsagesCore(sequence[i], usages);
1143 //                //    }
1144 //                //    //for (int i = 0; i < matches[0].Count; i++)
1145 //                //    //    AllUsagesCore(matches[0][i], usages);
1146 //                //    //usages.UnionWith(matches[0]);
1147 //                //    return usages.ToList();
1148 //                //}
1149 //                var firstLinkUsages = new HashSet<ulong>();
1150 //                AllUsagesCore(sequence[0], firstLinkUsages);
1151 //                firstLinkUsages.Add(sequence[0]);
1152 //                //var previousMatchings = firstLinkUsages.ToList(); //new List<ulong>() {
1153 //                //    sequence[0] }; // or all sequences, containing this element?
1154 //                //return GetAllPartiallyMatchingSequencesCore(sequence, firstLinkUsages,
1155 //                //    1).ToList();
1156 //                var results = new HashSet<ulong>();
1157 //                foreach (var match in GetAllPartiallyMatchingSequencesCore(sequence,
1158 //                //    firstLinkUsages, 1))
1159 //                //    {
1160 //                //        AllUsagesCore(match, results);
1161 //                //    }
1162 //                //    return results.ToList();
1163 //                }
1164 //                return new List<ulong>();
1165 //            });
1166 //        }
1167 //        /// <remarks>
1168 //        /// TODO: Может потребоваться ограничение на уровень глубины рекурсии
1169 //        /// </remarks>
1170 //        [MethodImpl(MethodImplOptions.AggressiveInlining)]
1171 //        public HashSet<ulong> AllUsages(ulong link)
1172 //        {
1173 //            return _sync.DoRead(() =>
1174 //            {
1175 //                var usages = new HashSet<ulong>();
1176 //                AllUsagesCore(link, usages);
1177 //                return usages;
1178 //            });
1179 //        }
1180 //        // При сборе всех использований (последовательностей) можно сохранять обратный путь к
1181 //        // той связи с которой начинался поиск (STTTSSSTT),
1182 //        // причём достаточно одного бита для хранения перехода влево или вправо
1183 //        [MethodImpl(MethodImplOptions.AggressiveInlining)]
1184 //        private void AllUsagesCore(ulong link, HashSet<ulong> usages)
1185 //        {
1186 //            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
↵ TotalMarkedSequenceSymbolFrequencyOneOffCounter<ulong>(Links, Options.MarkedSequenceMatcher,
↵ symbol);
1262 //          return counter.Count();
1263 //      }
1264 //      else
1265 //      {
1266 //          var counter = new TotalSequenceSymbolFrequencyOneOffCounter<ulong>(Links,
↵ symbol);
1267 //          return counter.Count();
1268 //      }
1269 //  }
1270 //  [MethodImpl(MethodImplOptions.AggressiveInlining)]
1271 //  private bool AllUsagesCore1(ulong link, HashSet<ulong> usages, Func<IList<LinkIndex>,
↵ LinkIndex> outerHandler)
1272 //  {
1273 //      bool handler(ulong doublet)
1274 //      {
1275 //          if (usages.Add(doublet))
1276 //          {
1277 //              if (outerHandler(new LinkAddress<LinkIndex>(doublet)) !=
↵ Constants.Continue)
1278 //              {
1279 //                  return false;
1280 //              }
1281 //              if (!AllUsagesCore1(doublet, usages, outerHandler))
1282 //              {
1283 //                  return false;
1284 //              }
1285 //          }
1286 //          return true;
1287 //      }
1288 //      return Links.Unsync.Each(link, Constants.Any, handler)
1289 //          && Links.Unsync.Each(Constants.Any, link, handler);
1290 //  }
1291 //
1292 //      /// <summary>
1293 //      /// <para>
1294 //      /// Calculates the all usages using the specified totals.
1295 //      /// </para>
1296 //      /// <para></para>
1297 //      /// </summary>
1298 //      /// <param name="totals">
1299 //      /// <para>The totals.</para>
1300 //      /// <para></para>
1301 //      /// </param>
1302 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
1303 //      public void CalculateAllUsages(ulong[] totals)
1304 //      {
1305 //          var calculator = new AllUsagesCalculator(Links, totals);
1306 //          calculator.Calculate();
1307 //      }
1308 //
1309 //      /// <summary>
1310 //      /// <para>
1311 //      /// Calculates the all usages 2 using the specified totals.
1312 //      /// </para>
1313 //      /// <para></para>
1314 //      /// </summary>
1315 //      /// <param name="totals">
1316 //      /// <para>The totals.</para>
1317 //      /// <para></para>
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 зацикливания
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,
↵ HashSet<ulong> intersectWith, HashSet<ulong> usages)
1668 //     {
1669 //         _links = links;
1670 //         _intersectWith = intersectWith;
1671 //         _usages = usages;
1672 //         _enter = new HashSet<ulong>(); // защита от зацикливания
1673 //     }
1674 //
1675 //     /// <summary>
1676 //     /// <para>
1677 //     /// Determines whether this instance collect.
1678 //     /// </para>
1679 //     /// <para></para>
1680 //     /// </summary>
1681 //     /// <param name="link">
1682 //     /// <para>The link.</para>
1683 //     /// <para></para>
1684 //     /// </param>
1685 //     /// <returns>
1686 //     /// <para>The bool</para>
1687 //     /// <para></para>
1688 //     /// </returns>
1689 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1690 //     public bool Collect(ulong link)
1691 //     {
1692 //         if (_enter.Add(link))
1693 //         {
1694 //             if (_intersectWith.Contains(link))
1695 //             {
1696 //                 _usages.Add(link);
1697 //             }
1698 //             _links.Unsync.Each(link, _links.Constants.Any, Collect);
1699 //             _links.Unsync.Each(_links.Constants.Any, link, Collect);
1700 //         }
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,
1929 //                                     ↪ next);
1930 //                     collector.Collect(linksToConnect[i]);
1931 //                     //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
1959 //         BitArray((int)_links.Total + 1);
1960 //         if (linksToConnect.Length > 0)
1961 //         {
1962 //             Links.EnsureLinkExists(linksToConnect);
1963 //             var collector1 = new AllUsagesCollector2(Links.Unsync, results);
1964 //             collector1.Collect(linksToConnect[0]);
1965 //             for (var i = 1; i < linksToConnect.Length; i++)
1966 //             {
1967 //                 var next = new BitString((long)Links.Unsync.Count() + 1); //new
1968 //                 BitArray((int)_links.Total + 1);
1969 //                 var collector = new AllUsagesCollector2(Links.Unsync, next);
1970 //                 collector.Collect(linksToConnect[i]);
1971 //                 results = results.And(next);
1972 //             }
1973 //             return results.GetSetUInt64Indices();
1974 //         }
1975 //     });
1976 // }
1977 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
1978 // private static ulong[] Simplify(ulong[] sequence)
1979 // {
1980 //     // Считаем новый размер последовательности
1981 //     long newLength = 0;
1982 //     var zeroOrManyStepped = false;
1983 //     for (var i = 0; i < sequence.Length; i++)
1984 //     {
1985 //         if (sequence[i] == ZeroOrMany)
1986 //         {
1987 //             if (zeroOrManyStepped)
1988 //             {
1989 //                 continue;
1990 //             }
1991 //             zeroOrManyStepped = true;
1992 //         }
1993 //         else
1994 //         {
1995 //             //if (zeroOrManyStepped) Is it efficient?
1996 //             zeroOrManyStepped = false;
1997 //         }
1998 //         newLength++;
1999 //     }
2000 //     // Строим новую последовательность
2001 //     zeroOrManyStepped = false;
2002 //     var newSequence = new ulong[newLength];
2003 //     long j = 0;
2004 //     for (var i = 0; i < sequence.Length; i++)
2005 //     {
2006 //         //var current = zeroOrManyStepped;
2007 //         //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) //
↳ coupleSource.Linker == Net.And &&
2352 //                  {
2353 //                      result[offset + 1] = couple;
2354 //                      if (++added == 2)
2355 //                      {
2356 //                          return false;
2357 //                      }
2358 //                  }
2359 //              }
2360 //              return true;
2361 //          });
2362 //          return added > 0;
2363 //      }
2364 //
2365 //      #endregion
2366 //
2367 //      #region Walkers
2368 //
2369 //      /// <summary>
2370 //      /// <para>
2371 //      /// Represents the pattern matcher.
2372 //      /// </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 //      //      {      /* a * matches zero or more instances */
2642 //      //      if (matchhere(regexp, text))
2643 //      //      return 1;
2644 //      //      } while (*text != '\0' && (*text++ == c || c == '.'));
2645 //      //      return 0;
2646 //      //}
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 -
2678 ↪ _lastMatchedBlockPosition);
2679 //      if (_sequencePosition < currentPatternBlock.Start)
2680 //      {
2681 //      _sequencePosition++;
2682 //      return true; // Двигаемся дальше
2683 //      }
2684 //      // Это последний блок
2685 //      if (_pattern.Count == _patternPosition + 1)
2686 //      {
2687 //      _patternPosition++;
2688 //      _sequencePosition = 0;
2689 //      return false; // Полное соответствие
2690 //      }
2691 //      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 //          /// </param>
2776 //          [MethodImpl(MethodImplOptions.AggressiveInlining)]
2777 //          public void AddAllPatternMatchedToResults(IEnumerable<ulong> sequencesToMatch)
2778 //          {
2779 //              foreach (var sequenceToMatch in sequencesToMatch)
2780 //              {
2781 //                  if (PatternMatch(sequenceToMatch))
2782 //                  {
2783 //                      _results.Add(sequenceToMatch);
2784 //                  }
2785 //              }
2786 //          }
2787 //      }
2788 //
2789 //      #endregion
2790 //  }
2791 // }

```

1.43 ./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 //     /// x*y - 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.
35 //     ///
36 //     /// Рост последовательности слева и справа.
37 //     /// Поиск со звездочкой.
38 //     /// URL, PURL - реестр используемых во вне ссылок на ресурсы,
39 //     /// так же проблема может быть решена при реализации дистанционных триггеров.
40 //     /// Нужны ли уникальные указатели вообще?
41 //     /// Что если обращение к информации будет происходить через содержимое всегда?
42 //     ///
43 //     /// Писать тесты.
44 //     ///
45 //     /// Можно убрать зависимость от конкретной реализации Links,
46 //     /// на зависимость от абстрактного элемента, который может быть представлен несколькими
47 //     /// ↪ способами.
48 //     ///
49 //     /// Можно ли как-то сделать один общий интерфейс
50 //     ///
51 //     ///

```

```

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(ICollection<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,
sequenceLink) - 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(ICollection<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(ICollection<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(ICollection<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,
377 //                          ↪ Options.SequenceMarkerLink, any), handler);
378 //                      }
379 //                      else
380 //                      {
381 //                          return Links.Unsync.Each(handler, new Link<LinkIndex>(any, any,
382 //                          ↪ any));
383 //                      }
384 //                  }
385 //                  if (Options.UseSequenceMarker)
386 //                  {
387 //                      var sequenceLinkValues = Links.Unsync.GetLink(link);
388 //                      if (sequenceLinkValues[Constants.SourcePart] ==
389 //                      ↪ Options.SequenceMarkerLink)
390 //                      {
391 //                          link = sequenceLinkValues[Constants.TargetPart];
392 //                      }
393 //                      var sequence = Options.Walker.Walk(link).ToArray().ShiftRight();
394 //                      sequence[0] = link;
395 //                      return handler(sequence);
396 //                  }
397 //                  else if (restriction.Count == 2)
398 //                  {
399 //                      throw new NotImplementedException();
400 //                  }
401 //                  else if (restriction.Count == 3)
402 //                  {
403 //                      return Links.Unsync.Each(restriction, handler);
404 //                  }
405 //                  else
406 //                  {
407 //                      var sequence = restriction.SkipFirst();
408 //                      if (Options.UseIndex && !Options.Index.MightContain(sequence))
409 //                      {
410 //                          return Constants.Break;
411 //                      }
412 //                      return EachCore(sequence, handler);
413 //                  }
414 //              }
415 //          });
416 //      }
417 //      [MethodImpl(MethodImplOptions.AggressiveInlining)]
418 //      private LinkIndex EachCore(IList<LinkIndex> values, ReadHandler<LinkIndex> handler)
419 //      {
420 //          var matcher = new Matcher(this, values, new HashSet<LinkIndex>(), handler);
421 //          // TODO: Find out why matcher.HandleFullMatched executed twice for the same
422 //          ↪ sequence Id.
423 //          Func<IList<LinkIndex>, LinkIndex> innerHandler = Options.UseSequenceMarker ?
424 //          ↪ (Func<IList<LinkIndex>, LinkIndex>)matcher.HandleFullMatchedSequence :
425 //          ↪ matcher.HandleFullMatched;
426 //          //if (sequence.Length >= 2)
427 //          if (StepRight(innerHandler, values[0], values[1]) != Constants.Continue)

```

```

422 //         {
423 //             return Constants.Break;
424 //         }
425 //         var last = values.Count - 2;
426 //         for (var i = 1; i < last; i++)
427 //         {
428 //             if (PartialStepRight(innerHandler, values[i], values[i + 1]) !=
↳ Constants.Continue)
429 //             {
430 //                 return Constants.Break;
431 //             }
432 //         }
433 //         if (values.Count >= 3)
434 //         {
435 //             if (StepLeft(innerHandler, values[values.Count - 2], values[values.Count -
↳ 1]) != Constants.Continue)
436 //             {
437 //                 return Constants.Break;
438 //             }
439 //         }
440 //         return Constants.Continue;
441 //     }
442 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
443 //     private LinkIndex PartialStepRight(Func<IList<LinkIndex>, LinkIndex> handler,
↳ LinkIndex left, LinkIndex right)
444 //     {
445 //         return Links.Unsync.Each(doublet =>
446 //         {
447 //             var doubletIndex = doublet[Constants.IndexPart];
448 //             if (StepRight(handler, doubletIndex, right) != Constants.Continue)
449 //             {
450 //                 return Constants.Break;
451 //             }
452 //             if (left != doubletIndex)
453 //             {
454 //                 return PartialStepRight(handler, doubletIndex, right);
455 //             }
456 //             return Constants.Continue;
457 //         }, new Link<LinkIndex>(Constants.Any, Constants.Any, left));
458 //     }
459 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
460 //     private LinkIndex StepRight(Func<IList<LinkIndex>, LinkIndex> handler, LinkIndex
↳ left, LinkIndex right) => Links.Unsync.Each(rightStep => TryStepRightUp(handler, right,
↳ rightStep[Constants.IndexPart]), new Link<LinkIndex>(Constants.Any, left, Constants.Any));
461 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
462 //     private LinkIndex TryStepRightUp(Func<IList<LinkIndex>, LinkIndex> handler, LinkIndex
↳ right, LinkIndex stepFrom)
463 //     {
464 //         var upStep = stepFrom;
465 //         var firstSource = Links.Unsync.GetTarget(upStep);
466 //         while (firstSource != right && firstSource != upStep)
467 //         {
468 //             upStep = firstSource;
469 //             firstSource = Links.Unsync.GetSource(upStep);
470 //         }
471 //         if (firstSource == right)
472 //         {
473 //             return handler(new LinkAddress<LinkIndex>(stepFrom));
474 //         }
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 //  /// <para></para>
624 //  /// </summary>
625 //  /// <param name="restriction">
626 //  /// <para>The restriction.</para>
627 //  /// <para></para>
628 //  /// </param>
629 //  [MethodImpl(MethodImplOptions.AggressiveInlining)]
630 //  public void Delete(ICollection<LinkIndex>? restriction)
631 //  {
632 //      _sync.DoWrite(() =>
633 //      {
634 //          var sequence = restriction.SkipFirst();
635 //          // TODO: Check all options only ones before loop execution

```

```

636 //         foreach (var linkToDelete in Each(sequence))
637 //         {
638 //             DeleteOneCore(linkToDelete);
639 //         }
640 //     });
641 // }
642 // [MethodImpl(MethodImplOptions.AggressiveInlining)]
643 // private void DeleteOneCore(LinkIndex link)
644 // {
645 //     if (Options.UseGarbageCollection)
646 //     {
647 //         var sequenceElements = GetSequenceElements(link);
648 //         var sequenceElementsContents = new
↵ Link<ulong>(Links.GetLink(sequenceElements));
649 //         var sequenceLink = GetSequenceByElements(sequenceElements);
650 //         if (Options.UseCascadeDelete || CountUsages(link) == 0)
651 //         {
652 //             if (sequenceLink != Constants.Null)
653 //             {
654 //                 Links.Unsync.Delete(sequenceLink);
655 //             }
656 //             Links.Unsync.Delete(link);
657 //         }
658 //         ClearGarbage(sequenceElementsContents.Source);
659 //         ClearGarbage(sequenceElementsContents.Target);
660 //     }
661 //     else
662 //     {
663 //         if (Options.UseSequenceMarker)
664 //         {
665 //             var sequenceElements = GetSequenceElements(link);
666 //             var sequenceLink = GetSequenceByElements(sequenceElements);
667 //             if (Options.UseCascadeDelete || CountUsages(link) == 0)
668 //             {
669 //                 if (sequenceLink != Constants.Null)
670 //                 {
671 //                     Links.Unsync.Delete(sequenceLink);
672 //                 }
673 //                 Links.Unsync.Delete(link);
674 //             }
675 //         }
676 //         else
677 //         {
678 //             if (Options.UseCascadeDelete || CountUsages(link) == 0)
679 //             {
680 //                 Links.Unsync.Delete(link);
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;
845 //         }
846 //
847 //         /// <summary>
848 //         /// <para>
849 //         /// Determines whether this instance is element.
850 //         /// </para>
851 //         /// <para></para>
852 //         /// </summary>
853 //         /// <param name="link">
854 //         /// <para>The link.</para>
855 //         /// <para></para>
856 //         /// </param>
857 //         /// <returns>
858 //         /// <para>The bool</para>
859 //         /// <para></para>
860 //         /// </returns>
861 //         [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(ICollection<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>
1072 //     /// <param name="sequencesToMatch">
1073 //     /// <para>The sequences to match.</para>
1074 //     /// <para></para>
1075 //     /// </param>
1076 //     [MethodImpl(MethodImplOptions.AggressiveInlining)]
1077 //     public void AddAllPartialMatchedToResults(IEnumerable<LinkIndex> sequencesToMatch)
1078 //     {
1079 //         foreach (var sequenceToMatch in sequencesToMatch)
1080 //         {
1081 //             if (PartialMatch(sequenceToMatch))
1082 //             {
1083 //                 _results.Add(sequenceToMatch);
1084 //             }
1085 //         }
1086 //     }
1087 //     /// <summary>

```

```

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

```

1.44 ./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,
    ↪ IList<TLinkAddress[]> groupedSequence)
41        {
42            var finalSequence = new TLinkAddress[groupedSequence.Count];
43            for (var i = 0; i < finalSequence.Length; i++)
44            {
45                var part = groupedSequence[i];
46                finalSequence[i] = part.Length == 1 ? part[0] :
    ↪ sequences.Create(part.ShiftRight());

```

```

47     }
48     return sequences.Create(finalSequence.ShiftRight());
49 }
50
51 /// <summary>
52 /// <para>
53 /// Returns the list using the specified sequences.
54 /// </para>
55 /// <para></para>
56 /// </summary>
57 /// <typeparam name="TLinkAddress">
58 /// <para>The link.</para>
59 /// <para></para>
60 /// </typeparam>
61 /// <param name="sequences">
62 /// <para>The sequences.</para>
63 /// <para></para>
64 /// </param>
65 /// <param name="sequence">
66 /// <para>The sequence.</para>
67 /// <para></para>
68 /// </param>
69 /// <returns>
70 /// <para>The list.</para>
71 /// <para></para>
72 /// </returns>
73 [MethodImpl(MethodImplOptions.AggressiveInlining)]
74 public static IList<TLinkAddress>? ToList<TLinkAddress>(this ILinks<TLinkAddress>
    ↪ sequences, TLinkAddress sequence)
75 {
76     var list = new List<TLinkAddress>();
77     var filler = new ListFiller<TLinkAddress, TLinkAddress>(list,
    ↪ sequences.Constants.Break);
78     sequences.Each(filler.AddSkipFirstAndReturnConstant, new
    ↪ LinkAddress<TLinkAddress>(sequence));
79     return list;
80 }
81 }
82 }

```

1.45 ./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
260                             ↪ link.");
261                     }
262                 }
263             }
264             if (MarkedSequenceMatcher == null)
265             {
266                 MarkedSequenceMatcher = new
267                     ↪ MarkedSequenceCriterionMatcher<TLinkAddress>(links, SequenceMarkerLink);
268             }
269         }
270         var balancedVariantConverter = new BalancedVariantConverter<TLinkAddress>(links);
271         if (UseCompression)
272         {
273             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 }

```

1.46 ./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,
        ↪ TLinkAddress>

```

```

17 {
18     private readonly IConverter<long, TLinkAddress> _int64ToLongRawNumberConverter;
19
20     /// <summary>
21     /// <para>
22     /// Initializes a new <see cref="DateTimeToLongRawNumberSequenceConverter"/> instance.
23     /// </para>
24     /// <para></para>
25     /// </summary>
26     /// <param name="int64ToLongRawNumberConverter">
27     /// <para>A int 64 to long raw number converter.</para>
28     /// <para></para>
29     /// </param>
30     [MethodImpl(MethodImplOptions.AggressiveInlining)]
31     public DateTimeToLongRawNumberSequenceConverter(IConverter<long, TLinkAddress>
        ↳ int64ToLongRawNumberConverter) => _int64ToLongRawNumberConverter =
        ↳ int64ToLongRawNumberConverter;
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 link</para>
45     /// <para></para>
46     /// </returns>
47     [MethodImpl(MethodImplOptions.AggressiveInlining)]
48     public TLinkAddress Convert(DateTime source) =>
        ↳ _int64ToLongRawNumberConverter.Convert(source.ToFileTimeUtc());
49 }
50 }

```

1.47 ./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> :
        ↳ IConverter<TLinkAddress, DateTime>
17    {
18        private readonly IConverter<TLinkAddress, long> _longRawNumberConverterToInt64;
19
20        /// <summary>
21        /// <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) =>
49         ↪ DateTime.FromFileTimeUtc(_longRawNumberConverterToInt64.Convert(source));
50 }

```

1.48 ./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 }

```

1.49 ./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>

```

```

27     /// </summary>
28     /// <param name="links">
29     /// <para>A links.</para>
30     /// <para></para>
31     /// </param>
32     /// <param name="addressToNumberConverter">
33     /// <para>A address to number converter.</para>
34     /// <para></para>
35     /// </param>
36     /// <param name="unicodeSymbolMarker">
37     /// <para>A unicode symbol marker.</para>
38     /// <para></para>
39     /// </param>
40     [MethodImpl(MethodImplOptions.AggressiveInlining)]
41     public CharToUnicodeSymbolConverter(ILinks<TLinkAddress> links, IConverter<TLinkAddress>
42     ↪ addressToNumberConverter, TLinkAddress unicodeSymbolMarker) : base(links)
43     {
44         _addressToNumberConverter = addressToNumberConverter;
45         _unicodeSymbolMarker = unicodeSymbolMarker;
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 link</para>
59     /// <para></para>
60     /// </returns>
61     [MethodImpl(MethodImplOptions.AggressiveInlining)]
62     public TLinkAddress Convert(char source)
63     {
64         var unaryNumber =
65         ↪ _addressToNumberConverter.Convert(_charToAddressConverter.Convert(source));
66         return _links.GetOrCreate(unaryNumber, _unicodeSymbolMarker);
67     }
68 }

```

1.50 ./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> :
19     ↪ LinksOperatorBase<TLinkAddress>, IConverter<string, TLinkAddress>
20     {
21         private readonly IConverter<string, IList<TLinkAddress>?>
22         ↪ _stringToUnicodeSymbolListConverter;
23         private readonly IConverter<IList<TLinkAddress>, TLinkAddress>
24         ↪ _unicodeSymbolListToSequenceConverter;
25
26         /// <summary>
27         /// <para>
28         /// Initializes a new <see cref="StringToUnicodeSequenceConverter"/> instance.
29         /// </para>
30         /// </summary>
31         /// <param name="links">
32         /// <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></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></para>
165  /// </summary>

```

```

166     /// <param name="source">
167     /// <para>The source.</para>
168     /// <para></para>
169     /// </param>
170     /// <returns>
171     /// <para>The link</para>
172     /// <para></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 }

```

1.51 `./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></para>
14     /// </summary>
15     /// <seealso cref="IConverter{string, IList{TLinkAddress}}"/>
16     public class StringToUnicodeSymbolsListConverter<TLinkAddress> : IConverter<string,
17         ↪ IList<TLinkAddress>?>
18     {
19         private readonly IConverter<char, TLinkAddress> _charToUnicodeSymbolConverter;
20
21         /// <summary>
22         /// <para>
23         /// Initializes a new <see cref="StringToUnicodeSymbolsListConverter"/> instance.
24         /// </para>
25         /// <para></para>
26         /// </summary>
27         /// <param name="charToUnicodeSymbolConverter">
28         /// <para>A char to unicode symbol converter.</para>
29         /// <para></para>
30         /// </param>
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public StringToUnicodeSymbolsListConverter(IConverter<char, TLinkAddress>
33             ↪ charToUnicodeSymbolConverter) => _charToUnicodeSymbolConverter =
34             ↪ charToUnicodeSymbolConverter;
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 elements.</para>
48         /// <para></para>
49         /// </returns>
50         [MethodImpl(MethodImplOptions.AggressiveInlining)]
51         public IList<TLinkAddress>? Convert(string source)
52         {
53             var elements = new TLinkAddress[source.Length];
54             for (var i = 0; i < elements.Length; i++)
55             {
56                 elements[i] = _charToUnicodeSymbolConverter.Convert(source[i]);
57             }
58             return elements;
59         }
60     }
61 }

```

1.52 ./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         // 0 - null link
119         // 1 - nil character (0 character)
120         // ...
121         // 65536 (0(1) + 65535 = 65536 possible values)
122
123     /// <summary>
124     /// <para>
125     /// Creates the char to link using the specified character.
126     /// </para>
127     /// <para></para>
128     /// </summary>
129     /// <param name="character">
130     /// <para>The character.</para>
131     /// <para></para>
132     /// </param>
133     /// <returns>
134     /// <para>The ulong</para>
135     /// <para></para>
136     /// </returns>
137     [MethodImpl(MethodImplOptions.AggressiveInlining)]
138     public static ulong FromCharToLink(char character) => (ulong)character + 1;
139
140     /// <summary>
141     /// <para>
142     /// Creates the link to char using the specified link.
143     /// </para>
144     /// <para></para>
145     /// </summary>
146     /// <param name="link">
147     /// <para>The link.</para>
148     /// <para></para>
149     /// </param>
150     /// <returns>
151     /// <para>The char</para>
152     /// <para></para>
153     /// </returns>
154     [MethodImpl(MethodImplOptions.AggressiveInlining)]
155     public static char FromLinkToChar(ulong link) => (char)(link - 1);

```

```

155     /// <summary>
156     /// <para>
157     /// Determines whether is char link.
158     /// </para>
159     /// </summary>
160     /// <param name="link">
161     /// <para>The link.</para>
162     /// </param>
163     /// <returns>
164     /// <para>The bool</para>
165     /// </returns>
166     [MethodImpl(MethodImplOptions.AggressiveInlining)]
167     public static bool IsCharLink(ulong link) => link <= MapSize;
168
169     /// <summary>
170     /// <para>
171     /// Creates the links to string using the specified links list.
172     /// </para>
173     /// </summary>
174     /// <param name="linksList">
175     /// <para>The links list.</para>
176     /// </param>
177     /// <returns>
178     /// <para>The string</para>
179     /// </returns>
180     [MethodImpl(MethodImplOptions.AggressiveInlining)]
181     public static string FromLinksToString(IList<ulong> linksList)
182     {
183         var sb = new StringBuilder();
184         for (int i = 0; i < linksList.Count; i++)
185         {
186             sb.Append(FromLinkToChar(linksList[i]));
187         }
188         return sb.ToString();
189     }
190
191     /// <summary>
192     /// <para>
193     /// Creates the sequence link to string using the specified link.
194     /// </para>
195     /// </summary>
196     /// <param name="link">
197     /// <para>The link.</para>
198     /// </param>
199     /// <param name="links">
200     /// <para>The links.</para>
201     /// </param>
202     /// <returns>
203     /// <para>The string</para>
204     /// </returns>
205     [MethodImpl(MethodImplOptions.AggressiveInlining)]
206     public static string FromSequenceLinkToString(ulong link, ILinks<ulong> links)
207     {
208         var sb = new StringBuilder();
209         if (links.Exists(link))
210         {
211             StopableSequenceWalker.WalkRight(link, links.GetSource, links.GetTarget,
212                 x => x <= MapSize || links.GetSource(x) == x || links.GetTarget(x) == x,
213                 element =>
214                 {
215                     sb.Append(FromLinkToChar(element));
216                     return true;
217                 });
218         }
219         return sb.ToString();
220     }
221
222     }
223
224
225
226
227
228
229
230
231

```

```

232     /// <summary>
233     /// <para>
234     /// Creates the chars to link array using the specified chars.
235     /// </para>
236     /// <para></para>
237     /// </summary>
238     /// <param name="chars">
239     /// <para>The chars.</para>
240     /// <para></para>
241     /// </param>
242     /// <returns>
243     /// <para>The ulong array</para>
244     /// <para></para>
245     /// </returns>
246     [MethodImpl(MethodImplOptions.AggressiveInlining)]
247     public static ulong[] FromCharsToLinkArray(char[] chars) => FromCharsToLinkArray(chars,
        ↪ chars.Length);
248
249     /// <summary>
250     /// <para>
251     /// Creates the chars to link array using the specified chars.
252     /// </para>
253     /// <para></para>
254     /// </summary>
255     /// <param name="chars">
256     /// <para>The chars.</para>
257     /// <para></para>
258     /// </param>
259     /// <param name="count">
260     /// <para>The count.</para>
261     /// <para></para>
262     /// </param>
263     /// <returns>
264     /// <para>The links sequence.</para>
265     /// <para></para>
266     /// </returns>
267     [MethodImpl(MethodImplOptions.AggressiveInlining)]
268     public static ulong[] FromCharsToLinkArray(char[] chars, int count)
269     {
270         // char array to ulong array
271         var linksSequence = new ulong[count];
272         for (var i = 0; i < count; i++)
273         {
274             linksSequence[i] = FromCharToLink(chars[i]);
275         }
276         return linksSequence;
277     }
278
279     /// <summary>
280     /// <para>
281     /// Creates the string to link array using the specified sequence.
282     /// </para>
283     /// <para></para>
284     /// </summary>
285     /// <param name="sequence">
286     /// <para>The sequence.</para>
287     /// <para></para>
288     /// </param>
289     /// <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;

```

```

385         while (absoluteLength < array.Length && array[absoluteLength] > LastCharLink)
386         {
387             relativeLength++;
388             absoluteLength++;
389         }
390     }
391     // copy array
392     var innerSequence = new ulong[relativeLength];
393     var maxLength = offset + relativeLength;
394     for (var i = offset; i < maxLength; i++)
395     {
396         innerSequence[i - offset] = array[i];
397     }
398     result.Add(innerSequence);
399     offset += relativeLength;
400 }
401 return result;
402 }
403 }
404 }

```

1.53 ./csharp/Platform.Data.Doublets.Sequences/Unicode/UnicodeSequenceToStringConverter.cs

```

1  using System;
2  using System.Runtime.CompilerServices;
3  using Platform.Interfaces;
4  using Platform.Converters;
5  using Platform.Data.Doublets.Sequences.Walkers;
6  using System.Text;
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 sequence to string converter.
15     /// </para>
16     /// <para></para>
17     /// </summary>
18     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
19     /// <seealso cref="IConverter{TLinkAddress, string}"/>
20     public class UnicodeSequenceToStringConverter<TLinkAddress> :
21         ↳ LinksOperatorBase<TLinkAddress>, IConverter<TLinkAddress, string>
22     {
23         private readonly ICriterionMatcher<TLinkAddress> _unicodeSequenceCriterionMatcher;
24         private readonly ISequenceWalker<TLinkAddress> _sequenceWalker;
25         private readonly IConverter<TLinkAddress, char> _unicodeSymbolToCharConverter;
26
27         /// <summary>
28         /// <para>
29         /// Initializes a new <see cref="UnicodeSequenceToStringConverter"/> instance.
30         /// </para>
31         /// </summary>
32         /// <param name="links">
33         /// <para>A links.</para>
34         /// </param>
35         /// <param name="unicodeSequenceCriterionMatcher">
36         /// <para>A unicode sequence criterion matcher.</para>
37         /// </param>
38         /// <param name="sequenceWalker">
39         /// <para>A sequence walker.</para>
40         /// </param>
41         /// <param name="unicodeSymbolToCharConverter">
42         /// <para>A unicode symbol to char converter.</para>
43         /// </param>
44         [MethodImpl(MethodImplOptions.AggressiveInlining)]
45         public UnicodeSequenceToStringConverter(ILinks<TLinkAddress> links,
46         ↳ ICriterionMatcher<TLinkAddress> unicodeSequenceCriterionMatcher,
47         ↳ ISequenceWalker<TLinkAddress> sequenceWalker, IConverter<TLinkAddress, char>
48         ↳ unicodeSymbolToCharConverter) : base(links)
49     {
50         _unicodeSequenceCriterionMatcher = unicodeSequenceCriterionMatcher;
51         _sequenceWalker = sequenceWalker;
52         _unicodeSymbolToCharConverter = unicodeSymbolToCharConverter;
53     }
54 }

```

```

55
56     /// <summary>
57     /// <para>
58     /// Converts the source.
59     /// </para>
60     /// <para></para>
61     /// </summary>
62     /// <param name="source">
63     /// <para>The source.</para>
64     /// <para></para>
65     /// </param>
66     /// <exception cref="ArgumentOutOfRangeException">
67     /// <para>Specified link is not a unicode sequence.</para>
68     /// <para></para>
69     /// </exception>
70     /// <returns>
71     /// <para>The string</para>
72     /// <para></para>
73     /// </returns>
74     [MethodImpl(MethodImplOptions.AggressiveInlining)]
75     public string Convert(TLinkAddress source)
76     {
77         if (!_unicodeSequenceCriterionMatcher.IsMatched(source))
78         {
79             throw new ArgumentOutOfRangeException(nameof(source), source, "Specified link is
            ↳ not a unicode sequence.");
80         }
81         var sequence = _links.GetSource(source);
82         var sb = new StringBuilder();
83         foreach(var character in _sequenceWalker.Walk(sequence))
84         {
85             sb.Append(_unicodeSymbolToCharConverter.Convert(character));
86         }
87         return sb.ToString();
88     }
89 }
90 }

```

1.54 ./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>,
        ↳ IConverter<TLinkAddress, char>
19     {
20         private static readonly UncheckedConverter<TLinkAddress, char> _addressToCharConverter =
            ↳ UncheckedConverter<TLinkAddress, char>.Default;
21         private readonly IConverter<TLinkAddress> _numberToAddressConverter;
22         private readonly ICriterionMatcher<TLinkAddress> _unicodeSymbolCriterionMatcher;
23
24         /// <summary>
25         /// <para>
26         /// Initializes a new <see cref="UnicodeSymbolToCharConverter"/> 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="numberToAddressConverter">
35         /// <para>A number to address converter.</para>
36         /// <para></para>
37         /// </param>
38         /// <param name="unicodeSymbolCriterionMatcher">

```

```

39     /// <para>A unicode symbol criterion matcher.</para>
40     /// <para></para>
41     /// </param>
42     [MethodImpl(MethodImplOptions.AggressiveInlining)]
43     public UnicodeSymbolToCharConverter(ILinks<TLinkAddress> links, IConverter<TLinkAddress>
        ↳ numberToAddressConverter, ICriterionMatcher<TLinkAddress>
        ↳ unicodeSymbolCriterionMatcher) : base(links)
44     {
45         _numberToAddressConverter = numberToAddressConverter;
46         _unicodeSymbolCriterionMatcher = unicodeSymbolCriterionMatcher;
47     }
48
49     /// <summary>
50     /// <para>
51     /// Converts the source.
52     /// </para>
53     /// <para></para>
54     /// </summary>
55     /// <param name="source">
56     /// <para>The source.</para>
57     /// <para></para>
58     /// </param>
59     /// <exception cref="ArgumentOutOfRangeException">
60     /// <para>Specified link is not a unicode symbol.</para>
61     /// <para></para>
62     /// </exception>
63     /// <returns>
64     /// <para>The char</para>
65     /// <para></para>
66     /// </returns>
67     [MethodImpl(MethodImplOptions.AggressiveInlining)]
68     public char Convert(TLinkAddress source)
69     {
70         if (!_unicodeSymbolCriterionMatcher.IsMatched(source))
71         {
72             throw new ArgumentOutOfRangeException(nameof(source), source, "Specified link is
        ↳ not a unicode symbol.");
73         }
74         return _addressToCharConverter.Convert(_numberToAddressConverter.Convert(_links.GetS
        ↳ ource(source)));
75     }
76 }
77 }

```

1.55 ./csharp/Platform.Data.Doublets.Sequences/Unicode/UnicodeSymbolsListToUnicodeSequenceConverter.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 unicode symbols list to unicode sequence converter.
13     /// </para>
14     /// <para></para>
15     /// </summary>
16     /// <seealso cref="LinksOperatorBase{TLinkAddress}"/>
17     /// <seealso cref="IConverter{IList{TLinkAddress}, TLinkAddress}"/>
18     public class UnicodeSymbolsListToUnicodeSequenceConverter<TLinkAddress> :
        ↳ LinksOperatorBase<TLinkAddress>, IConverter<IList<TLinkAddress>, TLinkAddress>
19     {
20         private readonly ISequenceIndex<TLinkAddress> _index;
21         private readonly IConverter<IList<TLinkAddress>, TLinkAddress>
        ↳ _listToSequenceLinkConverter;
22         private readonly TLinkAddress _unicodeSequenceMarker;
23
24         /// <summary>
25         /// <para>
26         /// Initializes a new <see cref="UnicodeSymbolsListToUnicodeSequenceConverter"/>
        ↳ 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="index">
35     /// <para>A index.</para>
36     /// <para></para>
37     /// </param>
38     /// <param name="listToSequenceLinkConverter">
39     /// <para>A list to sequence link converter.</para>
40     /// <para></para>
41     /// </param>
42     /// <param name="unicodeSequenceMarker">
43     /// <para>A unicode sequence marker.</para>
44     /// <para></para>
45     /// </param>
46     [MethodImpl(MethodImplOptions.AggressiveInlining)]
47     public UnicodeSymbolsListToUnicodeSequenceConverter(ILinks<TLinkAddress> links,
48         ↪ ISequenceIndex<TLinkAddress> index, IConverter<IList<TLinkAddress>, TLinkAddress>
49         ↪ listToSequenceLinkConverter, TLinkAddress unicodeSequenceMarker) : base(links)
50     {
51         _index = index;
52         _listToSequenceLinkConverter = listToSequenceLinkConverter;
53         _unicodeSequenceMarker = unicodeSequenceMarker;
54     }
55
56     /// <summary>
57     /// <para>
58     /// Initializes a new <see cref="UnicodeSymbolsListToUnicodeSequenceConverter"/>
59     ↪ instance.
60     /// </para>
61     /// <para></para>
62     /// </summary>
63     /// <param name="links">
64     /// <para>A links.</para>
65     /// <para></para>
66     /// </param>
67     /// <param name="listToSequenceLinkConverter">
68     /// <para>A list to sequence link converter.</para>
69     /// <para></para>
70     /// </param>
71     /// <param name="unicodeSequenceMarker">
72     /// <para>A unicode sequence marker.</para>
73     /// <para></para>
74     /// </param>
75     [MethodImpl(MethodImplOptions.AggressiveInlining)]
76     public UnicodeSymbolsListToUnicodeSequenceConverter(ILinks<TLinkAddress> links,
77         ↪ IConverter<IList<TLinkAddress>, TLinkAddress> listToSequenceLinkConverter,
78         ↪ TLinkAddress unicodeSequenceMarker)
79         : this(links, new Unindex<TLinkAddress>(), listToSequenceLinkConverter,
80             ↪ unicodeSequenceMarker) { }
81
82     /// <summary>
83     /// <para>
84     /// Converts the list.
85     /// </para>
86     /// <para></para>
87     /// </summary>
88     /// <param name="list">
89     /// <para>The list.</para>
90     /// <para></para>
91     /// </param>
92     /// <returns>
93     /// <para>The link</para>
94     /// <para></para>
95     /// </returns>
96     [MethodImpl(MethodImplOptions.AggressiveInlining)]
97     public TLinkAddress Convert(IList<TLinkAddress>? list)
98     {
99         _index.Add(list);
100         var sequence = _listToSequenceLinkConverter.Convert(list);
101         return _links.GetOrCreate(sequence, _unicodeSequenceMarker);
102     }
103 }

```

1.56 ./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 }

```

1.57 ./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">

```

```

47     /// <para>A links.</para>
48     /// <para></para>
49     /// </param>
50     /// <param name="stack">
51     /// <para>A stack.</para>
52     /// <para></para>
53     /// </param>
54     [MethodImpl(MethodImplOptions.AggressiveInlining)]
55     public LeftSequenceWalker(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack) :
56         ↪ base(links, stack, links.IsPartialPoint) { }
57
58     /// <summary>
59     /// <para>
60     /// Gets the next element after pop using the specified element.
61     /// </para>
62     /// <para></para>
63     /// </summary>
64     /// <param name="element">
65     /// <para>The element.</para>
66     /// <para></para>
67     /// </param>
68     /// <returns>
69     /// <para>The link</para>
70     /// <para></para>
71     /// </returns>
72     [MethodImpl(MethodImplOptions.AggressiveInlining)]
73     protected override TLinkAddress GetNextElementAfterPop(TLinkAddress element) =>
74         ↪ _links.GetSource(element);
75
76     /// <summary>
77     /// <para>
78     /// Gets the next element after push using the specified element.
79     /// </para>
80     /// <para></para>
81     /// </summary>
82     /// <param name="element">
83     /// <para>The element.</para>
84     /// <para></para>
85     /// </param>
86     /// <returns>
87     /// <para>The link</para>
88     /// <para></para>
89     /// </returns>
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     protected override TLinkAddress GetNextElementAfterPush(TLinkAddress element) =>
92         ↪ _links.GetTarget(element);
93
94     /// <summary>
95     /// <para>
96     /// Walks the contents using the specified element.
97     /// </para>
98     /// <para></para>
99     /// </summary>
100    /// <param name="element">
101    /// <para>The element.</para>
102    /// <para></para>
103    /// </param>
104    /// <returns>
105    /// <para>An enumerable of t link</para>
106    /// <para></para>
107    /// </returns>
108    [MethodImpl(MethodImplOptions.AggressiveInlining)]
109    protected override IEnumerable<TLinkAddress> WalkContents(TLinkAddress element)
110    {
111        var links = _links;
112        var parts = links.GetLink(element);
113        var start = links.Constants.SourcePart;
114        for (var i = parts.Count - 1; i >= start; i--)
115        {
116            var part = parts[i];
117            if (IsElement(part))
118            {
119                yield return part;
120            }
121        }
122    }

```

1.58 ./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">
36         /// <para>A links.</para>
37         /// </param>
38         /// <param name="isElement">
39         /// <para>A is element.</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         /// </param>
54         [MethodImpl(MethodImplOptions.AggressiveInlining)]
55         public LeveledSequenceWalker(ILinks<TLinkAddress> links) : base(links) => _isElement =
56         ↪ _links.IsPartialPoint;
57
58         /// <summary>
59         /// <para>
60         /// Walks the sequence.
61         /// </para>
62         /// <para></para>
63         /// </summary>
64         /// <param name="sequence">
65         /// <para>The sequence.</para>
66         /// </param>
67         /// <returns>
68         /// <para>An enumerable of t link</para>
69         /// </returns>
70         [MethodImpl(MethodImplOptions.AggressiveInlining)]
71         public IEnumerable<TLinkAddress> Walk(TLinkAddress sequence) => ToArray(sequence);
72
73         /// <summary>
74

```

```

75     /// <para>
76     /// Returns the array using the specified sequence.
77     /// </para>
78     /// <para></para>
79     /// </summary>
80     /// <param name="sequence">
81     /// <para>The sequence.</para>
82     /// <para></para>
83     /// </param>
84     /// <returns>
85     /// <para>The link array</para>
86     /// <para></para>
87     /// </returns>
88     [MethodImpl(MethodImplOptions.AggressiveInlining)]
89     public TLinkAddress[] ToArray(TLinkAddress sequence)
90     {
91         var length = 1;
92         var array = new TLinkAddress[length];
93         array[0] = sequence;
94         if (_isElement(sequence))
95         {
96             return array;
97         }
98         bool hasElements;
99         do
100         {
101             length *= 2;
102             #if USEARRAYPOOL
103                 var nextArray = ArrayPool.Allocate<ulong>(length);
104             #else
105                 var nextArray = new TLinkAddress[length];
106             #endif
107             hasElements = false;
108             for (var i = 0; i < array.Length; i++)
109             {
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 }

```

1.59 ./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,
            ↪ Func<TLinkAddress, bool> isElement) : base(links, stack, isElement) { }
39
40         /// <summary>
41         /// <para>
42         /// Initializes a new <see cref="RightSequenceWalker"/> instance.
43         /// </para>
44         /// <para></para>

```

```

45     /// </summary>
46     /// <param name="links">
47     /// <para>A links.</para>
48     /// <para></para>
49     /// </param>
50     /// <param name="stack">
51     /// <para>A stack.</para>
52     /// <para></para>
53     /// </param>
54     [MethodImpl(MethodImplOptions.AggressiveInlining)]
55     public RightSequenceWalker(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack) :
56         ↪ base(links, stack, links.IsPartialPoint) { }
57
58     /// <summary>
59     /// <para>
60     /// Gets the next element after pop using the specified element.
61     /// </para>
62     /// <para></para>
63     /// </summary>
64     /// <param name="element">
65     /// <para>The element.</para>
66     /// <para></para>
67     /// </param>
68     /// <returns>
69     /// <para>The link</para>
70     /// <para></para>
71     /// </returns>
72     [MethodImpl(MethodImplOptions.AggressiveInlining)]
73     protected override TLinkAddress GetNextElementAfterPop(TLinkAddress element) =>
74         ↪ _links.GetTarget(element);
75
76     /// <summary>
77     /// <para>
78     /// Gets the next element after push using the specified element.
79     /// </para>
80     /// <para></para>
81     /// </summary>
82     /// <param name="element">
83     /// <para>The element.</para>
84     /// <para></para>
85     /// </param>
86     /// <returns>
87     /// <para>The link</para>
88     /// <para></para>
89     /// </returns>
90     [MethodImpl(MethodImplOptions.AggressiveInlining)]
91     protected override TLinkAddress GetNextElementAfterPush(TLinkAddress element) =>
92         ↪ _links.GetSource(element);
93
94     /// <summary>
95     /// <para>
96     /// Walks the contents using the specified element.
97     /// </para>
98     /// <para></para>
99     /// </summary>
100    /// <param name="element">
101    /// <para>The element.</para>
102    /// <para></para>
103    /// </param>
104    /// <returns>
105    /// <para>An enumerable of t link</para>
106    /// <para></para>
107    /// </returns>
108    [MethodImpl(MethodImplOptions.AggressiveInlining)]
109    protected override IEnumerable<TLinkAddress> WalkContents(TLinkAddress element)
110    {
111        var parts = _links.GetLink(element);
112        for (var i = _links.Constants.SourcePart; i < parts.Count; i++)
113        {
114            var part = parts[i];
115            if (IsElement(part))
116            {
117                yield return part;
118            }
119        }
120    }
121 }

```

1.60 ./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>
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
49         /// <summary>
50         /// <para>
51         /// Initializes a new <see cref="SequenceWalkerBase"/> instance.
52         /// </para>
53         /// <para></para>
54         /// </summary>
55         /// <param name="links">
56         /// <para>A links.</para>
57         /// <para></para>
58         /// </param>
59         /// <param name="stack">
60         /// <para>A stack.</para>
61         /// <para></para>
62         /// </param>
63         [MethodImpl(MethodImplOptions.AggressiveInlining)]
64         protected SequenceWalkerBase(ILinks<TLinkAddress> links, IStack<TLinkAddress> stack) :
65             ↳ this(links, stack, links.IsPartialPoint) { }
66
67         /// <summary>
68         /// <para>
69         /// Walks 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>

```

```

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 }

```

1.61 ./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
17             ↪ IO.TemporaryFile());
18
19         public ILinks<TLinkAddress> CreateLinks<TLinkAddress>(string dataDbFilename)
20         {
21             var linksConstants = new
22                 ↪ LinksConstants<TLinkAddress>(enableExternalReferencesSupport: true);
23             return new
24                 ↪ UnitedMemoryLinks<TLinkAddress>(new
25                     ↪ FileMappedResizableDirectMemory(dataDbFilename),
26                     ↪ UnitedMemoryLinks<TLinkAddress>.DefaultLinksSizeStep, linksConstants,
27                     ↪ IndexTreeType.Default);
28         }
29
30         [Fact]
31         public void DecimalMaxValueTest()
32         {
33             var links = CreateLinks();
34             BigInteger bigInteger = new(decimal.MaxValue);
35             TLinkAddress negativeNumberMarker = links.Create();
36             AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
37             RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
38             BalancedVariantConverter<TLinkAddress> listToSequenceConverter = new(links);
39             BigIntegerToRawNumberSequenceConverter<TLinkAddress>
40                 ↪ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
41                 ↪ listToSequenceConverter, negativeNumberMarker);
42             RawNumberSequenceToBigIntegerConverter<TLinkAddress>
43                 ↪ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
44                 ↪ negativeNumberMarker);
45             var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
46             var bigIntFromSequence =
47                 ↪ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
48             Assert.Equal(bigInteger, bigIntFromSequence);
49         }
50     }
51 }

```

```

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>
50     ↪ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
51     ↪ listToSequenceConverter, negativeNumberMarker);
52     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
53     ↪ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
54     ↪ negativeNumberMarker);
55     var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
56     var bigIntFromSequence =
57     ↪ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
58     Assert.Equal(bigInteger, bigIntFromSequence);
59 }
60
61 [Fact]
62 public void ZeroValueTest()
63 {
64     var links = CreateLinks();
65     BigInteger bigInteger = new(0);
66     TLinkAddress negativeNumberMarker = links.Create();
67     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
68     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
69     BalancedVariantConverter<TLinkAddress> listToSequenceConverter = new(links);
70     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
71     ↪ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
72     ↪ listToSequenceConverter, negativeNumberMarker);
73     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
74     ↪ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
75     ↪ negativeNumberMarker);
76     var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
77     var bigIntFromSequence =
78     ↪ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
79     Assert.Equal(bigInteger, bigIntFromSequence);
80 }
81
82 [Fact]
83 public void OneValueTest()
84 {
85     var links = CreateLinks();
86     BigInteger bigInteger = new(1);
87     TLinkAddress negativeNumberMarker = links.Create();
88     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
89     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
90     BalancedVariantConverter<TLinkAddress> listToSequenceConverter = new(links);
91     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
92     ↪ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
93     ↪ listToSequenceConverter, negativeNumberMarker);
94     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
95     ↪ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
96     ↪ negativeNumberMarker);
97     var bigIntSequence = bigIntegerToRawNumberSequenceConverter.Convert(bigInteger);
98     var bigIntFromSequence =
99     ↪ rawNumberSequenceToBigIntegerConverter.Convert(bigIntSequence);
100     Assert.Equal(bigInteger, bigIntFromSequence);
101 }
102 }
103 }

```

1.62 ./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
30                 ↳ LinksConstants<TLinkAddress>(enableExternalReferencesSupport: true);
31             return new UnitedMemoryLinks<TLinkAddress>(new
32                 ↳ FileMappedResizableDirectMemory(dataDBFilename),
33                 ↳ UnitedMemoryLinks<TLinkAddress>.DefaultLinksSizeStep, linksConstants,
34                 ↳ IndexTreeType.Default);
35         }
36
37         public class ValueCriterionMatcher<TLinkAddress> : ICriterionMatcher<TLinkAddress>
38         {
39             public readonly ILinks<TLinkAddress> Links;
40             public readonly TLinkAddress Marker;
41             public ValueCriterionMatcher(ILinks<TLinkAddress> links, TLinkAddress marker)
42             {
43                 Links = links;
44                 Marker = marker;
45             }
46
47             public bool IsMatched(TLinkAddress link) =>
48                 ↳ EqualityComparer<TLinkAddress>.Default.Equals(Links.GetSource(link), Marker);
49         }
50
51         [Fact]
52         public void AppendArrayBug()
53         {
54             ILinks<TLinkAddress> links = CreateLinks();
55             TLinkAddress zero = default;
56             var markerIndex = Arithmetic.Increment(zero);
57             var meaningRoot = links.GetOrCreate(markerIndex, markerIndex);
58             var sequence = links.Create();
59             sequence = links.Update(sequence, meaningRoot, sequence);
60             var appendant = links.Create();
61             appendant = links.Update(appendant, meaningRoot, appendant);
62             ValueCriterionMatcher<TLinkAddress> valueCriterionMatcher = new(links, meaningRoot);
63             DefaultSequenceRightHeightProvider<ulong> defaultSequenceRightHeightProvider =
64                 ↳ new(links, valueCriterionMatcher);
65             DefaultSequenceAppender<TLinkAddress> defaultSequenceAppender = new(links, new
66                 ↳ DefaultStack<ulong>(), defaultSequenceRightHeightProvider);
67             var newArray = defaultSequenceAppender.Append(sequence, appendant);
68             var output = links.FormatStructure(newArray, link => link.IsFullPoint(), true);
69             Assert.Equal("(4:(2:1 2) (3:1 3))", output);
70         }
71     }
72 }

```

1.63 ./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 // }

```

```

16 //      }
17 //    }
18 //  }
19 // }

```

1.64 ./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,
94 //                 ↪ constants.Itself);
95 //
96 //             var unaryNumberToAddressConverter = new
97 //                 ↪ UnaryNumberToAddressAddOperationConverter<ulong>(links, unaryOne);
98 //             var unaryNumberIncrementer = new UnaryNumberIncrementer<ulong>(links,
99 //                 ↪ unaryOne);
100 //             var frequencyIncrementer = new FrequencyIncrementer<ulong>(links,
101 //                 ↪ frequencyMarker, unaryOne, unaryNumberIncrementer);
102 //             var frequencyPropertyOperator = new PropertyOperator<ulong>(links,
103 //                 ↪ frequencyPropertyMarker, frequencyMarker);
104 //             var index = new FrequencyIncrementingSequenceIndex<ulong>(links,
105 //                 ↪ frequencyPropertyOperator, frequencyIncrementer);
106 //             var linkToItsFrequencyNumberConverter = new
107 //                 ↪ LinkToItsFrequencyNumberConveter<ulong>(links, frequencyPropertyOperator,
108 //                 ↪ unaryNumberToAddressConverter);
109 //             var sequenceToItsLocalElementLevelsConverter = new
110 //                 ↪ SequenceToItsLocalElementLevelsConverter<ulong>(links, linkToItsFrequencyNumberConverter);
111 //             var optimalVariantConverter = new OptimalVariantConverter<ulong>(links,
112 //                 ↪ sequenceToItsLocalElementLevelsConverter);
113 //
114 //             var sequences = new Sequences(links, new SequencesOptions<ulong>() { Walker =
115 //                 ↪ new LevelledSequenceWalker<ulong>(links) });
116 //
117 //             ExecuteTest(sequences, sequence, sequenceToItsLocalElementLevelsConverter,
118 //                 ↪ index, optimalVariantConverter);
119 //         }
120 //     }
121 //
122 //     [Fact]
123 //     public static void DictionaryBasedFrequencyStoredOptimalVariantSequenceTest()
124 //     {
125 //         using (var scope = new TempLinksTestScope(useSequences: false))
126 //         {
127 //             var links = scope.Links;
128 //
129 //             links.UseUnicode();
130 //
131 //             var sequence = UnicodeMap.FromStringToLinkArray(_sequenceExample);
132 //
133 //             var totalSequenceSymbolFrequencyCounter = new
134 //                 ↪ TotalSequenceSymbolFrequencyCounter<ulong>(links);
135 //
136 //             var linkFrequenciesCache = new LinkFrequenciesCache<ulong>(links,
137 //                 ↪ totalSequenceSymbolFrequencyCounter);
138 //
139 //             var index = new
140 //                 ↪ CachedFrequencyIncrementingSequenceIndex<ulong>(linkFrequenciesCache);
141 //             var linkToItsFrequencyNumberConverter = new
142 //                 ↪ FrequenciesCacheBasedLinkToItsFrequencyNumberConverter<ulong>(linkFrequenciesCache);
143 //
144 //             var sequenceToItsLocalElementLevelsConverter = new
145 //                 ↪ 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 // }

```

1.65 ./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>
51     ↪ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
52     ↪ balancedVariantConverter, negativeNumberMarker);
53     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
54     ↪ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
55     ↪ negativeNumberMarker);
56     DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
57     ↪ bigIntegerToRawNumberSequenceConverter);
58     RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
59     ↪ rawNumberSequenceToBigIntegerConverter);
60     var rationalNumber = decimalToRationalConverter.Convert(@decimal);
61     var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
62     Assert.Equal(@decimal, decimalFromRational);
63 }
64
65 [Fact]
66 public void DecimalPositiveHalfTest()
67 {
68     const decimal @decimal = 0.5M;
69     var links = CreateLinks();
70     TLinkAddress negativeNumberMarker = links.Create();
71     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
72     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
73     BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
74     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
75     ↪ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
76     ↪ balancedVariantConverter, negativeNumberMarker);
77     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
78     ↪ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
79     ↪ negativeNumberMarker);
80     DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
81     ↪ bigIntegerToRawNumberSequenceConverter);
82     RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
83     ↪ rawNumberSequenceToBigIntegerConverter);
84     var rationalNumber = decimalToRationalConverter.Convert(@decimal);
85     var decimalFromRational = rationalToDecimalConverter.Convert(rationalNumber);
86     Assert.Equal(@decimal, decimalFromRational);
87 }
88
89 [Fact]
90 public void DecimalNegativeHalfTest()
91 {
92     const decimal @decimal = -0.5M;
93     var links = CreateLinks();
94     TLinkAddress negativeNumberMarker = links.Create();
95     AddressToRawNumberConverter<TLinkAddress> addressToRawNumberConverter = new();
96     RawNumberToAddressConverter<TLinkAddress> numberToAddressConverter = new();
97     BalancedVariantConverter<TLinkAddress> balancedVariantConverter = new(links);
98     BigIntegerToRawNumberSequenceConverter<TLinkAddress>
99     ↪ bigIntegerToRawNumberSequenceConverter = new(links, addressToRawNumberConverter,
100     ↪ balancedVariantConverter, negativeNumberMarker);
101     RawNumberSequenceToBigIntegerConverter<TLinkAddress>
102     ↪ rawNumberSequenceToBigIntegerConverter = new(links, numberToAddressConverter,
103     ↪ negativeNumberMarker);
104     DecimalToRationalConverter<TLinkAddress> decimalToRationalConverter = new(links,
105     ↪ bigIntegerToRawNumberSequenceConverter);
106     RationalToDecimalConverter<TLinkAddress> rationalToDecimalConverter = new(links,
107     ↪ 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 DecimalOneTest()
115 {
116     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 }

```

1.66 ./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 Sequences(links, new SequencesOptions

```

```

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 //
47 //         sw3.Stop();
48 //
49 //         Assert.True(sequence.SequenceEqual(readSequence1));
50 //
51 //         Assert.True(sequence.SequenceEqual(readSequence2));
52 //
53 //         // Assert.True(sw2.Elapsed < sw3.Elapsed);
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 // }

```

1.67 ./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
394   ↳ если этот путь зафиксировать? Запомнить след? Как две точки становятся линией? Чертой?
395   ↳ Гранью? Разделителем? Единицей?
396 //
397 // ![две белые точки, чёрная вертикальная
398   ↳ линия](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/4.png "две
399   ↳ белые точки, чёрная вертикальная
400   ↳ линия"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/4.png)
401 //
402 // Можно ли замкнуть движение? Может ли это быть кругом? Можно ли замкнуть время? Или остаётся
403   ↳ только спираль? Но что если замкнуть предел? Создать ограничение, разделение? Получится
404   ↳ замкнутая область? Полностью отделённая от всего остального? Но что это всё остальное? Что
405   ↳ можно делить? В каком направлении? Ничего или всё? Пустота или полнота? Начало или конец?
406   ↳ Или может быть это единица и ноль? Дуальность? Противоположность? А что будет с кругом если
407   ↳ у него нет размера? Будет ли круг точкой? Точка состоящая из точек?
408 //
409 // ![белая вертикальная линия, чёрный
410   ↳ круг](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/5.png "белая
411   ↳ вертикальная линия, чёрный
412   ↳ круг"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/5.png)
413 //
414 // Как ещё можно использовать грань, черту, линию? А что если она может что-то соединять, может
415   ↳ тогда её нужно повернуть? Почему то, что перпендикулярно вертикальному горизонтально?
416   ↳ Горизонт? Инвертирует ли это смысл? Что такое смысл? Из чего состоит смысл? Существует ли
417   ↳ элементарная единица смысла?
418 //
419 // ![белый круг, чёрная горизонтальная
420   ↳ линия](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/6.png "белый
421   ↳ круг, чёрная горизонтальная
422   ↳ линия"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/6.png)
423 //
424 // Соединять, допустим, а какой смысл в этом есть ещё? Что если помимо смысла "соединить,
425   ↳ связать", есть ещё и смысл направления "от начала к концу"? От предка к потомку? От
426   ↳ родителя к ребёнку? От общего к частному?
427 //
428 // ![белая горизонтальная линия, чёрная горизонтальная
429   ↳ стрелка](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/7.png
430   ↳ "белая горизонтальная линия, чёрная горизонтальная
431   ↳ стрелка"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/7.png)
432 //
433 // Шаг назад. Возьмём опять отделённую область, которая лишь та же замкнутая линия, что ещё она
434   ↳ может представлять собой? Объект? Но в чём его суть? Разве не в том, что у него есть
435   ↳ граница, разделяющая внутреннее и внешнее? Допустим связь, стрелка, линия соединяет два
436   ↳ объекта, как бы это выглядело?
437 //
438 // ![белая связь, чёрная направленная
439   ↳ связь](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/8.png "белая
440   ↳ связь, чёрная направленная
441   ↳ связь"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/8.png)
442 //
443 // Допустим у нас есть смысл "связать" и смысл "направления", много ли это нам даёт? Много
444   ↳ ли вариантов интерпретации? А что если уточнить, каким именно образом выполнена связь? Что
445   ↳ если можно задать ей чёткий, конкретный смысл? Что это будет? Тип? Глагол? Связка? Действие?
446   ↳ Трансформация? Переход из состояния в состояние? Или всё это и есть объект, суть которого в
447   ↳ его конечном состоянии, если конечно конец определён направлением?
448 //
449 // ![белая обычная и направленная связи, чёрная типизированная
450   ↳ связь](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/9.png "белая
451   ↳ обычная и направленная связи, чёрная типизированная
452   ↳ связь"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/9.png)
453 //
454 // А что если всё это время, мы смотрели на суть как бы снаружи? Можно ли взглянуть на это
455   ↳ изнутри? Что будет внутри объектов? Объекты ли это? Или это связи? Может ли эта структура
456   ↳ описать сама себя? Но что тогда получится, разве это не рекурсия? Может это фрактал?
457 //
458 // ![белая обычная и направленная связи с рекурсивной внутренней структурой, чёрная
459   ↳ типизированная связь с рекурсивной внутренней
460   ↳ структурой](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/10.png
461   ↳ "белая обычная и направленная связи с рекурсивной внутренней структурой, чёрная
462   ↳ типизированная связь с рекурсивной внутренней структурой"")](https://raw.githubusercontent.com/Konard/LinksPlatform/master/doc/Intro/10.png)
463 //
464 // На один уровень внутрь (вниз)? Или на один уровень во вне (вверх)? Или это можно назвать
465   ↳ шагом рекурсии или фрактала?
466 //

```



```

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.GetByKeys(compressedVariant, source, target) ==
↳ sequence[1]);
474 // Assert.True(links.GetByKeys(compressedVariant, target, source) ==
↳ sequence[2]);
475 // Assert.True(links.GetByKeys(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 //         var START = 0;
682 //         var END = arrays.Length;
683 //
684 //         // Collisions proved (cannot be solved by max doublet comparison, no stable
↪ rule)
685 //         // Stability issue starts at 10001 or 11000
686 //         //for (int i = START; i < END; i++)
687 //         //{
688 //             // var first = compressor1.Compress(arrays[i]);
689 //             // var second = compressor1.Compress(arrays[i]);
690 //
691 //             // if (first == second)
692 //             //     compressed1[i] = first;
693 //             // else
694 //             // {
695 //                 // // TODO: Find a solution for this case
696 //             // }
697 //         //}
698 //
699 //         for (int i = START; i < END; i++)
700 //         {
701 //             var first = compressor1.Create(arrays[i].ShiftRight());
702 //             var second = compressor1.Create(arrays[i].ShiftRight());
703 //
704 //             if (first == second)
705 //             {
706 //                 compressed1[i] = first;
707 //             }
708 //             else
709 //             {
710 //                 // TODO: Find a solution for this case
711 //             }
712 //         }
713 //
714 //         var elapsed1 = sw1.Elapsed;
715 //
716 //         var balancedVariantConverter = new
↪ BalancedVariantConverter<ulong>(scope2.Links);
717 //
718 //         var sw2 = Stopwatch.StartNew();
719 //
720 //         for (int i = START; i < END; i++)
721 //         {
722 //             var first = balancedVariantConverter.Convert(arrays[i]);
723 //             var second = balancedVariantConverter.Convert(arrays[i]);

```

```

724 //
725 //         if (first == second)
726 //         {
727 //             compressed2[i] = first;
728 //         }
729 //     }
730 //
731 //     var elapsed2 = sw2.Elapsed;
732 //
733 //     Debug.WriteLine($"Compressor: {elapsed1}, Balanced sequence creator:
↵ {elapsed2}");
734 //
735 //     Assert.True(elapsed1 > elapsed2);
736 //
737 //     // Checks
738 //     for (int i = START; i < END; i++)
739 //     {
740 //         var sequence1 = compressed1[i];
741 //         var sequence2 = compressed2[i];
742 //
743 //         if (sequence1 != _constants.Null && sequence2 != _constants.Null)
744 //         {
745 //             var decompress1 = UnicodeMap.FromSequenceLinkToString(sequence1,
↵ scope1.Links);
746 //
747 //             var decompress2 = UnicodeMap.FromSequenceLinkToString(sequence2,
↵ scope2.Links);
748 //
749 //             //var structure1 = scope1.Links.FormatStructure(sequence1, link =>
↵ link.IsPartialPoint());
750 //             //var structure2 = scope2.Links.FormatStructure(sequence2, link =>
↵ link.IsPartialPoint());
751 //
752 //             //if (sequence1 != Constants.Null && sequence2 != Constants.Null &&
↵ arrays[i].Length > 3)
753 //             //     Assert.False(structure1 == structure2);
754 //
755 //             Assert.True(strings[i] == decompress1 && decompress1 == decompress2);
756 //         }
757 //     }
758 //
759 //     Assert.True((int)(scope1.Links.Count() - UnicodeMap.MapSize) <
↵ totalCharacters);
760 //     Assert.True((int)(scope2.Links.Count() - UnicodeMap.MapSize) <
↵ totalCharacters);
761 //
762 //     Debug.WriteLine($"{{(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 RndomNumbersCompressionQualityTest()
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 =
971 //         ↪ sequences.CreateAllVariants2(sequence.Reverse().ToArray());
972 //
973 //         for (var i = 0; i < 1; i++)
974 //         {
975 //             var linksTotalUsages1 = new ulong[links.Count() + 1];
976 //
977 //             sequences.CalculateAllUsages(linksTotalUsages1);
978 //
979 //             var linksTotalUsages2 = new ulong[links.Count() + 1];
980 //
981 //             sequences.CalculateAllUsages2(linksTotalUsages2);
982 //
983 //             var intersection1 =
984 //             ↪ linksTotalUsages1.Intersect(linksTotalUsages2).ToList();
985 //             Assert.True(intersection1.Count == linksTotalUsages2.Length);
986 //         }
987 //
988 //         for (var i = 0; i < sequenceLength; i++)
989 //         {
990 //             links.Delete(sequence[i]);
991 //         }
992 //     }
993 // }

```

1.68 ./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 // }

```

1.69 ./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 = OUL;
166 //             var deleted = OUL;
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 // }

```

1.70 ./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 //
44 //         [Fact]
45 //         public static void CascadeUpdateTest()
46 //         {
47 //             var itself = _constants.Itself;
48 //             using (var scope = new TempLinksTestScope(useLog: true))
49 //             {
50 //                 var links = scope.Links;
51 //             }
52 //         }
53 //     }
54 // }

```

```

48 //
49 //         var l1 = links.Create();
50 //         var l2 = links.Create();
51 //
52 //         l2 = links.Update(l2, l2, l1, l2);
53 //
54 //         links.CreateAndUpdate(l2, itself);
55 //         links.CreateAndUpdate(l2, itself);
56 //
57 //         l2 = links.Update(l2, l1);
58 //
59 //         links.Delete(l2);
60 //
61 //         Global.Trash = links.Count();
62 //
63 //         links.Unsync.DisposeIfPossible(); // Close links to access log
64 //
65 //         Global.Trash = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Transition>(scope.TempTransactionLogFilename);
66 //     }
67 // }
68 //
69 // [Fact]
70 // public static void BasicTransactionLogTest()
71 // {
72 //     using (var scope = new TempLinksTestScope(useLog: true))
73 //     {
74 //         var links = scope.Links;
75 //         var l1 = links.Create();
76 //         var l2 = links.Create();
77 //
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 =
↪ (UInt64LinksTransactionsLayer)((LinksDisposableDecoratorBase<ulong>)links.Unsync).Links;
126 //              using (var transaction = transactionsLayer.BeginTransaction())
127 //              {
128 //                  var l1 = links.CreateAndUpdate(itself, itself);
129 //                  var l2 = links.CreateAndUpdate(itself, itself);
130 //
131 //                  l2 = links.Update(l2, l2, l1, l2);
132 //
133 //                  links.CreateAndUpdate(l2, itself);
134 //                  links.CreateAndUpdate(l2, itself);
135 //
136 //                  //Global.Trash = FileHelpers.ReadAll<UInt64LinksTransactionsLayer.Tra
↪ nsition>(scope.TempTransactionLogFilename);
137 //
138 //                  l2 = links.Update(l2, l1);
139 //
140 //                  links.Delete(l2);
141 //
142 //                  ExceptionThrower();
143 //
144 //                  transaction.Commit();
145 //              }
146 //
147 //              Global.Trash = links.Count();
148 //          }
149 //      }
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.CheckPathExistence(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
↵ getter.
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) ==
↵ "(5:(4:5 (6:5 4)) 6)");
401 //          Assert.True(links.FormatStructure(ac, link => link.IsFullPoint(), true) ==
↵ "(6:(5:(4:5 6) 6) 4)");
402 //          Assert.True(links.FormatStructure(ab, link => link.IsFullPoint(), true) ==
↵ "(4:(5:4 (6:5 4)) 6)");
403 //
404 //          // TODO: Think how to build balanced syntax tree while formatting structure
↵ (eg. "(4:(5:4 6) (6:5 4))" instead of "(4:(5:4 (6:5 4)) 6)")

```

```

405 //
406 //             Assert.True(sequences.SafeFormatSequence(cb, DefaultFormatter, false) ==
↳ "{5}{5}{4}{6}");
407 //             Assert.True(sequences.SafeFormatSequence(ac, DefaultFormatter, false) ==
↳ "{5}{6}{6}{4}");
408 //             Assert.True(sequences.SafeFormatSequence(ab, DefaultFormatter, false) ==
↳ "{4}{5}{4}{6}");
409 //         }
410 //
411 //     private static void DefaultFormatter(StringBuilder sb, ulong link)
412 //     {
413 //         sb.Append(link.ToString());
414 //     }
415 //
416 //     #endregion
417 //
418 //     #region Performance
419 //
420 //     /*
421 //     public static void RunAllPerformanceTests()
422 //     {
423 //         try
424 //         {
425 //             links.TestLinksInSteps();
426 //         }
427 //         catch (Exception ex)
428 //         {
429 //             ex.WriteToConsole();
430 //         }
431 //
432 //         return;
433 //
434 //         try
435 //         {
436 //             //ThreadPool.SetMaxThreads(2, 2);
437 //
438 //             // Запускаем все тесты дважды, чтобы первоначальная инициализация не повлияла
↳ на результат
439 //             // Также это дополнительно помогает в отладке
440 //             // Увеличивает вероятность попадания информации в кэши
441 //             for (var i = 0; i < 10; i++)
442 //             {
443 //                 //0 - 10 ГБ
444 //                 //Каждые 100 МБ срез цифр
445 //
446 //                 //links.TestGetSourceFunction();
447 //                 //links.TestGetSourceFunctionInParallel();
448 //                 //links.TestGetTargetFunction();
449 //                 //links.TestGetTargetFunctionInParallel();
450 //                 links.Create64BillionLinks();
451 //
452 //                 links.TestRandomSearchFixed();
453 //                 //links.Create64BillionLinksInParallel();
454 //                 links.TestEachFunction();
455 //                 //links.TestForeach();
456 //                 //links.TestParallelForeach();
457 //             }
458 //
459 //             links.TestDeletionOfAllLinks();
460 //
461 //         }
462 //         catch (Exception ex)
463 //         {
464 //             ex.WriteToConsole();
465 //         }
466 //     }*/
467 //
468 //     /*
469 //     public static void TestLinksInSteps()
470 //     {
471 //         const long gibibyte = 1024 * 1024 * 1024;
472 //         const long mebibyte = 1024 * 1024;
473 //
474 //         var totalLinksToCreate = gibibyte /
↳ Platform.Links.Data.Core.Doublets.Links.LinkSizeInBytes;
475 //         var linksStep = 102 * mebibyte /
↳ Platform.Links.Data.Core.Doublets.Links.LinkSizeInBytes;

```

```

476 //
477 //
478 //
479 //
480 //
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543 //
544 //
545 //
546 //
547 //

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

ConsoleHelpers.Debug();

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

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

ConsoleHelpers.Debug();

ConsoleHelpers.Debug("C S D");

for (int i = 0; i < loops; i++)
{
    ConsoleHelpers.Debug("{0} {1} {2}", creationMeasurements[i],
searchMeasurements[i], deletionMeasurements[i]);
}

ConsoleHelpers.Debug("C S D (no overhead)");

for (int i = 0; i < loops; i++)
{
    ConsoleHelpers.Debug("{0} {1} {2}", creationMeasurements[i] -
stepLoopOverhead, searchMeasurements[i] - stepLoopOverhead, deletionMeasurements[i] -
stepLoopOverhead);
}

ConsoleHelpers.Debug("All tests done. Total links left in database: {0}.",
links.Total);

private static void CreatePoints(this Platform.Links.Data.Core.Doublets.Links links,
long amountToCreate)
{
    for (long i = 0; i < amountToCreate; i++)
        links.Create(0, 0);
}

private static TimeSpan GetBaseRandomLoopOverhead(long loops)
{
    return Measure(() =>
    {
        ulong maxValue = RandomHelpers.DefaultFactory.NextUInt64();
        ulong result = 0;
        for (long i = 0; i < loops; i++)
        {
            var source = RandomHelpers.DefaultFactory.NextUInt64(maxValue);
            var target = RandomHelpers.DefaultFactory.NextUInt64(maxValue);

            result += maxValue + source + target;
        }
        Global.Trash = result;
    });
}

```

```

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,
        ↳ counter);
715 //                }
716 //
717 //                File.Delete(tempFilename);
718 //            }*/
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}",
        ↳ iterations, elapsedTime, (long)iterationsPerSecond, counter);
751 //                }
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 //             long counter = 0;
818 //
819 //             ConsoleHelpers.Debug("Testing parallel foreach through links.");
820 //
821 //             var sw = Stopwatch.StartNew();
822 //
823 //             //Parallel.ForEach((IEnumerable<ulong>)links, x =>
824 //             //{
825 //                 Interlocked.Increment(ref counter);
826 //             //});
827 //
828 //             var elapsedTime = sw.Elapsed;
829 //
830 //             var linksPerSecond = (double)counter / elapsedTime.TotalSeconds;
831 //
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 // }

```

1.71 ./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
↪ LinksConstants<TLinkAddress>(enableExternalReferencesSupport: true);
19             return new UnitedMemoryLinks<TLinkAddress>(new
↪ FileMappedResizableDirectMemory(dataDBFilename),
↪ UnitedMemoryLinks<TLinkAddress>.DefaultLinksSizeStep, linksConstants,
↪ IndexTreeType.Default);
20         }
21         [Fact]
22         public void FormatStructureWithExternalReferenceTest()
23         {
24             ILinks<TLinkAddress> links = CreateLinks();
25             TLinkAddress zero = default;
26             var one = Arithmetic.Increment(zero);
27             var markerIndex = one;
28             var meaningRoot = links.GetOrCreate(markerIndex, markerIndex);
29             var numberMarker = links.GetOrCreate(meaningRoot, Arithmetic.Increment(ref
↪ markerIndex));
30             AddressToRawNumberConverter<TLinkAddress> addressToNumberConverter = new();
31             var numberAddress = addressToNumberConverter.Convert(1);
32             var numberLink = links.GetOrCreate(numberMarker, numberAddress);
33             var linkNotation = links.FormatStructure(numberLink, link => link.IsFullPoint(),
↪ true);
34             Assert.Equal("(3:(2:1 2) 18446744073709551615)", linkNotation);
35         }
36     }
37 }

```

1.72 ./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
↳ PowerOf2ToUnaryNumberConverter<ulong>(links, one);
19 //         var toUnaryNumberConverter = new AddressToUnaryNumberConverter<ulong>(links,
↳ powerOf2ToUnaryNumberConverter);
20 //         var random = new System.Random(0);
21 //         ulong[] numbers = new ulong[N];
22 //         ulong[] unaryNumbers = new ulong[N];
23 //         for (int i = 0; i < N; i++)
24 //         {
25 //             numbers[i] = random.NextUInt64();
26 //             unaryNumbers[i] = toUnaryNumberConverter.Convert(numbers[i]);
27 //         }
28 //         var fromUnaryNumberConverterUsingOrOperation = new
↳ UnaryNumberToAddressOrOperationConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
29 //         var fromUnaryNumberConverterUsingAddOperation = new
↳ UnaryNumberToAddressAddOperationConverter<ulong>(links, one);
30 //         for (int i = 0; i < N; i++)
31 //         {
32 //             Assert.Equal(numbers[i],
↳ fromUnaryNumberConverterUsingOrOperation.Convert(unaryNumbers[i]));
33 //             Assert.Equal(numbers[i],
↳ fromUnaryNumberConverterUsingAddOperation.Convert(unaryNumbers[i]));
34 //         }
35 //     }
36 // }
37 // }
38 // }

```

1.73 ./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
↳ PowerOf2ToUnaryNumberConverter<ulong>(links, one);
30 //                 var addressToUnaryNumberConverter = new
↳ AddressToUnaryNumberConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
31 //                 var unaryNumberToAddressConverter = new
↳ UnaryNumberToAddressOrOperationConverter<ulong>(links, powerOf2ToUnaryNumberConverter);
32 //                 TestCharAndUnicodeSymbolConverters(links, meaningRoot,
↳ addressToUnaryNumberConverter, unaryNumberToAddressConverter);
33 //             }
34 //         }
35 //
36 //         [Fact]
37 //         public static void CharAndRawNumberUnicodeSymbolConvertersTest()
38 //         {
39 //             using (var scope = new Scope<Types<HeapResizableDirectMemory,
↳ UnitedMemoryLinks<ulong>>>())
40 //             {
41 //                 var links = scope.Use<ILinks<ulong>>();

```

```

42 //         var meaningRoot = links.CreatePoint();
43 //         var addressToRawNumberConverter = new AddressToRawNumberConverter<ulong>();
44 //         var rawNumberToAddressConverter = new RawNumberToAddressConverter<ulong>();
45 //         TestCharAndUnicodeSymbolConverters(links, meaningRoot,
↳ addressToRawNumberConverter, rawNumberToAddressConverter);
46 //     }
47 // }
48 // private static void TestCharAndUnicodeSymbolConverters(ILinks<ulong> links, ulong
↳ meaningRoot, IConverter<ulong> addressToNumberConverter, IConverter<ulong>
↳ numberToAddressConverter)
49 // {
50 //     var unicodeSymbolMarker = links.CreateAndUpdate(meaningRoot,
↳ links.Constants.Itself);
51 //     var charToUnicodeSymbolConverter = new CharToUnicodeSymbolConverter<ulong>(links,
↳ addressToNumberConverter, unicodeSymbolMarker);
52 //     var originalCharacter = 'H';
53 //     var characterLink = charToUnicodeSymbolConverter.Convert(originalCharacter);
54 //     var unicodeSymbolCriterionMatcher = new TargetMatcher<ulong>(links,
↳ unicodeSymbolMarker);
55 //     var unicodeSymbolToCharConverter = new UnicodeSymbolToCharConverter<ulong>(links,
↳ numberToAddressConverter, unicodeSymbolCriterionMatcher);
56 //     var resultingCharacter = unicodeSymbolToCharConverter.Convert(characterLink);
57 //     Assert.Equal(originalCharacter, resultingCharacter);
58 // }
59 //
60 // [Fact]
61 // public static void StringAndUnicodeSequenceConvertersTest()
62 // {
63 //     using (var scope = new TempLinksTestScope())
64 //     {
65 //         var links = scope.Links;
66 //
67 //         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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