

# LinksPlatform's Platform.Data.Doublents.Json Class Library

## 1.1 ./csharp/Platform.Data.Doublents.Json/DefaultJsonStorage.cs

```
1  using Platform.Numbers;
2  using Platform.Data.Doublents.Unicode;
3  using Platform.Data.Doublents.Sequences.Converters;
4  using Platform.Data.Doublents.CriterionMatchers;
5  using Platform.Data.Numbers.Raw;
6  using Platform.Converters;
7  using Platform.Data.Doublents.Sequences.Walkers;
8  using Platform.Collections.Stacks;
9  using System;
10 using System.Collections.Generic;
11 using Platform.Data.Doublents.Numbers.Rational;
12 using Platform.Data.Doublents.Numbers.Raw;
13 using Platform.Data.Doublents.Sequences.HeightProviders;
14 using Platform.Data.Doublents.Sequences;
15
16 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
17
18 namespace Platform.Data.Doublents.Json
19 {
20     public class DefaultJsonStorage<TLink> : IJsonStorage<TLink>
21     where TLink : struct
22     {
23         public readonly TLink Any;
24         public static readonly TLink Zero = default;
25         public static readonly TLink One = Arithmetic.Increment(Zero);
26         public readonly BalancedVariantConverter<TLink> BalancedVariantConverter;
27         public readonly IConverter<IList<TLink>, TLink> ListToSequenceConverter;
28         public readonly TLink MeaningRoot;
29         public readonly EqualityComparer<TLink> EqualityComparer =
30             ↳ EqualityComparer<TLink>.Default;
31         // Converters that are able to convert link's address (UInt64 value) to a raw number
32         ↳ represented with another UInt64 value and back
33         public readonly RawNumberToAddressConverter<TLink> NumberToAddressConverter = new();
34         public readonly AddressToRawNumberConverter<TLink> AddressToNumberConverter = new();
35         // Converters between BigInteger and raw number sequence
36         public readonly BigIntegerToRawNumberSequenceConverter<TLink>
37             ↳ BigIntegerToRawNumberSequenceConverter;
38         public readonly RawNumberSequenceToBigIntegerConverter<TLink>
39             ↳ RawNumberSequenceToBigIntegerConverter;
40         // Converters between decimal and rational number sequence
41         public readonly DecimalToRationalConverter<TLink> DecimalToRationalConverter;
42         public readonly RationalToDecimalConverter<TLink> RationalToDecimalConverter;
43         // Converters between string and unicode sequence
44         public readonly IConverter<string, TLink> StringToUnicodeSequenceConverter;
45         public readonly IConverter<TLink, string> UnicodeSequenceToStringConverter;
46         // For sequences
47         public readonly JsonArrayElementCriterionMatcher<TLink> JsonArrayElementCriterionMatcher;
48         public readonly DefaultSequenceRightHeightProvider<TLink>
49             ↳ DefaultSequenceRightHeightProvider;
50         public readonly DefaultSequenceAppender<TLink> DefaultSequenceAppender;
51         public IList<TLink> Links { get; }
52         public TLink DocumentMarker { get; }
53         public TLink ObjectMarker { get; }
54         public TLink MemberMarker { get; }
55         public TLink ValueMarker { get; }
56         public TLink StringMarker { get; }
57         public TLink EmptyStringMarker { get; }
58         public TLink NumberMarker { get; }
59         public TLink NegativeNumberMarker { get; }
60         public TLink ArrayMarker { get; }
61         public TLink EmptyArrayMarker { get; }
62         public TLink TrueMarker { get; }
63         public TLink FalseMarker { get; }
64         public TLink NullMarker { get; }
65
66         public DefaultJsonStorage(IList<TLink> links, IConverter<IList<TLink>, TLink>
67             ↳ listToSequenceConverter)
68         {
69             Links = links;
70             ListToSequenceConverter = listToSequenceConverter;
71             // Initializes constants
72             Any = Links.Constants.Any;
73             var markerIndex = One;
74             MeaningRoot = links.GetOrCreate(markerIndex, markerIndex);
75             var unicodeSymbolMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref
76                 ↳ markerIndex));
77             var unicodeSequenceMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref
78                 ↳ markerIndex));
79         }
80     }
81 }
```

```

71     DocumentMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref
    ↪ markerIndex));
72     ObjectMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
73     MemberMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
74     ValueMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
75     StringMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
76     EmptyStringMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref
    ↪ markerIndex));
77     NumberMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
78     NegativeNumberMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref
    ↪ markerIndex));
79     ArrayMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
80     EmptyArrayMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref
    ↪ markerIndex));
81     TrueMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
82     FalseMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
83     NullMarker = links.GetOrCreate(MeaningRoot, Arithmetic.Increment(ref markerIndex));
84     BalancedVariantConverter = new(links);
85     TargetMatcher<TLink> unicodeSymbolCriterionMatcher = new(Links, unicodeSymbolMarker);
86     TargetMatcher<TLink> unicodeSequenceCriterionMatcher = new(Links,
    ↪ unicodeSequenceMarker);
87     CharToUnicodeSymbolConverter<TLink> charToUnicodeSymbolConverter =
88         new(Links, AddressToNumberConverter, unicodeSymbolMarker);
89     UnicodeSymbolToCharConverter<TLink> unicodeSymbolToCharConverter =
90         new(Links, NumberToAddressConverter, unicodeSymbolCriterionMatcher);
91     StringToUnicodeSequenceConverter = new CachingConverterDecorator<string, TLink>(
92         new StringToUnicodeSequenceConverter<TLink>(Links, charToUnicodeSymbolConverter,
93             BalancedVariantConverter, unicodeSequenceMarker));
94     RightSequenceWalker<TLink> sequenceWalker =
95         new(Links, new DefaultStack<TLink>(), unicodeSymbolCriterionMatcher.IsMatched);
96     UnicodeSequenceToStringConverter = new CachingConverterDecorator<TLink, string>(
97         new UnicodeSequenceToStringConverter<TLink>(Links,
    ↪ unicodeSequenceCriterionMatcher, sequenceWalker,
98             unicodeSymbolToCharConverter));
99     BigIntegerToRawNumberSequenceConverter =
100         new(links, AddressToNumberConverter, ListToSequenceConverter,
    ↪ NegativeNumberMarker);
101     RawNumberSequenceToBigIntegerConverter = new(links, NumberToAddressConverter,
    ↪ NegativeNumberMarker);
102     DecimalToRationalConverter = new(links, BigIntegerToRawNumberSequenceConverter);
103     RationalToDecimalConverter = new(links, RawNumberSequenceToBigIntegerConverter);
104     JsonArrayElementCriterionMatcher = new(this);
105     DefaultSequenceRightHeightProvider = new(Links, JsonArrayElementCriterionMatcher);
106     DefaultSequenceAppender = new(Links, new DefaultStack<TLink>(),
    ↪ DefaultSequenceRightHeightProvider);
107 }
108
109 public TLink CreateString(string content)
110 {
111     var @string = GetStringSequence(content);
112     return Links.GetOrCreate(StringMarker, @string);
113 }
114
115 public TLink CreateStringValue(string content)
116 {
117     var @string = CreateString(content);
118     return CreateValue(@string);
119 }
120
121 public TLink CreateNumber(decimal number)
122 {
123     var numberSequence = DecimalToRationalConverter.Convert(number);
124     return Links.GetOrCreate(NumberMarker, numberSequence);
125 }
126
127 public TLink CreateNumberValue(decimal number)
128 {
129     var numberLink = CreateNumber(number);
130     return CreateValue(numberLink);
131 }
132
133 public TLink CreateBooleanValue(bool value) => CreateValue(value ? TrueMarker :
    ↪ FalseMarker);
134
135 public TLink CreateNullValue() => CreateValue(NullMarker);
136
137 public TLink CreateDocument(string name)
138 {

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139     var documentName = CreateString(name);
140     return Links.GetOrCreate(DocumentMarker, documentName);
141 }
142
143 public TLink CreateObject()
144 {
145     var @object = Links.Create();
146     return Links.Update(@object, newSource: ObjectMarker, newTarget: @object);
147 }
148
149 public TLink CreateObjectValue()
150 {
151     var @object = CreateObject();
152     return CreateValue(@object);
153 }
154
155 public TLink CreateArray(ICollection<TLink> array)
156 {
157     var arraySequence = array.Count == 0 ? EmptyArrayMarker :
        ↳ BalancedVariantConverter.Convert(array);
158     return CreateArray(arraySequence);
159 }
160
161 public TLink CreateArray(TLink sequence) => Links.GetOrCreate(ArrayMarker, sequence);
162
163 public TLink CreateArrayValue(ICollection<TLink> array)
164 {
165     var arrayLink = CreateArray(array);
166     return CreateValue(arrayLink);
167 }
168
169 public TLink CreateArrayValue(TLink sequence)
170 {
171     var array = CreateArray(sequence);
172     return CreateValue(array);
173 }
174
175 public TLink CreateMember(string name)
176 {
177     var nameLink = CreateString(name);
178     return Links.GetOrCreate(MemberMarker, nameLink);
179 }
180
181 public TLink CreateValue(TLink value) => Links.GetOrCreate(ValueMarker, value);
182
183 public TLink AttachObject(TLink parent) => Attach(parent, CreateObjectValue());
184
185 public TLink AttachString(TLink parent, string content)
186 {
187     var @string = CreateString(content);
188     var stringValue = CreateValue(@string);
189     return Attach(parent, stringValue);
190 }
191
192 public TLink AttachNumber(TLink parent, decimal number)
193 {
194     var numberLink = CreateNumber(number);
195     var numberValue = CreateValue(numberLink);
196     return Attach(parent, numberValue);
197 }
198
199 public TLink AttachBoolean(TLink parent, bool value)
200 {
201     var booleanValue = CreateBooleanValue(value);
202     return Attach(parent, booleanValue);
203 }
204
205 public TLink AttachNull(TLink parent)
206 {
207     var nullValue = CreateNullValue();
208     return Attach(parent, nullValue);
209 }
210
211 public TLink AttachArray(TLink parent, ICollection<TLink> array)
212 {
213     var arrayValue = CreateArrayValue(array);
214     return Attach(parent, arrayValue);
215 }
216

```

```

217 public TLink AttachMemberToObject(TLink @object, string keyName)
218 {
219     var member = CreateMember(keyName);
220     return Attach(@object, member);
221 }
222
223 public TLink Attach(TLink parent, TLink child) => Links.GetOrCreate(parent, child);
224
225 public TLink AppendArrayValue(TLink arrayValue, TLink appendant)
226 {
227     var array = GetArray(arrayValue);
228     var arraySequence = Links.GetTarget(array);
229     TLink newArrayValue;
230     if (EqualityComparer.Equals(arraySequence, EmptyArrayMarker))
231     {
232         newArrayValue = CreateArrayValue(appendant);
233     }
234     else
235     {
236         arraySequence = DefaultSequenceAppender.Append(arraySequence, appendant);
237         newArrayValue = CreateArrayValue(arraySequence);
238     }
239     return newArrayValue;
240 }
241
242 public TLink GetDocumentOrDefault(string name)
243 {
244     var stringSequence = GetStringSequence(name);
245     var @string = Links.SearchOrDefault(StringMarker, stringSequence);
246     if (EqualityComparer.Equals(@string, default))
247     {
248         return default;
249     }
250     return Links.SearchOrDefault(DocumentMarker, @string);
251 }
252
253 private TLink GetStringSequence(string content) => content == "" ? EmptyStringMarker :
    ↳ StringToUnicodeSequenceConverter.Convert(content);
254
255 public string GetString(TLink stringValue)
256 {
257     var current = stringValue;
258     TLink source;
259     for (int i = 0; i < 3; i++)
260     {
261         source = Links.GetSource(current);
262         if (EqualityComparer.Equals(source, StringMarker))
263         {
264             var sequence = Links.GetTarget(current);
265             var isEmpty = EqualityComparer.Equals(sequence, EmptyStringMarker);
266             return isEmpty ? "" : UnicodeSequenceToStringConverter.Convert(sequence);
267         }
268         current = Links.GetTarget(current);
269     }
270     throw new Exception("The passed link does not contain a string.");
271 }
272
273 public decimal GetNumber(TLink valueLink)
274 {
275     var current = valueLink;
276     TLink source;
277     TLink target;
278     for (int i = 0; i < 3; i++)
279     {
280         source = Links.GetSource(current);
281         target = Links.GetTarget(current);
282         if (EqualityComparer.Equals(source, NumberMarker))
283         {
284             return RationalToDecimalConverter.Convert(target);
285         }
286         current = target;
287     }
288     throw new Exception("The passed link does not contain a number.");
289 }
290
291 public TLink GetObject(TLink objectValueLink)
292 {
293     var current = objectValueLink;
294

```

```

295     TLink source;
296     for (int i = 0; i < 3; i++)
297     {
298         source = Links.GetSource(current);
299         if (EqualityComparer.Equals(source, ObjectMarker))
300         {
301             return current;
302         }
303         current = Links.GetTarget(current);
304     }
305     throw new Exception("The passed link does not contain an object.");
306 }
307
308 public TLink GetArray(TLink arrayValueLink)
309 {
310     var current = arrayValueLink;
311     TLink source;
312     for (int i = 0; i < 3; i++)
313     {
314         source = Links.GetSource(current);
315         if (EqualityComparer.Equals(source, ArrayMarker))
316         {
317             return current;
318         }
319         current = Links.GetTarget(current);
320     }
321     throw new Exception("The passed link does not contain an array.");
322 }
323
324 public TLink GetArraySequence(TLink array) => Links.GetTarget(array);
325
326 public TLink GetValueLink(TLink parent)
327 {
328     var query = new Link<TLink>(index: Any, source: parent, target: Any);
329     var resultLinks = Links.All(query);
330     switch (resultLinks.Count)
331     {
332     case 0:
333         return default;
334     case 1:
335         var resultLinkTarget = Links.GetTarget(resultLinks[0]);
336         if (EqualityComparer.Equals(Links.GetSource(resultLinkTarget), ValueMarker))
337         {
338             return resultLinkTarget;
339         }
340         else
341         {
342             throw new InvalidOperationException("The passed link is not a value.");
343         }
344     case > 1:
345         throw new InvalidOperationException("More than 1 value found.");
346     default:
347         throw new InvalidOperationException("The list elements length is negative.");
348     }
349 }
350
351 public TLink GetValueMarker(TLink value)
352 {
353     var target = Links.GetTarget(value);
354     var targetSource = Links.GetSource(target);
355     if (EqualityComparer.Equals(MeaningRoot, targetSource))
356     {
357         return target;
358     }
359     return targetSource;
360 }
361
362 public List<TLink> GetMembersLinks(TLink @object)
363 {
364     Link<TLink> query = new(index: Any, source: @object, target: Any);
365     List<TLink> members = new();
366     Links.Each(objectMemberLink =>
367     {
368         var memberLink = Links.GetTarget(objectMemberLink);
369         var memberMarker = Links.GetSource(memberLink);
370         if (EqualityComparer.Equals(memberMarker, MemberMarker))
371         {
372             members.Add(Links.GetIndex(objectMemberLink));
373         }
374     });
375 }

```

```

374         return Links.Constants.Continue;
375     }, query);
376     return members;
377 }
378 }
379 }

```

## 1.2 ./csharp/Platform.Data.Doublets.Json/IJsonStorage.cs

```

1 using System.Collections.Generic;
2
3 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
4
5 namespace Platform.Data.Doublets.Json
6 {
7     public interface IJsonStorage<TLink>
8     {
9         public ILinks<TLink> Links { get; }
10        public TLink DocumentMarker { get; }
11        public TLink ObjectMarker { get; }
12        public TLink StringMarker { get; }
13        public TLink EmptyStringMarker { get; }
14        public TLink MemberMarker { get; }
15        public TLink ValueMarker { get; }
16        public TLink NumberMarker { get; }
17        public TLink ArrayMarker { get; }
18        public TLink EmptyArrayMarker { get; }
19        public TLink TrueMarker { get; }
20        public TLink FalseMarker { get; }
21        public TLink NullMarker { get; }
22        TLink CreateString(string content);
23        TLink CreateStringValue(string content);
24        TLink CreateNumber(decimal number);
25        TLink CreateNumberValue(decimal number);
26        TLink CreateBooleanValue(bool value);
27        TLink CreateNullValue();
28        TLink CreateDocument(string name);
29        TLink GetDocumentOrDefault(string name);
30        TLink CreateObject();
31        TLink CreateObjectValue();
32        TLink CreateArray(IList<TLink> array);
33        TLink CreateArrayValue(IList<TLink> array) => CreateValue(CreateArray(array));
34        TLink CreateArrayValue(TLink array) => CreateValue(array);
35        TLink CreateMember(string name);
36        TLink CreateValue(TLink value);
37        TLink Attach(TLink source, TLink target);
38        TLink AttachObject(TLink parent);
39        TLink AttachString(TLink parent, string content);
40        TLink AttachNumber(TLink parent, decimal number);
41        TLink AttachBoolean(TLink parent, bool value);
42        TLink AttachNull(TLink parent);
43        TLink AttachArray(TLink parent, IList<TLink> array);
44        TLink AttachMemberToObject(TLink @object, string keyName);
45        TLink AppendArrayValue(TLink arrayValue, TLink appendant);
46        string GetString(TLink stringValue);
47        decimal GetNumber(TLink value);
48        TLink GetObject(TLink objectValue);
49        TLink GetArray(TLink arrayValueLink);
50        TLink GetArraySequence(TLink array);
51        TLink GetValueLink(TLink parent);
52        TLink GetValueMarker(TLink link);
53        List<TLink> GetMembersLinks(TLink @object);
54    }
55 }

```

## 1.3 ./csharp/Platform.Data.Doublets.Json/JsonArrayElementCriterionMatcher.cs

```

1 using System;
2 using System.Collections.Generic;
3 using System.Linq;
4 using System.Text;
5 using System.Threading.Tasks;
6 using System.Text.Json;
7 using System.Threading;
8 using System.IO;
9 using Platform.Converters;
10 using System.Collections;
11 using Platform.Data.Doublets.Sequences;
12 using Platform.Data.Doublets.Sequences.HeightProviders;
13 using Platform.Data.Doublets.Sequences.CriterionMatchers;
14 using Platform.Interfaces;

```

```

15
16 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
17
18 namespace Platform.Data.Doublets.Json
19 {
20     public class JsonArrayElementCriterionMatcher<TLink> : ICriterionMatcher<TLink>
21     {
22         public readonly IJsonStorage<TLink> Storage;
23         public JsonArrayElementCriterionMatcher(IJsonStorage<TLink> storage) => Storage =
            ↪ storage;
24         public bool IsMatched(TLink link) =>
            ↪ EqualityComparer<TLink>.Default.Equals(Storage.Links.GetSource(link),
            ↪ Storage.ValueMarker);
25     }
26 }

```

#### 1.4 ./csharp/Platform.Data.Doublets.Json/JsonExporter.cs

```

1 using System;
2 using System.Collections.Generic;
3 using System.Text.Json;
4 using System.Threading;
5 using Platform.Data.Doublets.Sequences.Walkers;
6 using Platform.Collections.Stacks;
7
8 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
9
10 namespace Platform.Data.Doublets.Json
11 {
12     public class JsonExporter<TLink>
13     {
14         public readonly IJsonStorage<TLink> Storage;
15         public readonly EqualityComparer<TLink> EqualityComparer =
            ↪ EqualityComparer<TLink>.Default;
16
17         public JsonExporter(IJsonStorage<TLink> storage) => Storage = storage;
18
19         private bool IsElement(TLink link)
20         {
21             var marker = Storage.Links.GetSource(link);
22             return EqualityComparer.Equals(marker, Storage.ValueMarker);
23         }
24
25         private void WriteStringValue(in Utf8JsonWriter utf8JsonWriter, TLink valueLink) =>
            ↪ utf8JsonWriter.WriteStringValue(Storage.GetString(valueLink));
26
27         private void WriteString(in Utf8JsonWriter utf8JsonWriter, string parent, TLink
            ↪ valueLink) => utf8JsonWriter.WriteString(parent, Storage.GetString(valueLink));
28
29         private void WriteNumberValue(in Utf8JsonWriter utf8JsonWriter, TLink valueLink) =>
            ↪ utf8JsonWriter.WriteNumberValue(Storage.GetNumber(valueLink));
30
31         private void WriteNumber(in Utf8JsonWriter utf8JsonWriter, string parent, TLink
            ↪ valueLink) => utf8JsonWriter.WriteNumber(parent, Storage.GetNumber(valueLink));
32
33         private void Write(ref Utf8JsonWriter utf8JsonWriter, string parent, TLink valueLink,
            ↪ CancellationToken cancellationToken)
34         {
35             if (cancellationToken.IsCancellationRequested)
36             {
37                 return;
38             }
39             var valueMarker = Storage.GetValueMarker(valueLink);
40             if (EqualityComparer.Equals(valueMarker, Storage.ObjectMarker))
41             {
42                 utf8JsonWriter.WriteStartObject(parent);
43                 var membersLinks = Storage.GetMembersLinks(Storage.GetObject(valueLink));
44                 foreach (var memberLink in membersLinks)
45                 {
46                     if (cancellationToken.IsCancellationRequested)
47                     {
48                         return;
49                     }
50                     Write(ref utf8JsonWriter, Storage.GetString(memberLink),
                        ↪ Storage.GetValueLink(memberLink), cancellationToken);
51                 }
52                 utf8JsonWriter.WriteEndObject();
53             }
54             else if (EqualityComparer.Equals(valueMarker, Storage.ArrayMarker))
55             {

```

```

56     var array = Storage.GetArray(valueLink);
57     var sequence = Storage.GetArraySequence(array);
58     utf8JsonWriter.WriteStartArray(parent);
59     if (!EqualityComparer.Equals(sequence, Storage.EmptyArrayMarker))
60     {
61         RightSequenceWalker<TLink> rightSequenceWalker = new(Storage.Links, new
        ↪ DefaultStack<TLink>(), IsElement);
62         var elements = rightSequenceWalker.Walk(sequence);
63         foreach (var element in elements)
64         {
65             if (cancellationToken.IsCancellationRequested)
66             {
67                 return;
68             }
69             Write(ref utf8JsonWriter, element, in cancellationToken);
70         }
71     }
72     utf8JsonWriter.WriteEndArray();
73 }
74 else if (EqualityComparer.Equals(valueMarker, Storage.StringMarker))
75 {
76     WriteString(in utf8JsonWriter, parent, valueLink);
77 }
78 else if (EqualityComparer.Equals(valueMarker, Storage.NumberMarker))
79 {
80     WriteNumber(in utf8JsonWriter, parent, valueLink);
81 }
82 else if (EqualityComparer.Equals(valueMarker, Storage.TrueMarker))
83 {
84     utf8JsonWriter.WriteBoolean(parent, true);
85 }
86 else if (EqualityComparer.Equals(valueMarker, Storage.FalseMarker))
87 {
88     utf8JsonWriter.WriteBoolean(parent, false);
89 }
90 else if (EqualityComparer.Equals(valueMarker, Storage.NullMarker))
91 {
92     utf8JsonWriter.WriteNull(parent);
93 }
94 }
95
96 private void Write(ref Utf8JsonWriter utf8JsonWriter, TLink valueLink, in
    ↪ CancellationToken cancellationToken)
97 {
98     if (cancellationToken.IsCancellationRequested)
99     {
100         return;
101     }
102     var valueMarker = Storage.GetValueMarker(valueLink);
103     if (EqualityComparer.Equals(valueMarker, Storage.ObjectMarker))
104     {
105         utf8JsonWriter.WriteStartObject();
106         var membersLinks = Storage.GetMembersLinks(Storage.GetObject(valueLink));
107         foreach (var memberLink in membersLinks)
108         {
109             if (cancellationToken.IsCancellationRequested)
110             {
111                 return;
112             }
113             Write(ref utf8JsonWriter, Storage.GetString(memberLink),
                ↪ Storage.GetValueLink(memberLink), cancellationToken);
114         }
115         utf8JsonWriter.WriteEndObject();
116     }
117     else if (EqualityComparer.Equals(valueMarker, Storage.ArrayMarker))
118     {
119         var array = Storage.GetArray(valueLink);
120         var sequence = Storage.GetArraySequence(array);
121         utf8JsonWriter.WriteStartArray();
122         if (!EqualityComparer.Equals(sequence, Storage.EmptyArrayMarker))
123         {
124             RightSequenceWalker<TLink> rightSequenceWalker = new(Storage.Links, new
                ↪ DefaultStack<TLink>(), IsElement);
125             var elements = rightSequenceWalker.Walk(sequence);
126             foreach (var element in elements)
127             {
128                 if (cancellationToken.IsCancellationRequested)
129                 {

```



```

130         return;
131     }
132     Write(ref utf8JsonWriter, element, in cancellationToken);
133 }
134 }
135 utf8JsonWriter.WriteEndArray();
136 }
137 else if (EqualityComparer.Equals(valueMarker, Storage.StringMarker))
138 {
139     WriteStringValue(in utf8JsonWriter, valueLink);
140 }
141 else if (EqualityComparer.Equals(valueMarker, Storage.NumberMarker))
142 {
143     WriteNumberValue(in utf8JsonWriter, valueLink);
144 }
145 else if (EqualityComparer.Equals(valueMarker, Storage.TrueMarker))
146 {
147     utf8JsonWriter.WriteBooleanValue(true);
148 }
149 else if (EqualityComparer.Equals(valueMarker, Storage.FalseMarker))
150 {
151     utf8JsonWriter.WriteBooleanValue(false);
152 }
153 else if (EqualityComparer.Equals(valueMarker, Storage.NullMarker))
154 {
155     utf8JsonWriter.WriteNullValue();
156 }
157 }
158
159 public void Export(TLink document, ref Utf8JsonWriter utf8JsonWriter, in
    ↳ Cancellation token cancellationToken)
160 {
161     if (EqualityComparer.Equals(document, default))
162     {
163         throw new Exception("No document with this name exists");
164     }
165     var valueLink = Storage.GetValueLink(document);
166     Write(ref utf8JsonWriter, valueLink, in cancellationToken);
167     utf8JsonWriter.Flush();
168 }
169
170 public void Export(string documentName, Utf8JsonWriter utf8JsonWriter, Cancellation token
    ↳ cancellationToken) => Export(Storage.GetDocumentOrDefault(documentName), ref
    ↳ utf8JsonWriter, in cancellationToken);
171 }
172 }

```

## 1.5 ./csharp/Platform.Data.Doublets.Json/JsonExporterCLI.cs

```

1 using System;
2 using System.IO;
3 using System.Text.Encodings.Web;
4 using Platform.Data.Doublets.Memory.United.Generic;
5 using Platform.IO;
6 using System.Text.Json;
7 using Platform.Data.Doublets.Memory;
8 using Platform.Data.Doublets.Sequences.Converters;
9 using Platform.Memory;
10
11 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
12
13 namespace Platform.Data.Doublets.Json
14 {
15     public class JsonExporterCli<TLink>
16         where TLink : struct
17     {
18         public void Run(params string[] args)
19         {
20             var linksFilePath = ConsoleHelpers.GetOrReadArgument(0, "Links file path", args);
21             var jsonFilePath = ConsoleHelpers.GetOrReadArgument(1, "JSON file path", args);
22             var documentName = ConsoleHelpers.GetOrReadArgument(2, "Document name", args);
23             if (!File.Exists(linksFilePath))
24             {
25                 Console.WriteLine($"${linksFilePath} file does not exist.");
26             }
27             using FileStream jsonFileStream = new(jsonFilePath, FileMode.Append);
28             JsonSerializerOptions utf8JsonWriterOptions = new()
29             {
30                 Encoder = JavaScriptEncoder.UnsafeRelaxedJsonEscaping,
31                 Indented = true

```

```

32     };
33     Utf8JsonWriter utf8JsonWriter = new(jsonFileStream, utf8JsonWriterOptions);
34     var linksConstants = new LinksConstants<TLink>(enableExternalReferencesSupport:
35         ↪ true);
36     using UnitedMemoryLinks<TLink> memoryAdapter = new (new
37         ↪ FileMappedResizableDirectMemory(linksFilePath),
38         ↪ UnitedMemoryLinks<TLink>.DefaultLinksSizeStep, linksConstants,
39         ↪ IndexTreeType.Default);
40     var links = memoryAdapter.DecorateWithAutomaticUniquenessAndUsagesResolution();
41     BalancedVariantConverter<TLink> balancedVariantConverter = new(links);
42     var storage = new DefaultJsonStorage<TLink>(links, balancedVariantConverter);
43     var exporter = new JsonExporter<TLink>(storage);
44     var document = storage.GetDocumentOrDefault(documentName);
45     if (storage.EqualityComparer.Equals(document, default))
46     {
47         Console.WriteLine("No document with this name.");
48     }
49     using ConsoleCancellation cancellation = new ();
50     var cancellationToken = cancellation.Token;
51     Console.WriteLine("Press CTRL+C to stop.");
52     try
53     {
54         exporter.Export(document, ref utf8JsonWriter, in cancellationToken);
55     }
56     catch (Exception exception)
57     {
58         Console.WriteLine(exception);
59         return;
60     }
61     finally
62     {
63         utf8JsonWriter.Dispose();
64     }
65     Console.WriteLine("Export completed successfully.");
66 }
67 }

```

## 1.6 ./csharp/Platform.Data.Doublets.Json/JsonImporter.cs

```

1  using System;
2  using System.Collections.Generic;
3  using System.Text.Json;
4  using System.Threading;
5
6  #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
7
8  namespace Platform.Data.Doublets.Json
9  {
10     public class JsonImporter<TLink>
11     {
12         public readonly IJsonStorage<TLink> Storage;
13         public readonly EqualityComparer<TLink> EqualityComparer =
14             ↪ EqualityComparer<TLink>.Default;
15         public readonly Stack<TLink> Parents = new ();
16         public JsonImporter(IJsonStorage<TLink> storage) => Storage = storage;
17
18         private void PopIfParentIsMember()
19         {
20             var parent = Parents.Peek();
21             var parentMarker = Storage.GetValueMarker(parent);
22             if (EqualityComparer.Equals(parentMarker, Storage.MemberMarker))
23             {
24                 Parents.Pop();
25             }
26         }
27
28         public TLink Import(string documentName, ref Utf8JsonReader utf8JsonReader, in
29             ↪ Cancellation token cancellationToken)
30         {
31             Parents.Clear();
32             if (!EqualityComparer.Equals(Storage.GetDocumentOrDefault(documentName), default))
33             {
34                 throw new Exception("The document with the specified name already exists.");
35             }
36             var document = Storage.CreateDocument(documentName);
37             Parents.Push(document);
38             TLink parent;
39             TLink parentMarker;
40             JsonTokenType tokenType;

```

```

39 TLink value;
40 TLink newParentArray;
41 while (utf8JsonReader.Read())
42 {
43     cancellationToken.ThrowIfCancellationRequested();
44     parent = Parents.Peek();
45     parentMarker = Storage.GetValueMarker(parent);
46     tokenType = utf8JsonReader.TokenType;
47     if (utf8JsonReader.TokenType == JsonTokenType.PropertyName)
48     {
49         var @object = Storage.GetObject(parent);
50         var property = utf8JsonReader.GetString();
51         Parents.Push(Storage.AttachMemberToObject(@object, property));
52     }
53     switch (tokenType)
54     {
55         case JsonTokenType.StartObject:
56         {
57             value = Storage.CreateObjectValue();
58             if (EqualityComparer.Equals(parentMarker, Storage.ArrayMarker))
59             {
60                 Parents.Pop();
61                 newParentArray = Storage.AppendArrayValue(parent, value);
62                 Parents.Push(newParentArray);
63                 Parents.Push(value);
64             }
65             else
66             {
67                 var @object = Storage.Attach(parent, value);
68                 Parents.Push(@object);
69             }
70             break;
71         }
72         case JsonTokenType.EndObject:
73             Parents.Pop();
74             break;
75         case JsonTokenType.StartArray:
76             value = Storage.CreateArrayValue(Array.Empty<TLink>());
77             Parents.Push(value);
78             break;
79         case JsonTokenType.EndArray:
80         {
81             var arrayValue = Parents.Pop();
82             parent = Parents.Peek();
83             parentMarker = Storage.GetValueMarker(parent);
84             if (EqualityComparer.Equals(parentMarker, Storage.ArrayMarker))
85             {
86                 Parents.Pop();
87                 newParentArray = Storage.AppendArrayValue(parent, arrayValue);
88                 Parents.Push(newParentArray);
89             }
90             Storage.Attach(parent, arrayValue);
91             break;
92         }
93         case JsonTokenType.String:
94         {
95             var @string = utf8JsonReader.GetString();
96             value = Storage.CreateStringValue(@string);
97             if (EqualityComparer.Equals(parentMarker, Storage.ArrayMarker))
98             {
99                 Parents.Pop();
100                 newParentArray = Storage.AppendArrayValue(parent, value);
101                 Parents.Push(newParentArray);
102             }
103             else
104             {
105                 Storage.Attach(parent, value);
106             }
107             break;
108         }
109         case JsonTokenType.Number:
110         {
111             value = Storage.CreateNumberValue(utf8JsonReader.GetDecimal());
112             if (EqualityComparer.Equals(parentMarker, Storage.ArrayMarker))
113             {
114                 Parents.Pop();
115                 newParentArray = Storage.AppendArrayValue(parent, value);
116                 Parents.Push(newParentArray);
117             }

```

```

118         else
119         {
120             Storage.Attach(parent, value);
121         }
122         break;
123     }
124     case JsonTokenType.True:
125     {
126         value = Storage.CreateBooleanValue(true);
127         if (EqualityComparer.Equals(parentMarker, Storage.ArrayMarker))
128         {
129             Parents.Pop();
130             newParentArray = Storage.AppendArrayValue(parent, value);
131             Parents.Push(newParentArray);
132         }
133         else
134         {
135             Storage.Attach(parent, value);
136         }
137         break;
138     }
139     case JsonTokenType.False:
140     {
141         value = Storage.CreateBooleanValue(false);
142         if (EqualityComparer.Equals(parentMarker, Storage.ArrayMarker))
143         {
144             Parents.Pop();
145             newParentArray = Storage.AppendArrayValue(parent, value);
146             Parents.Push(newParentArray);
147         }
148         else
149         {
150             Storage.Attach(parent, value);
151         }
152         break;
153     }
154     case JsonTokenType.Null:
155     {
156         value = Storage.CreateNullValue();
157         if (EqualityComparer.Equals(parentMarker, Storage.ArrayMarker))
158         {
159             Parents.Pop();
160             newParentArray = Storage.AppendArrayValue(parent, value);
161             Parents.Push(newParentArray);
162         }
163         else
164         {
165             Storage.Attach(parent, value);
166         }
167         break;
168     }
169 }
170 if (tokenType != JsonTokenType.PropertyName && tokenType !=
    ↳ JsonTokenType.StartObject && tokenType != JsonTokenType.StartArray)
171 {
172     PopIfParentIsMember();
173 }
174 }
175 return document;
176 }
177 }
178 }

```

## 1.7 ./csharp/Platform.Data.Doublets.Json/JsonImporterCli.cs

```

1 using System;
2 using System.IO;
3 using System.Text;
4 using Platform.Data.Doublets.Memory.United.Generic;
5 using Platform.IO;
6 using System.Text.Json;
7 using Platform.Data.Doublets.Memory;
8 using Platform.Data.Doublets.Sequences.Converters;
9 using Platform.Memory;
10
11 #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
12
13 namespace Platform.Data.Doublets.Json
14 {
15     public class JsonImporterCli<TLink>
16         where TLink : struct

```

```

17 {
18     public void Run(params string[] args)
19     {
20         var jsonFilePath = ConsoleHelpers.GetOrReadArgument(0, "JSON file path", args);
21         var documentName = ConsoleHelpers.GetOrReadArgument(1, "Document name", args);
22         var linksFilePath = ConsoleHelpers.GetOrReadArgument(2, "Links file path", args);
23         if (!File.Exists(jsonFilePath))
24         {
25             Console.WriteLine($"${jsonFilePath} file does not exist.");
26         }
27         var json = File.ReadAllText(jsonFilePath);
28         var encodedJson = Encoding.UTF8.GetBytes(json);
29         ReadOnlySpan<byte> readOnlySpanEncodedJson = new(encodedJson);
30         Utf8JsonReader utf8JsonReader = new(readOnlySpanEncodedJson);
31         LinksConstants<TLink> linksConstants = new(enableExternalReferencesSupport: true);
32         FileMappedResizableDirectMemory fileMappedResizableDirectMemory = new(linksFilePath);
33         var unitedMemoryLinks = UnitedMemoryLinks<TLink>.DefaultLinksSizeStep;
34         const IndexTreeType indexTreeType = IndexTreeType.Default;
35         using UnitedMemoryLinks<TLink> memoryAdapter = new(fileMappedResizableDirectMemory,
36             ↪ unitedMemoryLinks, linksConstants, indexTreeType);
37         var links = memoryAdapter.DecorateWithAutomaticUniquenessAndUsagesResolution();
38         BalancedVariantConverter<TLink> balancedVariantConverter = new(links);
39         DefaultJsonStorage<TLink> storage = new(links, balancedVariantConverter);
40         JsonImporter<TLink> importer = new(storage);
41         using ConsoleCancellation cancellation = new();
42         var cancellationToken = cancellation.Token;
43         Console.WriteLine("Press CTRL+C to stop.");
44         try
45         {
46             importer.Import(documentName, ref utf8JsonReader, in cancellationToken);
47         }
48         catch (Exception exception)
49         {
50             Console.WriteLine(exception);
51             return;
52         }
53         Console.WriteLine("Import completed successfully.");
54     }
55 }

```

## 1.8 ./csharp/Platform.Data.Doublets.Json.Tests/JsonImportAndExportTests.cs

```

1 using System.Text;
2 using System.Text.Json;
3 using System.Threading;
4 using System.IO;
5 using Xunit;
6 using TLink = System.UInt64;
7 using Platform.Data.Doublets.Memory.United.Generic;
8 using Platform.Memory;
9 using Platform.Data.Doublets.Memory;
10 using System.Text.RegularExpressions;
11 using Platform.Data.Doublets.Sequences.Converters;
12
13 namespace Platform.Data.Doublets.Json.Tests
14 {
15     public class JsonImportAndExportTests
16     {
17         public static BalancedVariantConverter<TLink> BalancedVariantConverter;
18
19         public static ILinks<TLink> CreateLinks() => CreateLinks<TLink>(new IO.TemporaryFile());
20
21         public static ILinks<TLink> CreateLinks<TLink>(string dataDBFilename)
22         {
23             var linksConstants = new LinksConstants<TLink>(enableExternalReferencesSupport:
24                 ↪ true);
25             return new UnitedMemoryLinks<TLink>(new
26                 ↪ FileMappedResizableDirectMemory(dataDBFilename),
27                 ↪ UnitedMemoryLinks<TLink>.DefaultLinksSizeStep, linksConstants,
28                 ↪ IndexTreeType.Default);
29         }
30
31         public static DefaultJsonStorage<TLink> CreateJsonStorage(ILinks<TLink> links) => new
32             ↪ (links, BalancedVariantConverter);
33
34         public TLink Import(IJsonStorage<TLink> storage, string documentName, byte[] json)
35         {
36             Utf8JsonReader utf8JsonReader = new(json);
37             JsonImporter<TLink> jsonImporter = new(storage);

```

```

33     CancellationTokenSource importCancellationTokenSource = new();
34     CancellationToken cancellationToken = importCancellationTokenSource.Token;
35     return jsonImporter.Import(documentName, ref utf8JsonReader, in cancellationToken);
36 }
37
38 public void Export(TLink documentLink, IJsonStorage<TLink> storage, in MemoryStream
→ stream)
39 {
40     Utf8JsonWriter writer = new(stream);
41     JsonExporter<TLink> jsonExporter = new(storage);
42     CancellationTokenSource exportCancellationTokenSource = new();
43     CancellationToken exportCancellationToken = exportCancellationTokenSource.Token;
44     jsonExporter.Export(documentLink, ref writer, in exportCancellationToken);
45     writer.Dispose();
46 }
47
48 [Theory]
49 [InlineData("{}")]
50 [InlineData("\"stringValue\"")]
51 [InlineData("228")]
52 [InlineData("0.5")]
53 [InlineData("[]")]
54 [InlineData("true")]
55 [InlineData("false")]
56 [InlineData("null")]
57 [InlineData("{ \"string\": \"string\" }")]
58 [InlineData("{ \"null\": null }")]
59 [InlineData("{ \"boolean\": false }")]
60 [InlineData("{ \"boolean\": true }")]
61 [InlineData("{ \"array\": [] }")]
62 [InlineData("{ \"array\": [1] }")]
63 [InlineData("{ \"object\": {} }")]
64 [InlineData("{ \"number\": 1 }")]
65 [InlineData("{ \"decimal\": 0.5 }")]
66 [InlineData("[null]")]
67 [InlineData("[true]")]
68 [InlineData("[false]")]
69 [InlineData("[[]]")]
70 [InlineData("[[1]]")]
71 [InlineData("[[0.5]]")]
72 [InlineData("[{}]")]
73 [InlineData("[\"The Venus Project\"]")]
74 [InlineData("[{ \"title\": \"The Venus Project\" } ]")]
75 [InlineData("[1,2,3,4]")]
76 [InlineData("[ -0.5, 0.5 ]")]
77 public void Test(string initialJson)
78 {
79     var links = CreateLinks();
80     BalancedVariantConverter = new(links);
81     var storage = CreateJsonStorage(links);
82     var json = Encoding.UTF8.GetBytes(initialJson);
83     var documentLink = Import(storage, "documentName", json);
84     MemoryStream stream = new();
85     Export(documentLink, storage, in stream);
86     string exportedJson = Encoding.UTF8.GetString(stream.ToArray());
87     stream.Dispose();
88     var minimizedInitialJson = Regex.Replace(initialJson,
→ "(\\"(?:[^\\"\\\\\\]|\\\\\\\\|\\\\\\.|\\\\\\s+)*\\")\\\\\\s+", "$1");
89     Assert.Equal(minimizedInitialJson, exportedJson);
90 }
91 }
92 }

```

## 1.9 ./csharp/Platform.Data.Doublets.Json.Tests/JsonStorageTests.cs

```

1 using Xunit;
2 using Platform.Data.Doublets.Memory.United.Generic;
3 using Platform.Data.Doublets.Memory;
4 using Platform.Memory;
5 using TLink = System.UInt32;
6 using System.IO;
7 using Xunit.Abstractions;
8 using Platform.Collections.Stacks;
9 using Platform.Data.Doublets.Sequences.Walkers;
10 using System.Collections.Generic;
11 using Platform.Data.Doublets.Sequences.Converters;
12
13 namespace Platform.Data.Doublets.Json.Tests
14 {
15     public class JsonStorageTests

```

```

16 {
17     private readonly ITestOutputHelper output;
18     public static BalancedVariantConverter<TLink> BalancedVariantConverter;
19
20     public JsonStorageTests(ITestOutputHelper output)
21     {
22         this.output = output;
23     }
24
25     public static ILinks<TLink> CreateLinks() => CreateLinks<TLink>(new
        ↳ Platform.IO.TemporaryFile());
26
27     public static ILinks<TLink> CreateLinks<TLink>(string dataDBFilename)
28     {
29         var linksConstants = new LinksConstants<TLink>(enableExternalReferencesSupport:
        ↳ true);
30         return new UnitedMemoryLinks<TLink>(new
        ↳ FileMappedResizableDirectMemory(dataDBFilename),
        ↳ UnitedMemoryLinks<TLink>.DefaultLinksSizeStep, linksConstants,
        ↳ IndexTreeType.Default);
31     }
32
33     public static DefaultJsonStorage<TLink> CreateJsonStorage()
34     {
35         var links = CreateLinks();
36         return CreateJsonStorage(links);
37     }
38
39     public static DefaultJsonStorage<TLink> CreateJsonStorage(ILinks<TLink> links)
40     {
41         BalancedVariantConverter = new(links);
42         return new DefaultJsonStorage<TLink>(links, BalancedVariantConverter);
43     }
44
45     [Fact]
46     public void ConstructorsTest() => CreateJsonStorage();
47
48     [Fact]
49     public void CreateDocumentTest()
50     {
51         var defaultJsonStorage = CreateJsonStorage();
52         defaultJsonStorage.CreateDocument("documentName");
53     }
54
55     [Fact]
56     public void GetDocumentTest()
57     {
58         var defaultJsonStorage = CreateJsonStorage();
59         var createdDocumentLink = defaultJsonStorage.CreateDocument("documentName");
60         var foundDocumentLink = defaultJsonStorage.GetDocumentOrDefault("documentName");
61         Assert.Equal(createdDocumentLink, foundDocumentLink);
62     }
63
64     [Fact]
65     public void CreateObjectTest()
66     {
67         var defaultJsonStorage = CreateJsonStorage();
68         var object0 = defaultJsonStorage.CreateObjectValue();
69         var object1 = defaultJsonStorage.CreateObjectValue();
70         Assert.NotEqual(object0, object1);
71     }
72
73     [Fact]
74     public void CreateStringTest()
75     {
76         var defaultJsonStorage = CreateJsonStorage();
77         defaultJsonStorage.CreateString("string");
78     }
79
80     [Fact]
81     public void CreateMemberTest()
82     {
83         var defaultJsonStorage = CreateJsonStorage();
84         var document = defaultJsonStorage.CreateDocument("documentName");
85         defaultJsonStorage.AttachObject(document);
86         defaultJsonStorage.CreateMember("keyName");
87     }
88
89     [Fact]

```

```

90 public void AttachObjectValueToDocumentTest()
91 {
92     var links = CreateLinks();
93     var defaultJsonStorage = CreateJsonStorage(links);
94     TLink document = defaultJsonStorage.CreateDocument("documentName");
95     TLink documentValueLink = defaultJsonStorage.AttachObject(document);
96     TLink createdObjectValue = links.GetTarget(documentValueLink);
97
98     TLink valueMarker = links.GetSource(createdObjectValue);
99     Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
100
101     TLink createdObject = links.GetTarget(createdObjectValue);
102     TLink objectMarker = links.GetSource(createdObject);
103     Assert.Equal(objectMarker, defaultJsonStorage.ObjectMarker);
104
105     TLink foundDocumentValue = defaultJsonStorage.GetValueLink(document);
106     Assert.Equal(createdObjectValue, foundDocumentValue);
107 }
108
109 [Fact]
110 public void AttachStringValueToDocumentTest()
111 {
112     var links = CreateLinks();
113     var defaultJsonStorage = CreateJsonStorage(links);
114     TLink document = defaultJsonStorage.CreateDocument("documentName");
115     TLink documentStringLink = defaultJsonStorage.AttachString(document, "stringName");
116     TLink createdStringValue = links.GetTarget(documentStringLink);
117
118     TLink valueMarker = links.GetSource(createdStringValue);
119     Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
120
121     TLink createdString = links.GetTarget(createdStringValue);
122     TLink stringMarker = links.GetSource(createdString);
123     Assert.Equal(stringMarker, defaultJsonStorage.StringMarker);
124
125     TLink foundStringValue = defaultJsonStorage.GetValueLink(document);
126     Assert.Equal(createdStringValue, foundStringValue);
127 }
128
129 [Fact]
130 public void AttachNumberToDocumentTest()
131 {
132     var links = CreateLinks();
133     var defaultJsonStorage = CreateJsonStorage(links);
134     TLink document = defaultJsonStorage.CreateDocument("documentName");
135     TLink documentNumberLink = defaultJsonStorage.AttachNumber(document, 2021);
136     TLink createdNumberValue = links.GetTarget(documentNumberLink);
137
138     TLink valueMarker = links.GetSource(createdNumberValue);
139     Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
140
141     TLink createdNumber = links.GetTarget(createdNumberValue);
142     TLink numberMarker = links.GetSource(createdNumber);
143     Assert.Equal(numberMarker, defaultJsonStorage.NumberMarker);
144
145     TLink foundNumberValue = defaultJsonStorage.GetValueLink(document);
146     Assert.Equal(createdNumberValue, foundNumberValue);
147 }
148
149 [Fact]
150 public void AttachTrueValueToDocumentTest()
151 {
152     var links = CreateLinks();
153     var defaultJsonStorage = CreateJsonStorage(links);
154     TLink document = defaultJsonStorage.CreateDocument("documentName");
155
156     TLink documentTrueValueLink = defaultJsonStorage.AttachBoolean(document, true);
157     TLink createdTrueValue = links.GetTarget(documentTrueValueLink);
158
159     TLink valueMarker = links.GetSource(createdTrueValue);
160     Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
161
162     TLink trueMarker = links.GetTarget(createdTrueValue);
163     Assert.Equal(trueMarker, defaultJsonStorage.TrueMarker);
164
165     TLink foundTrueValue = defaultJsonStorage.GetValueLink(document);
166     Assert.Equal(createdTrueValue, foundTrueValue);
167 }
168

```



```

169 [Fact]
170 public void AttachFalseValueToDocumentTest()
171 {
172     var links = CreateLinks();
173     var defaultJsonStorage = CreateJsonStorage(links);
174     TLink document = defaultJsonStorage.CreateDocument("documentName");
175
176     TLink documentFalseValueLink = defaultJsonStorage.AttachBoolean(document, false);
177     TLink createdFalseValue = links.GetTarget(documentFalseValueLink);
178
179     TLink valueMarker = links.GetSource(createdFalseValue);
180     Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
181
182     TLink falseMarker = links.GetTarget(createdFalseValue);
183     Assert.Equal(falseMarker, defaultJsonStorage.FalseMarker);
184
185     TLink foundFalseValue = defaultJsonStorage.GetValueLink(document);
186     Assert.Equal(createdFalseValue, foundFalseValue);
187 }
188
189 [Fact]
190 public void AttachNullValueToDocumentTest()
191 {
192     var links = CreateLinks();
193     var defaultJsonStorage = CreateJsonStorage(links);
194     TLink document = defaultJsonStorage.CreateDocument("documentName");
195
196     TLink documentNullValueLink = defaultJsonStorage.AttachNull(document);
197     TLink createdNullValue = links.GetTarget(documentNullValueLink);
198
199     TLink valueMarker = links.GetSource(createdNullValue);
200     Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
201
202     TLink nullMarker = links.GetTarget(createdNullValue);
203     Assert.Equal(nullMarker, defaultJsonStorage.NullMarker);
204
205     TLink foundNullValue = defaultJsonStorage.GetValueLink(document);
206     Assert.Equal(createdNullValue, foundNullValue);
207 }
208
209 [Fact]
210 public void AttachEmptyArrayValueToDocumentTest()
211 {
212     var links = CreateLinks();
213     var defaultJsonStorage = CreateJsonStorage(links);
214     TLink document = defaultJsonStorage.CreateDocument("documentName");
215
216     TLink documentArrayValueLink = defaultJsonStorage.AttachArray(document, new
217         ↪ TLink[0]);
218     TLink createdArrayValue = links.GetTarget(documentArrayValueLink);
219     output.WriteLine(links.Format(createdArrayValue));
220
221     TLink valueMarker = links.GetSource(createdArrayValue);
222     Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
223
224     TLink createdArrayLink = links.GetTarget(createdArrayValue);
225     TLink arrayMarker = links.GetSource(createdArrayLink);
226     Assert.Equal(arrayMarker, defaultJsonStorage.ArrayMarker);
227
228     TLink createArrayContents = links.GetTarget(createdArrayLink);
229     Assert.Equal(createArrayContents, defaultJsonStorage.EmptyArrayMarker);
230
231     TLink foundArrayValue = defaultJsonStorage.GetValueLink(document);
232     Assert.Equal(createdArrayValue, foundArrayValue);
233 }
234
235 [Fact]
236 public void AttachArrayValueToDocumentTest()
237 {
238     var links = CreateLinks();
239     var defaultJsonStorage = CreateJsonStorage(links);
240     TLink document = defaultJsonStorage.CreateDocument("documentName");
241
242     TLink arrayElement = defaultJsonStorage.CreateString("arrayElement");
243     TLink[] array = new TLink[3] { arrayElement, arrayElement, arrayElement };
244
245     TLink documentArrayValueLink = defaultJsonStorage.AttachArray(document, array);

```

```

247 TLink createdArrayValue = links.GetTarget(documentArrayValueLink);
248
249 DefaultStack<TLink> stack = new();
250 RightSequenceWalker<TLink> rightSequenceWalker = new(links, stack, (TLink
    ↳ arrayElementLink) => links.GetSource(arrayElementLink) ==
    ↳ defaultJsonStorage.ValueMarker);
251 IEnumerable<TLink> arrayElementsValuesLink =
    ↳ rightSequenceWalker.Walk(createdArrayValue);
252 Assert.NotEmpty(arrayElementsValuesLink);
253
254 output.WriteLine(links.Format(createdArrayValue));
255
256
257 TLink valueMarker = links.GetSource(createdArrayValue);
258 Assert.Equal(valueMarker, defaultJsonStorage.ValueMarker);
259
260 TLink createdArrayLink = links.GetTarget(createdArrayValue);
261 TLink arrayMarker = links.GetSource(createdArrayLink);
262 Assert.Equal(arrayMarker, defaultJsonStorage.ArrayMarker);
263
264 TLink createdArrayContents = links.GetTarget(createdArrayLink);
265 Assert.Equal(links.GetTarget(createdArrayContents), arrayElement);
266
267
268 TLink foundArrayValue = defaultJsonStorage.GetValueLink(document);
269 Assert.Equal(createdArrayValue, foundArrayValue);
270 }
271
272 [Fact]
273 public void GetObjectFromDocumentObjectValueLinkTest()
274 {
275     ILinks<TLink> links = CreateLinks();
276     var defaultJsonStorage = CreateJsonStorage(links);
277     TLink document = defaultJsonStorage.CreateDocument("documentName");
278     TLink documentObjectValueLink = defaultJsonStorage.AttachObject(document);
279     TLink objectValueLink = links.GetTarget(documentObjectValueLink);
280     TLink objectFromGetObject = defaultJsonStorage.GetObject(documentObjectValueLink);
281     output.WriteLine(links.Format(objectValueLink));
282     output.WriteLine(links.Format(objectFromGetObject));
283     Assert.Equal(links.GetTarget(objectValueLink), objectFromGetObject);
284 }
285
286 [Fact]
287 public void GetObjectFromObjectValueLinkTest()
288 {
289     ILinks<TLink> links = CreateLinks();
290     var defaultJsonStorage = CreateJsonStorage(links);
291     TLink document = defaultJsonStorage.CreateDocument("documentName");
292     TLink documentObjectValueLink = defaultJsonStorage.AttachObject(document);
293     TLink objectValueLink = links.GetTarget(documentObjectValueLink);
294     TLink objectFromGetObject = defaultJsonStorage.GetObject(objectValueLink);
295     Assert.Equal(links.GetTarget(objectValueLink), objectFromGetObject);
296 }
297
298 [Fact]
299 public void AttachStringValueToKey()
300 {
301     ILinks<TLink> links = CreateLinks();
302     var defaultJsonStorage = CreateJsonStorage(links);
303     TLink document = defaultJsonStorage.CreateDocument("documentName");
304     TLink documentObjectValue = defaultJsonStorage.AttachObject(document);
305     TLink @object = defaultJsonStorage.GetObject(documentObjectValue);
306     TLink memberLink = defaultJsonStorage.AttachMemberToObject(@object, "keyName");
307     TLink memberStringValueLink = defaultJsonStorage.AttachString(memberLink,
        ↳ "stringValue");
308     TLink stringValueLink = links.GetTarget(memberStringValueLink);
309     List<TLink> objectMembersLinks = defaultJsonStorage.GetMembersLinks(@object);
310     Assert.Equal(memberLink, objectMembersLinks[0]);
311     Assert.Equal(stringValueLink,
        ↳ defaultJsonStorage.GetValueLink(objectMembersLinks[0]));
312 }
313
314 [Fact]
315 public void AttachNumberValueToKey()
316 {
317     ILinks<TLink> links = CreateLinks();
318     var defaultJsonStorage = CreateJsonStorage(links);
319     TLink document = defaultJsonStorage.CreateDocument("documentName");

```

```

320 TLink documentObjectValue = defaultJsonStorage.AttachObject(document);
321 TLink @object = defaultJsonStorage.GetObject(documentObjectValue);
322 TLink memberLink = defaultJsonStorage.AttachMemberToObject(@object, "keyName");
323 TLink memberNumberValueLink = defaultJsonStorage.AttachNumber(memberLink, 123);
324 TLink numberValueLink = links.GetTarget(memberNumberValueLink);
325 List<TLink> objectMembersLinks = defaultJsonStorage.GetMembersLinks(@object);
326 Assert.Equal(memberLink, objectMembersLinks[0]);
327 Assert.Equal(numberValueLink,
    ↪ defaultJsonStorage.GetValueLink(objectMembersLinks[0]));
328 }
329
330 [Fact]
331 public void AttachObjectValueToKey()
332 {
333     ILinks<TLink> links = CreateLinks();
334     var defaultJsonStorage = CreateJsonStorage(links);
335     TLink document = defaultJsonStorage.CreateDocument("documentName");
336     TLink documentObjectValue = defaultJsonStorage.AttachObject(document);
337     TLink @object = defaultJsonStorage.GetObject(documentObjectValue);
338     TLink memberLink = defaultJsonStorage.AttachMemberToObject(@object, "keyName");
339     TLink memberObjectValueLink = defaultJsonStorage.AttachObject(memberLink);
340     TLink objectValueLink = links.GetTarget(memberObjectValueLink);
341     List<TLink> objectMembersLinks = defaultJsonStorage.GetMembersLinks(@object);
342     Assert.Equal(memberLink, objectMembersLinks[0]);
343     Assert.Equal(objectValueLink,
    ↪ defaultJsonStorage.GetValueLink(objectMembersLinks[0]));
344 }
345
346 [Fact]
347 public void AttachArrayValueToKey()
348 {
349     ILinks<TLink> links = CreateLinks();
350     var defaultJsonStorage = CreateJsonStorage(links);
351     TLink document = defaultJsonStorage.CreateDocument("documentName");
352     TLink documentObjectValue = defaultJsonStorage.AttachObject(document);
353     TLink @object = defaultJsonStorage.GetObject(documentObjectValue);
354     TLink memberLink = defaultJsonStorage.AttachMemberToObject(@object, "keyName");
355     TLink arrayElement = defaultJsonStorage.CreateString("arrayElement");
356     TLink[] array = new TLink[3] { arrayElement, arrayElement, arrayElement };
357     TLink memberArrayValueLink = defaultJsonStorage.AttachArray(memberLink, array);
358     TLink arrayValueLink = links.GetTarget(memberArrayValueLink);
359     List<TLink> objectMembersLinks = defaultJsonStorage.GetMembersLinks(@object);
360     Assert.Equal(memberLink, objectMembersLinks[0]);
361     Assert.Equal(arrayValueLink, defaultJsonStorage.GetValueLink(objectMembersLinks[0]));
362 }
363
364 [Fact]
365 public void AttachTrueValueToKey()
366 {
367     ILinks<TLink> links = CreateLinks();
368     var defaultJsonStorage = CreateJsonStorage(links);
369     TLink document = defaultJsonStorage.CreateDocument("documentName");
370     TLink documentObjectValue = defaultJsonStorage.AttachObject(document);
371     TLink @object = defaultJsonStorage.GetObject(documentObjectValue);
372     TLink memberLink = defaultJsonStorage.AttachMemberToObject(@object, "keyName");
373     TLink memberTrueValueLink = defaultJsonStorage.AttachBoolean(memberLink, true);
374     TLink trueValueLink = links.GetTarget(memberTrueValueLink);
375     List<TLink> objectMembersLinks = defaultJsonStorage.GetMembersLinks(@object);
376     Assert.Equal(memberLink, objectMembersLinks[0]);
377     Assert.Equal(trueValueLink, defaultJsonStorage.GetValueLink(objectMembersLinks[0]));
378 }
379
380 [Fact]
381 public void AttachFalseValueToKey()
382 {
383     ILinks<TLink> links = CreateLinks();
384     var defaultJsonStorage = CreateJsonStorage(links);
385     TLink document = defaultJsonStorage.CreateDocument("documentName");
386     TLink documentObjectValue = defaultJsonStorage.AttachObject(document);
387     TLink @object = defaultJsonStorage.GetObject(documentObjectValue);
388     TLink memberLink = defaultJsonStorage.AttachMemberToObject(@object, "keyName");
389     TLink memberFalseValueLink = defaultJsonStorage.AttachBoolean(memberLink, false);
390     TLink falseValueLink = links.GetTarget(memberFalseValueLink);
391     List<TLink> objectMembersLinks = defaultJsonStorage.GetMembersLinks(@object);
392     Assert.Equal(memberLink, objectMembersLinks[0]);
393     Assert.Equal(falseValueLink, defaultJsonStorage.GetValueLink(objectMembersLinks[0]));
394 }
395

```

```
[Fact]
public void AttachNullValueToKey()
{
    ILinks<TLink> links = CreateLinks();
    var defaultJsonStorage = CreateJsonStorage(links);
    TLink document = defaultJsonStorage.CreateDocument("documentName");
    TLink documentObjectValue = defaultJsonStorage.AttachObject(document);
    TLink @object = defaultJsonStorage.GetObject(documentObjectValue);
    TLink memberLink = defaultJsonStorage.AttachMemberToObject(@object, "keyName");
    TLink memberNullValueLink = defaultJsonStorage.AttachNull(memberLink);
    TLink nullValueLink = links.GetTarget(memberNullValueLink);
    List<TLink> objectMembersLinks = defaultJsonStorage.GetMembersLinks(@object);
    Assert.Equal(nullValueLink, defaultJsonStorage.GetValueLink(objectMembersLinks[0]));
}
}
```

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