

LinksPlatform's Platform.Numbers Class Library

1.1 ./csharp/Platform.Numbers/Arithmetic.cs

```
1  using System.Runtime.CompilerServices;
2
3  namespace Platform.Numbers
4  {
5      /// <summary>
6      /// <para>Represents a set of arithmetic methods.</para>
7      /// <para>Представляет набор арифметических методов.</para>
8      /// </summary>
9      public static class Arithmetic
10     {
11         /// <summary>
12         /// <para>Performing adding the x and y arguments.</para>
13         /// <para>Выполняет сложение аргументов x и y.</para>
14         /// </summary>
15         /// <typeparam name="T">
16         /// <para>The numbers' type.</para>
17         /// <para>Тип чисел.</para>
18         /// </typeparam>
19         /// <param name="x">
20         /// <para>The first term.</para>
21         /// <para>Первое слагаемое.</para>
22         /// </param>
23         /// <param name="y">
24         /// <para>The second term.</para>
25         /// <para>Второе слагаемое.</para>
26         /// </param>
27         /// <returns>
28         /// <para>Sum of x and y.</para>
29         /// <para>Сумма x и y.</para>
30         /// </returns>
31         [MethodImpl(MethodImplOptions.AggressiveInlining)]
32         public static T Add<T>(T x, T y) => Arithmetic<T>.Add(x, y);
33
34         /// <summary>
35         /// <para>Performs subtracting y from x.</para>
36         /// <para>Выполняет вычитание y из x.</para>
37         /// </summary>
38         /// <typeparam name="T">
39         /// <para>The numbers' type.</para>
40         /// <para>Тип чисел.</para>
41         /// </typeparam>
42         /// <param name="x">
43         /// <para>Minuend.</para>
44         /// <para>Уменьшаемое.</para>
45         /// </param>
46         /// <param name="y">
47         /// <para>Subtrahend.</para>
48         /// <para>Вычитаемое.</para>
49         /// </param>
50         /// <returns>
51         /// <para>Difference between x and y.</para>
52         /// <para>Разность между x и y.</para>
53         /// </returns>
54         [MethodImpl(MethodImplOptions.AggressiveInlining)]
55         public static T Subtract<T>(T x, T y) => Arithmetic<T>.Subtract(x, y);
56
57         /// <summary>
58         /// <para>Performs multiplication x by y.</para>
59         /// <para>Выполняет умножение x на y.</para>
60         /// </summary>
61         /// <typeparam name="T">
62         /// <para>The numbers' type.</para>
63         /// <para>Тип чисел.</para>
64         /// </typeparam>
65         /// <param name="x">
66         /// <para>First multiplier.</para>
67         /// <para>Первый множитель.</para>
68         /// </param>
69         /// <param name="y">
70         /// <para>Second multiplier.</para>
71         /// <para>Второй множитель.</para>
72         /// </param>
73         /// <returns>
74         /// <para>Product of x and y.</para>
75         /// <para>Произведение x и y.</para>
76         /// </returns>
```

```

77 [MethodImpl(MethodImplOptions.AggressiveInlining)]
78 public static T Multiply<T>(T x, T y) => Arithmetic<T>.Multiply(x, y);
79
80 /// <summary>
81 /// <para>Performs dividing x by y.</para>
82 /// <para>Выполняет деление x на y.</para>
83 /// </summary>
84 /// <typeparam name="T">
85 /// <para>The numbers' type.</para>
86 /// <para>Тип чисел.</para>
87 /// </typeparam>
88 /// <param name="x">
89 /// <para>Dividend.</para>
90 /// <para>Делимое.</para>
91 /// </param>
92 /// <param name="y">
93 /// <para>Divider.</para>
94 /// <para>Делитель.</para>
95 /// </param>
96 /// <returns>
97 /// <para>Quoitent of x and y.</para>
98 /// <para>Частное x и y.</para>
99 /// </returns>
100 [MethodImpl(MethodImplOptions.AggressiveInlining)]
101 public static T Divide<T>(T x, T y) => Arithmetic<T>.Divide(x, y);
102
103 /// <summary>
104 /// <para>Increasing the number by one.</para>
105 /// <para>Увеличивает число на единицу.</para>
106 /// </summary>
107 /// <typeparam name="T">
108 /// <para>The number's type.</para>
109 /// <para>Тип числа.</para>
110 /// </typeparam>
111 /// <param name="x">
112 /// <para>The number to increase.</para>
113 /// <para>Число для увеличения.</para>
114 /// </param>
115 /// <returns>
116 /// <para>Increase by one number.</para>
117 /// <para>Увеличенное на единицу число.</para>
118 /// </returns>
119 [MethodImpl(MethodImplOptions.AggressiveInlining)]
120 public static T Increment<T>(T x) => Arithmetic<T>.Increment(x);
121
122 /// <summary>
123 /// <para>Increases the value of argument by one.</para>
124 /// <para>Увеличивает значение аргумента на единицу.</para>
125 /// </summary>
126 /// <typeparam name="T">
127 /// <para>The number's type.</para>
128 /// <para>Тип числа.</para>
129 /// </typeparam>
130 /// <param name="x">
131 /// <para>The argument to increase.</para>
132 /// <para>Аргумент для увеличения.</para>
133 /// </param>
134 /// <returns>
135 /// <para>Increased argument value.</para>
136 /// <para>Увеличенное значение аргумента.</para>
137 /// </returns>
138 [MethodImpl(MethodImplOptions.AggressiveInlining)]
139 public static T Increment<T>(ref T x) => x = Arithmetic<T>.Increment(x);
140
141 /// <summary>
142 /// <para>Decreases number by one.</para>
143 /// <para>Уменьшение числа на единицу.</para>
144 /// </summary>
145 /// <typeparam name="T">
146 /// <para>The number's type.</para>
147 /// <para>Тип числа.</para>
148 /// </typeparam>
149 /// <param name="x">
150 /// <para>The number to reduce.</para>
151 /// <para>Число для уменьшения.</para>
152 /// </param>
153 /// <returns>
154 /// <para>Decreased by one number.</para>

```

```

155     /// <para>Уменьшенное на единицу число.</para>
156     /// </returns>
157     [MethodImpl(MethodImplOptions.AggressiveInlining)]
158     public static T Decrement<T>(T x) => Arithmetic<T>.Decrement(x);
159
160     /// <summary>
161     /// <para>Decreases the value of the argument by one.</para>
162     /// <para>Уменьшает значение аргумента на единицу.</para>
163     /// </summary>
164     /// <typeparam name="T">
165     /// <para>The number's type.</para>
166     /// <para>Тип числа.</para>
167     /// </typeparam>
168     /// <param name="x">
169     /// <para>The argument to reduce.</para>
170     /// <para>Аргумент для уменьшения.</para>
171     /// </param>
172     /// <returns>
173     /// <para>Decreased argument value.</para>
174     /// <para>Уменьшенное значение аргумента.</para>
175     /// </returns>
176     [MethodImpl(MethodImplOptions.AggressiveInlining)]
177     public static T Decrement<T>(ref T x) => x = Arithmetic<T>.Decrement(x);
178 }
179 }

```

1.2 ./csharp/Platform.Numbers/ArithmeticExtensions.cs

```

1  using System.Runtime.CompilerServices;
2
3  namespace Platform.Numbers
4  {
5      /// <summary>
6      /// <para>Represents a set of extension methods that perform arithmetic operations on
7      ///     ↪ arbitrary object types.</para>
8      /// <para>Представляет набор методов расширения выполняющих арифметические операции для
9      ///     ↪ объектов произвольного типа.</para>
10     /// </summary>
11     public static class ArithmeticExtensions
12     {
13         /// <summary>
14         /// <para>Increments the variable passed as an argument by one.</para>
15         /// <para>Увеличивает переданную в качестве аргумента переменную на единицу.</para>
16         /// </summary>
17         /// <typeparam name="T">
18         /// <para>The number's type.</para>
19         /// <para>Тип числа.</para>
20         /// </typeparam>
21         /// <param name="x">
22         /// <para>The reference to the incremented variable.</para>
23         /// <para>Ссылка на увеличиваемую переменную.</para>
24         /// </param>
25         /// <returns>
26         /// <para>The value of the argument incremented by one.</para>
27         /// <para>Увеличенное значение аргумента на единицу.</para>
28         /// </returns>
29         [MethodImpl(MethodImplOptions.AggressiveInlining)]
30         public static T Increment<T>(this ref T x) where T : struct => x =
31             ↪ Arithmetic<T>.Increment(x);
32
33         /// <summary>
34         /// <para>Decrements the variable passed as an argument by one.</para>
35         /// <para>Уменьшает переданную в качестве аргумента переменную на единицу.</para>
36         /// </summary>
37         /// <typeparam name="T">
38         /// <para>The number's type.</para>
39         /// <para>Тип числа.</para>
40         /// </typeparam>
41         /// <param name="x">
42         /// <para>The reference to the decremented variable.</para>
43         /// <para>Ссылка на уменьшаемую переменную.</para>
44         /// </param>
45         /// <returns>
46         /// <para>The value of the argument decremented by one.</para>
47         /// <para>Уменьшенное значение аргумента на единицу.</para>
48         /// </returns>
49         [MethodImpl(MethodImplOptions.AggressiveInlining)]
50         public static T Decrement<T>(this ref T x) where T : struct => x =
51             ↪ Arithmetic<T>.Decrement(x);

```

```
48     }
49 }
```

1.3 ./csharp/Platform.Numbers/Arithmetic[T].cs

```
1  using System;
2  using System.Reflection.Emit;
3  using System.Runtime.CompilerServices;
4  using Platform.Exceptions;
5  using Platform.Reflection;
6
7  // ReSharper disable StaticFieldInGenericType
8  namespace Platform.Numbers
9  {
10     /// <summary>
11     /// <para>Represents a set of compiled arithmetic operations delegates.</para>
12     /// <para>Представляет набор скомпилированных делегатов арифметических операций.</para>
13     /// </summary>
14     public static class Arithmetic<T>
15     {
16         /// <summary>
17         /// <para>A read-only field that represents a addition function delegate.</para>
18         /// <para>Поле только для чтения, представляющее делегат функции сложения.</para>
19         /// </summary>
20         public static readonly Func<T, T, T> Add = CompileAddDelegate();
21
22         /// <summary>
23         /// <para>A read-only field that represents a subtraction function delegate.</para>
24         /// <para>Поле только для чтения, представляющее делегат функции вычитания.</para>
25         /// </summary>
26         public static readonly Func<T, T, T> Subtract = CompileSubtractDelegate();
27
28         /// <summary>
29         /// <para>A read-only field that represents a multiplication function delegate.</para>
30         /// <para>Поле только для чтения, представляющее делегат функции умножения.</para>
31         /// </summary>
32         public static readonly Func<T, T, T> Multiply = CompileMultiplyDelegate();
33
34         /// <summary>
35         /// <para>A read-only field that represents a division function delegate.</para>
36         /// <para>Поле только для чтения, представляющее делегат функции деления.</para>
37         /// </summary>
38         public static readonly Func<T, T, T> Divide = CompileDivideDelegate();
39
40         /// <summary>
41         /// <para>A read-only field that represents a increment function delegate.</para>
42         /// <para>Поле только для чтения, представляющее делегат функции инкремента.</para>
43         /// </summary>
44         public static readonly Func<T, T> Increment = CompileIncrementDelegate();
45
46         /// <summary>
47         /// <para>A read-only field that represents a decrement function delegate.</para>
48         /// <para>Поле только для чтения, представляющее делегат функции декремента.</para>
49         /// </summary>
50         public static readonly Func<T, T> Decrement = CompileDecrementDelegate();
51         [MethodImpl(MethodImplOptions.AggressiveInlining)]
52         private static Func<T, T, T> CompileAddDelegate()
53         {
54             return DelegateHelpers.Compile<Func<T, T, T>>(emitter =>
55             {
56                 Ensure.Always.IsNumeric<T>();
57                 emitter.LoadArguments(0, 1);
58                 emitter.Add();
59                 emitter.Return();
60             });
61         }
62         [MethodImpl(MethodImplOptions.AggressiveInlining)]
63         private static Func<T, T, T> CompileSubtractDelegate()
64         {
65             return DelegateHelpers.Compile<Func<T, T, T>>(emitter =>
66             {
67                 Ensure.Always.IsNumeric<T>();
68                 emitter.LoadArguments(0, 1);
69                 emitter.Subtract();
70                 emitter.Return();
71             });
72         }
73         [MethodImpl(MethodImplOptions.AggressiveInlining)]
74         private static Func<T, T, T> CompileMultiplyDelegate()
75         {
```

```

76     return DelegateHelpers.Compile<Func<T, T, T>>(emitter =>
77     {
78         Ensure.Always.IsNumeric<T>();
79         emitter.LoadArguments(0, 1);
80         emitter.Emit(OpCodes.Mul);
81         emitter.Return();
82     });
83 }
84 [MethodImpl(MethodImplOptions.AggressiveInlining)]
85 private static Func<T, T, T> CompileDivideDelegate()
86 {
87     return DelegateHelpers.Compile<Func<T, T, T>>(emitter =>
88     {
89         Ensure.Always.IsNumeric<T>();
90         emitter.LoadArguments(0, 1);
91         if(NumericType<T>.IsSigned)
92         {
93             emitter.Emit(OpCodes.Div);
94         }
95         else
96         {
97             emitter.Emit(OpCodes.Div_Un);
98         }
99         emitter.Return();
100     });
101 }
102 [MethodImpl(MethodImplOptions.AggressiveInlining)]
103 private static Func<T, T> CompileIncrementDelegate()
104 {
105     return DelegateHelpers.Compile<Func<T, T>>(emitter =>
106     {
107         Ensure.Always.IsNumeric<T>();
108         emitter.LoadArgument(0);
109         emitter.Increment<T>();
110         emitter.Return();
111     });
112 }
113 [MethodImpl(MethodImplOptions.AggressiveInlining)]
114 private static Func<T, T> CompileDecrementDelegate()
115 {
116     return DelegateHelpers.Compile<Func<T, T>>(emitter =>
117     {
118         Ensure.Always.IsNumeric<T>();
119         emitter.LoadArgument(0);
120         emitter.Decrement<T>();
121         emitter.Return();
122     });
123 }
124 }
125 }

```

1.4 ./csharp/Platform.Numbers/Bit.cs

```

1 using System.Runtime.CompilerServices;
2
3 namespace Platform.Numbers
4 {
5     /// <summary>
6     /// <para>A set of operations on the set bits of a number.</para>
7     /// <para>Набор операций над установленными битами числа.</para>
8     /// </summary>
9     public static class Bit
10     {
11         /// <summary>
12         /// <para>Counts the number of bits set in a number.</para>
13         /// <para>Подсчитывает количество установленных бит в числе.</para>
14         /// </summary>
15         /// <param name="x">
16         /// <para>Bitwise number.</para>
17         /// <para>Число в битовом представлении.</para>
18         /// </param>
19         /// <returns>
20         /// <para>Number of bits set in a number.</para>
21         /// <para>Количество установленных бит в числе.</para>
22         /// </returns>
23         [MethodImpl(MethodImplOptions.AggressiveInlining)]
24         public static long Count(long x)
25         {
26             long n = 0;

```

```

27     while (x != 0)
28     {
29         n++;
30         x &= x - 1;
31     }
32     return n;
33 }
34
35 /// <summary>
36 /// <para>Searches for the first bit set in a number.</para>
37 /// <para>Ищет первый установленный бит в числе.</para>
38 /// </summary>
39 /// <param name="value">
40 /// <para>Bitwise number.</para>
41 /// <para>Число в битовом представлении.</para>
42 /// </param>
43 /// <returns>
44 /// <para>First bit set.</para>
45 /// <para>Первый установленный бит.</para>
46 /// </returns>
47 [MethodImpl(MethodImplOptions.AggressiveInlining)]
48 public static int GetLowestPosition(ulong value)
49 {
50     if (value == 0)
51     {
52         return -1;
53     }
54     var position = 0;
55     while ((value & 1UL) == 0)
56     {
57         value >>= 1;
58         ++position;
59     }
60     return position;
61 }
62
63 /// <summary>
64 /// <para>Performing bitwise inversion of a number.</para>
65 /// <para>Выполняет побитовую инверсию числа.</para>
66 /// </summary>
67 /// <typeparam name="T">
68 /// <para>The number's type.</para>
69 /// <para>Тип числа.</para>
70 /// </typeparam>
71 /// <param name="x">
72 /// <para>Number to invert.</para>
73 /// <para>Число для инверсии.</para>
74 /// </param>
75 /// <returns>
76 /// <para>Inverse value of the number.</para>
77 /// <para>Обратное значение числа.</para>
78 /// </returns>
79 [MethodImpl(MethodImplOptions.AggressiveInlining)]
80 public static T Not<T>(T x) => Bit<T>.Not(x);
81
82 /// <summary>
83 /// <para>Performing bitwise numbers addition.</para>
84 /// <para>Выполняет побитовое сложение чисел.</para>
85 /// </summary>
86 /// <typeparam name="T">
87 /// <para>The numbers' type.</para>
88 /// <para>Тип чисел.</para>
89 /// </typeparam>
90 /// <param name="x">
91 /// <para>First term.</para>
92 /// <para>Первое слагаемое.</para>
93 /// </param>
94 /// <param name="y">
95 /// <para>Second term.</para>
96 /// <para>Второе слагаемое.</para>
97 /// </param>
98 /// <returns>
99 /// <para>The logical sum of numbers</para>
100 /// <para>Логическая сумма чисел.</para>
101 /// </returns>
102 [MethodImpl(MethodImplOptions.AggressiveInlining)]
103 public static T Or<T>(T x, T y) => Bit<T>.Or(x, y);
104
105 /// <summary>

```

```

106 /// <para>Performs bitwise numbers multiplication.</para>
107 /// <para>Выполняет побитовое умножение чисел.</para>
108 /// <typeparam name="T">
109 /// <para>The numbers' type.</para>
110 /// <para>Тип чисел.</para>
111 /// </typeparam>
112 /// </summary>
113 /// <param name="x">
114 /// <para>First multiplier.</para>
115 /// <para>Первый множитель.</para>
116 /// </param>
117 /// <param name="y">
118 /// <para>Second multiplier.</para>
119 /// <para>Второй множитель.</para>
120 /// </param>
121 /// <returns>
122 /// <para>Logical product of numbers.</para>
123 /// <para>Логическое произведение чисел.</para>
124 /// </returns>
125 [MethodImpl(MethodImplOptions.AggressiveInlining)]
126 public static T And<T>(T x, T y) => Bit<T>.And(x, y);
127
128 /// <summary>
129 /// <para>Performs a bitwise shift of a number to the left by the specified number of
130 /// → bits.</para>
131 /// <para>Выполняет побитовый сдвиг числа влево на указанное количество бит.</para>
132 /// </summary>
133 /// <typeparam name="T">
134 /// <para>The number's type.</para>
135 /// <para>Тип числа.</para>
136 /// </typeparam>
137 /// <param name="x">
138 /// <para>The number on which the left bitwise shift operation will be performed.</para>
139 /// <para>Число над которым будет производиться операция побитового сдвига
140 /// → влево.</para>
141 /// </param>
142 /// <param name="y">
143 /// <para>The number of bits to shift.</para>
144 /// <para>Количество бит на которые выполнить сдвиг.</para>
145 /// </param>
146 /// <returns>
147 /// <para>The value with discarded high-order bits that are outside the range of the
148 /// → number's type and set low-order empty bit positions to zero.</para>
149 /// <para>Значение с отброшенными старшими битами, которые находятся за пределами
150 /// → диапазона типа числа и установленными пустыми битовыми позициями младших разрядов
151 /// → в ноль.</para>
152 /// </returns>
153 [MethodImpl(MethodImplOptions.AggressiveInlining)]
154 public static T ShiftLeft<T>(T x, int y) => Bit<T>.ShiftLeft(x, y);
155
156 /// <summary>
157 /// <para>Performs a bitwise shift of a number to the right by the specified number of
158 /// → bits.</para>
159 /// <para>Выполняет побитовый сдвиг числа вправо на указанное количество бит.</para>
160 /// </summary>
161 /// <typeparam name="T">
162 /// <para>The number's type.</para>
163 /// <para>Тип числа.</para>
164 /// </typeparam>
165 /// <param name="x">
166 /// <para>The number on which the right bitwise shift operation will be performed.</para>
167 /// <para>Число над которым будет производиться операция побитового сдвига
168 /// → вправо.</para>
169 /// </param>
170 /// <param name="y">
171 /// <para>The number of bits to shift.</para>
172 /// <para>Количество бит на которые выполнить сдвиг.</para>
173 /// </param>
174 /// <returns>
175 /// <para>The value with discarded low-order bits.</para>
176 /// <para>Значение с отброшенными младшими битами.</para>
177 /// </returns>
178 [MethodImpl(MethodImplOptions.AggressiveInlining)]
179 public static T ShiftRight<T>(T x, int y) => Bit<T>.ShiftRight(x, y);
180
181 /// <summary>

```

```

175     /// <para>Performs a partial write of a specified number of bits from source number to
    ↪ target number.</para>
176     /// <para>Выполняет частичную запись определенного количества бит исходного числа в
    ↪ целевое число.</para>
177     /// </summary>
178     /// <typeparam name="T">
179     /// <para>The numbers' type.</para>
180     /// <para>Тип чисел.</para>
181     /// </typeparam>
182     /// <param name="target">
183     /// <para>The value to which the partial write will be performed.</para>
184     /// <para>Значение в которое будет выполнена частичная запись.</para>
185     /// </param>
186     /// <param name="source">
187     /// <para>Data source for recording.</para>
188     /// <para>Источник данных для записи.</para>
189     /// </param>
190     /// <param name="shift">
191     /// <para>The start position to read from.</para>
192     /// <para>Стартовая позиция чтения.</para>
193     /// </param>
194     /// <param name="limit">
195     /// <para>The number of bits to write from source to target.</para>
196     /// <para>Количество бит, которые нужно записать из source в target.</para>
197     /// </param>
198     /// <returns>
199     /// <para>The target number updated with bits from source number.</para>
200     /// <para>Целевое число с обновленными битами из исходного числа.</para>
201     /// </returns>
202     [MethodImpl(MethodImplOptions.AggressiveInlining)]
203     public static T PartialWrite<T>(T target, T source, int shift, int limit) =>
    ↪ Bit<T>.PartialWrite(target, source, shift, limit);
204
205     /// <summary>
206     /// <para>Reads a specified number of bits from the number at specified position.</para>
207     /// <para>Считывает указанное количество бит из числа в указанной позиции.</para>
208     /// </summary>
209     /// <typeparam name="T">
210     /// <para>The number's type.</para>
211     /// <para>Тип числа.</para>
212     /// </typeparam>
213     /// <param name="target">
214     /// <para>The number from which the partial read will be performed.</para>
215     /// <para>Число из которого будет выполнено частичное чтение.</para>
216     /// </param>
217     /// <param name="shift">
218     /// <para>The start position to read from.</para>
219     /// <para>Стартовая позиция чтения.</para>
220     /// </param>
221     /// <param name="limit">
222     /// <para>The number of bits to read.</para>
223     /// <para>Количество бит, которые нужно считать.</para>
224     /// </param>
225     /// <returns>
226     /// <para>The number consisting of bits read from the source number.</para>
227     /// <para>Число состоящее из считанных из исходного числа бит.</para>
228     /// </returns>
229     [MethodImpl(MethodImplOptions.AggressiveInlining)]
230     public static T PartialRead<T>(T target, int shift, int limit) =>
    ↪ Bit<T>.PartialRead(target, shift, limit);
231 }
232 }

```

1.5 ./csharp/Platform.Numbers/BitExtensions.cs

```

1 using System.Runtime.CompilerServices;
2
3 namespace Platform.Numbers
4 {
5     /// <summary>
6     /// <para>Represents a set of bitwise operation.</para>
7     /// <para>Представляет набор битовых операций.</para>
8     /// </summary>
9     public static class BitwiseExtensions
10     {
11         /// <summary>
12         /// <para>Performs bitwise inversion of a number.</para>
13         /// <para>Выполняет побитовую инверсию числа.</para>
14         /// </summary>

```



```

15  /// <typeparam name="T">
16  /// <para>The number's type.</para>
17  /// <para>Тип числа.</para>
18  /// </typeparam>
19  /// <param name="target">
20  /// <para>The number to invert.</para>
21  /// <para>Число для инверсии.</para>
22  /// </param>
23  /// <returns>
24  /// <para>An inverted value of the number.</para>
25  /// <para>Обратное значение числа.</para>
26  /// </returns>
27  [MethodImpl(MethodImplOptions.AggressiveInlining)]
28  public static T Not<T>(this ref T target) where T : struct => target = Bit.Not(target);
29
30  /// <summary>
31  /// <para>Performs a partial write of a specified number of bits from source number to
32  /// <para>→ target number.</para>
33  /// <para>Выполняет частичную запись определенного количества бит исходного числа в
34  /// <para>→ целевое число.</para>
35  /// </summary>
36  /// <typeparam name="T">
37  /// <para>The numbers' type.</para>
38  /// <para>Тип чисел.</para>
39  /// </typeparam>
40  /// <param name="target">
41  /// <para>The value to which the partial write will be performed.</para>
42  /// <para>Значение в которое будет выполнена частичная запись.</para>
43  /// </param>
44  /// <param name="source">
45  /// <para>Data source for writing.</para>
46  /// <para>Источник данных для записи.</para>
47  /// </param>
48  /// <param name="shift">
49  /// <para>The start position to read from.</para>
50  /// <para>Стартовая позиция чтения.</para>
51  /// </param>
52  /// <param name="limit">
53  /// <para>The number of bits to write from source to target.</para>
54  /// <para>Количество бит, которые нужно записать из source в target.</para>
55  /// </param>
56  /// <returns>
57  /// <para>The target number updated with bits from source number.</para>
58  /// <para>Целевое число с обновленными битами из исходного числа.</para>
59  /// </returns>
60  [MethodImpl(MethodImplOptions.AggressiveInlining)]
61  public static T PartialWrite<T>(this ref T target, T source, int shift, int limit) where
62  /// <para>→ T : struct => target = Bit<T>.PartialWrite(target, source, shift, limit);
63
64  /// <summary>
65  /// <para>Reads a specified number of bits from the number at specified position.</para>
66  /// <para>Считывает указанное количество бит из числа в указанной позиции.</para>
67  /// </summary>
68  /// <typeparam name="T">
69  /// <para>The number's type.</para>
70  /// <para>Тип числа.</para>
71  /// </typeparam>
72  /// <param name="target">
73  /// <para>The number from which the partial read will be performed.</para>
74  /// <para>Число из которого будет выполнено частичное чтение.</para>
75  /// </param>
76  /// <param name="shift">
77  /// <para>The start position to read from.</para>
78  /// <para>Стартовая позиция чтения.</para>
79  /// </param>
80  /// <param name="limit">
81  /// <para>The number of bits to read.</para>
82  /// <para>Количество бит, которые нужно считать.</para>
83  /// </param>
84  /// <returns>
85  /// <para>The number consisting of bits read from the source number.</para>
86  /// <para>Число состоящее из считанных из исходного числа бит.</para>
87  /// </returns>
88  [MethodImpl(MethodImplOptions.AggressiveInlining)]
89  public static T PartialRead<T>(this T target, int shift, int limit) =>
90  /// <para>→ Bit<T>.PartialRead(target, shift, limit);
91
92  }

```

```
88 }
```

1.6 ./csharp/Platform.Numbers/Bit[T].cs

```
1 using System;
2 using System.Runtime.CompilerServices;
3 using Platform.Exceptions;
4 using Platform.Reflection;
5
6 // ReSharper disable StaticFieldInGenericType
7
8 namespace Platform.Numbers
9 {
10     /// <summary>
11     /// <para>Represents a set of compiled bit operations delegates.</para>
12     /// <para>Представляет набор скомпилированных делегатов битовых операций.</para>
13     /// </summary>
14     public static class Bit<T>
15     {
16         /// <summary>
17         /// <para>A read-only field that represents a bitwise inversion function delegate.</para>
18         /// <para>Поле только для чтения, представляющее делегат функции побитовой инверсии
19         → числа.</para>
20         /// </summary>
21         public static readonly Func<T, T> Not = CompileNotDelegate();
22
23         /// <summary>
24         /// <para>A read-only field that represents a logic addition function delegate.</para>
25         /// <para>Поле только для чтения, представляющее делегат функции логического
26         → сложения.</para>
27         /// </summary>
28         public static readonly Func<T, T, T> Or = CompileOrDelegate();
29
30         /// <summary>
31         /// <para>A read-only field that represents a logic multiplication function
32         → delegate.</para>
33         /// <para>Поле только для чтения, представляющее делегат функции логического
34         → умножения.</para>
35         /// </summary>
36         public static readonly Func<T, T, T> And = CompileAndDelegate();
37
38         /// <summary>
39         /// <para>A read-only field that represents a bitwise left shift function
40         → delegate.</para>
41         /// <para>Поле только для чтения, представляющее делегат функции побитового сдвига числа
42         → влево.</para>
43         /// </summary>
44         public static readonly Func<T, int, T> ShiftLeft = CompileShiftLeftDelegate();
45
46         /// <summary>
47         /// <para>A read-only field that represents a bitwise right shift function
48         → delegate.</para>
49         /// <para>Поле только для чтения, представляющее делегат функции побитового сдвига числа
50         → вправо.</para>
51         /// </summary>
52         public static readonly Func<T, int, T> ShiftRight = CompileShiftRightDelegate();
53
54         /// <summary>
55         /// <para>A read-only field that represents a bitwise number representation partial
56         → rewrite function delegate.</para>
57         /// <para>Поле только для чтения, представляющее делегат функции частичной побитовой
58         → перезаписи представления числа.</para>
59         /// </summary>
60         public static readonly Func<T, T, int, int, T> PartialWrite =
61         → CompilePartialWriteDelegate();
62
63         /// <summary>
64         /// <para>A read-only field that represents a bitwise number representation partial read
65         → function delegate.</para>
66         /// <para>Поле только для чтения, представляющее делегат функции частичного побитового
67         → считывания числа.</para>
68         /// </summary>
69         public static readonly Func<T, int, int, T> PartialRead = CompilePartialReadDelegate();
70         [MethodImpl(MethodImplOptions.AggressiveInlining)]
71         private static Func<T, T> CompileNotDelegate()
72         {
73             return DelegateHelpers.Compile<Func<T, T>>(emitter =>
74             {
75                 Ensure.Always.IsNumeric<T>();
76             });
77         }
78     }
79 }
```

```

63         emitter.LoadArguments(0);
64         emitter.Not();
65         emitter.Return();
66     });
67 }
68 [MethodImpl(MethodImplOptions.AggressiveInlining)]
69 private static Func<T, T, T> CompileOrDelegate()
70 {
71     return DelegateHelpers.Compile<Func<T, T, T>>(emitter =>
72     {
73         Ensure.Always.IsNumeric<T>();
74         emitter.LoadArguments(0, 1);
75         emitter.Or();
76         emitter.Return();
77     });
78 }
79 [MethodImpl(MethodImplOptions.AggressiveInlining)]
80 private static Func<T, T, T> CompileAndDelegate()
81 {
82     return DelegateHelpers.Compile<Func<T, T, T>>(emitter =>
83     {
84         Ensure.Always.IsNumeric<T>();
85         emitter.LoadArguments(0, 1);
86         emitter.And();
87         emitter.Return();
88     });
89 }
90 [MethodImpl(MethodImplOptions.AggressiveInlining)]
91 private static Func<T, int, T> CompileShiftLeftDelegate()
92 {
93     return DelegateHelpers.Compile<Func<T, int, T>>(emitter =>
94     {
95         Ensure.Always.IsNumeric<T>();
96         emitter.LoadArguments(0, 1);
97         emitter.ShiftLeft();
98         emitter.Return();
99     });
100 }
101 [MethodImpl(MethodImplOptions.AggressiveInlining)]
102 private static Func<T, int, T> CompileShiftRightDelegate()
103 {
104     return DelegateHelpers.Compile<Func<T, int, T>>(emitter =>
105     {
106         Ensure.Always.IsNumeric<T>();
107         emitter.LoadArguments(0, 1);
108         emitter.ShiftRight<T>();
109         emitter.Return();
110     });
111 }
112 [MethodImpl(MethodImplOptions.AggressiveInlining)]
113 private static Func<T, T, int, int, T> CompilePartialWriteDelegate()
114 {
115     return DelegateHelpers.Compile<Func<T, T, int, int, T>>(emitter =>
116     {
117         Ensure.Always.IsNumeric<T>();
118         var constants = GetConstants();
119         var bitsNumber = constants.Item1;
120         var numberFilledWithOnes = constants.Item2;
121         ushort shiftArgument = 2;
122         ushort limitArgument = 3;
123         var checkLimit = emitter.DefineLabel();
124         var calculateSourceMask = emitter.DefineLabel();
125         // Check shift
126         emitter.LoadArgument(shiftArgument);
127         emitter.LoadConstant(0);
128         emitter.BranchIfGreaterOrEqual(checkLimit); // Skip fix
129         // Fix shift
130         emitter.LoadConstant(bitsNumber);
131         emitter.LoadArgument(shiftArgument);
132         emitter.Add();
133         emitter.StoreArgument(shiftArgument);
134         emitter.MarkLabel(checkLimit);
135         // Check limit
136         emitter.LoadArgument(limitArgument);
137         emitter.LoadConstant(0);
138         emitter.BranchIfGreaterOrEqual(calculateSourceMask); // Skip fix
139         // Fix limit
140         emitter.LoadConstant(bitsNumber);

```

```

141     emitter.LoadArgument(limitArgument);
142     emitter.Add();
143     emitter.StoreArgument(limitArgument);
144     emitter.MarkLabel(calculateSourceMask);
145     var sourceMask = emitter.DeclareLocal<T>();
146     var targetMask = emitter.DeclareLocal<T>();
147     emitter.LoadConstant(typeof(T), numberFilledWithOnes);
148     emitter.LoadArgument(limitArgument);
149     emitter.ShiftLeft();
150     emitter.Not();
151     emitter.LoadConstant(typeof(T), numberFilledWithOnes);
152     emitter.And();
153     emitter.StoreLocal(sourceMask);
154     emitter.LoadLocal(sourceMask);
155     emitter.LoadArgument(shiftArgument);
156     emitter.ShiftLeft();
157     emitter.Not();
158     emitter.StoreLocal(targetMask);
159     emitter.LoadArgument(0); // target
160     emitter.LoadLocal(targetMask);
161     emitter.And();
162     emitter.LoadArgument(1); // source
163     emitter.LoadLocal(sourceMask);
164     emitter.And();
165     emitter.LoadArgument(shiftArgument);
166     emitter.ShiftLeft();
167     emitter.Or();
168     emitter.Return();
169 });
170 }
171 [MethodImpl(MethodImplOptions.AggressiveInlining)]
172 private static Func<T, int, int, T> CompilePartialReadDelegate()
173 {
174     return DelegateHelpers.Compile<Func<T, int, int, T>>(emitter =>
175     {
176         Ensure.Always.IsNumeric<T>();
177         var constants = GetConstants();
178         var bitsNumber = constants.Item1;
179         var numberFilledWithOnes = constants.Item2;
180         ushort shiftArgument = 1;
181         ushort limitArgument = 2;
182         var checkLimit = emitter.DefineLabel();
183         var calculateSourceMask = emitter.DefineLabel();
184         // Check shift
185         emitter.LoadArgument(shiftArgument);
186         emitter.LoadConstant(0);
187         emitter.BranchIfGreaterOrEqual(checkLimit); // Skip fix
188         // Fix shift
189         emitter.LoadConstant(bitsNumber);
190         emitter.LoadArgument(shiftArgument);
191         emitter.Add();
192         emitter.StoreArgument(shiftArgument);
193         emitter.MarkLabel(checkLimit);
194         // Check limit
195         emitter.LoadArgument(limitArgument);
196         emitter.LoadConstant(0);
197         emitter.BranchIfGreaterOrEqual(calculateSourceMask); // Skip fix
198         // Fix limit
199         emitter.LoadConstant(bitsNumber);
200         emitter.LoadArgument(limitArgument);
201         emitter.Add();
202         emitter.StoreArgument(limitArgument);
203         emitter.MarkLabel(calculateSourceMask);
204         var sourceMask = emitter.DeclareLocal<T>();
205         var targetMask = emitter.DeclareLocal<T>();
206         emitter.LoadConstant(typeof(T), numberFilledWithOnes);
207         emitter.LoadArgument(limitArgument); // limit
208         emitter.ShiftLeft();
209         emitter.Not();
210         emitter.LoadConstant(typeof(T), numberFilledWithOnes);
211         emitter.And();
212         emitter.StoreLocal(sourceMask);
213         emitter.LoadLocal(sourceMask);
214         emitter.LoadArgument(shiftArgument);
215         emitter.ShiftLeft();
216         emitter.StoreLocal(targetMask);
217         emitter.LoadArgument(0); // target
218         emitter.LoadLocal(targetMask);

```

```

219         emitter.And();
220         emitter.LoadArgument(shiftArgument);
221         emitter.ShiftRight<T>();
222         emitter.Return();
223     });
224 }
225 [MethodImpl(MethodImplOptions.AggressiveInlining)]
226 private static Tuple<int, T> GetConstants()
227 {
228     var type = typeof(T);
229     if (type == typeof(ulong))
230     {
231         return new Tuple<int, T>(64, (T)(object)ulong.MaxValue);
232     }
233     if (type == typeof(uint))
234     {
235         return new Tuple<int, T>(32, (T)(object)uint.MaxValue);
236     }
237     if (type == typeof(ushort))
238     {
239         return new Tuple<int, T>(16, (T)(object)ushort.MaxValue);
240     }
241     if (type == typeof(byte))
242     {
243         return new Tuple<int, T>(8, (T)(object)byte.MaxValue);
244     }
245     throw new NotSupportedException();
246 }
247 }
248 }

```

1.7 ./csharp/Platform.Numbers/Math.cs

```

1  using System;
2  using System.Runtime.CompilerServices;
3
4  namespace Platform.Numbers
5  {
6      /// <summary>
7      /// <para>Represents a set of math methods.</para>
8      /// <para>Представляет набор математических методов.</para>
9      /// </summary>
10     /// <remarks>Resizable array (FileMappedMemory) for values cache may be used. or cached
11     ↪ oeis.org</remarks>
12     public static class Math
13     {
14         private static readonly ulong[] _factorials =
15         {
16             1, 1, 2, 6, 24, 120, 720, 5040, 40320, 362880, 3628800, 39916800,
17             479001600, 6227020800, 87178291200, 1307674368000, 20922789888000,
18             355687428096000, 6402373705728000, 121645100408832000, 2432902008176640000
19         };
20         private static readonly ulong[] _catalans =
21         {
22             1, 1, 2, 5, 14, 42, 132, 429, 1430, 4862, 16796, 58786, 208012,
23             742900, 2674440, 9694845, 35357670, 129644790, 477638700, 1767263190,
24             6564120420, 24466267020, 91482563640, 343059613650, 1289904147324, 4861946401452,
25             18367353072152, 69533550916004, 263747951750360, 1002242216651368, 3814986502092304,
26             14544636039226909, 55534064877048198, 212336130412243110, 812944042149730764,
27             ↪ 3116285494907301262, 11959798385860453492
28         };
29
30         /// <summary>
31         /// <para>Represents the limit for calculating the catanal number, supported by the <see
32         ↪ cref="ulong"/> type.</para>
33         /// <para>Представляет предел расчёта катаналового числа, поддерживаемый <see
34         ↪ cref="ulong"/> типом.</para>
35         /// </summary>
36         public static readonly ulong MaximumFactorialNumber = 20;
37
38         /// <summary>
39         /// <para>Represents the limit for calculating the factorial number, supported by the
40         ↪ <see cref="ulong"/> type.</para>
41         /// <para>Представляет предел расчёта факториала числа, поддерживаемый <see
42         ↪ cref="ulong"/> типом.</para>
43         /// </summary>
44         public static readonly ulong MaximumCatalanIndex = 36;
45
46         /// <summary>

```

```

41  /// <para>Returns the product of all positive integers less than or equal to the number
    ↳ specified as an argument.</para>
42  /// <para>Возвращает произведение всех положительных чисел меньше или равных указанному
    ↳ в качестве аргумента числу.</para>
43  /// </summary>
44  /// <param name="n">
45  /// <para>The maximum positive number that will participate in factorial's
    ↳ product.</para>
46  /// <para>Максимальное положительное число, которое будет участвовать в произведении
    ↳ факториала.</para>
47  /// </param>
48  /// <returns>
49  /// <para>The product of all positive integers less than or equal to the number
    ↳ specified as an argument.</para>
50  /// <para>Произведение всех положительных чисел меньше или равных указанному, в качестве
    ↳ аргумента, числу.</para>
51  /// </returns>
52  public static ulong Factorial(ulong n)
53  {
54      if (n >= 0 && n <= MaximumFactorialNumber)
55      {
56          return _factorials[n];
57      }
58      else
59      {
60          throw new ArgumentOutOfRangeException($"Only numbers from 0 to
            ↳ {MaximumFactorialNumber} are supported by unsigned integer with 64 bits
            ↳ length.");
61      }
62  }
63
64  /// <summary>
65  /// <para>Returns the Catalan Number with the number specified as an argument.</para>
66  /// <para>Возвращает Число Катанала с номером, указанным в качестве аргумента.</para>
67  /// </summary>
68  /// <param name="n">
69  /// <para>The number of the Catalan number.</para>
70  /// <para>Номер Числа Катанала.</para>
71  /// </param>
72  /// <returns>
73  /// <para>The Catalan Number with the number specified as an argument.</para>
74  /// <para>Число Катанала с номером, указанным в качестве аргумента.</para>
75  /// </returns>
76  public static ulong Catalan(ulong n)
77  {
78      if (n >= 0 && n <= MaximumCatalanIndex)
79      {
80          return _catalans[n];
81      }
82      else
83      {
84          throw new ArgumentOutOfRangeException($"Only numbers from 0 to
            ↳ {MaximumCatalanIndex} are supported by unsigned integer with 64 bits
            ↳ length.");
85      }
86  }
87
88  /// <summary>
89  /// <para>Checks if a number is a power of two.</para>
90  /// <para>Проверяет, является ли число степенью двойки.</para>
91  /// </summary>
92  /// <param name="x">
93  /// <para>The number to check.</para>
94  /// <para>Число для проверки.</para>
95  /// </param>
96  /// <returns>
97  /// <para>True if the number is a power of two otherwise false.</para>
98  /// <para>True, если число является степенью двойки, иначе - false.</para>
99  /// </returns>
100 [MethodImpl(MethodImplOptions.AggressiveInlining)]
101 public static bool IsPowerOfTwo(ulong x) => (x & x - 1) == 0;
102
103 /// <summary>
104 /// <para>Takes a module from a number.</para>
105 /// <para>Берёт модуль от числа.</para>
106 /// </summary>
107 /// <typeparam name="T">

```

```

108     /// <para>The number's type.</para>
109     /// <para>Тип числа.</para>
110     /// </typeparam>
111     /// <param name="x">
112     /// <para>The number from which to take the absolute value.</para>
113     /// <para>Число, от которого необходимо взять абсолютное значение.</para>
114     /// </param>
115     /// <returns>
116     /// <para>The absolute value of the number.</para>
117     /// <para>Абсолютное значение числа.</para>
118     /// </returns>
119     [MethodImpl(MethodImplOptions.AggressiveInlining)]
120     public static T Abs<T>(T x) => Math<T>.Abs(x);
121
122     /// <summary>
123     /// <para>Makes a number negative.</para>
124     /// <para>Делает число отрицательным.</para>
125     /// </summary>
126     /// <typeparam name="T">
127     /// <para>The number's type.</para>
128     /// <para>Тип числа.</para>
129     /// </typeparam>
130     /// <param name="x">
131     /// <para>The number to be made negative.</para>
132     /// <para>Число которое нужно сделать отрицательным.</para>
133     /// </param>
134     /// <returns>
135     /// <para>A negative number.</para>
136     /// <para>Отрицательное число.</para>
137     /// </returns>
138     [MethodImpl(MethodImplOptions.AggressiveInlining)]
139     public static T Negate<T>(T x) => Math<T>.Negate(x);
140 }
141 }

```

1.8 ./csharp/Platform.Numbers/MathExtensions.cs

```

1 using System.Runtime.CompilerServices;
2
3 namespace Platform.Numbers
4 {
5     /// <summary>
6     /// <para>Represents a set of extension methods that perform mathematical operations on
7     /// ↳ arbitrary object types.</para>
8     /// <para>Представляет набор методов расширения выполняющих математические операции для
9     /// ↳ объектов произвольного типа.</para>
10    /// </summary>
11    public static class MathExtensions
12    {
13        /// <summary>
14        /// <para>Takes a module from a number.</para>
15        /// <para>Берёт модуль от числа.</para>
16        /// </summary>
17        /// <typeparam name="T">
18        /// <para>The number's type.</para>
19        /// <para>Тип числа.</para>
20        /// </typeparam>
21        /// <param name="x">
22        /// <para>The number from which to take the absolute value.</para>
23        /// <para>Число от которого необходимо взять абсолютное значение.</para>
24        /// </param>
25        /// <returns>
26        /// <para>The absolute value of a number.</para>
27        /// <para>Абсолютное значение числа.</para>
28        /// </returns>
29        [MethodImpl(MethodImplOptions.AggressiveInlining)]
30        public static T Abs<T>(this ref T x) where T : struct => x = Math<T>.Abs(x);
31
32        /// <summary>
33        /// <para>Makes a number negative.</para>
34        /// <para>Делает число отрицательным.</para>
35        /// </summary>
36        /// <typeparam name="T">
37        /// <para>The number's type.</para>
38        /// <para>Тип числа.</para>
39        /// </typeparam>
40        /// <param name="x">
41        /// <para>The number to be made negative.</para>
42        /// <para>Число которое нужно сделать отрицательным.</para>
43        /// </param>
44        /// <returns>
45        /// <para>A negative number.</para>
46        /// <para>Отрицательное число.</para>
47        /// </returns>
48        [MethodImpl(MethodImplOptions.AggressiveInlining)]
49        public static T Negate<T>(this ref T x) where T : struct => x = Math<T>.Negate(x);
50    }
51 }

```

```

41     /// </param>
42     /// <returns>
43     /// <para>Negative number.</para>
44     /// <para>Отрицательное число.</para>
45     /// </returns>
46     [MethodImpl(MethodImplOptions.AggressiveInlining)]
47     public static T Negate<T>(this ref T x) where T : struct => x = Math<T>.Negate(x);
48 }
49 }

```

1.9 ./csharp/Platform.Numbers/Math[T].cs

```

1  using System;
2  using System.Runtime.CompilerServices;
3  using Platform.Exceptions;
4  using Platform.Reflection;
5
6  // ReSharper disable StaticFieldInGenericType
7  namespace Platform.Numbers
8  {
9      /// <summary>
10     /// <para>Represents a set of compiled math operations delegates.</para>
11     /// <para>Представляет набор скомпилированных делегатов математических операций.</para>
12     /// </summary>
13     public static class Math<T>
14     {
15         /// <summary>
16         /// <para>A read-only field that represents a number modulus calculation function
17         ↪ delegate.</para>
18         /// <para>Поле только для чтения, которое представляет делегат функции вычисления модуля
19         ↪ числа.</para>
20         /// </summary>
21         public static readonly Func<T, T> Abs = CompileAbsDelegate();
22
23         /// <summary>
24         /// <para>A read-only field that represents a number negation function delegate.</para>
25         /// <para>Поле только для чтения, которое представляет делегат функции отрицания
26         ↪ числа.</para>
27         /// </summary>
28         public static readonly Func<T, T> Negate = CompileNegateDelegate();
29
30         [MethodImpl(MethodImplOptions.AggressiveInlining)]
31         private static Func<T, T> CompileAbsDelegate()
32         {
33             return DelegateHelpers.Compile<Func<T, T>>(emitter =>
34             {
35                 Ensure.Always.IsNumeric<T>();
36                 emitter.LoadArgument(0);
37                 if (NumericType<T>.IsSigned)
38                 {
39                     emitter.Call(typeof(System.Math).GetMethod("Abs", Types<T>.Array));
40                 }
41                 emitter.Return();
42             });
43         }
44
45         [MethodImpl(MethodImplOptions.AggressiveInlining)]
46         private static Func<T, T> CompileNegateDelegate()
47         {
48             return DelegateHelpers.Compile<Func<T, T>>(emitter =>
49             {
50                 emitter.LoadArgument(0);
51                 emitter.Negate();
52                 emitter.Return();
53             });
54         }
55     }
56 }

```

1.10 ./csharp/Platform.Numbers.Tests/ArithmeticExtensionsTests.cs

```

1  using Xunit;
2
3  namespace Platform.Numbers.Tests
4  {
5      public static class ArithmeticExtensionsTests
6      {
7          [Fact]
8          public static void IncrementTest()
9          {
10             var number = 0UL;
11             var returnValue = number.Increment();

```



```

12         Assert.Equal(1UL, returnValue);
13         Assert.Equal(1UL, number);
14     }
15
16     [Fact]
17     public static void DecrementTest()
18     {
19         var number = 1UL;
20         var returnValue = number.Decrement();
21         Assert.Equal(0UL, returnValue);
22         Assert.Equal(0UL, number);
23     }
24 }
25 }

```

1.11 ./csharp/Platform.Numbers.Tests/ArithmeticTests.cs

```

1  using System;
2  using Xunit;
3
4  namespace Platform.Numbers.Tests
5  {
6      public static class ArithmeticTests
7      {
8          [Fact]
9          public static void CompiledOperationsTest()
10         {
11             Assert.Equal(3, Arithmetic.Add(1, 2));
12             Assert.Equal(1, Arithmetic.Subtract(2, 1));
13             Assert.Equal(8, Arithmetic.Multiply(2, 4));
14             Assert.Equal(4, Arithmetic.Divide(8, 2));
15             Assert.Equal(2, Arithmetic.Increment(1));
16             Assert.Equal(1UL, Arithmetic.Decrement(2UL));
17             Assert.Throws<NotSupportedException>(() => Arithmetic<string>.Subtract("1", "2"));
18         }
19     }
20 }

```

1.12 ./csharp/Platform.Numbers.Tests/BitTests.cs

```

1  using System;
2  using Platform.Reflection;
3  using Xunit;
4
5  namespace Platform.Numbers.Tests
6  {
7      public static class BitTests
8      {
9          [Theory]
10         [InlineData(00, -1)] // 0000 0000 (none, -1)
11         [InlineData(01, 00)] // 0000 0001 (first, 0)
12         [InlineData(08, 03)] // 0000 1000 (forth, 3)
13         [InlineData(88, 03)] // 0101 1000 (forth, 3)
14         public static void GetLowestBitPositionTest(ulong value, int expectedPosition)
15         {
16             Assert.True(Bit.GetLowestPosition(value) == expectedPosition);
17         }
18
19         [Fact]
20         public static void ByteBitwiseOperationsTest()
21         {
22             Assert.True(Bit<byte>.Not(2) == unchecked((byte)~2));
23             Assert.True(Bit<byte>.Or(1, 2) == (1 | 2));
24             Assert.True(Bit<byte>.And(1, 2) == (1 & 2));
25             Assert.True(Bit<byte>.ShiftLeft(1, 2) == (1 << 2));
26             Assert.True(Bit<byte>.ShiftRight(1, 2) == (1 >> 2));
27             Assert.Equal(NumericType<byte>.MaxValue >> 1,
28                 Bit<byte>.ShiftRight(NumericType<byte>.MaxValue, 1));
29         }
30
31         [Fact]
32         public static void UInt16BitwiseOperationsTest()
33         {
34             Assert.True(Bit<ushort>.Not(2) == unchecked((ushort)~2));
35             Assert.True(Bit<ushort>.Or(1, 2) == (1 | 2));
36             Assert.True(Bit<ushort>.And(1, 2) == (1 & 2));
37             Assert.True(Bit<ushort>.ShiftLeft(1, 2) == (1 << 2));
38             Assert.True(Bit<ushort>.ShiftRight(1, 2) == (1 >> 2));
39             Assert.Equal(NumericType<ushort>.MaxValue >> 1,
40                 Bit<ushort>.ShiftRight(NumericType<ushort>.MaxValue, 1));
41         }
42     }
43 }

```

```

39     }
40
41     [Fact]
42     public static void UInt32BitwiseOperationsTest()
43     {
44         Assert.True(Bit<uint>.Not(2) == unchecked((uint)~2));
45         Assert.True(Bit<uint>.Or(1, 2) == (1 | 2));
46         Assert.True(Bit<uint>.And(1, 2) == (1 & 2));
47         Assert.True(Bit<uint>.ShiftLeft(1, 2) == (1 << 2));
48         Assert.True(Bit<uint>.ShiftRight(1, 2) == (1 >> 2));
49         Assert.Equal(NumericType<uint>.MaxValue >> 1,
50             ↪ Bit<uint>.ShiftRight(NumericType<uint>.MaxValue, 1));
51     }
52
53     [Fact]
54     public static void UInt64BitwiseOperationsTest()
55     {
56         Assert.True(Bit<ulong>.Not(2) == unchecked((ulong)~2));
57         Assert.True(Bit<ulong>.Or(1, 2) == (1 | 2));
58         Assert.True(Bit<ulong>.And(1, 2) == (1 & 2));
59         Assert.True(Bit<ulong>.ShiftLeft(1, 2) == (1 << 2));
60         Assert.True(Bit<ulong>.ShiftRight(1, 2) == (1 >> 2));
61         Assert.Equal(NumericType<ulong>.MaxValue >> 1,
62             ↪ Bit<ulong>.ShiftRight(NumericType<ulong>.MaxValue, 1));
63     }
64
65     [Fact]
66     public static void PartialReadWriteTest()
67     {
68         {
69             uint firstValue = 1;
70             uint secondValue = 1543;
71
72             // Pack (join) two values at the same time
73             uint value = secondValue << 1 | firstValue;
74
75             uint unpackagedFirstValue = value & 1;
76             uint unpackagedSecondValue = (value & 0xFFFFFFF0) >> 1;
77
78             Assert.True(firstValue == unpackagedFirstValue);
79             Assert.True(secondValue == unpackagedSecondValue);
80
81             // Using universal functions:
82             Assert.True(PartialRead(value, 0, 1) == firstValue);
83             Assert.True(PartialRead(value, 1, -1) == secondValue);
84
85             firstValue = 0;
86             secondValue = 6892;
87
88             value = PartialWrite(value, firstValue, 0, 1);
89             value = PartialWrite(value, secondValue, 1, -1);
90
91             Assert.True(PartialRead(value, 0, 1) == firstValue);
92             Assert.True(PartialRead(value, 1, -1) == secondValue);
93         }
94
95         {
96             uint firstValue = 1;
97             uint secondValue = 1543;
98
99             // Pack (join) two values at the same time
100             uint value = secondValue << 1 | firstValue;
101
102             uint unpackagedFirstValue = value & 1;
103             uint unpackagedSecondValue = (value & 0xFFFFFFF0) >> 1;
104
105             Assert.True(firstValue == unpackagedFirstValue);
106             Assert.True(secondValue == unpackagedSecondValue);
107
108             // Using universal functions:
109             Assert.True(Bit.PartialRead(value, 0, 1) == firstValue);
110             Assert.True(Bit.PartialRead(value, 1, -1) == secondValue);
111
112             firstValue = 0;
113             secondValue = 6892;
114
115             value = Bit.PartialWrite(value, firstValue, 0, 1);
116             value = Bit.PartialWrite(value, secondValue, 1, -1);
117
118             Assert.True(Bit.PartialRead(value, 0, 1) == firstValue);

```

```

117     Assert.True(Bit.PartialRead(value, 1, -1) == secondValue);
118 }
119
120 {
121     uint firstValue = 1;
122     uint secondValue = 1543;
123
124     // Pack (join) two values at the same time
125     uint value = secondValue << 1 | firstValue;
126
127     uint unpackagedFirstValue = value & 1;
128     uint unpackagedSecondValue = (value & 0xFFFFFFF0) >> 1;
129
130     Assert.True(firstValue == unpackagedFirstValue);
131     Assert.True(secondValue == unpackagedSecondValue);
132
133     // Using universal functions:
134     var readMasksAndShiftFor0And1 = GetReadMaskAndShift(0, 1);
135     var readMasksAndShiftFor1AndMinus1 = GetReadMaskAndShift(1, -1);
136     var writeMasksAndShiftFor0And1 = GetWriteMasksAndShift(0, 1);
137     var writeMasksAndShiftFor1AndMinus1 = GetWriteMasksAndShift(1, -1);
138
139     Assert.True(PartialRead(value, readMasksAndShiftFor0And1) == firstValue);
140     Assert.True(PartialRead(value, readMasksAndShiftFor1AndMinus1) == secondValue);
141
142     firstValue = 0;
143     secondValue = 6892;
144
145     value = PartialWrite(value, firstValue, writeMasksAndShiftFor0And1);
146     value = PartialWrite(value, secondValue, writeMasksAndShiftFor1AndMinus1);
147
148     Assert.True(PartialRead(value, readMasksAndShiftFor0And1) == firstValue);
149     Assert.True(PartialRead(value, readMasksAndShiftFor1AndMinus1) == secondValue);
150 }
151 }
152
153 // TODO: Can be optimized using precalculation of TargetMask and SourceMask
154 private static uint PartialWrite(uint target, uint source, int shift, int limit)
155 {
156     if (shift < 0)
157     {
158         shift = 32 + shift;
159     }
160     if (limit < 0)
161     {
162         limit = 32 + limit;
163     }
164     var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
165     var targetMask = ~(sourceMask << shift);
166     return target & targetMask | (source & sourceMask) << shift;
167 }
168 private static uint PartialRead(uint target, int shift, int limit)
169 {
170     if (shift < 0)
171     {
172         shift = 32 + shift;
173     }
174     if (limit < 0)
175     {
176         limit = 32 + limit;
177     }
178     var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
179     var targetMask = sourceMask << shift;
180     return (target & targetMask) >> shift;
181 }
182 private static Tuple<uint, uint, int> GetWriteMasksAndShift(int shift, int limit)
183 {
184     if (shift < 0)
185     {
186         shift = 32 + shift;
187     }
188     if (limit < 0)
189     {
190         limit = 32 + limit;
191     }
192     var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
193     var targetMask = ~(sourceMask << shift);
194     return new Tuple<uint, uint, int>(targetMask, sourceMask, shift);
195 }

```

```

196 private static Tuple<uint, int> GetReadMaskAndShift(int shift, int limit)
197 {
198     if (shift < 0)
199     {
200         shift = 32 + shift;
201     }
202     if (limit < 0)
203     {
204         limit = 32 + limit;
205     }
206     var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
207     var targetMask = sourceMask << shift;
208     return new Tuple<uint, int>(targetMask, shift);
209 }
210 private static uint PartialWrite(uint target, uint targetMask, uint source, uint
    ↪ sourceMask, int shift) => target & targetMask | (source & sourceMask) << shift;
211 private static uint PartialWrite(uint target, uint source, Tuple<uint, uint, int>
    ↪ masksAndShift) => PartialWrite(target, masksAndShift.Item1, source,
    ↪ masksAndShift.Item2, masksAndShift.Item3);
212 private static uint PartialRead(uint target, uint targetMask, int shift) => (target &
    ↪ targetMask) >> shift;
213 private static uint PartialRead(uint target, Tuple<uint, int> masksAndShift) =>
    ↪ PartialRead(target, masksAndShift.Item1, masksAndShift.Item2);
214
215 [Fact]
216 public static void BugWithLoadingConstantOf8Test()
217 {
218     Bit<byte>.PartialWrite(0, 1, 5, -5);
219 }
220 }
221 }

```

1.13 ./csharp/Platform.Numbers.Tests/MathExtensionsTests.cs

```

1 using Xunit;
2
3 namespace Platform.Numbers.Tests
4 {
5     public static class MathExtensionsTests
6     {
7         [Fact]
8         public static void AbsTest()
9         {
10             var number = -1L;
11             var returnValue = number.Abs();
12             Assert.Equal(1L, returnValue);
13             Assert.Equal(1L, number);
14         }
15
16         [Fact]
17         public static void NegateTest()
18         {
19             var number = 2L;
20             var returnValue = number.Negate();
21             Assert.Equal(-2L, returnValue);
22             Assert.Equal(-2L, number);
23         }
24
25         [Fact]
26         public static void UnsignedNegateTest()
27         {
28             var number = 2UL;
29             var returnValue = number.Negate();
30             Assert.Equal(18446744073709551614, returnValue);
31             Assert.Equal(18446744073709551614, number);
32         }
33     }
34 }

```

1.14 ./csharp/Platform.Numbers.Tests/MathTests.cs

```

1 using Xunit;
2
3 namespace Platform.Numbers.Tests
4 {
5     public static class MathTests
6     {
7         [Fact]
8         public static void CompiledOperationsTest()
9         {

```

```

10         Assert.True(Math.Abs(Arithmetic<double>.Subtract(3D, 2D) - 1D) < 0.01);
11     }
12 }
13 }

```

1.15 ./csharp/Platform.Numbers.Tests/SystemTests.cs

```

1  using Xunit;
2
3  namespace Platform.Numbers.Tests
4  {
5      public static class SystemTests
6      {
7          [Fact]
8          public static void PossiblePackTwoValuesIntoOneTest()
9          {
10              uint value = 0;
11
12              // Set one to first bit
13              value |= 1;
14
15              Assert.True(value == 1);
16
17              // Set zero to first bit
18              value &= 0xFFFFFFFF;
19
20              // Get first bit
21              uint read = value & 1;
22
23              Assert.True(read == 0);
24
25              uint firstValue = 1;
26              uint secondValue = 1543;
27
28              // Pack (join) two values at the same time
29              value = (secondValue << 1) | firstValue;
30
31              uint unpackedFirstValue = value & 1;
32              uint unpackedSecondValue = (value & 0xFFFFFFFF) >> 1;
33
34              Assert.True(firstValue == unpackedFirstValue);
35              Assert.True(secondValue == unpackedSecondValue);
36
37              // Using universal functions:
38
39              Assert.True(PartialRead(value, 0, 1) == firstValue);
40              Assert.True(PartialRead(value, 1, -1) == secondValue);
41
42              firstValue = 0;
43              secondValue = 6892;
44
45              value = PartialWrite(value, firstValue, 0, 1);
46              value = PartialWrite(value, secondValue, 1, -1);
47
48              Assert.True(PartialRead(value, 0, 1) == firstValue);
49              Assert.True(PartialRead(value, 1, -1) == secondValue);
50          }
51          private static uint PartialWrite(uint target, uint source, int shift, int limit)
52          {
53              if (shift < 0)
54              {
55                  shift = 32 + shift;
56              }
57              if (limit < 0)
58              {
59                  limit = 32 + limit;
60              }
61              var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
62              var targetMask = ~(sourceMask << shift);
63              return (target & targetMask) | ((source & sourceMask) << shift);
64          }
65          private static uint PartialRead(uint target, int shift, int limit)
66          {
67              if (shift < 0)
68              {
69                  shift = 32 + shift;
70              }
71              if (limit < 0)
72              {
73                  limit = 32 + limit;
74              }

```

```
75         var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
76         var targetMask = sourceMask << shift;
77         return (target & targetMask) >> shift;
78     }
79 }
80 }
```

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