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

```
using System.Runtime.CompilerServices;

namespace Platform.Numbers
{
    /// <summary>
    /// <para>Represents a set of arithmetic methods.</para>
    /// <para>Представляет набор арифметических методов.</para>
    /// </summary>
    public static class Arithmetic
    {
        /// <summary>
        /// <para>Performing adding the x and y arguments.</para>
        /// <para>Выполняет сложение аргументов x и y.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The numbers' type.</para>
        /// <para>Тип чисел.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The first term.</para>
        /// <para>Первое слагаемое.</para>
        /// </param>
        /// <param name="y">
        /// <para>The second term.</para>
        /// <para>Второе слагаемое.</para>
        /// </param>
        /// <returns>
        /// <para>Sum of x and y.</para>
        /// <para>Сумма x и y.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Add<T>(T x, T y) => Arithmetic<T>.Add(x, y);

        /// <summary>
        /// <para>Performs subtracting y from x.</para>
        /// <para>Выполняет вычитание y из x.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The numbers' type.</para>
        /// <para>Тип чисел.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>Minuend.</para>
        /// <para>Уменьшаемое.</para>
        /// </param>
        /// <param name="y">
        /// <para>Subtrahend.</para>
        /// <para>Вычитаемое.</para>
        /// </param>
        /// <returns>
        /// <para>Difference between x and y.</para>
        /// <para>Разность между x и y.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Subtract<T>(T x, T y) => Arithmetic<T>.Subtract(x, y);

        /// <summary>
        /// <para>Performs multiplication x by y.</para>
        /// <para>Выполняет умножение x на y.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The numbers' type.</para>
        /// <para>Тип чисел.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>First multiplier.</para>
        /// <para>Первый множитель.</para>
        /// </param>
        /// <param name="y">
        /// <para>Second multiplier.</para>
        /// <para>Второй множитель.</para>
        /// </param>
        /// <returns>
        /// <para>Product of x and y.</para>
        /// <para>Произведение x и y.</para>
        /// </returns>
```

```
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Multiply<T>(T x, T y) => Arithmetic<T>.Multiply(x, y);

        /// <summary>
        /// <para>Performs dividing x by y.</para>
        /// <para>Выполняет деление x на y.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The numbers' type.</para>
        /// <para>Тип чисел.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>Dividend.</para>
        /// <para>Делимое.</para>
        /// </param>
        /// <param name="y">
        /// <para>Divider.</para>
        /// <para>Делитель.</para>
        /// </param>
        /// <returns>
        /// <para>Quoitent of x and y.</para>
        /// <para>Частное x и y.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Divide<T>(T x, T y) => Arithmetic<T>.Divide(x, y);

        /// <summary>
        /// <para>Increasing the number by one.</para>
        /// <para>Увеличивает число на единицу.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The number to increase.</para>
        /// <para>Число для увеличения.</para>
        /// </param>
        /// <returns>
        /// <para>Increase by one number.</para>
        /// <para>Увеличенное на единицу число.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Increment<T>(T x) => Arithmetic<T>.Increment(x);

        /// <summary>
        /// <para>Increases the value of argument by one.</para>
        /// <para>Увеличивает значение аргумента на единицу.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The argument to increase.</para>
        /// <para>Аргумент для увеличения.</para>
        /// </param>
        /// <returns>
        /// <para>Increased argument value.</para>
        /// <para>Увеличенное значение аргумента.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Increment<T>(ref T x) => x = Arithmetic<T>.Increment(x);

        /// <summary>
        /// <para>Decreases number by one.</para>
        /// <para>Уменьшение числа на единицу.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The number to reduce.</para>
        /// <para>Число для уменьшения.</para>
        /// </param>
        /// <returns>
        /// <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>Уменьшеное 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
       ↪  arbitrary object types.</para>
7      /// <para>Представляет набор методов расширения выполняющих арифметические операции для
       ↪  объектов произвольного типа.</para>
8      /// </summary>
9      public static class ArithmeticExtensions
10     {
11         /// <summary>
12         /// <para>Increments the variable passed as an argument by one.</para>
13         /// <para>Увеличивает переданную в качестве аргумента переменную на единицу.</para>
14         /// </summary>
15         /// <typeparam name="T">
16         /// <para>The number's type.</para>
17         /// <para>Тип числа.</para>
18         /// </typeparam>
19         /// <param name="x">
20         /// <para>The reference to the incremented variable.</para>
21         /// <para>Ссылка на увеличиваемую переменную.</para>
22         /// </param>
23         /// <returns>
24         /// <para>The value of the argument incremented by one.</para>
25         /// <para>Увеличенное значение аргумента на единицу.</para>
26         /// </returns>
27         [MethodImpl(MethodImplOptions.AggressiveInlining)]
28         public static T Increment<T>(this ref T x) where T : struct => x =
           ↪  Arithmetic<T>.Increment(x);
29 
30         /// <summary>
31         /// <para>Decrements the variable passed as an argument by one.</para>
32         /// <para>Уменьшает переданную в качестве аргумента переменную на единицу.</para>
33         /// </summary>
34         /// <typeparam name="T">
35         /// <para>The number's type.</para>
36         /// <para>Тип числа.</para>
37         /// </typeparam>
38         /// <param name="x">
39         /// <para>The reference to the decremented variable.</para>
40         /// <para>Ссылка на уменьшаемую переменную.</para>
41         /// </param>
42         /// <returns>
43         /// <para>The value of the argument decremented by one.</para>
44         /// <para>Уменьшеное значение аргумента на единицу.</para>
45         /// </returns>
46         [MethodImpl(MethodImplOptions.AggressiveInlining)]
47         public static T Decrement<T>(this ref T x) where T : struct => x =
           ↪  Arithmetic<T>.Decrement(x);
```

```
    }
}
```

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

```
using System;
using System.Reflection.Emit;
using System.Runtime.CompilerServices;
using Platform.Exceptions;
using Platform.Reflection;

// ReSharper disable StaticFieldInGenericType
namespace Platform.Numbers
{
    /// <summary>
    /// <para>Represents a set of compiled arithmetic operations delegates.</para>
    /// <para>Представляет набор скомпилированных делегатов арифметических операций.</para>
    /// </summary>
    public static class Arithmetic<T>
    {
        /// <summary>
        /// <para>A read-only field that represents a addition function delegate.</para>
        /// <para>Поле только для чтения, представляющее делегат функции сложения.</para>
        /// </summary>
        public static readonly Func<T, T, T> Add = CompileAddDelegate();

        /// <summary>
        /// <para>A read-only field that represents a subtraction function delegate.</para>
        /// <para>Поле только для чтения, представляющее делегат функции вычитания.</para>
        /// </summary>
        public static readonly Func<T, T, T> Subtract = CompileSubtractDelegate();

        /// <summary>
        /// <para>A read-only field that represents a multiplication function delegate.</para>
        /// <para>Поле только для чтения, представляющее делегат функции умножения.</para>
        /// </summary>
        public static readonly Func<T, T, T> Multiply = CompileMultiplyDelegate();

        /// <summary>
        /// <para>A read-only field that represents a division function delegate.</para>
        /// <para>Поле только для чтения, представляющее делегат функции деления.</para>
        /// </summary>
        public static readonly Func<T, T, T> Divide = CompileDivideDelegate();

        /// <summary>
        /// <para>A read-only field that represents a increment function delegate.</para>
        /// <para>Поле только для чтения, представляющее делегат функции инкремента.</para>
        /// </summary>
        public static readonly Func<T, T> Increment = CompileIncrementDelegate();

        /// <summary>
        /// <para>A read-only field that represents a decrement function delegate.</para>
        /// <para>Поле только для чтения, представляющее делегат функции декремента.</para>
        /// </summary>
        public static readonly Func<T, T> Decrement = CompileDecrementDelegate();

        /// <summary>
        /// <para>
        /// Compiles the add delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and t and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, T, T> CompileAddDelegate()
        {
            return DelegateHelpers.Compile<Func<T, T, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                emiter.LoadArguments(0, 1);
                emiter.Add();
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
```

```
76          /// Compiles the subtract delegate.
77          /// </para>
78          /// <para></para>
79          /// </summary>
80          /// <returns>
81          /// <para>A func of t and t and t</para>
82          /// <para></para>
83          /// </returns>
84          [MethodImpl(MethodImplOptions.AggressiveInlining)]
85          private static Func<T, T, T> CompileSubtractDelegate()
86          {
87              return DelegateHelpers.Compile<Func<T, T, T>>(emiter =>
88              {
89                  Ensure.Always.IsNumeric<T>();
90                  emiter.LoadArguments(0, 1);
91                  emiter.Subtract();
92                  emiter.Return();
93              });
94          }
95
96          /// <summary>
97          /// <para>
98          /// Compiles the multiply delegate.
99          /// </para>
100         /// <para></para>
101         /// </summary>
102         /// <returns>
103         /// <para>A func of t and t and t</para>
104         /// <para></para>
105         /// </returns>
106         [MethodImpl(MethodImplOptions.AggressiveInlining)]
107         private static Func<T, T, T> CompileMultiplyDelegate()
108         {
109             return DelegateHelpers.Compile<Func<T, T, T>>(emiter =>
110             {
111                 Ensure.Always.IsNumeric<T>();
112                 emiter.LoadArguments(0, 1);
113                 emiter.Emit(OpCodes.Mul);
114                 emiter.Return();
115             });
116         }
117
118         /// <summary>
119         /// <para>
120         /// Compiles the divide delegate.
121         /// </para>
122         /// <para></para>
123         /// </summary>
124         /// <returns>
125         /// <para>A func of t and t and t</para>
126         /// <para></para>
127         /// </returns>
128         [MethodImpl(MethodImplOptions.AggressiveInlining)]
129         private static Func<T, T, T> CompileDivideDelegate()
130         {
131             return DelegateHelpers.Compile<Func<T, T, T>>(emiter =>
132             {
133                 Ensure.Always.IsNumeric<T>();
134                 emiter.LoadArguments(0, 1);
135                 if(NumericType<T>.IsSigned)
136                 {
137                     emiter.Emit(OpCodes.Div);
138                 }
139                 else
140                 {
141                     emiter.Emit(OpCodes.Div_Un);
142                 }
143                 emiter.Return();
144             });
145         }
146
147         /// <summary>
148         /// <para>
149         /// Compiles the increment delegate.
150         /// </para>
151         /// <para></para>
152         /// </summary>
153         /// <returns>
```

```
        /// <para>A func of t and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, T> CompileIncrementDelegate()
        {
            return DelegateHelpers.Compile<Func<T, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                emiter.LoadArgument(0);
                emiter.Increment<T>();
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Compiles the decrement delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, T> CompileDecrementDelegate()
        {
            return DelegateHelpers.Compile<Func<T, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                emiter.LoadArgument(0);
                emiter.Decrement<T>();
                emiter.Return();
            });
        }
    }
}
```

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

```
using System.Runtime.CompilerServices;

namespace Platform.Numbers
{
    /// <summary>
    /// <para>A set of operations on the set bits of a number.</para>
    /// <para>Набор операций над установленными битами числа.</para>
    /// </summary>
    public static class Bit
    {
        /// <summary>
        /// <para>Counts the number of bits set in a number.</para>
        /// <para>Подсчитывает количество установленных бит в числе.</para>
        /// </summary>
        /// <param name="x">
        /// <para>Bitwise number.</para>
        /// <para>Число в битовом представлении.</para>
        /// </param>
        /// <returns>
        /// <para>Number of bits set in a number.</para>
        /// <para>Количество установленных бит в числе.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static long Count(long x)
        {
            long n = 0;
            while (x != 0)
            {
                n++;
                x &= x - 1;
            }
            return n;
        }

        /// <summary>
        /// <para>Searches for the first bit set in a number.</para>
        /// <para>Ищет первый установленный бит в числе.</para>
        /// </summary>
        /// <param name="value">
```

```
        /// <para>Bitwise number.</para>
        /// <para>Число в битовом представлении.</para>
        /// </param>
        /// <returns>
        /// <para>First bit set.</para>
        /// <para>Первый установленный бит.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static int GetLowestPosition(ulong value)
        {
            if (value == 0)
            {
                return -1;
            }
            var position = 0;
            while ((value & 1UL) == 0)
            {
                value >>= 1;
                ++position;
            }
            return position;
        }

        /// <summary>
        /// <para>Performing bitwise inversion of a number.</para>
        /// <para>Выполняет побитовую инверсию числа.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>Number to invert.</para>
        /// <para>Число для инверсии.</para>
        /// </param>
        /// <returns>
        /// <para>Inverse value of the number.</para>
        /// <para>Обратное значение числа.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Not<T>(T x) => Bit<T>.Not(x);

        /// <summary>
        /// <para>Performing bitwise numbers addition.</para>
        /// <para>Выполняет побитовое сложение чисел.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The numbers' type.</para>
        /// <para>Тип чисел.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>First term.</para>
        /// <para>Первое слагаемое.</para>
        /// </param>
        /// <param name="y">
        /// <para>Second term.</para>
        /// <para>Второе слагаемое.</para>
        /// </param>
        /// <returns>
        /// <para>The logical sum of numbers</para>
        /// <para>Логическая сумма чисел.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Or<T>(T x, T y) => Bit<T>.Or(x, y);

        /// <summary>
        /// <para>Performs bitwise numbers multiplication.</para>
        /// <para>Выполняет побитовое умножение чисел.</para>
        /// <typeparam name="T">
        /// <para>The numbers' type.</para>
        /// <para>Тип чисел.</para>
        /// </typeparam>
        /// </summary>
        /// <param name="x">
        /// <para>First multiplier.</para>
        /// <para>Первый множитель.</para>
        /// </param>
        /// <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
            ↪  bits.</para>
130         /// <para>Выполняет побитовый свиг числа влево на указанное количество бит.</para>
131         /// </summary>
132         /// <typeparam name="T">
133         /// <para>The number's type.</para>
134         /// <para>Тип числа.</para>
135         /// </typeparam>
136         /// <param name="x">
137         /// <para>The number on which the left bitwise shift operation will be performed.</para>
138         /// <para>Число над которым будет производиться операция пиботового смещения
            ↪  влево.</para>
139         /// </param>
140         /// <param name="y">
141         /// <para>The number of bits to shift.</para>
142         /// <para>Количество бит на которые выполнить смещение.</para>
143         /// </param>
144         /// <returns>
145         /// <para>The value with discarded high-order bits that are outside the range of the
            ↪  number's type and set low-order empty bit positions to zero.</para>
146         /// <para>Значение с отброшенными старшими битами, которые находятся за пределами
            ↪  диапазона типа числа и устанавливленными пустыми битовыми позициями младших разрядов
            ↪  в ноль.</para>
147         /// </returns>
148         [MethodImpl(MethodImplOptions.AggressiveInlining)]
149         public static T ShiftLeft<T>(T x, int y) => Bit<T>.ShiftLeft(x, y);
150 
151         /// <summary>
152         /// <para>Performs a bitwise shift of a number to the right by the specified number of
            ↪  bits.</para>
153         /// <para>Выполняет побитовый свиг числа вправо на указанное количество бит.</para>
154         /// </summary>
155         /// <typeparam name="T">
156         /// <para>The number's type.</para>
157         /// <para>Тип числа.</para>
158         /// </typeparam>
159         /// <param name="x">
160         /// <para>The number on which the right bitwise shift operation will be performed.</para>
161         /// <para>Число над которым будет производиться операция побитового смещения
            ↪  вправо.</para>
162         /// </param>
163         /// <param name="y">
164         /// <para>The number of bits to shift.</para>
165         /// <para>Количество бит на которые выполнить смещение.</para>
166         /// </param>
167         /// <returns>
168         /// <para>The value with discarded low-order bits.</para>
169         /// <para>Значение с отброшенными младшими битами.</para>
170         /// </returns>
171         [MethodImpl(MethodImplOptions.AggressiveInlining)]
172         public static T ShiftRight<T>(T x, int y) => Bit<T>.ShiftRight(x, y);
173 
174         /// <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
            ↪  target number.</para>
32          /// <para>Выполняет частичную запись определенного количества бит исходного числа в
            ↪  целевое число.</para>
33          /// </summary>
34          /// <typeparam name="T">
35          /// <para>The numbers' type.</para>
36          /// <para>Тип чисел.</para>
37          /// </typeparam>
38          /// <param name="target">
39          /// <para>The value to which the partial write will be performed.</para>
40          /// <para>Значение в которое будет выполнена частичная запись.</para>
41          /// </param>
42          /// <param name="source">
43          /// <para>Data source for writing.</para>
44          /// <para>Источник данных для записи.</para>
45          /// </param>
46          /// <param name="shift">
47          /// <para>The start position to read from.</para>
48          /// <para>Стартовая позиция чтения.</para>
49          /// </param>
50          /// <param name="limit">
51          /// <para>The number of bits to write from source to target.</para>
52          /// <para>Количество бит, которые нужно записать из source в target.</para>
53          /// </param>
54          /// <returns>
55          /// <para>The target number updated with bits from source number.</para>
56          /// <para>Целевое число с обновленными битами из исходного числа.</para>
57          /// </returns>
58          [MethodImpl(MethodImplOptions.AggressiveInlining)]
59          public static T PartialWrite<T>(this ref T target, T source, int shift, int limit) where
            ↪  T : struct => target = Bit<T>.PartialWrite(target, source, shift, limit);
60
61          /// <summary>
62          /// <para>Reads a specified number of bits from the number at specified position.</para>
63          /// <para>Считывает указанное количество бит из числа в указанной позиции.</para>
64          /// </summary>
65          /// <typeparam name="T">
66          /// <para>The number's type.</para>
67          /// <para>Тип числа.</para>
68          /// </typeparam>
69          /// <param name="target">
70          /// <para>The number from which the partial read will be performed.</para>
71          /// <para>Число из которого будет выполнено частичное чтение.</para>
72          /// </param>
73          /// <param name="shift">
74          /// <para>The start position to read from.</para>
75          /// <para>Стартовая позиция чтения.</para>
76          /// </param>
77          /// <param name="limit">
78          /// <para>The number of bits to read.</para>
79          /// <para>Количество бит, которые нужно считать.</para>
80          /// </param>
81          /// <returns>
82          /// <para>The number consisting of bits read from the source number.</para>
83          /// <para>Число состоящее из считанных из исходного числа бит.</para>
84          /// </returns>
85          [MethodImpl(MethodImplOptions.AggressiveInlining)]
86          public static T PartialRead<T>(this T target, int shift, int limit) =>
            ↪  Bit<T>.PartialRead(target, shift, limit);
87      }
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
            ↪  числа.</para>
19          /// </summary>
20          public static readonly Func<T, T> Not = CompileNotDelegate();
21
22          /// <summary>
23          /// <para>A read-only field that represents a logic addition function delegate.</para>
24          /// <para>Поле только для чтения, представляющее делегат функции логического
            ↪  сложения.</para>
25          /// </summary>
26          public static readonly Func<T, T, T> Or = CompileOrDelegate();
27
28          /// <summary>
29          /// <para>A read-only field that represents a logic multiplication function
            ↪  delegate.</para>
30          /// <para>Поле только для чтения, представляющее делегат функции логического
            ↪  умножения.</para>
31          /// </summary>
32          public static readonly Func<T, T, T> And = CompileAndDelegate();
33
34          /// <summary>
35          /// <para>A read-only field that represents a bitwise left shift function
            ↪  delegate.</para>
36          /// <para>Поле только для чтения, представляющее делегат функции побитового сдвига числа
            ↪  влево.</para>
37          /// </summary>
38          public static readonly Func<T, int, T> ShiftLeft = CompileShiftLeftDelegate();
39
40          /// <summary>
41          /// <para>A read-only field that represents a bitwise right shift function
            ↪  delegate.</para>
42          /// <para>Поле только для чтения, представляющее делегат функции побитового сдвига числа
            ↪  вправо.</para>
43          /// </summary>
44          public static readonly Func<T, int, T> ShiftRight = CompileShiftRightDelegate();
45
46          /// <summary>
47          /// <para>A read-only field that represents a bitwise number representation partial
            ↪  rewrite function delegate.</para>
48          /// <para>Поле только для чтения, представляющее делегат функции частичной побитовой
            ↪  перезаписи представления числа.</para>
49          /// </summary>
50          public static readonly Func<T, T, int, int, T> PartialWrite =
            ↪  CompilePartialWriteDelegate();
51
52          /// <summary>
53          /// <para>A read-only field that represents a bitwise number representation partial read
            ↪  function delegate.</para>
54          /// <para>Поле только для чтения, представляющее делегат функции частичного побитового
            ↪  считывания числа.</para>
55          /// </summary>
56          public static readonly Func<T, int, int, T> PartialRead = CompilePartialReadDelegate();
57
58          /// <summary>
59          /// <para>
60          /// Compiles the not delegate.
61          /// </para>
62          /// <para></para>
63          /// </summary>
64          /// <returns>
65          /// <para>A func of t and t</para>
66          /// <para></para>
67          /// </returns>
68          [MethodImpl(MethodImplOptions.AggressiveInlining)]
69          private static Func<T, T> CompileNotDelegate()
70          {
71              return DelegateHelpers.Compile<Func<T, T>>(emiter =>
72              {
73                  Ensure.Always.IsNumeric<T>();
74                  emiter.LoadArguments(0);
75                  emiter.Not();
```

```
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Compiles the or delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and t and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, T, T> CompileOrDelegate()
        {
            return DelegateHelpers.Compile<Func<T, T, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                emiter.LoadArguments(0, 1);
                emiter.Or();
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Compiles the and delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and t and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, T, T> CompileAndDelegate()
        {
            return DelegateHelpers.Compile<Func<T, T, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                emiter.LoadArguments(0, 1);
                emiter.And();
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Compiles the shift left delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and int and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, int, T> CompileShiftLeftDelegate()
        {
            return DelegateHelpers.Compile<Func<T, int, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                emiter.LoadArguments(0, 1);
                emiter.ShiftLeft();
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Compiles the shift right delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and int and t</para>
```

```
154         /// <para></para>
155         /// </returns>
156         [MethodImpl(MethodImplOptions.AggressiveInlining)]
157         private static Func<T, int, T> CompileShiftRightDelegate()
158         {
159             return DelegateHelpers.Compile<Func<T, int, T>>(emiter =>
160             {
161                 Ensure.Always.IsNumeric<T>();
162                 emiter.LoadArguments(0, 1);
163                 emiter.ShiftRight<T>();
164                 emiter.Return();
165             });
166         }
167 
168         /// <summary>
169         /// <para>
170         /// Compiles the partial write delegate.
171         /// </para>
172         /// <para></para>
173         /// </summary>
174         /// <returns>
175         /// <para>A func of t and t and int and int and t</para>
176         /// <para></para>
177         /// </returns>
178         [MethodImpl(MethodImplOptions.AggressiveInlining)]
179         private static Func<T, T, int, int, T> CompilePartialWriteDelegate()
180         {
181             return DelegateHelpers.Compile<Func<T, T, int, int, T>>(emiter =>
182             {
183                 Ensure.Always.IsNumeric<T>();
184                 var constants = GetConstants();
185                 var bitsNumber = constants.Item1;
186                 var numberFilledWithOnes = constants.Item2;
187                 ushort shiftArgument = 2;
188                 ushort limitArgument = 3;
189                 var checkLimit = emiter.DefineLabel();
190                 var calculateSourceMask = emiter.DefineLabel();
191                 // Check shift
192                 emiter.LoadArgument(shiftArgument);
193                 emiter.LoadConstant(0);
194                 emiter.BranchIfGreaterOrEqual(checkLimit); // Skip fix
195                 // Fix shift
196                 emiter.LoadConstant(bitsNumber);
197                 emiter.LoadArgument(shiftArgument);
198                 emiter.Add();
199                 emiter.StoreArgument(shiftArgument);
200                 emiter.MarkLabel(checkLimit);
201                 // Check limit
202                 emiter.LoadArgument(limitArgument);
203                 emiter.LoadConstant(0);
204                 emiter.BranchIfGreaterOrEqual(calculateSourceMask); // Skip fix
205                 // Fix limit
206                 emiter.LoadConstant(bitsNumber);
207                 emiter.LoadArgument(limitArgument);
208                 emiter.Add();
209                 emiter.StoreArgument(limitArgument);
210                 emiter.MarkLabel(calculateSourceMask);
211                 var sourceMask = emiter.DeclareLocal<T>();
212                 var targetMask = emiter.DeclareLocal<T>();
213                 emiter.LoadConstant(typeof(T), numberFilledWithOnes);
214                 emiter.LoadArgument(limitArgument);
215                 emiter.ShiftLeft();
216                 emiter.Not();
217                 emiter.LoadConstant(typeof(T), numberFilledWithOnes);
218                 emiter.And();
219                 emiter.StoreLocal(sourceMask);
220                 emiter.LoadLocal(sourceMask);
221                 emiter.LoadArgument(shiftArgument);
222                 emiter.ShiftLeft();
223                 emiter.Not();
224                 emiter.StoreLocal(targetMask);
225                 emiter.LoadArgument(0); // target
226                 emiter.LoadLocal(targetMask);
227                 emiter.And();
228                 emiter.LoadArgument(1); // source
229                 emiter.LoadLocal(sourceMask);
230                 emiter.And();
231                 emiter.LoadArgument(shiftArgument);
```

```
                emiter.ShiftLeft();
                emiter.Or();
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Compiles the partial read delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and int and int and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, int, int, T> CompilePartialReadDelegate()
        {
            return DelegateHelpers.Compile<Func<T, int, int, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                var constants = GetConstants();
                var bitsNumber = constants.Item1;
                var numberFilledWithOnes = constants.Item2;
                ushort shiftArgument = 1;
                ushort limitArgument = 2;
                var checkLimit = emiter.DefineLabel();
                var calculateSourceMask = emiter.DefineLabel();
                // Check shift
                emiter.LoadArgument(shiftArgument);
                emiter.LoadConstant(0);
                emiter.BranchIfGreaterOrEqual(checkLimit); // Skip fix
                // Fix shift
                emiter.LoadConstant(bitsNumber);
                emiter.LoadArgument(shiftArgument);
                emiter.Add();
                emiter.StoreArgument(shiftArgument);
                emiter.MarkLabel(checkLimit);
                // Check limit
                emiter.LoadArgument(limitArgument);
                emiter.LoadConstant(0);
                emiter.BranchIfGreaterOrEqual(calculateSourceMask); // Skip fix
                // Fix limit
                emiter.LoadConstant(bitsNumber);
                emiter.LoadArgument(limitArgument);
                emiter.Add();
                emiter.StoreArgument(limitArgument);
                emiter.MarkLabel(calculateSourceMask);
                var sourceMask = emiter.DeclareLocal<T>();
                var targetMask = emiter.DeclareLocal<T>();
                emiter.LoadConstant(typeof(T), numberFilledWithOnes);
                emiter.LoadArgument(limitArgument); // limit
                emiter.ShiftLeft();
                emiter.Not();
                emiter.LoadConstant(typeof(T), numberFilledWithOnes);
                emiter.And();
                emiter.StoreLocal(sourceMask);
                emiter.LoadLocal(sourceMask);
                emiter.LoadArgument(shiftArgument);
                emiter.ShiftLeft();
                emiter.StoreLocal(targetMask);
                emiter.LoadArgument(0); // target
                emiter.LoadLocal(targetMask);
                emiter.And();
                emiter.LoadArgument(shiftArgument);
                emiter.ShiftRight<T>();
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Gets the constants.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <exception cref="NotSupportedException">
```

```
        /// <para></para>
        /// <para></para>
        /// </exception>
        /// <returns>
        /// <para>A tuple of int and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Tuple<int, T> GetConstants()
        {
            var type = typeof(T);
            if (type == typeof(ulong))
            {
                return new Tuple<int, T>(64, (T)(object)ulong.MaxValue);
            }
            if (type == typeof(uint))
            {
                return new Tuple<int, T>(32, (T)(object)uint.MaxValue);
            }
            if (type == typeof(ushort))
            {
                return new Tuple<int, T>(16, (T)(object)ushort.MaxValue);
            }
            if (type == typeof(byte))
            {
                return new Tuple<int, T>(8, (T)(object)byte.MaxValue);
            }
            throw new NotSupportedException();
        }
    }
}
```

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

```
using System;
using System.Runtime.CompilerServices;

namespace Platform.Numbers
{
    /// <summary>
    /// <para>Represents a set of math methods.</para>
    /// <para>Представляет набор математических методов.</para>
    /// </summary>
    /// <remarks>Resizable array (FileMappedMemory) for values cache may be used. or cached oeis.org</remarks>
    public static class Math
    {
        private static readonly ulong[] _factorials =
        {
            1, 1, 2, 6, 24, 120, 720, 5040, 40320, 362880, 3628800, 39916800,
            479001600, 6227020800, 87178291200, 1307674368000, 20922789888000,
            355687428096000, 6402373705728000, 121645100408832000, 2432902008176640000
        };

        private static readonly ulong[] _catalans =
        {
            1, 1, 2, 5, 14, 42, 132, 429, 1430, 4862, 16796, 58786, 208012,
            742900, 2674440, 9694845, 35357670, 129644790, 477638700, 1767263190,
            6564120420, 24466267020, 91482563640, 343059613650, 1289904147324, 4861946401452,
            18367353072152, 69533550916004, 263747951750360, 1002242216651368, 3814986502092304,
            14544636039226909, 55534064877048198, 212336130412243110, 812944042149730764,
            3116285494907301262, 11959798385860453492
        };

        /// <summary>
        /// <para>Represents the limit for calculating the catanal number, supported by the <see cref="ulong"/> type.</para>
        /// <para>Представляет предел расчёта каталонового числа, поддерживаемый <see cref="ulong"/> типом.</para>
        /// </summary>
        public static readonly ulong MaximumFactorialNumber = 20;

        /// <summary>
        /// <para>Represents the limit for calculating the factorial number, supported by the <see cref="ulong"/> type.</para>
        /// <para>Представляет предел расчёта факториала числа, поддерживаемый <see cref="ulong"/> типом.</para>
        /// </summary>
        public static readonly ulong MaximumCatalanIndex = 36;

```

```
41          /// <summary>
42          /// <para>Returns the product of all positive integers less than or equal to the number
            ↪  specified as an argument.</para>
43          /// <para>Возвращает произведение всех положительных чисел меньше или равных указанному
            ↪  в качестве аргумента числу.</para>
44          /// </summary>
45          /// <param name="n">
46          /// <para>The maximum positive number that will participate in factorial's
            ↪  product.</para>
47          /// <para>Максимальное положительное число, которое будет участвовать в произведении
            ↪  факториала.</para>
48          /// </param>
49          /// <returns>
50          /// <para>The product of all positive integers less than or equal to the number
            ↪  specified as an argument.</para>
51          /// <para>Произведение всех положительных чисел меньше или равных указанному, в качестве
            ↪  аргумента, числу.</para>
52          /// </returns>
53          public static ulong Factorial(ulong n)
54          {
55              if (n >= 0 && n <= MaximumFactorialNumber)
56              {
57                  return _factorials[n];
58              }
59              else
60              {
61                  throw new ArgumentOutOfRangeException($"Only numbers from 0 to
                    ↪  {MaximumFactorialNumber} are supported by unsigned integer with 64 bits
                    ↪  length.");
62              }
63          }
64
65          /// <summary>
66          /// <para>Returns the Catalan Number with the number specified as an argument.</para>
67          /// <para>Возвращает Число Катанала с номером, указанным в качестве аргумента.</para>
68          /// </summary>
69          /// <param name="n">
70          /// <para>The number of the Catalan number.</para>
71          /// <para>Номер Числа Катанала.</para>
72          /// </param>
73          /// <returns>
74          /// <para>The Catalan Number with the number specified as an argument.</para>
75          /// <para>Число Катанала с номером, указанным в качестве аргумента.</para>
76          /// </returns>
77          public static ulong Catalan(ulong n)
78          {
79              if (n >= 0 && n <= MaximumCatalanIndex)
80              {
81                  return _catalans[n];
82              }
83              else
84              {
85                  throw new ArgumentOutOfRangeException($"Only numbers from 0 to
                    ↪  {MaximumCatalanIndex} are supported by unsigned integer with 64 bits
                    ↪  length.");
86              }
87          }
88
89          /// <summary>
90          /// <para>Checks if a number is a power of two.</para>
91          /// <para>Проверяет, является ли число степенью двойки.</para>
92          /// </summary>
93          /// <param name="x">
94          /// <para>The number to check.</para>
95          /// <para>Число для проверки.</para>
96          /// </param>
97          /// <returns>
98          /// <para>True if the number is a power of two otherwise false.</para>
99          /// <para>True, если число является степенью двойки, иначе - false.</para>
100         /// </returns>
101         [MethodImpl(MethodImplOptions.AggressiveInlining)]
102         public static bool IsPowerOfTwo(ulong x) => (x & x - 1) == 0;
103
104         /// <summary>
105         /// <para>Takes a module from a number.</para>
106         /// <para>Берёт модуль от числа.</para>
107         /// </summary>
```

```
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The number from which to take the absolute value.</para>
        /// <para>Число, от которого необходимо взять абсолютное значение.</para>
        /// </param>
        /// <returns>
        /// <para>The absolute value of the number.</para>
        /// <para>Абсолютное значение числа.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Abs<T>(T x) => Math<T>.Abs(x);

        /// <summary>
        /// <para>Makes a number negative.</para>
        /// <para>Делает число отрицательным.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The number to be made negative.</para>
        /// <para>Число которое нужно сделать отрицательным.</para>
        /// </param>
        /// <returns>
        /// <para>A negative number.</para>
        /// <para>Отрицательное число.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Negate<T>(T x) => Math<T>.Negate(x);
    }
}
```

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

```
using System.Runtime.CompilerServices;

namespace Platform.Numbers
{
    /// <summary>
    /// <para>Represents a set of extension methods that perform mathematical operations on
    ↪  arbitrary object types.</para>
    /// <para>Представляет набор методов расширения выполняющих математические операции для
    ↪  объектов произвольного типа.</para>
    /// </summary>
    public static class MathExtensions
    {
        /// <summary>
        /// <para>Takes a module from a number.</para>
        /// <para>Берёт модуль от числа.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The number from which to take the absolute value.</para>
        /// <para>Число от которого необходимо взять абсолютное значение.</para>
        /// </param>
        /// <returns>
        /// <para>The absolute value of a number.</para>
        /// <para>Абсолютное значение числа.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Abs<T>(this ref T x) where T : struct => x = Math<T>.Abs(x);

        /// <summary>
        /// <para>Makes a number negative.</para>
        /// <para>Делает число отрицательным.</para>
        /// </summary>
        /// <typeparam name="T">
        /// <para>The number's type.</para>
        /// <para>Тип числа.</para>
        /// </typeparam>
        /// <param name="x">
        /// <para>The number to be made negative.</para>
```

```
        /// <para>Число которое нужно сделать отрицательным.</para>
        /// </param>
        /// <returns>
        /// <para>Negative number.</para>
        /// <para>Отрицательное число.</para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        public static T Negate<T>(this ref T x) where T : struct => x = Math<T>.Negate(x);
    }
}
```

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

```
using System;
using System.Runtime.CompilerServices;
using Platform.Exceptions;
using Platform.Reflection;

// ReSharper disable StaticFieldInGenericType
namespace Platform.Numbers
{
    /// <summary>
    /// <para>Represents a set of compiled math operations delegates.</para>
    /// <para>Представляет набор скомпилированных делегатов математических операций.</para>
    /// </summary>
    public static class Math<T>
    {
        /// <summary>
        /// <para>A read-only field that represents a number modulus calculation function
        ↪  delegate.</para>
        /// <para>Поле только для чтения, которое представляет делегат функции вычисления модуля
        ↪  числа.</para>
        /// </summary>
        public static readonly Func<T, T> Abs = CompileAbsDelegate();

        /// <summary>
        /// <para>A read-only field that represents a number negation function delegate.</para>
        /// <para>Поле только для чтения, которое представляет делегат функции отрицания
        ↪  числа.</para>
        /// </summary>
        public static readonly Func<T, T> Negate = CompileNegateDelegate();

        /// <summary>
        /// <para>
        /// Compiles the abs delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, T> CompileAbsDelegate()
        {
            return DelegateHelpers.Compile<Func<T, T>>(emiter =>
            {
                Ensure.Always.IsNumeric<T>();
                emiter.LoadArgument(0);
                if (NumericType<T>.IsSigned)
                {
                    emiter.Call(typeof(System.Math).GetMethod("Abs", Types<T>.Array));
                }
                emiter.Return();
            });
        }

        /// <summary>
        /// <para>
        /// Compiles the negate delegate.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <returns>
        /// <para>A func of t and t</para>
        /// <para></para>
        /// </returns>
        [MethodImpl(MethodImplOptions.AggressiveInlining)]
        private static Func<T, T> CompileNegateDelegate()
```

```
        {
            return DelegateHelpers.Compile<Func<T, T>>(emiter =>
            {
                emiter.LoadArgument(0);
                emiter.Negate();
                emiter.Return();
            });
        }
    }
}
```

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

```
using Xunit;

namespace Platform.Numbers.Tests
{
    /// <summary>
    /// <para>
    /// Represents the arithmetic extensions tests.
    /// </para>
    /// <para></para>
    /// </summary>
    public static class ArithmeticExtensionsTests
    {
        /// <summary>
        /// <para>
        /// Tests that increment test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void IncrementTest()
        {
            var number = 0UL;
            var returnValue = number.Increment();
            Assert.Equal(1UL, returnValue);
            Assert.Equal(1UL, number);
        }

        /// <summary>
        /// <para>
        /// Tests that decrement test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void DecrementTest()
        {
            var number = 1UL;
            var returnValue = number.Decrement();
            Assert.Equal(0UL, returnValue);
            Assert.Equal(0UL, number);
        }
    }
}
```

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

```
using System;
using Xunit;

namespace Platform.Numbers.Tests
{
    /// <summary>
    /// <para>
    /// Represents the arithmetic tests.
    /// </para>
    /// <para></para>
    /// </summary>
    public static class ArithmeticTests
    {
        /// <summary>
        /// <para>
        /// Tests that compiled operations test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void CompiledOperationsTest()
```

```
        {
            Assert.Equal(3, Arithmetic.Add(1, 2));
            Assert.Equal(1, Arithmetic.Subtract(2, 1));
            Assert.Equal(8, Arithmetic.Multiply(2, 4));
            Assert.Equal(4, Arithmetic.Divide(8, 2));
            Assert.Equal(2, Arithmetic.Increment(1));
            Assert.Equal(1UL, Arithmetic.Decrement(2UL));
            Assert.Throws<NotSupportedException>(() => Arithmetic<string>.Subtract("1", "2"));
        }
    }
}
```

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

```
using System;
using Platform.Reflection;
using Xunit;

namespace Platform.Numbers.Tests
{
    /// <summary>
    /// <para>
    /// Represents the bit tests.
    /// </para>
    /// <para></para>
    /// </summary>
    public static class BitTests
    {
        /// <summary>
        /// <para>
        /// Tests that get lowest bit position test.
        /// </para>
        /// <para></para>
        /// </summary>
        /// <param name="value">
        /// <para>The value.</para>
        /// <para></para>
        /// </param>
        /// <param name="expectedPosition">
        /// <para>The expected position.</para>
        /// <para></para>
        /// </param>
        [Theory]
        [InlineData(00, -1)] // 0000 0000 (none, -1)
        [InlineData(01, 00)] // 0000 0001 (first, 0)
        [InlineData(08, 03)] // 0000 1000 (forth, 3)
        [InlineData(88, 03)] // 0101 1000 (forth, 3)
        public static void GetLowestBitPositionTest(ulong value, int expectedPosition)
        {
            Assert.True(Bit.GetLowestPosition(value) == expectedPosition);
        }

        /// <summary>
        /// <para>
        /// Tests that byte bitwise operations test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void ByteBitwiseOperationsTest()
        {
            Assert.True(Bit<byte>.Not(2) == unchecked((byte)~2));
            Assert.True(Bit<byte>.Or(1, 2) == (1 | 2));
            Assert.True(Bit<byte>.And(1, 2) == (1 & 2));
            Assert.True(Bit<byte>.ShiftLeft(1, 2) == (1 << 2));
            Assert.True(Bit<byte>.ShiftRight(1, 2) == (1 >> 2));
            Assert.Equal(NumericType<byte>.MaxValue >> 1,
            ↪  Bit<byte>.ShiftRight(NumericType<byte>.MaxValue, 1));
        }

        /// <summary>
        /// <para>
        /// Tests that u int 16 bitwise operations test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void UInt16BitwiseOperationsTest()
        {
```

```
65              Assert.True(Bit<ushort>.Not(2) == unchecked((ushort)~2));
66              Assert.True(Bit<ushort>.Or(1, 2) == (1 | 2));
67              Assert.True(Bit<ushort>.And(1, 2) == (1 & 2));
68              Assert.True(Bit<ushort>.ShiftLeft(1, 2) == (1 << 2));
69              Assert.True(Bit<ushort>.ShiftRight(1, 2) == (1 >> 2));
70              Assert.Equal(NumericType<ushort>.MaxValue >> 1,
                ↪  Bit<ushort>.ShiftRight(NumericType<ushort>.MaxValue, 1));
71          }
72
73          /// <summary>
74          /// <para>
75          /// Tests that u int 32 bitwise operations test.
76          /// </para>
77          /// <para></para>
78          /// </summary>
79          [Fact]
80          public static void UInt32BitwiseOperationsTest()
81          {
82              Assert.True(Bit<uint>.Not(2) == unchecked((uint)~2));
83              Assert.True(Bit<uint>.Or(1, 2) == (1 | 2));
84              Assert.True(Bit<uint>.And(1, 2) == (1 & 2));
85              Assert.True(Bit<uint>.ShiftLeft(1, 2) == (1 << 2));
86              Assert.True(Bit<uint>.ShiftRight(1, 2) == (1 >> 2));
87              Assert.Equal(NumericType<uint>.MaxValue >> 1,
                ↪  Bit<uint>.ShiftRight(NumericType<uint>.MaxValue, 1));
88          }
89
90          /// <summary>
91          /// <para>
92          /// Tests that u int 64 bitwise operations test.
93          /// </para>
94          /// <para></para>
95          /// </summary>
96          [Fact]
97          public static void UInt64BitwiseOperationsTest()
98          {
99              Assert.True(Bit<ulong>.Not(2) == unchecked((ulong)~2));
100             Assert.True(Bit<ulong>.Or(1, 2) == (1 | 2));
101             Assert.True(Bit<ulong>.And(1, 2) == (1 & 2));
102             Assert.True(Bit<ulong>.ShiftLeft(1, 2) == (1 << 2));
103             Assert.True(Bit<ulong>.ShiftRight(1, 2) == (1 >> 2));
104             Assert.Equal(NumericType<ulong>.MaxValue >> 1,
                ↪  Bit<ulong>.ShiftRight(NumericType<ulong>.MaxValue, 1));
105         }
106
107         /// <summary>
108         /// <para>
109         /// Tests that partial read write test.
110         /// </para>
111         /// <para></para>
112         /// </summary>
113         [Fact]
114         public static void PartialReadWriteTest()
115         {
116             {
117                 uint firstValue = 1;
118                 uint secondValue = 1543;
119
120                 // Pack (join) two values at the same time
121                 uint value = secondValue << 1 | firstValue;
122
123                 uint unpackagedFirstValue = value & 1;
124                 uint unpackagedSecondValue = (value & 0xFFFFFFFE) >> 1;
125
126                 Assert.True(firstValue == unpackagedFirstValue);
127                 Assert.True(secondValue == unpackagedSecondValue);
128
129                 // Using universal functions:
130                 Assert.True(PartialRead(value, 0, 1) == firstValue);
131                 Assert.True(PartialRead(value, 1, -1) == secondValue);
132
133                 firstValue = 0;
134                 secondValue = 6892;
135
136                 value = PartialWrite(value, firstValue, 0, 1);
137                 value = PartialWrite(value, secondValue, 1, -1);
138
139                 Assert.True(PartialRead(value, 0, 1) == firstValue);
140                 Assert.True(PartialRead(value, 1, -1) == secondValue);
```

```
        }

        {
            uint firstValue = 1;
            uint secondValue = 1543;

            // Pack (join) two values at the same time
            uint value = secondValue << 1 | firstValue;

            uint unpackagedFirstValue = value & 1;
            uint unpackagedSecondValue = (value & 0xFFFFFFFE) >> 1;

            Assert.True(firstValue == unpackagedFirstValue);
            Assert.True(secondValue == unpackagedSecondValue);

            // Using universal functions:
            Assert.True(Bit.PartialRead(value, 0, 1) == firstValue);
            Assert.True(Bit.PartialRead(value, 1, -1) == secondValue);

            firstValue = 0;
            secondValue = 6892;

            value = Bit.PartialWrite(value, firstValue, 0, 1);
            value = Bit.PartialWrite(value, secondValue, 1, -1);

            Assert.True(Bit.PartialRead(value, 0, 1) == firstValue);
            Assert.True(Bit.PartialRead(value, 1, -1) == secondValue);
        }

        {
            uint firstValue = 1;
            uint secondValue = 1543;

            // Pack (join) two values at the same time
            uint value = secondValue << 1 | firstValue;

            uint unpackagedFirstValue = value & 1;
            uint unpackagedSecondValue = (value & 0xFFFFFFFE) >> 1;

            Assert.True(firstValue == unpackagedFirstValue);
            Assert.True(secondValue == unpackagedSecondValue);

            // Using universal functions:
            var readMasksAndShiftFor0And1 = GetReadMaskAndShift(0, 1);
            var readMasksAndShiftFor1AndMinus1 = GetReadMaskAndShift(1, -1);
            var writeMasksAndShiftFor0And1 = GetWriteMasksAndShift(0, 1);
            var writeMasksAndShiftFor1AndMinus1 = GetWriteMasksAndShift(1, -1);

            Assert.True(PartialRead(value, readMasksAndShiftFor0And1) == firstValue);
            Assert.True(PartialRead(value, readMasksAndShiftFor1AndMinus1) == secondValue);

            firstValue = 0;
            secondValue = 6892;

            value = PartialWrite(value, firstValue, writeMasksAndShiftFor0And1);
            value = PartialWrite(value, secondValue, writeMasksAndShiftFor1AndMinus1);

            Assert.True(PartialRead(value, readMasksAndShiftFor0And1) == firstValue);
            Assert.True(PartialRead(value, readMasksAndShiftFor1AndMinus1) == secondValue);
        }
    }

    // TODO: Can be optimized using precalculation of TargetMask and SourceMask
    private static uint PartialWrite(uint target, uint source, int shift, int limit)
    {
        if (shift < 0)
        {
            shift = 32 + shift;
        }
        if (limit < 0)
        {
            limit = 32 + limit;
        }
        var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
        var targetMask = ~(sourceMask << shift);
        return target & targetMask | (source & sourceMask) << shift;
    }

    private static uint PartialRead(uint target, int shift, int limit)
    {
```

```
            if (shift < 0)
            {
                shift = 32 + shift;
            }
            if (limit < 0)
            {
                limit = 32 + limit;
            }
            var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
            var targetMask = sourceMask << shift;
            return (target & targetMask) >> shift;
        }

        private static Tuple<uint, uint, int> GetWriteMasksAndShift(int shift, int limit)
        {
            if (shift < 0)
            {
                shift = 32 + shift;
            }
            if (limit < 0)
            {
                limit = 32 + limit;
            }
            var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
            var targetMask = ~(sourceMask << shift);
            return new Tuple<uint, uint, int>(targetMask, sourceMask, shift);
        }

        private static Tuple<uint, int> GetReadMaskAndShift(int shift, int limit)
        {
            if (shift < 0)
            {
                shift = 32 + shift;
            }
            if (limit < 0)
            {
                limit = 32 + limit;
            }
            var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
            var targetMask = sourceMask << shift;
            return new Tuple<uint, int>(targetMask, shift);
        }

        private static uint PartialWrite(uint target, uint targetMask, uint source, uint
        ↪  sourceMask, int shift) => target & targetMask | (source & sourceMask) << shift;

        private static uint PartialWrite(uint target, uint source, Tuple<uint, uint, int>
        ↪  masksAndShift) => PartialWrite(target, masksAndShift.Item1, source,
        ↪  masksAndShift.Item2, masksAndShift.Item3);

        private static uint PartialRead(uint target, uint targetMask, int shift) => (target &
        ↪  targetMask) >> shift;

        private static uint PartialRead(uint target, Tuple<uint, int> masksAndShift) =>
        ↪  PartialRead(target, masksAndShift.Item1, masksAndShift.Item2);

        /// <summary>
        /// <para>
        /// Tests that bug with loading constant of 8 test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void BugWithLoadingConstantOf8Test()
        {
            Bit<byte>.PartialWrite(0, 1, 5, -5);
        }
    }
}
```

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

```
using Xunit;

namespace Platform.Numbers.Tests
{
    /// <summary>
    /// <para>
    /// Represents the math extensions tests.
    /// </para>
```

```
    /// <para></para>
    /// </summary>
    public static class MathExtensionsTests
    {
        /// <summary>
        /// <para>
        /// Tests that abs test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void AbsTest()
        {
            var number = -1L;
            var returnValue = number.Abs();
            Assert.Equal(1L, returnValue);
            Assert.Equal(1L, number);
        }

        /// <summary>
        /// <para>
        /// Tests that negate test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void NegateTest()
        {
            var number = 2L;
            var returnValue = number.Negate();
            Assert.Equal(-2L, returnValue);
            Assert.Equal(-2L, number);
        }

        /// <summary>
        /// <para>
        /// Tests that unsigned negate test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void UnsignedNegateTest()
        {
            var number = 2UL;
            var returnValue = number.Negate();
            Assert.Equal(18446744073709551614, returnValue);
            Assert.Equal(18446744073709551614, number);
        }
    }
}
```

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

```
using Xunit;

namespace Platform.Numbers.Tests
{
    /// <summary>
    /// <para>
    /// Represents the math tests.
    /// </para>
    /// <para></para>
    /// </summary>
    public static class MathTests
    {
        /// <summary>
        /// <para>
        /// Tests that compiled operations test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void CompiledOperationsTest()
        {
            Assert.True(Math.Abs(Arithmetic<double>.Subtract(3D, 2D) - 1D) < 0.01);
        }
    }
}
```

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

```
using Xunit;

namespace Platform.Numbers.Tests
{
    /// <summary>
    /// <para>
    /// Represents the system tests.
    /// </para>
    /// <para></para>
    /// </summary>
    public static class SystemTests
    {
        /// <summary>
        /// <para>
        /// Tests that possible pack two values into one test.
        /// </para>
        /// <para></para>
        /// </summary>
        [Fact]
        public static void PossiblePackTwoValuesIntoOneTest()
        {
            uint value = 0;

            // Set one to first bit
            value |= 1;

            Assert.True(value == 1);

            // Set zero to first bit
            value &= 0xFFFFFFFE;

            // Get first bit
            uint read = value & 1;

            Assert.True(read == 0);

            uint firstValue = 1;
            uint secondValue = 1543;

            // Pack (join) two values at the same time
            value = (secondValue << 1) | firstValue;

            uint unpackagedFirstValue = value & 1;
            uint unpackagedSecondValue = (value & 0xFFFFFFFE) >> 1;

            Assert.True(firstValue == unpackagedFirstValue);
            Assert.True(secondValue == unpackagedSecondValue);

            // Using universal functions:

            Assert.True(PartialRead(value, 0, 1) == firstValue);
            Assert.True(PartialRead(value, 1, -1) == secondValue);

            firstValue = 0;
            secondValue = 6892;

            value = PartialWrite(value, firstValue, 0, 1);
            value = PartialWrite(value, secondValue, 1, -1);

            Assert.True(PartialRead(value, 0, 1) == firstValue);
            Assert.True(PartialRead(value, 1, -1) == secondValue);
        }

        private static uint PartialWrite(uint target, uint source, int shift, int limit)
        {
            if (shift < 0)
            {
                shift = 32 + shift;
            }
            if (limit < 0)
            {
                limit = 32 + limit;
            }
            var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
            var targetMask = ~(sourceMask << shift);
            return (target & targetMask) | ((source & sourceMask) << shift);
        }

        private static uint PartialRead(uint target, int shift, int limit)
```

```
80          {
81              if (shift < 0)
82              {
83                  shift = 32 + shift;
84              }
85              if (limit < 0)
86              {
87                  limit = 32 + limit;
88              }
89              var sourceMask = ~(uint.MaxValue << limit) & uint.MaxValue;
90              var targetMask = sourceMask << shift;
91              return (target & targetMask) >> shift;
92          }
93      }
94  }
```

Index