1.1 ./csharp/Platform.RegularExpressions.Transformer.CSharpToCpp/CSharpToCppTransformer.cs

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text.RegularExpressions;

#pragma warning disable CS1591 // Missing XML comment for publicly visible type or member

namespace Platform.RegularExpressions.Transformer.CSharpToCpp
{
    public class CSharpToCppTransformer : Transformer
    {
        public static readonly IList<ISubstitutionRule> FirstStage = new List<SubstitutionRule>
        {
            // // ...
            //
            (new Regex(@"(\r?\n)?[ \t]+//+.+"), "", null, 0),
            // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
            //
            (new Regex(@"^\s*?\#pragma[\sa-zA-Z0-9]+$"), "", null, 0),
            // {\n\n\n
            // {
            (new Regex(@"{\s+[\r\n]+"), "{" + Environment.NewLine, null, 0),
            // Platform.Collections.Methods.Lists
            // Platform::Collections::Methods::Lists
            (new Regex(@"(namespace[^\r\n]+?)\.([^\r\n]+?)"), "$1::$2", null, 20),
            // Comparer<TArgument>.Default.Compare(maximumArgument, minimumArgument) < 0
            // maximumArgument < minimumArgument
            (new Regex(@"Comparer<[^>\n]+>\.Default\.Compare\(\s*(?<first>[^,)\n]+),\s*(?<second>[^\)\n]+)\s*\)\s*(?<comparison>[<>=]=?)\s*0"), "${first} ${comparison} ${second}", null, 0),
            // out TProduct
            // TProduct
            (new Regex(@"(?<before>(<|, ))(in|out) (?<typeParameter>[a-zA-Z0-9]+)(?<after>(>|,))"), "${before}${typeParameter}${after}", null, 10),
            // public ...
            // public: ...
            (new Regex(@"(?<newLineAndIndent>\r?\n?[ \t]*)(?<before>[^\{\(\r\n]*)(?<access>private|protected|public)[ \t]+(?![^\{\(\r\n]*(interface|class|struct)[^\{\(\r\n]*[\{\(\r\n])"), "${newLineAndIndent}${access}: ${before}", null, 0),
            // public: static bool CollectExceptions { get; set; }
            // public: inline static bool CollectExceptions;
            (new Regex(@"(?<access>(private|protected|public): )(?<before>(static )?[^\r\n]+)(?<name>[a-zA-Z0-9]+) {[^;}]*(?<=\W)get;[^;}]*(?<=\W)set;[^;}]*}"), "${access}inline ${before}${name};", null, 0),
            // public abstract class
            // class
            (new Regex(@"((public|protected|private|internal|abstract|static) )*(?<category>interface|class|struct)"), "${category}", null, 0),
            // class GenericCollectionMethodsBase<TElement> {
            // template <typename TElement> class GenericCollectionMethodsBase {
            (new Regex(@"class ([a-zA-Z0-9]+)<([a-zA-Z0-9]+)>([^{]+){"), "template <typename $2> class $1$3{", null, 0),
            // static void TestMultipleCreationsAndDeletions<TElement>(SizedBinaryTreeMethodsBase<TElement> tree, TElement* root)
            // template<typename T> static void TestMultipleCreationsAndDeletions<TElement>(SizedBinaryTreeMethodsBase<TElement> tree, TElement* root)
            (new Regex(@"static ([a-zA-Z0-9]+) ([a-zA-Z0-9]+)<([a-zA-Z0-9]+)>\(([^\)\r\n]+)\)"), "template <typename $3> static $1 $2($4)", null, 0),
            // interface IFactory<out TProduct> {
            // template <typename TProduct> class IFactory { public:
            (new Regex(@"interface (?<interface>[a-zA-Z0-9]+)<(?<typeParameters>[a-zA-Z0-9,]+)>(?<whitespace>[^{]+){"), "template <typename...> class ${interface}; template <typename ${typeParameters}> class ${interface}<${typeParameters}>${whitespace}{" + Environment.NewLine + "public:", null, 0),
            // template <typename TObject, TProperty, TValue>
            // template <typename TObject, typename TProperty, TValue>
            (new Regex(@"(?<before>template <(, )?typename [a-zA-Z0-9]+)+, )(?<typeParameter>[a-zA-Z0-9]+)(?<after>(,|>))"), "${before}typename ${typeParameter}${after}", null, 10),
```

```
53              // Insert markers
54              // private: static void BuildExceptionString(this StringBuilder sb, Exception
                ↪  exception, int level)
55              // /*~extensionMethod~BuildExceptionString~*/private: static void
                ↪  BuildExceptionString(this StringBuilder sb, Exception exception, int level)
56              (new Regex(@"private: static [^\r\n]+ (?<name>[a-zA-Z0-9]+)\(this [^\)\r\n]+\)"),
                ↪  "/*~extensionMethod~${name}~*/$0", null, 0),
57              // Move all markers to the beginning of the file.
58              (new Regex(@"\A(?<before>[^\r\n]+\r?\n(.|\n)+)(?<marker>/\*~extensionMethod~(?<name>
                ↪  [a-zA-Z0-9]+)~\*/)"), "${marker}${before}", null,
                ↪  10),
59              // /*~extensionMethod~BuildExceptionString~*/...sb.BuildExceptionString(exception.In
                ↪  nerException, level +
                ↪  1);
60              // /*~extensionMethod~BuildExceptionString~*/...BuildExceptionString(sb,
                ↪  exception.InnerException, level + 1);
61              (new Regex(@"(?<before>/\*~extensionMethod~(?<name>[a-zA-Z0-9]+)~\*/(.|\n)+\W)(?<var
                ↪  iable>[_a-zA-Z0-9]+)\.\k<name>\("), "${before}${name}(${variable}, ", null,
                ↪  50),
62              // Remove markers
63              // /*~extensionMethod~BuildExceptionString~*/
64              //
65              (new Regex(@"/\*~extensionMethod~[a-zA-Z0-9]+~\*/"), "", null, 0),
66              // (this
67              // (
68              (new Regex(@"\(this "), "(", null, 0),
69              // public: static readonly EnsureAlwaysExtensionRoot Always = new
                ↪  EnsureAlwaysExtensionRoot();
70              // public:inline static EnsureAlwaysExtensionRoot Always;
71              (new Regex(@"(?<access>(private|protected|public): )?static readonly
                ↪  (?<type>[a-zA-Z0-9]+) (?<name>[a-zA-Z0-9_]+) = new \k<type>\(\);"),
                ↪  "${access}inline static ${type} ${name};", null, 0),
72              // public: static readonly string ExceptionContentsSeparator = "---";
73              // public: inline static const char* ExceptionContentsSeparator = "---";
74              (new Regex(@"(?<access>(private|protected|public): )?static readonly string
                ↪  (?<name>[a-zA-Z0-9_]+) = ""(?<string>(\""|[^""\r\n])+)"";"), "${access}inline
                ↪  static const char* ${name} = \"${string}\";", null, 0),
75              // private: const int MaxPath = 92;
76              // private: static const int MaxPath = 92;
77              (new Regex(@"(?<access>(private|protected|public): )?(const|static readonly)
                ↪  (?<type>[a-zA-Z0-9]+) (?<name>[_a-zA-Z0-9]+) = (?<value>[^;\r\n]+);"),
                ↪  "${access}static const ${type} ${name} = ${value};", null, 0),
78              //  ArgumentNotNull(EnsureAlwaysExtensionRoot root, TArgument argument) where
                ↪  TArgument : class
79              //  ArgumentNotNull(EnsureAlwaysExtensionRoot root, TArgument* argument)
80              (new Regex(@"(?<before> [a-zA-Z]+\(([a-zA-Z *,]+, |))(?<type>[a-zA-Z]+)(?<after>(|
                ↪  [a-zA-Z *,]+)\))[ \r\n]+where \k<type> : class"), "${before}${type}*${after}",
                ↪  null, 0),
81              // protected: abstract TElement GetFirst();
82              // protected: virtual TElement GetFirst() = 0;
83              (new Regex(@"(?<access>(private|protected|public): )?abstract
                ↪  (?<method>[^;\r\n]+);"), "${access}virtual ${method} = 0;", null, 0),
84              // TElement GetFirst();
85              // virtual TElement GetFirst() = 0;
86              (new Regex(@"([\r\n]+[ ]+)((?!return)[a-zA-Z0-9]+ [a-zA-Z0-9]+\([^\)\r\n]*\))(;[
                ↪  ]*[\r\n]+)"), "$1virtual $2 = 0$3", null, 1),
87              // protected: readonly TreeElement[] _elements;
88              // protected: TreeElement _elements[N];
89              (new Regex(@"(?<access>(private|protected|public): )?readonly
                ↪  (?<type>[a-zA-Z<>0-9]+)([\[\]]+) (?<name>[_a-zA-Z0-9]+);"), "${access}${type}
                ↪  ${name}[N];", null, 0),
90              // protected: readonly TElement Zero;
91              // protected: TElement Zero;
92              (new Regex(@"(?<access>(private|protected|public): )?readonly
                ↪  (?<type>[a-zA-Z<>0-9]+) (?<name>[_a-zA-Z0-9]+);"), "${access}${type} ${name};",
                ↪  null, 0),
93              // internal
94              //
95              (new Regex(@"(\W)internal\s+"), "$1", null, 0),
96              // static void NotImplementedException(ThrowExtensionRoot root) => throw new
                ↪  NotImplementedException();
97              // static void NotImplementedException(ThrowExtensionRoot root) { return throw new
                ↪  NotImplementedException(); }
```

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98              (new Regex(@"(^\s+)(private|protected|public)?(: )?(template \<[^>\r\n]+\> )?(static
                ↪  )?(override )?([a-zA-Z0-9]+
                ↪  )([a-zA-Z0-9]+)\(([^\(\r\n]*)\)\s+=>\s+throw([^;\r\n]+);"),
                ↪  "$1$2$3$4$5$6$7$8($9) { throw$10; }", null, 0),
99              // SizeBalancedTree(int capacity) => a = b;
100             // SizeBalancedTree(int capacity) { a = b; }
101             (new Regex(@"(^\s+)(private|protected|public)?(: )?(template \<[^>\r\n]+\> )?(static
                ↪  )?(override )?(void )?([a-zA-Z0-9]+)\(([^\(\r\n]*)\)\s+=>\s+([^;\r\n]+);"),
                ↪  "$1$2$3$4$5$6$7$8($9) { $10; }", null, 0),
102             // int SizeBalancedTree(int capacity) => a;
103             // int SizeBalancedTree(int capacity) { return a; }
104             (new Regex(@"(^\s+)(private|protected|public)?(: )?(template \<[^>\r\n]+\> )?(static
                ↪  )?(override )?([a-zA-Z0-9]+
                ↪  )([a-zA-Z0-9]+)\(([^\(\r\n]*)\)\s+=>\s+([^;\r\n]+);"), "$1$2$3$4$5$6$7$8($9) {
                ↪  return $10; }", null, 0),
105             // () => Integer<TElement>.Zero,
106             // () { return Integer<TElement>.Zero; },
107             (new Regex(@"\(\)\s+=>\s+(?<expression>[^(),;\r\n]+(\(((?<parenthesis>\()|(?<-parent
                ↪  hesis>\))|[^();\r\n]*?)*?\))?[^(),;\r\n]*)(?<after>,|\);)"), "() { return
                ↪  ${expression}; }${after}", null, 0),
108             // => Integer<TElement>.Zero;
109             // { return Integer<TElement>.Zero; }
110             (new Regex(@"\)\s+=>\s+([^;\r\n]+?);"), ") { return $1; }", null, 0),
111             // () { return avlTree.Count; }
112             // [&]()-> auto { return avlTree.Count; }
113             (new Regex(@"(?<before>, |\(\)\(\) { return (?<expression>[^;\r\n]+); }"),
                ↪  "${before}[&]()-> auto { return ${expression}; }", null, 0),
114             // Count => GetSizeOrZero(Root);
115             // GetCount() { return GetSizeOrZero(Root); }
116             (new Regex(@"(\W)([A-Z][a-zA-Z]+)\s+=>\s+([^;\r\n]+);"), "$1Get$2() { return $3; }",
                ↪  null, 0),
117             // ArgumentInRange(const char* message) { const char* messageBuilder() { return
                ↪  message; }
118             // ArgumentInRange(const char* message) { auto messageBuilder = [&]() -> const char*
                ↪  { return message; };
119             (new Regex(@"(?<before>\W[_a-zA-Z0-9]+\([^\)\n]*\)[\s\n]*{[\s\n]*([^{}]|\n)*?(\r?\n)
                ↪  ?[ \t]*)(?<returnType>[_a-zA-Z0-9*:]+[_a-zA-Z0-9*: ]*)
                ↪  (?<methodName>[_a-zA-Z0-9]+)\((?<arguments>[^\)\n]*)\)\s*{(?<body>([^}]|\n)+?)}"
                ↪  ), "${before}auto ${methodName} = [&]() -> ${returnType} {${body}};", null,
                ↪  10),
120             // Func<TElement> treeCount
121             // std::function<TElement()> treeCount
122             (new Regex(@"Func<([a-zA-Z0-9]+)> ([a-zA-Z0-9]+)"), "std::function<$1()> $2", null,
                ↪  0),
123             // Action<TElement> free
124             // std::function<void(TElement)> free
125             (new Regex(@"Action<([a-zA-Z0-9]+)> ([a-zA-Z0-9]+)"), "std::function<void($1)> $2",
                ↪  null, 0),
126             // Predicate<TArgument> predicate
127             // std::function<bool(TArgument)> predicate
128             (new Regex(@"Predicate<([a-zA-Z0-9]+)> ([a-zA-Z0-9]+)"), "std::function<bool($1)>
                ↪  $2", null, 0),
129             // var
130             // auto
131             (new Regex(@"(\W)var(\W)"), "$1auto$2", null, 0),
132             // unchecked
133             //
134             (new Regex(@"[\r\n]{2}\s*?unchecked\s*?$"), "", null, 0),
135             // throw new InvalidOperationException
136             // throw std::runtime_error
137             (new Regex(@"throw new (InvalidOperationException|Exception)"), "throw
                ↪  std::runtime_error", null, 0),
138             // void RaiseExceptionIgnoredEvent(Exception exception)
139             // void RaiseExceptionIgnoredEvent(const std::exception& exception)
140             (new Regex(@"(\(|, )(System\.Exception|Exception)( |\))"), "$1const
                ↪  std::exception&$3", null, 0),
141             // EventHandler<Exception>
142             // EventHandler<std::exception>
143             (new Regex(@"(\W)(System\.Exception|Exception)(\W)"), "$1std::exception$3", null, 0),
144             // override void PrintNode(TElement node, StringBuilder sb, int level)
145             // void PrintNode(TElement node, StringBuilder sb, int level) override
146             (new Regex(@"override ([a-zA-Z0-9 \*\+]+)(\([^\)\r\n]+?\))"), "$1$2 override", null,
                ↪  0),
147             // return (range.Minimum, range.Maximum)
148             // return {range.Minimum, range.Maximum}
149             (new Regex(@"(?<before>return\s*)\((?<values>[^\)\n]+)\)(?!\()(?<after>\W)"),
                ↪  "${before}{${values}}${after}", null, 0),
```

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150                 // string
151                 // const char*
152                 (new Regex(@"(\W)string(\W)"), "$1const char*$2", null, 0),
153                 // System.ValueTuple
154                 // std::tuple
155                 (new Regex(@"(?<before>\W)(System\.)?ValueTuple(?!\s*=)(?<after>\W)"),
                    ↪  "${before}std::tuple${after}", null, 0),
156                 // sbyte
157                 // std::int8_t
158                 (new Regex(@"(?<before>\W)((System\.)?SB|sb)yte(?!\s*=)(?<after>\W)"),
                    ↪  "${before}std::int8_t${after}", null, 0),
159                 // sbyte.MinValue
160                 // INT8_MIN
161                 (new Regex(@"(?<before>\W)std::int8_t\.MinValue(?<after>\W)"),
                    ↪  "${before}INT8_MIN${after}", null, 0),
162                 // sbyte.MaxValue
163                 // INT8_MAX
164                 (new Regex(@"(?<before>\W)std::int8_t\.MaxValue(?<after>\W)"),
                    ↪  "${before}INT8_MAX${after}", null, 0),
165                 // short
166                 // std::int16_t
167                 (new Regex(@"(?<before>\W)((System\.)?Int16|short)(?!\s*=)(?<after>\W)"),
                    ↪  "${before}std::int16_t${after}", null, 0),
168                 // short.MinValue
169                 // INT16_MIN
170                 (new Regex(@"(?<before>\W)std::int16_t\.MinValue(?<after>\W)"),
                    ↪  "${before}INT16_MIN${after}", null, 0),
171                 // short.MaxValue
172                 // INT16_MAX
173                 (new Regex(@"(?<before>\W)std::int16_t\.MaxValue(?<after>\W)"),
                    ↪  "${before}INT16_MAX${after}", null, 0),
174                 // int
175                 // std::int32_t
176                 (new Regex(@"(?<before>\W)((System\.)?I|i)nt(32)?(?!\s*=)(?<after>\W)"),
                    ↪  "${before}std::int32_t${after}", null, 0),
177                 // int.MinValue
178                 // INT32_MIN
179                 (new Regex(@"(?<before>\W)std::int32_t\.MinValue(?<after>\W)"),
                    ↪  "${before}INT32_MIN${after}", null, 0),
180                 // int.MaxValue
181                 // INT32_MAX
182                 (new Regex(@"(?<before>\W)std::int32_t\.MaxValue(?<after>\W)"),
                    ↪  "${before}INT32_MAX${after}", null, 0),
183                 // long
184                 // std::int64_t
185                 (new Regex(@"(?<before>\W)((System\.)?Int64|long)(?!\s*=)(?<after>\W)"),
                    ↪  "${before}std::int64_t${after}", null, 0),
186                 // long.MinValue
187                 // INT64_MIN
188                 (new Regex(@"(?<before>\W)std::int64_t\.MinValue(?<after>\W)"),
                    ↪  "${before}INT64_MIN${after}", null, 0),
189                 // long.MaxValue
190                 // INT64_MAX
191                 (new Regex(@"(?<before>\W)std::int64_t\.MaxValue(?<after>\W)"),
                    ↪  "${before}INT64_MAX${after}", null, 0),
192                 // byte
193                 // std::uint8_t
194                 (new Regex(@"(?<before>\W)((System\.)?Byte|byte)(?!\s*=)(?<after>\W)"),
                    ↪  "${before}std::uint8_t${after}", null, 0),
195                 // byte.MinValue
196                 // (std::uint8_t)0
197                 (new Regex(@"(?<before>\W)std::uint8_t\.MinValue(?<after>\W)"),
                    ↪  "${before}(std::uint8_t)0${after}", null, 0),
198                 // byte.MaxValue
199                 // UINT8_MAX
200                 (new Regex(@"(?<before>\W)std::uint8_t\.MaxValue(?<after>\W)"),
                    ↪  "${before}UINT8_MAX${after}", null, 0),
201                 // ushort
202                 // std::uint16_t
203                 (new Regex(@"(?<before>\W)((System\.)?UInt16|ushort)(?!\s*=)(?<after>\W)"),
                    ↪  "${before}std::uint16_t${after}", null, 0),
204                 // ushort.MinValue
205                 // (std::uint16_t)0
206                 (new Regex(@"(?<before>\W)std::uint16_t\.MinValue(?<after>\W)"),
                    ↪  "${before}(std::uint16_t)0${after}", null, 0),
207                 // ushort.MaxValue
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            // UINT16_MAX
            (new Regex(@"(?<before>\W)std::uint16_t\.MaxValue(?<after>\W)"),
            ↪  "${before}UINT16_MAX${after}", null, 0),
            // uint
            // std::uint32_t
            (new Regex(@"(?<before>\W)((System\.)?UI|ui)nt(32)?(?!\s*=)(?<after>\W)"),
            ↪  "${before}std::uint32_t${after}", null, 0),
            // uint.MinValue
            // (std::uint32_t)0
            (new Regex(@"(?<before>\W)std::uint32_t\.MinValue(?<after>\W)"),
            ↪  "${before}(std::uint32_t)0${after}", null, 0),
            // uint.MaxValue
            // UINT32_MAX
            (new Regex(@"(?<before>\W)std::uint32_t\.MaxValue(?<after>\W)"),
            ↪  "${before}UINT32_MAX${after}", null, 0),
            // ulong
            // std::uint64_t
            (new Regex(@"(?<before>\W)((System\.)?UInt64|ulong)(?!\s*=)(?<after>\W)"),
            ↪  "${before}std::uint64_t${after}", null, 0),
            // ulong.MinValue
            // (std::uint64_t)0
            (new Regex(@"(?<before>\W)std::uint64_t\.MinValue(?<after>\W)"),
            ↪  "${before}(std::uint64_t)0${after}", null, 0),
            // ulong.MaxValue
            // UINT64_MAX
            (new Regex(@"(?<before>\W)std::uint64_t\.MaxValue(?<after>\W)"),
            ↪  "${before}UINT64_MAX${after}", null, 0),
            // char*[] args
            // char* args[]
            (new Regex(@"([_a-zA-Z0-9:\*]?)\[\] ([a-zA-Z0-9]+)"), "$1 $2[]", null, 0),
            // @object
            // object
            (new Regex(@"@([_a-zA-Z0-9]+)"), "$1", null, 0),
            // using Platform.Numbers;
            //
            (new Regex(@"([\r\n]{2}|^)\s*?using [\.a-zA-Z0-9]+;\s*?$"), "", null, 0),
            // struct TreeElement { }
            // struct TreeElement { };
            (new Regex(@"(struct|class) ([a-zA-Z0-9]+)(\s+){([\sa-zA-Z0-9;:_]+?)}([^;])"), "$1
            ↪  $2$3{$4};$5", null, 0),
            // class Program { }
            // class Program { };
            (new Regex(@"(struct|class) ([a-zA-Z0-9]+[^\r\n]*)([\r\n]+(?<indentLevel>[\t
            ↪  ]*)?)\{([\S\s]+?[\r\n]+\k<indentLevel>)\}([^;]|$)"), "$1 $2$3{$4};$5", null, 0),
            // class SizedBinaryTreeMethodsBase : GenericCollectionMethodsBase
            // class SizedBinaryTreeMethodsBase : public GenericCollectionMethodsBase
            (new Regex(@"class ([a-zA-Z0-9]+) : ([a-zA-Z0-9]+)"), "class $1 : public $2", null,
            ↪  0),
            // class IProperty : ISetter<TValue, TObject>, IProvider<TValue, TObject>
            // class IProperty : public ISetter<TValue, TObject>, IProvider<TValue, TObject>
            (new Regex(@"(?<before>class [a-zA-Z0-9]+ : ((public [a-zA-Z0-9]+(<[a-zA-Z0-9
            ↪  ,]+>)?, )+)?)(?<inheritedType>(?!public)[a-zA-Z0-9]+(<[a-zA-Z0-9
            ↪  ,]+>)?)(?<after>(, [a-zA-Z0-9]+(?!>)|[ \r\n]+))"), "${before}public
            ↪  ${inheritedType}${after}", null, 10),
            // Insert scope borders.
            // ref TElement root
            // ~!root!~ref TElement root
            (new Regex(@"(?<definition>(?<= |\()(ref [a-zA-Z0-9]+|[a-zA-Z0-9]+(?<!ref))
            ↪  (?<variable>[a-zA-Z0-9]+)(?=\)|, | =))"), "~!${variable}!~${definition}", null,
            ↪  0),
            // Inside the scope of ~!root!~ replace:
            // root
            // *root
            (new Regex(@"(?<definition>~!(?<pointer>[a-zA-Z0-9]+)!~ref [a-zA-Z0-9]+
            ↪  \k<pointer>(?=\)|, | =))(?<before>((?<!~!\k<pointer>!~)(.|\n))*?)(?<prefix>(\W
            ↪  |\())\k<pointer>(?<suffix>( |\)|;|,))"),
            ↪  "${definition}${before}${prefix}*${pointer}${suffix}", null, 70),
            // Remove scope borders.
            // ~!root!~
            //
            (new Regex(@"~!(?<pointer>[a-zA-Z0-9]+)!~"), "", null, 5),
            // ref auto root = ref
            // ref auto root =
            (new Regex(@"ref ([a-zA-Z0-9]+) ([a-zA-Z0-9]+) = ref(\W)"), "$1* $2 =$3", null, 0),
            // *root = ref left;
            // root = left;
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266             (new Regex(@"\*([a-zA-Z0-9]+) = ref ([a-zA-Z0-9]+)(\W)"), "$1 = $2$3", null, 0),
267             // (ref left)
268             // (left)
269             (new Regex(@"\(ref ([a-zA-Z0-9]+)(\)|\(|,)"), "($1$2", null, 0),
270             //  ref TElement
271             //  TElement*
272             (new Regex(@"( |\()ref ([a-zA-Z0-9]+) "), "$1$2* ", null, 0),
273             // ref sizeBalancedTree.Root
274             // &sizeBalancedTree->Root
275             (new Regex(@"ref ([a-zA-Z0-9]+)\.([a-zA-Z0-9\*]+)"), "&$1->$2", null, 0),
276             // ref GetElement(node).Right
277             // &GetElement(node)->Right
278             (new Regex(@"ref ([a-zA-Z0-9]+)\(([a-zA-Z0-9\*]+)\)\.([a-zA-Z0-9]+)"),
                ↪  "&$1($2)->$3", null, 0),
279             // GetElement(node).Right
280             // GetElement(node)->Right
281             (new Regex(@"([a-zA-Z0-9]+)\(([a-zA-Z0-9\*]+)\)\.([a-zA-Z0-9]+)"), "$1($2)->$3",
                ↪  null, 0),
282             // [Fact]\npublic: static void SizeBalancedTreeMultipleAttachAndDetachTest()
283             // public: TEST_METHOD(SizeBalancedTreeMultipleAttachAndDetachTest)
284             (new Regex(@"\[Fact\][\s\n]+(public: )?(static )?void ([a-zA-Z0-9]+)\(\)"), "public:
                ↪  TEST_METHOD($3)", null, 0),
285             // class TreesTests
286             // TEST_CLASS(TreesTests)
287             (new Regex(@"class ([a-zA-Z0-9]+)Tests"), "TEST_CLASS($1)", null, 0),
288             // Assert.Equal
289             // Assert::AreEqual
290             (new Regex(@"(Assert)\.Equal"), "$1::AreEqual", null, 0),
291             // Assert.Throws
292             // Assert::ExpectException
293             (new Regex(@"(Assert)\.Throws"), "$1::ExpectException", null, 0),
294             // $"Argument {argumentName} is null."
295             // ((std::string)"Argument ").append(argumentName).append(" is null.").data()
296             (new Regex(@"\$""(?<left>(\\""|[^""\r\n])*){(?<expression>[_a-zA-Z0-9]+)}(?<right>(\
                ↪  \""|[^""\r\n])*)"""),
                ↪  "((std::string)$\"${left}\").append(${expression}).append(\"${right}\").data()",
                ↪  null, 10),
297             // $"
298             // "
299             (new Regex(@"\$"""), "\"", null, 0),
300             // Console.WriteLine("...")
301             // printf("...\n")
302             (new Regex(@"Console\.WriteLine\(""([^""\r\n]+)""\)"), "printf(\"$1\\n\")", null, 0),
303             // TElement Root;
304             // TElement Root = 0;
305             (new Regex(@"(\r?\n[\t ]+)(private|protected|public)?(:
                ↪  )?([a-zA-Z0-9:_]+(?<!return)) ([_a-zA-Z0-9]+);"), "$1$2$3$4 $5 = 0;", null, 0),
306             // TreeElement _elements[N];
307             // TreeElement _elements[N] = { {0} };
308             (new Regex(@"(\r?\n[\t ]+)(private|protected|public)?(: )?([a-zA-Z0-9]+)
                ↪  ([_a-zA-Z0-9]+)\[([_a-zA-Z0-9]+)\];"), "$1$2$3$4 $5[$6] = { {0} };", null, 0),
309             // auto path = new TElement[MaxPath];
310             // TElement path[MaxPath] = { {0} };
311             (new Regex(@"(\r?\n[\t ]+)[a-zA-Z0-9]+ ([a-zA-Z0-9]+) = new
                ↪  ([a-zA-Z0-9]+)\[([_a-zA-Z0-9]+)\];"), "$1$3 $2[$4] = { {0} };", null, 0),
312             // private: static readonly ConcurrentBag<std::exception> _exceptionsBag = new
                ↪  ConcurrentBag<std::exception>();
313             // private: inline static std::mutex _exceptionsBag_mutex; \n\n private: inline
                ↪  static std::vector<std::exception> _exceptionsBag;
314             (new Regex(@"(?<begin>\r?\n?(?<indent>[ \t]+))(?<access>(private|protected|public):
                    )?static readonly ConcurrentBag<(?<argumentType>[^;\r\n]+)>
                ↪  (?<name>[_a-zA-Z0-9]+) = new ConcurrentBag<\k<argumentType>>\(\);"),
                ↪  "${begin}private: inline static std::mutex ${name}_mutex;" + Environment.NewLine
                ↪  + Environment.NewLine + "${indent}${access}inline static
                ↪  std::vector<${argumentType}> ${name};", null, 0),
315             // public: static IReadOnlyCollection<std::exception> GetCollectedExceptions() {
                ↪  return _exceptionsBag; }
316             // public: static std::vector<std::exception> GetCollectedExceptions() { return
                ↪  std::vector<std::exception>(_exceptionsBag); }
317             (new Regex(@"(?<access>(private|protected|public): )?static
                ↪  IReadOnlyCollection<(?<argumentType>[^;\r\n]+)> (?<methodName>[_a-zA-Z0-9]+)\(\)
                ↪  { return (?<fieldName>[_a-zA-Z0-9]+); }"), "${access}static
                ↪  std::vector<${argumentType}> ${methodName}() { return
                ↪  std::vector<${argumentType}>(${fieldName}); }", null, 0),
318             // public: static event EventHandler<std::exception> ExceptionIgnored =
                ↪  OnExceptionIgnored; ... };
```

```
319             // ... public: static inline Platform::Delegates::MulticastDelegate<void(void*,
                ↪  const std::exception&)> ExceptionIgnored = OnExceptionIgnored; };
320             (new Regex(@"(?<begin>\r?\n(\r?\n)?(?<halfIndent>[
                    \t]+)\k<halfIndent>)(?<access>(private|protected|public): )?static event
                ↪  EventHandler<(?<argumentType>[^;\r\n]+)> (?<name>[_a-zA-Z0-9]+) = (?<defaultDele
                ↪  gate>[_a-zA-Z0-9]+);(?<middle>(.|\n)+?)(?<end>\r?\n\k<halfIndent>};)"),
                ↪  "${middle}" + Environment.NewLine + Environment.NewLine +
                ↪  "${halfIndent}${halfIndent}${access}static inline
                ↪  Platform::Delegates::MulticastDelegate<void(void*, const ${argumentType}&)>
                ↪  ${name} = ${defaultDelegate};${end}", null, 0),
321             // Insert scope borders.
322             // class IgnoredExceptions { ... private: inline static std::vector<std::exception>
                ↪  _exceptionsBag;
323             // class IgnoredExceptions {/*~_exceptionsBag~*/ ... private: inline static
                ↪  std::vector<std::exception> _exceptionsBag;
324             (new Regex(@"(?<classDeclarationBegin>\r?\n(?<indent>[\t ]*)class [^{\r\n]+\r\n[\t
                    ]*{)(?<middle>((?!class).|\n)+?)(?<vectorFieldDeclaration>(?<access>(private|pro
                ↪  tected|public): )inline static std::vector<(?<argumentType>[^;\r\n]+)>
                ↪  (?<fieldName>[_a-zA-Z0-9]+);)"),
                ↪  "${classDeclarationBegin}/*~${fieldName}~*/${middle}${vectorFieldDeclaration}",
                ↪  null, 0),
325             // Inside the scope of ~!_exceptionsBag!~ replace:
326             // _exceptionsBag.Add(exception);
327             // _exceptionsBag.push_back(exception);
328             (new Regex(@"(?<scope>/\*~(?<fieldName>[_a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<befor
                ↪  e>((?<!/\*~\k<fieldName>~\*/)(.|\n))*?)\k<fieldName>\.Add"),
                ↪  "${scope}${separator}${before}${fieldName}.push_back", null, 10),
329             // Remove scope borders.
330             // /*~_exceptionsBag~*/
331             //
332             (new Regex(@"/\*~[_a-zA-Z0-9]+~\*/"), "", null, 0),
333             // Insert scope borders.
334             // class IgnoredExceptions { ... private: static std::mutex _exceptionsBag_mutex;
335             // class IgnoredExceptions {/*~_exceptionsBag~*/ ... private: static std::mutex
                ↪  _exceptionsBag_mutex;
336             (new Regex(@"(?<classDeclarationBegin>\r?\n(?<indent>[\t ]*)class [^{\r\n]+\r\n[\t
                ↪  ]*{)(?<middle>((?!class).|\n)+?)(?<mutexDeclaration>private: inline static
                ↪  std::mutex (?<fieldName>[_a-zA-Z0-9]+)_mutex;)"),
                ↪  "${classDeclarationBegin}/*~${fieldName}~*/${middle}${mutexDeclaration}", null,
                ↪  0),
337             // Inside the scope of ~!_exceptionsBag!~ replace:
338             // return std::vector<std::exception>(_exceptionsBag);
339             // std::lock_guard<std::mutex> guard(_exceptionsBag_mutex); return
                ↪  std::vector<std::exception>(_exceptionsBag);
340             (new Regex(@"(?<scope>/\*~(?<fieldName>[_a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<befor
                ↪  e>((?<!/\*~\k<fieldName>~\*/)(.|\n))*?){(?<after>((?!lock_guard)[^{};\r\n])*\k<f
                ↪  ieldName>[^;}\r\n]*;)"), "${scope}${separator}${before}{
                ↪  std::lock_guard<std::mutex> guard(${fieldName}_mutex);${after}", null, 10),
341             // Inside the scope of ~!_exceptionsBag!~ replace:
342             // _exceptionsBag.Add(exception);
343             // std::lock_guard<std::mutex> guard(_exceptionsBag_mutex); \r\n
                ↪  _exceptionsBag.Add(exception);
344             (new Regex(@"(?<scope>/\*~(?<fieldName>[_a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<befor
                    e>((?<!/\*~\k<fieldName>~\*/)(.|\n))*?){(?<after>((?!lock_guard)([^{};]|\n))*?\r
                ↪  ?\n(?<indent>[ \t]*)\k<fieldName>[^;}\r\n]*;)"),
                ↪  "${scope}${separator}${before}{" + Environment.NewLine +
                ↪  "${indent}std::lock_guard<std::mutex> guard(${fieldName}_mutex);${after}", null,
                ↪  10),
345             // Remove scope borders.
346             // /*~_exceptionsBag~*/
347             //
348             (new Regex(@"/\*~[_a-zA-Z0-9]+~\*/"), "", null, 0),
349             // Insert scope borders.
350             // class IgnoredExceptions { ... public: static inline
                ↪  Platform::Delegates::MulticastDelegate<void(void*, const std::exception&)>
                ↪  ExceptionIgnored = OnExceptionIgnored;
351             // class IgnoredExceptions {/*~ExceptionIgnored~*/ ... public: static inline
                ↪  Platform::Delegates::MulticastDelegate<void(void*, const std::exception&)>
                ↪  ExceptionIgnored = OnExceptionIgnored;
352             (new Regex(@"(?<classDeclarationBegin>\r?\n(?<indent>[\t ]*)class [^{\r\n]+\r\n[\t
                    ]*{)(?<middle>((?!class).|\n)+?)(?<eventDeclaration>(?<access>(private|protected
                ↪  |public): )static inline
                ↪  Platform::Delegates::MulticastDelegate<(?<argumentType>[^;\r\n]+)>
                ↪  (?<name>[_a-zA-Z0-9]+) = (?<defaultDelegate>[_a-zA-Z0-9]+);)"),
                ↪  "${classDeclarationBegin}/*~${name}~*/${middle}${eventDeclaration}", null, 0),
353             // Inside the scope of ~!ExceptionIgnored!~ replace:
```

```
354                 // ExceptionIgnored.Invoke(NULL, exception);
355                 // ExceptionIgnored(NULL, exception);
356                 (new Regex(@"(?<scope>/\*~(?<eventName>[a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before
                    ↪  >((?<!/\*~\k<eventName>~\*/)(.|\n))*?)\k<eventName>\.Invoke"),
                    ↪  "${scope}${separator}${before}${eventName}", null, 10),
357                 // Remove scope borders.
358                 // /*~ExceptionIgnored~*/
359                 //
360                 (new Regex(@"/\*~[a-zA-Z0-9]+~\*/"), "", null, 0),
361                 // Insert scope borders.
362                 // auto added = new StringBuilder();
363                 // /*~sb~*/std::string added;
364                 (new Regex(@"(auto|(System\.Text\.)?StringBuilder) (?<variable>[a-zA-Z0-9]+) = new
                    ↪  (System\.Text\.)?StringBuilder\(\);"), "/*~${variable}~*/std::string
                    ↪  ${variable};", null, 0),
365                 // static void Indent(StringBuilder sb, int level)
366                 // static void Indent(/*~sb~*/StringBuilder sb, int level)
367                 (new Regex(@"(?<start>, |\()(System\.Text\.)?StringBuilder
                    ↪  (?<variable>[a-zA-Z0-9]+)(?<end>,|\))"), "${start}/*~${variable}~*/std::string&
                    ↪  ${variable}${end}", null, 0),
368                 // Inside the scope of ~!added!~ replace:
369                 // sb.ToString()
370                 // sb.data()
371                 (new Regex(@"(?<scope>/\*~(?<variable>[a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>
                    ↪  ((?<!/\*~\k<variable>~\*/)(.|\n))*?)\k<variable>\.ToString\(\)"),
                    ↪  "${scope}${separator}${before}${variable}.data()", null, 10),
372                 // sb.AppendLine(argument)
373                 // sb.append(argument).append('\n')
374                 (new Regex(@"(?<scope>/\*~(?<variable>[a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>
                    ↪  ((?<!/\*~\k<variable>~\*/)(.|\n))*?)\k<variable>\.AppendLine\((?<argument>[^\),\
                    ↪  r\n]+)\)"),
                    ↪  "${scope}${separator}${before}${variable}.append(${argument}).append(1, '\\n')",
                    ↪  null, 10),
375                 // sb.Append('\t', level);
376                 // sb.append(level, '\t');
377                 (new Regex(@"(?<scope>/\*~(?<variable>[a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>
                    ↪  ((?<!/\*~\k<variable>~\*/)(.|\n))*?)\k<variable>\.Append\('(?<character>[^'\r\n]
                    ↪  +)', (?<count>[^\),\r\n]+)\)"),
                    ↪  "${scope}${separator}${before}${variable}.append(${count}, '${character}')",
                    ↪  null, 10),
378                 // sb.Append(argument)
379                 // sb.append(argument)
380                 (new Regex(@"(?<scope>/\*~(?<variable>[a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>
                    ↪  ((?<!/\*~\k<variable>~\*/)(.|\n))*?)\k<variable>\.Append\((?<argument>[^\),\r\n]
                    ↪  +)\)"), "${scope}${separator}${before}${variable}.append(${argument})", null,
                    ↪  10),
381                 // Remove scope borders.
382                 // /*~sb~*/
383                 //
384                 (new Regex(@"/\*~[a-zA-Z0-9]+~\*/"), "", null, 0),
385                 // Insert scope borders.
386                 // auto added = new HashSet<TElement>();
387                 // ~!added!~std::unordered_set<TElement> added;
388                 (new Regex(@"auto (?<variable>[a-zA-Z0-9]+) = new
                    ↪  HashSet<(?<element>[a-zA-Z0-9]+)>\(\);"),
                    ↪  "~!${variable}!~std::unordered_set<${element}> ${variable};", null, 0),
389                 // Inside the scope of ~!added!~ replace:
390                 // added.Add(node)
391                 // added.insert(node)
392                 (new Regex(@"(?<scope>~!(?<variable>[a-zA-Z0-9]+)!~)(?<separator>.|\n)(?<before>((?<
                    ↪  !~!\k<variable>!~)(.|\n))*?)\k<variable>\.Add\((?<argument>[a-zA-Z0-9]+)\)"),
                    ↪  "${scope}${separator}${before}${variable}.insert(${argument})", null, 10),
393                 // Inside the scope of ~!added!~ replace:
394                 // added.Remove(node)
395                 // added.erase(node)
396                 (new Regex(@"(?<scope>~!(?<variable>[a-zA-Z0-9]+)!~)(?<separator>.|\n)(?<before>((?<
                    ↪  !~!\k<variable>!~)(.|\n))*?)\k<variable>\.Remove\((?<argument>[a-zA-Z0-9]+)\)"),
                    ↪  "${scope}${separator}${before}${variable}.erase(${argument})", null, 10),
397                 // if (added.insert(node)) {
398                 // if (!added.contains(node)) { added.insert(node);
399                 (new Regex(@"if \((?<variable>[a-zA-Z0-9]+)\.insert\((?<argument>[a-zA-Z0-9]+)\)\)(?
                    ↪  <separator>[\t ]*[\r\n]+)(?<indent>[\t ]*){"), "if
                    ↪  (!${variable}.contains(${argument}))${separator}${indent}{" +
                    ↪  Environment.NewLine + "${indent}    ${variable}.insert(${argument});", null, 0),
400                 // Remove scope borders.
401                 // ~!added!~
```

```
            //
            (new Regex(@"~![a-zA-Z0-9]+!~"), "", null, 5),
            // Insert scope borders.
            // auto random = new System.Random(0);
            // std::srand(0);
            (new Regex(@"[a-zA-Z0-9\.]+ ([a-zA-Z0-9]+) = new
            ↪  (System\.)?Random\(([a-zA-Z0-9]+)\);"), "~!$1!~std::srand($3);", null, 0),
            // Inside the scope of ~!random!~ replace:
            // random.Next(1, N)
            // (std::rand() % N) + 1
            (new Regex(@"(?<scope>~!(?<variable>[a-zA-Z0-9]+)!~)(?<separator>.|\n)(?<before>((?<
            ↪  !~!\k<variable>!~)(.|\n))*?)\k<variable>\.Next\((?<from>[a-zA-Z0-9]+),
            ↪  (?<to>[a-zA-Z0-9]+)\)"), "${scope}${separator}${before}(std::rand() % ${to}) +
            ↪  ${from}", null, 10),
            // Remove scope borders.
            // ~!random!~
            //
            (new Regex(@"~![a-zA-Z0-9]+!~"), "", null, 5),
            // Insert method body scope starts.
            // void PrintNodes(TElement node, StringBuilder sb, int level) {
            // void PrintNodes(TElement node, StringBuilder sb, int level) {/*method-start*/
            (new Regex(@"(?<start>\r?\n[\t ]+)(?<prefix>((private|protected|public): )?(virtual
            ↪  )?[a-zA-Z0-9:_]+
            ↪  )?(?<method>[a-zA-Z][a-zA-Z0-9]*)\((?<arguments>[^\)]*)\)(?<override>(
            ↪  override)?)(?<separator>[ \t\r\n]*)\{(?<end>[^~])"), "${start}${prefix}${method}
            ↪  (${arguments})${override}${separator}{/*method-start*/${end}", null,
            ↪  0),
            // Insert method body scope ends.
            // {/*method-start*/...}
            // {/*method-start*/.../*method-end*/}
            (new Regex(@"\{/\*method-start\*/(?<body>((?<bracket>\{)|(?<-bracket>\})|[^\{\}]*)+)
            ↪  \}"), "{/*method-start*/${body}/*method-end*/}", null,
            ↪  0),
            // Inside method bodies replace:
            // GetFirst(
            // this->GetFirst(
            //(new Regex(@"(?<separator>(\(|, |([\W]) |return ))(?<!(->|\*
            ↪  ))(?<method>(?!sizeof)[a-zA-Z0-9]+)\((?!\) \{)"),
            ↪  "${separator}this->${method}(", null, 1),
            (new Regex(@"(?<scope>/\*method-start\*/)(?<before>((?<!/\*method-end\*/)(.|\n))*?)(
            ↪  ?<separator>[\W](?<!(::|\.|->)))(?<method>(?!sizeof)[a-zA-Z0-9]+)\((?!\)
            ↪  \{)(?<after>(.|\n)*?)(?<scopeEnd>/\*method-end\*/)"),
            ↪  "${scope}${before}${separator}this->${method}(${after}${scopeEnd}", null, 100),
            // Remove scope borders.
            // /*method-start*/
            //
            (new Regex(@"/\*method-(start|end)\*/"), "", null, 0),
            // Insert scope borders.
            // const std::exception& ex
            // const std::exception& ex/*~ex~*/
            (new Regex(@"(?<before>\(| )(?<variableDefinition>(const )?(std::)?exception&?
            ↪  (?<variable>[_a-zA-Z0-9]+))(?<after>\W)"),
            ↪  "${before}${variableDefinition}/*~${variable}~*/${after}", null, 0),
            // Inside the scope of ~!ex!~ replace:
            // ex.Message
            // ex.what()
            (new Regex(@"(?<scope>/\*~(?<variable>[_a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before
            ↪  >((?<!/\*~\k<variable>~\*/)(.|\n))*?)\k<variable>\.Message"),
            ↪  "${scope}${separator}${before}${variable}.what()", null, 10),
            // Remove scope borders.
            // /*~ex~*/
            //
            (new Regex(@"/\*~[_a-zA-Z0-9]+~\*/"), "", null, 0),
            // throw new ArgumentNullException(argumentName, message);
            // throw std::invalid_argument(((std::string)"Argument
            ↪  ").append(argumentName).append(" is null: ").append(message).append("."));
            (new Regex(@"throw new
            ↪  ArgumentNullException\((?<argument>[a-zA-Z]*[Aa]rgument[a-zA-Z]*),
            ↪  (?<message>[a-zA-Z]*[Mm]essage[a-zA-Z]*(\(\))?)\);"), "throw
            ↪  std::invalid_argument(((std::string)\"Argument \").append(${argument}).append(\"
            ↪  is null: \").append(${message}).append(\".\"));", null, 0),
            // throw new ArgumentException(message, argumentName);
            // throw std::invalid_argument(((std::string)"Invalid
            ↪  ").append(argumentName).append(" argument: ").append(message).append("."));
```

```
450             (new Regex(@"throw new
                ↪  ArgumentException\((?<message>[a-zA-Z]*[Mm]essage[a-zA-Z]*(\(\))?),
                ↪  (?<argument>[a-zA-Z]*[Aa]rgument[a-zA-Z]*)\);"), "throw
                ↪  std::invalid_argument(((std::string)\"Invalid \").append(${argument}).append(\"
                ↪  argument: \").append(${message}).append(\".\"));", null, 0),
451             // throw new ArgumentOutOfRangeException(argumentName, argumentValue,
                ↪  messageBuilder());
452             // throw std::invalid_argument(((std::string)"Value
                ↪  [").append(std::to_string(argumentValue)).append("] of argument
                ↪  [").append(argumentName).append("] is out of range:
                ↪  ").append(messageBuilder()).append("."));
453             (new Regex(@"throw new ArgumentOutOfRangeException\((?<argument>[a-zA-Z]*[Aa]rgument
                    [a-zA-Z]*([Nn]ame[a-zA-Z]*)?),
                ↪  (?<argumentValue>[a-zA-Z]*[Aa]rgument[a-zA-Z]*([Vv]alue[a-zA-Z]*)?),
                ↪  (?<message>[a-zA-Z]*[Mm]essage[a-zA-Z]*(\(\))?)\);"), "throw
                ↪  std::invalid_argument(((std::string)\"Value
                ↪  [\").append(std::to_string(${argumentValue})).append(\"] of argument
                ↪  [\").append(${argument}).append(\"] is out of range:
                ↪  \").append(${message}).append(\".\"));", null, 0),
454             // throw new NotSupportedException();
455             // throw std::logic_error("Not supported exception.");
456             (new Regex(@"throw new NotSupportedException\(\);"), "throw std::logic_error(\"Not
                ↪  supported exception.\");", null, 0),
457             // throw new NotImplementedException();
458             // throw std::logic_error("Not implemented exception.");
459             (new Regex(@"throw new NotImplementedException\(\);"), "throw std::logic_error(\"Not
                ↪  implemented exception.\");", null, 0),
460         }.Cast<ISubstitutionRule>().ToList();
461
462         public static readonly IList<ISubstitutionRule> LastStage = new List<SubstitutionRule>
463         {
464             // ICounter<int, int> c1;
465             // ICounter<int, int>* c1;
466             (new Regex(@"(?<abstractType>I[A-Z][a-zA-Z0-9]+(<[^>\r\n]+>)?)
                ↪  (?<variable>[_a-zA-Z0-9]+);"), "${abstractType}* ${variable};", null, 0),
467             // (expression)
468             // expression
469             (new Regex(@"(\(| )\(([a-zA-Z0-9_\*:]+)\)(,| |;|\))"), "$1$2$3", null, 0),
470             // (method(expression))
471             // method(expression)
472             (new Regex(@"(?<firstSeparator>(\(|
                ↪  ))\((?<method>[a-zA-Z0-9_\->\*:]+)\((?<expression>((?<parenthesis>\()|(?<-parent
                ↪  hesis>\))|[a-zA-Z0-9_\->\*:]*)+)(?(parenthesis)(?!))\)\)(?<lastSeparator>(,|
                ↪  |;|\)))"), "${firstSeparator}${method}(${expression})${lastSeparator}", null, 0),
473             // return ref _elements[node];
474             // return &_elements[node];
475             (new Regex(@"return ref ([_a-zA-Z0-9]+)\[([_a-zA-Z0-9\*]+)\];"), "return &$1[$2];",
                ↪  null, 0),
476             // null
477             // nullptr
478             (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)null
                ↪  (?<after>\W)"), "${before}nullptr${after}", null,
                ↪  10),
479             // default
480             // 0
481             (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)defa
                ↪  ult(?<after>\W)"), "${before}0${after}", null,
                ↪  10),
482             // object x
483             // void *x
484             (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)([O|
                ↪  o]bject|System\.Object) (?<after>\w)"), "${before}void *${after}", null,
                ↪  10),
485             // <object>
486             // <void*>
487             (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)(?<!
                ↪  \w )([O|o]bject|System\.Object)(?<after>\W)"), "${before}void*${after}", null,
                ↪  10),
488             // ArgumentNullException
489             // std::invalid_argument
490             (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)(Sys
                ↪  tem\.)?ArgumentNullException(?<after>\W)"),
                ↪  "${before}std::invalid_argument${after}", null, 10),
491             // #region Always
492             //
493             (new Regex(@"(^|\r?\n)[ \t]*\#(region|endregion)[^\r\n]*(\r?\n|$)"), "", null, 0),
```

```
            // //#define ENABLE_TREE_AUTO_DEBUG_AND_VALIDATION
            //
            (new Regex(@"\/\/[ \t]*\#define[ \t]+[_a-zA-Z0-9]+[ \t]*"), "", null, 0),
            // #if USEARRAYPOOL\r\n#endif
            //
            (new Regex(@"#if [a-zA-Z0-9]+\s+#endif"), "", null, 0),
            // [Fact]
            //
            (new Regex(@"(?<firstNewLine>\r?\n|\A)(?<indent>[\t
            ↪  ]+)\[[a-zA-Z0-9]+(\((?<expression>((?<parenthesis>\()|(?<-parenthesis>\))|[^()\r
            ↪  \n]*)+)(?(parenthesis)(?!))\))?\][ \t]*(\r?\n\k<indent>)?"),
            ↪  "${firstNewLine}${indent}", null, 5),
            // \n ... namespace
            // namespace
            (new Regex(@"(\S[\r\n]{1,2})?[\r\n]+namespace"), "$1namespace", null, 0),
            // \n ... class
            // class
            (new Regex(@"(\S[\r\n]{1,2})?[\r\n]+class"), "$1class", null, 0),
        }.Cast<ISubstitutionRule>().ToList();

        public CSharpToCppTransformer(IList<ISubstitutionRule> extraRules) :
        ↪  base(FirstStage.Concat(extraRules).Concat(LastStage).ToList()) { }

        public CSharpToCppTransformer() : base(FirstStage.Concat(LastStage).ToList()) { }
    }
}
```

1.2 ./csharp/Platform.RegularExpressions.Transformer.CSharpToCpp.Tests/CSharpToCppTransformerTests.cs

```
using Xunit;

namespace Platform.RegularExpressions.Transformer.CSharpToCpp.Tests
{
    public class CSharpToCppTransformerTests
    {
        [Fact]
        public void EmptyLineTest()
        {
            // This test can help to test basic problems with regular expressions like incorrect
            ↪  syntax
            var transformer = new CSharpToCppTransformer();
            var actualResult = transformer.Transform("", new Context(null));
            Assert.Equal("", actualResult);
        }

        [Fact]
        public void HelloWorldTest()
        {
            const string helloWorldCode = @"using System;
class Program
{
    public static void Main(string[] args)
    {
        Console.WriteLine(""Hello, world!"");
    }
}";
            const string expectedResult = @"class Program
{
    public: static void Main(const char* args[])
    {
        printf(""Hello, world!\n"");
    }
};";
            var transformer = new CSharpToCppTransformer();
            var actualResult = transformer.Transform(helloWorldCode, new Context(null));
            Assert.Equal(expectedResult, actualResult);
        }
    }
}
```

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