LinksPlatform's Platform.RegularExpressions.Transformer.CSharpToCpp Class Library

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

```csharp
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 : TextTransformer
    {
        public static readonly IList<ISubstitutionRule> FirstStage = new List<SubstitutionRule>
        {
            // // ...
            //
            (new Regex(@"(\r?\n)?[ \t]+//+.+"), "", 0),
            // #pragma warning disable CS1591 // Missing XML comment for publicly visible type or member
            //
            (new Regex(@"^\s*?\#pragma[\sa-zA-Z0-9]+$"), "", 0),
            // {\n\n\n
            // {
            (new Regex(@"{\s+[\r\n]+"), "{" + Environment.NewLine, 0),
            // Platform.Collections.Methods.Lists
            // Platform::Collections::Methods::Lists
            (new Regex(@"(namespace[^\r\n]+?)\.([^\r\n]+?)"), "$1::$2", 20),
            // Insert markers
            // EqualityComparer<T> _equalityComparer = EqualityComparer<T>.Default;
            // EqualityComparer<T> _equalityComparer = EqualityComparer<T>.Default;/*~_comparer~*/
            (new Regex(@"(?<declaration>EqualityComparer<(?<type>[^>\n]+)> (?<comparer>[a-zA-Z0-9_]+) = EqualityComparer<\k<type>>\.Default;)"), "${declaration}/*~${comparer}~*/", 0),
            // /*~_equalityComparer~*/..._equalityComparer.Equals(Minimum, value)
            // /*~_equalityComparer~*/...Minimum == value
            (new Regex(@"(?<before>/\*~(?<comparer>[a-zA-Z0-9_]+)~\*/(.|\n)+\W)\k<comparer>\.Equals\((?<left>[^,\n]+), (?<right>[^)\n]+)\)"), "${before}${left} == ${right}", 50),
            // Remove markers
            // /*~_equalityComparer~*/
            //
            (new Regex(@"\r?\n[^\n]+/\*~[a-zA-Z0-9_]+~\*/\r\n([ \t]*\r\n)?"), Environment.NewLine, 10),
            // Insert markers
            // Comparer<T> _comparer = Comparer<T>.Default;
            // Comparer<T> _comparer = Comparer<T>.Default;/*~_comparer~*/
            (new Regex(@"(?<declaration>Comparer<(?<type>[^>\n]+)> (?<comparer>[a-zA-Z0-9_]+) = Comparer<\k<type>>\.Default;)"), "${declaration}/*~${comparer}~*/", 0),
            // /*~_comparer~*/..._comparer.Compare(Minimum, value) <= 0
            // /*~_comparer~*/...Minimum <= value
            (new Regex(@"(?<before>/\*~(?<comparer>[a-zA-Z0-9_]+)~\*/(.|\n)+\W)\k<comparer>\.Compare\((?<left>[^,\n]+), (?<right>[^)\n]+)\)\s*(?<comparison>[<>=]=?)\s*0(?<after>\D)"), "${before}${left} ${comparison} ${right}${after}", 50),
            // Remove markers
            // private static readonly Comparer<T> _comparer = Comparer<T>.Default;/*~_comparer~*/
            //
            (new Regex(@"\r?\n[^\n]+/\*~[a-zA-Z0-9_]+~\*/\r\n([ \t]*\r\n)?"), Environment.NewLine, 10),
            // 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(?<after>\D)"), "${first} ${comparison} ${second}${after}", 0),
            // out TProduct
            // TProduct
            (new Regex(@"(?<before>(<|, ))(in|out) (?<typeParameter>[a-zA-Z0-9]+)(?<after>(>|,))"), "${before}${typeParameter}${after}", 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}: ${before}", 0),
            // public: static bool CollectExceptions { get; set; }
            // public: inline static bool CollectExceptions;
            (new Regex(@"(?<access>(private|protected|public): )(?<before>(static )?[^\r\n]+ )(?<name>[a-zA-Z0-9]+) {[^;}]*(?<=\W)get;[^;}]*(?<=\W)set;[^;}]*}"), "${access}inline ${before}${name};", 0),
            // public abstract class
            // class
            (new Regex(@"((public|protected|private|internal|abstract|static) )*(?<category>interface|class|struct)"), "${category}", 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{", 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)", 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}>${whitespace}{" + Environment.NewLine + " public:", 0),
            // template <typename TObject, TProperty, TValue>
            // template <typename TObject, typename TProperty, TValue>
            (new Regex(@"(?<before>template <((, )?typename [a-zA-Z0-9]+)+, )(?<typeParameter>[a-zA-Z0-9]+)(?<after>(,|>))"), "${before}typename ${typeParameter}${after}", 10),
            // Insert markers
            // private: static void BuildExceptionString(this StringBuilder sb, Exception exception, int level)
            // /*~extensionMethod~BuildExceptionString~*/private: static void BuildExceptionString(this StringBuilder sb, Exception exception, int level)
            (new Regex(@"private: static [^\r\n]+ (?<name>[a-zA-Z0-9]+)\(this [^\)\r\n]+\)"), "/*~extensionMethod~${name}~*/$0", 0),
            // Move all markers to the beginning of the file.
            (new Regex(@"\A(?<before>[^\r\n]+\r?\n(.|\n)+)(?<marker>/\*~extensionMethod~(?<name>[a-zA-Z0-9]+)~\*/)"), "${marker}${before}", 10),
            // /*~extensionMethod~BuildExceptionString~*/...sb.BuildExceptionString(exception.InnerException, level + 1);
            // /*~extensionMethod~BuildExceptionString~*/...BuildExceptionString(sb, exception.InnerException, level + 1);
            (new Regex(@"(?<before>/\*~extensionMethod~(?<name>[a-zA-Z0-9]+)~\*/(.|\n)+\W)(?<variable>[_a-zA-Z0-9]+)\.\k<name>\("), "${before}${name}(${variable}, ", 50),
            // Remove markers
            // /*~extensionMethod~BuildExceptionString~*/
            //
            (new Regex(@"/\*~extensionMethod~[a-zA-Z0-9]+~\*/"), "", 0),
            // (this
            // (
            (new Regex(@"\(this "), "(", 0),
            // public: static readonly EnsureAlwaysExtensionRoot Always = new EnsureAlwaysExtensionRoot();
            // public:inline static EnsureAlwaysExtensionRoot Always;
            (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} ${name};", 0),
            // public: static readonly string ExceptionContentsSeparator = "---";
            // public: inline static const char* ExceptionContentsSeparator = "---";
            (new Regex(@"(?<access>(private|protected|public): )?(const|static readonly) string (?<name>[a-zA-Z0-9_]+) = ""(?<string>(\""|[^""\r\n])+)"";"), "${access}inline static const char* ${name} = \"${string}\";", 0),
            // private: const int MaxPath = 92;
            // private: inline static const int MaxPath = 92;
            (new Regex(@"(?<access>(private|protected|public): )?(const|static readonly) (?<type>[a-zA-Z0-9]+) (?<name>[_a-zA-Z0-9]+) = (?<value>[^;\r\n]+);"), "${access}inline static const ${type} ${name} = ${value};", 0),
            //  ArgumentNotNull(EnsureAlwaysExtensionRoot root, TArgument argument) where TArgument : class
            //  ArgumentNotNull(EnsureAlwaysExtensionRoot root, TArgument* argument)
            (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}*${after}", 0),
            // protected: abstract TElement GetFirst();
            // protected: virtual TElement GetFirst() = 0;
            (new Regex(@"(?<access>(private|protected|public): )?abstract (?<method>[^;\r\n]+);"), "${access}virtual ${method} = 0;", 0),
            // TElement GetFirst();
            // virtual TElement GetFirst() = 0;
            (new Regex(@"([\r\n]+[ ]+)((?!return)[a-zA-Z0-9]+ [a-zA-Z0-9]+\([^\)\r\n]*\))(;[ ]*[\r\n]+)"), "$1virtual $2 = 0$3", 1),
            // protected: readonly TreeElement[] _elements;
            // protected: TreeElement _elements[N];
            (new Regex(@"(?<access>(private|protected|public): )?readonly (?<type>[a-zA-Z<>0-9]+)([\[\]]+) (?<name>[_a-zA-Z0-9]+);"), "${access}${type} ${name}[N];", 0),
            // protected: readonly TElement Zero;
            // protected: TElement Zero;
            (new Regex(@"(?<access>(private|protected|public): )?readonly (?<type>[a-zA-Z<>0-9]+) (?<name>[_a-zA-Z0-9]+);"), "${access}${type} ${name};", 0),
            // internal
            //
            (new Regex(@"(\W)internal\s+"), "$1", 0),
            // static void NotImplementedException(ThrowExtensionRoot root) => throw new NotImplementedException();
            // static void NotImplementedException(ThrowExtensionRoot root) { return throw new NotImplementedException(); }
            (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; }", 0),
            // SizeBalancedTree(int capacity) => a = b;
            // SizeBalancedTree(int capacity) { a = b; }
            (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; }", 0),
            // int SizeBalancedTree(int capacity) => a;
            // int SizeBalancedTree(int capacity) { return a; }
            (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; }", 0),
            // () => Integer<TElement>.Zero,
            // () { return Integer<TElement>.Zero; },
            (new Regex(@"\(\)\s+=>\s+(?<expression>[^(),;\r\n]+(\(((?<parenthesis>\()|(?<-parenthesis>\))|[^();\r\n]*?)*?\))?[^(),;\r\n]*)(?<after>,|\);)"), "() { return ${expression}; }${after}", 0),
            // => Integer<TElement>.Zero;
            // { return Integer<TElement>.Zero; }
            (new Regex(@"\)\s+=>\s+([^;\r\n]+?);"), ") { return $1; }", 0),
            // () { return avlTree.Count; }
            // [&]()-> auto { return avlTree.Count; }
            (new Regex(@"(?<before>, |\()\(\) { return (?<expression>[^;\r\n]+); }"), "${before}[&]()-> auto { return ${expression}; }", 0),
            // Count => GetSizeOrZero(Root);
            // GetCount() { return GetSizeOrZero(Root); }
            (new Regex(@"(\W)([A-Z][a-zA-Z]+)\s+=>\s+([^;\r\n]+);"), "$1Get$2() { return $3; }", 0),
            // ArgumentInRange(const char* message) { const char* messageBuilder() { return message; }
            // ArgumentInRange(const char* message) { auto messageBuilder = [&]() -> const char* { return message; };
            (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}};", 10),
            // Func<TElement> treeCount
            // std::function<TElement()> treeCount
            (new Regex(@"Func<([a-zA-Z0-9]+)> ([a-zA-Z0-9]+)"), "std::function<$1()> $2", 0),
            // Action<TElement> free
            // std::function<void(TElement)> free
            (new Regex(@"Action<([a-zA-Z0-9]+)> ([a-zA-Z0-9]+)"), "std::function<void($1)> $2", 0),
            // Predicate<TArgument> predicate
            // std::function<bool(TArgument)> predicate
            (new Regex(@"Predicate<([a-zA-Z0-9]+)> ([a-zA-Z0-9]+)"), "std::function<bool($1)> $2", 0),
            // var
            // auto
            (new Regex(@"(\W)var(\W)"), "$1auto$2", 0),
            // unchecked
            //
            (new Regex(@"[\r\n]{2}\s*?unchecked\s*?$"), "", 0),
            // throw new InvalidOperationException
            // throw std::runtime_error
            (new Regex(@"throw new (InvalidOperationException|Exception)"), "throw std::runtime_error", 0),
            // void RaiseExceptionIgnoredEvent(Exception exception)
            // void RaiseExceptionIgnoredEvent(const std::exception& exception)
            (new Regex(@"(\(|, )(System\.Exception|Exception)( |\))"), "$1const std::exception&$3", 0),
            // EventHandler<Exception>
            // EventHandler<std::exception>
            (new Regex(@"(\W)(System\.Exception|Exception)(\W)"), "$1std::exception$3", 0),
            // override void PrintNode(TElement node, StringBuilder sb, int level)
            // void PrintNode(TElement node, StringBuilder sb, int level) override
            (new Regex(@"override ([a-zA-Z0-9 \*\+]+)(\([^\)\r\n]+?\))"), "$1$2 override", 0),
            // return (range.Minimum, range.Maximum)
            // return {range.Minimum, range.Maximum}
            (new Regex(@"(?<before>return\s*)\((?<values>[^\)\n]+)\)(?!\()(?<after>\W)"), "${before}{${values}}${after}", 0),
            // string
            // const char*
            (new Regex(@"(\W)string(\W)"), "$1const char*$2", 0),
            // System.ValueTuple
            // std::tuple
            (new Regex(@"(?<before>\W)(System\.)?ValueTuple(?!\s*=)(?<after>\W)"), "${before}std::tuple${after}", 0),
            // sbyte
            // std::int8_t
            (new Regex(@"(?<before>\W)((System\.)?SB|sb)yte(?!\s*=)(?<after>\W)"), "${before}std::int8_t${after}", 0),
            // short
            // std::int16_t
            (new Regex(@"(?<before>\W)((System\.)?Int16|short)(?!\s*=)(?<after>\W)"), "${before}std::int16_t${after}", 0),
            // int
            // std::int32_t
            (new Regex(@"(?<before>\W)((System\.)?I|i)nt(32)?(?!\s*=)(?<after>\W)"), "${before}std::int32_t${after}", 0),
            // long
            // std::int64_t
            (new Regex(@"(?<before>\W)((System\.)?Int64|long)(?!\s*=)(?<after>\W)"), "${before}std::int64_t${after}", 0),
            // byte
            // std::uint8_t
            (new Regex(@"(?<before>\W)((System\.)?Byte|byte)(?!\s*=)(?<after>\W)"), "${before}std::uint8_t${after}", 0),
            // ushort
            // std::uint16_t
            (new Regex(@"(?<before>\W)((System\.)?UInt16|ushort)(?!\s*=)(?<after>\W)"), "${before}std::uint16_t${after}", 0),
            // uint
            // std::uint32_t
            (new Regex(@"(?<before>\W)((System\.)?UI|ui)nt(32)?(?!\s*=)(?<after>\W)"), "${before}std::uint32_t${after}", 0),
            // ulong
            // std::uint64_t
            (new Regex(@"(?<before>\W)((System\.)?UInt64|ulong)(?!\s*=)(?<after>\W)"), "${before}std::uint64_t${after}", 0),
            // char*[] args
            // char* args[]
            (new Regex(@"([_a-zA-Z0-9:\*]?)\[\] ([a-zA-Z0-9]+)"), "$1 $2[]", 0),
            // @object
            // object
            (new Regex(@"@([_a-zA-Z0-9]+)"), "$1", 0),
            // float.MinValue
            // std::numeric_limits<float>::min()
            (new Regex(@"(?<before>\W)(?<type>std::[a-z0-9_]+|float|double)\.MinValue(?<after>\W)"), "${before}std::numeric_limits<${type}>::min()${after}", 0),
            // double.MaxValue
            // std::numeric_limits<float>::max()
            (new Regex(@"(?<before>\W)(?<type>std::[a-z0-9_]+|float|double)\.MaxValue(?<after>\W)"), "${before}std::numeric_limits<${type}>::max()${after}", 0),
            // using Platform.Numbers;
            //
            (new Regex(@"([\r\n]{2}|^)\s*?using [\.a-zA-Z0-9]+;\s*?$"), "", 0),
            // struct TreeElement { }
            // struct TreeElement { };
            (new Regex(@"(struct|class) ([a-zA-Z0-9]+)(\s+){([\sa-zA-Z0-9;:_]+?)}([^;])"), "$1 $2$3{$4};$5", 0),
            // class Program { }
            // class Program { };
            (new Regex(@"(struct|class) ([a-zA-Z0-9]+[^\r\n]*)([\r\n]+(?<indentLevel>[\t ]*)?)\{([\S\s]+?[\r\n]+\k<indentLevel>)\}([^;]|$)"), "$1 $2$3{$4};$5", 0),
            // class SizedBinaryTreeMethodsBase : GenericCollectionMethodsBase
            // class SizedBinaryTreeMethodsBase : public GenericCollectionMethodsBase
            (new Regex(@"class ([a-zA-Z0-9]+) : ([a-zA-Z0-9]+)"), "class $1 : public $2", 0),
            // class IProperty : ISetter<TValue, TObject>, IProvider<TValue, TObject>
            // class IProperty : public ISetter<TValue, TObject>, IProvider<TValue, TObject>
            (new Regex(@"(?<before>class [a-zA-Z0-9]+ : ((public [a-zA-Z0-9]+(<[a-zA-Z0-9 ,]+>)?, )+)?)(?<inheritedType>(?!public)[a-zA-Z0-9]+(<[a-zA-Z0-9 ,]+>)?)(?<after>(, [a-zA-Z0-9]+(?!>)|[ \r\n]+))"), "${before}public ${inheritedType}${after}", 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}", 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}", 70),
            // Remove scope borders.
            // ~!root!~
            //
            (new Regex(@"~!(?<pointer>[a-zA-Z0-9]+)!~"), "", 5),
            // ref auto root = ref
            // ref auto root =
            (new Regex(@"ref ([a-zA-Z0-9]+) ([a-zA-Z0-9]+) = ref(\W)"), "$1* $2 =$3", 0),
            // *root = ref left;
            // root = left;
            (new Regex(@"\*([a-zA-Z0-9]+) = ref ([a-zA-Z0-9]+)(\W)"), "$1 = $2$3", 0),
            // (ref left)
            // (left)
            (new Regex(@"\(ref ([a-zA-Z0-9]+)(\)|\(|,)"), "($1$2", 0),
            //  ref TElement
            //  TElement*
            (new Regex(@"( |\()ref ([a-zA-Z0-9]+) "), "$1$2* ", 0),
            // ref sizeBalancedTree.Root
            // &sizeBalancedTree->Root
            (new Regex(@"ref ([a-zA-Z0-9]+)\.([a-zA-Z0-9\*]+)"), "&$1->$2", 0),
            // ref GetElement(node).Right
            // &GetElement(node)->Right
            (new Regex(@"ref ([a-zA-Z0-9]+)\(([a-zA-Z0-9\*]+)\)\.([a-zA-Z0-9]+)"), "&$1($2)->$3", 0),
            // GetElement(node).Right
            // GetElement(node)->Right
            (new Regex(@"([a-zA-Z0-9]+)\(([a-zA-Z0-9\*]+)\)\.([a-zA-Z0-9]+)"), "$1($2)->$3", 0),
            // [Fact]\npublic: static void SizeBalancedTreeMultipleAttachAndDetachTest()
            // public: TEST_METHOD(SizeBalancedTreeMultipleAttachAndDetachTest)
            (new Regex(@"\[Fact\][\s\n]+(public: )?(static )?void ([a-zA-Z0-9]+)\(\)"), "public: TEST_METHOD($3)", 0),
            // class TreesTests
            // TEST_CLASS(TreesTests)
            (new Regex(@"class ([a-zA-Z0-9]+)Tests"), "TEST_CLASS($1)", 0),
            // Assert.Equal
            // Assert::AreEqual
            (new Regex(@"(Assert)\.Equal"), "$1::AreEqual", 0),
            // Assert.Throws
            // Assert::ExpectException
            (new Regex(@"(Assert)\.Throws"), "$1::ExpectException", 0),
            // $"Argument {argumentName} is null."
            // ((std::string)"Argument ").append(argumentName).append(" is null.").data()
            (new Regex(@"\$""(?<left>(\\""|[^""\r\n])*){(?<expression>[_a-zA-Z0-9]+)}(?<right>(\\""|[^""\r\n])*)"""), "((std::string)$\"${left}\").append(${expression}).append(\"${right}\").data()", 10),
            // $"
            // "
            (new Regex(@"\$"""), "\"", 0),
            // Console.WriteLine("...")
            // printf("...\n")
            (new Regex(@"Console\.WriteLine\(""([^""\r\n]+)""\)"), "printf(\"$1\\n\")", 0),
            // TElement Root;
            // TElement Root = 0;
            (new Regex(@"(\r?\n[\t ]+)(private|protected|public)?(: )?([a-zA-Z0-9:_]+(?<!return)) ([_a-zA-Z0-9]+);"), "$1$2$3$4 $5 = 0;", 0),
            // TreeElement _elements[N];
            // TreeElement _elements[N] = { {0} };
            (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} };", 0),
            // auto path = new TElement[MaxPath];
            // TElement path[MaxPath] = { {0} };
            (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} };", 0),
            // private: static readonly ConcurrentBag<std::exception> _exceptionsBag = new ConcurrentBag<std::exception>();
            // private: inline static std::mutex _exceptionsBag_mutex; \n\n private: inline static std::vector<std::exception> _exceptionsBag;
            (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};", 0),
            // public: static IReadOnlyCollection<std::exception> GetCollectedExceptions() { return _exceptionsBag; }
            // public: static std::vector<std::exception> GetCollectedExceptions() { return std::vector<std::exception>(_exceptionsBag); }
            (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}>(${fieldName}); }", 0),
            // public: static event EventHandler<std::exception> ExceptionIgnored = OnExceptionIgnored; ... };
            // ... public: static inline Platform::Delegates::MulticastDelegate<void(void*, const std::exception&)> ExceptionIgnored = OnExceptionIgnored; };
            (new Regex(@"(?<begin>\r?\n(\r?\n)?(?<halfIndent>[ \t]+)\k<halfIndent>)(?<access>(private|protected|public): )?static event EventHandler<(?<argumentType>[^;\r\n]+)> (?<name>[_a-zA-Z0-9]+) = (?<defaultDelegate>[_a-zA-Z0-9]+);(?<middle>(.|\n)+?)(?<end>\r?\n\k<halfIndent>};)"), "${middle}" + Environment.NewLine + Environment.NewLine + "${halfIndent}${halfIndent}${access}static inline Platform::Delegates::MulticastDelegate<void(void*, const ${argumentType}&)> ${name} = ${defaultDelegate};${end}", 0),
            // Insert scope borders.
            // class IgnoredExceptions { ... private: inline static std::vector<std::exception> _exceptionsBag;
            // class IgnoredExceptions {/*~_exceptionsBag~*/ ... private: inline static std::vector<std::exception> _exceptionsBag;
            (new Regex(@"(?<classDeclarationBegin>\r?\n(?<indent>[\t ]*)class [^{\r\n]+\r\n[\t ]*{)(?<middle>((?!class).|\n)+?)(?<vectorFieldDeclaration>(?<access>(private|protected|public): )inline static std::vector<(?<argumentType>[^;\r\n]+)> (?<fieldName>[_a-zA-Z0-9]+);)"), "${classDeclarationBegin}/*~${fieldName}~*/${middle}${vectorFieldDeclaration}", 0),
            // Inside the scope of ~!_exceptionsBag!~ replace:
            // _exceptionsBag.Add(exception);
            // _exceptionsBag.push_back(exception);
            (new Regex(@"(?<scope>/\*~(?<fieldName>[_a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>((?<!/\*~\k<fieldName>~\*/)(.|\n))*?)\k<fieldName>\.Add"), "${scope}${separator}${before}${fieldName}.push_back", 10),
            // Remove scope borders.
            // /*~_exceptionsBag~*/
            //
            (new Regex(@"/\*~[_a-zA-Z0-9]+~\*/"), "", 0),
            // Insert scope borders.
            // class IgnoredExceptions { ... private: static std::mutex _exceptionsBag_mutex;
            // class IgnoredExceptions {/*~_exceptionsBag~*/ ... private: static std::mutex _exceptionsBag_mutex;
            (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}", 0),
            // Inside the scope of ~!_exceptionsBag!~ replace:
            // return std::vector<std::exception>(_exceptionsBag);
            // std::lock_guard<std::mutex> guard(_exceptionsBag_mutex); return std::vector<std::exception>(_exceptionsBag);
            (new Regex(@"(?<scope>/\*~(?<fieldName>[_a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>((?<!/\*~\k<fieldName>~\*/)(.|\n))*?){(?<after>((?!lock_guard)[^{};\r\n])*\k<fieldName>[^;}\r\n]*;)"), "${scope}${separator}${before}{ std::lock_guard<std::mutex> guard(${fieldName}_mutex);${after}", 10),
            // Inside the scope of ~!_exceptionsBag!~ replace:
            // _exceptionsBag.Add(exception);
            // std::lock_guard<std::mutex> guard(_exceptionsBag_mutex); \r\n _exceptionsBag.Add(exception);
            (new Regex(@"(?<scope>/\*~(?<fieldName>[_a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>((?<!/\*~\k<fieldName>~\*/)(.|\n))*?){(?<after>((?!lock_guard)([^{};]|\n))*?\r?\n(?<indent>[ \t]*)\k<fieldName>[^;}\r\n]*;)"), "${scope}${separator}${before}{" + Environment.NewLine + "${indent}std::lock_guard<std::mutex> guard(${fieldName}_mutex);${after}", 10),
            // Remove scope borders.
            // /*~_exceptionsBag~*/
            //
            (new Regex(@"/\*~[_a-zA-Z0-9]+~\*/"), "", 0),
            // Insert scope borders.
            // class IgnoredExceptions { ... public: static inline Platform::Delegates::MulticastDelegate<void(void*, const std::exception&)> ExceptionIgnored = OnExceptionIgnored;
            // class IgnoredExceptions {/*~ExceptionIgnored~*/ ... public: static inline Platform::Delegates::MulticastDelegate<void(void*, const std::exception&)> ExceptionIgnored = OnExceptionIgnored;
            (new Regex(@"(?<classDeclarationBegin>\r?\n(?<indent>[\t ]*)class [^{\r\n]+\r\n[\t ]*{)(?<middle>((?!class).|\n)+?)(?<eventDeclaration>(?<access>(private|protected|public): )static inline Platform::Delegates::MulticastDelegate<(?<argumentType>[^;\r\n]+)> (?<name>[_a-zA-Z0-9]+) = (?<defaultDelegate>[_a-zA-Z0-9]+);)"), "${classDeclarationBegin}/*~${name}~*/${middle}${eventDeclaration}", 0),
            // Inside the scope of ~!ExceptionIgnored!~ replace:
            // ExceptionIgnored.Invoke(NULL, exception);
            // ExceptionIgnored(NULL, exception);
            (new Regex(@"(?<scope>/\*~(?<eventName>[a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>((?<!/\*~\k<eventName>~\*/)(.|\n))*?)\k<eventName>\.Invoke"), "${scope}${separator}${before}${eventName}", 10),
            // Remove scope borders.
            // /*~ExceptionIgnored~*/
            //
            (new Regex(@"/\*~[a-zA-Z0-9]+~\*/"), "", 0),
            // Insert scope borders.
            // auto added = new StringBuilder();
            // /*~sb~*/std::string added;
            (new Regex(@"(auto|(System\.Text\.)?StringBuilder) (?<variable>[a-zA-Z0-9]+) = new (System\.Text\.)?StringBuilder\(\);"), "/*~${variable}~*/std::string ${variable};", 0),
            // static void Indent(StringBuilder sb, int level)
            // static void Indent(/*~sb~*/StringBuilder sb, int level)
            (new Regex(@"(?<start>, |\()(System\.Text\.)?StringBuilder (?<variable>[a-zA-Z0-9]+)(?<end>,|\))"), "${start}/*~${variable}~*/std::string& ${variable}${end}", 0),
            // Inside the scope of ~!added!~ replace:
            // sb.ToString()
            // sb.data()
            (new Regex(@"(?<scope>/\*~(?<variable>[a-zA-Z0-9]+)~\*/)(?<separator>.|\n)(?<before>((?<!/\*~\k<variable>~\*/)(.|\n))*?)\k<variable>\.ToString\(\)"), "${scope}${separator}${before}${variable}.data()", 10),
            // sb.AppendLine(argument)
            // sb.append(argument).append('\n')
            (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')", 10),
            // sb.Append('\t', level);
            // sb.append(level, '\t');
            (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}')", 10),
            // sb.Append(argument)
            // sb.append(argument)
            (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})", 10),
            // Remove scope borders.
            // /*~sb~*/
            //
            (new Regex(@"/\*~[a-zA-Z0-9]+~\*/"), "", 0),
            // Insert scope borders.
            // auto added = new HashSet<TElement>();
            // ~!added!~std::unordered_set<TElement> added;
            (new Regex(@"auto (?<variable>[a-zA-Z0-9]+) = new HashSet<(?<element>[a-zA-Z0-9]+)>\(\);"), "~!${variable}!~std::unordered_set<${element}> ${variable};", 0),
            // Inside the scope of ~!added!~ replace:
            // added.Add(node)
            // added.insert(node)
            (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})", 10),
            // Inside the scope of ~!added!~ replace:
            // added.Remove(node)
            // added.erase(node)
            (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})", 10),
            // if (added.insert(node)) {
            // if (!added.contains(node)) { added.insert(node);
            (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});", 0),
            // Remove scope borders.
            // ~!added!~
            //
            (new Regex(@"~![a-zA-Z0-9]+!~"), "", 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);", 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}", 10),
            // Remove scope borders.
            // ~!random!~
            //
            (new Regex(@"~![a-zA-Z0-9]+!~"), "", 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*/${end}", 0),
            // Insert method body scope ends.
            // {/*method-start*/...}
            // {/*method-start*/.../*method-end*/}
            (new Regex(@"\{/\*method-start\*/(?<body>((?<bracket>\{)|(?<-bracket>\})|[^\{\}]*)+)\}"), "{/*method-start*/${body}/*method-end*/}", 0),
            // Inside method bodies replace:
            // GetFirst(
            // this->GetFirst(
            //(new Regex(@"(?<separator>(\(|, |([\W]) |return ))(?<!(->|\* ))(?<method>(?!sizeof)[a-zA-Z0-9]+)\((?!\) \{)"), "${separator}this->${method}(", 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}", 100),
            // Remove scope borders.
            // /*method-start*/
            //
            (new Regex(@"/\*method-(start|end)\*/"), "", 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}", 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()", 10),
            // Remove scope borders.
            // /*~ex~*/
            //
            (new Regex(@"/\*~[_a-zA-Z0-9]+~\*/"), "", 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(\".\"));", 0),
            // throw new ArgumentException(message, argumentName);
            // throw std::invalid_argument(((std::string)"Invalid ").append(argumentName).append(" argument: ").append(message).append("."));
            (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(\".\"));", 0),
            // throw new ArgumentOutOfRangeException(argumentName, argumentValue, messageBuilder());
            // 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("."));
            (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(\".\"));", 0),
            // throw new NotSupportedException();
            // throw std::logic_error("Not supported exception.");
            (new Regex(@"throw new NotSupportedException\(\);"), "throw std::logic_error(\"Not supported exception.\");", 0),
            // throw new NotImplementedException();
            // throw std::logic_error("Not implemented exception.");
            (new Regex(@"throw new NotImplementedException\(\);"), "throw std::logic_error(\"Not implemented exception.\");", 0),
        }.Cast<ISubstitutionRule>().ToList();

        public static readonly IList<ISubstitutionRule> LastStage = new List<SubstitutionRule>
        {
            // ICounter<int, int> c1;
            // ICounter<int, int>* c1;
            (new Regex(@"(?<abstractType>I[A-Z][a-zA-Z0-9]+(<[^>\r\n]+>)?) (?<variable>[_a-zA-Z0-9]+);"), "${abstractType}* ${variable};", 0),
            // (expression)
            // expression
            (new Regex(@"(\(| )\(([a-zA-Z0-9_\*:]+)\)(,| |;|\))"), "$1$2$3", 0),
            // (method(expression))
            // method(expression)
            (new Regex(@"(?<firstSeparator>(\(| ))\((?<method>[a-zA-Z0-9_\->\*:]+)\((?<expression>((?<parenthesis>\()|(?<-parenthesis>\))|[a-zA-Z0-9_\->\*:]*)+)(?(parenthesis)(?!))\)\)(?<lastSeparator>(,| |;|\)))"), "${firstSeparator}${method}(${expression})${lastSeparator}", 0),
            // return ref _elements[node];
            // return &_elements[node];
            (new Regex(@"return ref ([_a-zA-Z0-9]+)\[([_a-zA-Z0-9\*]+)\];"), "return &$1[$2];", 0),
            // null
            // nullptr
            (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)null(?<after>\W)"), "${before}nullptr${after}", 10),
            // default
            // 0
            (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)default(?<after>\W)"), "${before}0${after}", 10),
            // object x
            // void *x
            (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)([O|o]bject|System\.Object) (?<after>\w)"), "${before}void *${after}", 10),
            // <object>
            // <void*>
            (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)(?<!\w )([O|o]bject|System\.Object)(?<after>\W)"), "${before}void*${after}", 10),
            // ArgumentNullException
            // std::invalid_argument
            (new Regex(@"(?<before>\r?\n[^""\r\n]*(""(\\""|[^""\r\n])*""[^""\r\n]*)*)(?<=\W)(System\.)?ArgumentNullException(?<after>\W)"), "${before}std::invalid_argument${after}", 10),
            // #region Always
            //
            (new Regex(@"(^|\r?\n)[ \t]*\#(region|endregion)[^\r\n]*(\r?\n|$)"), "", 0),
            // //#define ENABLE_TREE_AUTO_DEBUG_AND_VALIDATION
            //
            (new Regex(@"\/\/[ \t]*\#define[ \t]+[_a-zA-Z0-9]+[ \t]*"), "", 0),
            // #if USEARRAYPOOL\r\n#endif
            //
            (new Regex(@"#if [a-zA-Z0-9]+\s+#endif"), "", 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}", 5),
            // \n ... namespace
            // namespace
            (new Regex(@"(\S[\r\n]{1,2})?[\r\n]+namespace"), "$1namespace", 0),
            // \n ... class
            // class
            (new Regex(@"(\S[\r\n]{1,2})?[\r\n]+class"), "$1class", 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("");
            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);
            Assert.Equal(expectedResult, actualResult);
        }
    }
}
```

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