Roslyn Analyzers

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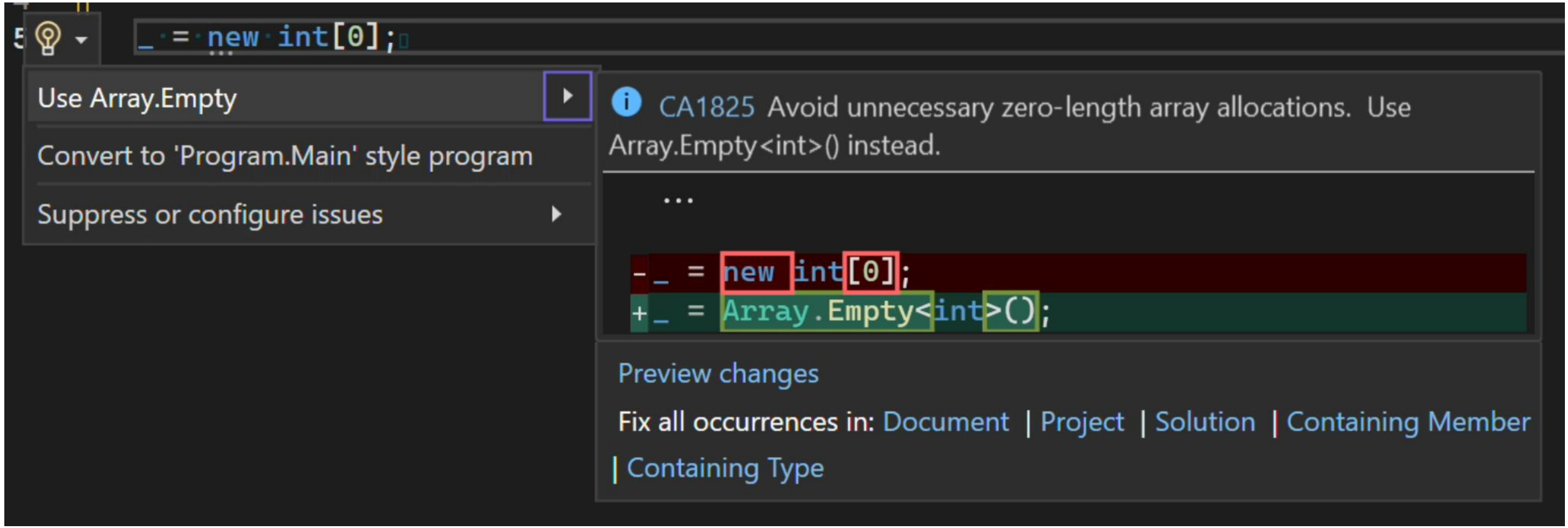
What's a Roslyn Analyzer?



Goals

- Understand what are Roslyn analyzers
- Be able to write your first analyzer

What is Roslyn?

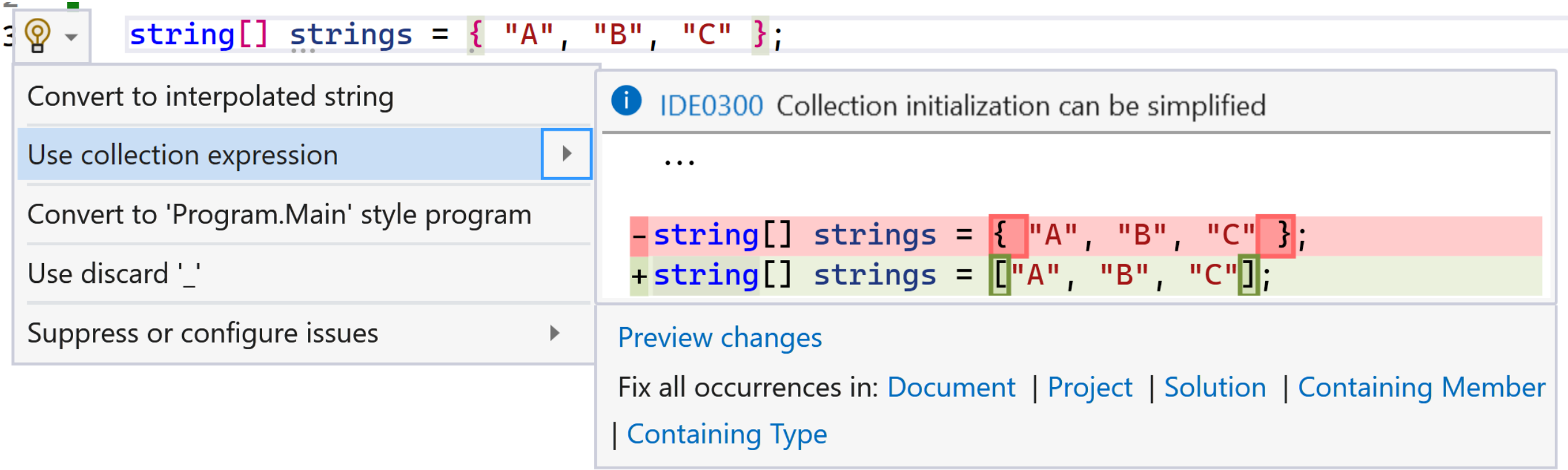
- C# and VB.NET compilers
- First CTP in 2011, first RTM in VS2015
- Provide language services (completion, refactoring, formatter…)
- Enables building code analysis tools
- Open source
  - https://github.com/dotnet/roslyn
  - https://github.com/dotnet/csharplang
  - https://github.com/dotnet/vblang

Roslyn Analyzer

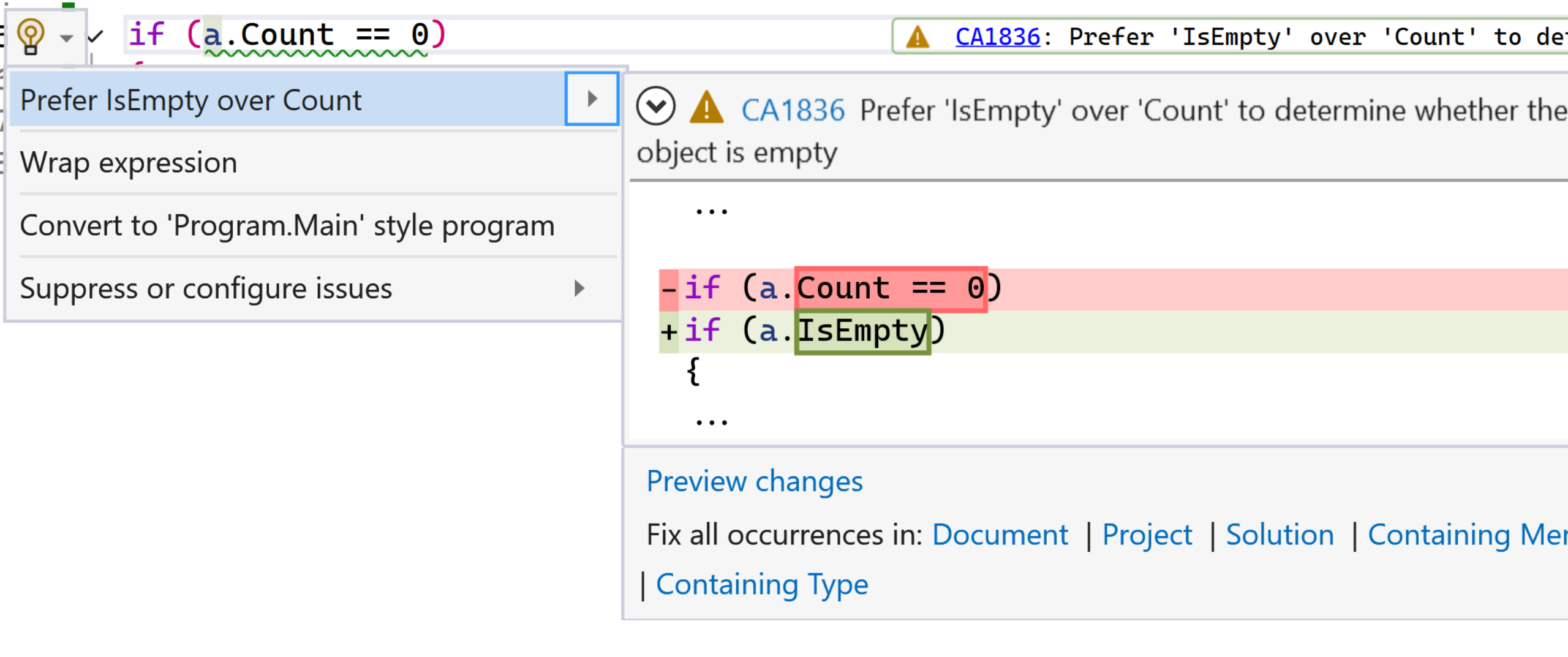
- Static analysis
- Detect patterns in code and optionally suggest fixes
- Can report suggestions, warnings, errors
- Integrated in build process
- Integrated in IDE
  - Detect issues when writing code => save time in code reviews

Examples

New language features



New .NET features



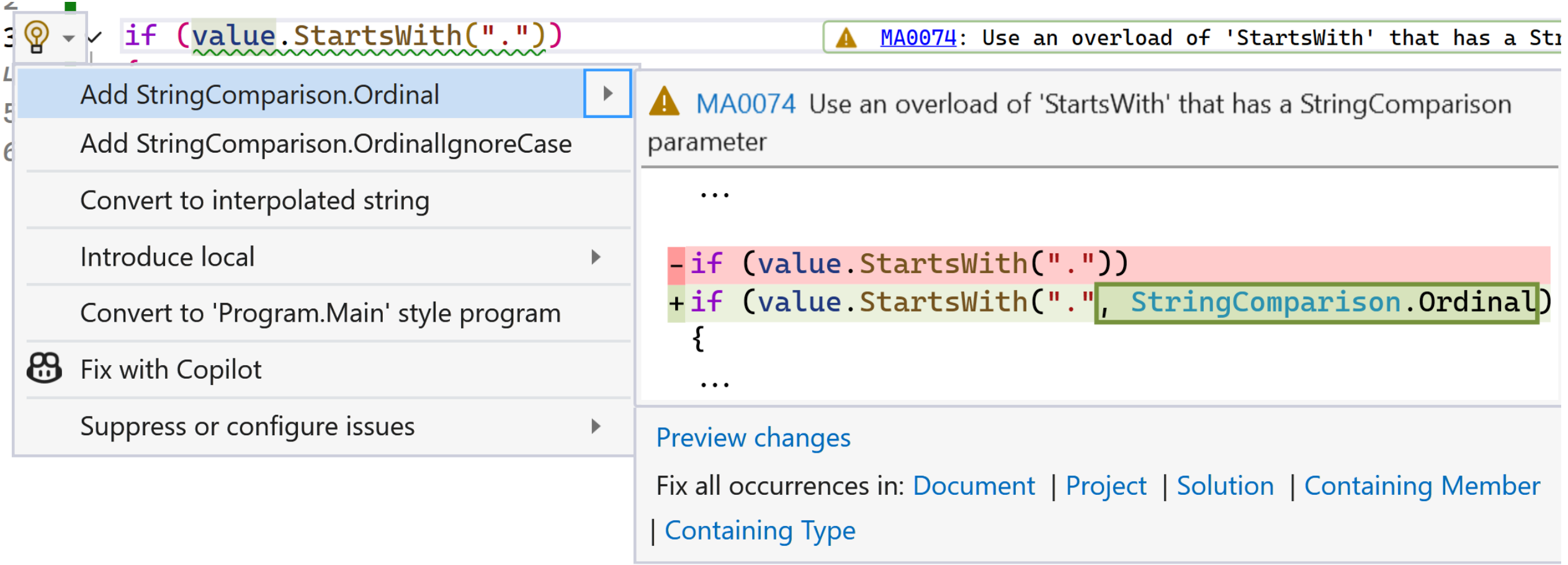
Potential bugs

```
static Task Sample(Func<Task> action)
{
    using var scope = new Scope();
    return action();
}
```

MA0100: Await task before disposing of resources

Show potential fixes (Alt+Enter or Ctrl+.)

Potential bugs



Security

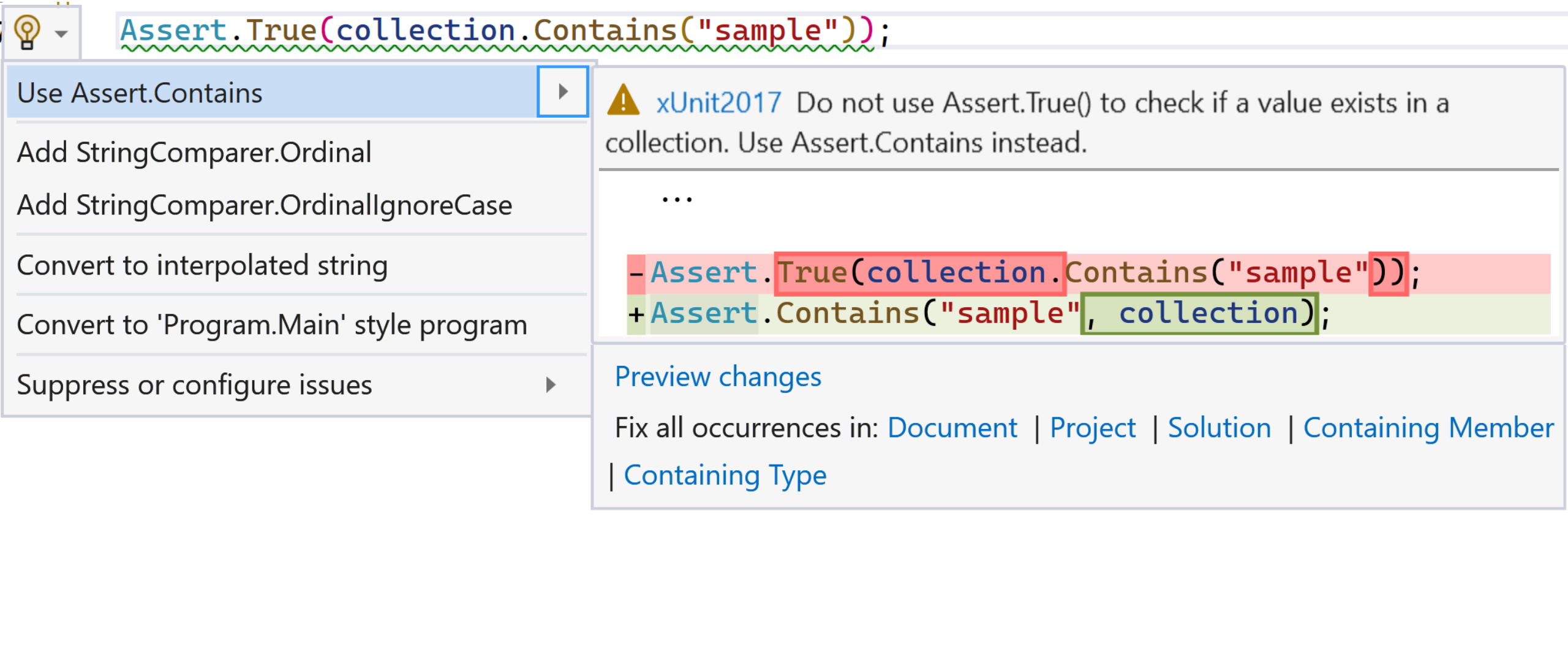
```
ZipArchiveEntry zipArchiveEntry = default!;

zipArchiveEntry.ExtractToFile(zipArchiveEntry.FullName);
```

(local variable) ZipArchiveEntry zipArchiveEntry

'zipArchiveEntry' is not null here.

CA5389: When creating path for 'void ZipFileExtensions.ExtractToFile(ZipArchiveEntry source, string destinationFileName) in method <top-level-statements-entry-point>' from relative archive item path to extract file and the source is an untrusted zip archive, make sure to sanitize relative archive item path 'string ZipArchiveEntry.FullName in method <top-level-statements-entry-point>'

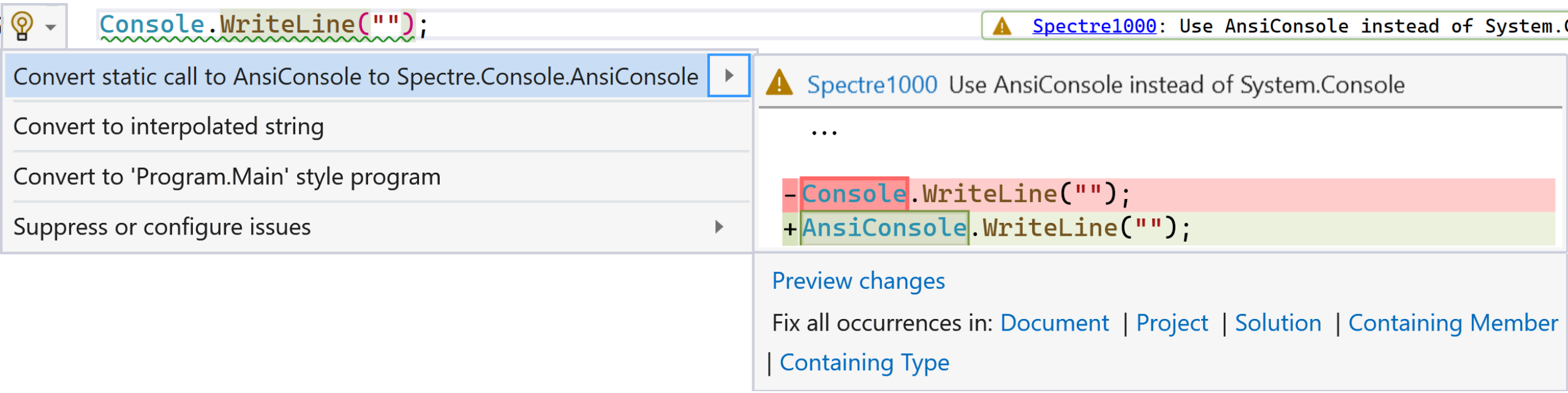
Usage of libraries



Usage of libraries

```
[Theory]
[InlineData("test")]
public void Foo(int value)
{
    Assert.Equal(1, value);
}
```

Usage of libraries



Ban symbols

```
_ = DateTime.Now;
```

readonly struct System.DateTime

Represents an instant in time, typically expressed as a date and time of day.

RS0030: The symbol 'DateTime.Now' is banned in this project: Use System.DateTime.UtcNow instead

Some Roslyn analyzers

- Microsoft.CodeAnalysis.NetAnalyzers
- Microsoft.CodeAnalysis.BannedApiAnalyzers
- xunit.analyzers
- FakeItEasy.Analyzer
- Spectre.Console.Analyzer
- Roslynator.Analyzers
- Meziantou.Analyzer 😉

Roslyn concepts (for analyzers)

Compilation

- All information needed to compile a project
  - Compiler options
  - Source files
  - Referenced assemblies
  - ❌No concept of TFM or NuGet packages
  - ❌*Not aware of other projects in the solution*

- Useful to access available types
  - GetTypeByMetadataName("System.Action`1")
  - GetSpecialType(SpecialType.System_String)

Syntax Tree

- Represent the file parsed by the compiler
- Every bit of information in a code file is represented in the tree
- Syntax tree is immutable
- May represent code that is not valid
  - ⚠️ It's more common than valid code
- Different syntax nodes for C# and VB.NET

Semantic Model

- Allow to get information about nodes in the syntax tree
  - What's the type of a variable?
  - Which method is called?
  - What's the symbol created by a syntax node?
  - Is this value constant?
  - May a value be null? (Nullable Reference Types)
  - Is a type/method/variable accessible from a location?

ISymbol

- Represents a symbol (namespace, class, method, parameter, variable, assembly, etc.) exposed by the compiler
- A symbol can be from your code or references
- Signature only

- To Compare symbols
  - SymbolEqualityComparer.Default
  - SymbolEqualityComparer.IncludeNullability

Operation

- Abstraction from the syntax
- Common types for C# and VB.NET
- Mix of Syntax tree and Semantic model
- Can only represent the method body and attributes

- C# has many ways to do the same thing
  - new int[0]
  - new int[] {}
  - int[] sample = { };
  - const int length = 0; new int[length]

  => IArrayCreationOperation with 1 dimension of constant length 0

DiagnosticDescriptor

```
private static readonly DiagnosticDescriptor Rule = new(
    id: "Sample001",
    title: "Replace new System.EventArgs",
    messageFormat: "Replace new System.EventArgs",
    description: "Replace new System.EventArgs with EventArgs.Empty for better performance"
    category: "Performance",
    defaultSeverity: DiagnosticSeverity.Info,
    isEnabledByDefault: true,
    helpLinkUri: "https://www.meziantou.net/");
```

DiagnosticAnalyzer / CodeFixProvider

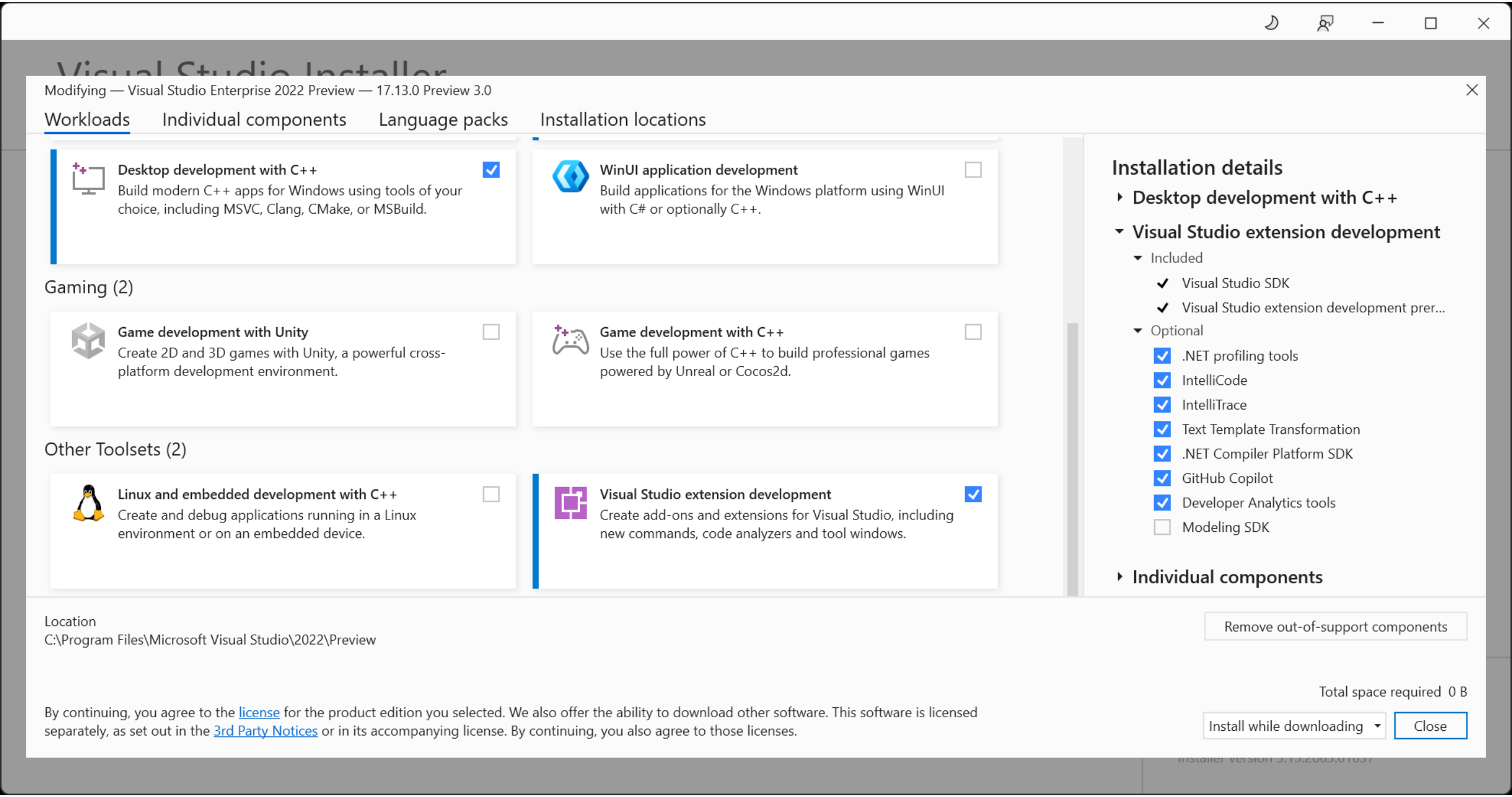
- DiagnosticAnalyzer
  - Register callbacks to indicate Roslyn what to analyze (SyntaxNode, Operation, Symbol)
  - Report diagnostic in the code (Rule descriptor + location)

- CodeFixProvider
  - Indicates which rule ids are supported
  - Transform a solution/document to fix a diagnostic

Let’s create an analyzer

Requirements

- Detect: `new System.EventArgs()`
- Fix: `System.EventArgs.Empty`


Visual Studio Installer
Modifying — Visual Studio Enterprise 2022 Preview — 17.13.0 Preview 3.0
Workloads
Individual components
Language packs
Installation locations
Desktop development with C++
Build modern C++ apps for Windows using tools of your choice, including MSVC, Clang, CMake, or MSBuild.
WinUI application development
Build applications for the Windows platform using WinUI with C# or optionally C++.
Gaming (2)
Game development with Unity
Create 2D and 3D games with Unity, a powerful cross-platform development environment.
Game development with C++
Use the full power of C++ to build professional games powered by Unreal or Cocos2d.
Other Toolsets (2)
Linux and embedded development with C++
Create and debug applications running in a Linux environment or on an embedded device.
Visual Studio extension development
Create add-ons and extensions for Visual Studio, including new commands, code analyzers and tool windows.
Installation details
Desktop development with C++
Visual Studio extension development
Included
Visual Studio SDK
Visual Studio extension development prer...
Optional
.NET profiling tools
IntelliCode
IntelliTrace
Text Template Transformation
.NET Compiler Platform SDK
GitHub Copilot
Developer Analytics tools
Modeling SDK
Individual components
Location
C:\Program Files\Microsoft Visual Studio\2022\Preview
Remove out-of-support components
Total space required 0 B
By continuing, you agree to the license for the product edition you selected. We also offer the ability to download other software. This software is licensed separately, as set out in the 3rd Party Notices or in its accompanying license. By continuing, you also agree to those licenses.
Install while downloading
Close

Create a new project

analyzer

Clear all

All languages | All platforms | All project types

Recent project templates

- Console App — C#
- .NET Aspire Starter App — C#
- xUnit.net v3 Test Project (xUnit.net Team) — C#
- ASP.NET Core Web API — C#
- Worker Service — C#
- Class Library — C#
- Analyzer with Code Fix (.NET Standard) — C#
- MSTest Test Project — C#
- xUnit Test Project — C#
- WPF Application — C#

Analyzer with Code Fix (.NET Standard)

Create a C# analyzer that comes with a code fix and generates diagnostics. The analyzer can be deployed as either a NuGet package or a VSIX extension.

C# | Windows | Linux | macOS | Roslyn | Extensions

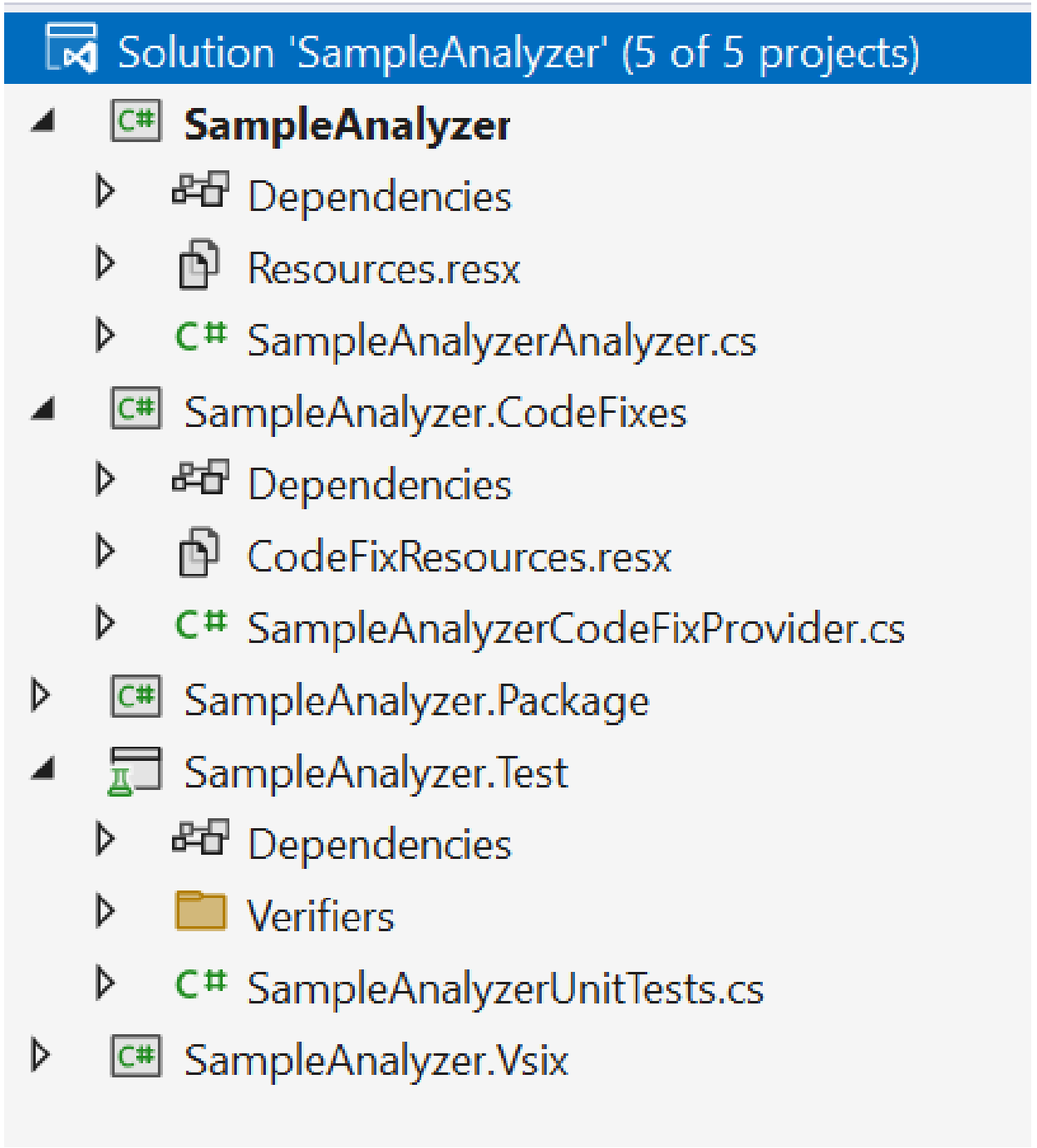
Analyzer with Code Fix (.NET Standard)

Create a Visual Basic analyzer that comes with a code fix and generates diagnostics. The analyzer can be deployed as either a NuGet package or a VSIX extension.

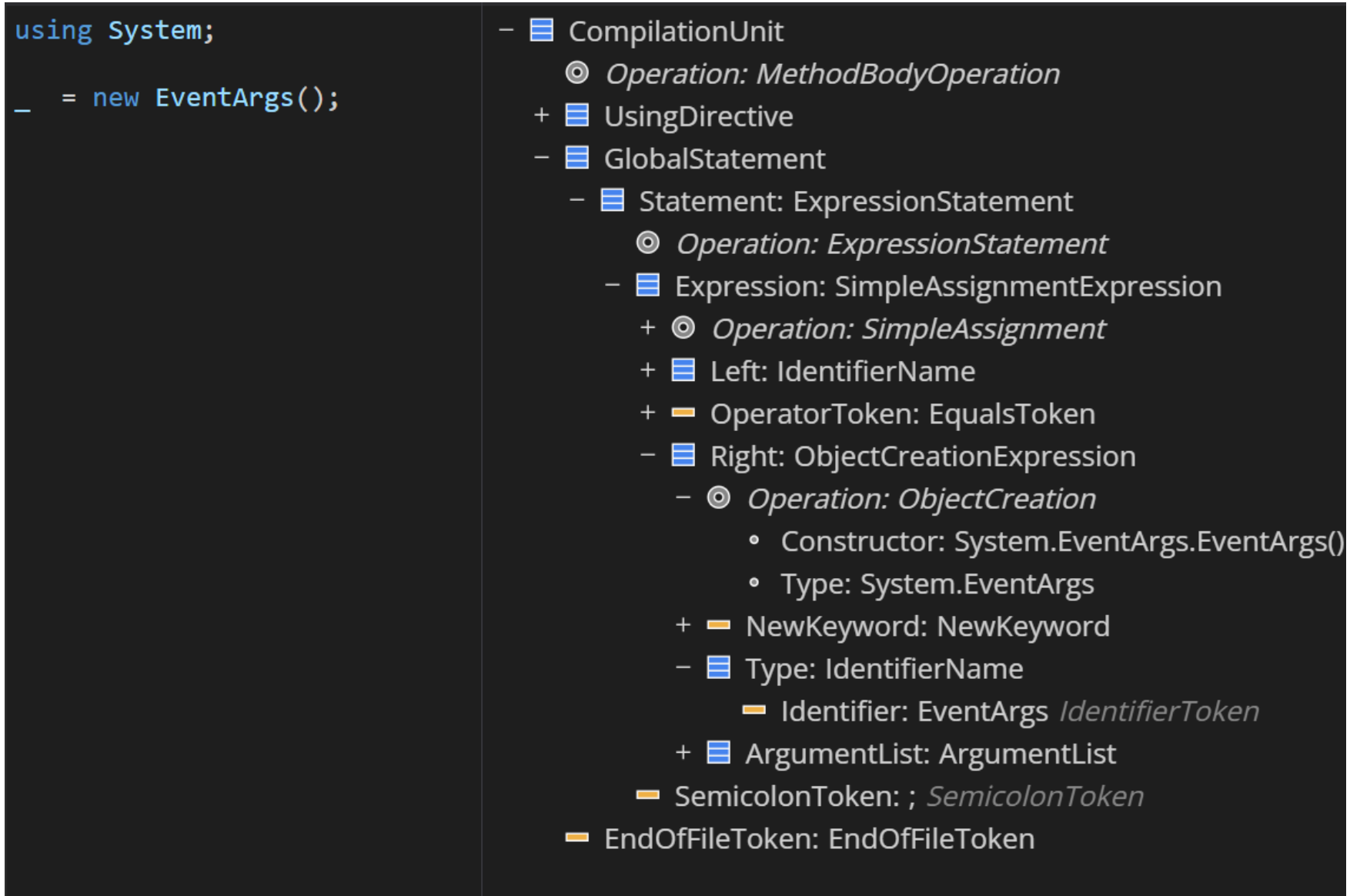
Visual Basic | Windows | Linux | macOS | Roslyn | Extensions

Not finding what you're looking for?
Install more tools and features

Back | Next


Solution 'SampleAnalyzer' (5 of 5 projects)
SampleAnalyzer
Dependencies
Resources.resx
SampleAnalyzerAnalyzer.cs
SampleAnalyzer.CodeFixes
Dependencies
CodeFixResources.resx
SampleAnalyzerCodeFixProvider.cs
SampleAnalyzer.Package
SampleAnalyzer.Test
Dependencies
Verifiers
SampleAnalyzerUnitTests.cs
SampleAnalyzer.Vsix

Sharplab.io

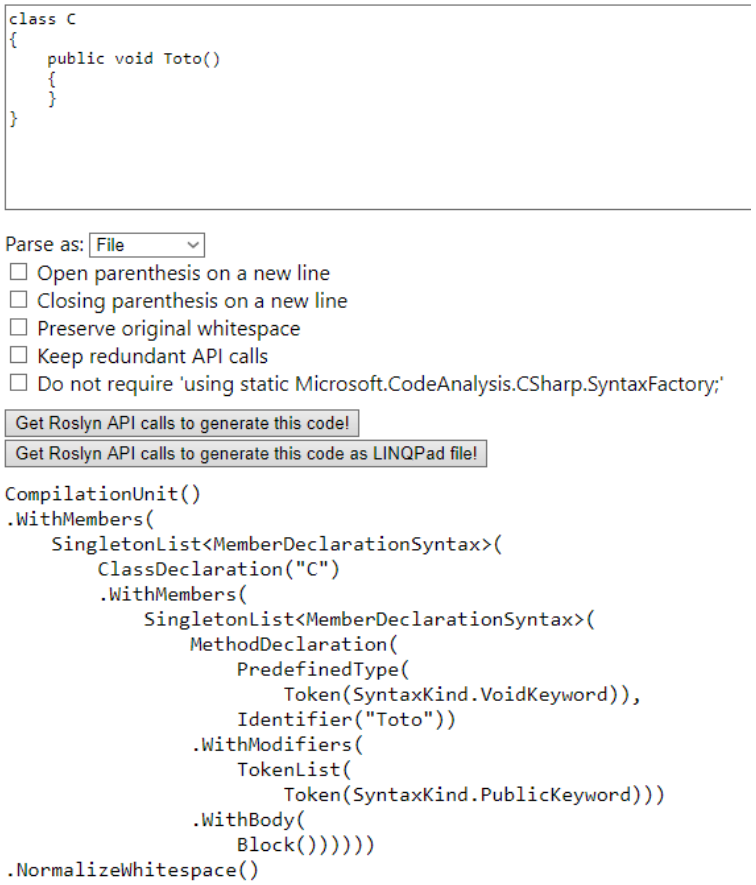

using System;
_ = new EventArgs();
CompilationUnit
Operation: MethodBodyOperation
UsingDirective
GlobalStatement
Statement: ExpressionStatement
Operation: ExpressionStatement
Expression: SimpleAssignmentExpression
Operation: SimpleAssignment
Left: IdentifierName
OperatorToken: EqualsToken
Right: ObjectCreationExpression
Operation: ObjectCreation
Constructor: System.EventArgs.EventArgs()
Type: System.EventArgs
NewKeyword: NewKeyword
Type: IdentifierName
Identifier: EventArgs IdentifierToken
ArgumentList: ArgumentList
SemicolonToken: ; SemicolonToken
EndOfFileToken: EndOfFileToken

```
[DiagnosticAnalyzer(LanguageNames.CSharp)]
public class SampleAnalyzer : DiagnosticAnalyzer
{
    private static readonly DiagnosticDescriptor Rule = new...;

    public override ImmutableArray<DiagnosticDescriptor> SupportedDiagnostics => ImmutableArray.Create(Rule);

    public override void Initialize(AnalysisContext context)
    {
        context.ConfigureGeneratedCodeAnalysis(GeneratedCodeAnalysisFlags.None);
        context.EnableConcurrentExecution();

        context.RegisterOperationAction(AnalyzeObjectCreation, OperationKind.ObjectCreation);

        static void AnalyzeObjectCreation(OperationAnalysisContext context)
        {
            var eventArgsSymbol = context.Compilation.GetTypeByMetadataName("System.EventArgs");
            if (eventArgsSymbol == null)
                return;

            var objectCreation = (IObjectCreationOperation)context.Operation;
            if (objectCreation.Arguments.Length > 0)
                return;

            if (SymbolEqualityComparer.Default.Equals(objectCreation.Type, eventArgsSymbol))
            {
                context.ReportDiagnostic(Diagnostic.Create(Rule, objectCreation.Syntax.GetLocation()));
            }
        }
    }
}
```

```
[ExportCodeFixProvider(LanguageNames.CSharp, Name = nameof(MsDevMtlSampleCodeFixProvider)), Shared]
public class MsDevMtlSampleCodeFixProvider : CodeFixProvider
{
    public sealed override ImmutableArray<string> FixableDiagnosticIds
        => ImmutableArray.Create("Sample001");

    public sealed override async Task RegisterCodeFixesAsync(CodeFixContext context)
    {
        var root = await context.Document.GetSyntaxRootAsync(context.CancellationToken).ConfigureAwait(false);
        var diagnostic = context.Diagnostics.First();
        var diagnosticSpan = diagnostic.Location.SourceSpan;

        var nodeToFix = root.FindNode(diagnosticSpan, getInnermostNodeForTie: true);

        context.RegisterCodeFix(
            CodeAction.Create(
                title: "Replace with EventArgs.Empty",
                createChangedDocument: cancellationToken => Fix(context, nodeToFix, cancellationToken),
                equivalenceKey: "CodeFixTitle"),
            diagnostic);
    }

    private async Task<Document> Fix(CodeFixContext context, SyntaxNode nodeToFix, CancellationToken cancellationToken)
    {
        var editor = await DocumentEditor.CreateAsync(context.Document, cancellationToken).ConfigureAwait(false);
        var generator = editor.Generator;

        var typeSymbol = editor.SemanticModel.Compilation.GetTypeByMetadataName("System.EventArgs");
        if (typeSymbol is null)
            return context.Document;

        var newExpression = generator.MemberAccessExpression(generator.TypeExpression(typeSymbol), "Empty");
        editor.ReplaceNode(nodeToFix, newExpression);
        return editor.GetChangedDocument();
    }
```

Roslyn quoter

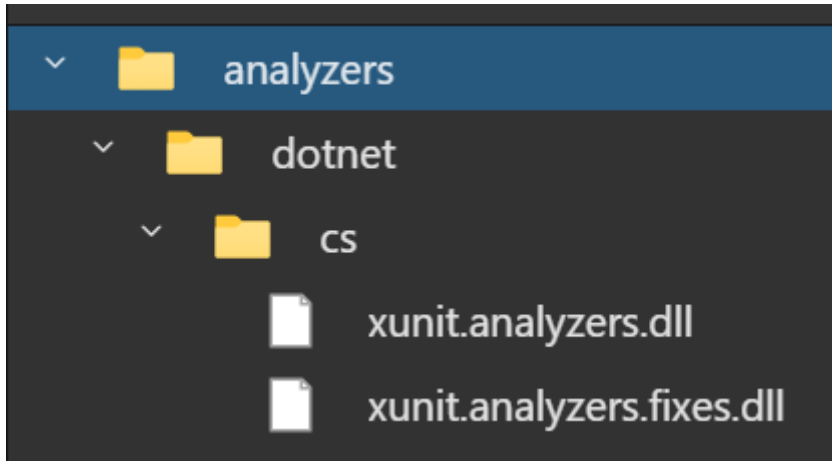
https://github.com/KirillOsenkov/RoslynQuoter



```
[TestMethod]
public async Task TestMethod3()
{
    var test = new CSharpCodeFixTest<MsDevMtlSampleAnalyzer, MsDevMtlSampleCodeFixProvider, DefaultVerifier>();
    test.ReferenceAssemblies = ReferenceAssemblies.NetStandard.NetStandard20;
    test.TestCode = /*lang=c#-test*/ """
        using System;

        class Sample
        {
            void A()
            {
                _ = [|new EventArgs()|];
            }
        }
        """;

    test.FixedCode = /*lang=c#-test*/ """
        using System;

        class Sample
        {
            void A()
            {
                _ = EventArgs.Empty;
            }
        }
        """;

    await test.RunAsync();
}
```

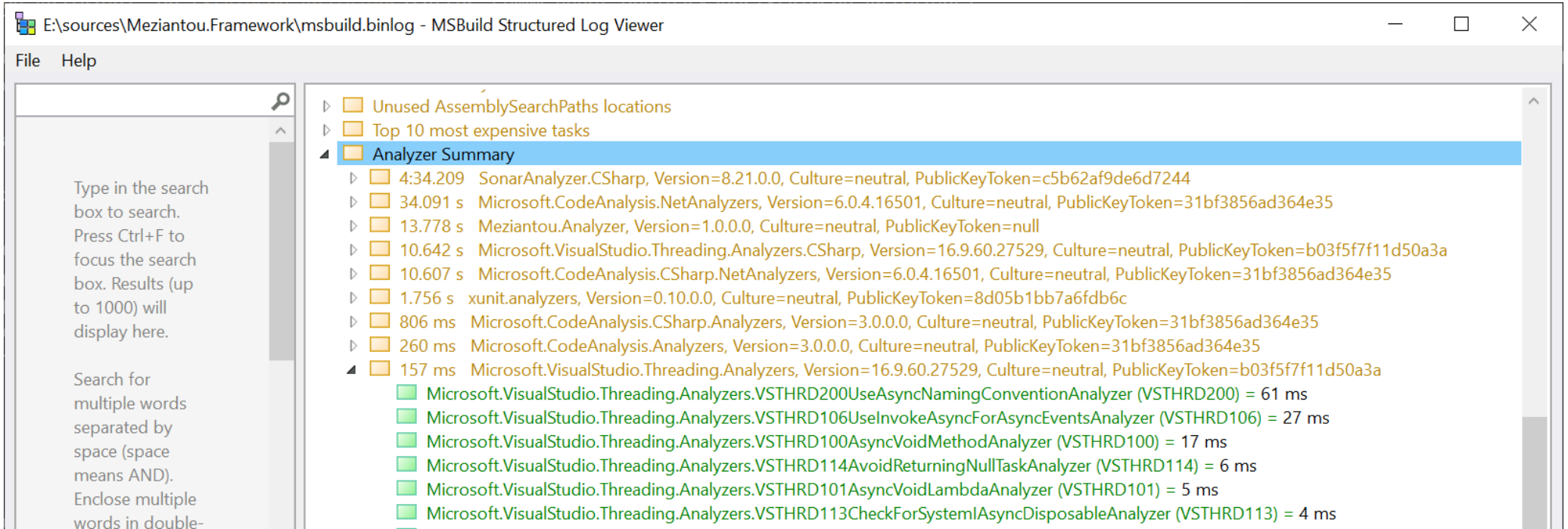
Package a Roslyn analyzer

- DLL must target .NET Standard 2.0
- NuGet package with the following structure



Performance

- Be careful with performance
  - Can increase build time
  - Can slow down IDE
  - `<ReportAnalyzer>true</ReportAnalyzer>` + dotnet build /bl



Roslyn version

- Select the right version of Roslyn
  - 4.12.0 - VS2022 (17.12)
  - 3.11.0 - VS2019 (16.11)
  - See https://learn.microsoft.com/en-us/visualstudio/extensibility/roslyn-version-support

Configuration

[*.cs]

dotnet_diagnostic.Sample0001.severity = error