BASTA!

.NET, WINDOWS, VISUAL STUDIO

Besseres C#

Workshop

BASTA! Spring 2014

Code Contracts

Workshop

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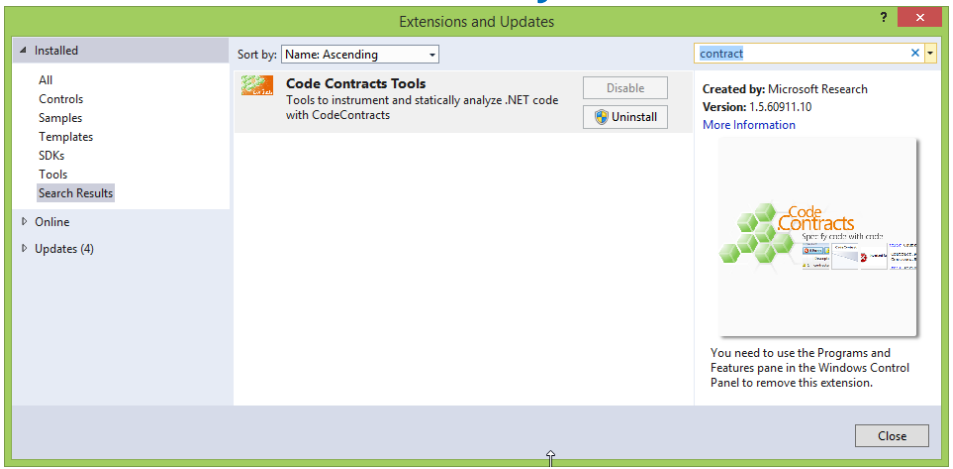
Saves the day.

What are Code Contracts

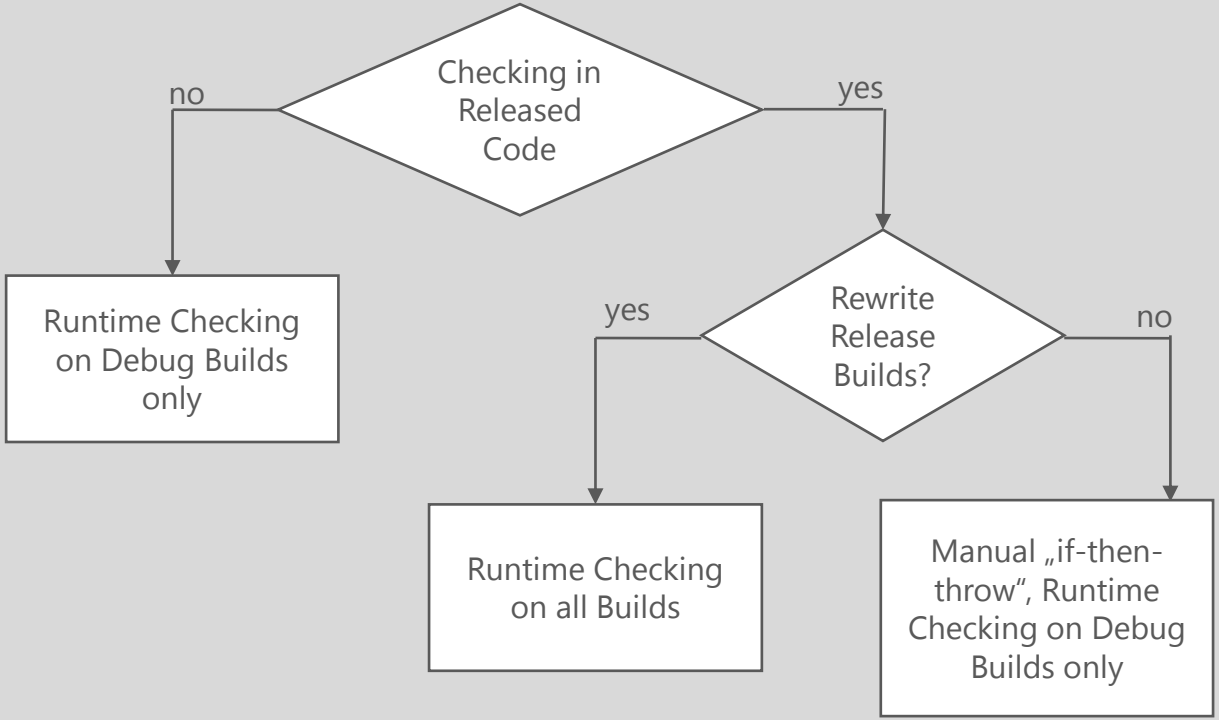
- Conditions
  - Preconditions
  - Postconditions
  - Object invariants
- Runtime Checking
  - Rewrites IL Code
  - Conditional
- Static Code Analysis
- Documentation
  - E.g. with Sandcastle

Code Contracts in .NET and VS

- System.Diagnostics.Contracts namespace
- Visual Studio Gallery



Runtime Checking



```
Contract.Requires(x != null);


// Use the following syntax if you need to throw a specific
// exception. This is only available if you run code contracts
// rewriter on all builds.
Contract.Requires<ArgumentNullException>(x != null, "x");


// „Legacy requires“ – necessary if you want runtime checking
// even on release builds without running code contracts
// rewriter
if ( x == null )
{
  // Single throw statement, nothing else!
  throw new …Exception(…);
}
// No „else“ clause
…
// Necessary after all “legacy requires”
Contract.EndContractBlock();
```

Preconditions

Contract.Requires

Note that members mentioned in preconditions must have proper visibility

- Important so that caller could check precondition prior calling
- See also ContractPublicPropertyName

```
Contract.Ensures(this.X > 0);


// Postcondition in case of an exception
Contract.EnsuresOnThrow<Exception>(this.X == 0);


// Postcondition on result
Contract.Ensures(Contract.Result<int>() > 0);


// Accessing old values in ensures
Contract.Ensures(Contract.OldValue(this.X) < this.X);


// Postcondition on out variables
Contract.Ensures(Contract.ValueAtReturn(out x) > 0);
```

Postconditions

Contract.Ensures

Note that all postconditions for async methods are checked when the method returns the task

Exception: Ensures that contain *Contract.Result<…>().Result*

```
[ContractInvariantMethod]
private void ObjectInvariant()
{
  // Nothing else than calls to Contract.Invariant
  Contract.Invariant(this.x >= 0);
  Contract.Invariant(this.x > this.y);
  ...
}


// Use invariants on automatic properties instead of pre- and
// postconditions
public int X { get; private set; }

[ContractInvariantMethod]
private void ObjectInvariant()
{
  // Will become Contract.Ensures in property getter and
  // Contract.Requires in property setter
  Contract.Invariant(this.X >= 0);
}
```

Invariants

ContractInvariantMethod

Conditions indicating whether an object is in a valid state

Checked at the end of each public method

```
// Checked during runtime and static code analysis
Contract.Assert(this.x > 0);

// Checked during runtime but not proven through static code
// analysis
Contract.Assume(this.x > 0);
```

Assert and *Assume*

```
Contract.Requires(Contract.ForAll(
  listOfValues, // IEnumerable
  value => value > 0));


// Indexed-based syntax
Contract.Ensures(Contract.ForAll(
  0,
  Contract.Result<int[]>().Length,
  index => Contract.Result<int[]>()[index] > 0))
```

Quantifications

Alternatives

Contract.Exists
Enumerable.All
Enumerable.Any

```
static class ContractHelper
{
  // Helper methods for „legacy requires“
  [ContractArgumentValidator]
  public static void NotNull(object arg, string paramName)
  {
    if (arg == null)
    {
      throw new ArgumentNullException(paramName, …);
    }

    Contract.EndContractBlock();
  }
}


ContractHelper.NotNull(x, "x");
```

Contract Helpers

Use *ContractArgumentValidator* for legacy requires

Use *ContractAbbreviator* for set of contracts

Contract Inheritance

- Contracts are inherited
- Preconditions must be defined at the root of the inheritance chain
  Ancestors cannot have weaker or stronger preconditions
- Add stronger postconditions or invariants in ancestor types if needed

Additional Topics

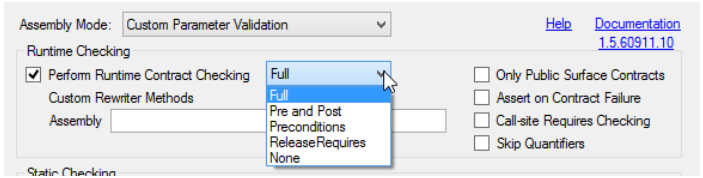
- Contracts for interfaces and abstracts
  See *ContractClass* and *ContractClassFor*
- Use *Pure* attribute to mark side-effect free methods
  Such methods can appear in contracts
- Explicitly control runtime checking and inheritance
  ContractRuntimeIgnored
  ContractOption

Tips, Tricks, and Best Practices

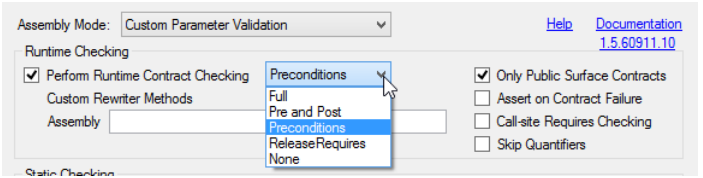
- Do you want to have runtime checking on release builds?
  If yes, decide whether you want to run code contract rewriter on release builds

- Example

Debug



Release



Checking Level	Enabled Runtime Checks						
	Legacy	Requires⟨E⟩	Requires	Ensures	Invariants	Asserts	Assumes
Full	X	X	X	X	X	X	X
Pre and Post	X	X	X	X			
Preconditions	X	X	X				
ReleaseRequires	X	X					
None							

Source: Code Contracts User Docs

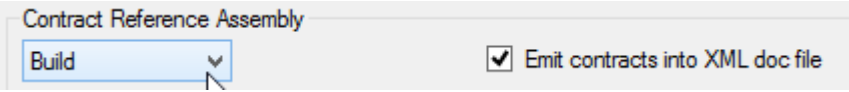
```
[TestClass]
public class InitializeTests
{
  [AssemblyInitialize]
  public static void AssemblyInitialize(TestContext tc)
  {
    Contract.ContractFailed += (sender, e) =>
    {
      e.SetUnwind(); // cause code to abort after event
      Assert.Fail(e.FailureKind.ToString() + ":" + e.Message);
    };
  }
}
```

Tips, Tricks, and Best Practices

- Make sure that contract failures are not hidden with try-catch during unit tests
- Don't write unit tests to intentionally contract failures
  - Exception: Legacy requires

Tips, Tricks, and Best Practices

- If necessary, you can alert other developers to use code contract tools for building
- Code contract tools install handy code snippets
- Deliver a Contract Reference Assembly
  Make contracts available to referencing assemblies



- Add contract information in XML doc file
  Sandcastle understands them

For details see Code Contracts User Docs

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Q&A

Thank your for coming!

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