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Software Design X-Rays

Fix Technical Debt with Behavioral Code Analysis

The Pragmatic Bookshelf

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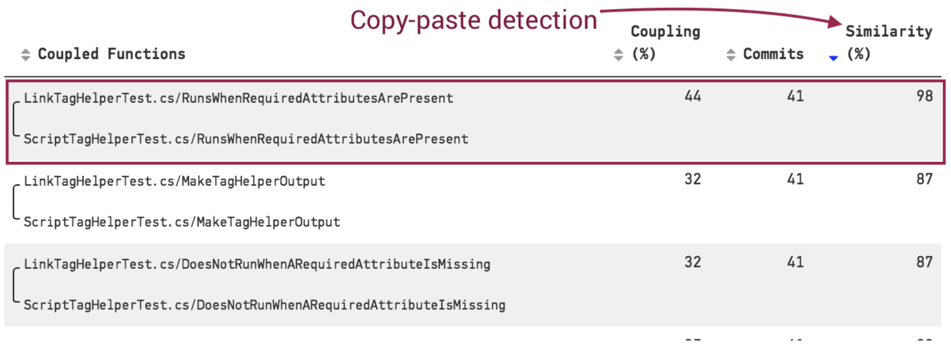
The Dirty Secret of Copy-Paste

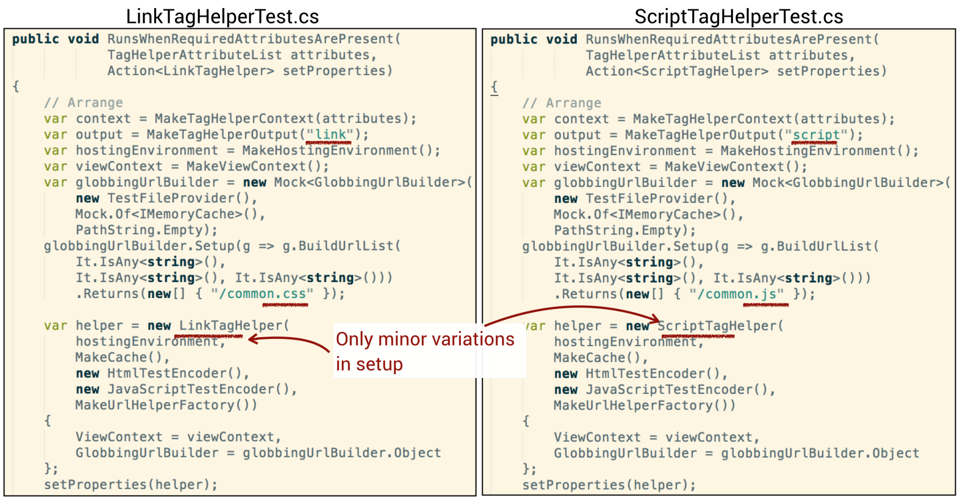
While visualizations are important to get the overall picture, the numbers from an X-Ray analysis often provide more details that help uncover design issues. The next figure shows the detailed results from the X-Rays of LinkTagHelperTest.cs and ScriptTagHelperTest.cs.



Coupled Functions	Coupling (%)	Commits	Similarity (%)
LinkTagHelperTest.cs/RunsWhenRequiredAttributesArePresent ScriptTagHelperTest.cs/RunsWhenRequiredAttributesArePresent	44	41	98
LinkTagHelperTest.cs/MakeTagHelperOutput ScriptTagHelperTest.cs/MakeTagHelperOutput	32	41	87
LinkTagHelperTest.cs/DoesNotRunWhenARequiredAttributeIsMissing ScriptTagHelperTest.cs/DoesNotRunWhenARequiredAttributeIsMissing	32	41	87

The table in the preceding figure presents an interesting finding. We see that several methods have a high degree of *code similarity*. That is, the implementation of several methods is very similar, which is an indication of copied-and-pasted code. For example, the highlighted row shows that there's a code similarity of 98 percent between two methods in different files. The figure on page 6 shows part of the code, and you see that there's a shared test abstraction wanting to get out.

Since these methods are changed together in almost half the commits that touch those files, this is copy-paste that actually matters for your productivity. Let me clarify by revealing a dirty secret about copy-paste.



LinkTagHelperTest.cs

```
public void RunsWhenRequiredAttributesArePresent(
        TagHelperAttributeList attributes,
        Action<LinkTagHelper> setProperties)
{
    // Arrange
    var context = MakeTagHelperContext(attributes);
    var output = MakeTagHelperOutput("link");
    var hostingEnvironment = MakeHostingEnvironment();
    var viewContext = MakeViewContext();
    var globbingUrlBuilder = new Mock<GlobbingUrlBuilder>(
        new TestFileProvider(),
        Mock.Of<IMemoryCache>(),
        PathString.Empty);
    globbingUrlBuilder.Setup(g => g.BuildUrlList(
        It.IsAny<string>(),
        It.IsAny<string>(), It.IsAny<string>()))
        .Returns(new[] { "/common.css" });

    var helper = new LinkTagHelper(
        hostingEnvironment,
        MakeCache(),
        new HtmlTestEncoder(),
        new JavaScriptTestEncoder(),
        MakeUrlHelperFactory())
    {
        ViewContext = viewContext,
        GlobbingUrlBuilder = globbingUrlBuilder.Object
    };
    setProperties(helper);
```

ScriptTagHelperTest.cs

```
public void RunsWhenRequiredAttributesArePresent(
        TagHelperAttributeList attributes,
        Action<ScriptTagHelper> setProperties)
{
    // Arrange
    var context = MakeTagHelperContext(attributes);
    var output = MakeTagHelperOutput("script");
    var hostingEnvironment = MakeHostingEnvironment();
    var viewContext = MakeViewContext();
    var globbingUrlBuilder = new Mock<GlobbingUrlBuilder>(
        new TestFileProvider(),
        Mock.Of<IMemoryCache>(),
        PathString.Empty);
    globbingUrlBuilder.Setup(g => g.BuildUrlList(
        It.IsAny<string>(),
        It.IsAny<string>(), It.IsAny<string>()))
        .Returns(new[] { "/common.js" });

    var helper = new ScriptTagHelper(
        hostingEnvironment,
        MakeCache(),
        new HtmlTestEncoder(),
        new JavaScriptTestEncoder(),
        MakeUrlHelperFactory())
    {
        ViewContext = viewContext,
        GlobbingUrlBuilder = globbingUrlBuilder.Object
    };
    setProperties(helper);
```

Clone Detection 101

Copy-paste detectors are underused in our industry despite the obvious risks and costs associated with software clones. The pioneering work in this field was done by Brenda Baker in her seminal paper *On Finding Duplication and Near-Duplication in Large Software Systems [Bak95]*. There are several clone-detection algorithms to chose from, all with different trade-offs. The simplest algorithms look for common text patterns in the code. More elaborate clone detectors compare the *abstract syntax trees* to detect structural similarities and yield better precision.[5]

These algorithms are implemented by several open and commercial clone detectors. For example, I use *Clone Digger* for Java and Python,[6] and *Simian* for .NET code.[7] It's also an interesting learning experience to implement a simple clone detector yourself. The *Rabin–Karp algorithm* is a good starting point (see *Efficient randomized pattern-matching algorithms [KR87]*).

In the previous chapter we saw that low-quality code isn't necessarily a problem. Now we'll challenge another wide-spread belief by asserting that copy-paste code isn't always bad.

5. https://en.wikipedia.org/wiki/Abstract_syntax_tree
6. http://clonedigger.sourceforge.net/
7. http://www.harukizaemon.com/simian/

Like everything else, the relative merits of a coding strategy depend on context. Copy-paste isn't a problem in itself; copying and pasting may well be the right thing to do if the two chunks of code evolve in different directions. If they don't—that is, if we keep making the same changes to different parts of the program—that's when we get a problem.

This is important since research on the topic estimates that in your typical codebase, 5–20 percent of all code is duplicated to some degree. (See *On Finding Duplication and Near-Duplication in Large Software Systems [Bak95]* and *Experiment on the Automatic Detection of Function Clones in a Software System Using Metrics [MLM96]* for studies of commercial software systems.) That's a lot of code. We can't inspect and improve all of it, nor should we. Just as with hotspots, we need to prioritize the software clones we want to get rid of. The change coupling analysis combined with a code-similarity metric is a simple and reliable way to identify the software clones that really matter for your productivity and code quality. Again, note that this is information you cannot get from the code alone; we need a temporal perspective to prioritize the severity of software clones.

Once we've identified the software clones that matter, we want to refactor them. We typically approach that refactoring by extracting the repeated pattern into a new method and parameterizing it with the concept that varies. This makes the code a little bit cheaper to maintain as our temporal dependency disappears. We also get less code, and that's good because all code carries a cost. It's a *liability*.[8] The more code we can remove while still getting the job done, the better. Killing software clones is a good starting point here.

8. https://blogs.msdn.microsoft.com/elee/2009/03/11/source-code-is-a-liability-not-an-asset/