[Quick note] How to build CodeQL DB with closed-source project(.NET Assembly) (English translation)

[Quick note] How to build CodeQL DB with closed-source project(.NET Assembly) - Jang, Medium.

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Content (translated into English)

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CodeQL

Csharp

Database

Query

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[[image: Jang]](https://testbnull.medium.com/?source=post_page---byline--237b829b6778----------------------------)

Jang

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I started writing this article about a year ago (09/2023); however, due to various legal concerns, work commitments, and mainly a lack of motivation to write, it remained a draft until now. And because such a long time passed between writing the different parts, there may be some inconsistencies among them. I respectfully ask readers to review them and help the author make corrections. Thank you!

 # Miscellaneous

After spending three years working on a project about Semmle/CodeQL, my thesis happened to involve it as well, so I took the opportunity to finish the project I had left incomplete years ago.

A brief introduction to CodeQL:

Broadly speaking, it is a platform for finding potential vulnerabilities, variants, or unoptimized code in your source code. In short, it is a source-code scanning platform!

What distinguishes CodeQL from other source-code scanning tools is that every component of the source code is "*datafied*." Scanning the source code involves using QL — Query Language — to access this data, similarly to using SQL database management systems. Here is a simple example:

```
Từ tất cả **Class**
tìm những **class **có **tên **= "Person"
```

Represented in CodeQL, this becomes:

```
from Class clazz
where clazz.hasName("Person")
select clazz
```

CodeQL's query language is very explicit, making it highly approachable for beginners, including those who are new to coding and people who specialize in data.

CodeQL is also freely available for everyone to use and contribute Queries. If you contribute a Query that is useful to the community, you may even receive a bounty of around 1–2k$ directly from GitHub.

It can be operated automatically or semi-automatically. With the enterprise version, CodeQL can be integrated into DevOps to check code quality, scan for vulnerabilities, ...

With the public license, CodeQL allows researchers to use it with **open-source** projects.

Because the public version of CodeQL is intended for use with open-source projects, when creating a Database for querying, all of the project's source code must be compilable (or interpretable); even a minor Exception will stop the entire DB creation process. This has a major impact on subsequent queries.

The source code may use a third-party library. During DB creation, information about the contents of that code will not be collected, for example:

```
import java.util.*;
import org.apache.commons.collections.Transformer;
import org.apache.commons.collections.map.LazyMap; //[1]
import org.apache.commons.lang.StringUtils;

private void createMap(){
   Transformer reverseString = new Transformer( ) {
      public Object transform( Object object ) {
         String name = (String) object;
         String reverse = StringUtils.reverse( name );
         return reverse;
      }
   }

   Map names = new HashMap( );
   Map lazyNames = LazyMap.decorate( names, reverseString );//[2]

   String name = (String) lazyNames.get( "Thomas" );
   System.out.println( "Key: Thomas, Value: " + name );
}
```

The Apache Commons Collections library is used—specifically, *LazyMap *and *Transformer*. While CodeQL creates the database, it will only detect that the method *createMap()* calls *LazyMap.decorate()*; it will not know what *LazyMap.decorate()* does with the data.

Because the dataset is incomplete in this way, subsequent data queries become inaccurate. There will be many cases where manually reading the code shows that the call graph reaches a given point, but querying returns no results at all, without even revealing where the call graph was interrupted ¯\\( )/¯. This is precisely why I tried to find a way to build a database that also includes bundled libraries and files that have already been compiled.

Back in 2020–2021, I successfully built a DB for Java without needing the source code and shared it here. The idea was simply to:

- decompile all jar files
- create a test build file with the command `javac`
- and finally have CodeQL create a database using that build file

After successfully building DBs for several commonly encountered closed-source products, I also tried learning how to write queries to find bugs. However, the DBs were quite large, so queries looking for DataFlow almost never returned any results; CodeQL would usually freeze and crash the machine entirely .

This is another weakness of CodeQL, as well as other source-code scanning tools: once the DB becomes too large (around 300MB), querying is no longer effective.

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 # Build a CodeQL DB for a closed-source C# project

Recently, I revisited several projects—specifically my graduation thesis—which also involved CodeQL and C# in particular, so I had to look back and see whether GitHub had made any further optimizations since then.

For C#, building a DB for a closed-source project is fairly easy and does not require the entire project to build successfully (for example, when dependencies are missing, ...).

Since no one has ever posted (or dared to post) a guide for building a DB for a closed-source C# project, I decided to write down a few steps that I usually follow when building one.

Step 1: Collect DLL

I usually use dnSpy for collection. First, click the `Debug` > `Attach to Proccess` tab, then select the process in which the service is running to debug it. For targets such as Exchange and SharePoint, this process is usually `w3wp.exe`

After successfully attaching the debugger, continue to `Debug` > `Windows` > `Modules`

This window lists all managed dll files (which, for now, can be understood as dll files written in C#) that the process has loaded into memory. Next, Right click > select `Open All Modules`, and all these dll files will be loaded into dnSpy

Step 2: Decompile all DLL to source code

The dll files that were just loaded will appear in the Assembly Explorer window. Here, press Ctrl + A to select all DLL files, then select `File` > `Export to Project`

Choose the appropriate VS version. I usually choose VS2019 based on intuition, then click Export and wait. Some errors may appear during this process, but just ignore them.

Step 3.0: Patch CodeQL

TLDR; with the default codeql, building a closed-source database will miss many dependencies, so we must perform this additional step

At the time of writing, I was using codeql version 2.13.3. This version does not officially support building closed-source projects, so we need to modify it slightly to make the build possible.

The codeql tool for building a csharp database is located at: **codeql\csharp\tools\win64\:**

The closed-source build flow is as follows:

*codeql command line -> set env -> Semmle.Autobuild.CSharp.exe *-> *Semmle.Extraction.CSharp.Standalone.exe*

These exe files are built with .NET Core 7.0, so the main executable files are the correspondingly named .dll files.

We can verify this by viewing the process tree while building the db with codeql.

Here, we need to pay attention to the command line:

```
Semmle.Extraction.CSharp.Standalone.exe --references:.
```

According to the usage section of **Semmle.Extraction.CSharp.Standalone.exe**, we can see that the `— references:` option allows additional dependency paths to be passed in for the build process.

However, the ironic thing is that with the default version of codeql, we cannot customize this option through the codeql command line because it has been hardcoded at: **Semmle.Autobuild.CSharp.StandaloneBuildRule**:

I solved this by creating an additional proxy exe file to replace the original **Semmle.Extraction.CSharp.Standalone.exe**, placing it in the middle to inject additional customized parameters before forwarding them to the real file:

Semmle.Autobuild.CSharp.exe -> Semmle.Extraction.CSharp.Standalone ***Proxy**** -> Semmle.Extraction.CSharp.Standalone ***real***

proxy src

After replacing the **Semmle.Extraction.CSharp.Standalone.exe** file with the proxy file, we can proceed to the next step!

Step 3: Build C# DB

Open cmd in the project folder exported above and enter the following build command:

```
codeql database create SPTestDB --language=csharp -Obuildless=true --overwrite
```

Here, `SPTestDB` is the name of the CodeQL DB, and the `-Obuildless=true` option allows the DB to be built without requiring the entire project to compile successfully.

The build process can take anywhere from approximately 15–20 minutes to 1–2 days, depending on the size of the project and your machine's specifications. Once the build is complete, the DB will be created in the folder where codeql was run:

We have thus successfully built a CodeQL DB without needing the project's source code.

However, because the project is very large (~500MB compressed), you should run queries on a reasonably powerful computer. In particular, carefully review each query before running it and limit the queried dataset as much as possible for optimal performance.

Running queries indiscriminately can cause the codeql query server to hang/crash/stop responding, especially queries involving Data flow tracing.

Below are some sample queries I often use with large db files like this:

- https://gist.github.com/testanull/b7c4dca00e287e5008943ece22ee3aa4
- https://gist.github.com/testanull/4c1d13a27c821d061c6191a53fa361a8
- https://gist.github.com/testanull/a9fa62dd29f0f128fcd6825f962daff5

I found these on my machine and included them here as examples, but at this point I no longer remember exactly what they were used for either =)).

If you have any questions about this topic, please message me on telegram at `@testanull`, and I will look into it again with you!

Thank you for reading this far!

Jang
