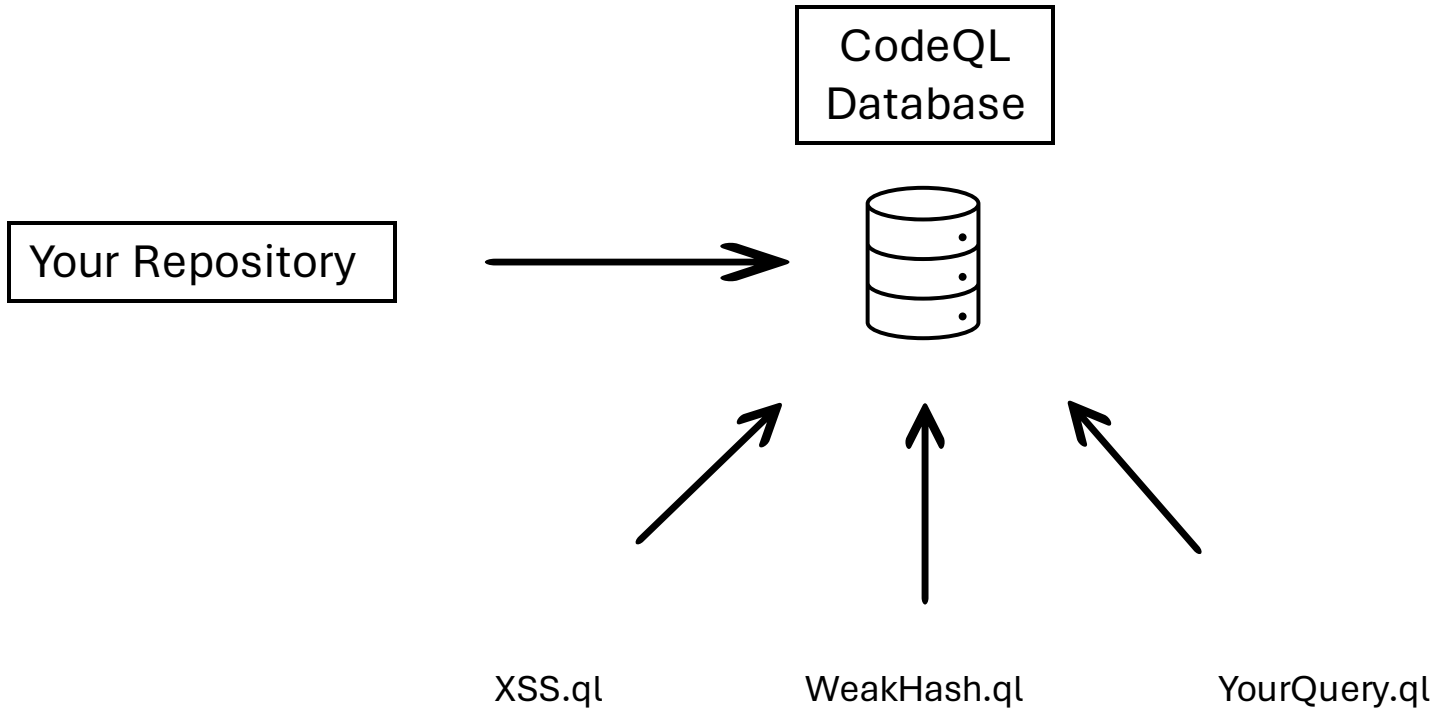
Intro to CodeQL

An Example

- Deserialization risks in use of BinaryFormatter and related types - .NET | Microsoft Learn
- "BinaryFormatter deserializing user input is bad"
  - What is user input? What does that look like in code?
  - How does that user input get to the Deserialize call?
  - What if it's sanitized before the call?

What is CodeQL

- Similar tools
  - Roslyn
  - SonarCloud
- "Code as Data"
  - Abstract Syntax Tree
  - **Dataflows**



When to use CodeQL?

- Security: Bug Classes as queries
- At Microsoft:
  - SDL (Security Development Lifecycle) rules
  - Security incident response
  - Other efforts:
    - "how many services are using x method"
    - CBOM for Cryptography

When NOT to use CodeQL

- Slower to run on large databases
- High learning curve
- Other tools: Semgrep, Roslyn

Getting a CodeQL Database

Option 1 – Existing Repository

- Github has >200,000 databases for repositories
- Any repository with github code scanning enabled

Option 2 – Create your own

- codeql database create

Logistics/software

- Download the latest codeql cli: github/codeql-cli-binaries: Binaries for the CodeQL CLI
- Download VSCode: https://code.visualstudio.com/
- Download CodeQL Extension for VSCode: Installing CodeQL for Visual Studio Code - GitHub Docs
- Clone workshop repository: chanel-y/BSides-CodeQL101: Starter Files and Docs for CodeQL Workshop for BSides Vancouver 2024 (github.com)
- Clone sample project repository: chanel-y/BSides-Sample-Project (github.com)

Demo + Walkthrough

Creating a CodeQL database and writing our first query

DataFlow/Path Queries

Why Dataflow?

```
public RSA CreateWeakKey()
{
    RSA key = RSA.Create(1024);
    return key;
}
```

Why Dataflow?

```
public RSA CreateWeakKey1()
{
    int weakKeySize = 1024;
    RSA key = RSA.Create(weakKeySize);
    return key;
}

public RSA CreateKey(int keySize)
{
    RSA key = RSA.Create(weakKeySize);
    return key;
}

public RSA CreateWeakKey2()
{
    int weakKeySize = 1024;
    return CreateKey(weakKeySize);
}
```

DataFlow Syntax

```
module MyFlowConfiguration implements DataFlow::ConfigSig {
  predicate isSource(DataFlow::Node source) { ... }
  predicate isSink(DataFlow::Node sink) { … }
}

module MyFlow = DataFlow::Global<MyFlowConfiguration>;

from DataFlow::Node source, DataFlow::Node sink
where MyFlow::flow(source, sink)
select source, "Dataflow to $@.", sink, sink.toString()
```

DataFlow vs TaintTracking

DataFlow

```
source = "mysource";
intermediary = source
mySink(intermediary);
```

TaintTracking

```
source = "mysource";
intermediary = source + "something";
mySink(intermediary);
```

DataFlow vs TaintTracking Syntax

DataFlow

```
module MyFlowConfiguration implements DataFlow::ConfigSig {
  predicate isSource(DataFlow::Node source) { ... }
  predicate isSink(DataFlow::Node sink) { … }
}

module MyFlow = DataFlow::Global<MyFlowConfiguration>;

from DataFlow::Node source, DataFlow::Node sink
where MyFlow::flow(source, sink)
select source, "Dataflow to sink"
```

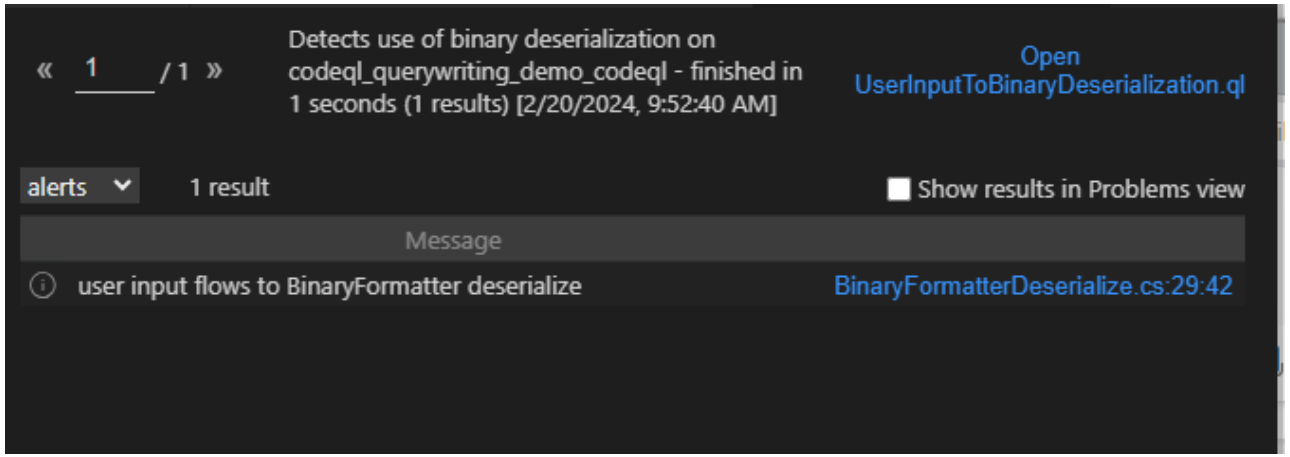
TaintTracking

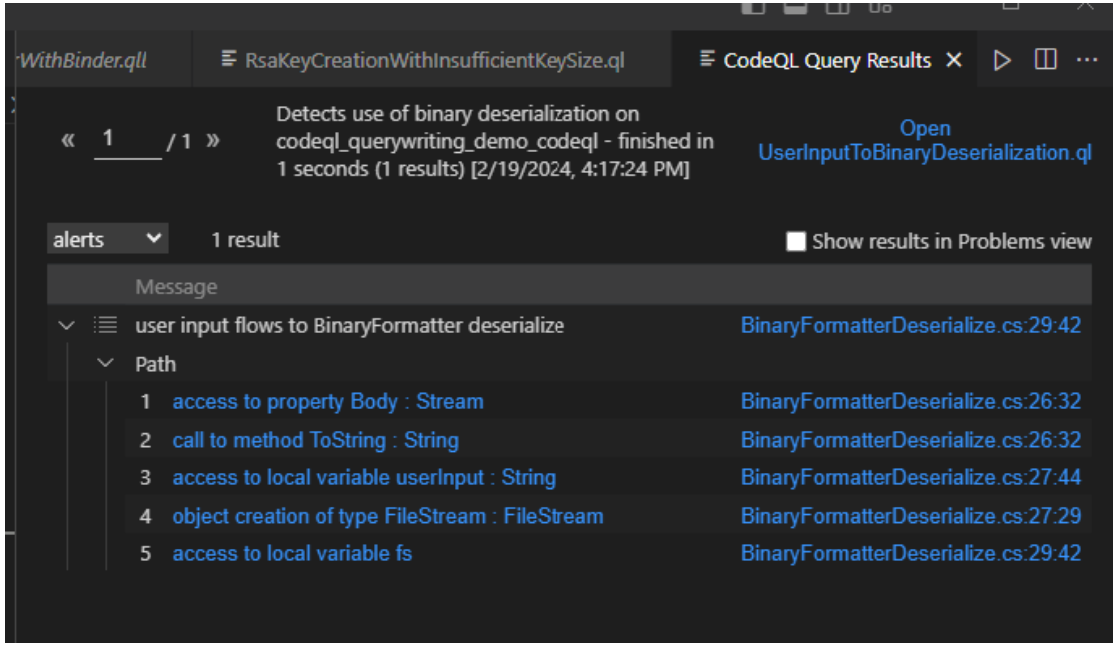
```
module MyFlowConfiguration implements DataFlow::ConfigSig {
  predicate isSource(DataFlow::Node source) { ... }
  predicate isSink(DataFlow::Node sink) { … }
}

module MyFlow = TaintTracking::Global<MyFlowConfiguration>;

from DataFlow::Node source, DataFlow::Node sink
where MyFlow::flow(source, sink)
select source, "Dataflow to sink"
```

Path Queries!





Path Query Syntax

"Normal" DataFlow

```
@kind problem
...
module MyFlowConfiguration implements DataFlow::ConfigSig {
  predicate isSource(DataFlow::Node source) { ... }
  predicate isSink(DataFlow::Node sink) { … }
}

module MyFlow = DataFlow::Global<MyFlowConfiguration>;

from DataFlow::Node source, DataFlow::Node sink
where MyFlow::flow(source, sink)
select source, "Dataflow to sink."
```

Path Query

```
@kind path-problem
...
module MyFlowConfiguration implements DataFlow::ConfigSig {
  predicate isSource(DataFlow::Node source) { … }
  predicate isSink(DataFlow::Node sink) { … }
}

module MyFlow = DataFlow::Global<MyFlowConfiguration>;
Import MyFlow::PathGraph

from MyFlow::Node source, MyFlow::Node sink
where MyFlow::flow(source, sink)
select sink.getNode(), source, sink, "Dataflow to sink."
```

Writing a DataFlow Query

- Define a source
- Define a sink
- Define any additional steps and barriers
- Decide whether dataflow vs tainttracking and problem vs path-problem

DataFlow/Path Query Exercises

You've been Intro'd to CodeQL, now what?

Getting Familiar with QL

- "I don't know what this is in CodeQL"
  - CTRL-F through github's existing queries
  - Use the AST to see where to start
- "I don't know how to use this class/predicate in CodeQL"
  - CTRL-F through github's existing queries
  - Standard Library: CodeQL standard libraries (github.com)
- I'm truly, fully stuck
  - Public github security slack: codeql-writing (Channel) - GitHub Security Lab - Slack
  - Email me!

Additional CodeQL Topics to Explore

- Other Languages covered by CodeQL: CodeQL language guides — CodeQL (github.com)
- Unit tests for CodeQL: Testing custom queries - GitHub Docs
- QLPacks: Creating and working with CodeQL packs - GitHub Docs
- Multi-repository variant analysis: Running CodeQL queries at scale with multi-repository variant analysis - GitHub Docs

Additional Learning Resources

- Github CodeQL docs: CodeQL overview — CodeQL (github.com)
- QL tutorials — CodeQL (github.com)
- Github CodeQL CTFs: Capture the flag | GitHub Security Lab
- A Practical Introduction to CodeQL by jorgectf: Practical Introduction to CodeQL :: jorgectf — blog
- CodeQL Zero to Hero (part 1 of 3): CodeQL zero to hero part 1: The fundamentals of static analysis for vulnerability research - The GitHub Blog

Thanks!

Email: chanelyoung99@gmail.com

LinkedIn: chanelyoung99