Lab: Using Static Analysis

Estimated time needed: 30 minutes

Welcome to the hands-on lab for **Using Static Analysis**! Static analysis is a debugging method that automatically inspects source code before execution. In this lab, you will learn more about static analysis and how to install, configure, and use SonarQube for static analysis of your project code.

Learning Objectives

By the end of this lab, you will be able to:

- Describe the benefits of using static analysis
- Install and configure SonarQube
- Run static analysis scans
- Interpret security reports from SonarQube

Understanding Static Code Analysis

Static code analysis, a debugging method that inspects source code, is performed in a non-runtime environment, meaning it examines the code without executing the program. This practice is also known as source code analysis.

While testing is traditionally carried out by the coder running the program, source code analysis can be done even before a program has been finished. This gives developers the advantage of catching any mistakes early.

Source code analysis tools, also known as **Static Application Security Testing (SAST)** tools, analyze your source code to find security flaws. SAST tools can be added into your IDE. They can help you detect issues during software development and can save time and effort, especially when compared to finding vulnerabilities later in the development cycle.

In the next section, you will use **SonarQube**, an open-source platform built by SonarSource for continuous code quality assessment. It can integrate with your existing workflow to enable continuous code inspection across your project branches and pull requests.

Getting Started

While you might already have a dedicated SonarQube stage set up in your CI/CD pipeline, it is useful to know how to run SonarQube locally. By doing this, you can shorten the feedback loop to change code, run scans, and view results.

In this lab, you will be guided through setting up SonarQube and using it to run analysis of an application in the Cloud IDE with Docker. Everything can be done in the terminal on the right panel. You should be able to replicate this lab easily in any environment that has Docker installed, including your own developer workstation.

To get a SonarCube server up and running, you will:

1. Create a Docker network for SonarQube and PostgreSQl to communicate on
2. Set up PostgreSQL running in a Docker container
3. Set up SonarQube running in a Docker container
4. Download the SonarQube scanner Docker image
5. Set up an alias to run scans using the `sonar-scanner-cli` Docker container
6. Scan some code and interpret the results

Click **Next** to get started.

Step 1: Setup PostgreSQL database

SonarQube depends on a database to work correctly. While SonarQube can run in a docker container without a database, when the container is deleted, all of the data is deleted with it. This may be fine for quick development scans, but if you want to build history over time, it is a best practice to use an external database, even for local development.

In this lab, we will use the PostgreSQL database by pulling its docker image. Before we do that, we will need a Docker network to connect the database to SonarQube and, later, the SonarScanner. This will be your first task.

Your Task

1. Open a terminal from the top menu bar by selecting `Terminal -> New Terminal`

2. Next, from the terminal shell, run the `docker network` command to create a **docker network** called `mynet`.

   ```
   docker network create mynet
   ```

   The docker network that you created is called `mynet`, which will be used to establish a communication between the PostgreSQL container and the SonarQube container that you will create later.

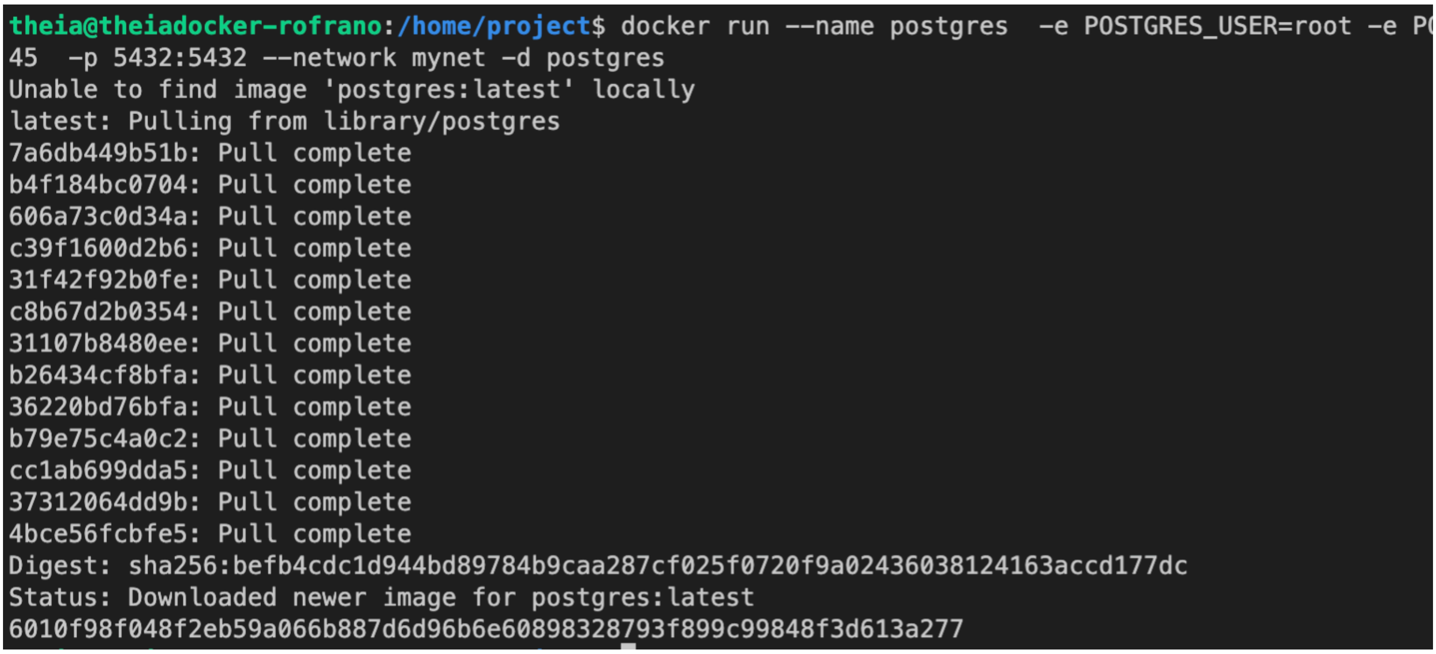
3. Finally, use the `docker run` command to create a PostgreSQL docker container:

   ```
   docker run --name postgres  -e POSTGRES_USER=root -e POSTGRES_PASSWORD=Test12345  -p 5432:5432 --network mynet -d postgres
   ```

   You will see that simply by requesting to run the container, Docker knows to download the image. You should see a lot of output about downloading and expanding the layers of the Docker image for `postgres`.

Results

Your final output should look something like this:



```
theia@theiadocker-rofrano:/home/project$ docker run --name postgres  -e POSTGRES_USER=root -e P
45  -p 5432:5432 --network mynet -d postgres
Unable to find image 'postgres:latest' locally
latest: Pulling from library/postgres
7a6db449b51b: Pull complete
b4f184bc0704: Pull complete
606a73c0d34a: Pull complete
c39f1600d2b6: Pull complete
31f42f92b0fe: Pull complete
c8b67d2b0354: Pull complete
31107b8480ee: Pull complete
b26434cf8bfa: Pull complete
36220bd76bfa: Pull complete
b79e75c4a0c2: Pull complete
cc1ab699dda5: Pull complete
37312064dd9b: Pull complete
4bce56fcbfe5: Pull complete
Digest: sha256:befb4cdc1d944bd89784b9caa287cf025f0720f9a02436038124163accd177dc
Status: Downloaded newer image for postgres:latest
6010f98f048f2eb59a066b887d6d96b6e60898328793f899c99848f3d613a277
```

Step 2: Setup SonarQube server

Now that we have the PostgreSQL database running, we can create the SonarCube server and attach it to the database. To avoid having to install SonarQube and have the proper Java environment to run it, you will use a Docker container for running your SonarQube server. Luckily, SonarQube provides one that you can use.

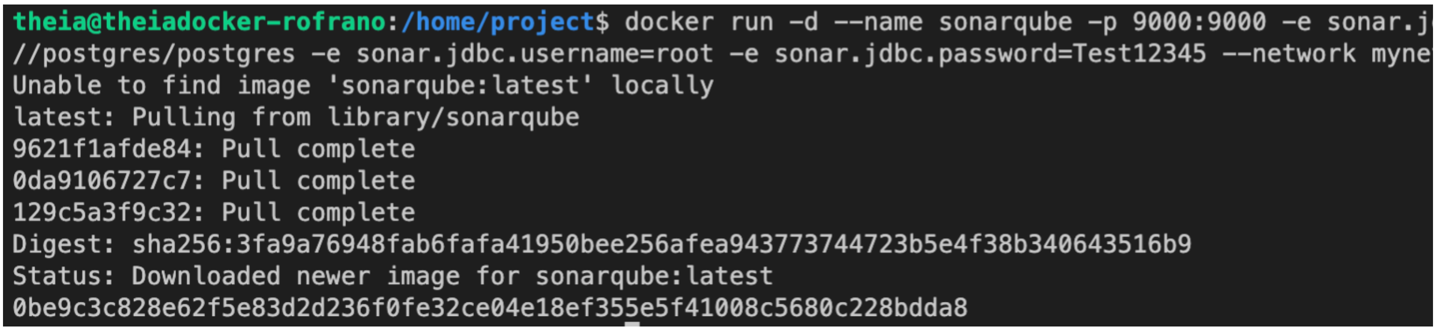
Your Task

Use the following `docker run` command to run a SonarQube docker container on port `9000`:

```
docker run -d --name sonarqube -p 9000:9000 -e sonar.jdbc.url=jdbc:postgresql://postgres/postgres -e sonar.jdbc.username=root -e sonar.jdbc.password=Test12345 --network mynet sonarqube
```

This command uses the `-p` flag to expose port `9000` for SonarQube to communicate outside of the container. It also sets several environment variables with the `-e` command. Using Docker to run server on your desktop gives you an enormous amount of freedom and flexibility as a developer.

Again you will see the layers of the SonarQube docker image be downloaded and extracted. Your final output should look something like this:



```
theia@theiadocker-rofrano:/home/project$ docker run -d --name sonarqube -p 9000:9000 -e sonar.j
//postgres/postgres -e sonar.jdbc.username=root -e sonar.jdbc.password=Test12345 --network myne
Unable to find image 'sonarqube:latest' locally
latest: Pulling from library/sonarqube
9621f1afde84: Pull complete
0da9106727c7: Pull complete
129c5a3f9c32: Pull complete
Digest: sha256:3fa9a76948fab6fafa41950bee256afea943773744723b5e4f38b340643516b9
Status: Downloaded newer image for sonarqube:latest
0be9c3c828e62f5e83d2d236f0fe32ce04e18ef355e5f41008c5680c228bdda8
```

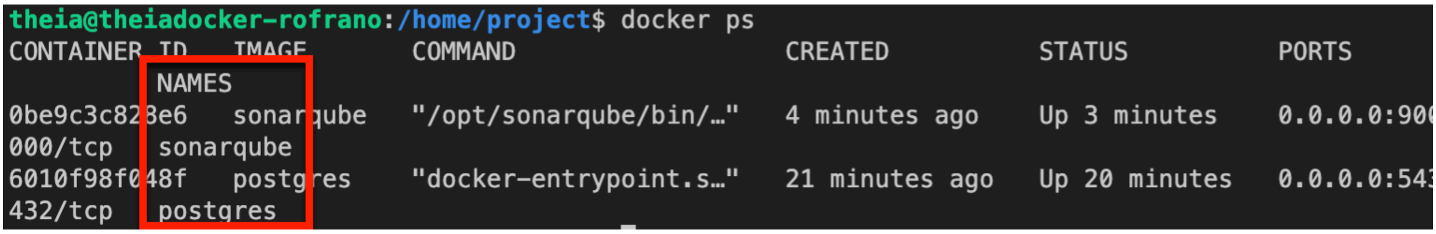
Check for Success

Now that both PostgreSQL and SonarQube images have been downloaded, and both containers have been started, you can use the `docker ps` command to check that they are running.

Use the `docker ps` command to check the containers:

```
docker ps
```

You should see similar output to the following with a container named `postgres` and a container named `sonarqube`:



```
theia@theiadocker-rofrano:/home/project$ docker ps
CONTAINER ID   IMAGE       COMMAND                  CREATED          STATUS          PORTS
               NAMES
0be9c3c828e6   sonarqube   "/opt/sonarqube/bin/…"   4 minutes ago    Up 3 minutes    0.0.0.0:900
000/tcp        sonarqube
6010f98f048f   postgres    "docker-entrypoint.s…"   21 minutes ago   Up 20 minutes   0.0.0.0:54
432/tcp        postgres
```

Congratulations! Your SonarQube should now be up and running!

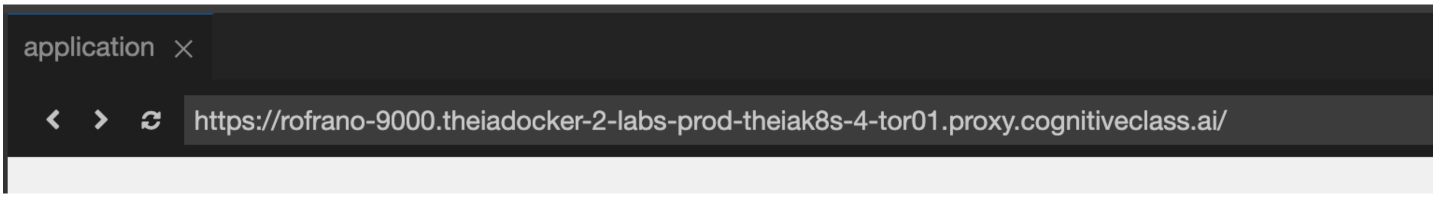
You've now completed the installation part, and you are ready to move on to generating a scanner token for your project!

Step 3: Log in to SonarQube

You are now ready to use SonarQube. You can launch the web UI by clicking the `[Launch SonarQube UI]` button below. It may take a while for SonarQube to start.

Launch SonarQube UI

> Note: You might want to open this web page in your browser instead of the Cloud IDE because the SonarQube UI is quite large, and it may be difficult to navigate using Cloud IDE browser. Once you click **Launch SonarQube UI**, there will be an arrow icon in the upper-right of the terminal panel that will open a new page for you.



https://rofrano-9000.theiadocker-2-labs-prod-theiak8s-4-tor01.proxy.cognitiveclass.ai/

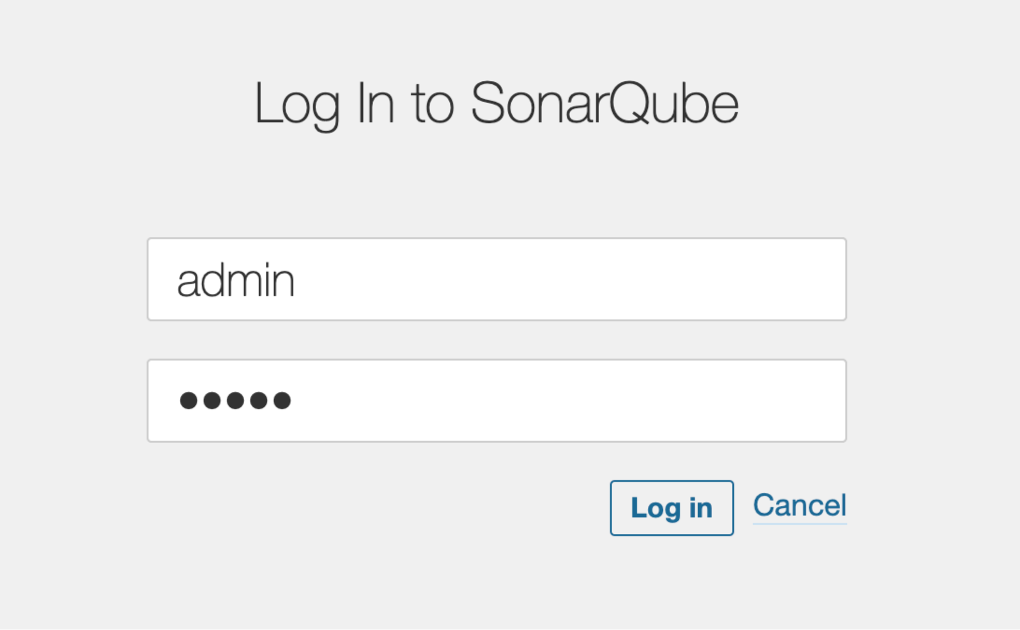
Change credentials

Use the following default credentials to login into the SonarQube.

```
username: admin
password: admin
```

Then click the `[Log in]` button. Once you have logged in, you will be prompted to change your password.

Note: Don't forget to save your new password!



Log In to SonarQube

admin

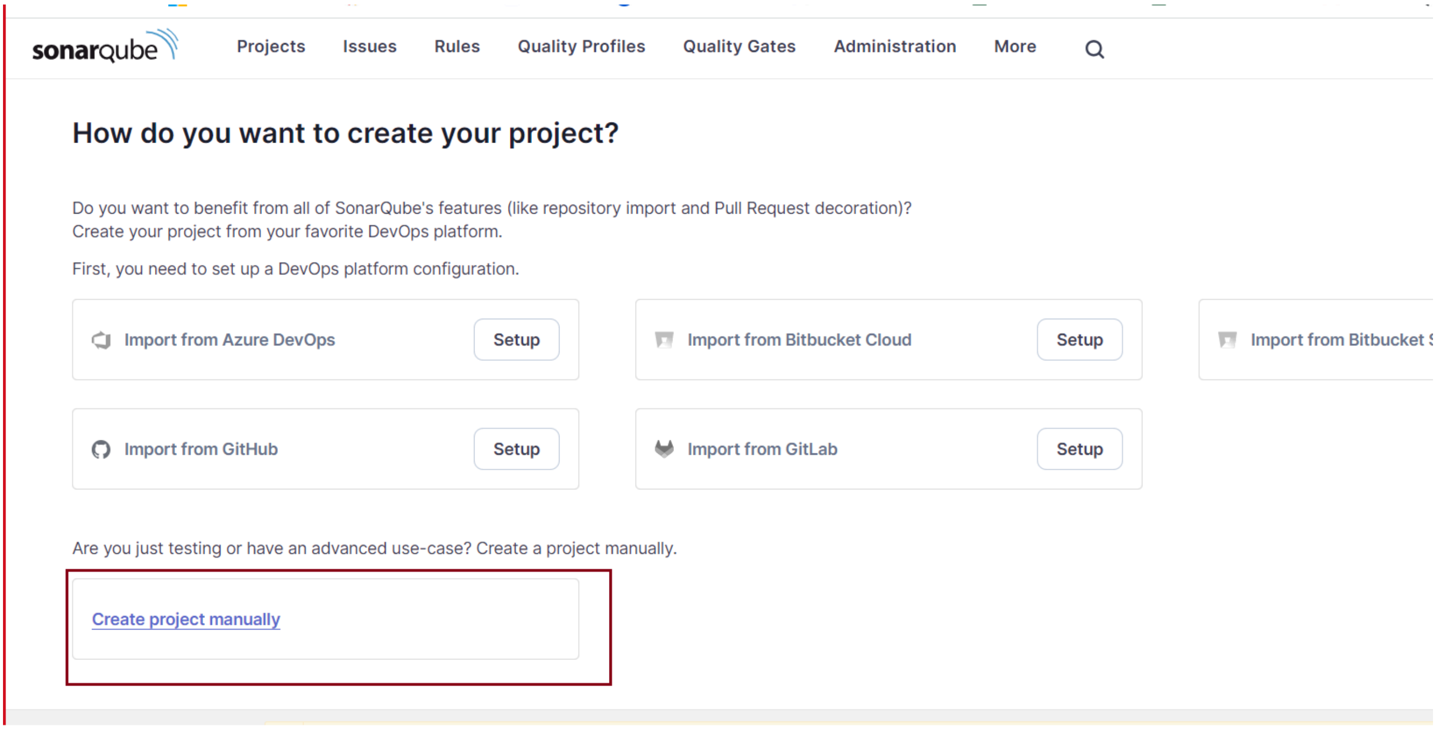
●●●●●

Once you have finished resetting the password, you will be directed to the home page of SonarQube.

Step 4: Create a SonarQube Project

To run the SonarQube scanner on your code, you will first need to create a project token. There are many ways to create a token, but for this lab you will use the **manual** setup.

Click on the **Manually** icon on the bottom left.



How do you want to create your project?

Do you want to benefit from all of SonarQube's features (like repository import and Pull Request decoration)? Create your project from your favorite DevOps platform.

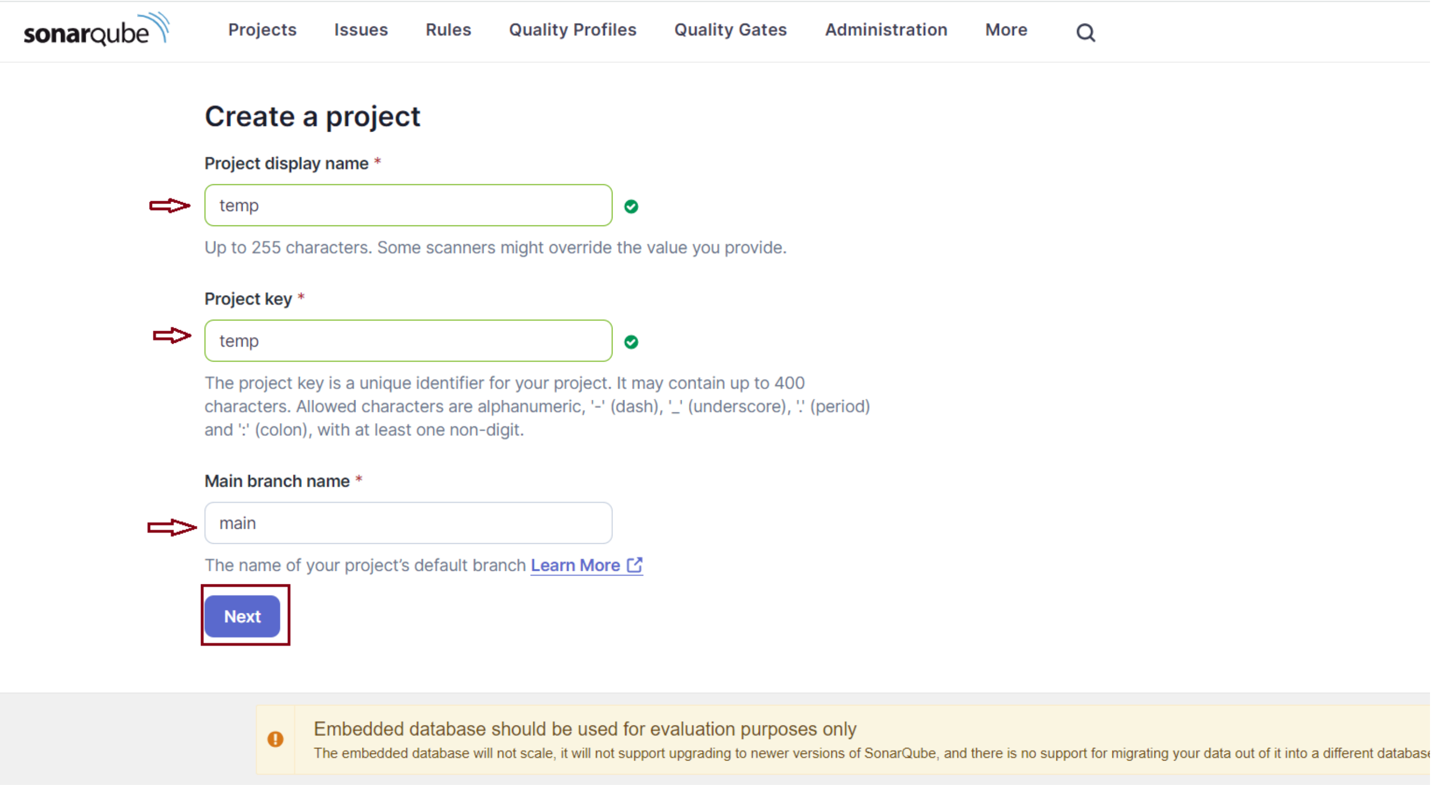
First, you need to set up a DevOps platform configuration.

Are you just testing or have an advanced use-case? Create a project manually.

On the next page, create a project by following these steps:

1. Set the project display name to `temp`.
2. Set the project key to `temp` (this will happen by default).
3. Ensure the `main` branch is selected
4. Press the `Next` button to continue.

Note: If you get an error message, try again.



Create a project

Project display name *

temp

Up to 255 characters. Some scanners might override the value you provide.

Project key *

temp

The project key is a unique identifier for your project. It may contain up to 400 characters. Allowed characters are alphanumeric, '-' (dash), '_' (underscore), '.' (period) and ':' (colon), with at least one non-digit.

Main branch name *

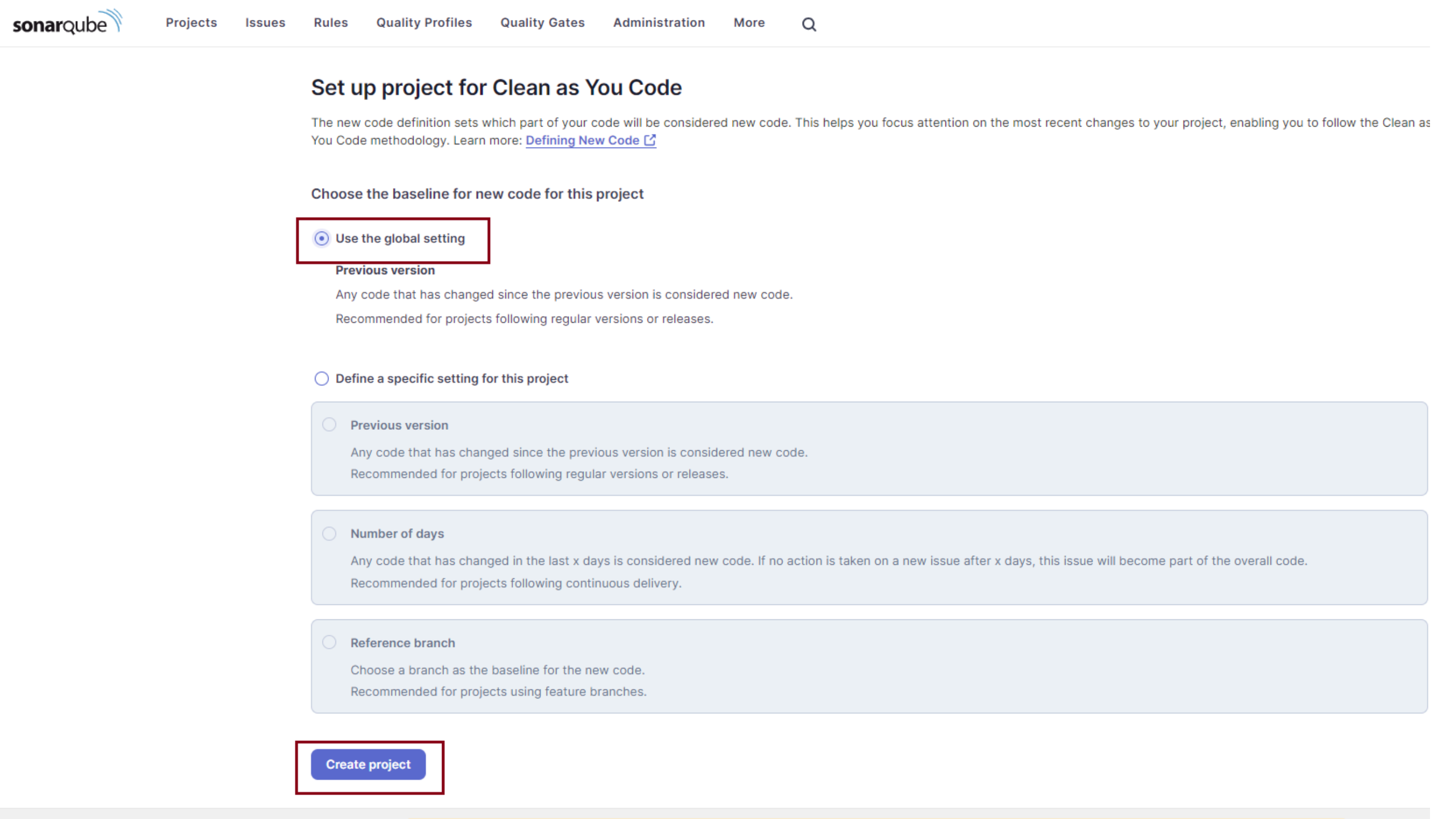
main

The name of your project's default branch Learn More

Embedded database should be used for evaluation purposes only

The embedded database will not scale, it will not support upgrading to newer versions of SonarQube, and there is no support for migrating your data out of it into a different databas

Please select `Use the global setting` and then click on `Create project`.



Set up project for Clean as You Code

The new code definition sets which part of your code will be considered new code. This helps you focus attention on the most recent changes to your project, enabling you to follow the Clean as You Code methodology. Learn more: Defining New Code

Choose the baseline for new code for this project

● Use the global setting

Previous version

Any code that has changed since the previous version is considered new code.

Recommended for projects following regular versions or releases.

○ Define a specific setting for this project

○ Previous version

Any code that has changed since the previous version is considered new code.
Recommended for projects following regular versions or releases.

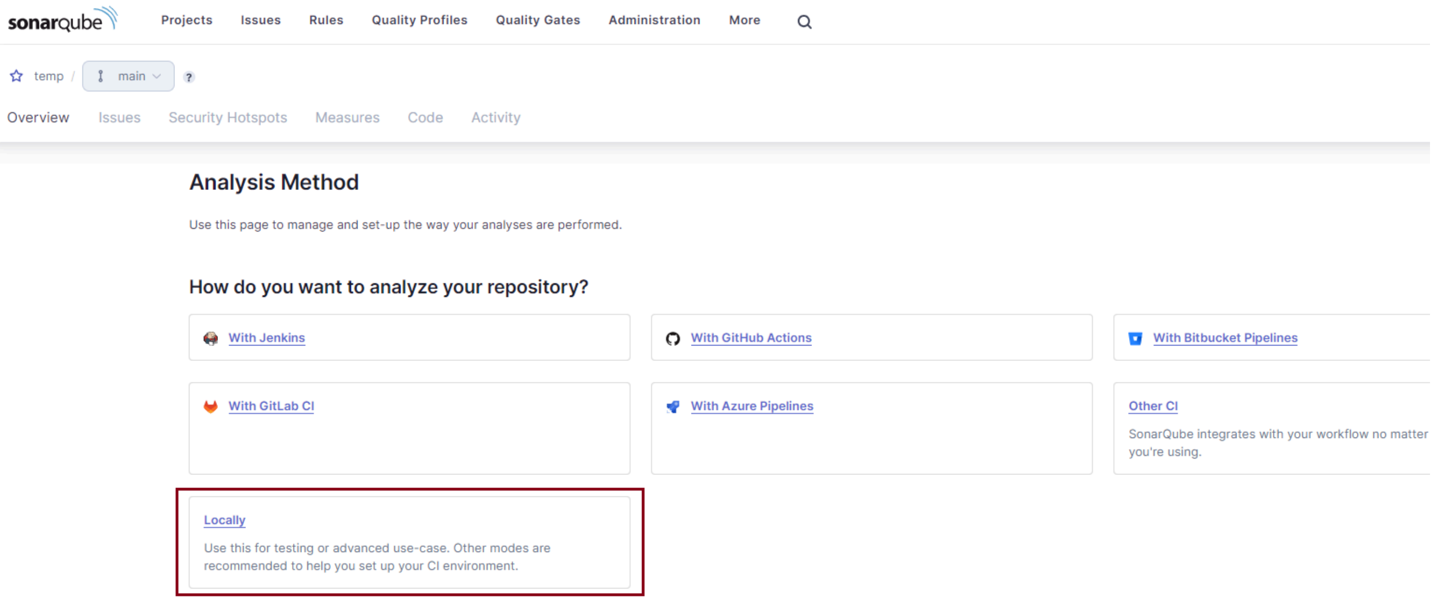
○ Number of days

Any code that has changed in the last x days is considered new code. If no action is taken on a new issue after x days, this issue will become part of the overall code.
Recommended for projects following continuous delivery.

○ Reference branch

Choose a branch as the baseline for the new code.
Recommended for projects using feature branches.

On the next page, where it asks how you want to analyze your repository, select the `Locally` option.



Analysis Method

Use this page to manage and set-up the way your analyses are performed.

How do you want to analyze your repository?

With Jenkins

With GitHub Actions

With Bitbucket Pipelines

With GitLab CI

With Azure Pipelines

Other CI

SonarQube integrates with your workflow no matter you're using.

Locally

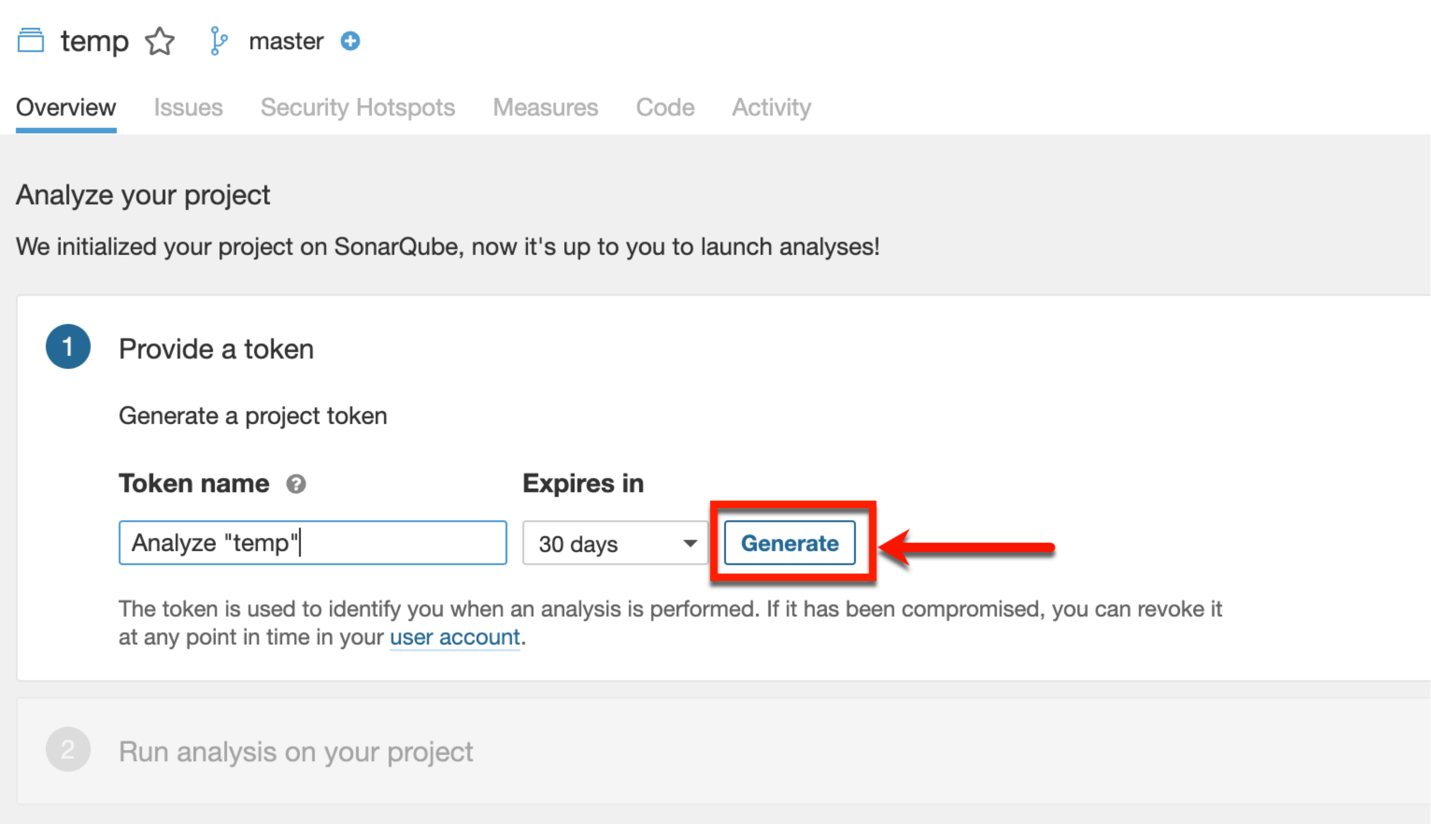
Use this for testing or advanced use-case. Other modes are recommended to help you set up your CI environment.

In the next step, you will generate a token for your project.

Step 5: Generate SonarQube Scanner Token

Before you can scan your code, you will need to generate a token. You can generate a token on the **Analyze your project** page at the **Provide a token** step.

Click the **Generate** button.



temp ☆ master

Overview Issues Security Hotspots Measures Code Activity

Analyze your project

We initialized your project on SonarQube, now it's up to you to launch analyses!

1 Provide a token

Generate a project token

Token name ? **Expires in**

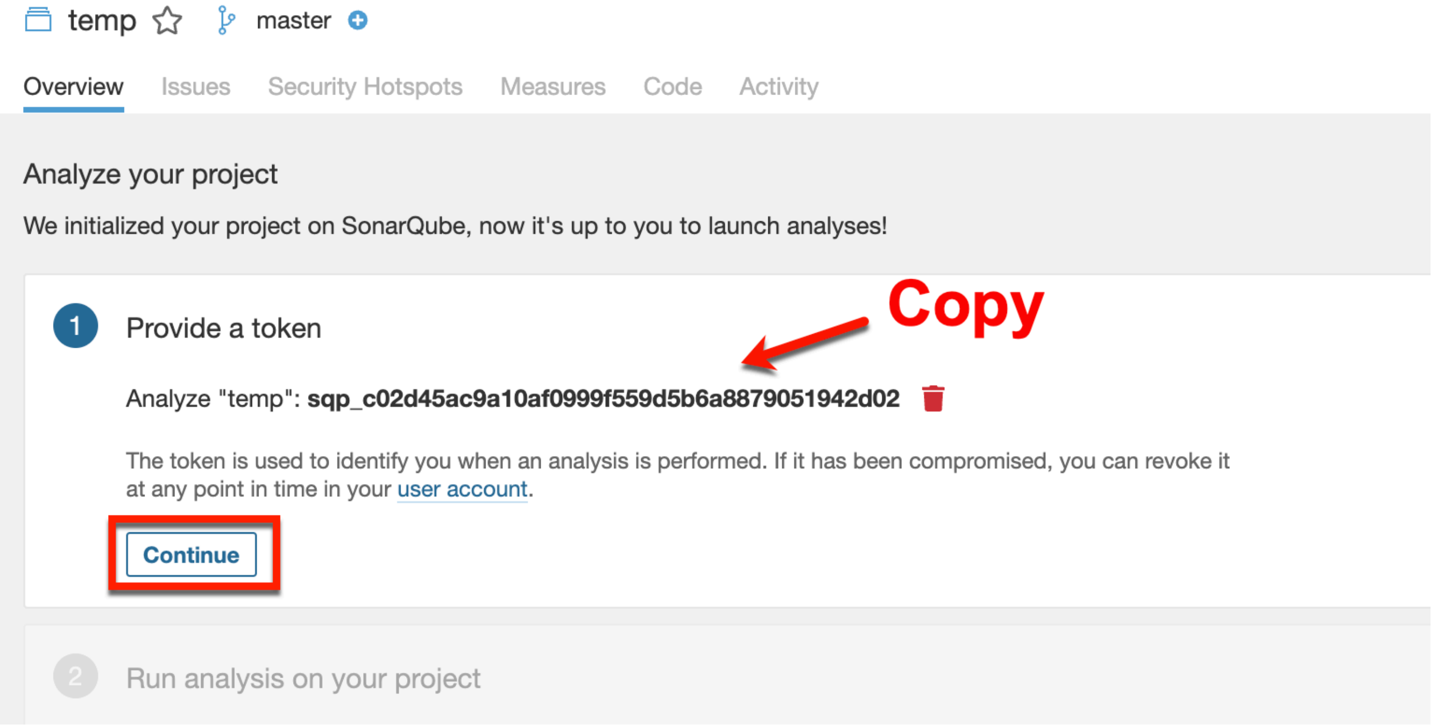
Analyze "temp" | 30 days ▾ | **Generate**

The token is used to identify you when an analysis is performed. If it has been compromised, you can revoke it at any point in time in your user account.

2 Run analysis on your project

Next, you will see the token that has been generated. You want to highlight the token text, copy it, and then paste it in a safe place. You will need it later to submit your scans.

Then click the **Continue** button.



temp ☆ master

Overview Issues Security Hotspots Measures Code Activity

Analyze your project

We initialized your project on SonarQube, now it's up to you to launch analyses!

1 Provide a token

Copy

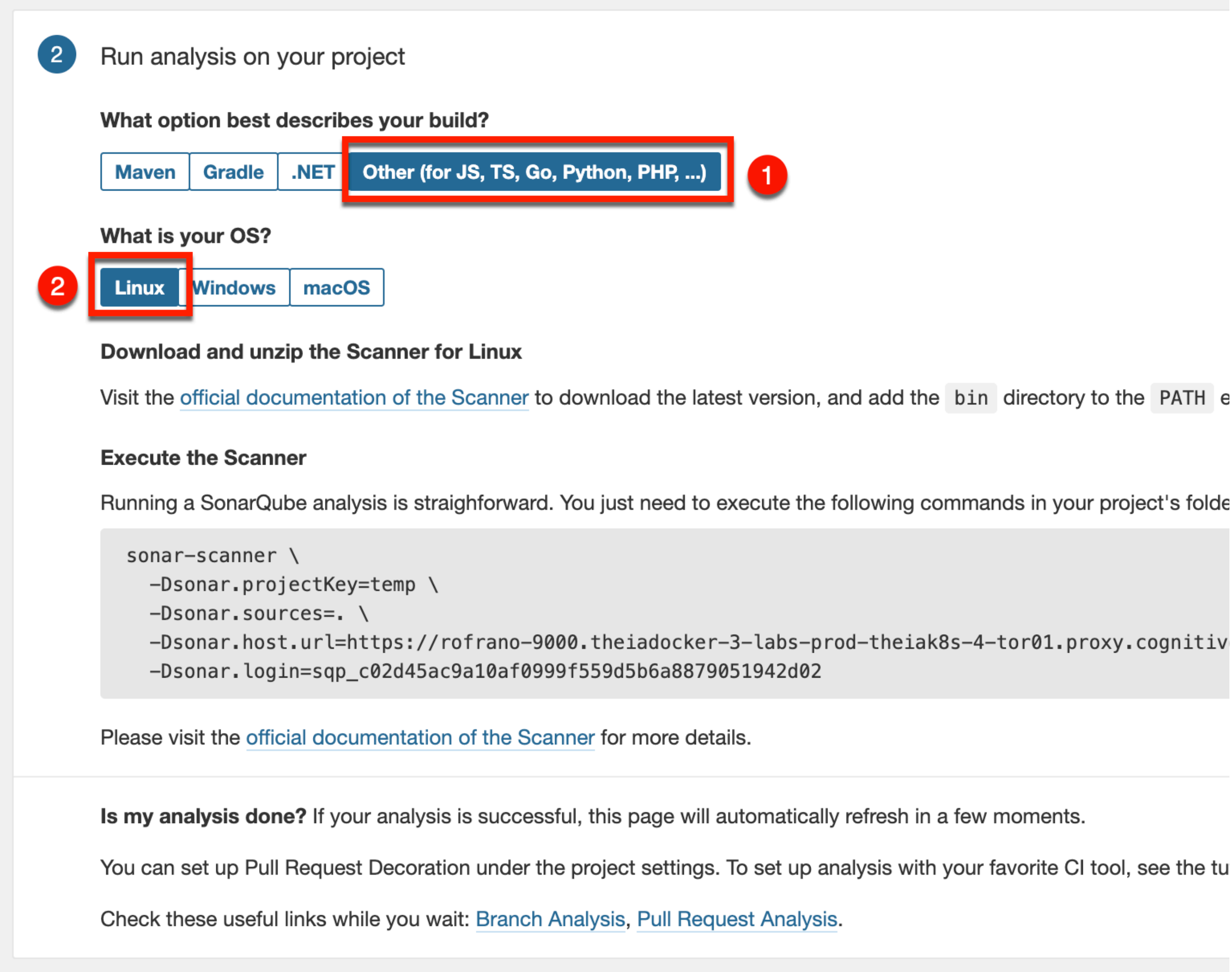
Analyze "temp": **sqp_c02d45ac9a10af0999f559d5b6a8879051942d02**

The token is used to identify you when an analysis is performed. If it has been compromised, you can revoke it at any point in time in your user account.

Continue

2 Run analysis on your project

This will take you to a page where you will need to answer some questions about your project's configuration, such as the language and the operating system (OS) used.



Run analysis on your project

What option best describes your build?

What is your OS?

Download and unzip the Scanner for Linux

Visit the official documentation of the Scanner to download the latest version, and add the `bin` directory to the `PATH` e

Execute the Scanner

Running a SonarQube analysis is straighforward. You just need to execute the following commands in your project's folde

```
sonar-scanner \
  -Dsonar.projectKey=temp \
  -Dsonar.sources=. \
  -Dsonar.host.url=https://rofrano-9000.theiadocker-3-labs-prod-theiak8s-4-tor01.proxy.cognitiv
  -Dsonar.login=sqp_c02d45ac9a10af0999f559d5b6a8879051942d02
```

Please visit the official documentation of the Scanner for more details.

Is my analysis done? If your analysis is successful, this page will automatically refresh in a few moments.

You can set up Pull Request Decoration under the project settings. To set up analysis with your favorite CI tool, see the tu

Check these useful links while you wait: Branch Analysis, Pull Request Analysis.

For the selections, you must choose:

1. Other, (for JS, TS, Go, Python. PHP, …)
2. Linux
3. Copy

Important!

It is very important to copy this command to a safe place! You will see the command that is generated so that you can run the scanner on your code. This command is unique to your project.

Make sure that you save that command somewhere since you will be needing it in a future step!

Step 6: Ready the SonarQube Scanner

It is important to understand that the SonarQube server that stores the results of scans is separate and distinct from the SonarQube scanner which performs the actual scanning. Up until now, we've created a database for storing the analysis results and provisioned a SonarQube server for serving the UI.

To get the SonarQube scanner to work in the Cloud IDE, you can either install it locally or pull its docker image and run its docker container. In this lab, you will be pulling the docker image and running its docker container.

Your Task

1. First, we will use the `docker pull` command to download the `sonarsource/sonar-scanner-cli` image from Docker hub so that it is available locally for use.

   ```
   docker pull sonarsource/sonar-scanner-cli
   ```

   Note: If you don't pull the image, it will be pulled the first time you run the scanner. We are doing this now to save time later.

2. Run the following bash `alias` command in the terminal, which creates an alias `sonar-scanner` for running the scanner later using the `scanner-cli` docker container:

   ```
   alias sonar-scanner='docker run --rm -v "$(pwd):/usr/src" sonarsource/sonar-scanner-cli'
   ```

   Note: This command is mounting the current working directory as a volume at `/usr/src` inside the container, which is where `sonar-scanner` is looking for the source code. You can set this up on your own computer as well.

Any arguments that you pass into the `sonar-scanner` command will be passed into the container version as well. This is how you can easily run commands in Docker containers as if they were actually installed on your computer.

Now that we have the scanner ready let's get ourselves a project to run an analysis on!

Step 7: Getting a Sample Project

You need some code to scan. We are going to use a project from the IBM CI/CD course to scan for security vulnerabilities.

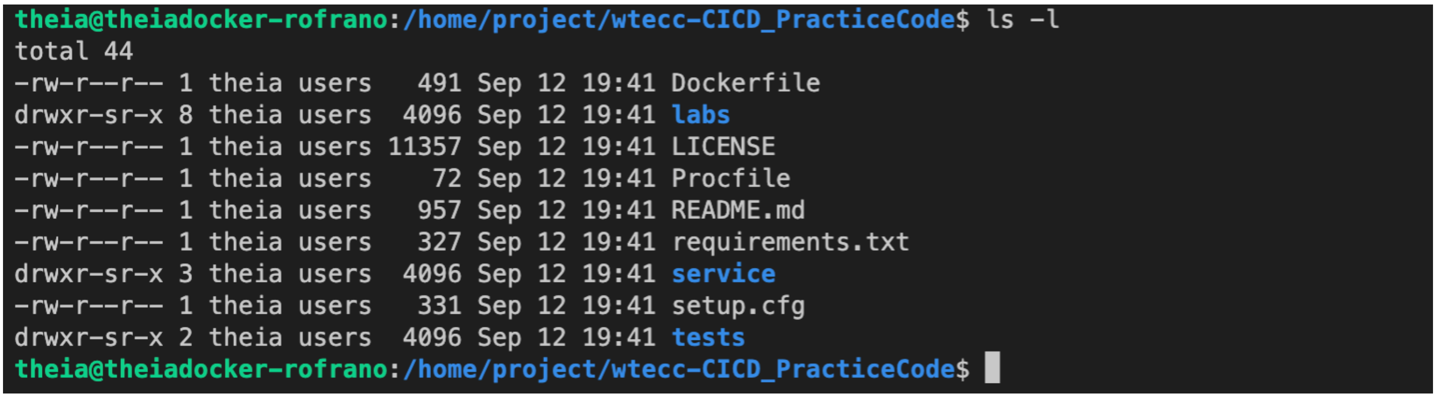
In the terminal, use the `git clone` command to clone a CI/CD python project from its GitHub repository and then `cd` to the `wtecc-CICD_PracticeCode` project directory.

```
git clone https://github.com/ibm-developer-skills-network/wtecc-CICD_PracticeCode.git
cd wtecc-CICD_PracticeCode
```

Use the `ls -l` command to view the files:

```
ls -l
```

You should see the following:



```
theia@theiadocker-rofrano:/home/project/wtecc-CICD_PracticeCode$ ls -l
total 44
-rw-r--r-- 1 theia users   491 Sep 12 19:41 Dockerfile
drwxr-sr-x 8 theia users  4096 Sep 12 19:41 labs
-rw-r--r-- 1 theia users 11357 Sep 12 19:41 LICENSE
-rw-r--r-- 1 theia users    72 Sep 12 19:41 Procfile
-rw-r--r-- 1 theia users   957 Sep 12 19:41 README.md
-rw-r--r-- 1 theia users   327 Sep 12 19:41 requirements.txt
drwxr-sr-x 3 theia users  4096 Sep 12 19:41 service
-rw-r--r-- 1 theia users   331 Sep 12 19:41 setup.cfg
drwxr-sr-x 2 theia users  4096 Sep 12 19:41 tests
theia@theiadocker-rofrano:/home/project/wtecc-CICD_PracticeCode$ 
```

You are now ready to do some scanning.

Step 8: Running the Scanner

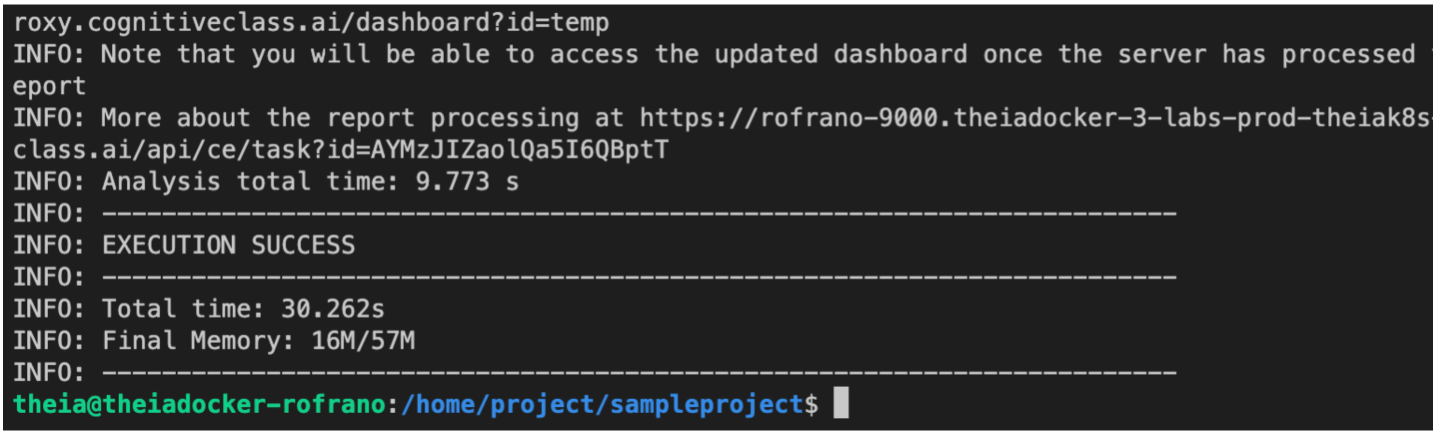
You now have everything you need to conduct a static analysis on the code. In the terminal, run the command you saved from "Step 5: Generate SonarQube Token." It should look similar to the following:

```
### THIS IS AN EXAMPLE ONLY ### DO NOT PASTE THIS ###
sonar-scanner \
   -Dsonar.projectKey=temp \
   -Dsonar.sources=. \
   -Dsonar.host.url=https://{YOUR SONARQUBE URL} \
   -Dsonar.login={YOUR PROJECT TOKEN}
```

Your Task

1. Paste your own command from SonarQube that you generated in Step 5. Your command has all of the parameters, including the project token, to allow the scan to work. Do not use the example code above.
2. Once you hit enter, the scanner starts a static analysis in your current project directory and will run for a while.

When the scan completes, the end of the output should look like the following:



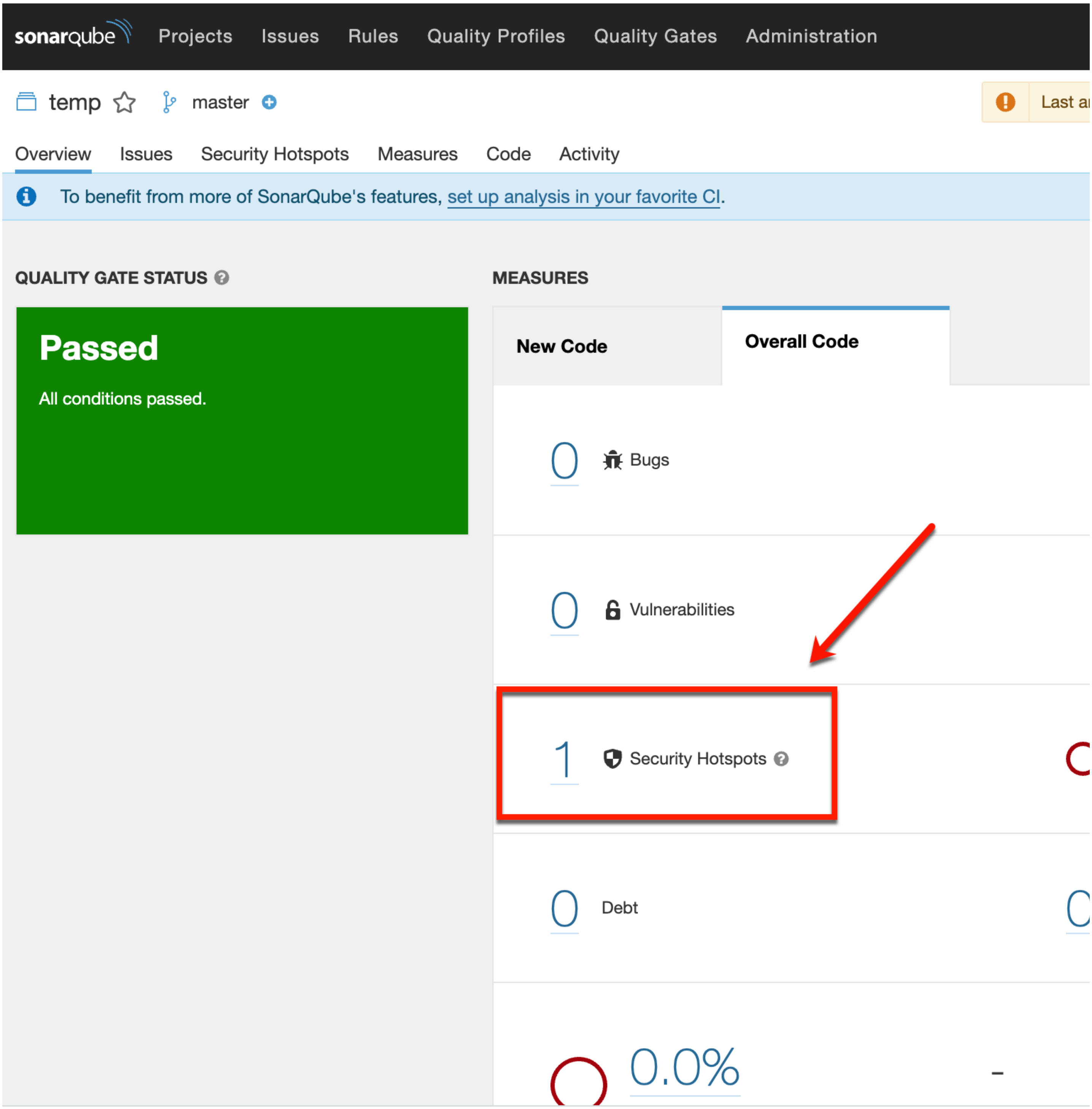
```
roxy.cognitiveclass.ai/dashboard?id=temp
INFO: Note that you will be able to access the updated dashboard once the server has processed 
eport
INFO: More about the report processing at https://rofrano-9000.theiadocker-3-labs-prod-theiak8s
class.ai/api/ce/task?id=AYMzJIZaolQa5I6QBptT
INFO: Analysis total time: 9.773 s
INFO: ------------------------------------------------------------------------
INFO: EXECUTION SUCCESS
INFO: ------------------------------------------------------------------------
INFO: Total time: 30.262s
INFO: Final Memory: 16M/57M
INFO: ------------------------------------------------------------------------
theia@theiadocker-rofrano:/home/project/sampleproject$ 
```

Step 9: Interpret the scan results

Once the code scan and analysis are done, you can view the results on the SonarQube UI. It might be easier to see the results in a new browser window. You can press the `[Launch SonarQube UI in Browser]` button to open a new browser window with the results.

Launch SonarQube UI in Browser

If you view the report, you will see that the overall report is passing, but there is one security item that is flagged.



To benefit from more of SonarQube's features, set up analysis in your favorite CI.

QUALITY GATE STATUS

Passed

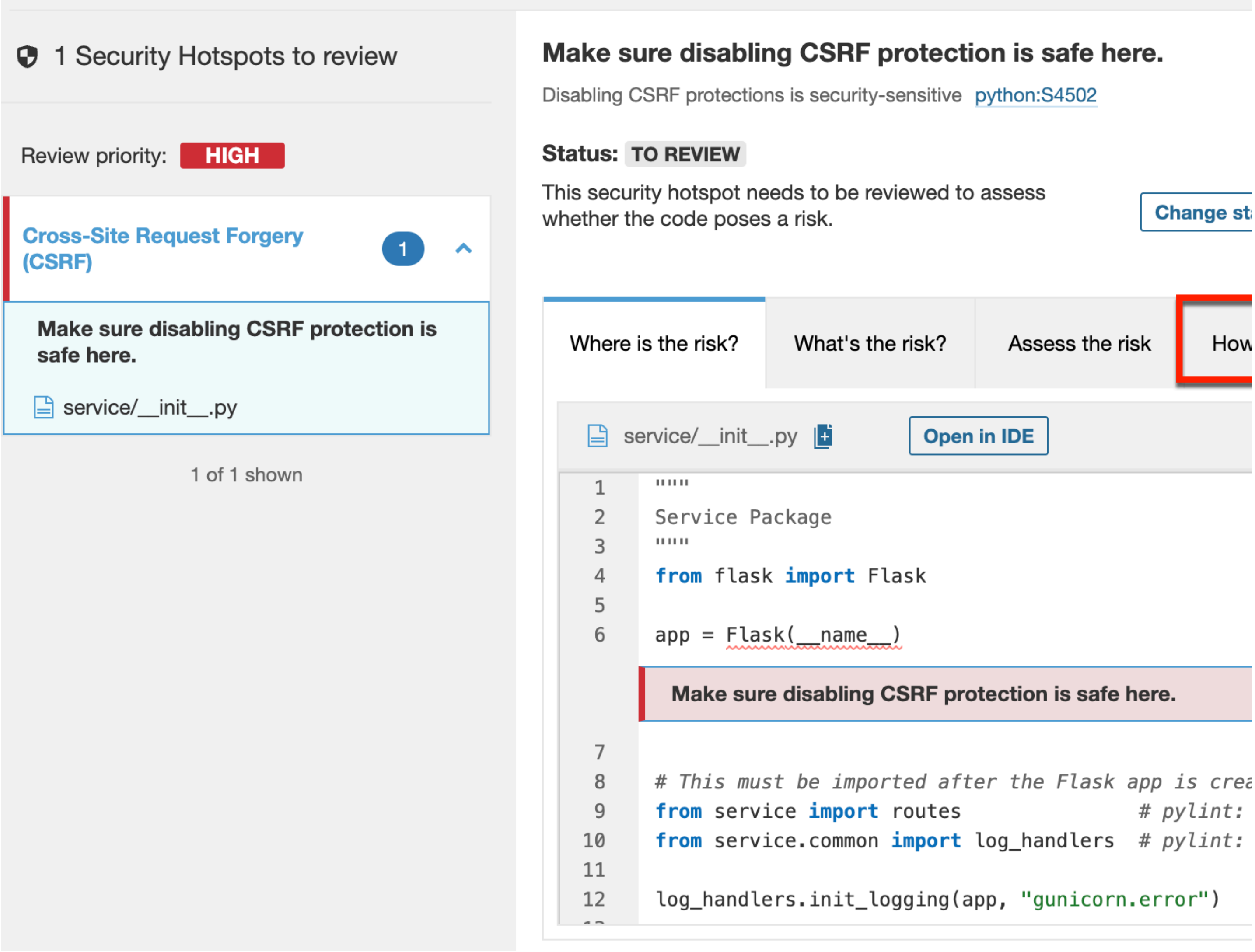
All conditions passed.

MEASURES

If you click the link for the **1** next to **Security Hotspots** you will see some information about it.

Across the top tabs you can see the following labels:

- **Where is the risk?**
- **What's the risk?**
- **Assess the risk**
- **How can I fix it?**



1 Security Hotspots to review

Review priority: HIGH

Cross-Site Request Forgery (CSRF) 1

Make sure disabling CSRF protection is safe here.

service/__init__.py

1 of 1 shown

Make sure disabling CSRF protection is safe here.

Disabling CSRF protections is security-sensitive python:S4502

Status: TO REVIEW

This security hotspot needs to be reviewed to assess whether the code poses a risk.

```
"""
Service Package
"""
from flask import Flask

app = Flask(__name__)
```

Make sure disabling CSRF protection is safe here.

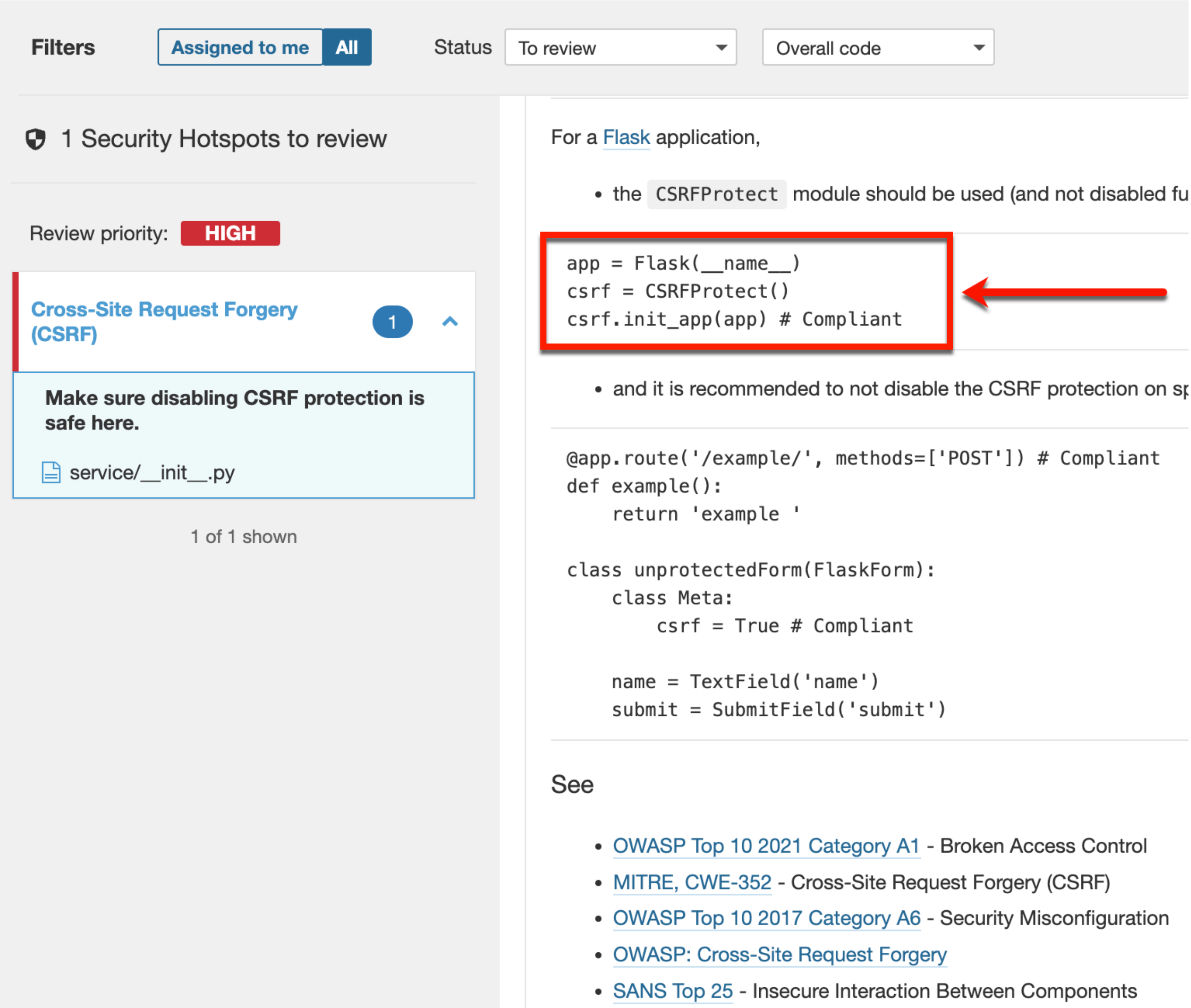
```

# This must be imported after the Flask app is crea
from service import routes                # pylint:
from service.common import log_handlers   # pylint:

log_handlers.init_logging(app, "gunicorn.error")
```

Under the **Where is the risk?** tab, the report is telling you that there is a potential Cross Site Request Forgery (CSRF) risk because the sample code we used didn’t include appropriate security measures to protect it.

Your next question might be, “How can I fix it?” You can find that out by clicking the **How can I fix it?** tab.



Make sure disabling CSRF protection is safe here.

service/__init__.py

For a Flask application,

- the CSRFProtect module should be used (and not disabled fu

```
app = Flask(__name__)
csrf = CSRFProtect()
csrf.init_app(app) # Compliant
```

- and it is recommended to not disable the CSRF protection on sp

```
@app.route('/example/', methods=['POST']) # Compliant
def example():
    return 'example '

class unprotectedForm(FlaskForm):
    class Meta:
        csrf = True # Compliant

    name = TextField('name')
    submit = SubmitField('submit')
```

See

- OWASP Top 10 2021 Category A1 - Broken Access Control
- MITRE, CWE-352 - Cross-Site Request Forgery (CSRF)
- OWASP Top 10 2017 Category A6 - Security Misconfiguration
- OWASP: Cross-Site Request Forgery
- SANS Top 25 - Insecure Interaction Between Components

The **How can I fix it?** tab gives you some things to look out for.

This application is written using the Flask framework. If you scroll down to the section about Flask, it tells you exactly how to use the `CSRFProtect` class to fix the problem, along with some other advice.

```
app = Flask(__name__)
csrf = CSRFProtect()
csrf.init_app(app) # Compliant
```

If this were your original code, you would want to make the suggested changes to your application and run the scan again to be sure that it was fixed.

Conclusion

Congratulations! You have completed this lab on static analysis, which is an integral step in secure app development. You are now well on your way to making your applications safer by running static analysis security scans on them.

You now understand how static analysis can be used to detect vulnerabilities in a project. You also know how to get started with open-source tools like SonarQube to perform static analyses.

Next Steps

Detecting the different kinds of vulnerabilities is just one of the first steps in secure app development. You also need to understand the meaning behind those vulnerabilities in order to take correct actions. There is no better way to learn than by doing.

Your next challenge is to set up SonarQube in your development environment, perform security scans on your code, and fix the problems that it finds. You are well on your way to writing more secure code!

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