OpenRefactory

Intelligent Code Repair
iCR for Java

Private Platform
User Guide 2.0

Release 2.0

Table of Contents

1.0 Introduction

Thank you for choosing OpenRefactory's *Intelligent Code Repair (iCR) for Java (iCR)*. iCR combines source level static analysis and machine learning for examining programs to detect security, reliability, and compliance issues and combines that with behavior-enhancing code refactoring technology to create safe and reliable corrections for those flaws. This results in code free from many serious security vulnerabilities and programming errors.

iCR for Java is offered as both an on-demand service, available through a cloud-provider like Amazon's AWS or Microsoft's Azure, and as a subscription service for private platform deployment. In both versions of the service, customers can choose to analyze and repair projects which are managed by well accepted cloud-based Version Control Systems such as GitHub, GitHub or BitBucket, or projects which are already copied into a project folder.

This User Guide will provide the details about the specific features of the private platform version. For details about the cloud-based service, please refer to the *iCR for Java Cloud Deployment User Guide 2.0*.

In the private deployment version, you subscribe to the service through contact with OpenRefactory. With either a paid subscription or, possibly, a limited time free trial subscription, you will be provided a package that contains everything you will need to operate *iCR for Java*.

The *iCR for Java* package contains the **iCR Navigator, Analysis Engine** and **Reviewer**. You use the Navigator to help you to select the projects that you want to make available for processing. The Navigator launches the Analysis Engine as needed and the Reviewer us used to browse through the fixes that were generated. The reviewer uses a "diff" window so that you can see the original code alongside the fixes that were generated. You can also use the reviewer to browse all the source in the affected file if you wish.

iCR for Java runs on a dedicated server that you provide as a Docker image. It is expected that this server has the Docker container infrastructure installed. From the Docker site: "Docker provides a way to run applications securely isolated in a container, packaged with all its dependencies and libraries." This allows you to install iCR for Java as part of your Development Operations infrastructure with confidence that it will not disrupt your infrastructure. The server may be dedicated hardware within your development network or could be part of private, cloud-based development environment.

This guide will show you how to connect to your Cloud-based version-control system (VCS) with support for both GitHub and GitLab systems. Or you may choose to process projects which are already extracted from the VCS and positioned into project folders.

You select a project for analysis, initiate an analysis of that project, and then review the results. The review process presents to you all the flaws detected and allows you to review each correction whereby you can accept or reject the recommended fix. For accepted fixes, you can then incorporate them back into your project.

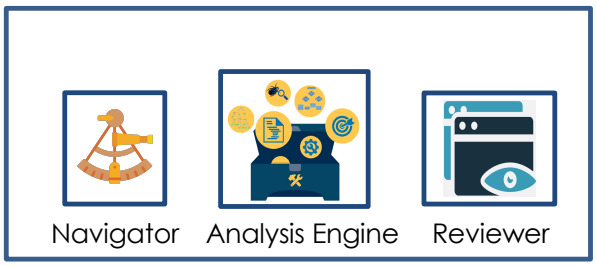
2.0 Overview

The following is a quick overview of how to use *iCR for Java*. It is assumed that you have installed and launched *iCR for Java* from the package that you received from OpenRefactory (see 3.0 Getting Started). It is also assumed that you know the IP address of the host server where you installed iCR for Java.

Using that IP address, connect to the service using a standard browser of your choice.

iCR for Java consists of 3 major components:

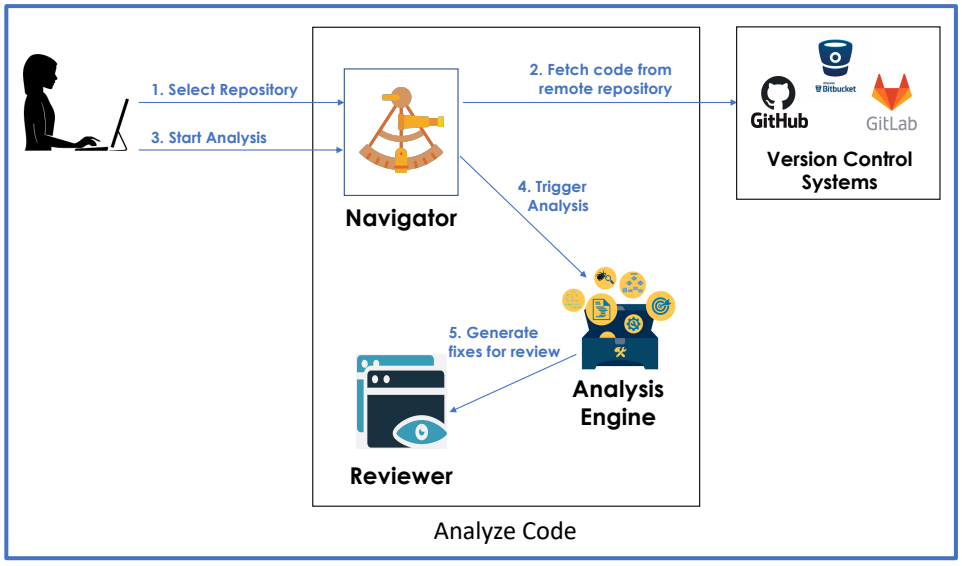
1. The **Navigator** is the main component with which you interact;
2. The **Analysis Engine** analyzes source code and generates fixes;
3. The **Reviewer** helps you to review, approve/reject and apply the fixes.



Using the Navigator, you will:

1. Direct the Analysis Engine to scan the source code of your Java project; and
2. Initiate the Reviewer(s) to examine the generated fixes and accept or reject them.

To understand how each of these steps is executed, let's first look at how to select and analyze a project. Figure 1 outlines the steps taken to select the code to be analyzed and initiating the analysis.



Step 1. Select the repository that you are using to manage your source code. This may be a version-control system (VCS) available on the cloud or as an in-house service. iCR for Java supports your choice of GitHub and GitLab systems. BitBucket will be available in a future release.

Step 2. Navigator connects with the repository and fetches the source code to the server. The Navigator will use OAuth to authenticate with your VCS service. Once connected with the VCS, Navigator will present you with a view of all the available repositories associated with your User ID. You may then clone any repository you wish to examine, and you will have all of the branches available for analysis.

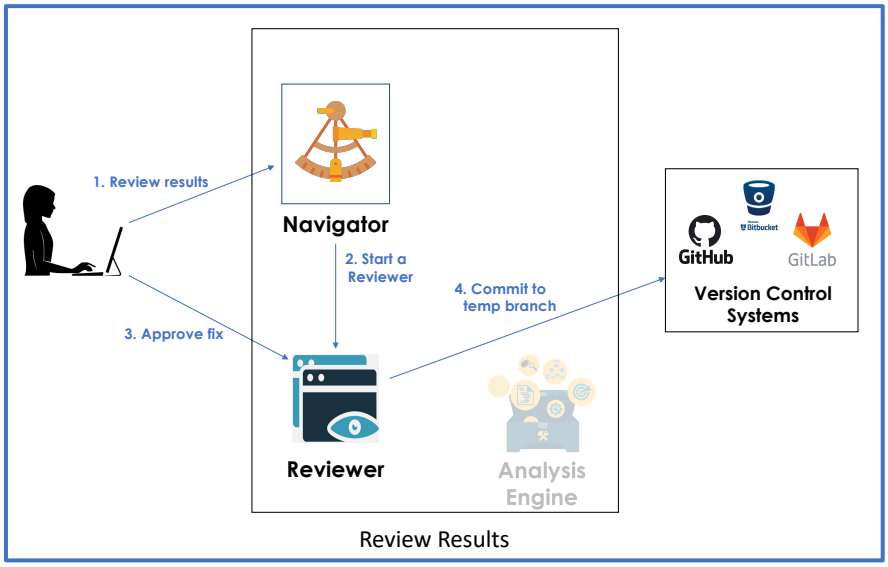
Step 3. Pick a branch to analyze and simply click on the Analyze button on Navigator.

Step 4. Navigator will start the Analysis Engine as a background process. You may monitor the progress from Navigator in a separate browser tab. For a long running analysis, you may choose to receive a notification and exit iCR. Only one analysis can be run at a time.

Step 5. The Analysis Engine analyzes the source code and prepares the fixes. You may choose to have the Navigator send you an email notification when the analysis completes and the fixes are ready.

iCR for Java employs a suite of scalable deep analysis tools to provide a comprehensive analysis of your program's flow with emphasis on tracking references across methods. From that analysis, iCR for Java then employs a broad family of what we call **Fixers** which are focused on common Java programming flaws and coding standards such as the SEI CERT Oracle Coding Standard for Java. See *Appendix A* for a list of supported fixers in *iCR for Java*.

Once a project has been analyzed and fixes generated, they are available for review. The diagram below outlines the steps taken to perform a reviewing session.



Step 1. Return to the Navigator when analysis is complete to review the fixes. Select any branch that has been analyzed and click on **Review** button on the Navigator. You may review past results even when the Analysis Engine is running on something else.

Step 2. The Navigator starts the Reviewer component in a separate tab.

Step 3. The Reviewer allows you to browse all of the fixes and gives you the opportunity to accept or reject various fixes. Any number of your developers can review and approve fixes concurrently. After approving fixes, you can **Apply** them to your project. If there are fixes that you are not clear about or you think are incorrect, you can let our developers know by filling out a quick feedback report for that particular fix.

Step 4. The Reviewer creates a temporary branch in your repository with the potential fixes placed there as `git` commits. This gives you a standard way of choosing when you want to roll these fixes into your project branch(es).

The remainder of this guide will provide you with all the details needed to help you to run *iCR for Java* on your projects.

3.0 Getting Started

3.1 Installing *iCR for Java*

It is quick and easy to get going on analyzing and automatically correcting programming errors in your Java projects. With your iCR for Java subscription (either paid or a possible free trial subscription), you will be sent a zip file with the *iCR for Java* package.

The examples in the guide will be using Linux as the reference platform. Support for platforms other than Linux will be supported in future releases. All of the installation and configuration shown in this section will be performed from a command line interface. So, your first step would be to SSH into your server and login.

Your Linux system must also be configured with two important packages:

1. You must have the `zip/unzip` package. This is frequently already installed on your Linux distribution but, if not, you will need to install it since the *iCR for Java* package is distributed in `zip` format;
2. The iCR for Java framework is designed to operate within a Docker environment. Docker allows you to install packages like iCR on your private Linux platform and know that it will be protected from other software on your system and your network.

   If you need to install Docker, please refer to the Docker installation instructions which can be found here: https://docs.docker.com/engine/install/.

   NOTE:
   Once Docker is installed, you will want to follow the common practice of creating a User Group to allow Docker access without requiring root privileges for each user. To learn how to do that, please refer to: https://docs.docker.com/engine/install/linux-postinstall/. These instructions assume that you have done that so executing the `icrforjava` commands will not require typing `sudo` before each command invocation.

Once your system is configured with the required packages you can install the *iCR for Java* package.

From the command line, copy the provided zip file into a convenient directory. To keep these instructions simple, we will assume that all of the files noted above were expanded from the zip file into the same folder/directory. For the examples used here, we will use:

```
/home/userid/tools/icr
```

as the example folder/directory.

The zip file will contain:

1. `iCR_for_Java-Private_Platform_User_Guide_v2.0`:
   This guide;
2. `icr-for-java.tar`:
   This is the Docker image that implements *iCR for Java*. Instructions on how to use it are detailed in this guide;
3. `license.json`:
   This is your license from OpenRefactory to enable the service;
4. `install-icr`:
   This is the script used to install *iCR for Java* on your host system;
5. `icrforjava`:
   This is the command used to manage your server after installation. Use it to start up your *iCR for Java* service, update configuration values or even remove it from your host server completely;

6. `EULA_for_iCR_for_Java`:
   This is the End-User license which gives you the authority to use the *iCR for Java* on your private platform. You must have read and accepted this prior to receiving and installing this package.

With the zip file expanded, the first step is to install the iCR for Java components. To do that, execute the `install-icr` command. This installation step will require `root` privileges so MUST be done using `sudo`. Run the command as follows:

```
sudo ./install-icr
```

You should see output that looks like the following:

```
034acb3a48e7: Loading layer [==================================================>]  253.1MB/253.1MB
dd925e02d664: Loading layer [==================================================>]  1.313GB/1.313GB
0537bb84bd7d: Loading layer [==================================================>]  720.6MB/720.6MB
Loaded image: icr-for-java:local
```

This will accomplish a number of things for you:

- The Docker image will be installed into your Docker registry under the name `icr-for-java:local;`
- The scripts will be copied to `usr/bin` where they will be accessible to all your developers who have access to your host system;
- The companion files, such as the EULA, will be saved in your `/etc` directory in a new directory named `/etc/icr-data`.

3.2 Managing your service

With the files copied and the Docker image installed, you can begin to run the service. One of the items installed is the `icrforjava` command script. This command is used to stop/start the service, update critical parameters used by the service and to uninstall the software if you need to do that.

The usage model for the command is as follows:

```
icrforjava [-a] [-d] [-l] [-p] [-c <cmd>] <arg>
```

The options can be combined in a single command. However, the `-c <cmd>` should always go last since it is used to invoke server operations.

We'll begin by looking at the first four options.

3.2.1 `icrforjava -a <IP Address>`

The `-a` option is used to provide *iCR for Java* with an IP Address for the server. Typically, the IP address for the server is determined using `localhost`. However, if you are using a cloud-based repository, such as GitHub, there needs to be a way for GitHub to reach the server from outside of the private platform's possibly protected network. In that case, you would need to provide an external public IP address for your firewall to allow GitHub to reach the *iCR for Java* server. You can configure *iCR for Java* with the public IP address using this command.

3.2.2 `icrforjava -d <directory-path>`

The `-d` option is used to anchor *iCR for Java* with the point in your host file system where you plan to store projects for local access. While you may access GitHub or GitLab to process repositories managed by those systems, you may also want to analyze and review projects resident in your local file system. You can also include directories that may be attached via a network attached storage and mounted into your file system. The default anchor point is the /`home` directory under which user directories are normally located within Linux.

3.2.3 icrforjava -l <license-key>

The `-l` option is used when there is a need to update or replace your activation license. This might happen if you need to move the service to another host. The license is activated when you first run *iCR for Java* (not when it I installed) and connect to the Navigator for the first time. After that, your service is node-locked to the host computer. Should your license become damaged or unusable, this is a way for us to provide you with a new license.

3.2.4 icrforjava -p <default-passphrase>

The default passphrase for *iCR for java* is set to: `icrforjava`. When you first login to the service, you use the default passphrase to gain access to the Navigator. If the passphrase is set to the default, you will be prompted each time you connect to the Navigator to change it from the default to some other practical passphrase.

Using the `-p` option allows you to reset the passphrase back to the original default or a new default phrase as specified by the string `<default-passphrase>` that you provide. Just remember that, if you change the default, the Navigator will check to see if the default passphrase is in force and will continue to prompt you to change it.

3.2.5 icrforjava -c <cmd>

The previous four options were used to update or change some configuration values. To actually operate *iCR for Java* you use the `-c <cmd>` option. There are three specific `<cmd>` values that can be used to control your server's operation:

- `icrforjava -c start`
  This is the command that is used to start the *iCR for Java* server. It assumes that you have successfully installed the service on your host machine using `install-icr`. It starts the Docker image from scratch. The first time that `start` is invoked, the service will be node-locked to this host using the license provided in the package that you received. The default passphrase will be used to access the Navigator for the first time. The default string is: "`icrforjava`". You will be prompted to change it once you access the Navigator.

- `icrforjava -c stop`
  The `stop` command is used to stop the running instance of *iCR for Java*. The Docker container is stopped and any activity in progress is interrupted. For example, if the service is stopped during an analysis, that analysis will be abandoned. All results from previous analyses, however, are still available and can be viewed again once the service is restarted using the `start` command.

- `icrforjava -c uninstall`
  There may be cases where you wish to remove *iCR for Java* entirely from your host system. If so, run the `uninstall` command. This will remove all of the Docker information as well as the directories that were created as part of the `install-icr` process. All results from analyses will be removed. Please be certain that you want to remove everything if you decide to run this command. If you need to restore *iCR for Java*, and you have kept your original package, you can re-install the service using the `install-icr` command again.

3.2.6 Opening Ports

iCR for Java uses a browser interface to interact with the Navigator and the Reviewer. It may be that the host system for the service is behind a firewall or has security restrictions applied to it to limit network access. For the service to run correctly, a number of TCP ports must be open to the server. Some of these ports may already be open as they allow, for example, remote logins over SSH or other browser access. A couple of the ports are unique to iCR for Java. The ports that you need to have open are the following TCP ports:

1. **22** – This is the SSH port to allow you to access your server. You use this to securely login into your host system to be able to run the *iCR for Java* commands.

2. **80** – This is the regular HTTP port to allow browsers to access your server.
3. **443** – This is the secure HTTPS port to allow browsers to access your server.
4. **3002** – This port is used by your Browser to work with the Navigator.
5. **3003** – This port is used by your Browser to work with the Reviewer.

3.3 Accessing your source code

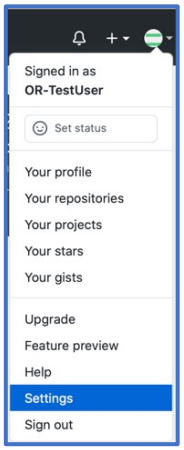
iCR for Java is designed to work with source code managed by industry leading version-control systems (VCS). In this release, iCR supports GitHub and GitLab. iCR also allows you to copy or upload a project source tree to your server and analyze it that way if your source code is managed off of the cloud.

Assuming that you are using a cloud-based VCS, you need to authorize *iCR for Java* to access your projects. Once you are logged into your source code control system, iCR will connect to your specific repositories and analyze the specific project branches that you identify. In order to do this securely, and to ensure that OpenRefactory NEVER has access to your Users' login credentials, we employ the industry standard protocol: OAuth[1].

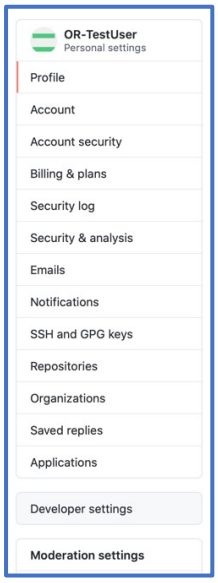
From Wikipedia: "**OAuth** is an open standard for access delegation, commonly used as a way for Internet users to grant websites or applications access to their information on other websites but without giving them the passwords."

To allow iCR to use OAuth, you must authorize it with your VCS. For these examples, we will be using GitHub. Similar steps are available for GitLab (see Appendix B for details).

To register a new OAuth app in GitHub, login into GitHub and traverse to "*Settings*"->

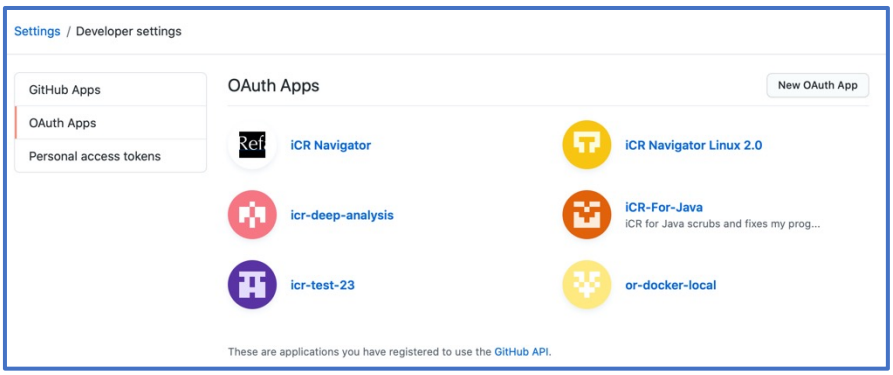


[1] OAuth reference: https://medium.com/security-operations/what-is-oauth-and-why-should-i-use-it-5aa2f27ce387

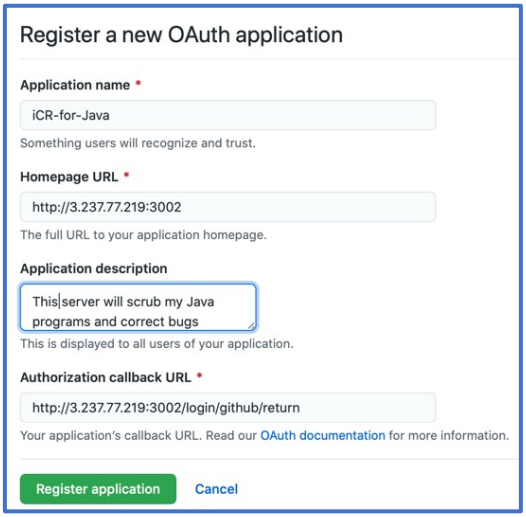


<- Then, select "*Developer settings*"

From here, click on "*OAuth Apps*". This will open the page allowing you to add *iCR for Java* to the set of approved third parties from which you will accept login redirect requests.



Clicking will open the window shown to the right.



You can enter a helpful string, such as "*iCR-for-Java*" for the Application name. The Homepage URL will need to use the IP address of your host system. For the purposes of this guide, we will use an example IP address, `http://3.237.77.219`.

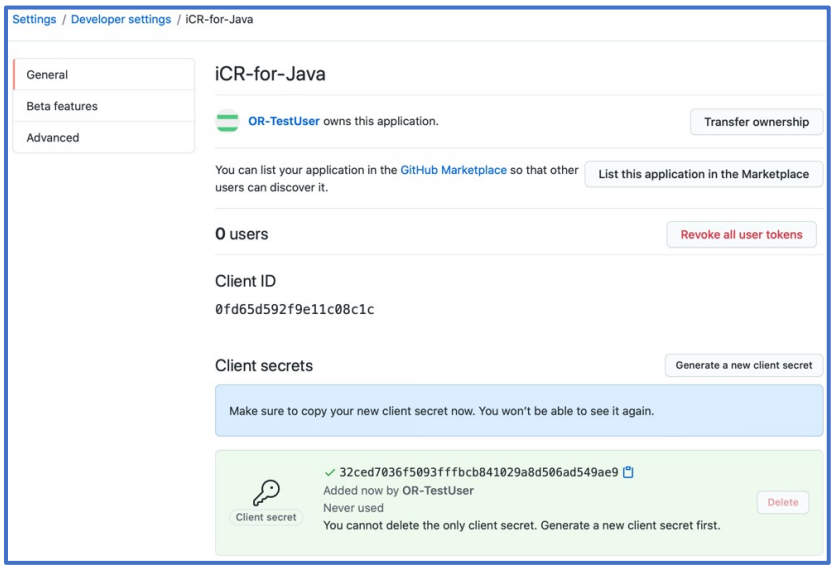
iCR uses port 3002 to communicate with the browser, so that needs to be added to the IP address to create the Homepage URL.

Using the sample IP address, you would enter:
`http://3.237.77.219:3002`

The application description is optional so you can leave it blank. Note that this information will not necessarily be seen by anyone logging into GitHub. Once the OAuth app is created, Users will log in to GitHub using their private credentials and will not see this information.

The Authorization callback needs to provide the server's URL of the callback, so, enter:
`http://3.237.77.219:3002/login/github/return`

Clicking on “Register Application” opens a window that asks you to create the secret keys that you will use on your server to authenticate it with GitHub.



You will need both the client ID (`0fd65d592f9e11c08c1c`) and the client secret (`32ced7036f5093fffbcb841029a8d506ad54ad549ae9`). Copy and paste these values in a convenient place as you will need to present them to the Navigator when you first select GitHub as your preferred repository, as described in Section 4.5 Selecting your source code.

A similar process is used to allow access for GitLab. Details of that are given in Appendix B.

With this information setup, you are ready to connect to *iCR for Java* for the first time.

4.0 Using the Navigator

This section will introduce you to the iCR Navigator, which is used to help you manage you project analyses. It assumes that you are familiar with the Getting Started procedures outlined in Section 3 and have already installed *iCR for Java* on your host server. You know your server’s IP address, and have created the OAuth credentials to allow your developers to securely log into your cloud-based version-control service (VCS).

In the examples to follow, we will work with GitHub as the example cloud-based VCS.

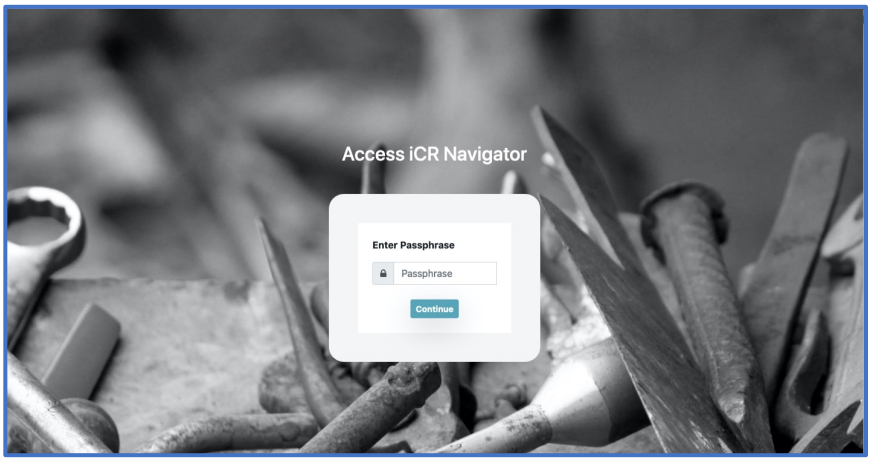
4.1 Connecting to the Navigator

The *iCR for Java* service is accessible using any industry standard browser such as Chrome, Firefox, Safari or Edge. To begin working with iCR, you need to access your server via the browser. It is reached using your server’s IP address. In our examples we are using `3.237.77.219` as the public IP address. ICR uses port 3002 to reach the Navigator which is the application that will help you to manage your interactions with *iCR for Java*.

Access the Navigator by entering your Server IP address followed by port 3002 into your browser. Using our IP address as an example, this is the URL to enter:

```
http://3.237.77.219:3002
```

Entering this URL will take you to the welcome screen for *iCR for Java*:



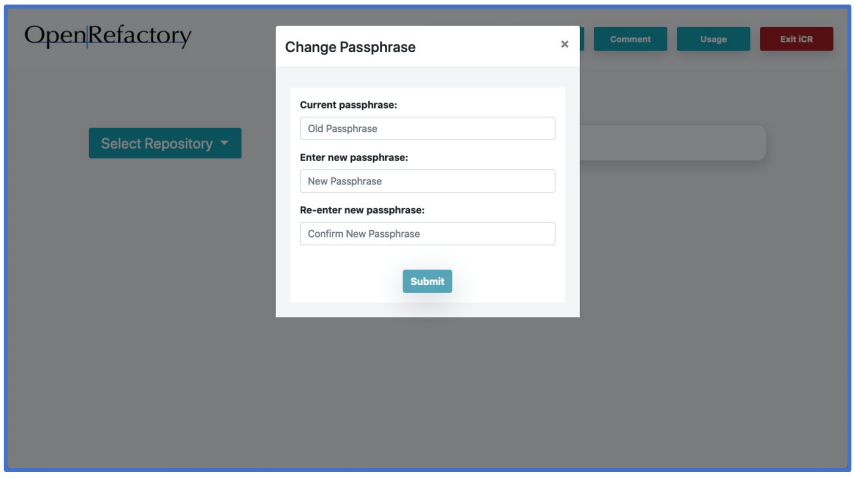
You are presented with a window that prompts the user to enter a passphrase. Since the IP address to your Server is public, it is possible to have uninvited "guests" attempt to access your service. To protect the service from unwanted access, you must enter the secret passphrase before you can access the service. The initial, default passphrase is set to `icrforjava`.

NOTE: You can reset the default passphrase to a different string if you wish using the command
`icrforjava -p <default-passphrase>`.

So, type in the default passphrase:
`icrforjava`
to enter *iCR for Java*.

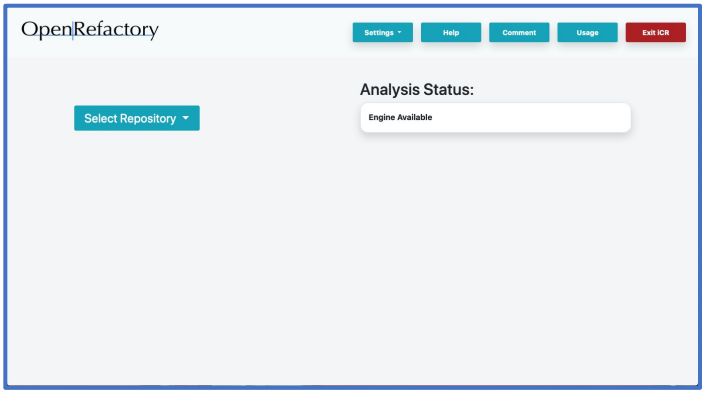
4.2 Setting your private passphrase

Entering the passphrase will bring you to the Navigator where you will be prompted immediately to alter the passphrase to something other than the default. The phrase should be at least 8 characters long and you may use any alphanumeric values as well as special characters.



4.3 The Navigator top banner

Once the passphrase is updated, you are presented with the Navigator Home screen. From here, you can select and open project repositories with your projects, analyze one of more branches of any of these projects and then, following analysis, you can review and apply corrections to flaws detected in those branches.

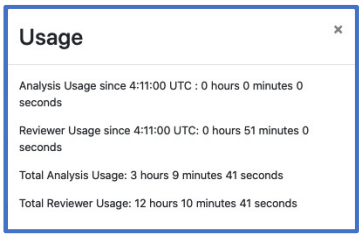


At the top of screen, on the right side, you see 5 buttons:

- **Settings**
- **Help**
- **Comments**
- **Usage**
- **Exit iCR**

The **Settings** button is used to change the main passphrase and to update OAuth credentials if you have chosen to modify those. The **Help** button will take you to the OpenRefactory Website where you can download help documents, such as this guide, and view the Video Tutorials to help you learn how to use *iCR for Java*. The **Comment** button allows you to send your feedback to OpenRefactory. Your feedback helps us to improve the interface and also helps us to improve the quality of the service by getting feedback concerning potential false positives or improvements on the Fixers.

The **Usage** button helps you to learn how much time you have spent doing analysis and reviewing. This gives you the knowledge of how much time you have accumulated doing both Analysis and Reviewing Fixes.

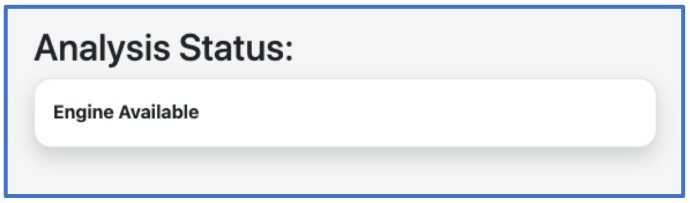


Finally, the **Exit iCR** button takes you out of iCR for Java and back to the *iCR for Java* welcome screen. To re-enter, you would, of course, have to enter your new passphrase.

These buttons will be presented on all other screens in the application so that you can always **Exit iCR** at any time or provide feedback and get help. You may only change the settings from this Home Screen, however.

4.4 The Analysis Engine status

Below the top banner, the status of the Analysis Engine is displayed on the right side. Since the analysis process is very RAM and CPU-intensive, iCR currently only support one analysis at a time. The status window lets you know that the engine is available for a new analysis. Or, if an analysis is in progress, it will display a brief summary of the ongoing analysis.

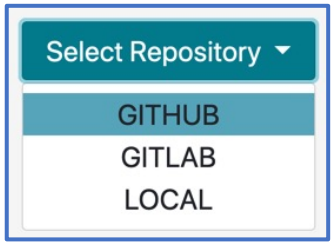


The status shown on the left indicates that the Analysis Engine is available for use.

4.5 Selecting Your Source Code

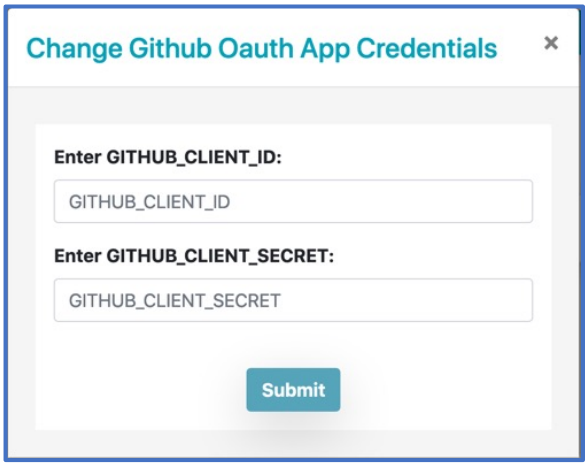
Below the banner on the left side opposite the Engine Status is where you start the process of selecting your source code to be analyzed or reviewed.

Your first step is to select the repository where your project resides. *iCR for Java* is best used when working with a commercial Version-Control System (VCS) like GitHub or GitLab. The button is a drop-down menu from which you can select your VCS. Or you can set up a path to a local directory on your server where you have uploaded your project.



4.5.1 Using a Cloud-based VCS

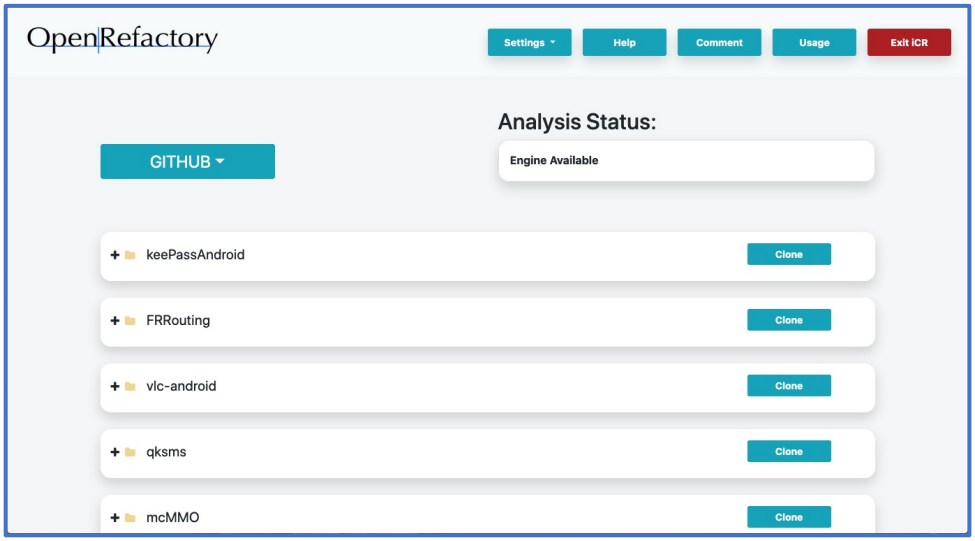
From Section 3.3 Accessing your source code, you will have already set up the OAuth credentials to allow logins to your preferred VCS. Assuming that you have done that, select your VCS from the pull-down menu. For our examples, we will be using GitHub.



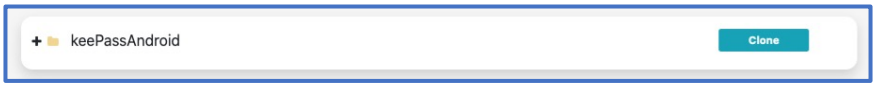
The very first time a user attempts to reach GitHub following the OAuth configuration, the Navigator will pop up a window requesting you to enter the Client ID and Secret keys from the OAuth configuration. As explained in Section 3.3 Accessing you source code, hopefully you copied the Client ID and Secret somewhere so that you can enter them here. Once done, users may login into their GitHub accounts without needed to repeat this process.

If there is some reason to change the OAuth Client ID and Secret, you can get back to this window using the **Settings** button on the main menu.

If you are already logged into GitHub from earlier activity on your browser, then your repository will become available right away. Otherwise, you will be redirected to the GitHub Website for Authentication. Once logged in, you will now see all of your available GitHub projects.



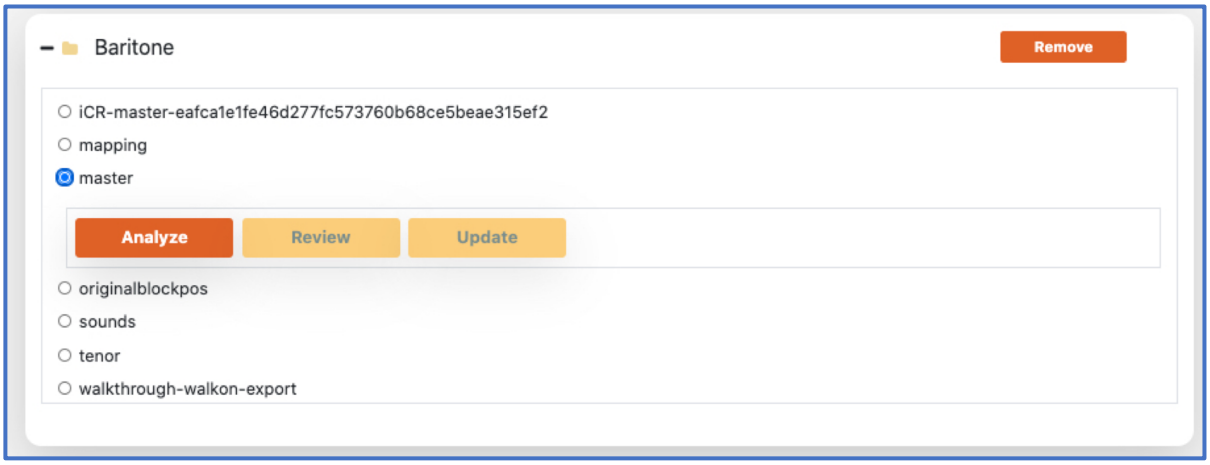
Each project is presented with a "+" sign so that you can open it up to view its branches. Before you can browse the project branches, however, you need to "clone" a copy of the project from GitHub. The **Clone** button is to the right of the project name box.



For our example, we will use a project called Baritone, which we show below as cloned and ready for analysis. Note that, once cloned, the **Clone** button is replaced by **Remove**. This provides you with a way of removing a project if you desire. When you remove a project, however, note that ALL RESULTS WILL BE

REMOVED. That is, any analysis that you have performed and not applied to your project will be lost. Clicking on the "+" will enumerate all of the available branches:

In our example, the Baritone project shows many branches. Only one branch at a time can be selected. That is reflected using the radio buttons to choose which branch to examine. Let's look at the master branch.



Selecting its radio button causes three new options to appear:

- **Analyze**
- **Review**
- **Update**

The first button, **Analyze**, is always available and allows you to perform an analysis on the branch. Clicking on it will take you to the Analysis screen which will display status on the ongoing analysis. Section 5.0 will describe the Analysis Engine further.

The second button, **Review**, is not available unless one of more analyses of this branch have been executed. Once an analysis is complete, you would want to click **Review** so that you can begin the process of looking at the detected problems and the corrections that iCR has provided. Section 6.4 Handling Resultscovers the details of the Reviewer within *iCR for Java*.

The third button, **Update**, is made available when the current status of the branch is out of date with the currently checked-in status. That is, it may be "behind" the current master copy of the branch on the VCS repository. This is not unusual in that your developers may be working with a branch while others are also working on it. If you have made updates to the branch using the Reviewer those changes may already have been incorporated into the "master" branch.

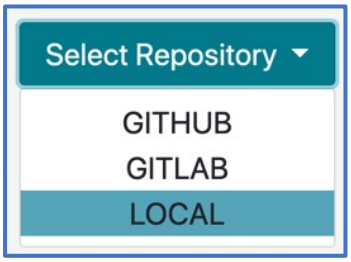
Even though you may not have completed reviewing all of the corrections offered in the last analysis, you may decide to interrupt that process and perform a more up-to-date analysis using the latest "master" version. If so, you can select the **Update** button. This will cause the Navigator to pull-down the most recent version of source code to the *iCR for Java* server.

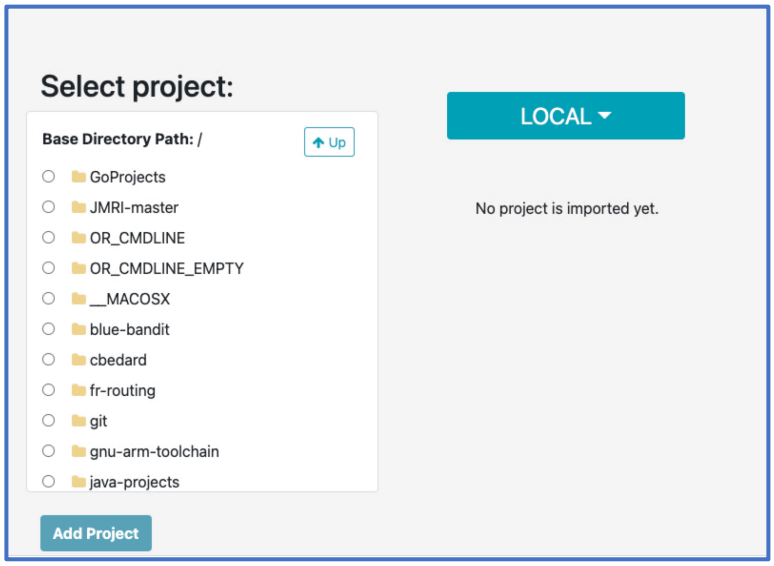
Naturally, this will make further review of the old source invalid and so should be followed by a click of the **Analyze** button, to perform a new analysis of the updated source code. In such a case, you may also decide to simply **Remove** the project entirely and **Clone** it again. Doing so removes all past history of earlier analyses.

4.5.2 Using a local project

You may choose to not access source code from a cloud-based repository. *iCR for Java* also supports accessing projects that are accessible directly on your server. Any of your developers may be given login access to your server. From a shell console, you can upload projects to it or, you may mount a network attached file system. In this case, it would need to be mounted as a subdirectory of your configured anchor point in the file system.

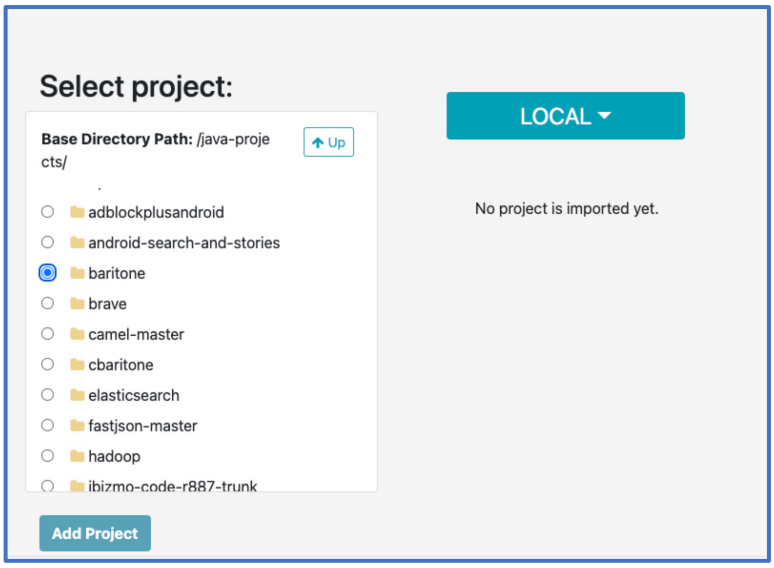
To select one of these local projects instead of a Git repository, choose the "LOCAL" option on the "Select Repository" drop-down menu.





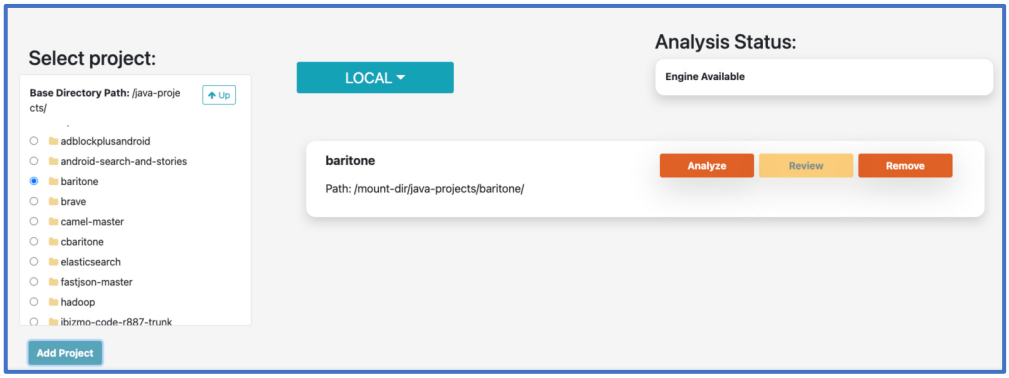
Selecting this option brings up the **Select Project** window on the left side of the screen. By default, it is anchored at `/home`. However, you can reposition this anchor point using the `icrforjava -d <directory-path>` as noted earlier in Section 3.2.2.

From the **Select Project** frame, you can scroll down through directories and subdirectories looking for the desired project for analysis.



In this example, we will select a project called `baritone` which is located within the directory `java-projects` (which is displayed as the **Base Directory Path**).

Clicking on **Add Project** brings the project into our list of available projects.



Now the project has been added to the list of locally accessible projects available for analysis. Note that the **Analyze**, **Review** and **Remove** buttons are now available. The **Review** button is grayed out until an analysis is complete and results are available for review.

The **Remove** button allows you to drop this project form the list of available projects.

Note:

If you choose to remove a project ALL OF ITS RESULTS will also be deleted.

You can add as many projects as you wish.

5.0 Using the Analysis Engine

iCR for Java supports the analysis of projects being managed by Cloud-Based services such as GitHub or GitLab as well as locally accessible projects. For the purposes of demonstrating the Analysis Engine and the Reviewer, we will use examples using the cloud-based repositories. The behavior when using locally accessible projects is nearly identical and should be easy to infer from the following descriptions.

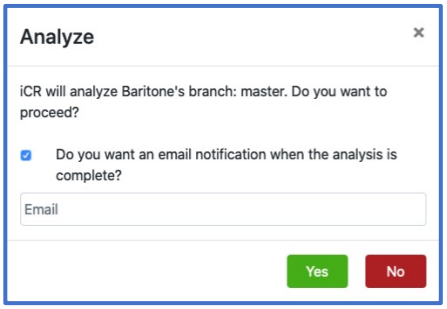
5.1 Initiating an analysis

To begin the analysis of a project, you will have logged into your Version-Control System (VCS) such as GitHub, which is being used in our examples. You connected to the Navigator using your server's Public IP address and port 3002 (See 3.0 Getting Started). Once connected to the Navigator, you selected the project you want to analyze, Cloned it and then selected the branch that you wish to analyze (See 4.5 Selection Your Source Code).

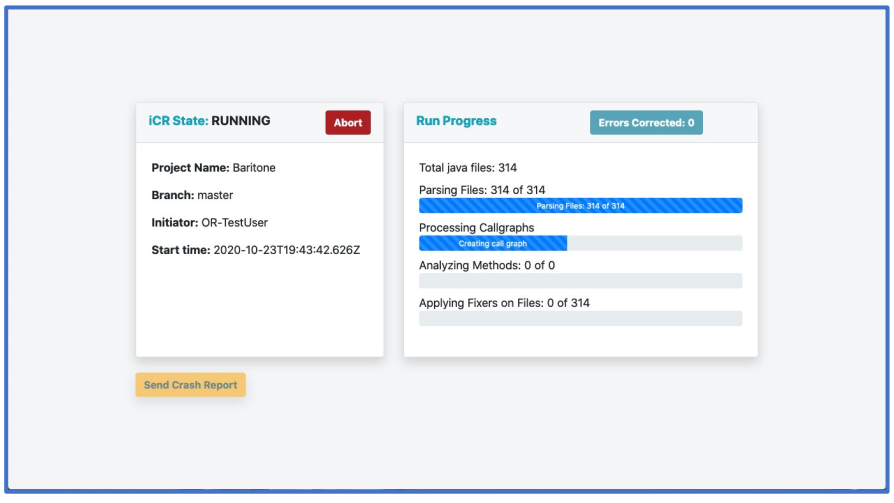
To begin the analysis of the branch, click on the Analyze button.

Smaller projects (< 100,000 Lines of Code) tend to be less complex in terms of number of files and methods. These may be analyzed within minutes. However, larger projects (> 1M LoC) may take much longer to analyze. That's OK. You don't have to sit and watch as it could take many hours for a large, complex project to be thoroughly analyzed.

Clicking the **Analyze** button gives you the option of requesting an email notification when the analysis completes. If you select the box requesting a notification, an email prompt is displayed. Enter the email to which iCR will address your notification.

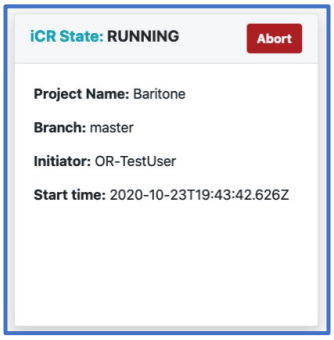


To begin the analysis, click **Yes**. A new tab opens which takes you to the Monitor Analysis screen.



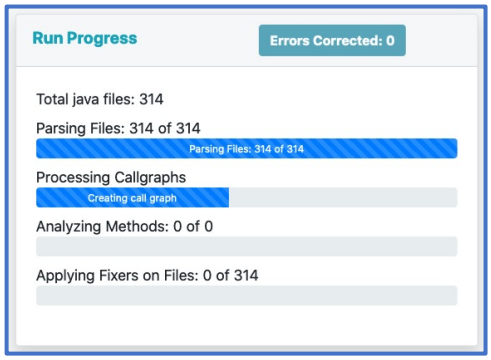
5.2 Monitoring the analysis

This Monitor Analysis screen displays the progress of the analysis of a project.



The window on the left displays information about the project including:

- The current state of analysis;
- The name of the project;
- The branch within that project being analyzed;
- The User ID of the User who initiated this analysis;
- Time when the analysis began;
- There is also an **Abort** button to stop the analysis.



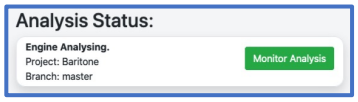
The window on the right displays the phases of the analysis and their progress. A total count of the number of errors that have been corrected so far is at the top of the window.

Various phases of the analysis are shown with progress bars to give you a sense of how far the analysis has progressed.

Once analysis completes, the end time is added to the state display.

While you may choose to watch the Monitor Analysis display, as noted earlier, analysis make take a long time for complex projects. In some cases, it may take many hours. So, you can go back to the Navigator tab and **Exit iCR** and return when you are notified that the analysis is done. Or from the Navigator, you may choose to review the results from an earlier analysis in a different project or branch.

If you return to the Navigator home screen, you will see that the Analysis Status has changed.



The status now shows that there is a project running. The name and branch of what is being analyzed is displayed. You will also note that a new button has appeared. It is the **Monitor Analysis** button. Clicking on this button will open a new Monitor tab so that you can check up on progress.

5.3 Interrupting the analysis

It could happen that you started an analysis on a project with the wrong branch and want to start over. Or, after watching the progress for some time (remember, many large and complex projects could take many hours to analyze) you may decide to abandon the analysis.

In either case, you may decide to **Abort** the analysis. If so, click on the **Abort** button at the top of the left window. This will terminate the analysis. If you terminate the analysis you will lose any information you produced to that point.

You can help out OpenRefactory determine if there was an issue with your analysis by clicking on **Send Crash Report** which is the button at the bottom left of the left window. Selecting this is at your discretion but it will help us to help you complete your analysis.

When clicked, a crash report window appears. You can enter the experience that you encountered as to why you aborted the analysis. For example, it could be as simple as “I was analyzing the wrong branch”. Or it may be that you thought the analysis was not progressing.

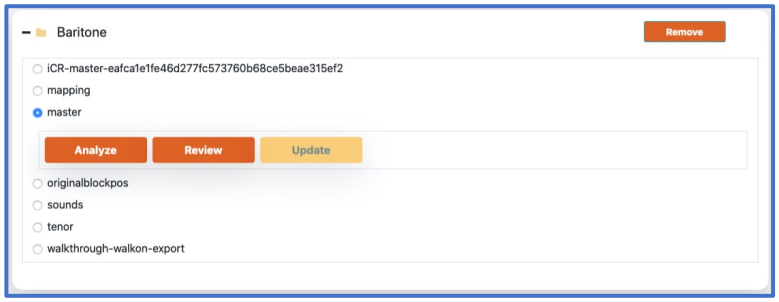
In the latter case, we request that you consider clicking on the option labeled "*Send the console log of the run*". From the log, we may be able to determine whether the analysis was in the wrong or if it was progressing but just taking longer than you expected.

We want to be clear that the log may contain various snippets of your source code such as Method and Class names. We made this optional so that if you have a concern about OpenRefactory seeing even a tiny fragment of your source code, you can refuse to forward the log. Of course, this means that we will not likely be able to determine the cause of a failure if one occurred. But we believe that having you retain complete control of your source code is necessary for you to be able to trust that we treat your code with the utmost privacy.

Once your analysis for each project is complete and fixes have been applied, you can stop your server or keep it running for others to use.

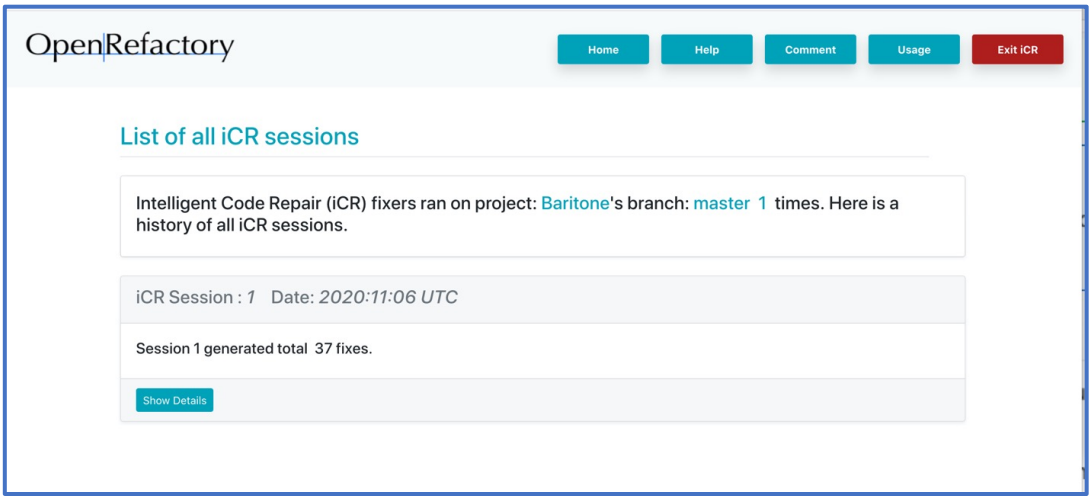
6.0 Reviewing Your Results

Once you have completed an analysis of one of your project branches, you can use the Navigator to begin reviewing the results. Using our earlier example project, following completion of the analysis on the master branch, the Navigator now shows the **Review** button as being available.



Clicking on the **Review** button will open a browser tab with a new Reviewer screen. Notice that the top banner from the Navigator screen is also available in the Reviewer, with one exception. The **Settings** button is gone and replaced by the **Home** screen. This allows you to return to a Navigator from this same tab. This is convenient if you have closed the Navigator tab following the initiation of a Reviewer session.

The initial screen displays a summary of all previous analysis sessions (if any). You may have run the ICR Engine more than once. It is helpful to repeat the analysis as you make changes to your code base. Subsequent runs may reveal new issues that were introduced with the changes in the code base. The sessions will be listed with the most recent at the top of the list and will have the highest Session number.



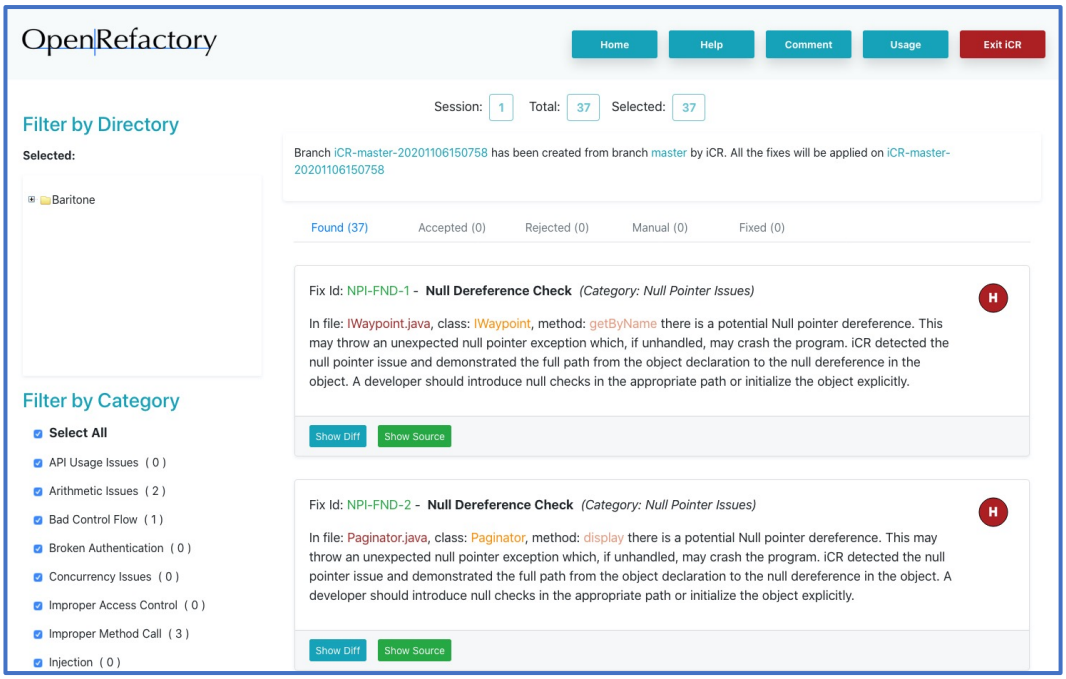
To view the results of any previous analysis, click on its **Show Details** button.

While you can select the results of any past session, only the most recent will permit the user to make changes. Results from older sessions may only be viewed.

In the example above, we will be reviewing the initial set of results that we just produced so will click on the **Show Details** button at the bottom of the "iCR Session: *1*" box.

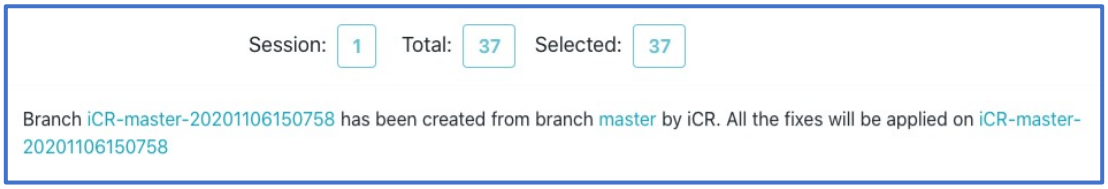
6.1 Reviewer summary and filters

The Reviewer results are displayed using a combination viewing panes with filters.



The window is divided into 3 panes. At the top left is the *Filter by Directory* pane. Below that is the *Filter by Category* pane. Finally, to the right of both of the filter panes is the *Fixes* pane.

The top portion of the *Fixes* pane displays a quick summary of the results. The Session number, the total number of fixes produced by the analysis is shown along with information about which fixes have been selected for display. At launch, all fixes are displayed by default.



The branch name that was the subject of this analysis is also displayed. More importantly, there is an additional branch name displayed. When you accept and then apply fixes, the Reviewer will create Git commits and apply them to a new, temporary branch in your repository. This allows *iCR for Java* to automatically update your source code in a fashion that allows you to prepare and review pull-requests before merging them into your actual project branch. In this example, the temporary branch is named: iCR-master-20201106150758.

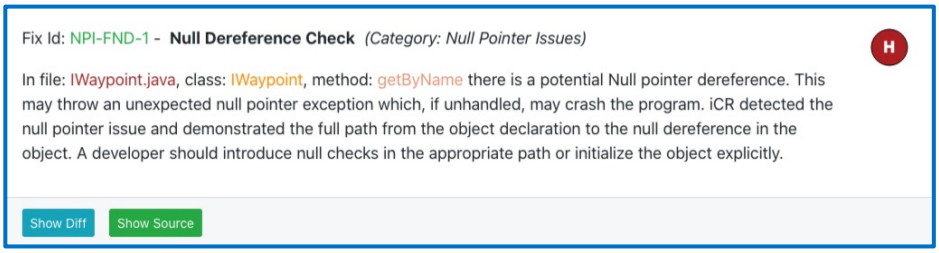
The tabs summarize the states of the various fixes. When the Reviewer is first launched following a fresh analysis, all the fixes generated are accounted for in the *Found* tab. It shows the total number of fixes (37, in this example). The other states of a fix are:

- *Accepted* – This fix has been approved for future application to the code base
- *Rejected* – This fix has been rejected
- *Manual* – There were conflicts in accepting all of the fixes so some manual intervention will be required
- *Fixed* – These are fixes that have been accepted and applied to the code base. Their state can no longer be changed

Note that each of the above tabs will show the total number of fixes in that state. If there are no fixes in that state, the tab will be inactive. How the state of a fix is modified will be described in a later section.

Up to 10 fixes are presented at any one time. The bottom of the *Fixes* pane shows the number of pages of fixes available for review and allows navigation across the pages. Also, the summary bar at the top of the page will not scroll off the top of the pane keeping the summary and the various state tabs available all of the time.

Each fix is identified with a unique Fix ID to help to distinguish each fix as it moves through the system. In this example below, the fix ID is NPI-FND-I. There is a title for the fix: **Null Deference Check**, and the category within which this fix belongs: *Null Pointer Issues*.



There is also a description of the fix which includes the file name where the fix was produced: IWaypoint.java, the particular class: iWaypoint and the method: getByName. This information makes it easier for you to find the specific place in the code where the fix is being applied.

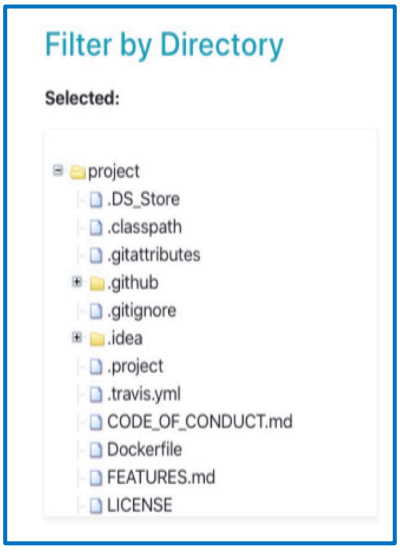
In the top right corner of the box is an icon that presents OpenRefactory's view of the risk associated with the bug being corrected. There are three levels of risk being assessed:

- H High
- M Medium and
- L Low

Higher risk bugs represent flaws that represent greater potential vulnerabilities if not corrected.

6.2 Filter by Directory pane

While this example "only" shows 37 fixes, larger projects may uncover many more fixes to be reviewed and eventually applied. As such it is helpful to be able to narrow the set of fixes to be reviewed.

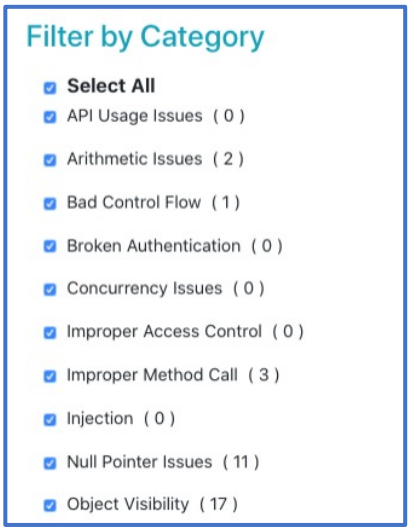


One way to limit the fixes to be displayed is by selecting a subset of the files to be viewed. The *Filter by Directory* enables that. To navigate the directory structure and locate subdirectories of files, simply click on the "+" next to each folder to display the next level down. In our example, here is the view of the expanded "project" directory. Clicking on a folder will only display fixes from within that folder and its sub-folders. Clicking on a single file will limit the display to fixes that only apply to that file.

The pane is scrollable so that you can see to any depth of directory that you wish.

6.3 Filter by Category pane

Another way to filter the set of reviewable fixes is by constraining the various classes of fixers that are to be reviewed using *Filter by Category*. When the Reviewer is first launched, all of the categories are selected by default. This is indicated by showing that the "*Select All*" box is checked, and each individual category box is checked.



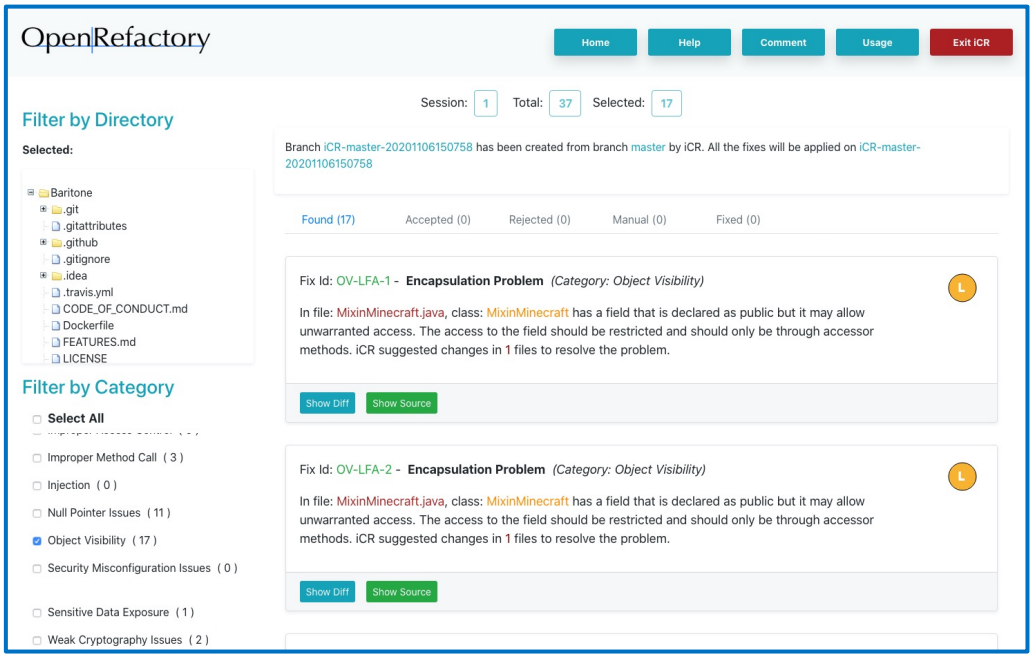
When all categories are selected and the entire project directory is selected, the summary will show all fixes that are available for review. In this example, that is 37.

Category filters are combined with the directory filter to limit the fixes summaries to only those fixes within that directory subtree AND the selected categories.

You may want to ONLY review fixes in a single category. In this case, you may click on the *Select All* option. Doing that deselects all of the categories. Then, you can click on only the one (or multiple) categories of particular interest. Clicking *Select All* will reset the category filters and all fixes will be displayed again.

If there is a directory subtree selected, only fixes in that category within the selected subdirectory or file will be shown.

In the example provided here, we have selected only those fixes in the *Object Visibility* category. Because of that, the summary at the top of the *Fixes* pane is updated to reflect that now, only 17 fixes are selected for review. Note that the *Found* tab also reflects this.

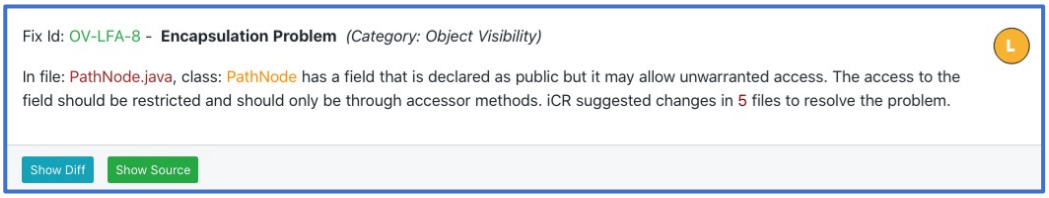


6.4 Handling Results

6.4.1 Reviewing a fix

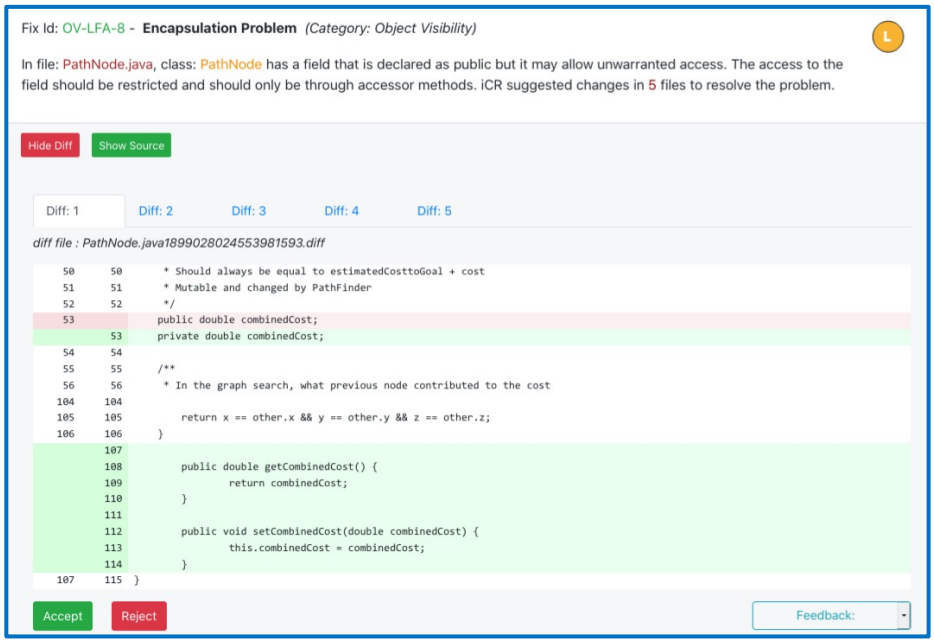
Once you have filtered for the set of fixes for review, you may begin processing them. That typically begins with clicking on the *Found* tab to see what fixes need to be reviewed. In our example, we will be looking at a set of fixes within the Object Visibility category. There were 17 fixes identified.

To show how to process a fix, we will look at Fix OV-LFA-8. In this example, it has detected an encapsulation problem where a variable that should be declared private to the class was declared as public.



To correct this Encapsulation Problem, the variable is made private and a pair of accessor methods to set and get the value is created. Any other files that reference the variable are updated to use the accessor methods instead of modifying the variable directly. As a result, the summary of the fix shows that there are offered changes to a total of 5 files.

To see the diffs for all of the 5 files, click on the **Show Diff** button. Doing that reveals an expanded display.

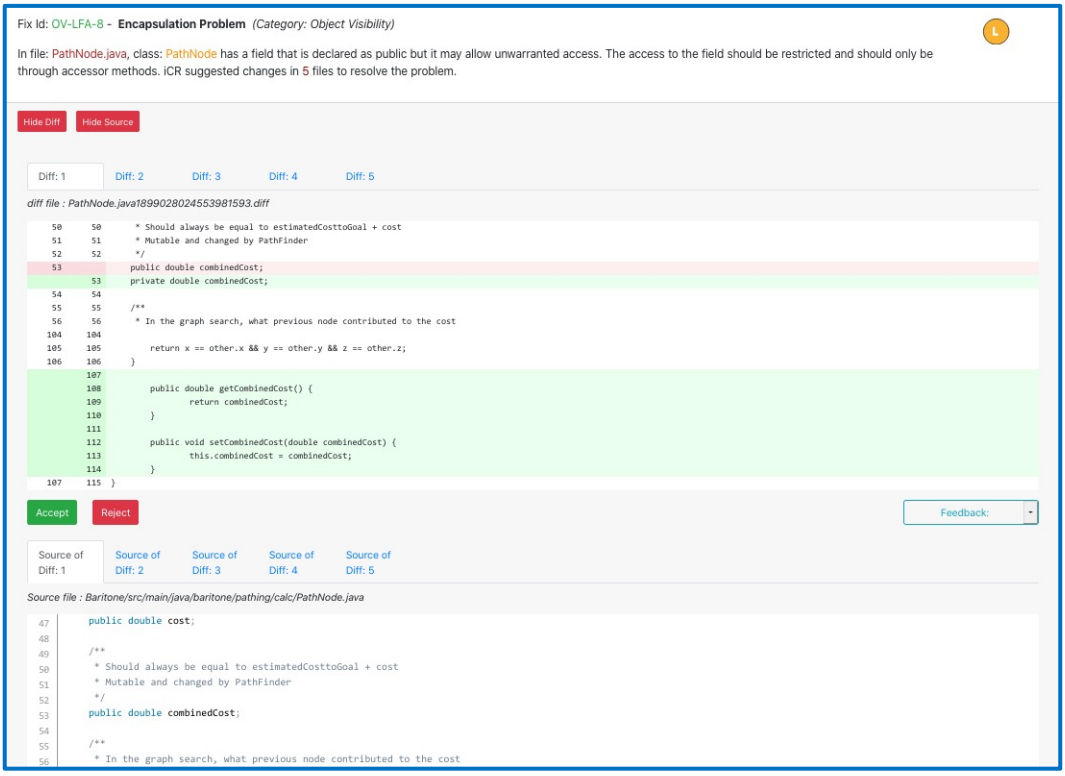


Since there were 5 files affected, there are 5 *Diff:* tabs shown where each tab corresponds to the changes suggested for each affected file. In this example, *Diff: 1* is selected and displayed. This is the diff for the file containing the improperly declared public variable.

The lines that were changed are identified by the red highlighted statements. In this example, that is Line 53. The text below that shows the corrected code with green highlights. The class variable `double combinedCost` was declared `public` but should be `private`. The iCR generated code corrects the issue by making the variable `private` shown as the replacement for line 53. In addition, the accessor methods `getCombinedCost` and `setCombinedCost` are added to allow controlled access to the now private variable as shown in added lines 107 through 114.

If you want to browse the original source file associated with this fix, you can click on the **Show Source** tab. A scrollable window will appear below the diff window with tabs for each of the files that have a diff for this fix. You can click on any tab to browse the source for any of the affected files. In this case *Source of Diff: 1*.

You can scroll through the original source file independently of the diff window.



Once you are satisfied with reviewing a particular correction, you can select other *Diff:* tabs to review all the suggested changes for this fix.

To view other fixes, scroll through the list of fixes or select new filters.

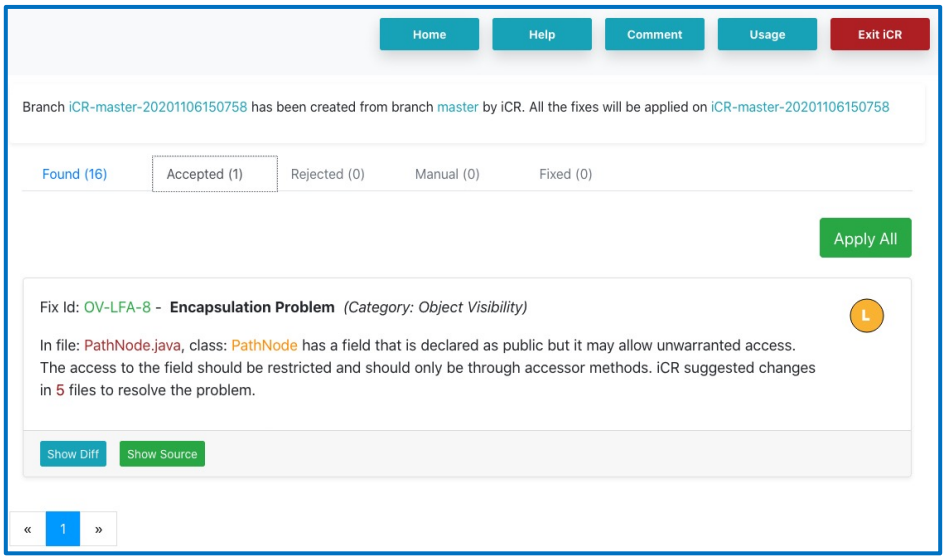
6.4.2 Accepting a fix

Continuing with the example of Fix OV-LFA-8, there are 2 buttons at the bottom left of the diff window. They are labeled **Accept** and **Reject**. These options allow you to make a decision on whether or not the changes are desired.

By clicking the **Accept** button, the fix (OV-LFA-8) is placed in the *Accepted* state. All of the changes are connected and changing some without the others would result in invalid code. It does not really matter which particular diff is used to accept or reject the changes. In the above example, **Accept** is chosen for *Diff: 1*. Once chosen, the Diff window closes, and the fix disappears from the list of *Found* fixes.

Note that the summary tab now shows one fix in the *Accepted* state. Its tab is now highlighted in Blue because it is no longer empty.

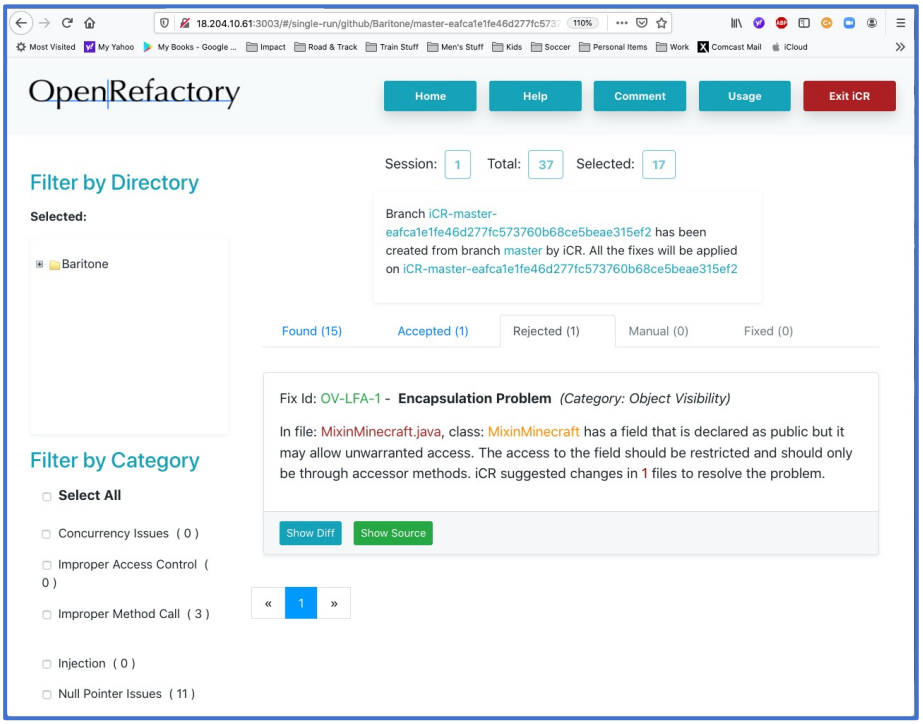
Clicking on the *Accepted* tab brings up the list of accepted fixes. In this example, there is the fix we just accepted, fix OV-LFA-8, with changes to 5 files.



6.4.3 Rejecting a fix

It may be that there is a reason for not accepting a fix. If so, you may choose to click on the **Reject** button. This behaves in exactly the same way as accepting a fix. All of the diffs associated with this fix are kept together and the fix moves to the *Rejected* state. For an example of this, we will reject fix OV-LFA-1. After clicking the **Reject** button, the fix is moved to the *Rejected* state and that is reflected in the summary tab. As before, the *Rejected* tab becomes highlighted as it is now active with one rejected fix in that state.

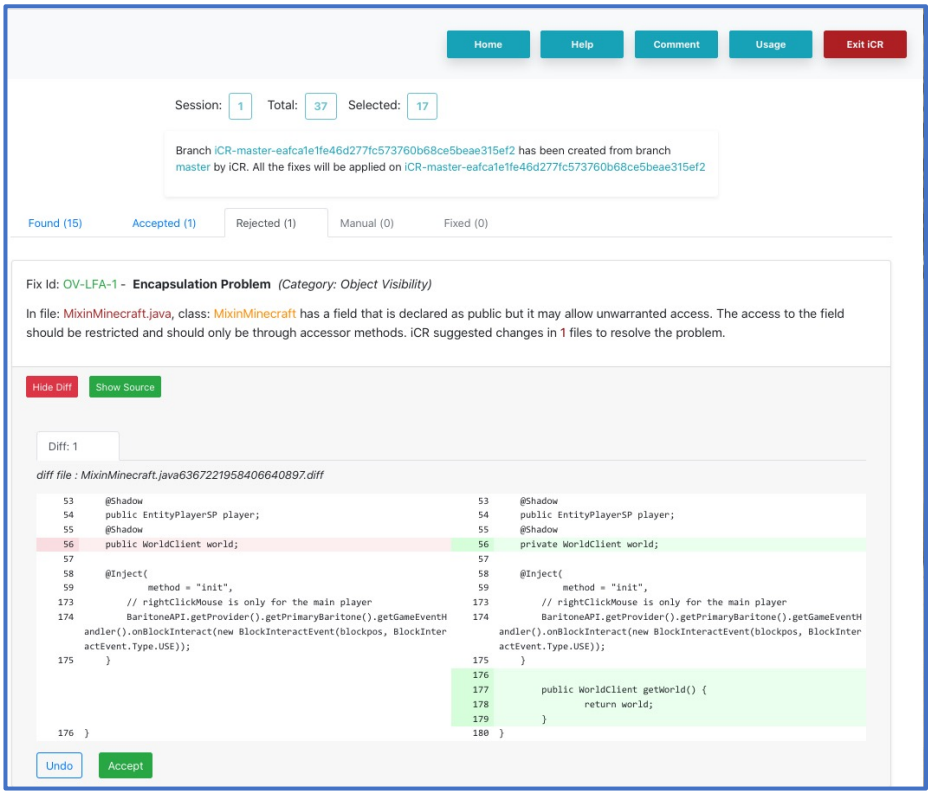
Clicking on it reveals the rejected fix:



6.4.4 Undoing a fix

Using the above example of OV-LFA-1, it may be realized that the fix is, indeed, needed, and that you want to change its status. This is easy to do by clicking on the one of the diffs to review the changes.

Clicking on the **Show Diff** button, as before, will display the original code and the rejected changes. But you will notice that the buttons at the bottom of the window are different from the *Found* fixes with a new button at the bottom.



A new **Undo** button is now available. If it is chosen, then the fix moves back to the *Found* state where it can be left for further review later.

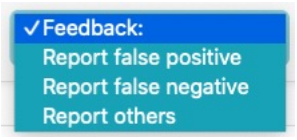
Since this example is one of a rejected fix, then the other option, to accept it instead, is also offered. So, you can click on the **Accept** button, and the fix will be moved from *Rejected* to *Accepted*.

A similar process works for *Accepted* fixes. Should the user decide to reject it instead, the **Reject** button is available. Also, as in the example above, the **Undo** button is also there as so the fix may be moved back to the *Found* state for later review.

A fix can be moved from any one of *Accepted*, *Rejected* and *Found* states by clicking the appropriate button while displaying a diff.

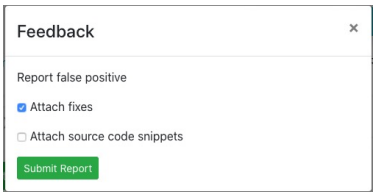
6.4.5 Providing feedback

When looking at diffs that are in the *Found* state, you will note that there is another option shown on the bottom right of the diff window opposite the **Accept** and **Reject** buttons. This is a pull-down menu that offers your developers the opportunity to provide feedback to OpenRefactory engineers.



While iCR for Java has a comprehensive analysis engine, there are always ways to improve it. Should your engineers determine that there may be an error in the analysis, or some other issue that they would like to see improved, they can select one of the feedback options and write a brief email for our development team.

The feedback window gives your developers the options to include the text of the fix and source code snippets so that we can evaluate our analysis and our correction.



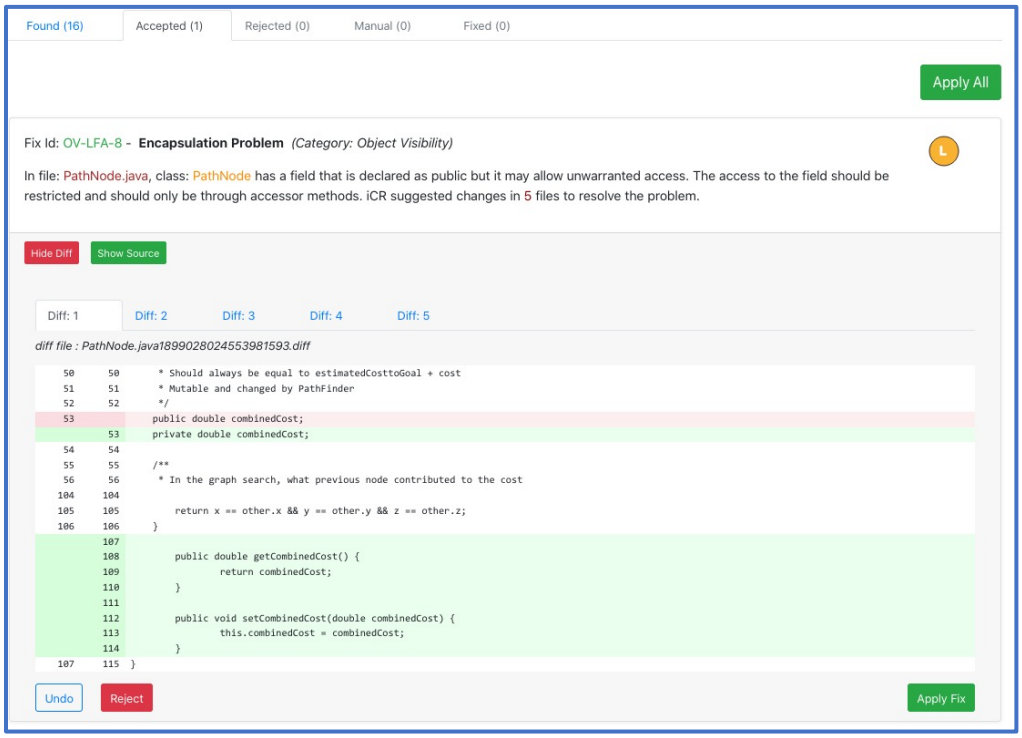
We are constantly finding ways to improve both our analysis and the quality of our fixes, so your feedback would be welcome.

6.4.6 Applying the fixes

The Reviewer provides the ability for you to select, browse and identify fixes to be accepted or rejected. The main purpose of this process is be able to apply these fixes to the source code itself.

When reviewing fixes in the *Accepted* state, you may click on the **Show Diff** button to review the offered changes. The display is a bit different from the one shown earlier.

Since this is an *Accepted* fix, the options at the bottom of the window are different. The **Undo** button is there as before, but now the user has the option of changing their mind and rejecting the change. That will move it over to the *Rejected* state.



And there is an additional option on the right side of the window that is only available for fixes in the *Accepted* state. The **Apply Fix** button offers you the ability to insert the corrected code into the project itself. Clicking on **Apply Fix** instructs the Reviewer to create `git` specific `commits` to the temporary branch.

Also, at the top of the page shown above, there is a new button that appears at the top right of that window. That is the **Apply All** button which becomes active when any fixes are moved to the *Accepted* state. Clicking on this will tell the Reviewer to apply all of the fixes which are in the *Accepted* state. This is a quick way of applying all the currently accepted fixes in one step.

Once fixes have been applied, they are moved into the *Fixed* state. Once in the *Fixed* state, the fixes cannot be undone other than having a developer manually edit the code. It is exactly the same as if the developer had modified the code directly and committed them manually.

6.4.7 Cases needing manual attention

The *iCR for Java* engine creates fixes independently of other fixes. As such, it is sometimes the case when the same area of code may be affected by overlapping fixes. Since some fixes may be accepted and others

rejected, there are cases where the Reviewer cannot make an unambiguous set of edits to the code to result in the correct output when **Apply Fix** or **Apply All** is clicked. In those cases where the changes could not be safely applied automatically, the Reviewer will move the fix into the *Manual* state.

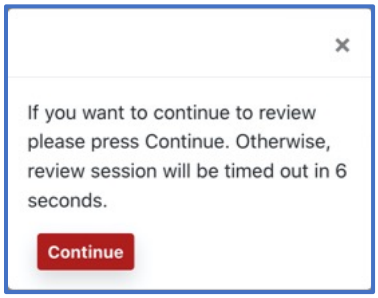
Once a fix is in the *Manual* state, it is treated the same as those in the *Fixed* state in that its state can no longer be changed. It would need to be edited manually to incorporate any desired fixes and the `commits` or other edits to the source code in the temporary branch would need to also be performed manually.

6.4.8 Ending a Reviewer session

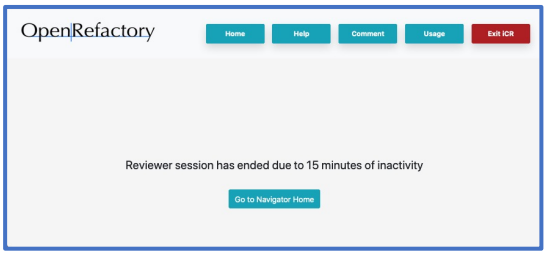
It may be the case, especially if you are executing *iCR for Java* for the first time, that there will be many offered fixes to be reviewed. You may want to distribute the task of reviewing the fixes to multiple members of your team. Or, you may want to review fixes in batches over time.

You can end a Reviewing session at any time by clicking on the **Home** button. This is recommended so that you can avoid unnecessary usage charges. This will redirect your tab back to the Navigator. This is handy if you had closed the Navigator tab from before. Or, you can simply close the Reviewer tab and return to your previous Navigator tab. In either case, your Reviewer session ends, and your usage accrual is stopped.

Because *iCR for Java* is a pay-as-you-go service, the Reviewer also monitors your activity. If you are idle for a period of 15 minutes, the reviewer pops up an alert asking if you want to continue the session. If so, simply click continue to proceed.



If you allow the timeout to expire, your Reviewer session will end, and a simple display will be shown to let you know that iCR for Java ended your session and your usage accrual has stopped.



Of course, you can always end your session by simply clicking the **Exit iCR** button.

You may return at any time to the Navigator by clicking on its tab. However, it is strongly recommended that you explicitly end each Reviewer session to limit your usage time accrual.

7.0 When You Are Complete

Once you have reviewed all of your results, you can exit the Navigator. To close a Reviewer session, simply close the tab or click the **Home** button. To leave the Navigator, you may close the Navigator tab or click **Exit iCR**.

If you have completed all the analyses and have reviewed all of your results, you can check them on your VCS and verify the commits are there. Any fixes that were applied will be committed to the temporary branch as identified in the Reviewer header banner.

Once satisfied that you are complete, you can go to your terminal console and stop the server using `icrforjava -c stop`. Note that stopping the server will leave all of your previous results available for later. You can restart the server using `icrforjava -c start`. Of course, it may be more convenient to always keep the server running so that other developers can analyze their projects

OpenRefactory appreciates receiving all feedback on its products that users are willing to provide. Please contact us at info@openrefactory.com if there are any questions or suggestions for improvements on the operation of *iCR for Java*.

Appendix A – List of Supported Fixers

This appendix enumerates the currently supported set of Fixers for the *iCR for Java* Analysis Engine. OpenRefactory is constantly updating this list as new algorithms are developed for additional Fixers. Please contact OpenRefactory at info@openrefactory.com to stay current on available Fixers.

API Usage Issues (7):

Add Controller Class Restrictions –
A Spring `@Controller` class that uses `@SessionAttributes` have to call `setComplete()` on the `SessionStatus` object from an `@RequestMapping` method. This is specific to the Spring framework.

Add Component Package Location –
A class with annotation `@ComponentScan` should include all component (Service, Repository, Controller, RestController) packages. Otherwise, the classes will not be available in the Spring application context. This is specific to the Spring framework.

Add Default Package Restrictions –
The default package should not contain a class with `@ComponentScan`, `@SpringBootApplication`, or `@ServletComponentScan` annotation. This is specific to the Spring framework.

Block Serialization with Append –
An object output stream that is opened in append mode should not be serialized because the data will be stored in the wrong format and a deserialization attempt will result in an exception being thrown.

Replace Confusing Scope Combination –
Classes with annotation `@Controller`, `@Service`, or `@Repository` are singleton classes and if they have `@Scope` annotation, that should be explicitly specified. This is specific to the Spring framework.

Replace EnableAutoConfiguration with Import –
A class with annotation `@EnableAutoConfiguration`, should be replaced by `@Import`, as `@EnableAutoConfiguration` may include unnecessary beans which slows down an application. This is specific to the Spring framework.

Remove Method Call –
Remove unnecessary method calls that have been deprecated.

Arithmetic Issues (1):

Fix Zero Division –
Removes zero division opportunities in code. Fixes CWE 369, CERT Secure coding standard NUM02-J.

Bad Control Flow (4):

Add Missing Breaks –
Unexpected control flow because of missing `break` statements in `switch`. Fixes CWE 484.

Fix Equality Check –
Confusing object equality (equals method) with reference equality (== operator) and vice versa lead to inappropriate control flow, thus leading to hard-to-debug root causes. Perform appropriate equality checks according to the context. Fixes CWE 595, CWE 597, CERT Secure coding standard EXP03-J, CERT Secure coding standard EXP50-J.

Move Default Statement –
Switch statements should handle default case after everything else is handled.

Remove Unused Semicolon –
Remove unexpected control flow scenarios because of bad use of delimiters.

Broken Authentication (2):

Fix Hard-coded Key –
Cryptographic keys or other credentials should not be kept hard-coded in the source code. An attacker can extract the strings or byte arrays from an application source code or binary. Fixes CWE 798, OWASP A2-Broken Authentication, CERT Secure coding standard MSC03-J.

Fix Hard-coded Password –
User passwords should not be kept hard-coded in the source code. An attacker can extract the strings or byte arrays from an application source code or binary. Fixes CWE 259, OWASP A2-Broken Authentication, CERT Secure coding standard MSC03-J.

Concurrency Issues (4):

Avoid Value-Based Class Locks –
Synchronization should avoid value-based classes as locks. Fixes CERT Secure coding standard LCK01-J.

Avoid String and Boxed Primitive Locks –
Synchronization should avoid `Strings` and boxed primitives that can be reused. Fixes CERT Secure coding standard LCK01-J.

Remove Servlet Mutable Fields –
Make the instance fields of the servlet classes to be `static` or `final`, or remove them. The servlet container creates one instance of each servlet for each HTTP request and the threads will share the instance fields, leading to concurrency issues. Fixes CERT Secure coding standard MSC11-J.

Synchronize with Proper Class –
Synchronization should avoid using `getClass()` methods. Fixes CERT Secure coding standard LCK02-J.

Improper Access Control (2):

Get Proper Permission –
Get Proper Permission from the super `ClassLoader` if any class extends the `URLClassLoader`. Fixes CERT Secure coding standard SEC07-J.

Prevent Persistent Entity Short-circuiting –

Persistent objects annotated with `@Entity` or `@Document` should not be used as arguments in methods annotated with `@RequestMapping` and similar other annotations. This is specific to the Spring framework. Fixes CWE 915, OWASP A5-Broken Access Control Issue.

Improper Method Call (4):

Check Return Result –

Method `return` values that return error codes should be checked against error codes before being used. Fixes CWE 252.

Fix Finalize Method Implementation –

`finalize` method should be avoided or if used, called properly with reference to `Object.finalize`. Fixes CWE 568, CERT Secure coding standard MET12-J.

Call Super Method –

Overriding methods should reference the method in the parent class.

Prevent Incompatible Transactional Calls –

Methods should not call same-class methods with incompatible "`@Transactional`" values.

Injection (8):

Prevent SQL Injection –

Constructing SQL queries with untrusted user provided data, e.g., URL parameters, enables attackers to inject code in place of data that changes the meaning of the SQL query. Identify potential SQL injection opportunities. Fixes CWE 20, CWE 85, CWE 943, OWASP A1-Injection Issue, CERT Secure coding standard IDS00-J.

Prevent Cross-site Scripting –

When endpoints reflect back tainted, user-provided data such as `POST` content, URL parameters, etc., it may allow attackers to inject code that will eventually be executed on the browser of a user. Identify potential SQL injection opportunities. Fixes CWE 79, CWE 80, CWE 81, CWE 82, CWE 83, CWE 84, CWE 85, CWE 86, CWE 87, OWASP A7-XSS.

Prevent Path Manipulation –

Constructing file system paths from untrusted user-provided data such as `POST` content, URL parameters, etc., enables attackers to inject specific path browsing symbols, such as "..", to manipulate the file path and to access files that they are not allowed to access otherwise. Identify potential path manipulation opportunities. Fixes CWE 22, CWE 23, CWE 36, CWE 99, CWE 641, OWASP A1-Injection, OWASP A5-Improper Access Control.

Prevent OS Command Injection –

Applications that execute operating system calls should not use untrusted user-provided data to create the command or command parameters. Identify potential OS command injection opportunities. Fixes CWE 77, CWE 78, CWE 88, OWASP A1-Injection.

Prevent XPath Injection –

Constructing `XPath` expressions using untrusted user-provided data such as `POST` content, URL parameters, etc., enables attackers to inject specially crafted values that change the way the expression is supposed to interpreted under normal circumstances. Identify potential `XPath` injection opportunities. Fixes CWE 643, OWASP A1-Injection, CERT secure coding standard IDS53-J.

Prevent LDAP Injection –

Constructing `LDAP` names or search filters using untrusted user-provided data enables attackers to inject values that change the way the name or the filter is supposed to interpreted under normal circumstances. Identify potential `LDAP` injection opportunities. Fixes CWE 90, OWASP A1-Injection, CERT secure coding standard IDS54-J.

Prevent Regular Expression Denial of Service –

Using external strings as regular expressions leads to potential denial of service attack since evaluating the regular expressions is CPU intensive. Identify potential regular expression injection opportunities. Fixes CWE 400, OWASP A1-Injection.

Prevent SQL Injection in Prepared Statement –

`Prepared Statement` is used to prevent SQL injection attacks. But, constructing SQL queries with string concatenation using untrusted user provided data, e.g., URL parameters, undermines the benefits of a `Prepared Statement`. Identify potential SQL injection opportunities. Fixes CWE 20, CWE 85, CWE 943, OWASP A1-Injection Issue, CERT Secure coding standard IDS00-J.

Null Pointer Issues (2):

Bad Return Value –

Methods with boxed type `return` values should not return `null`. Fixes CWE 476, CERT Secure coding standard EXP01-J.

Fix Null Dereference –

A pointer which has not been initialized is used as if it pointed to a valid memory area in the heap. A null pointer issue happens because the developer mistakenly did not allocate an object or has mistakenly assumed that that the object is allocated when in fact it is null. Fixes CWE 476, CERT Secure coding standard EXP01-J.

Object Visibility (2):

Add Qualifier for Static –

Access inherited static fields using the parent class as the qualifier.

Limit Field Access –

Accessibility of fields in Java classes should be limited. Fixes CWE 582, CWE 607, CERT Secure Coding Standard OBJ01-J and OBJ13-J.

Security Misconfiguration Issues (11):

Declare EJB Connectors Properly –

Following EJB 3.0 conventions, application security interceptors must be listed in the `ejb-jar.xml` file, or they will not be treated as default interceptors. Fixes OWASP A6-Security Misconfiguration Issue.

Remove Duplicate Validation Forms –

The names of Struts validation forms should be unique. When there are duplicate validation form names, the Struts Validator arbitrarily chooses one of the forms to use for input validation and discards the other. This is specific to the Struts framework. Fixes CWE 102, OWASP A6-Security Misconfiguration Issue.

Use Declared Filter –

Every filter declared in web.xml file should be used in an element. Otherwise such filters are not invoked. Fixes OWASP A6-Security Misconfiguration Issue.

Limit Scope of Maven Dependencies –

System dependencies in Maven are sought at a specific path that matches a configuration and cannot be ported. If an artifact is deployed in an environment that is different from the original configuration, the build would fail.

Track Messages During Restart –

In Spring, `DefaultMessageListenerContainer` is implemented as a Java Message Service (JMS) polling component. While the Spring container is going through a restart/shut down, the message listener may discard messages and will therefore lose them. The message listener container should be declared such that the messages are not discarded. This is specific to the Spring framework.

Allow Automatic Connection Recovery –

Spring framework uses a factory object (`SingleConnectionFactory`) that returns the same connection for all connection requests. This should be declared with a setting to allow automatic recovery when the connection goes bad. This is specific to the Spring framework.

Stop Debugging Web Remoting –

Direct Web Remoting (DWR) is a Java and JavaScript library that enables RPC calls in an Ajaxian application. If the debug mode of DWR is turned on, it will allow users to access information exposed under the debugging servlet. This is specific to the DWR library.

Remove Duplicate Servlet Definition –

When a deployment descriptor contains the same name for multiple servlets, only the first one is deployed, and the others are ignored.

Avoid GET Mix –

Spring framework annotations should use `HTTP GET` method and not mix it with other methods. Fixes CWE 352, OWASP A6-Security Misconfiguration Issue.

Use Proper Request Mapping –

Ensures that Proper Request Mappings are used. Fixes CWE 352, OWASP A6-Security Misconfiguration Issue.

Annotate Public Method –

Spring framework annotations should be accompanying a public method.

Sensitive Data Exposure (4):

Replace Random Generator –

Weak random number generator should be replaced with a strong random number generator. Fixes CWE 330, CWE 332, CWE 336, CWE 337, OWASP A6-Security Misconfiguration Issue, Secure coding standard MSC63-J.

Remove Weak Seed –

A strong random number generator does not need a seed value to be set. Setting the seed with a constant or a predictable value will weaken the random generator itself. If a seed value is set explicitly, it should be removed. Fixes CWE 337, OWASP A6-Security Misconfiguration Issue, CERT secure coding standard MSC63-J.

Use Proper Dependency Injection –

Non-static members and constructors in classes with annotation `@Controller`, `@Service`, or `@Repository` should have proper annotations (any one of `@Autowired`, `@Value`, `@Resource`, or `@Inject`). This is specific to the Spring framework. Fixes OWASP A3-Sensitive Data Exposure Issue.

Prevent XML eXternal Entity –

XML Document Type Definition (DTD) should be disabled to prevent information disclosure via XXE attacks. Fixes CWE 611, CWE 827, OWASP A4-XML eXternal Entities.

Weak Cryptography Issues (6):

Use Strong Password Encoder –

Authentication manager should use a strong password encoder. This is specific to the Spring framework. Fixes CWE 327, CWE 328, OWASP A2-Broken Authentication Issue, OWASP A6-Security Misconfiguration Issue.

Use Strong Hash Function –

Hashing should be done using strong hashing algorithm such as SHA-256 or SHA-3. Fixes CWE 327, CWE 328, OWASP A6-Security Misconfiguration Issue.

Use Secure Socket Protocol –

SSL context objects should use a secure socket protocol such as TLS or DTLS. Fixes CWE 326, CWE 327, OWASP A3-Sensitive Data Exposure, OWASP A6-Security Misconfiguration Issue.

Restrict Access to Broadcast Receiver –

While registering broadcast receivers in Android, broadcast permission should be specified so that a receiver only receives broadcasts sent by components having proper permission. This is specific to Android applications. Fixes CWE 925, OWASP A1-Injection.

Restrict Access to Broadcast Sender –

While sending broadcast messages in Android, broadcast permission should be specified so that only receivers with proper permission can receive it. This is specific to Android applications. Fixes CWE 927, OWASP A3-Sensitive Data Exposure.

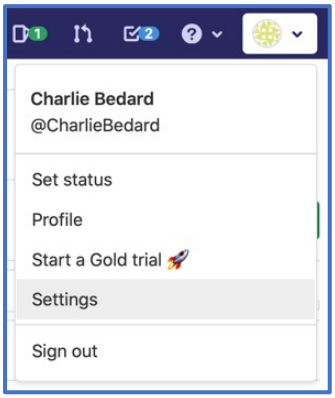
Prevent Sharing of User Preferences –

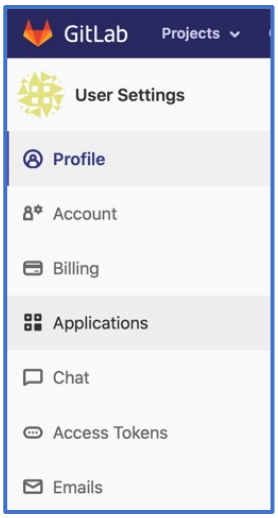
Android `getPreferences` and `getSharedPreferences` should use private mode when invoked, so that the preferences are not exposed globally. Fixes OWASP A3-Sensitive Data Exposure.

Appendix B – GitLab OAuth Setup

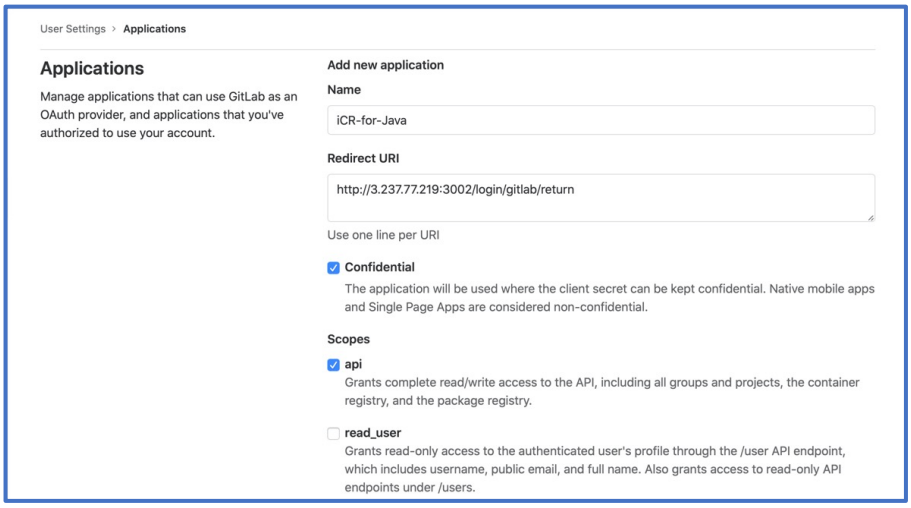
Section 3.3 Accessing Your Code, describes how to create the OAuth credentials needed to access GitHub. This appendix adds the additional details if you are planning on using GitLab to access your source code.

GitLab also uses the OAuth standard to allow you to tell GitLab that your *iCR for Java* server is allowed to redirect login credentials for GitLab to authenticate. To set this up, login into GitLab and go to your user menu at the top right of the GitLab menu bar. From there, select "Settings" from the pull-down menu.





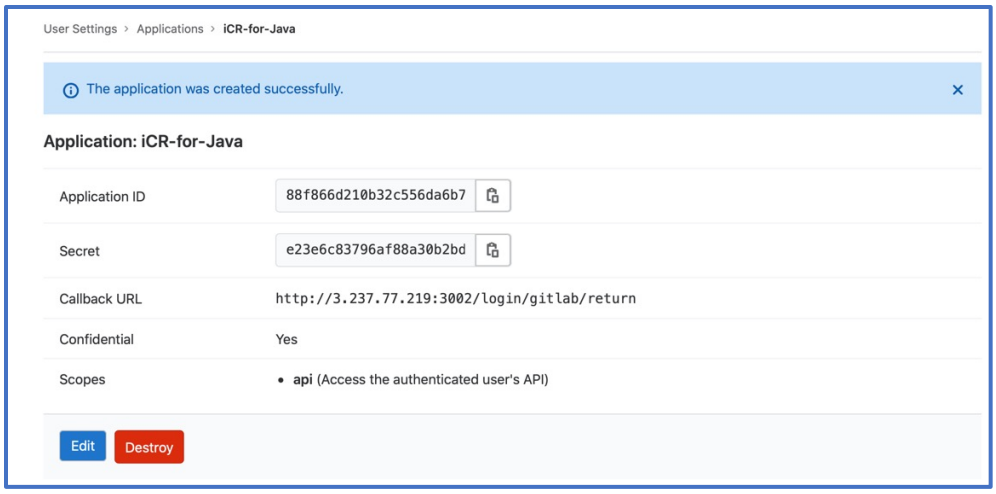
The "Settings" menu offers a number of configurable options. Click on "Applications" to go to the Applications authorization page.



The "Applications" page is where you tell GitLab to allow your Server to allow logins redirected from the Server. For the application "Name" use whatever you like. "iCR-for-Java" has been used in this example. You also must enter the redirect URL to the server. GitLab's OAuth uses that to verify the authorization handshake. Enter the URL as your server's IP address with port 3002 and the callback text. Using the example IP address from Section 3.3, enter:

`http://3.237.77.219:3002/login/gitlab/return`

You need to select both the "Confidential" and the "api" options.



As was noted for GitLab, once you have completed this step, you will need to copy the Application ID and the Secret. From here, the process is the same as outlined for GitHub.