BREW: Manual (https://github.com/FoelliX/BREW/wiki)

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BREW

Benchmark Refinement and Execution Wizard (BREW)

The Benchmark Refinement and Execution Wizard (BREW) can be used to do what the name suggests, first refine and then execute a benchmark.

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Changelog

Runthrough

Runthrough

The following instructions deal with the installation of BREW. Along with that Amandroid will be installed. Hence, BREW will be setup to use Amandroid only. (The operating system considered is Linux.)

1. Download the latest version of BREW: here
   - Unzip it!
2. Download Amandroid: https://bintray.com/arguslab/maven/argus-saf/3.1.2
   (direct link: https://bintray.com/arguslab/maven/download_file?file_path=com%2Fgithub%2Farguslab%2Fargus-saf_2.12%2F3.1.2%2Fargus-saf_2.12-3.1.2-assembly.jar)
3. Download the `DirectLeak1` app from DroidBench 3.0: https://github.com/secure-software-engineering/DroidBench/raw/develop/apk/AndroidSpecific/DirectLeak1.apk
4. Setup a configuration
   - Create file `config_amandroid.xml` located in the directory of BREW
   - Copy and Paste the following content:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<config>
<androidPlatforms>/path/to/android/platforms/</androidPlatforms>
<maxMemory>8</maxMemory>
<tools>
  <tool name="Amandroid" version="1">
    <priority>1</priority>
    <execute>
      <run>/path/to/Amandroid/aqlRun.sh %APP_APK% %MEMORY%</run>
      <result>/path/to/Amandroid/outputPath/%APP_APK_FILENAME%/result/AppData.txt</result>
      <instances>0</instances>
      <memoryPerInstance>4</memoryPerInstance>
    </execute>
    <path>/path/to/Amandroid</path>
    <questions>IntraAppFlows</questions>
    <runOnExit>/path/to/BREW/flushMemory.sh</runOnExit>
    <runOnAbort>/path/to/BREW/killpid.sh %PID%</runOnAbort>
  </tool>
</tools>
</config>
```

   - Adjust the path to the Android SDK's platforms directory (`<androidPlatforms>/path/to/android/platforms/</androidPlatforms>`)
   - Adjust the path for Amandroid (`<path>/path/to/Amandroid</path>`) (The directory should contain the previously downloaded .jar file.)
   - Use the same path in `<run>` and `<result>`
   - Adjust the path to flushMemory.sh and killpid.sh to the path of BREW in `<runOnExit>` and `<runOnAbort>`.
   - Lastly adjust `<maxMemory>` and `<memoryPerInstance>`. The latter has to be less than or equal to the first value. Both values are given in gigabytes. (If sufficient memory is provided, a tool might be executed multiple times in parallel.)
5. Make `flushMemory.sh` and `killpid.sh`, located in BREW directory, executeable:

```
chmod u+x flushMemory.sh killpid.sh
```

6. Create launch script

```
cd /path/to/Amandroid
nano aqlRun.sh
```

7. Copy and Paste the following:

```
#!/bin/bash
rm -R outputPath
java -Xmx${2}g -jar argus-saf_2.12-3.1.2-assembly.jar t -o outputPath ${1}
```

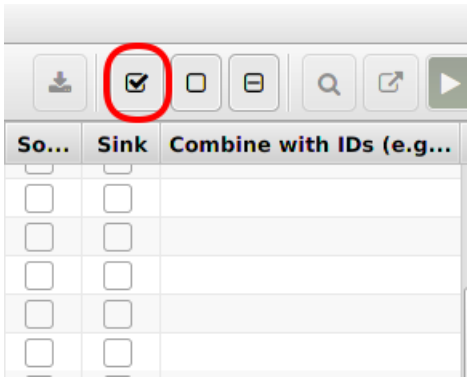
8. Save *(Ctrl+o)* and exit *(Ctrl+x)* nano
9. Make the script executable:

```
chmod u+x aqlRun.sh
```

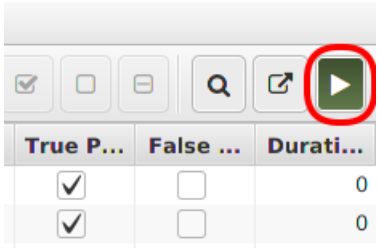
10. Finally, launch BREW

```
cd /path/to/BREW
java -jar BREW-1.2.0.jar -config config_amandroid.xml -d detailed
```

11. Load the app
    - Open the *File* menu
    - Click on *Load File..*
    - Navigate to and select `DirectLeak1.apk`
12. Click on *Next* (Green Right-Arrow in the toolbar)
13. Click on *Preselect source & sinks based on SuSi*



14. Click on *Next* again
15. Click on "Run"



16. Wait for the result and inspect it!

Install & Compile

Install

To simply install BREW you must

- download the current release: here
- and unzip it
- done!

For a *hello world* like tutorial follow therunthrough tutorial.

Compile

To compile BREW by yourself follow these steps:

- Clone the repository
- Build the Maven project by:

  ```
  cd /path/to/project/BREW
  mvn
  ```

  (Test might not be completely up-to-date, consider skipping: `mvn -DskipTests`)

Launch parameters

Launch Parameters

BREW can be launched with the parameters mentioned in the table below.

Parameter	Meaning
`-help`, `-h`, `-?`, `-man`, `-manpage`	Outputs a very brief manual, which contains a list of all available parameters
`-config "X"`, `-cfg "X"`, `-c "X"`	By default the config.xml file in the tool's directory is used as configuration. With this parameter a different configuration file can be chosen. `X` has to reference the path to and the configuration file itself.
`-rules "X"`	By default the rule-set in rules.xml file is loaded. With this parameter a different rule file can be chosen `X` has to reference the path to and the rule file itself.
`-output "X"`, `-out "X"`, `-o "X"`	The answer to a query is automatically saved in the `answers` directory. This parameter can be used to store it in a second directory. `X` has to define this directory including its path.
`-timeout "X"s/m/h`, `-t "X"s/m/h`	With this parameter the maximum execution time of each tool can be set. If it expires the tool's execution is aborted. `X` refers to this time in seconds (e.g. 10s), minutes or hours.
`-debug "X"`, `-d "X"`	The output generated during the execution of this tool can be set to different levels `X` may be set to: `error`, `warning`, `normal`, `debug`, `detailed` (ascending precision from left to right). Additionally it can be set to `short`, the output will then be equal to `normal` but shorter at some points. By default it is set to `normal`.
`-df "X"`, `-dtf "X"`, `-debugToFile "X"`	Sets the log level (`X`) that should be logged to file (into `log.txt`). The default value is `important`.
`-nogui`	If this parameter is added, the GUI will not be launched. Instead the currently stored benchmark in `data/data.ser` is directly executed. (Or use -ns, -noSplash to skip the splashscreen.)
`-backup`, `-bak`, `-b`	To backup previously computed results on startup add one of these parameters.
`-reset`, `-re`, `-r`	To reset BREW on startup add one of these parameters.
`--from "X"`, `--to "X"`	If only some benchmark cases shall be executed these parameters can be used to set the limits.
`-taintbench "X"`, `-tb "X"`	To attach associated TaintBench (findings) directory.
`-taintbenchapps "X"`, `-tba "X"`	To attach associated TaintBench (apps) directory.
`-taintbench-writeback`, `-tbwb`	Enables writing (back) additional information (Jimple statements) to TaintBench's findings.
`-l`, `-libs`, `-libraries`	To not exclude library classes while finding sources and sinks.

Further Options

More options can be configured in `config.properties`. If the file does not exist, it will be created when you run BREW for the first time.

Configuration

Configuration

Configuring BREW works just as configuring the underlying AQL-System. Therefore, we refer to the configuration tutorial of the AQL-System.

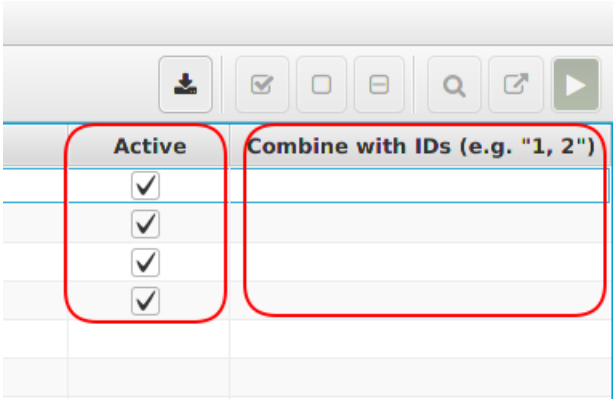
Benchmarking

Benchmarking

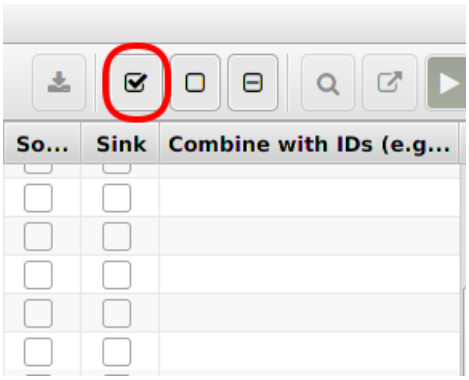
Setup/Load/Execute

1. Setup a Benchmark

- Open the *File* menu
  - Click on *Load File..* and choose an application
    OR
  - Click on *Load Folder..* and select a directory containing a set of apps
- Deselect testcases you do not want to run.
- To build an inter-app testcase activate the initial app and enter all other apps' IDs in the last column (*Combine with IDs*). Deactivate the other apps.



- Click on *Next* (Green Right-Arrow in the toolbar)
- On the next screen specify which statements are sources and sinks. There exist two options to do so:
  - manually by selecting the checkboxes
    OR
  - click on *Preselect Sources & Sinks based on SuSi*

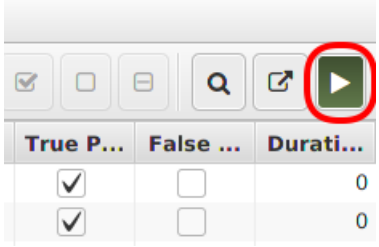


- Sources & Sinks can be combined by entering appropiate IDs in the *Combine with IDs* column. This makes sense if multiple statements may be expectable as source for the same resource, for example.
- Click on *Next* (Green Right-Arrow in the toolbar)
- Finally, decide which of the generated benchmark cases should be found (*True Positive*) and which should *not* be found (*False Positive*).
- The setup is done. Feel free to save the benchmark.

2. Load & Execute a Benchmark

- Open the *File* menu
  - Click *Open..* and choose the benchmark you want to load. You can also add another benchmark to an already opened one by clicking on *Add...*

- Click on *Next* (Green Right-Arrow in the toolbar)
- Click on *Next* again
- Click on *Run Benchmark*



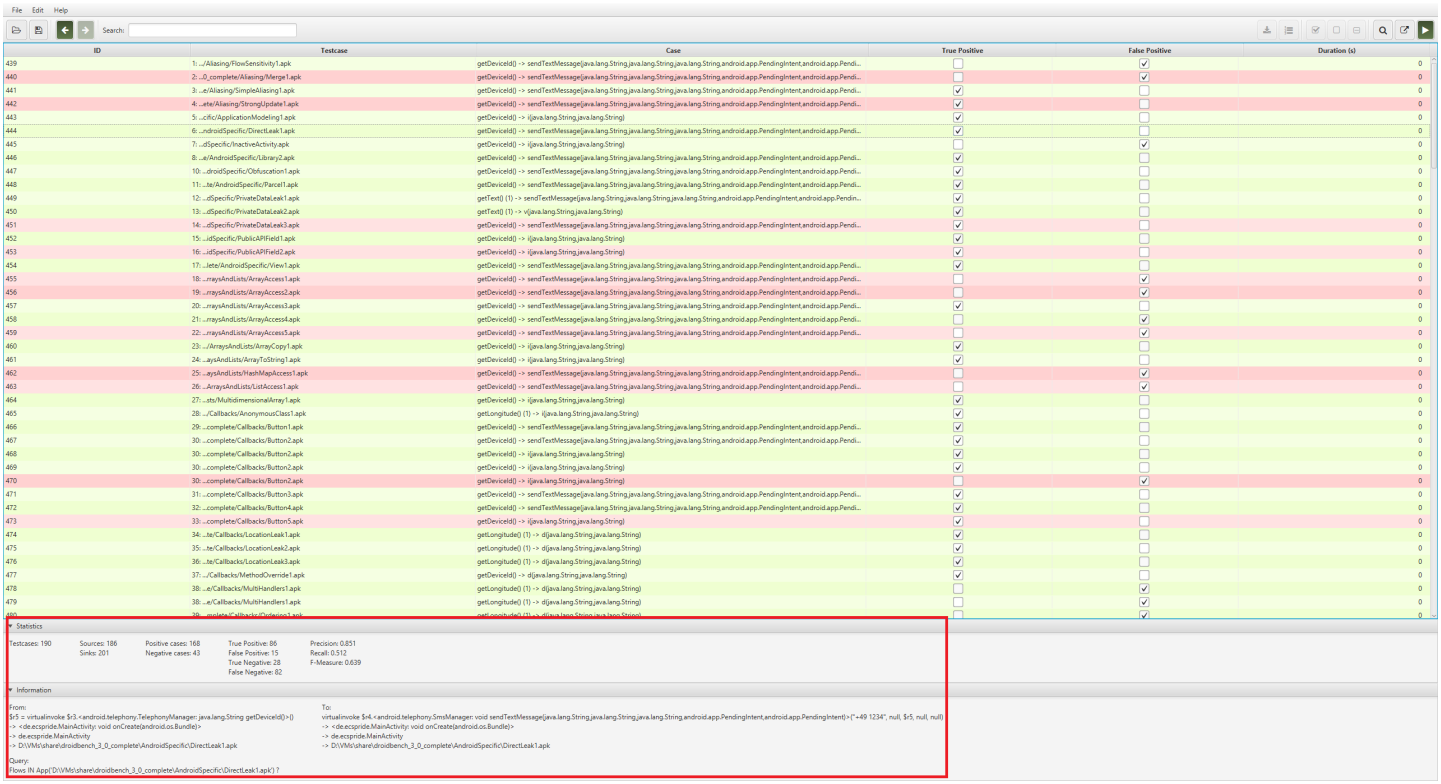
Refine a benchmark

To refine a benchmark just open one (see **2.**) and edit it as described for a new one (see **1.**).

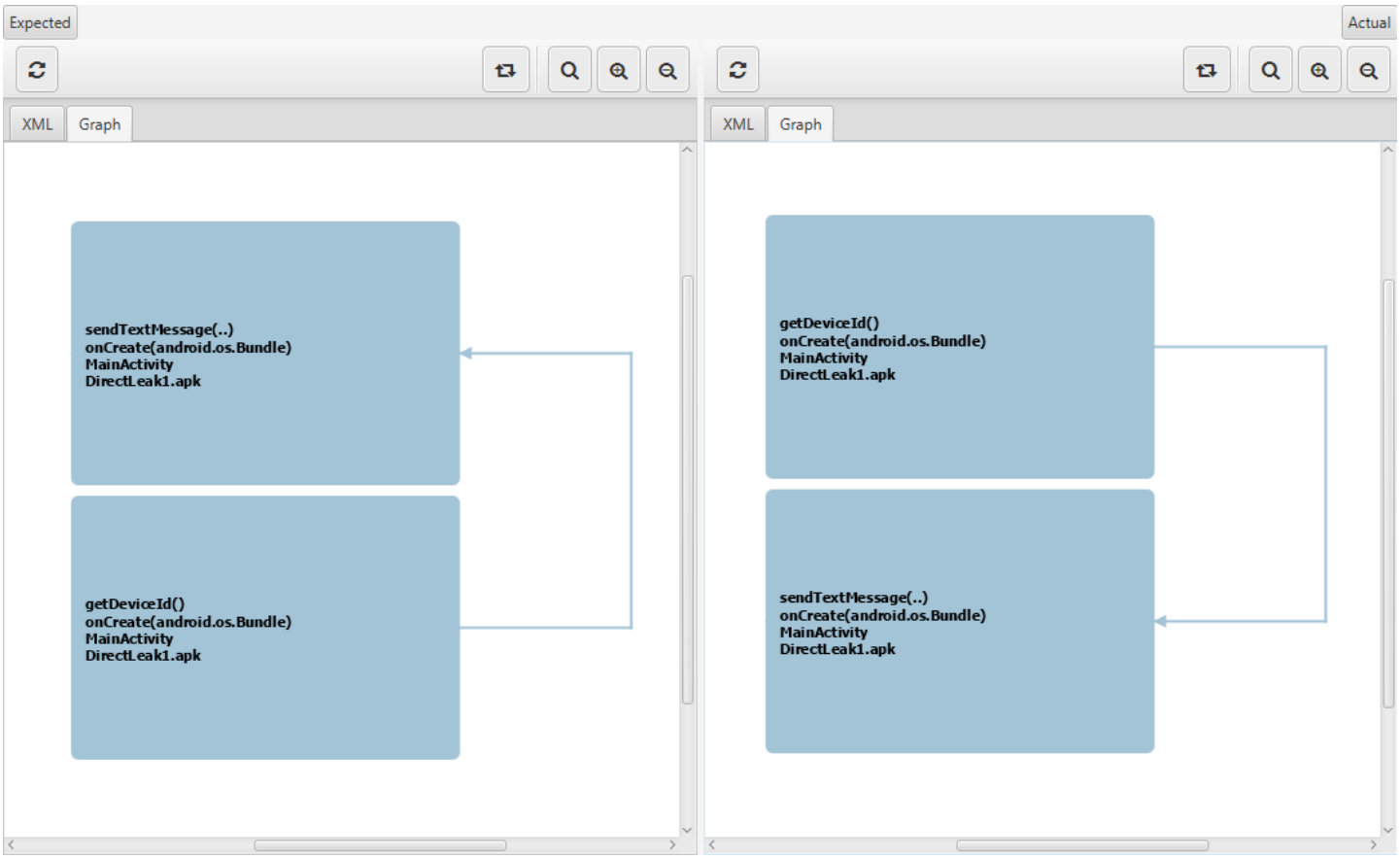
Evaluation

Evaluation of Benchmarks

After executing a benchmark successfully, the result should look like:



- Legend:
  - A *red*, *green* row indicates a *failed*, *successful* benchmark case, respectively.
  - A *blue* row stands for an *aborted* or *timed-out* benchmark case.
- The values for Precision, Recall and F-measure can be checked in *Statistics* pane.
- To inspect a single results:
  - Select one benchmark case in the table and check the information pane. It shows, for example, which AQL-Query would be executed to evaulate this case.
  - Press *V* or click on *Show in Viewer* (magnifying glass in the toolbar) to review the expected and actual result.
    - *(optional)* Switch to the graphical representation on both sides in order to get a better overview.


Expected
XML
Graph
sendTextMessage(..)
onCreate(android.os.Bundle)
MainActivity
DirectLeak1.apk
getDeviceId()
onCreate(android.os.Bundle)
MainActivity
DirectLeak1.apk
Actual
XML
Graph
getDeviceId()
onCreate(android.os.Bundle)
MainActivity
DirectLeak1.apk
sendTextMessage(..)
onCreate(android.os.Bundle)
MainActivity
DirectLeak1.apk

Load AQL-System results

Load AQL-System results

1. Run a query in the AQL-System (see thequery execution tutorial)
2. Save the computed AQL-Answer
3. Load results in BREW
    - Launch BREW
    - Load the same app that was considered in the query or open a benchmark that contains this app
    - Click twice on *Next* (Green Right-Arrow in the toolbar)
    - Open the *Edit* menu
        - Click on *Mark successful (Result based - XML)*and choose the saved AQL-Answer

ReproDroid

Fully load a ReproDroid benchmark

- Download the latest BREW release: https://github.com/FoelliX/BREW/releases
- Download a ReproDroid benchmark: https://FoelliX.github.io/ReproDroid
  - e.g. the refined benchmark version of DroidBench 3.0:https://uni-paderborn.sciebo.de/s/ZmlRvtzI6pVYHVP/download?path=%2Fbenchmarks&files=DroidBench30.zip
- Extract both downloaded archives: Let us assume `%BREW%` and `%benchmark%` refer to the respective extracted archives.
- Choose the tool for which you want to load the benchmark (for this example we assume it is Amandroid).
- Copy `%benchmark%/results/Amandroid/data` to `%BREW%/data`
- Start BREW with
  - config_toolset1.xml (for Amandroid, DroidSafe, FlowDroid and IccTA)
  - config_toolset2.xml (for DIALDroid and DidFail)
- Click on *Next* (Green rightarrow in the toolbar)
- Click on *Directory (Ignore parent directory)*
- Select the `%benchmark%/benchmark/apks` directory
- If any warnings appear, just click *OK*
- Click on *Next* (Green rightarrow in the toolbar) again
- Click *Yes*
- Inspect the fully loaded benchmark result
  - The lower *Statistics* pane shows general information such as precision, recall and F-measure
  - Individual results can be reviewed by selecting a case and clicking on*Show in Viewer* (magnifying glass in toolbar) or pressing *v*.

Changelog

BREW: Changelog

2.0.0

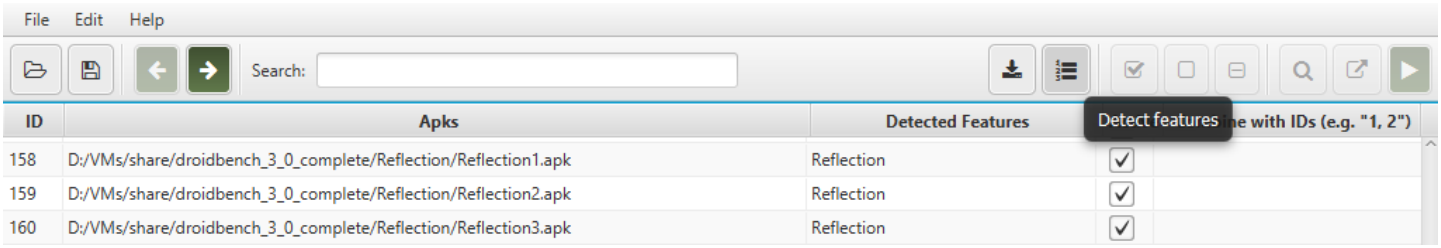
- The rules introduced in 1.2.0 have been moved to the AQL-System (Rules Tutorial). Nothing has changed, however, more rule options are available now.
- TaintBench is now supported.
- Bugfixes and tweaks
- ...

1.2.0

With BREW version 1.2.0 mainly two improvements are introduced. Both help to select the best tool associated with any benchmark case. Futhermore, the new version relies on the up-to-date AQL-System (v. 1.2.0).
IMPORTANT: This makes it mandatory to upgrade existing configurations (seeConfiguration Upgrades)!

1. Features

BREW 1.2.0 allows to automatically determine or specify features for certain benchmark cases. This way tools can be choosen more selectively based on a tool's priority to handle certain features.



Example: The following configuration holds two artificial tools, namely `AwesomeDroid` and `LameDroid`.

```
<tool name="AwesomeDroid" version="1">
   <priority>1</priority>
   <priority feature="Awesome">3</priority>
   ...
</tool>
<tool name="LameDroid" version="1">
   <priority>2</priority>
   ...
</tool>
```

For arbitrary benchmark cases `LameDroid` has the highest priority (`2`). For benchmark cases with the associated `Awesome` feature assigned `AwesomeDroid` has the highest priority (`3`) and will be selected.

2. Rules

The same features can be used to activate (query transformation) rules for certain benchmark cases. These rules are loaded from an XML file. The structure of such a file is defined through the rules.xsd schema. The launchparameter `-rules X` can be used to load rules from file `X`.

Inside any rule the following variables can be used:

Variable	Meaning
%QUERY%	The original query before applying the rule without question mark, if the original query ends with a question mark
%FILE_i%	File number i (i in [1, n]) from the original query
%FEATURE_i%	Feature number i (i in [1, n]) from the original query

Variable	Meaning
%FEATURES%	All features from the original query

Example: Let us consider the following query `Flows IN App('AwesomeApp.apk') FEATURING 'Awesome' ?`.
With the rule-set below in place, it gets transformed to `FILTER [ Flows IN App('AwesomeApp.apk') FEATURING 'Awesome' ? ]` since only the rule with the highest priority is applied.

```
<rules>
   <rule always="true">
      <priority>1</priority>
      <query>UNIFY [ %QUERY% ?, Permissions IN App('%FILE_1%') ? ]</query>
   </rule>
   <rule always="false">
      <priority feature="Awesome">2</priority>
      <query>FILTER [ %QUERY% ? ]</query>
   </rule>
</rules>
```

The first rule included is always applied (see attribute `always="true"`) independently of the features mentioned in the query. However, since its priority is only `1` the sencond rule gets applied with a priority of `2` for this query.