Software Testing, Verification and Validation

September 23, 2022
Week #2 — Recitation #1

U.PORTO
FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO

Static Verification

Static Verification

Static Testing is a software testing technique which is used to check *faults* in a software application without executing its source code. It is concerned with the analysis of the static system representation (source code, documents, models, prototypes, etc.) to discover *faults*.

- Early detection of faults prior to test execution.
- Early warning about suspicious aspects of the code or design.
- Detecting dependencies and inconsistencies in software models, such as links.
- Improved maintainability of code and design.
- Prevention of faults, if lessons are learned in development.

Static Verification

The two main types of static testing techniques are:

- **Manual examinations**: Manual examinations include analysis of code done manually, also known as **Reviews.**
- **Automated analysis using tools:** Automated analysis are basically static analysis which is done using tools.

Static Verification Tools

What can static analysis do?

A form of automated testing:

- Check for violations of standards.
- Check for things which may be faulty.
- Can find unreachable code, undeclared variables, parameter type mis-matches, uncalled functions, etc.
- Static analysis tools are scalable and generally require less time to set up.

The objective of static analysis is to find faults in software source code and software models. Static analysis is performed without actually executing the software being examined by the tool. As with reviews, static analysis finds faults rather than failures.

Types of Static Analysis Tools

- Lexical: Words, strings, and regexps.
- Syntactic: Tree of program structure.
- Control flow graph.
- Data flow graph.

Here are a few examples of well-know static analysis tools:

- [Checkstyle](https://checkstyle.sourceforge.io)
- [SpotBugs](https://spotbugs.github.io)
- [PMD](https://pmd.github.io)
- [Google's Error Prone](https://errorprone.info)
- [SourceMeter](https://www.sourcemeter.com)
- [Checkmarx](https://www.checkmarx.com)

False Positive / Negative

Many static analysis tools are based on heuristics which may produce a large number of warning messages, which need to be well managed to allow the most effective use of the tool.

- Correct positive: Warning, and a true problem (👍 let's fix it!)
- Correct negative: No warning, no problem. (no action required 😎)
- False positive: Warning, but not a problem (annoying 😡)
- False negative: Problem, but no warning (dangerous 💣)

Data flow analysis

Data-flow analysis is a technique for gathering information about the possible set of values calculated at various points in a computer program. In other words, study program’s variables.

```
x = y + z;    // x is defined, y and z are used

if (a > b) {  // a and b are used
  read(s);    // s is defined
}
```

Data flow analysis

```
n = 0;
read(x);
n = 1;   // anomaly: n is re-defined
         // without being used
```

Control flow analysis

In computer science, control-flow analysis (CFA) is a static-code-analysis technique for determining the control flow of a program. A control-flow graph (CFG) is a representation, using graph notation, of all paths that might be traversed through a program during its execution.

Control flow analysis can check, e.g.,

- Infinite loops
- Unreachable code

(Code) Metrics

- Lines of code
- Complexity: number of if-statements per method
- Coupling: number of classes a class depend on
- Cohesion: correlation between variables and methods
- Nesting levels: relate to how deeply nested statements are within other IF statements.
- Cyclomatic complexity is a software metric used to indicate the complexity of a program, i.e., of a flow graph. It is a quantitative measure of the number of linearly independent paths through a program’s source code. The more complex the flow graph, the greater the measure.

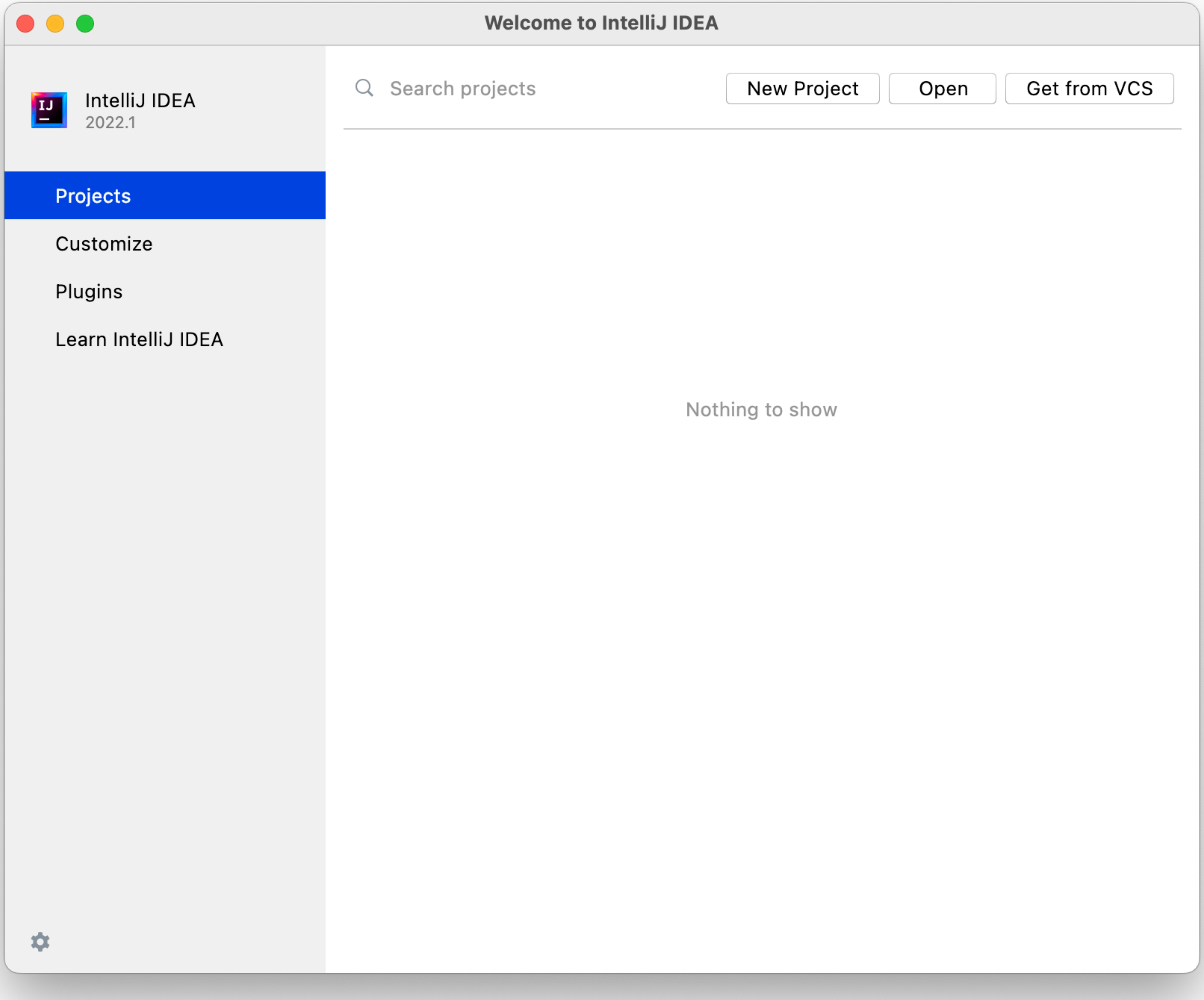
Demo

https://paginas.fe.up.pt/~jcmc/tvvs/2022-2023/recitations/recitation-1-jpacman.zip

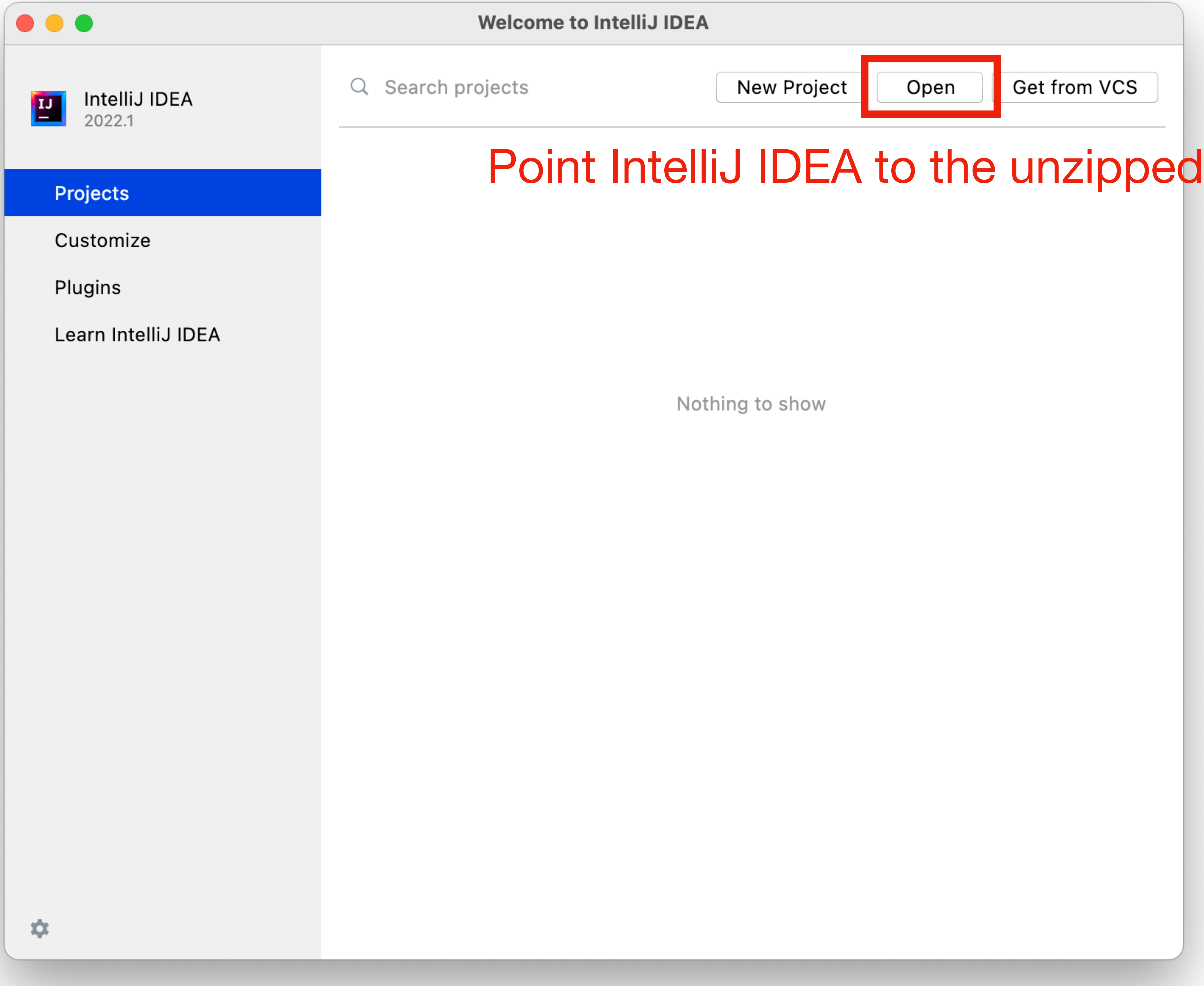
1. Get the jpacman game's source code available in here, https://paginas.fe.up.pt/~jcmc/tvvs/2022-2023/recitations/recitation-1-jpacman.zip.

2. Unzip the given recitation-1-jpacman.zip file.

3. Open IntelliJ IDEA.

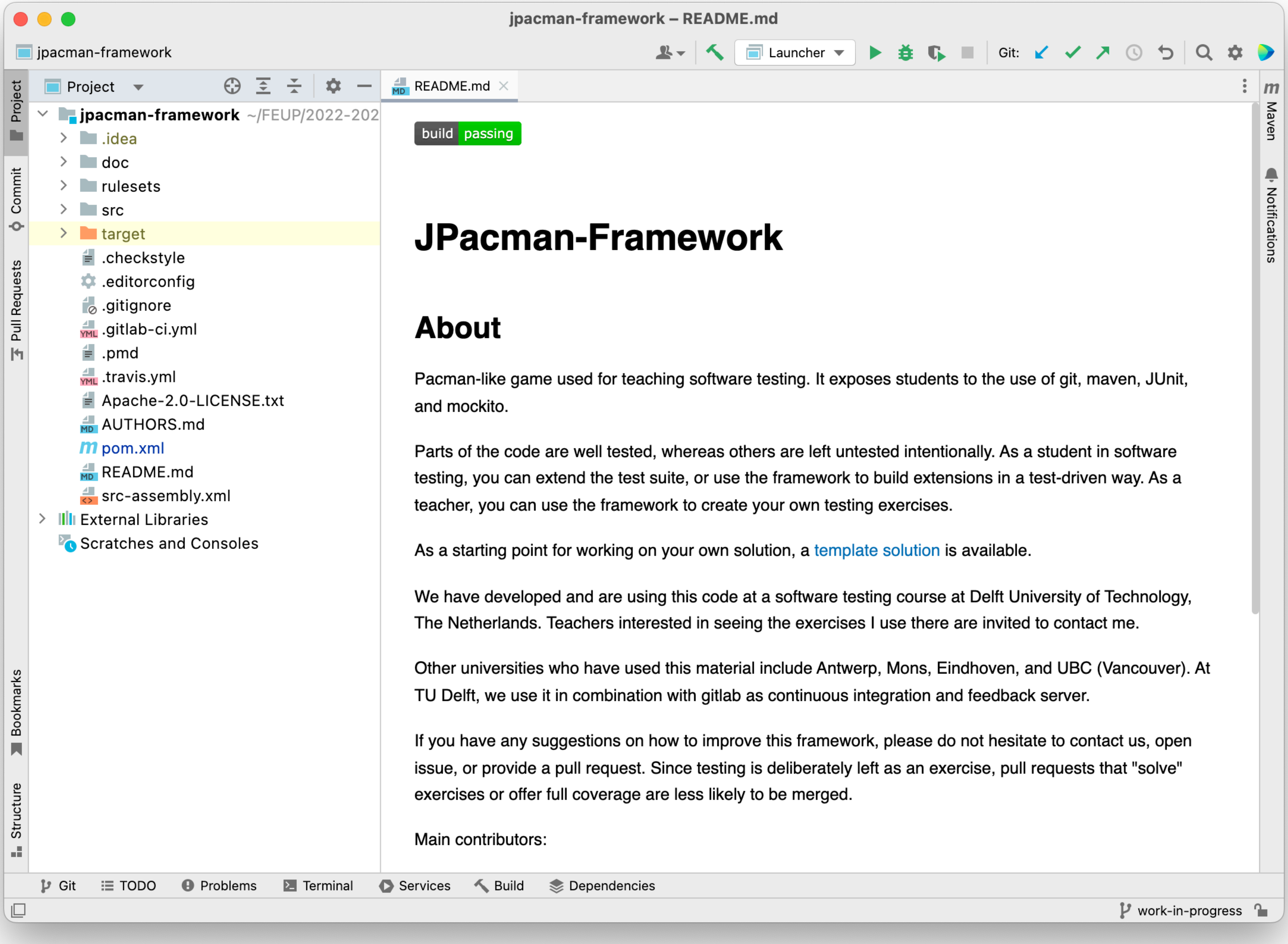


Welcome to IntelliJ IDEA
IJ
IntelliJ IDEA
2022.1
Projects
Customize
Plugins
Learn IntelliJ IDEA
Search projects
New Project
Open
Get from VCS
Nothing to show



Nothing to show

Point IntelliJ IDEA to the unzipped folder.



JPacman-Framework

About

Pacman-like game used for teaching software testing. It exposes students to the use of git, maven, JUnit, and mockito.

Parts of the code are well tested, whereas others are left untested intentionally. As a student in software testing, you can extend the test suite, or use the framework to build extensions in a test-driven way. As a teacher, you can use the framework to create your own testing exercises.

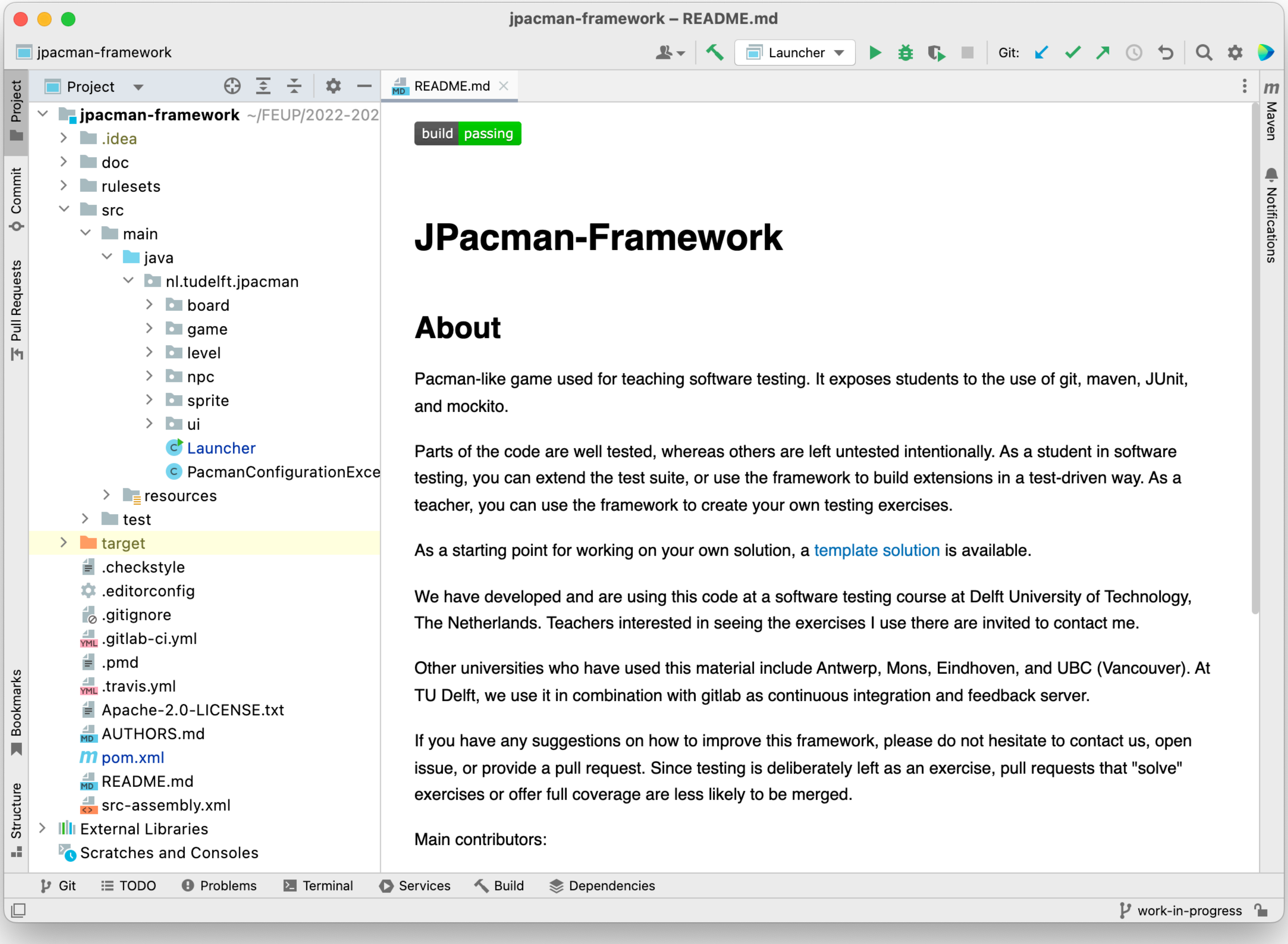
As a starting point for working on your own solution, a template solution is available.

We have developed and are using this code at a software testing course at Delft University of Technology, The Netherlands. Teachers interested in seeing the exercises I use there are invited to contact me.

Other universities who have used this material include Antwerp, Mons, Eindhoven, and UBC (Vancouver). At TU Delft, we use it in combination with gitlab as continuous integration and feedback server.

If you have any suggestions on how to improve this framework, please do not hesitate to contact us, open issue, or provide a pull request. Since testing is deliberately left as an exercise, pull requests that "solve" exercises or offer full coverage are less likely to be merged.

Main contributors:



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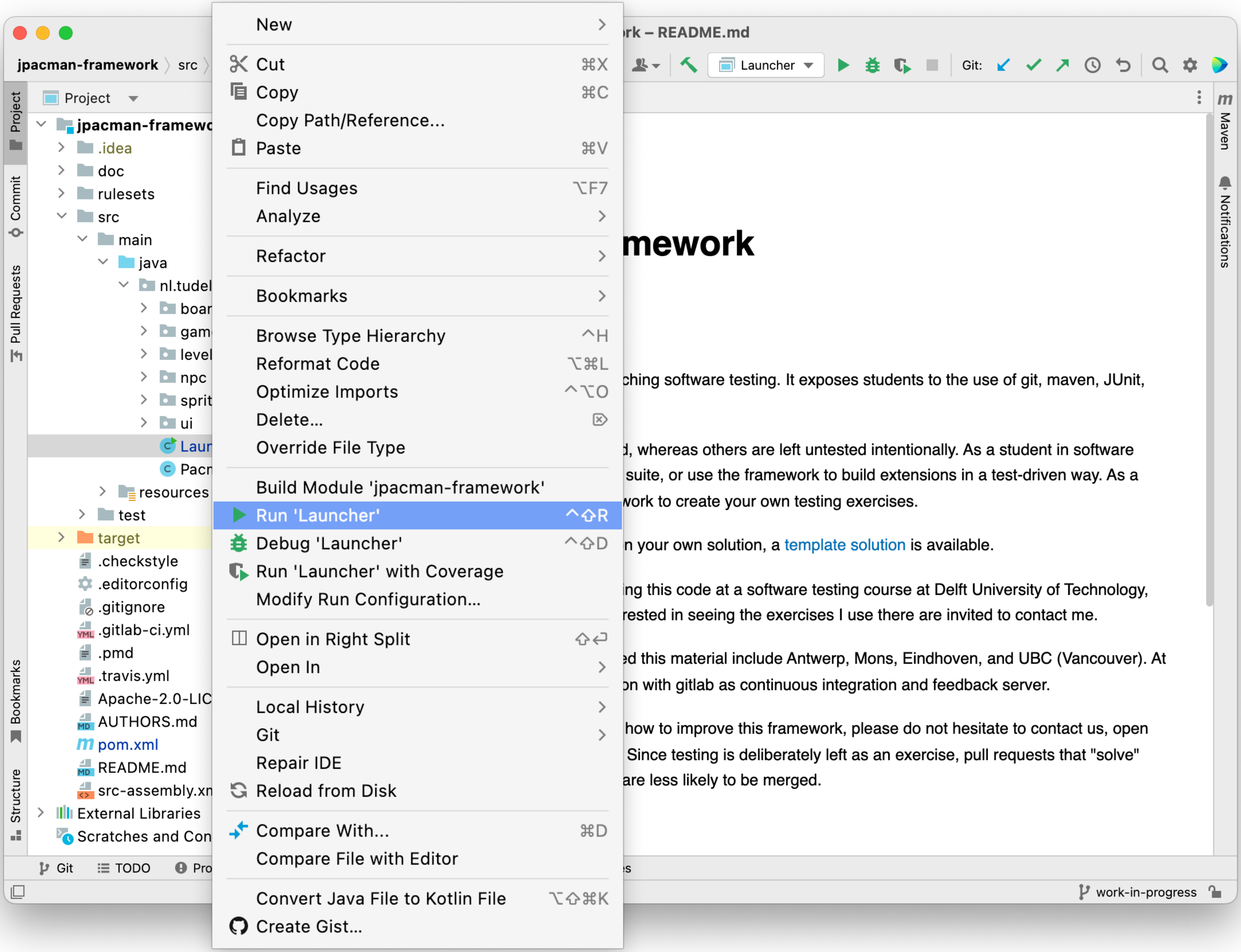

mework

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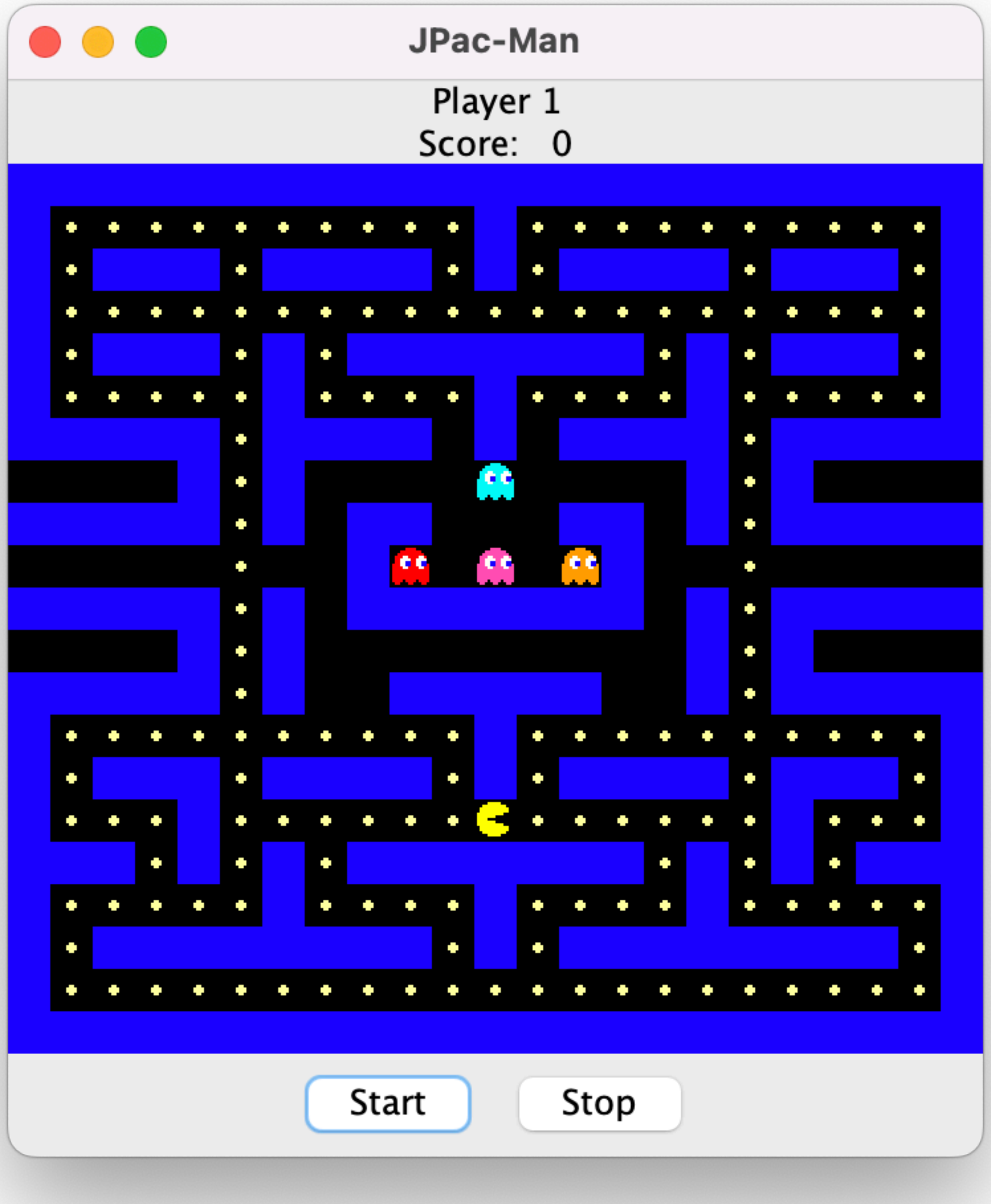
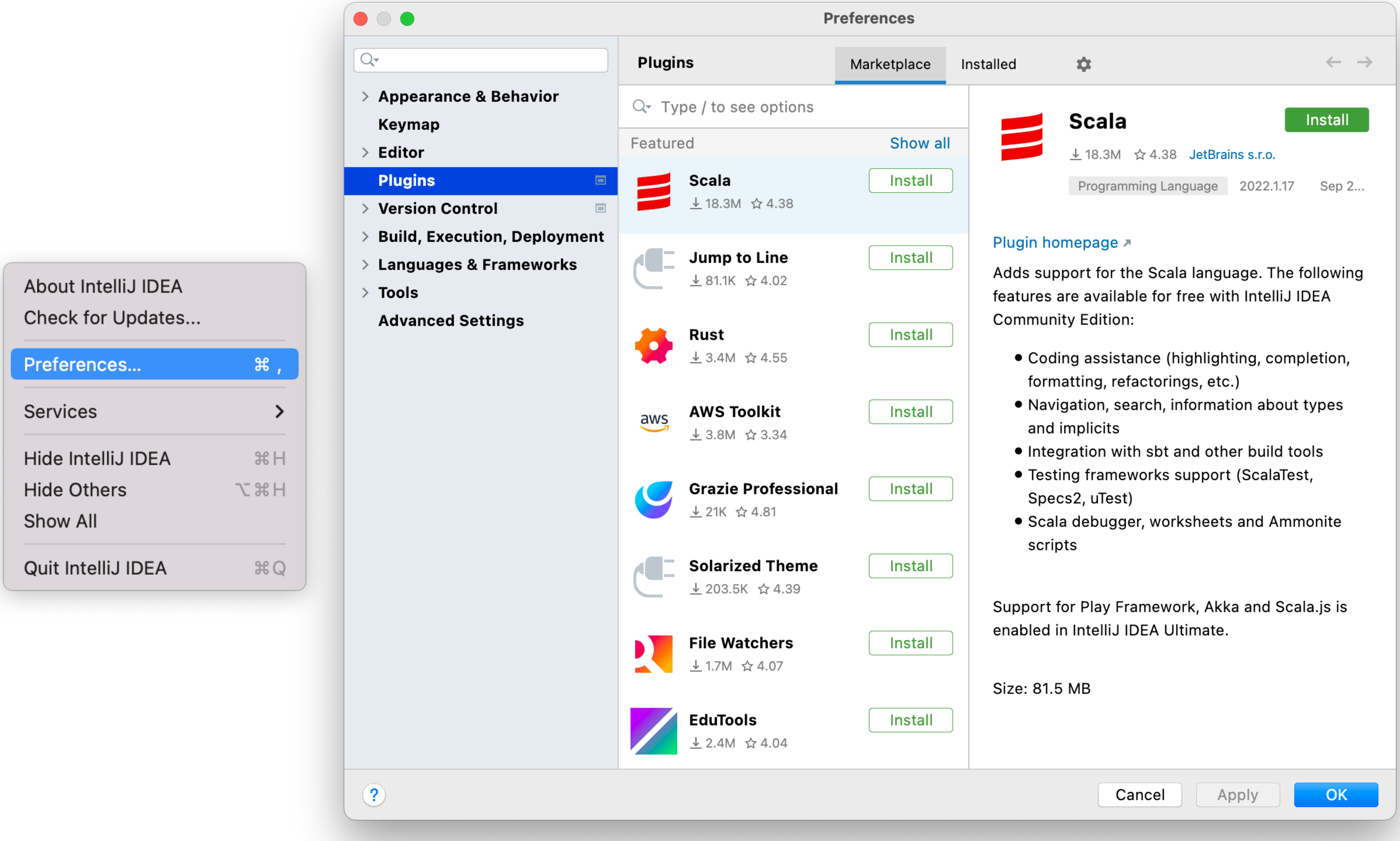


Player 1

Score: 0

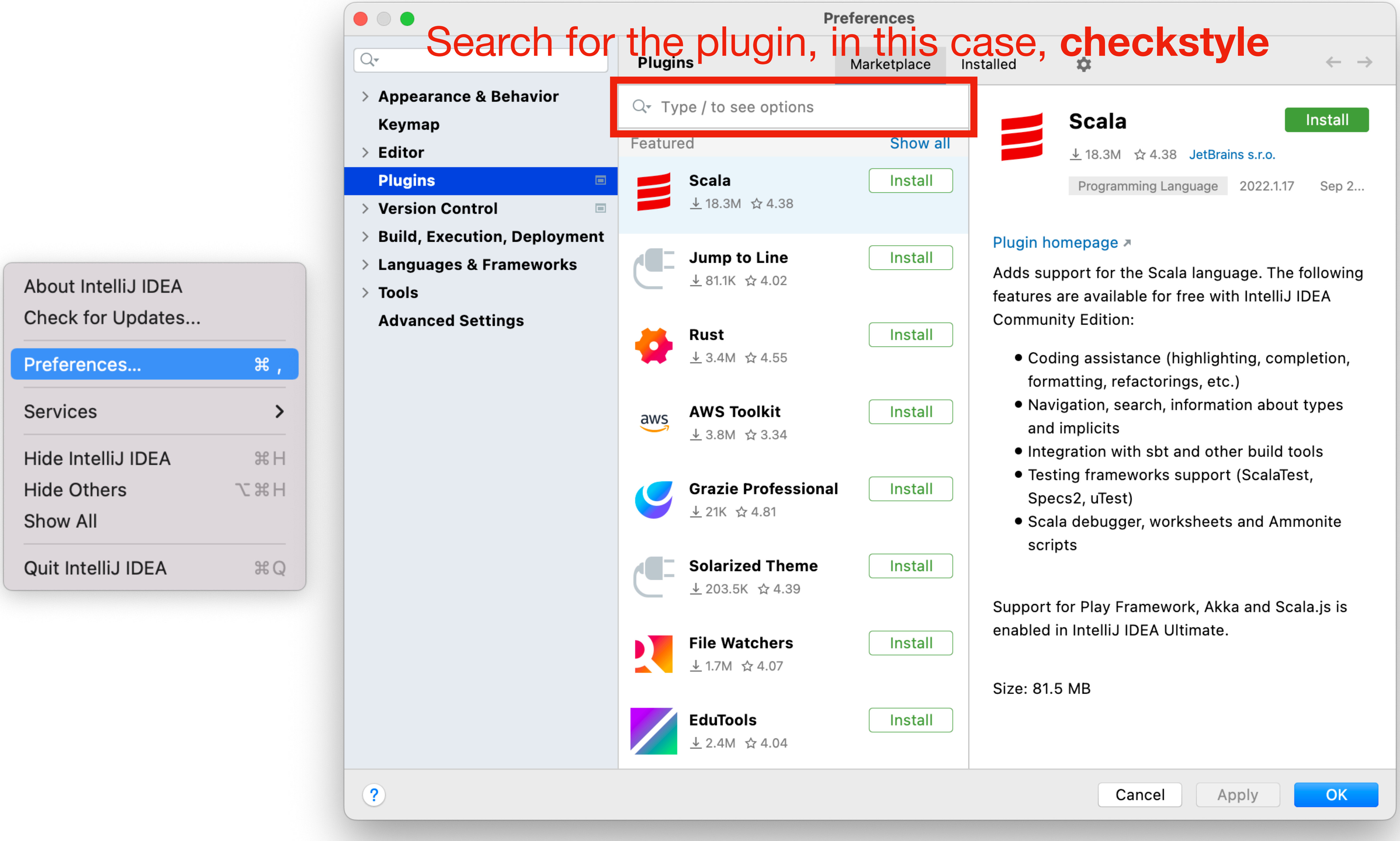


Adds support for the Scala language. The following features are available for free with IntelliJ IDEA Community Edition:

- Coding assistance (highlighting, completion, formatting, refactorings, etc.)
- Navigation, search, information about types and implicits
- Integration with sbt and other build tools
- Testing frameworks support (ScalaTest, Specs2, uTest)
- Scala debugger, worksheets and Ammonite scripts

Support for Play Framework, Akka and Scala.js is enabled in IntelliJ IDEA Ultimate.

Size: 81.5 MB



Search for the plugin, in this case, **checkstyle**

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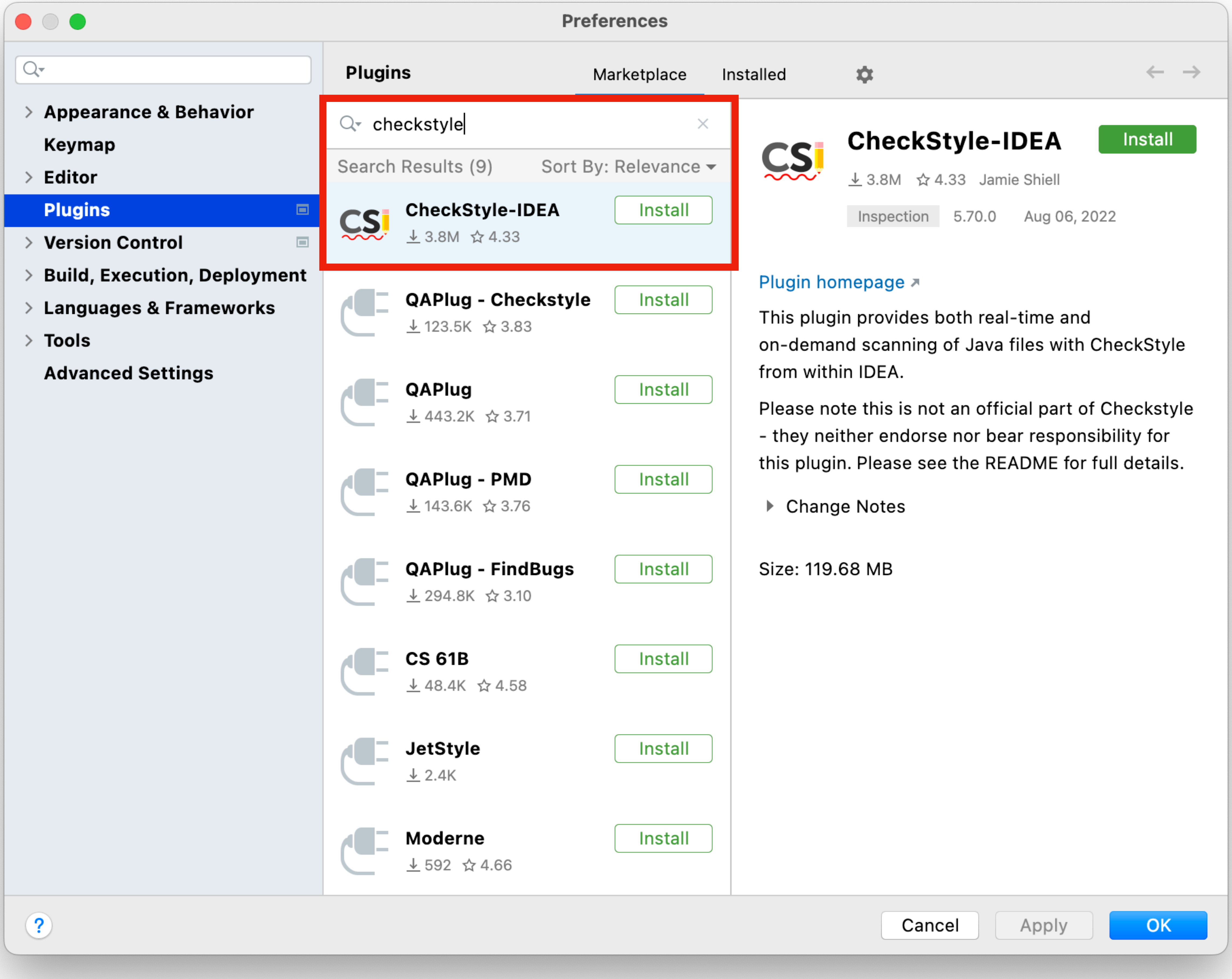


checkstyle

Search Results (9) Sort By: Relevance

Plugin	Downloads	Rating
CheckStyle-IDEA	3.8M	4.33
QAPlug - Checkstyle	123.5K	3.83
QAPlug	443.2K	3.71
QAPlug - PMD	143.6K	3.76
QAPlug - FindBugs	294.8K	3.10
CS 61B	48.4K	4.58
JetStyle	2.4K	
Moderne	592	4.66

CheckStyle-IDEA

3.8M ☆ 4.33 Jamie Shiell

Inspection 5.70.0 Aug 06, 2022

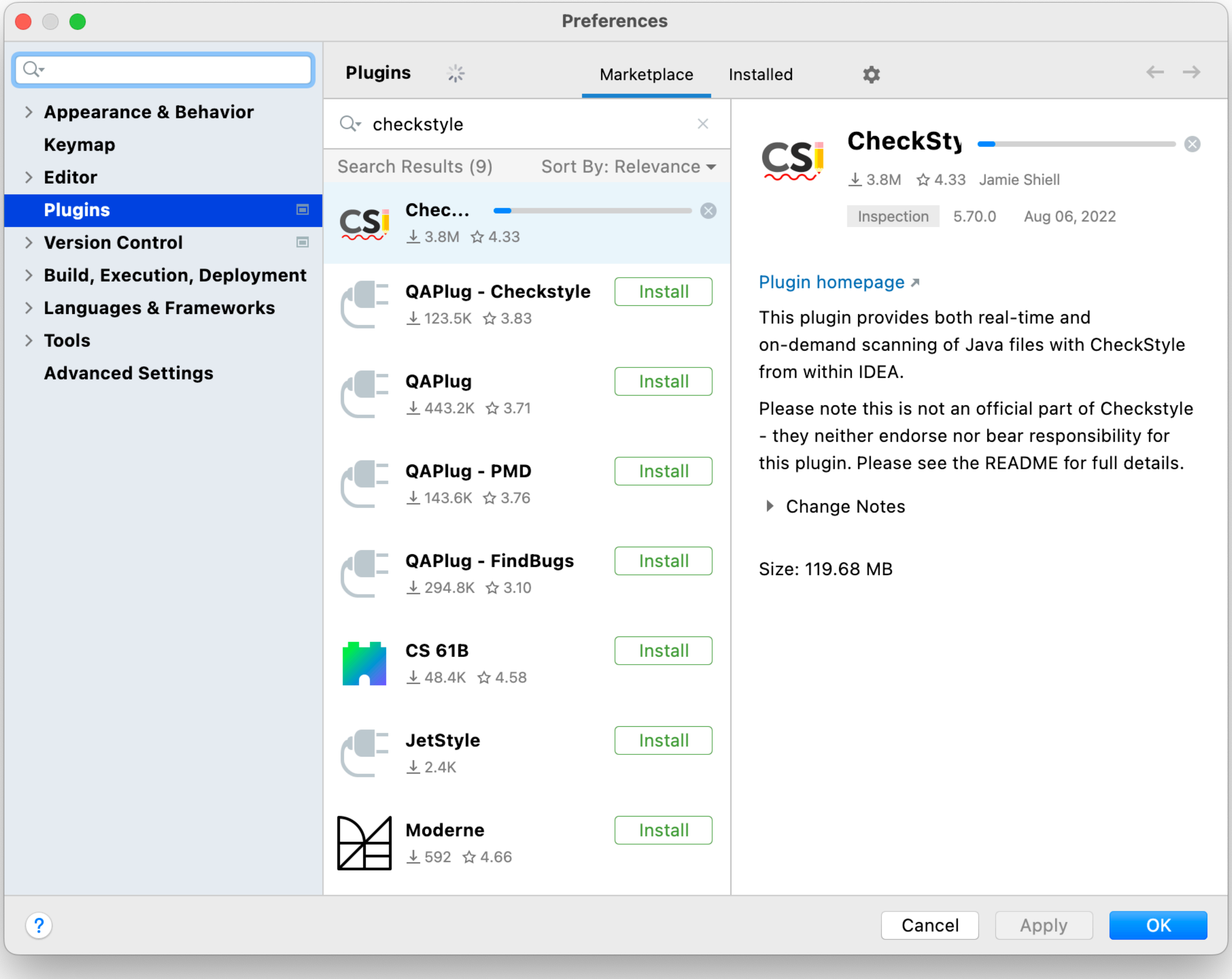
Plugin homepage ↗

This plugin provides both real-time and on-demand scanning of Java files with CheckStyle from within IDEA.

Please note this is not an official part of Checkstyle - they neither endorse nor bear responsibility for this plugin. Please see the README for full details.

▸ Change Notes

Size: 119.68 MB



checkstyle

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Chec… 3.8M ☆ 4.33	
QAPlug - Checkstyle 123.5K ☆ 3.83	Install
QAPlug 443.2K ☆ 3.71	Install
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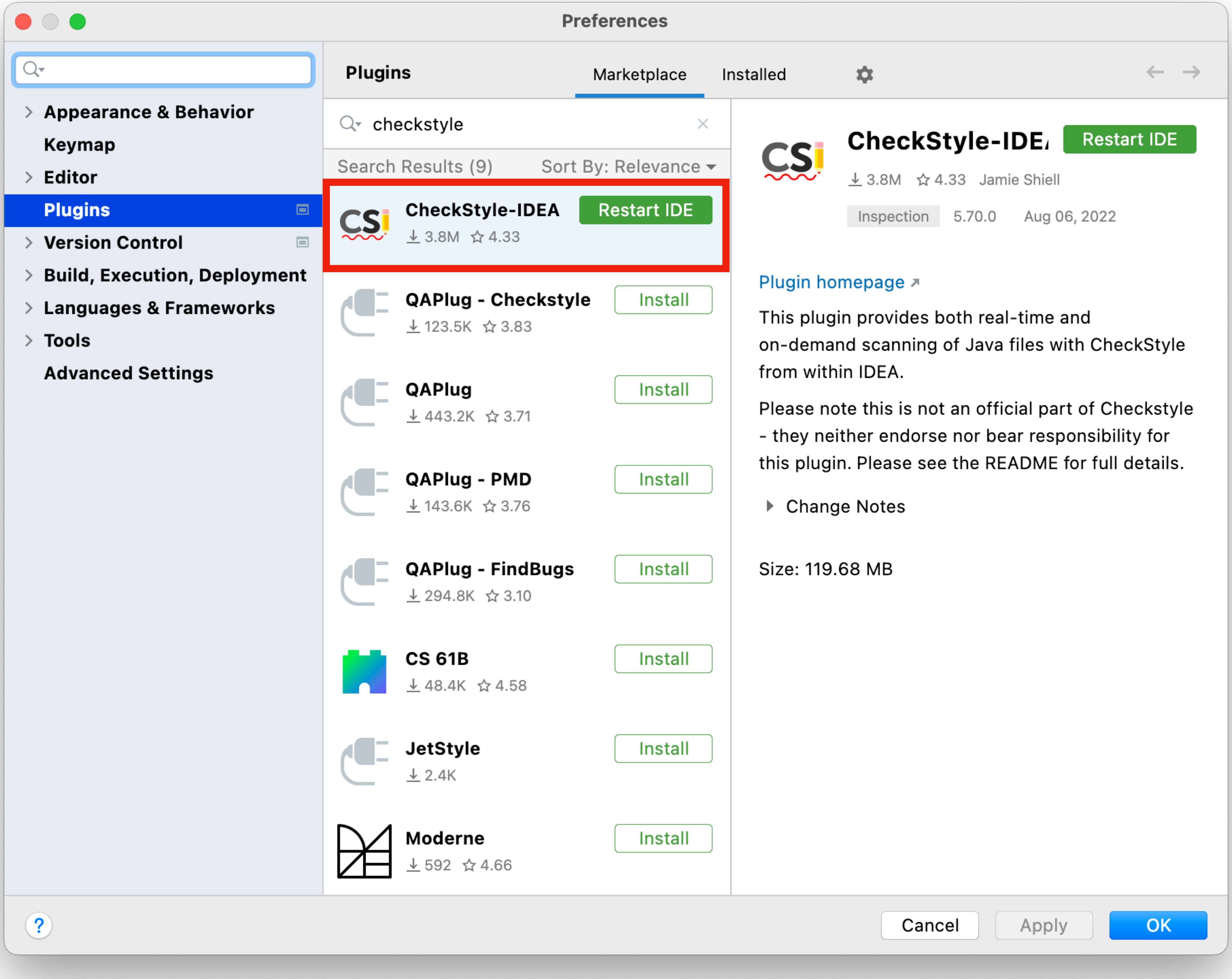

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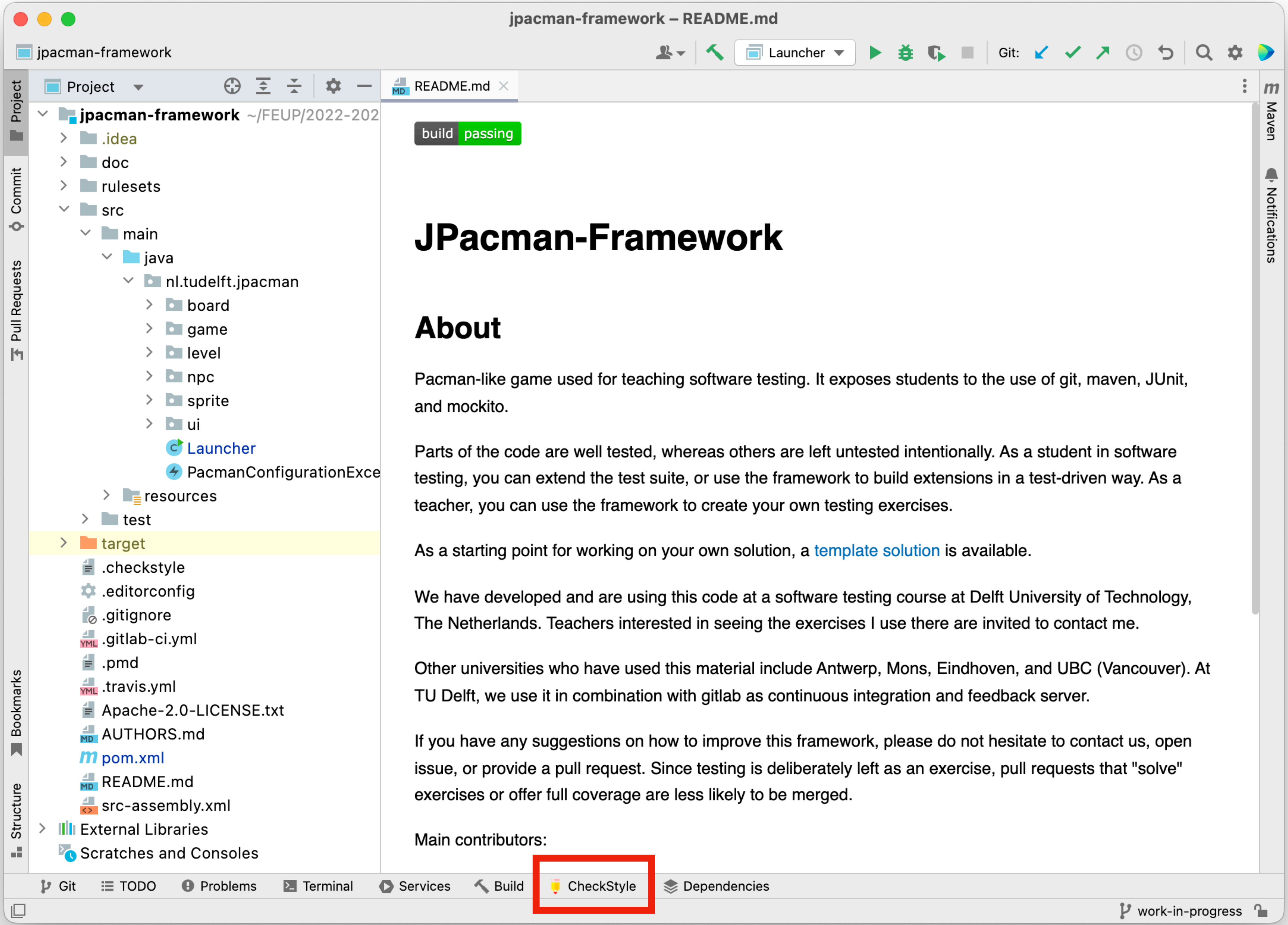

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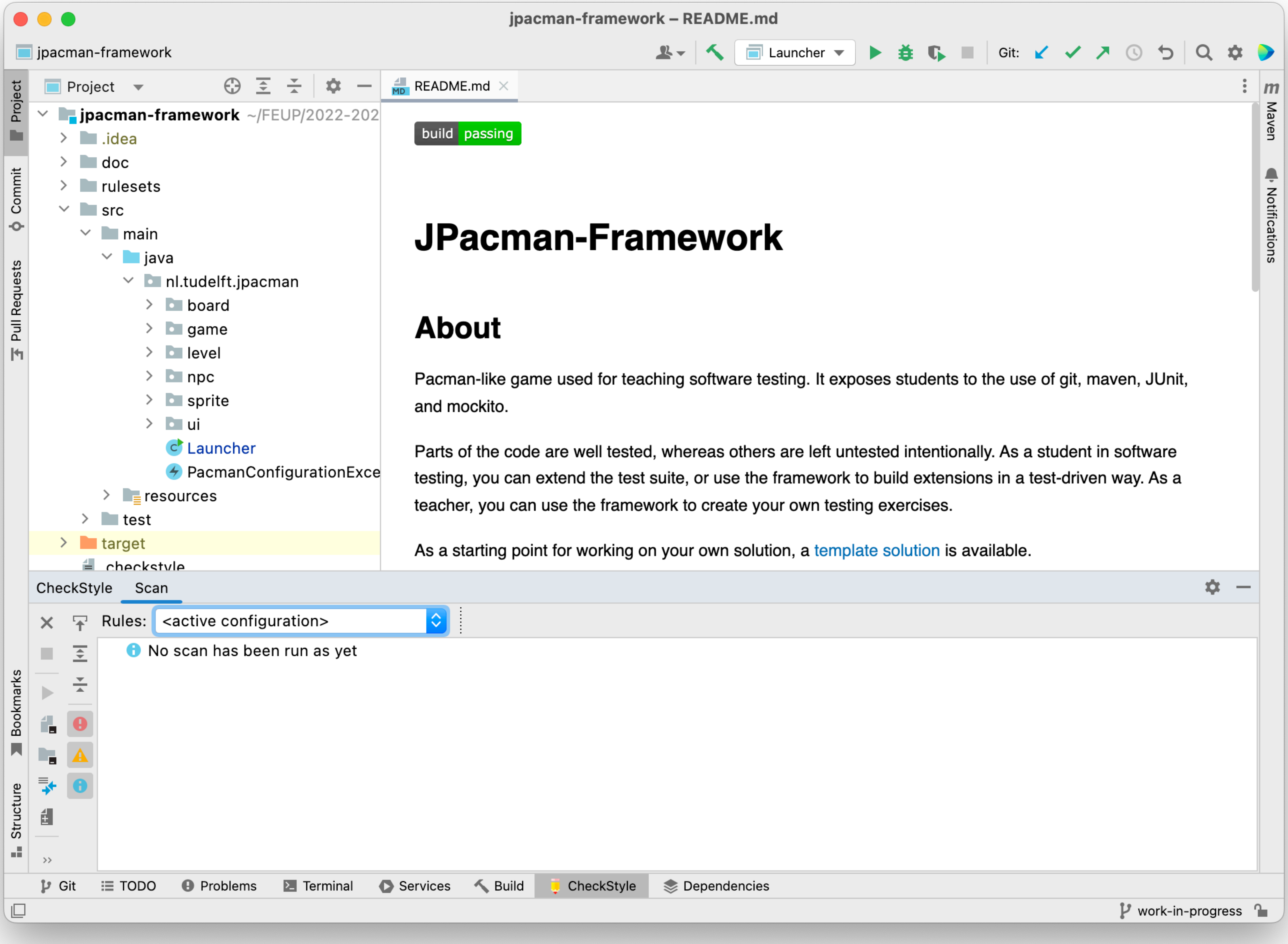
A new panel has been added to the editor



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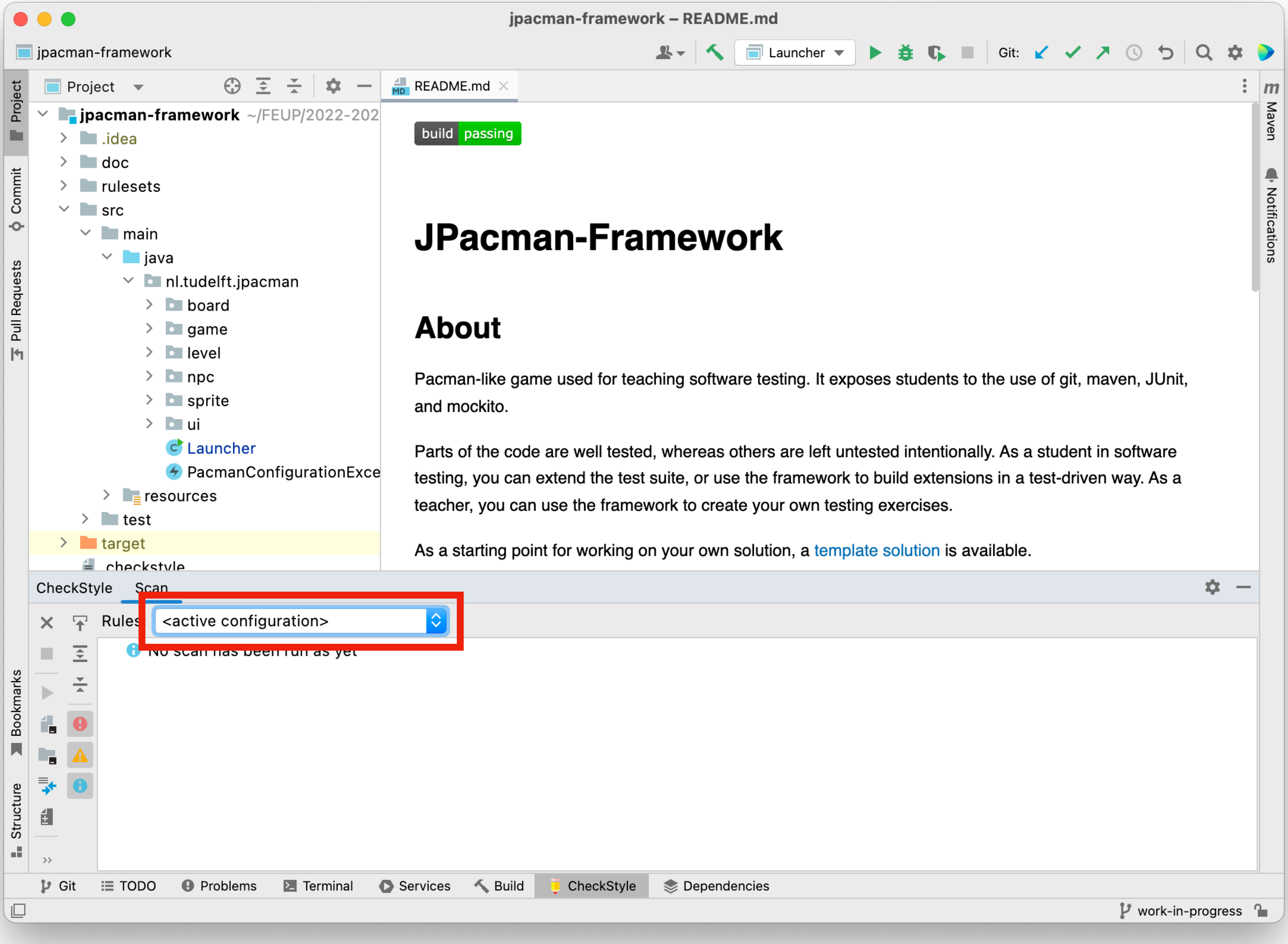
Rules: <active configuration>

No scan has been run as yet



build passing

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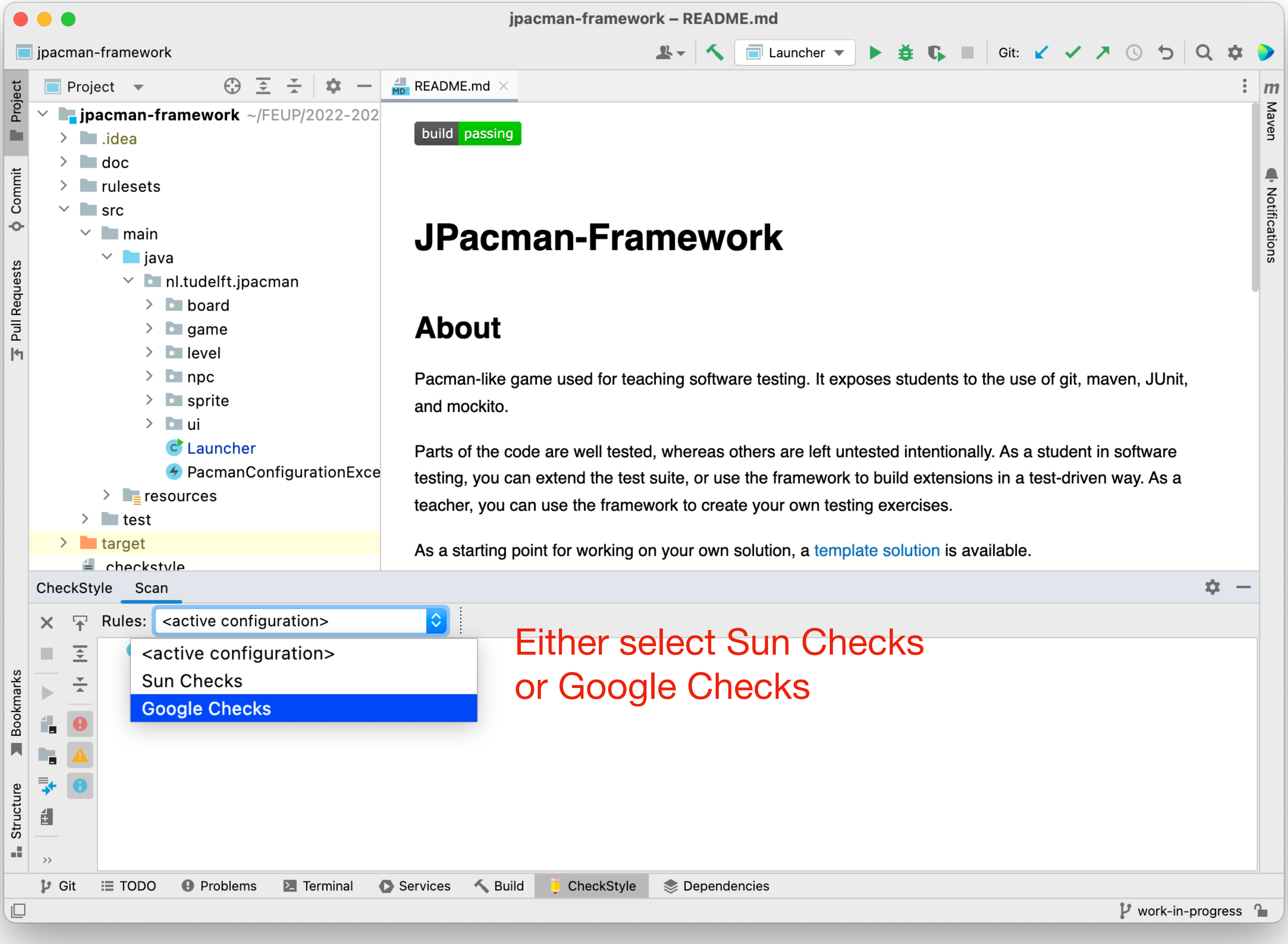

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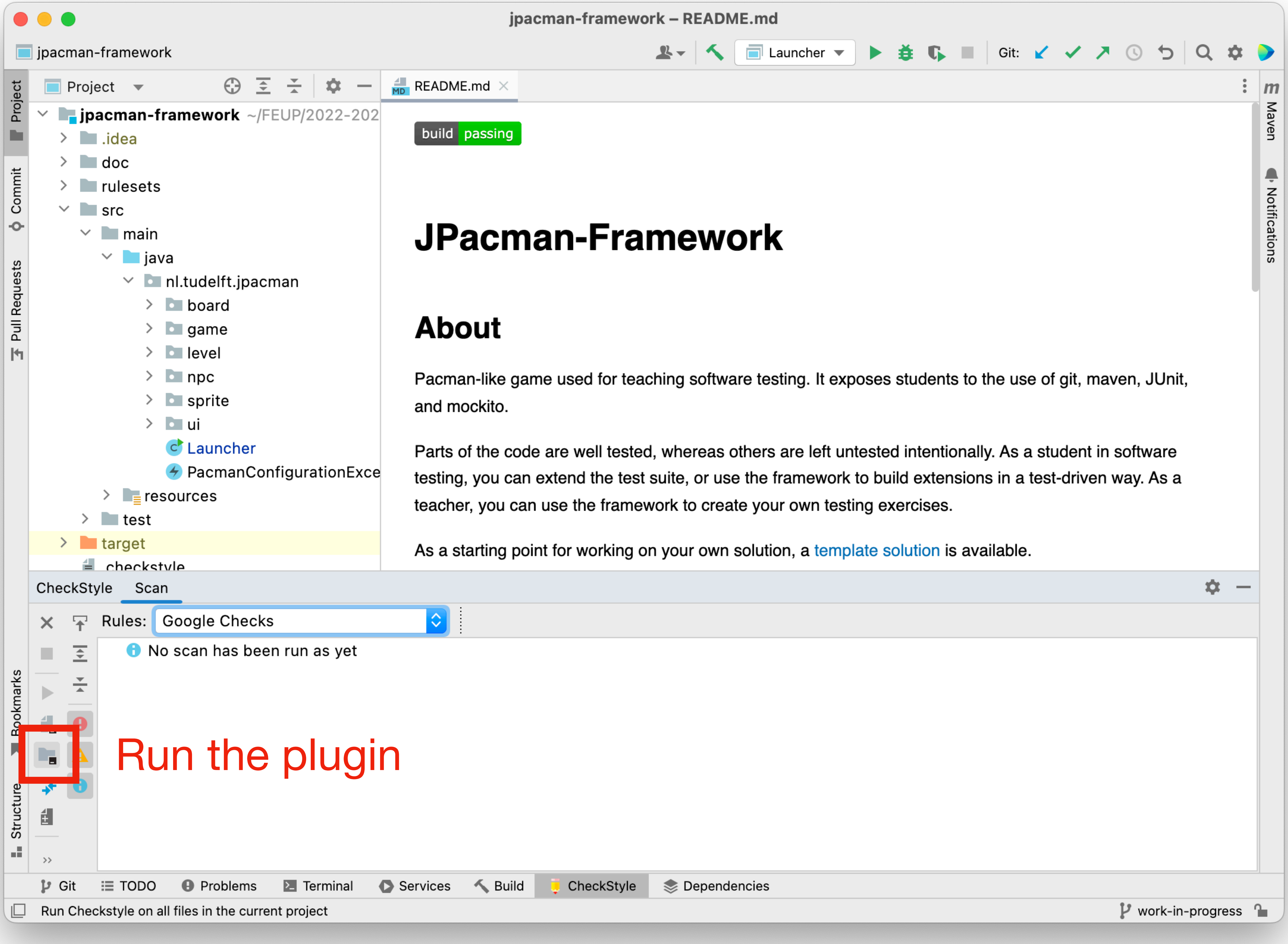
Rules: <active configuration>

Either select Sun Checks or Google Checks



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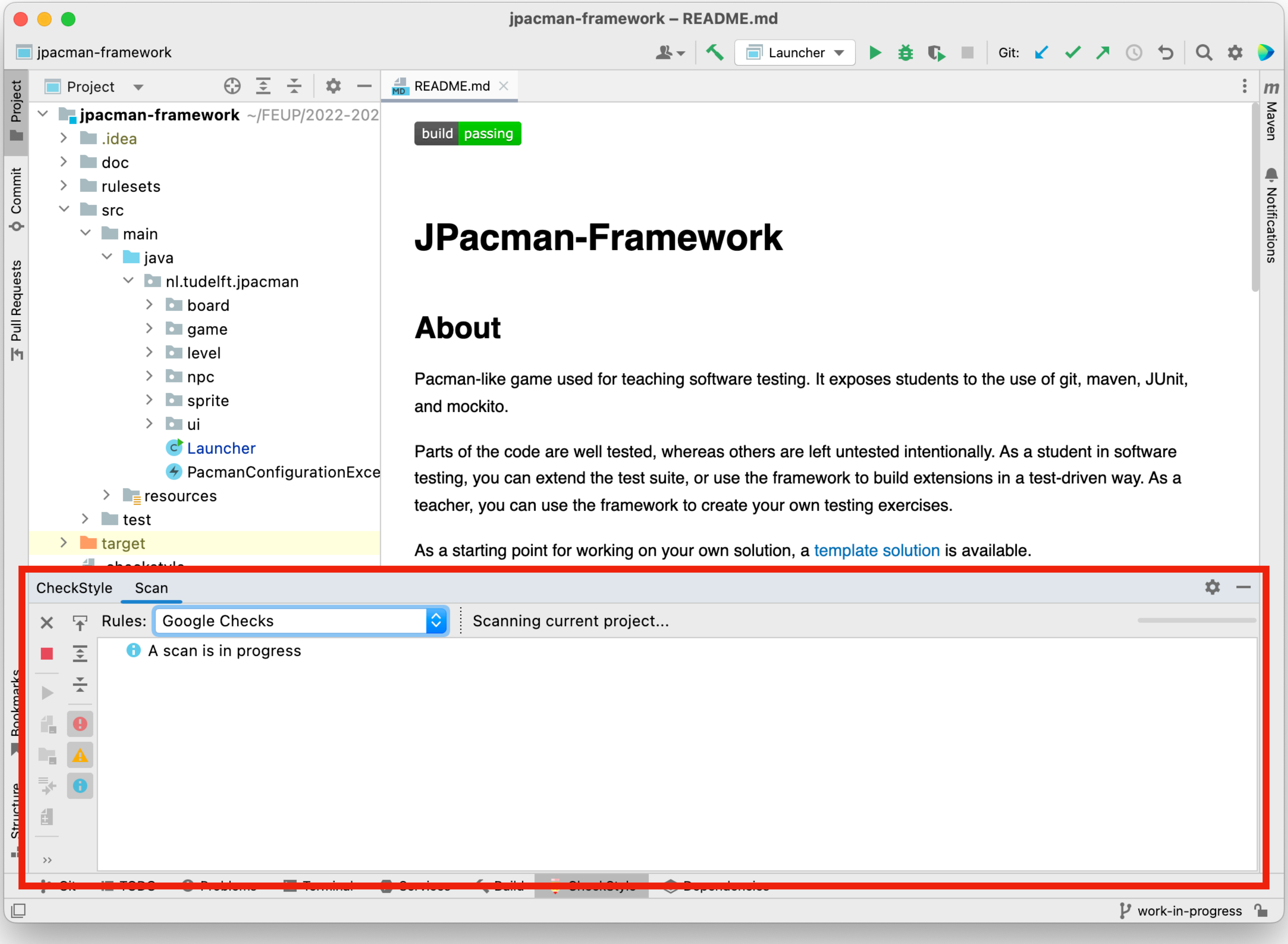
Rules: Google Checks

No scan has been run as yet

Run the plugin

Run Checkstyle on all files in the current project



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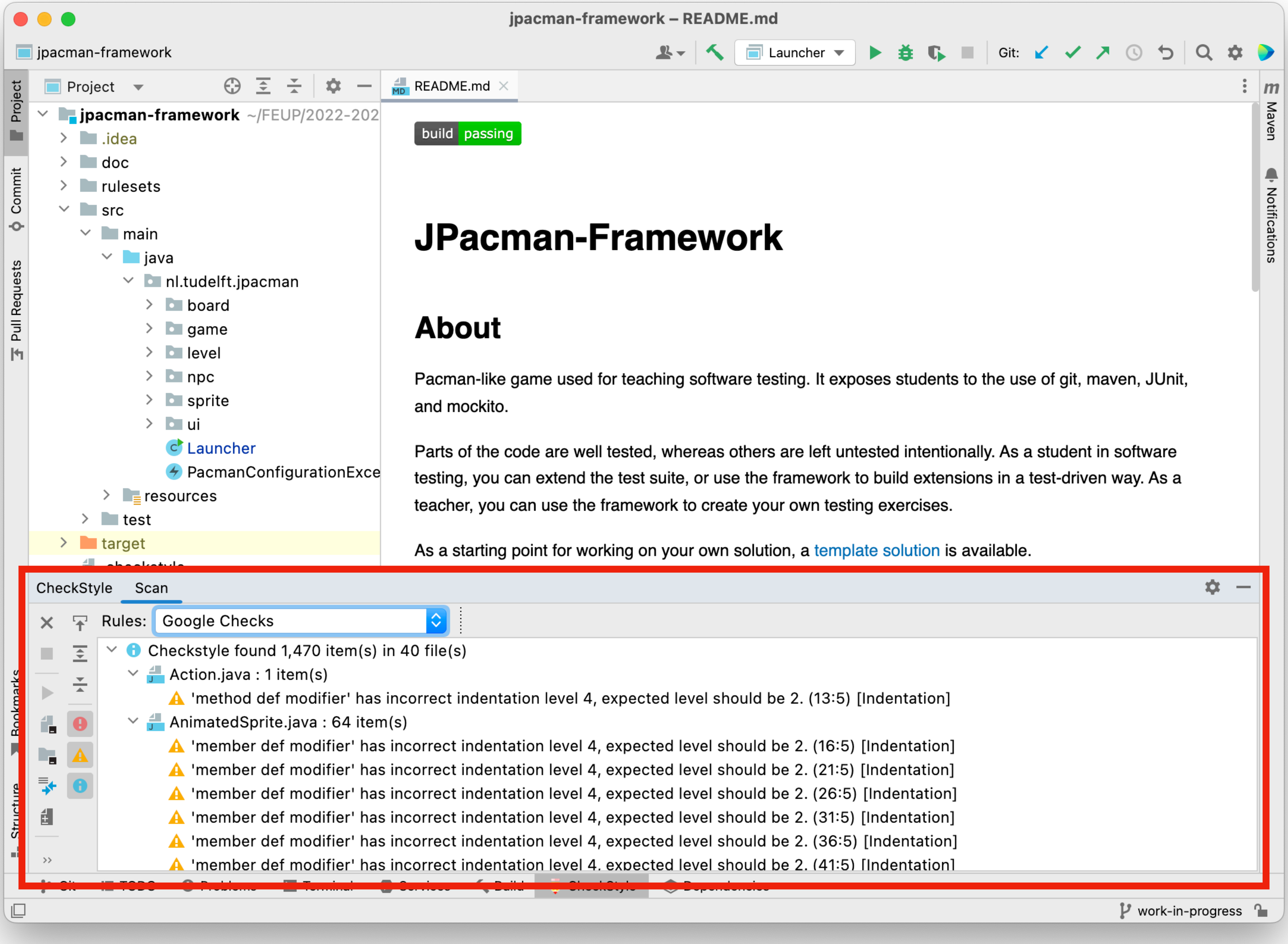
Rules: Google Checks

Scanning current project...

A scan is in progress



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Rules: Google Checks

```
Checkstyle found 1,470 item(s) in 40 file(s)
  Action.java : 1 item(s)
    'method def modifier' has incorrect indentation level 4, expected level should be 2. (13:5) [Indentation]
  AnimatedSprite.java : 64 item(s)
    'member def modifier' has incorrect indentation level 4, expected level should be 2. (16:5) [Indentation]
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    'member def modifier' has incorrect indentation level 4, expected level should be 2. (36:5) [Indentation]
    'member def modifier' has incorrect indentation level 4, expected level should be 2. (41:5) [Indentation]
```

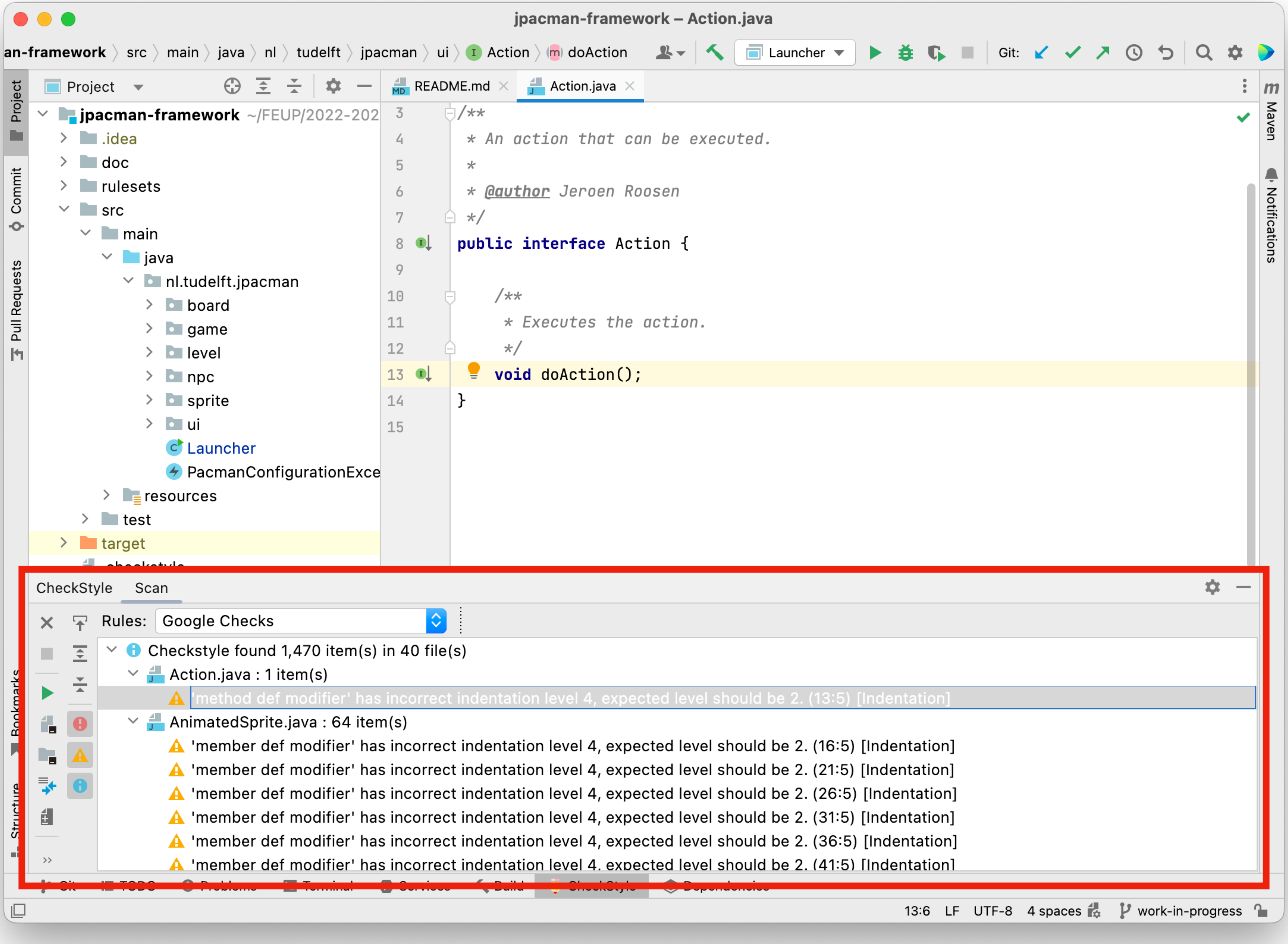

```
/**
 * An action that can be executed.
 *
 * @author Jeroen Roosen
 */
public interface Action {

    /**
     * Executes the action.
     */
    void doAction();
}
```

Rules: Google Checks

```
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```

- Perform the exact same steps for the two other tools:
    - PMD, https://pmd.github.io
    - SpotBugs, https://spotbugs.github.io/index.html