DepClean: Automatically revealing bloated software dependencies in Maven projects

César Soto Valero, Nicolas Harrand,
Martin Monperrus, and Benoit Baudry

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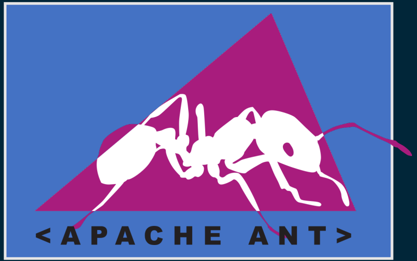
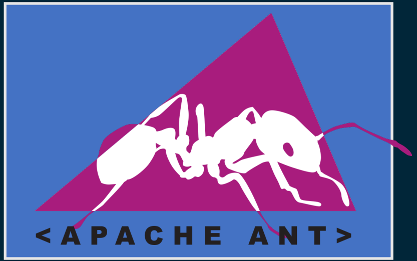
AND SOFTWARE PROGRAM

Dependency managers in Java

Dependency managers in Java



Dependency managers in Java



build.xml

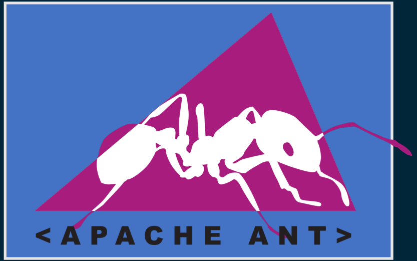
Dependency managers in Java

<APACHE ANT>

build.xml

maven

Dependency managers in Java



build.xml

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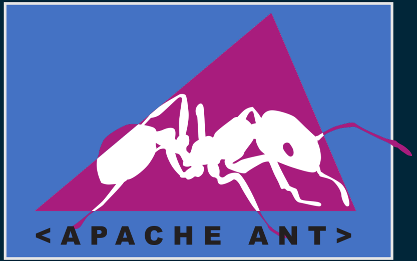
Dependency managers in Java



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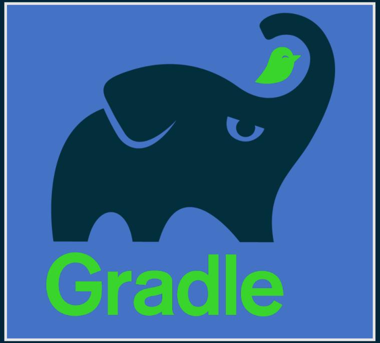

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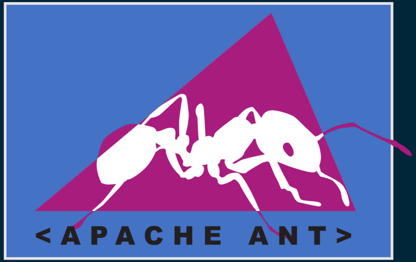
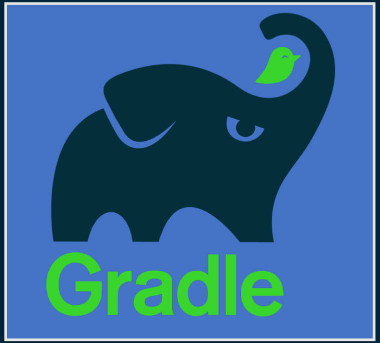


build.xml

pom.xml



build.gradle

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How many dependencies do we actually use?

Dependency tree

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```
<dependency>
    <groupId>org.A</groupId>
    <artifactId>A</artifactId>
</dependency>
<dependency>
    <groupId>org.B</groupId>
    <artifactId>B</artifactId>
</dependency>
<dependency>
    <groupId>org.C</groupId>
    <artifactId>C</artifactId>
</dependency>
```

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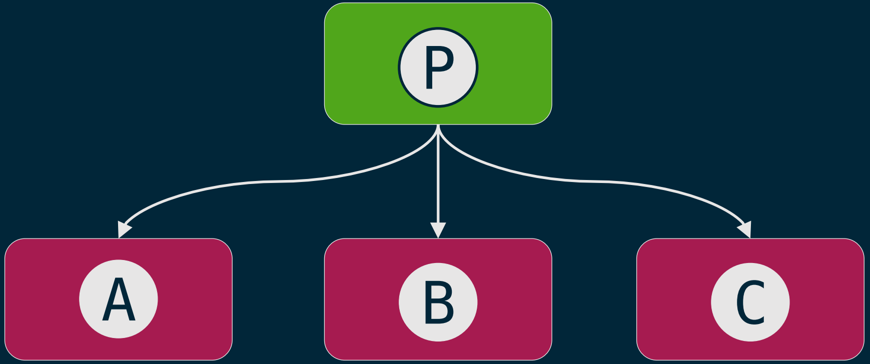
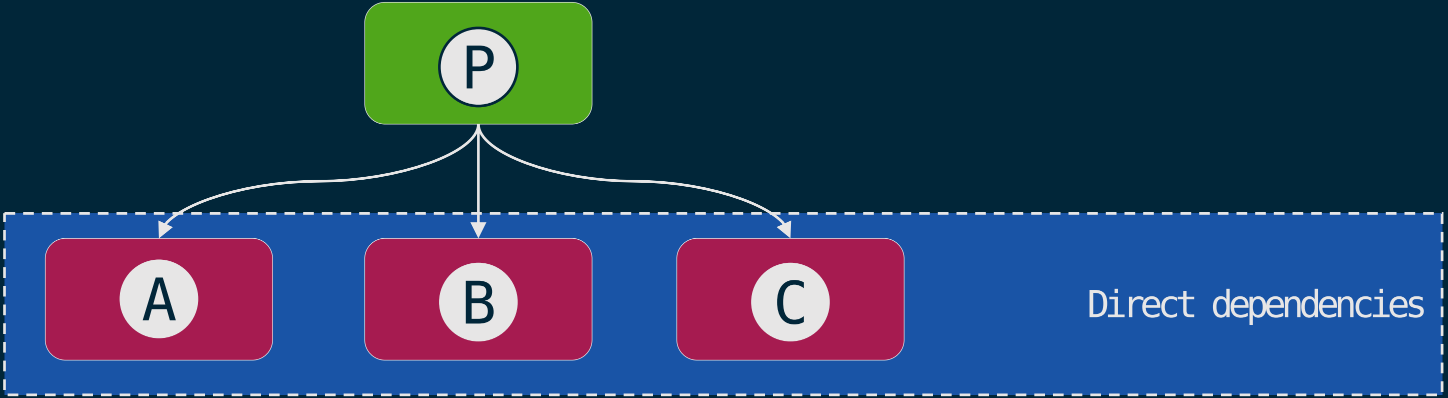


Dependency tree



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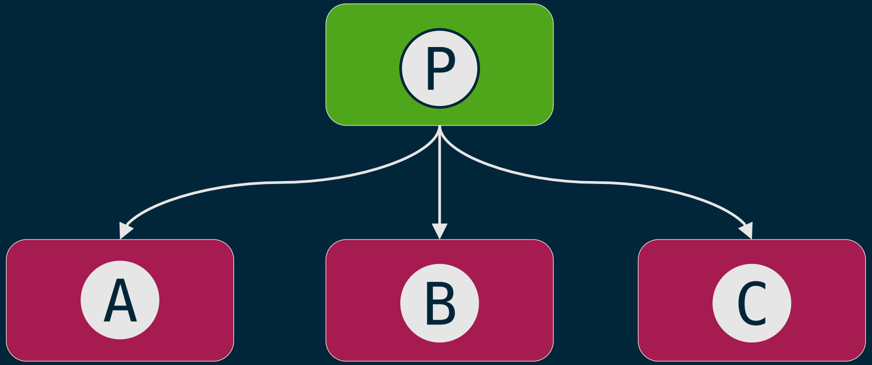

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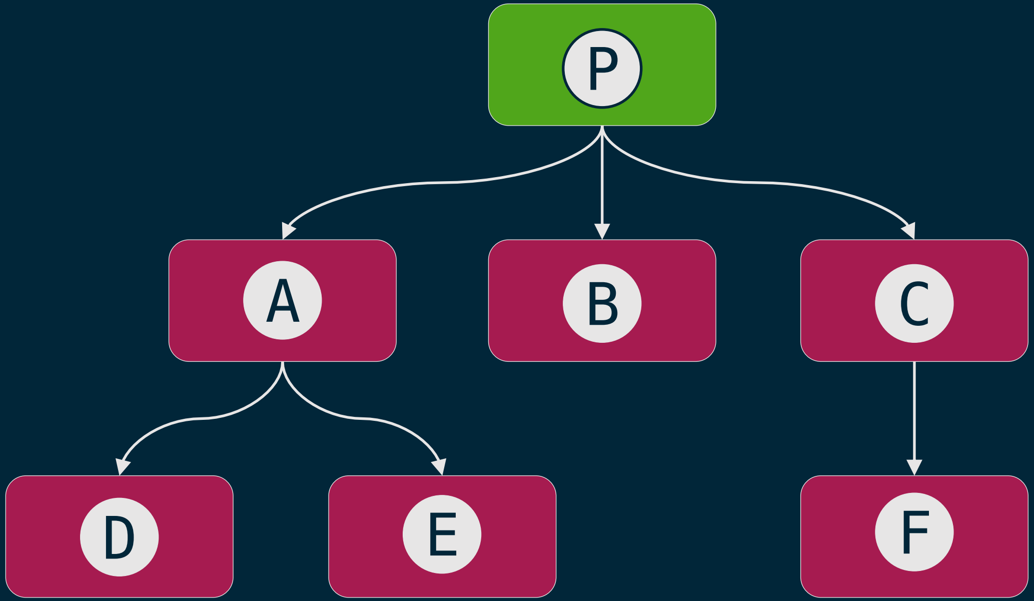

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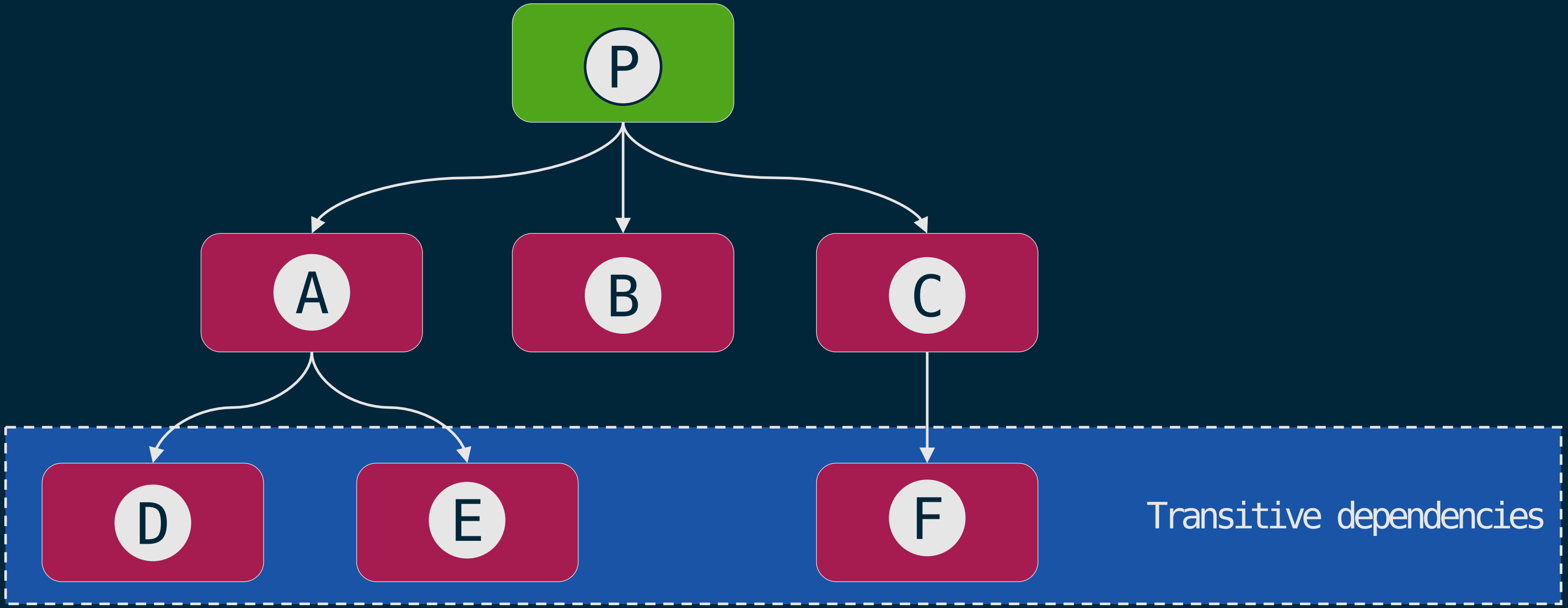

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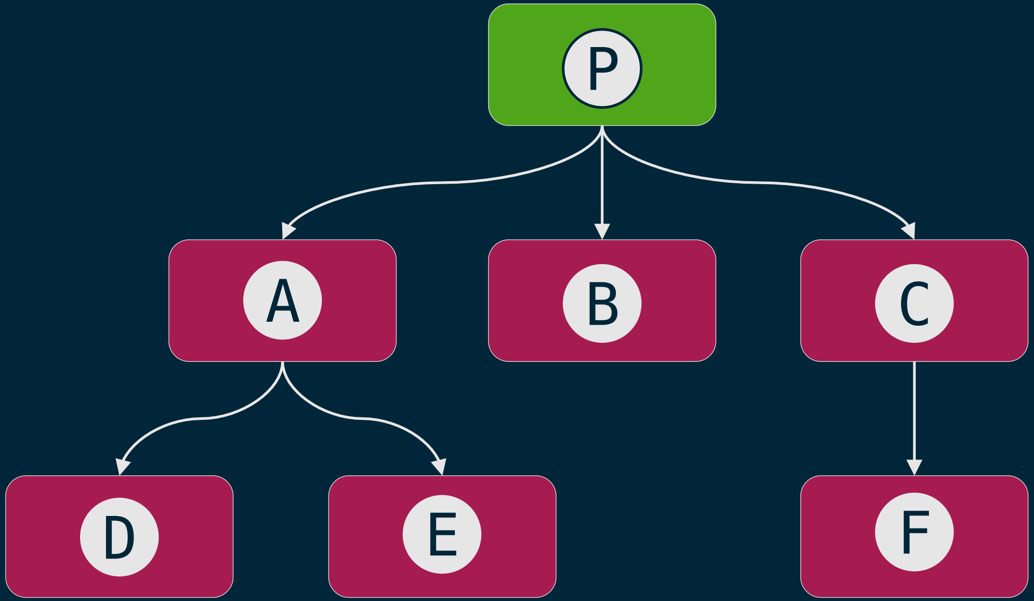

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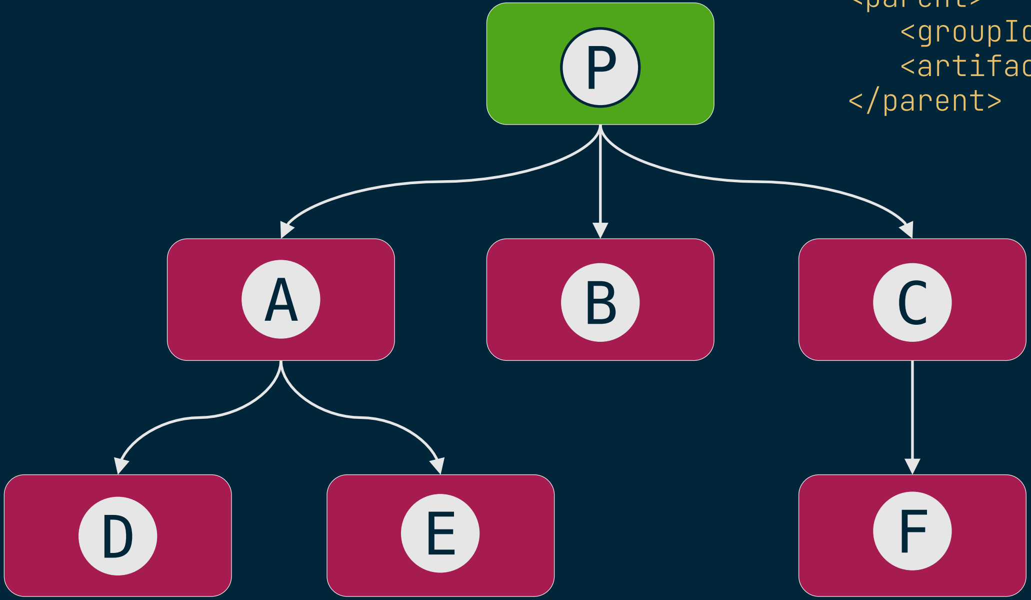
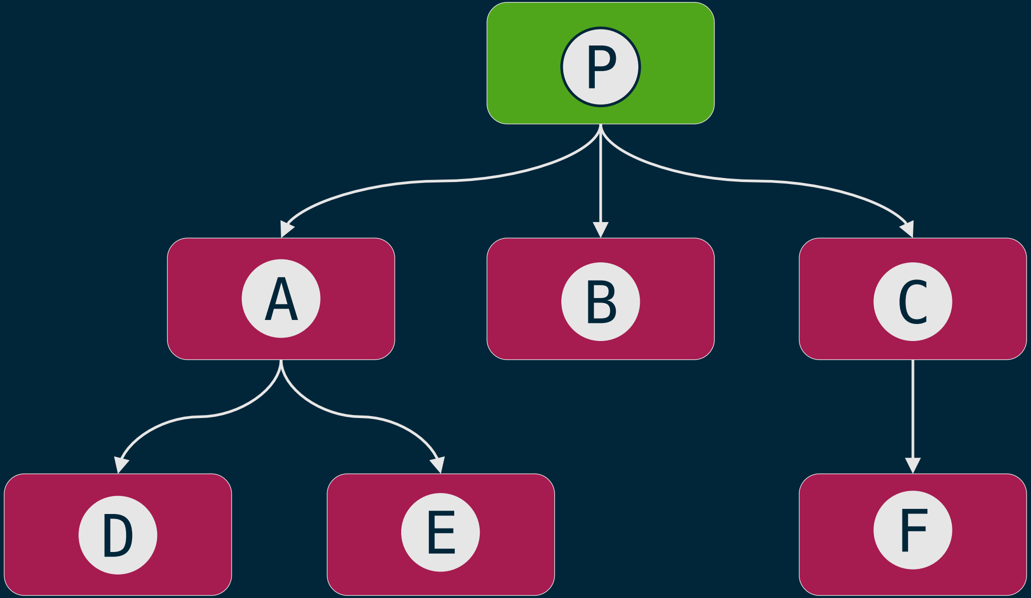


```
<parent>
   <groupId>org.Q</groupId>
   <artifactId>Q</artifactId>
</parent>
```

Dependency tree



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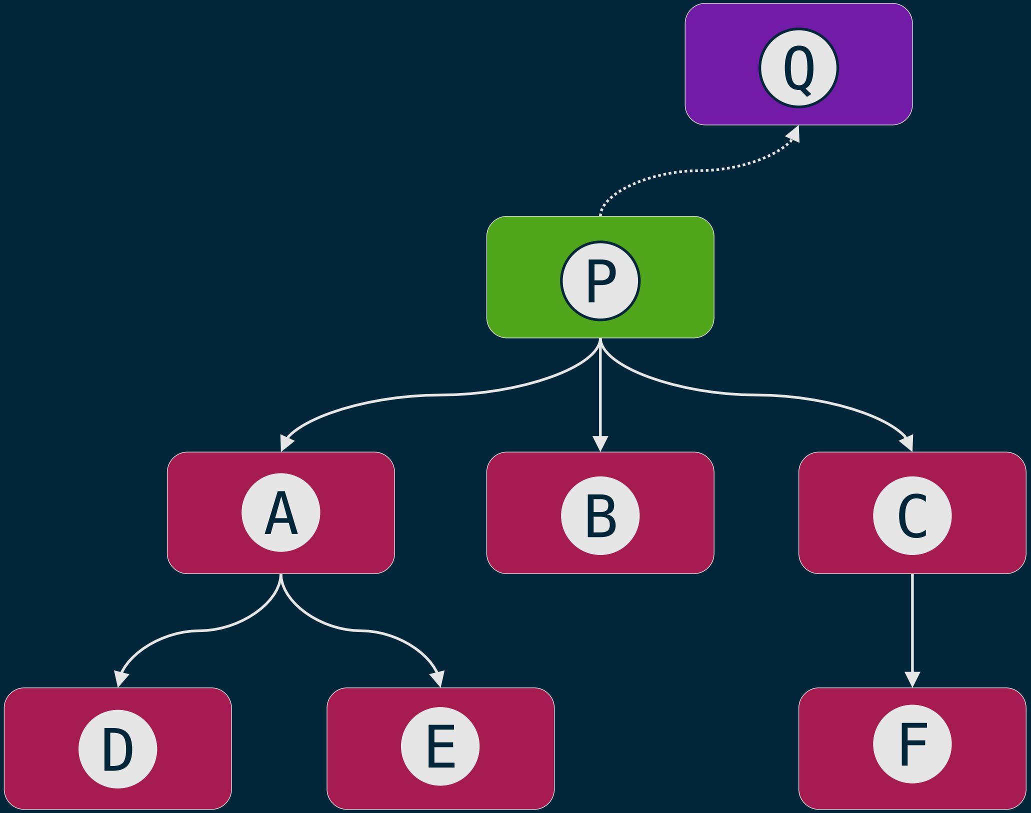

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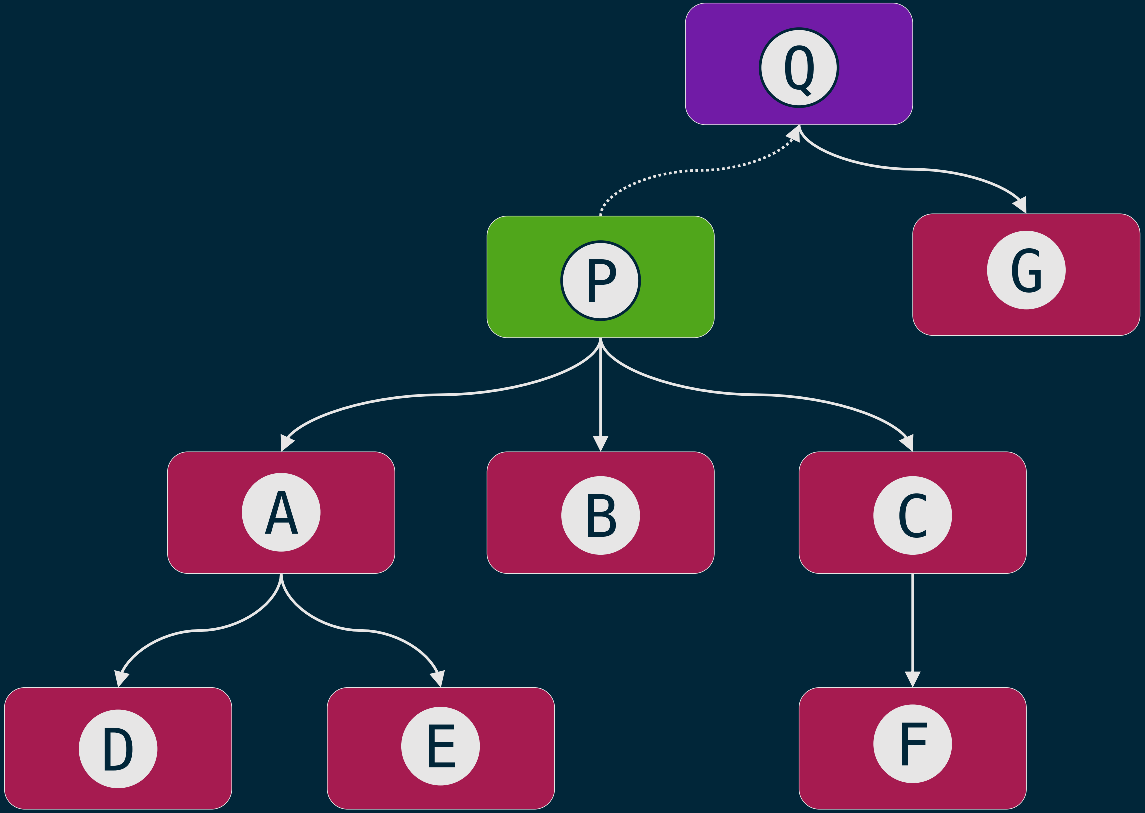

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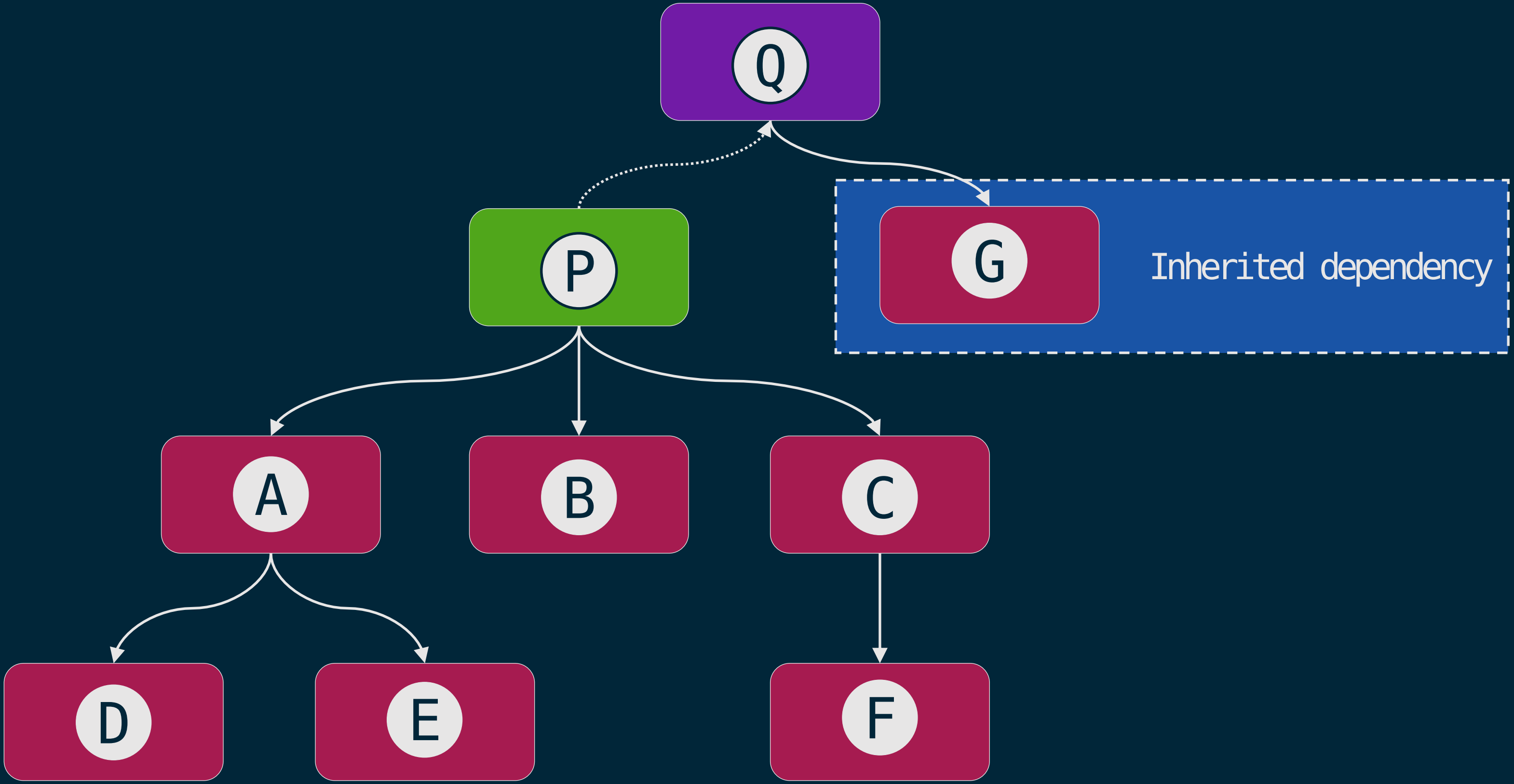
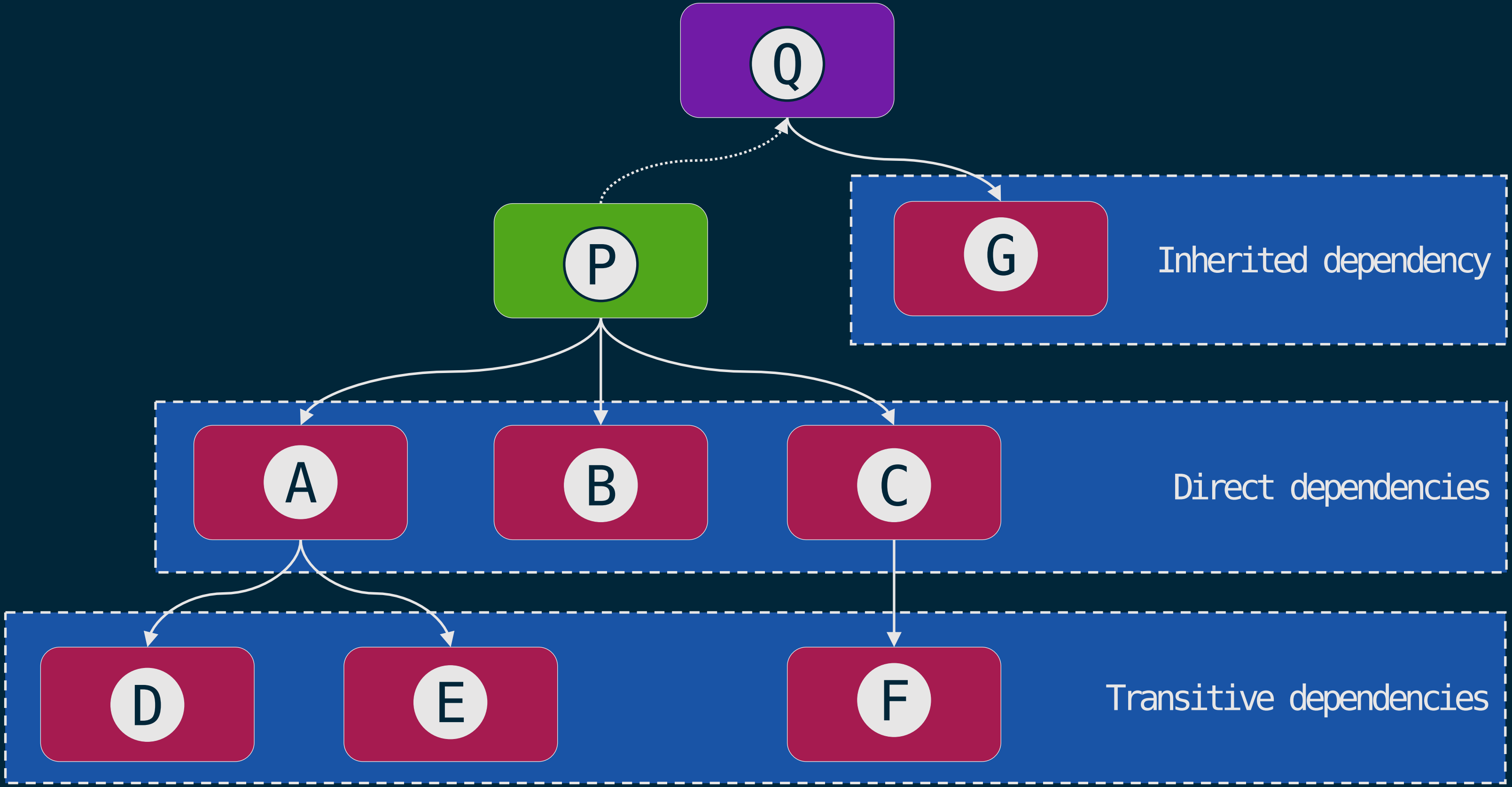


Dependency tree



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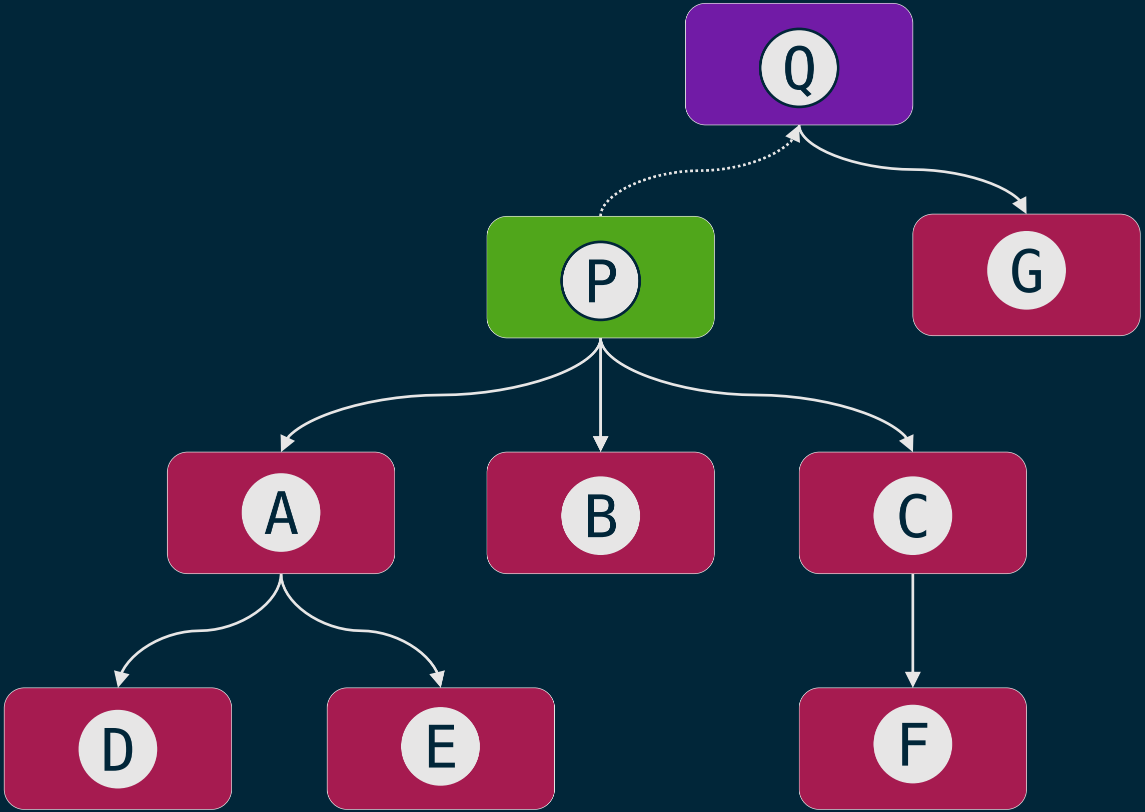
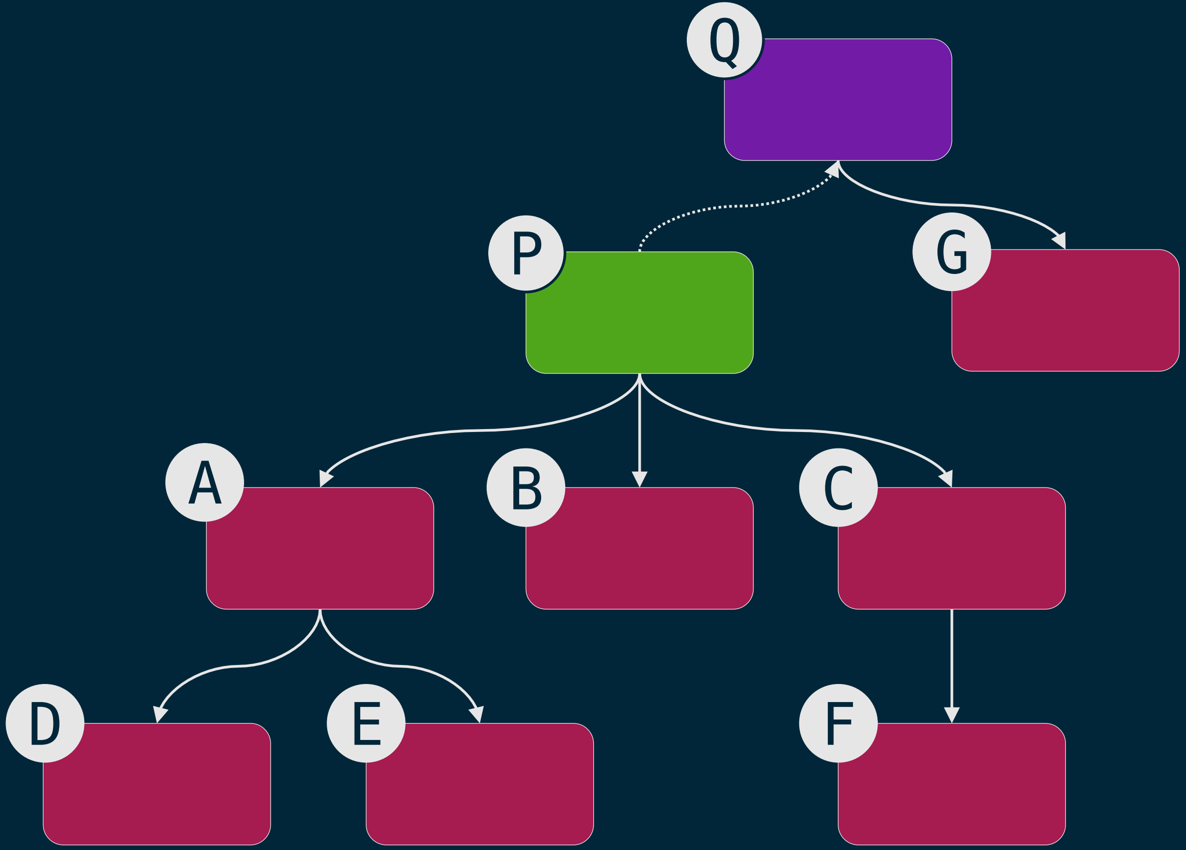
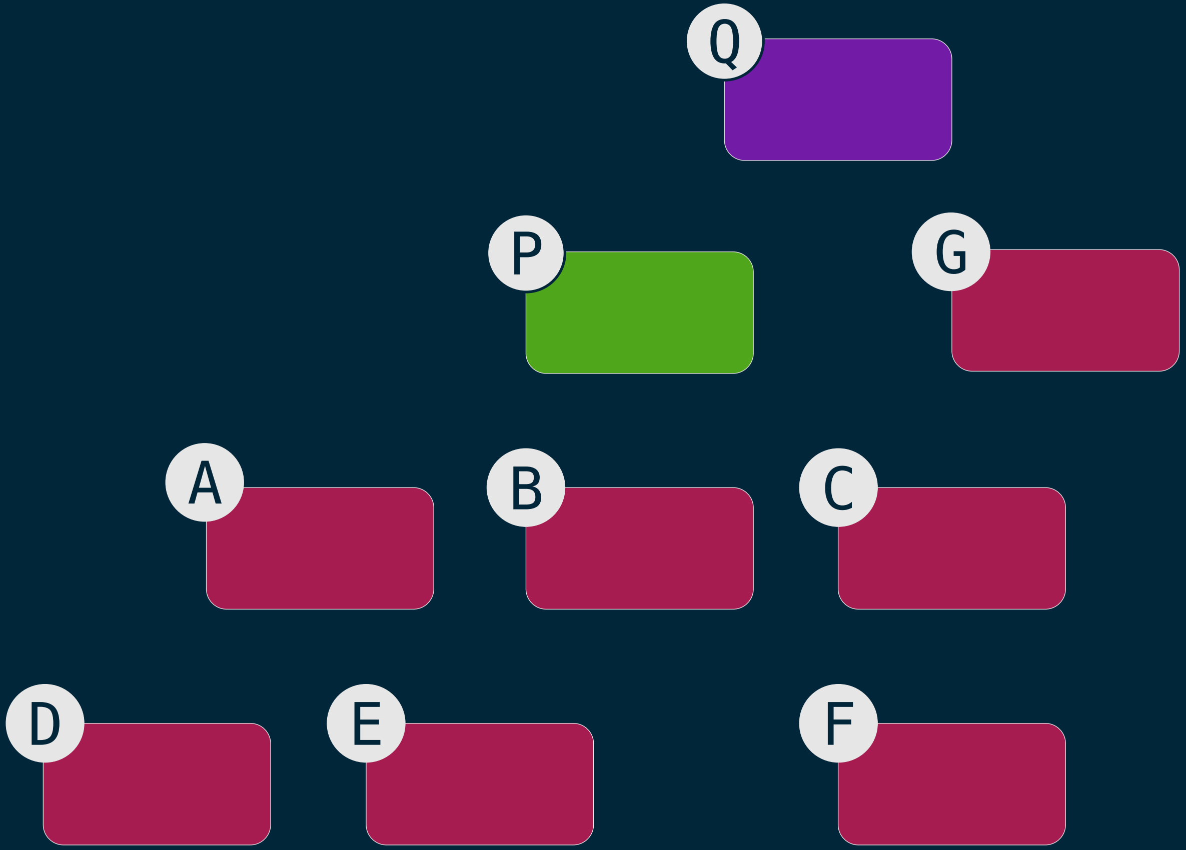


Dependency tree



Bytecode calls



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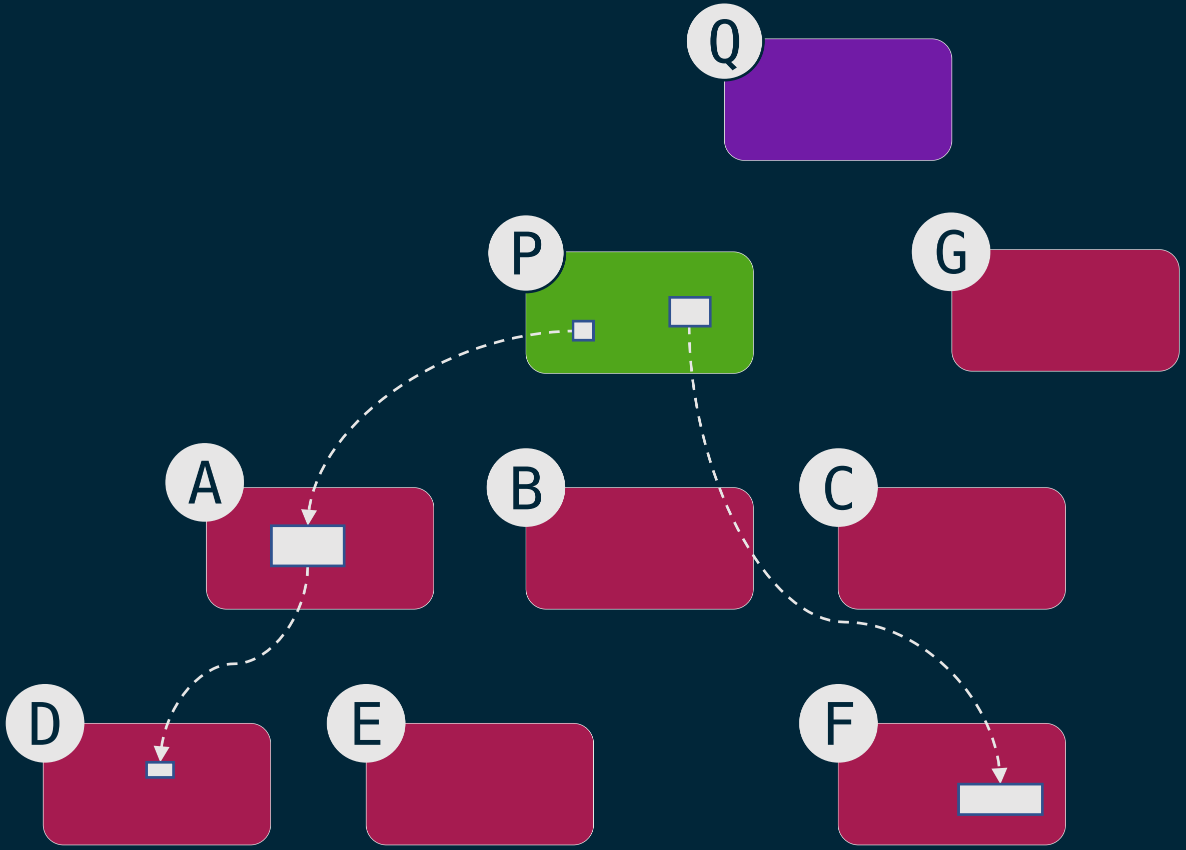

DepClean

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- Detect and report bloated dependencies

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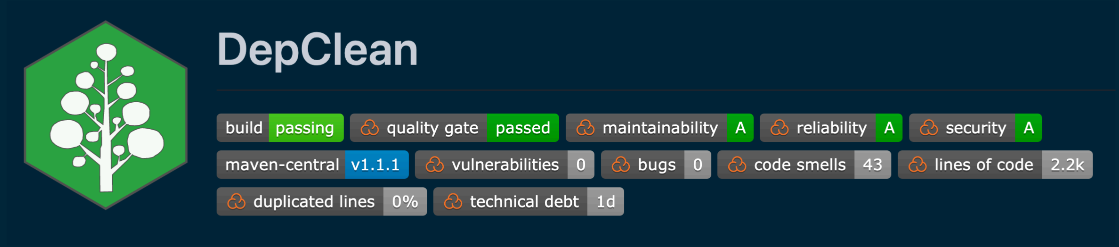
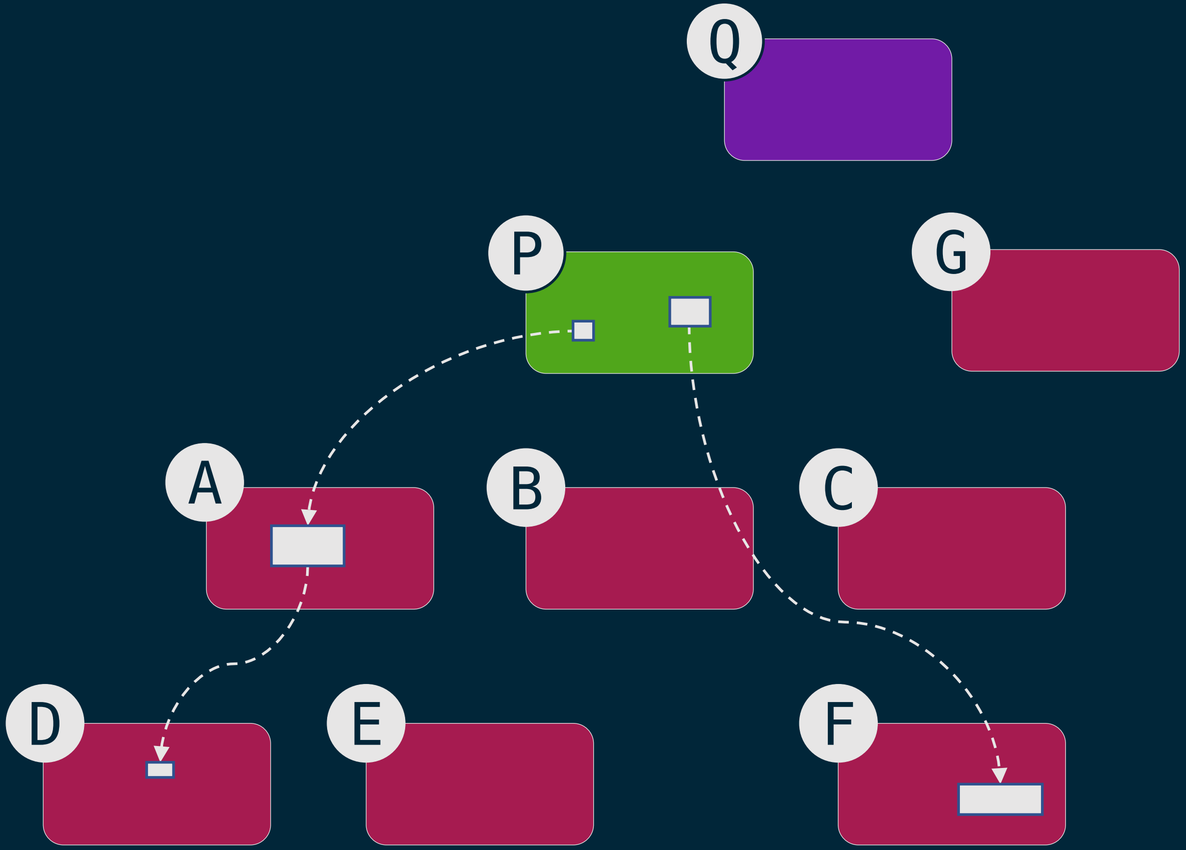
https://github.com/castor-software/depclean



DepClean

build passing | quality gate passed | maintainability A | reliability A | security A
maven-central v1.1.1 | vulnerabilities 0 | bugs 0 | code smells 43 | lines of code 2.2k
duplicated lines 0% | technical debt 1d

Debloat direct dependencies



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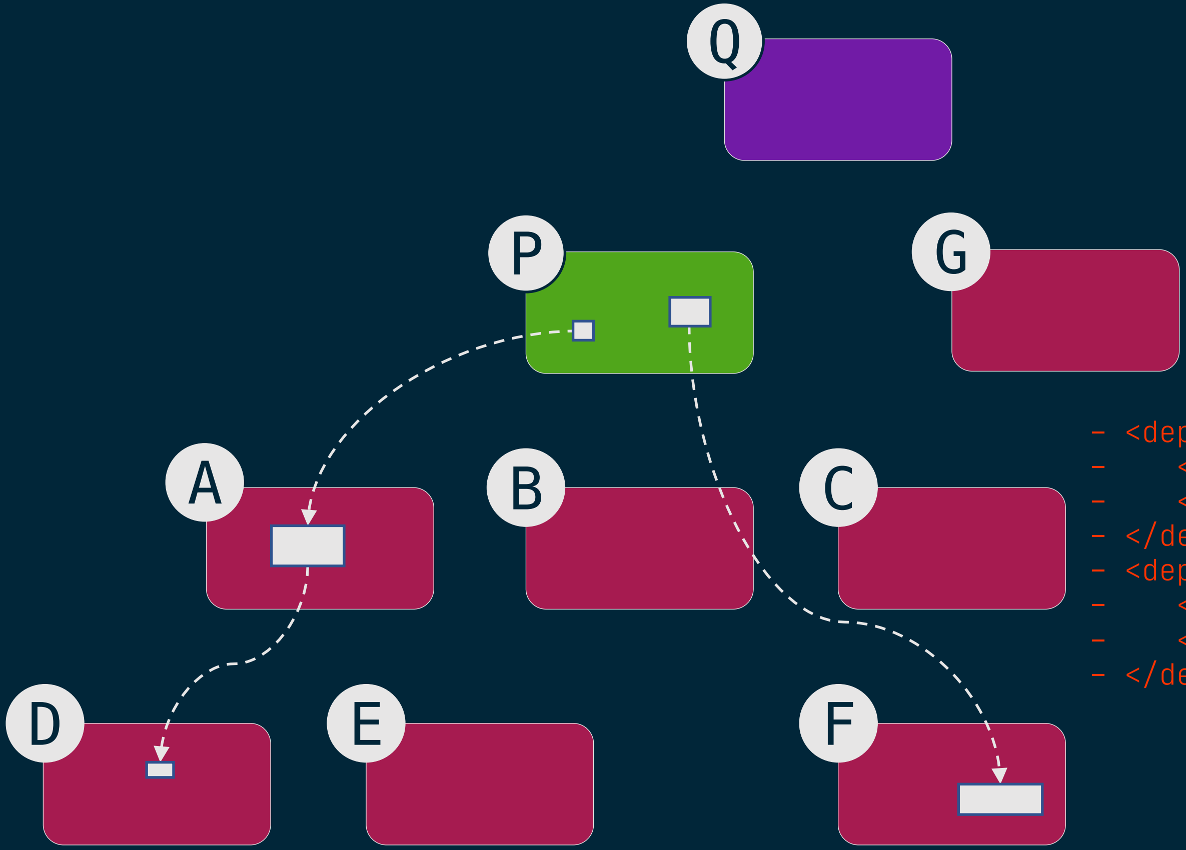

```
- <dependency>
-     <groupId>org.B</groupId>
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-     <artifactId>C</artifactId>
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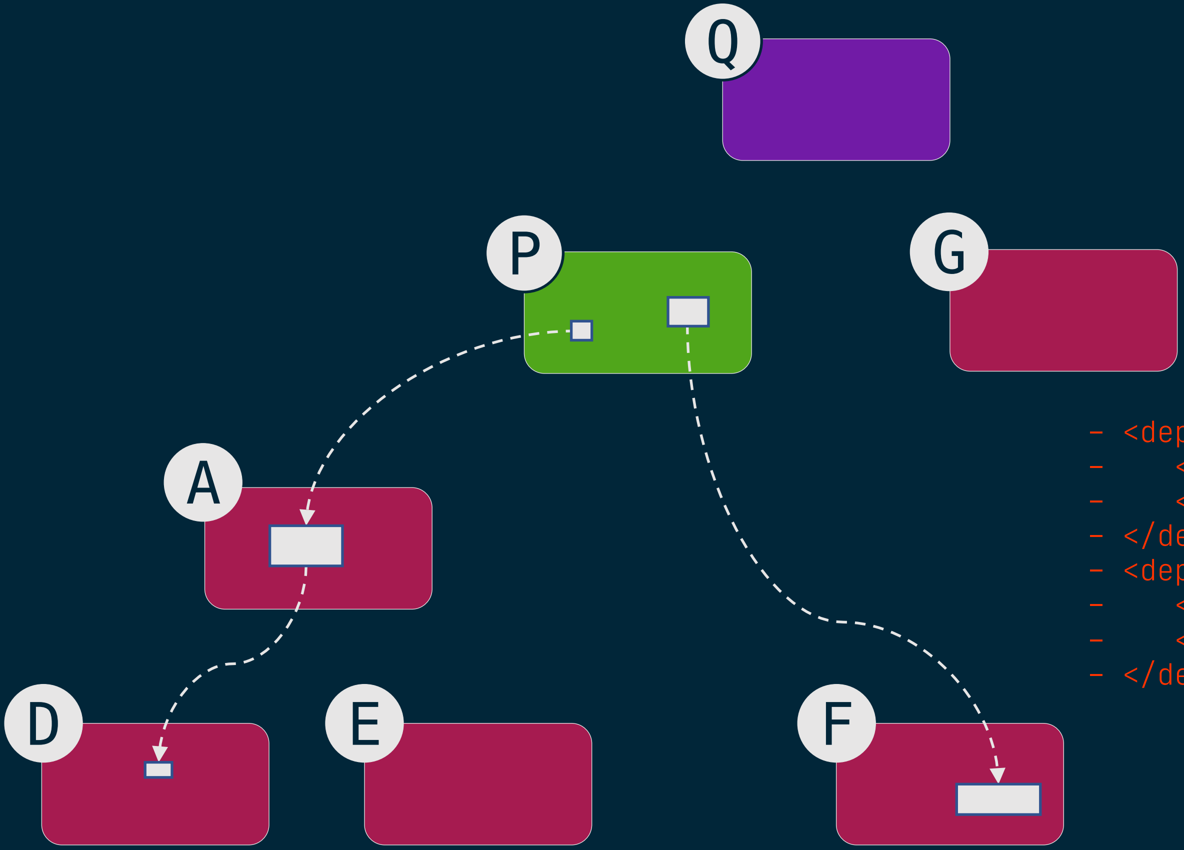

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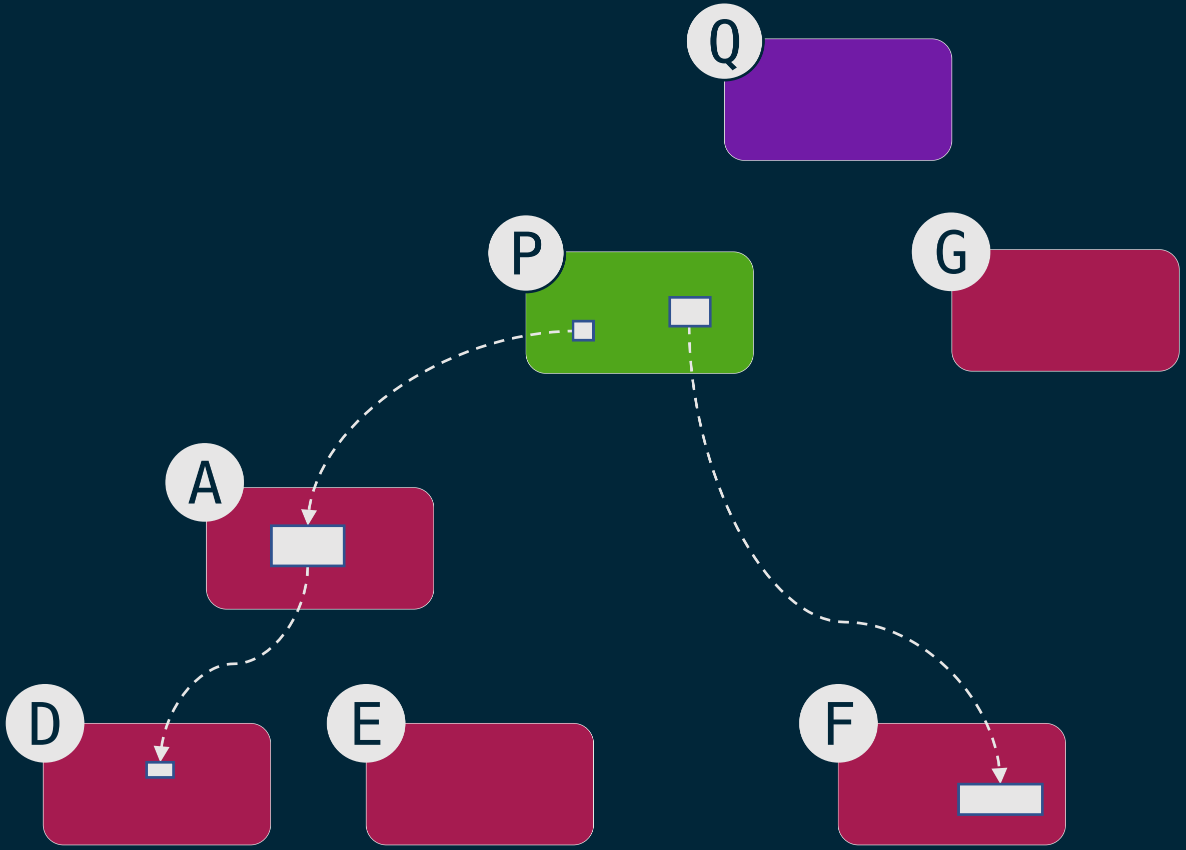
Debloat transitive dependencies



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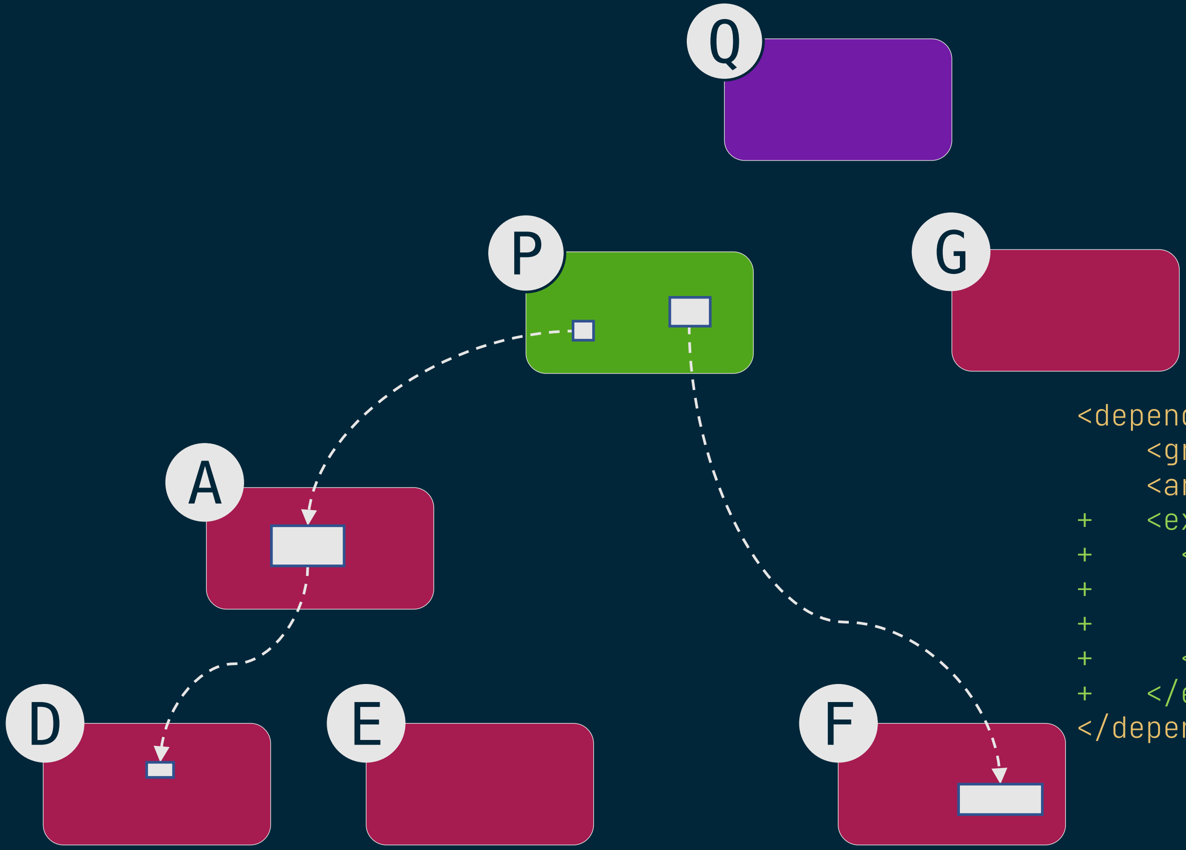

```
<dependency>
    <groupId>org.A</groupId>
    <artifactId>A</artifactId>
+   <exclusions>
+     <exclusion>
+       <groupId>org.E</groupId>
+       <artifactId>E</artifactId>
+     </exclusion>
+   </exclusions>
</dependency>
```

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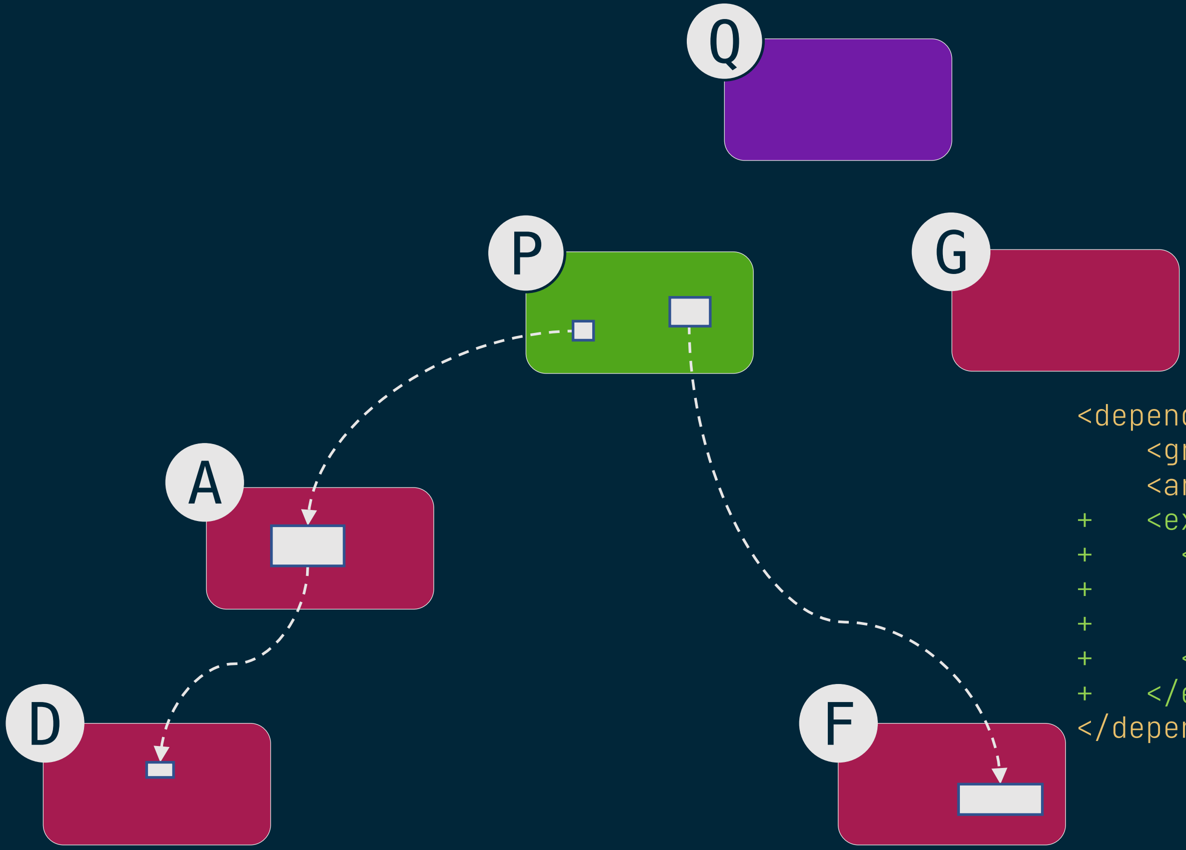

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<dependency>
    <groupId>org.A</groupId>
    <artifactId>A</artifactId>
+   <exclusions>
+     <exclusion>
+       <groupId>org.E</groupId>
+       <artifactId>E</artifactId>
+     </exclusion>
+   </exclusions>
</dependency>
```
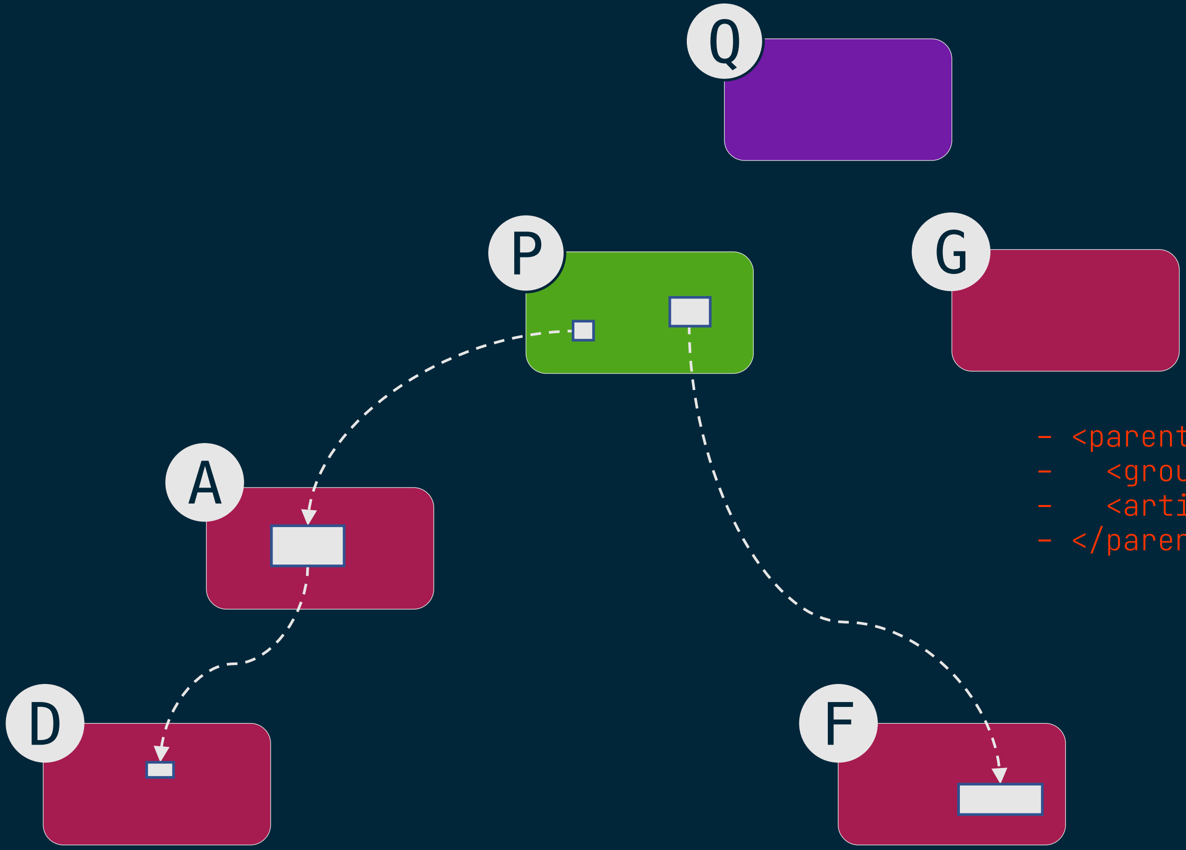

Debloat inherited dependencies



```
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-   <groupId>org.Q</groupId>
-   <artifactId>Q</artifactId>
- </parent>
```
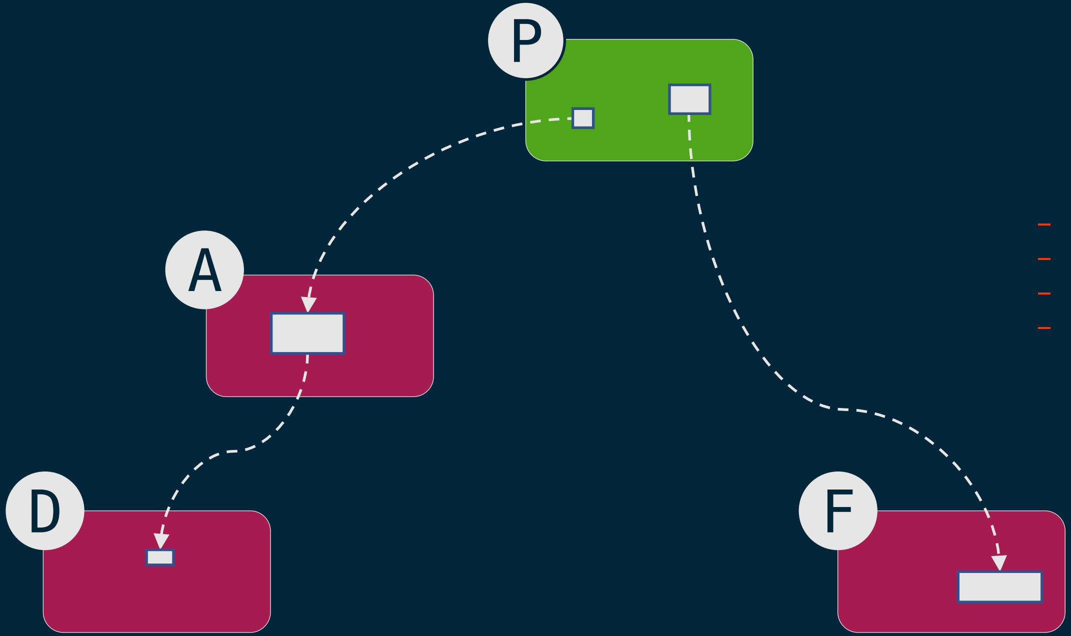

Debloat inherited dependencies



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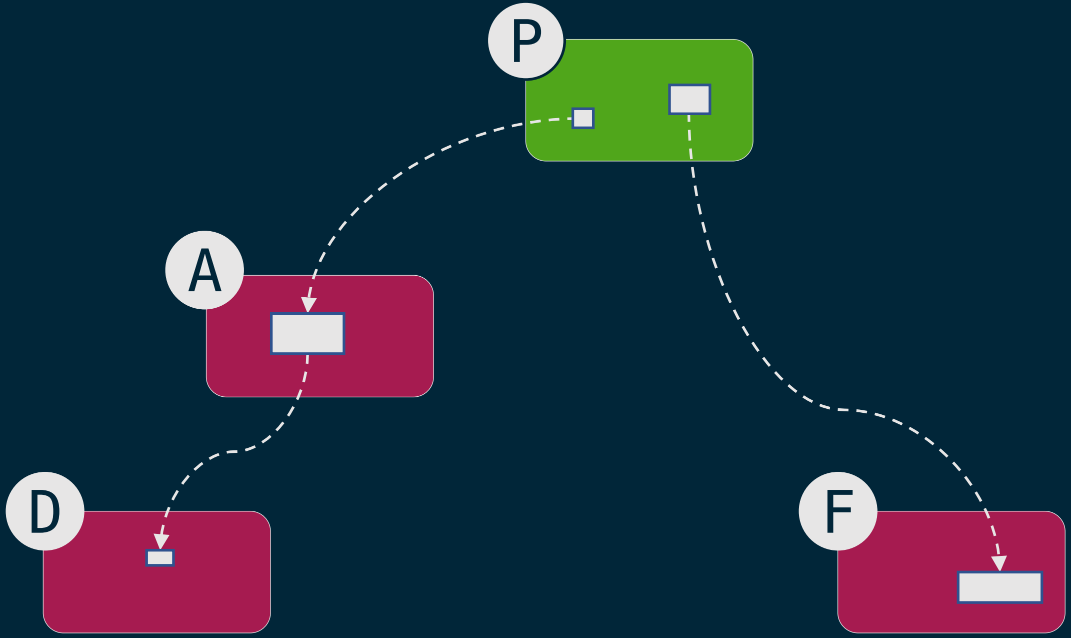
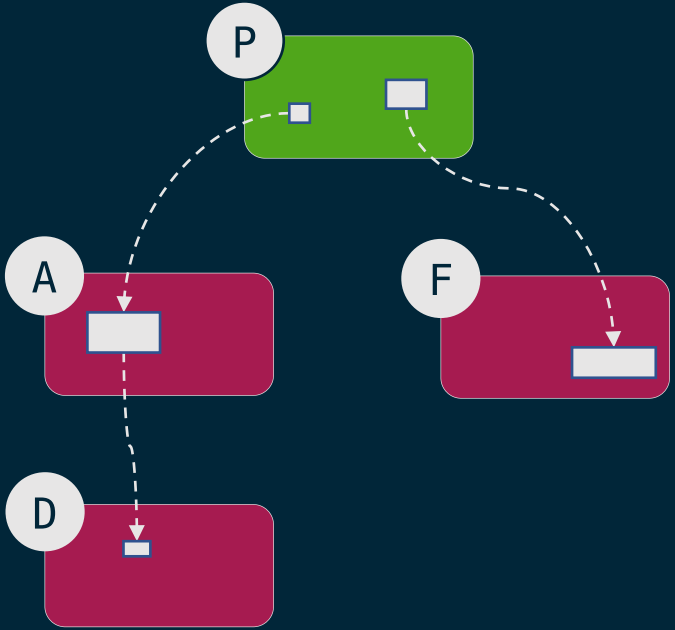
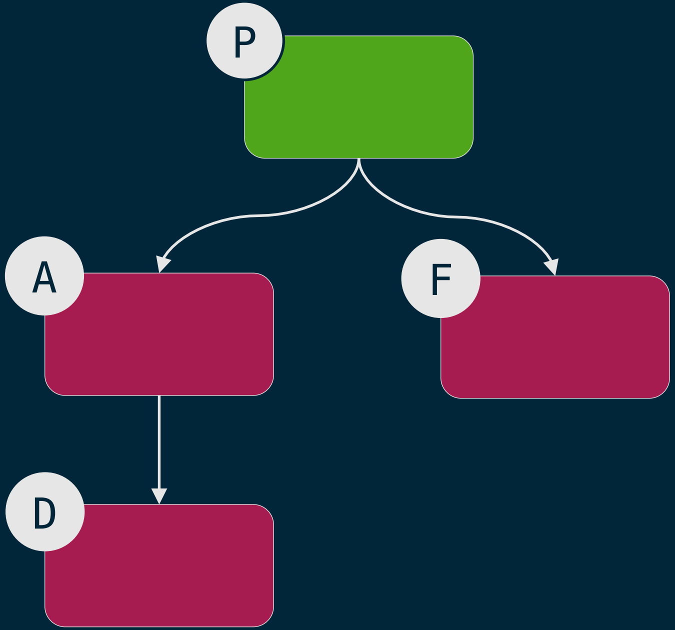


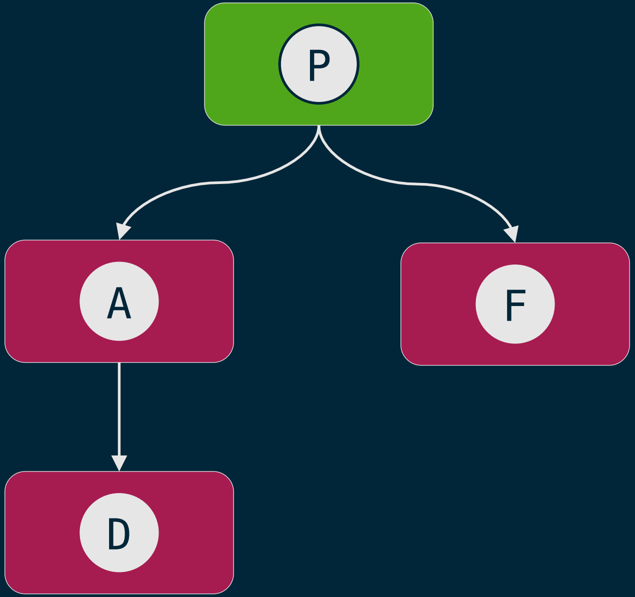
Debloat analysis result



Debloated dependency tree



Debloated dependency tree



Objective

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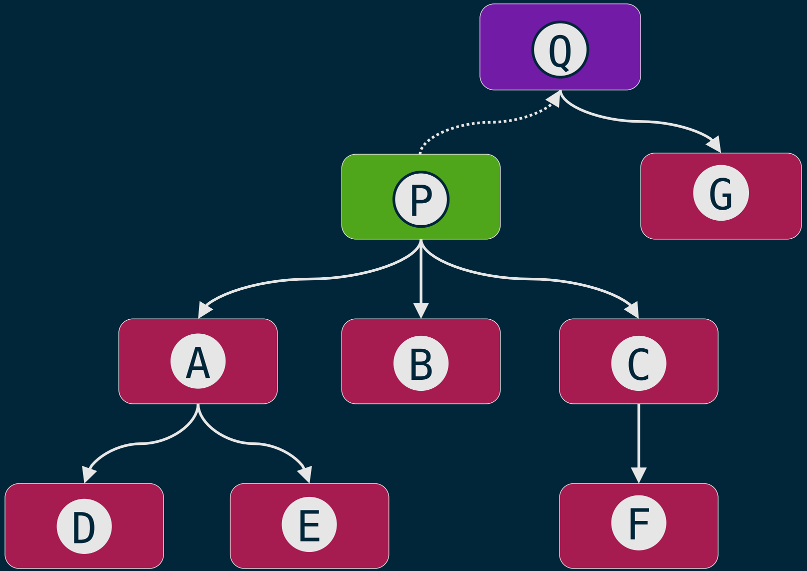

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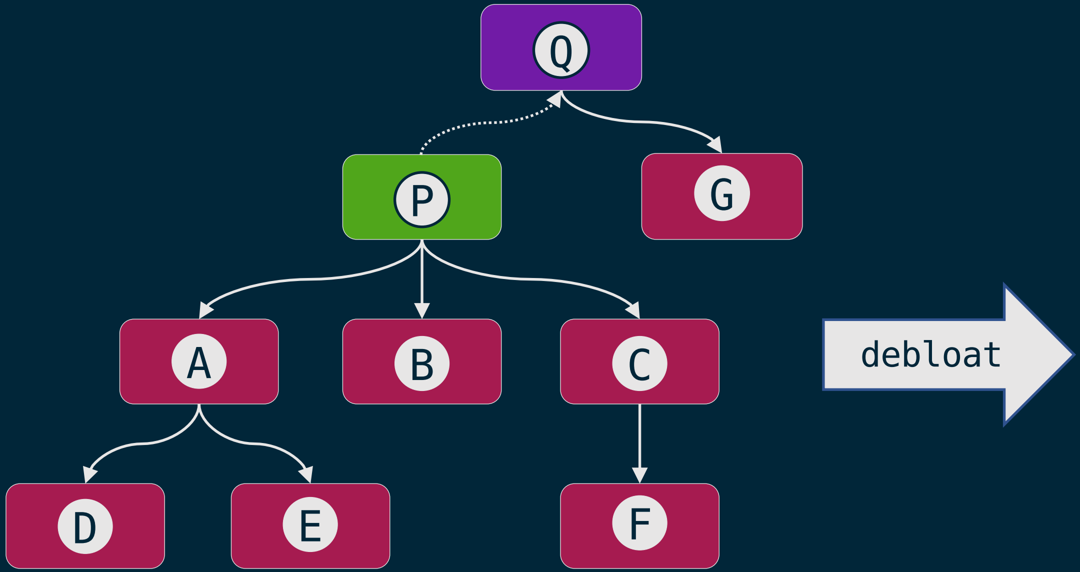

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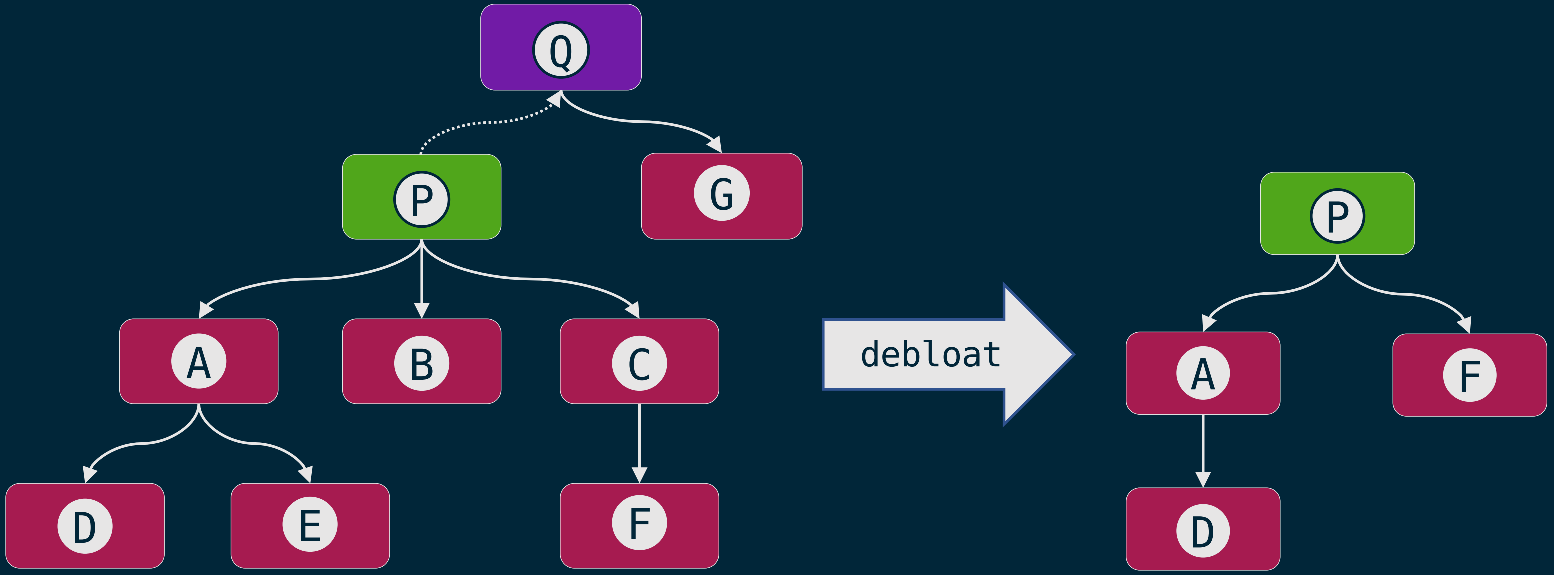

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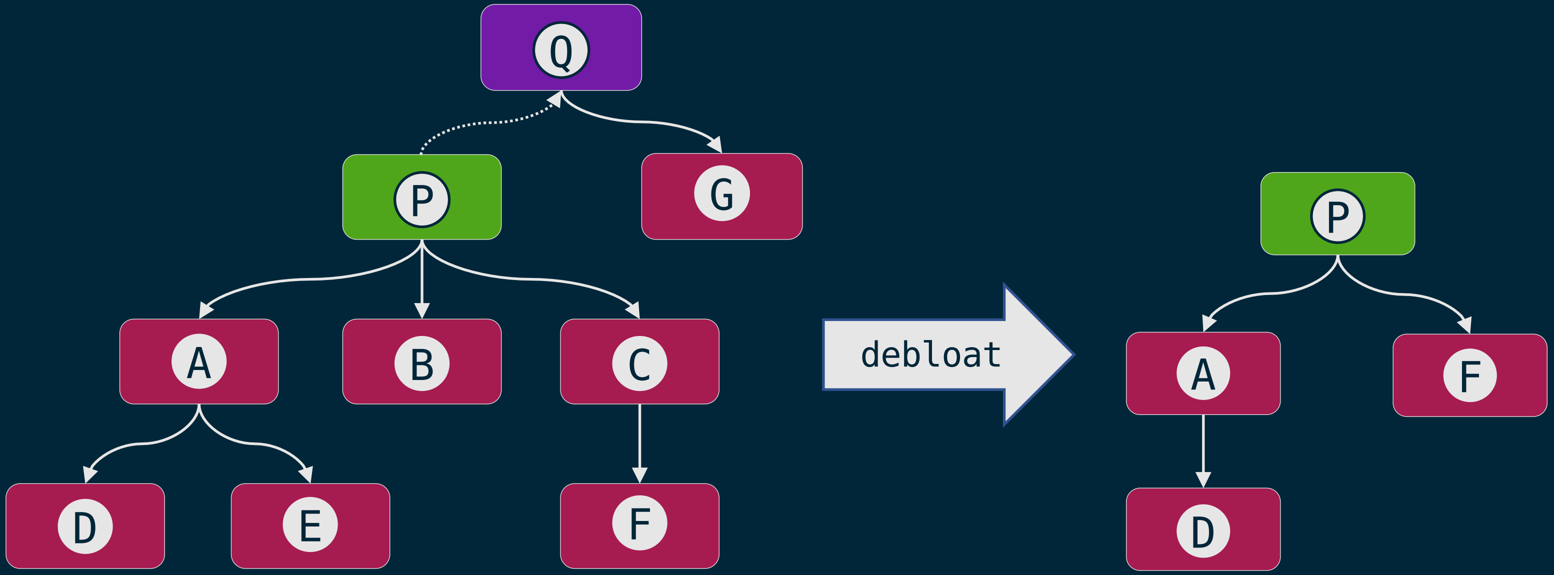

The objective of DepClean is to reduce the size of the dependency tree by debloating unused dependencies, automatically.

DepClean

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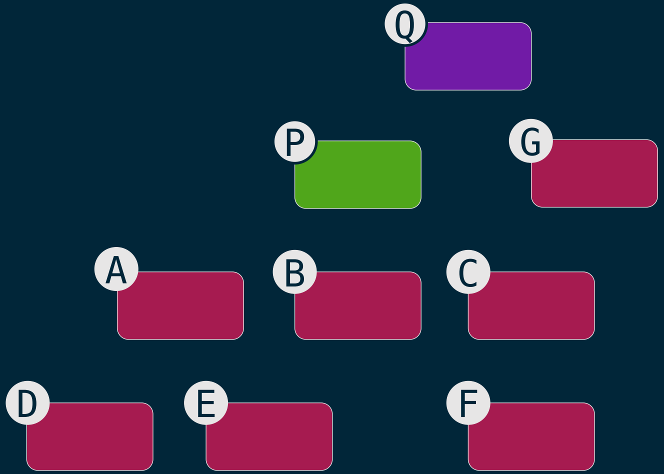

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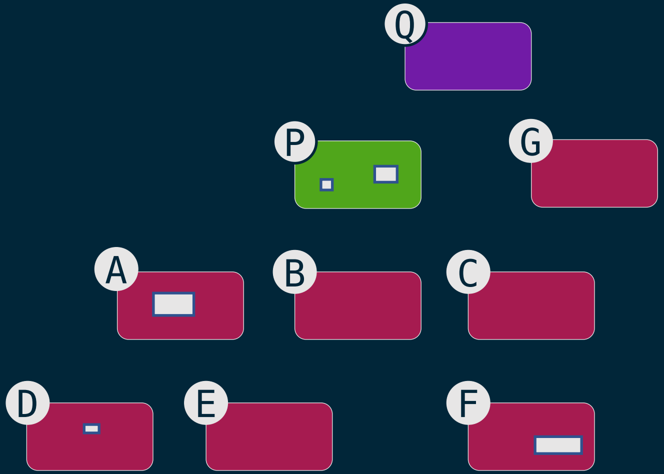

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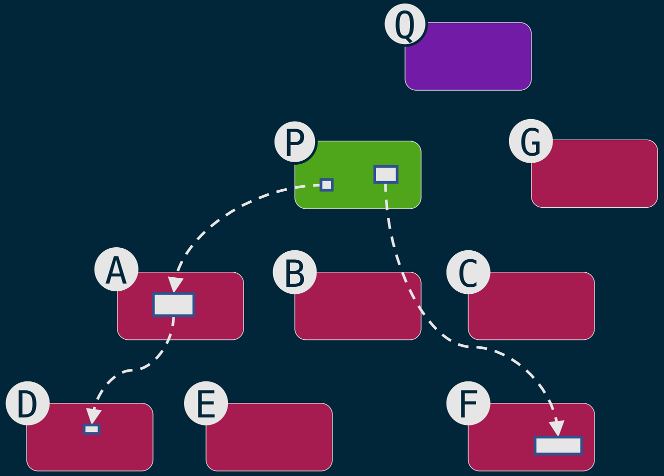
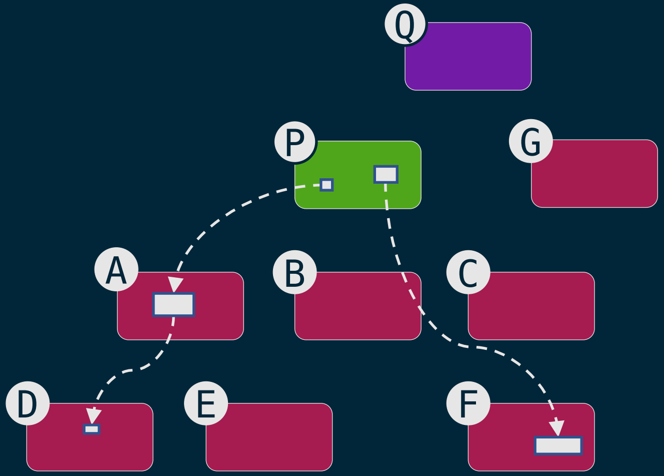


DepClean

- Based on static analysis
- Available as a Maven goal with various configurations



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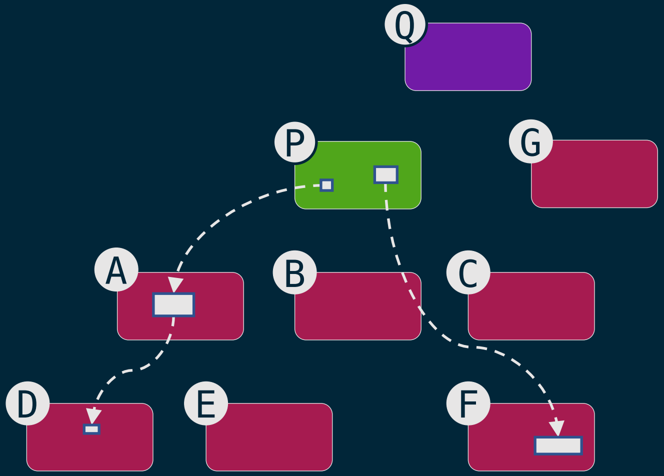
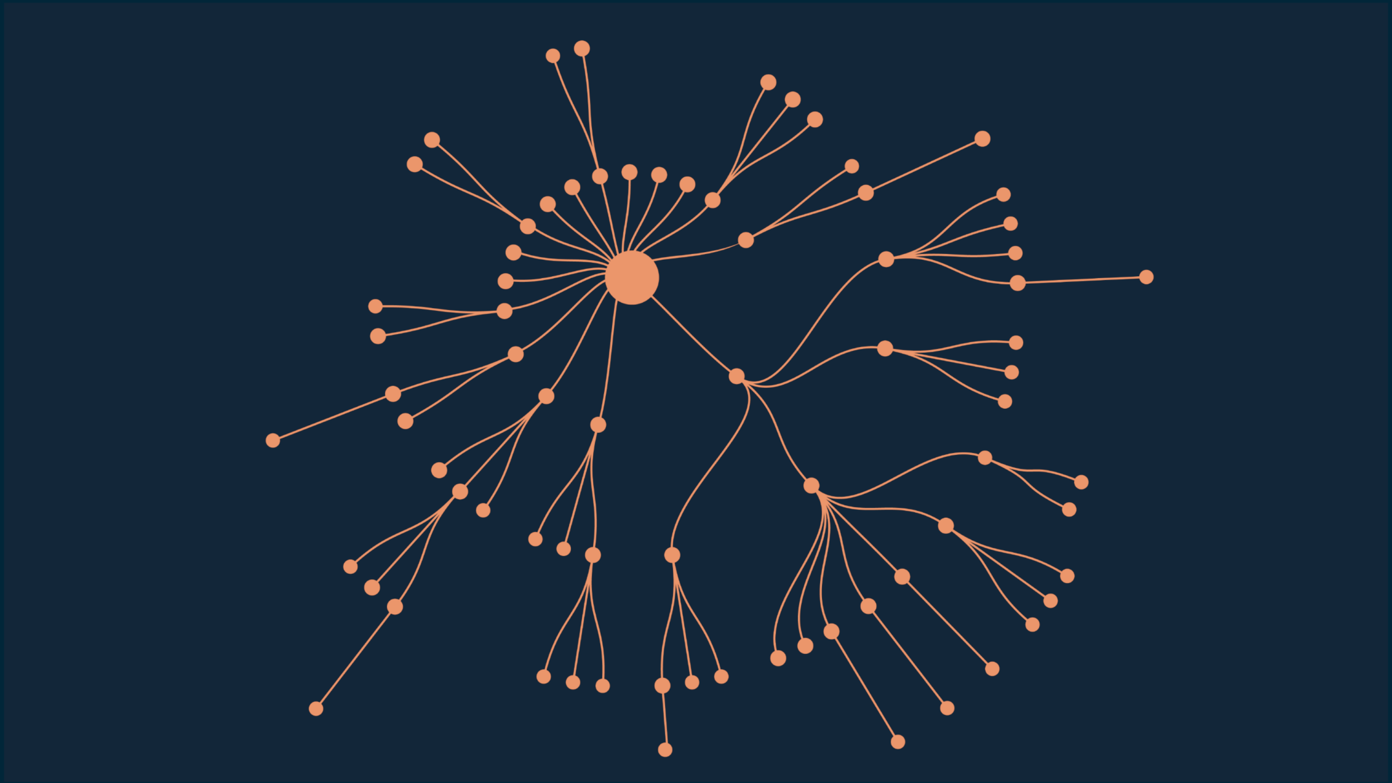


```xml
<plugin>
    <groupId>se.kth.castor</groupId>
    <artifactId>depclean-maven-plugin</artifactId>
    <version>1.1.1</version>
    <executions>
        <execution>
            <goals>
                <goal>depclean</goal>
            </goals>
        </execution>
    </executions>
</plugin>
```

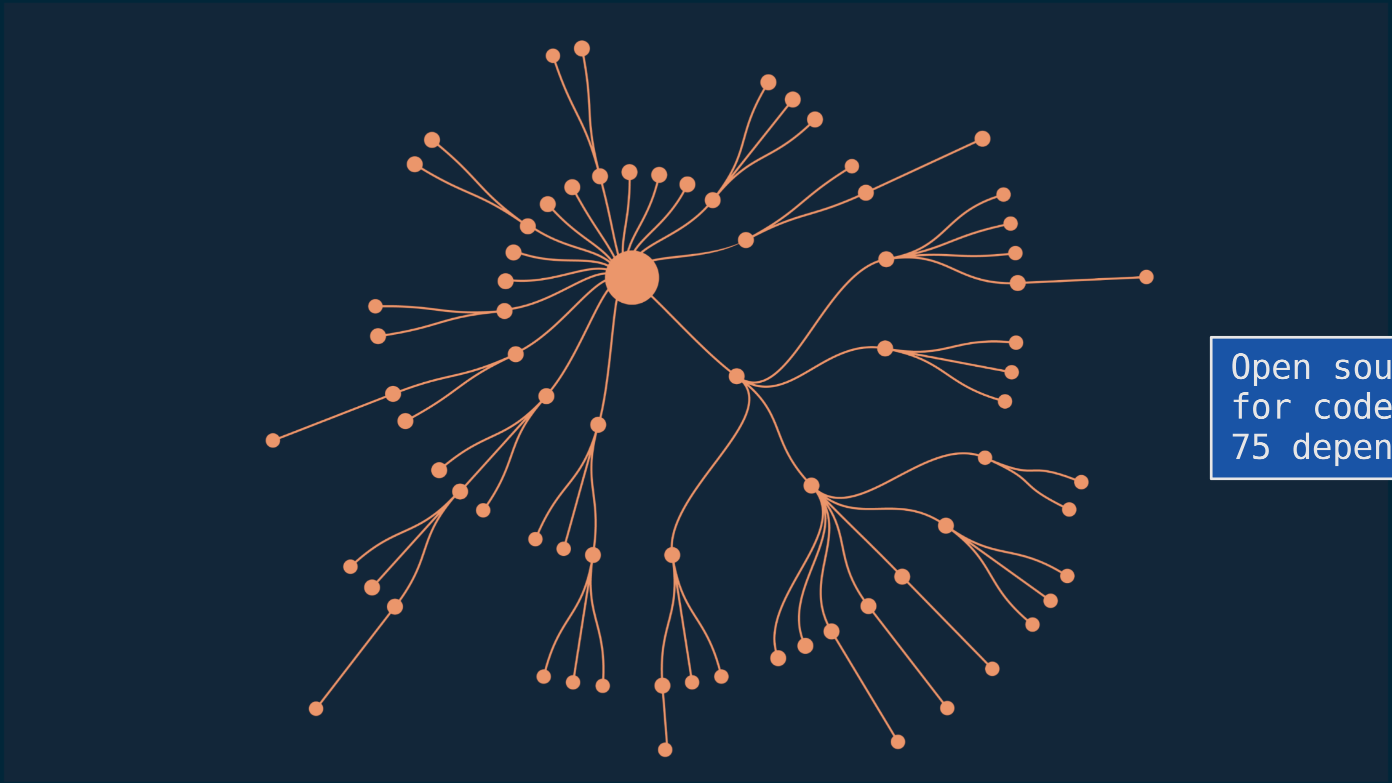
How much dependency bloat exists out there?

Example: Spoon library



https://github.com/INRIA/spoon

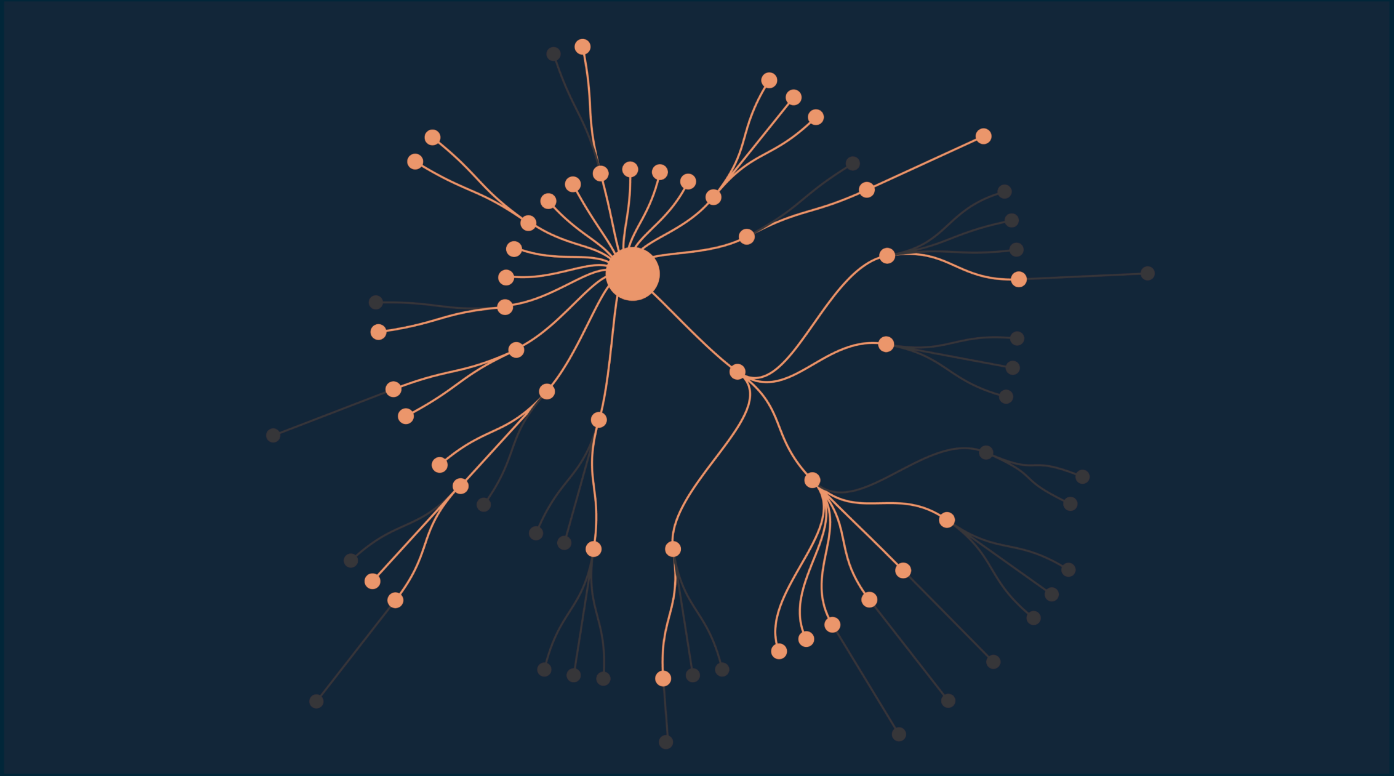
Example: Spoon library



Open source library for code analysis, 75 dependencies

https://github.com/INRIA/spoon

Regular Maven analysis



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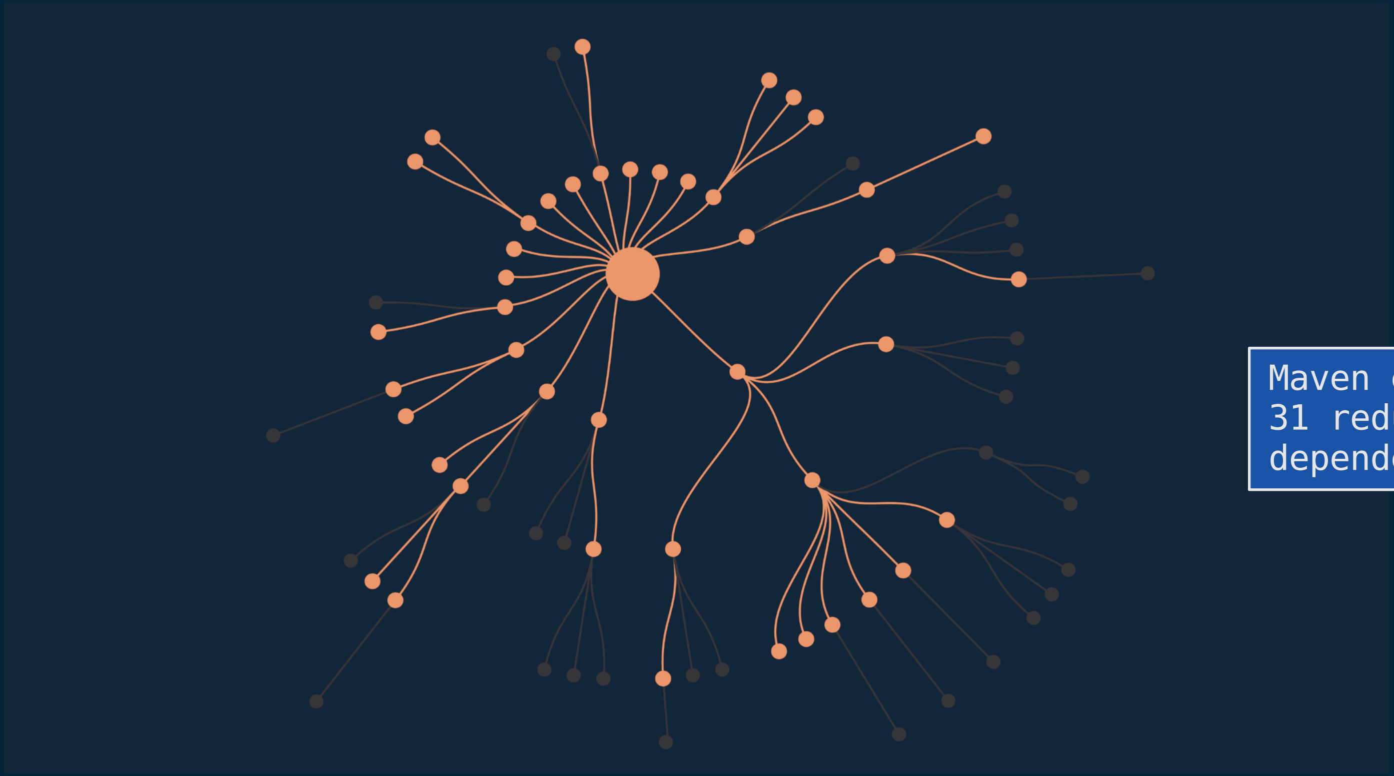
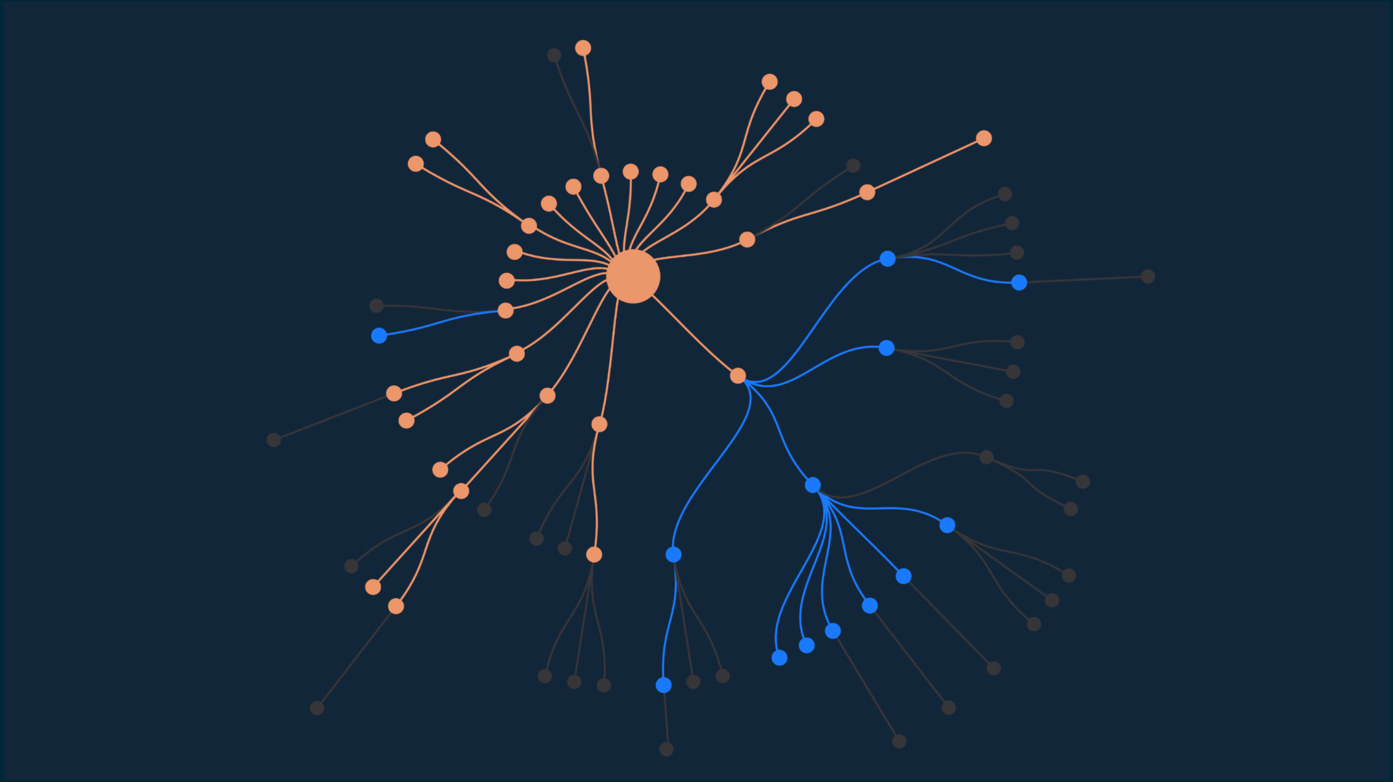
Regular Maven analysis



Maven excludes 31 redundant dependencies

https://github.com/INRIA/spoon

DepClean novel analysis



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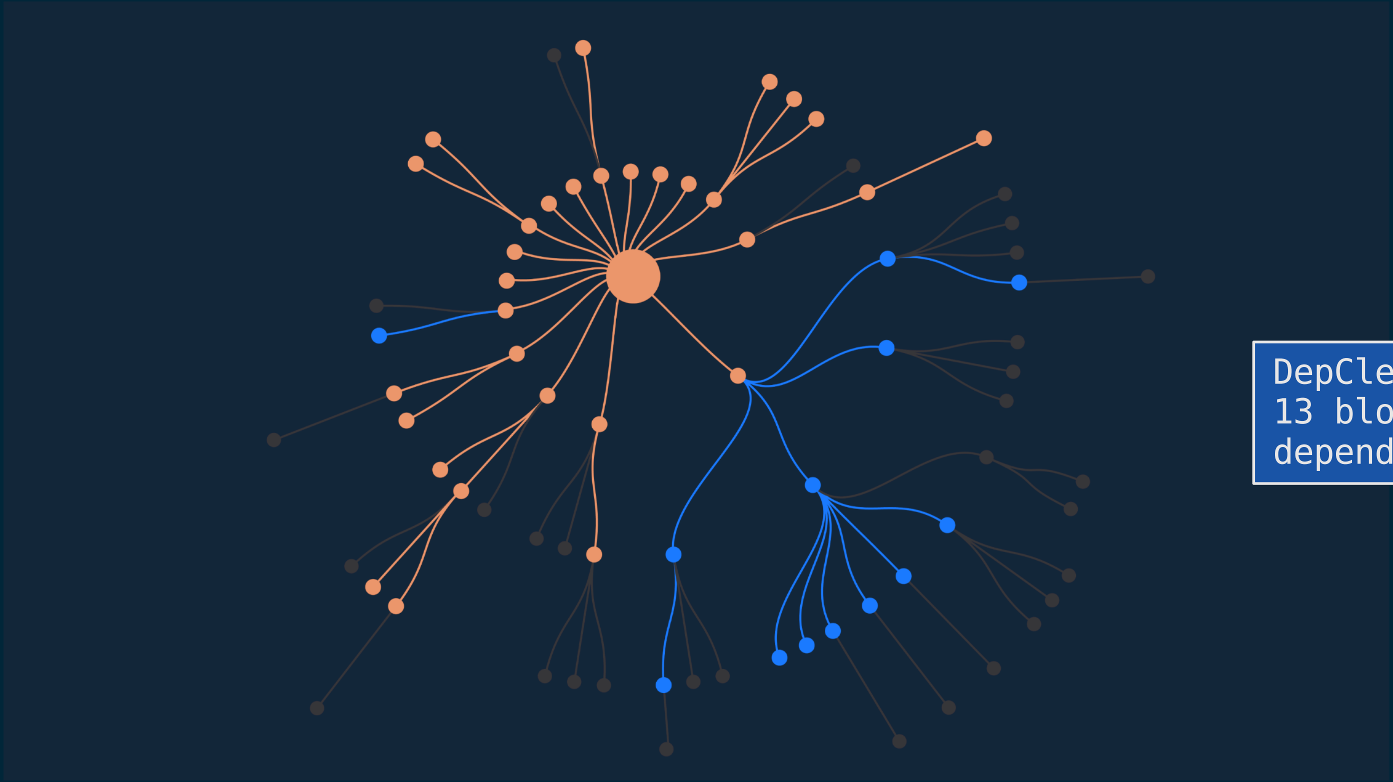

DepClean detects 13 bloated dependencies

https://github.com/INRIA/spoon

Debloated Spoon library

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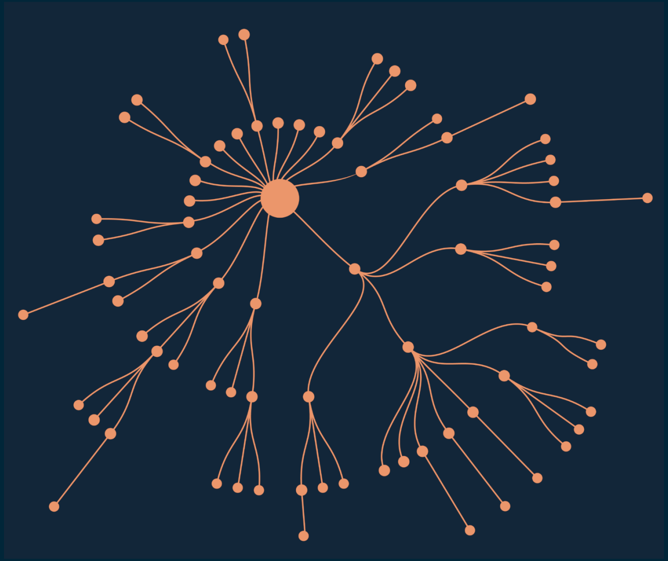
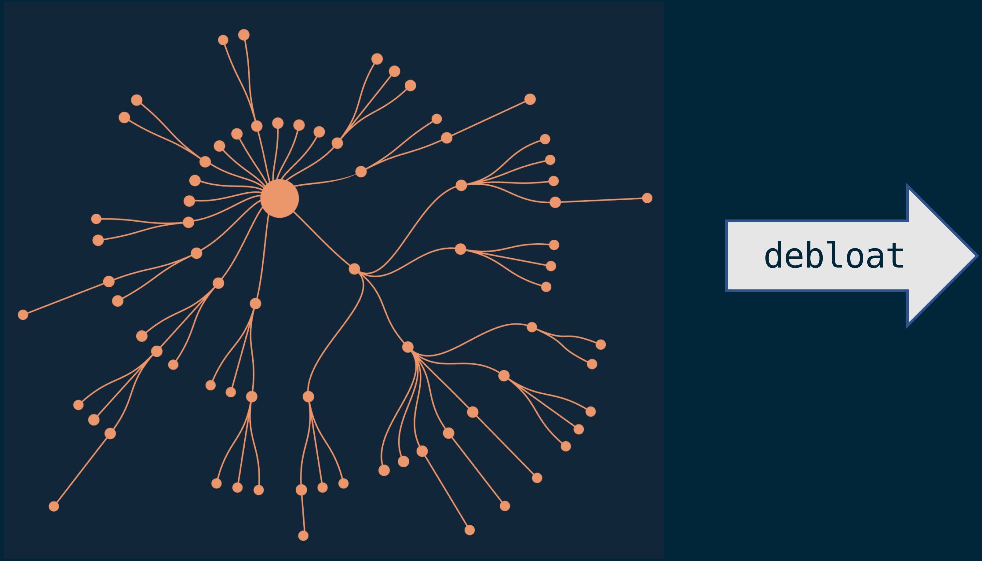


Debloated Spoon library



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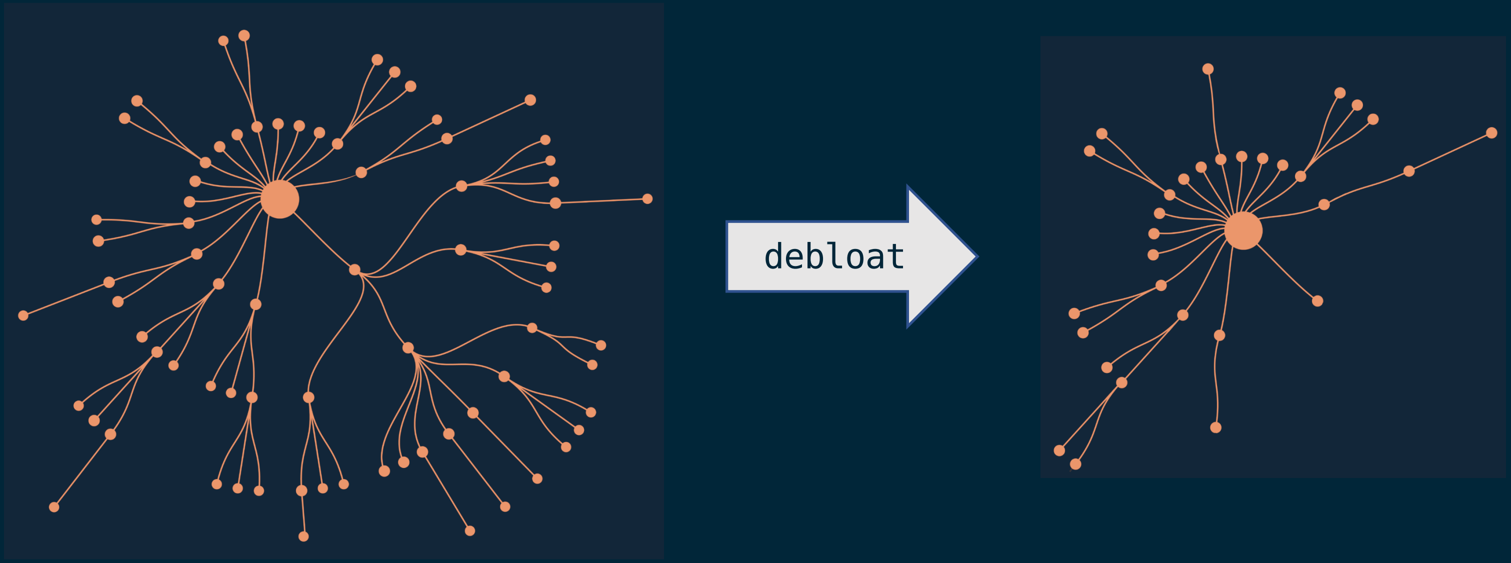

debloat

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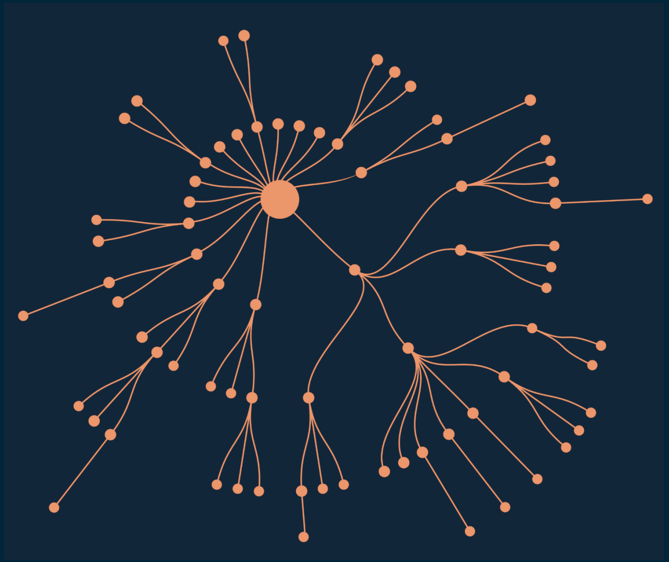
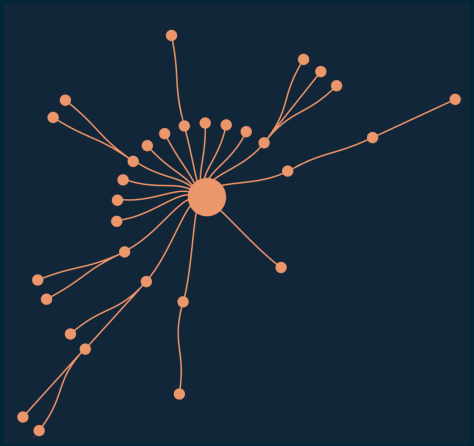


debloat



	JAR Size (MB)	#Classes
Before	16.2	7 425
After	12.7	5 593
Reduction (%)	27.6%	24.7%

The Maven ecosystem is big

“The Maven Dependency Graph: a Temporal Graph-based Representation of Maven Central” (published in MSR’19)

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3.6 million artifacts in 2019

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Large scale empirical study

“A Comprehensive Study of Bloated Dependencies in the Maven Ecosystem” (accepted for publication in EMSE 2021)

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  - 498K transitive (69%)

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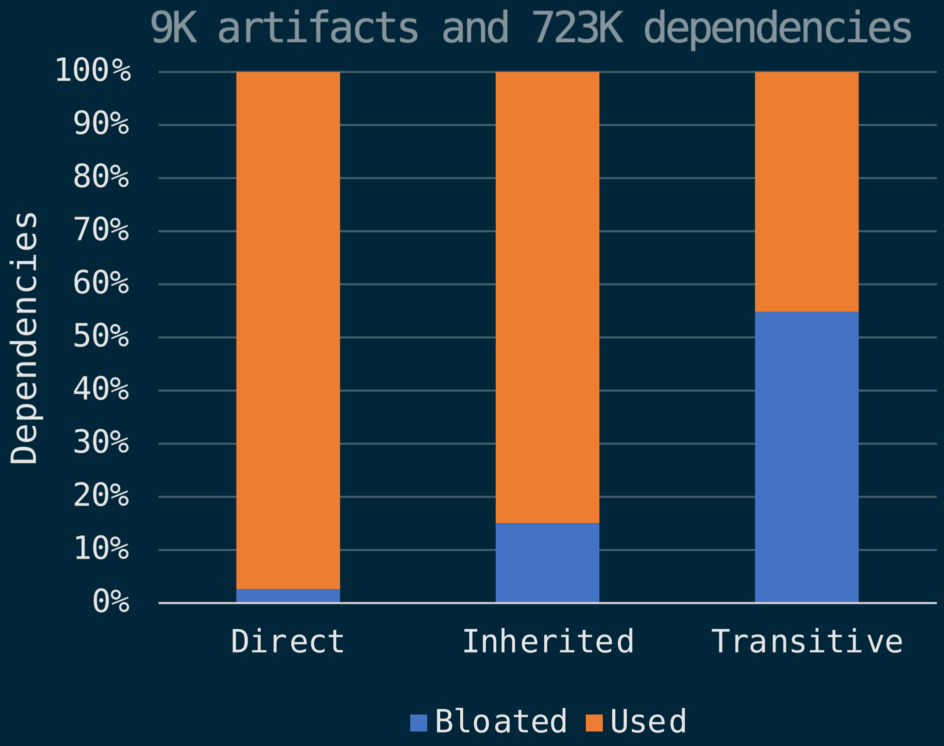
Results



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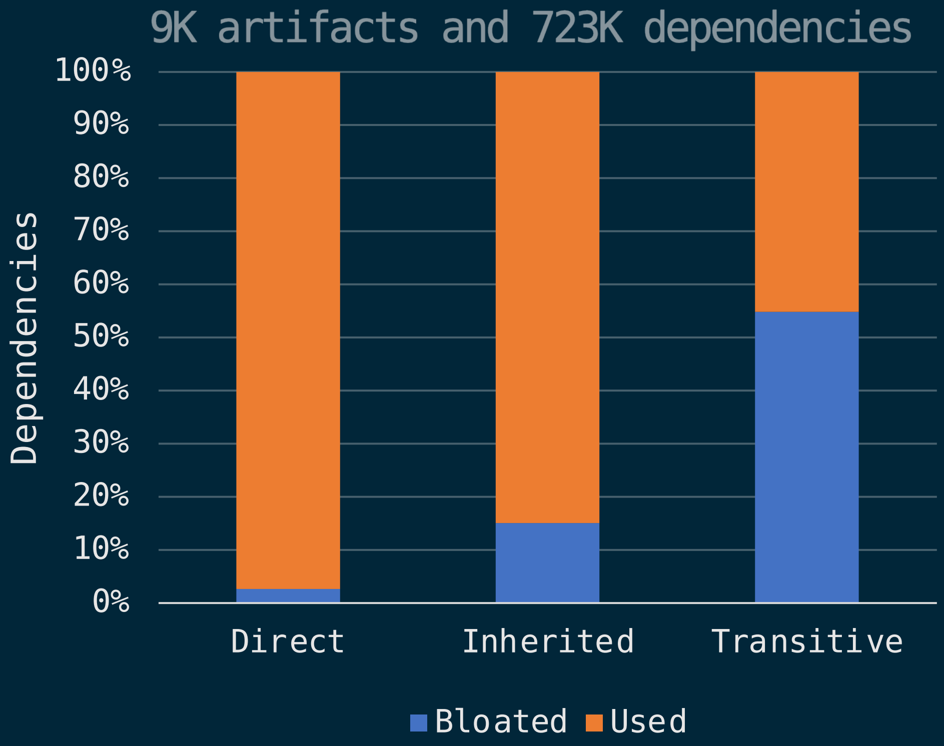

- 2.7% of direct dependencies are bloated
- 15.1% of inherited dependencies are bloated
- 57% of transitive dependencies are bloated

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How much dependency bloat exists out there?

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- 75% of all the dependency relationships are bloated
- 3472 (36%) artifacts have at least one bloated direct dependency declared in the pom
- 8305 (86%) artifacts have at least one bloated transitive dependency

“A Comprehensive Study of Bloated Dependencies in the Maven Ecosystem” (accepted for publication in EMSE 2021)

Do developers care about bloated dependencies?

User study

“A Comprehensive Study of Bloated Dependencies in the Maven Ecosystem” (accepted for publication in EMSE 2021)

User study

- 30 software projects

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- 30 software projects
  - Open source

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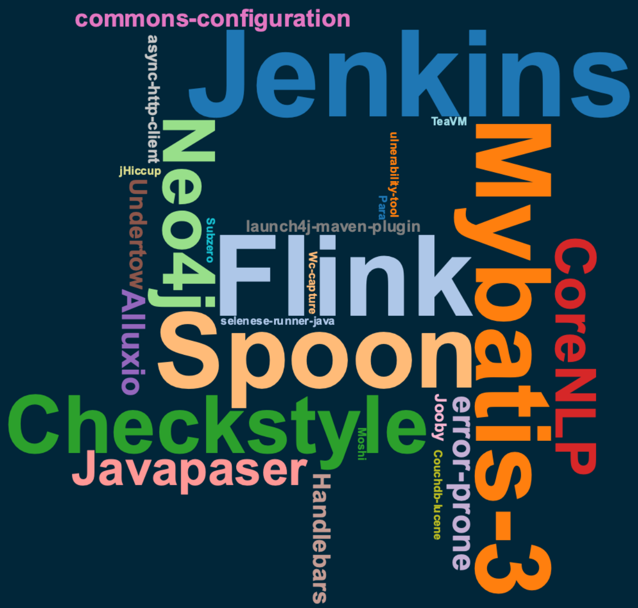
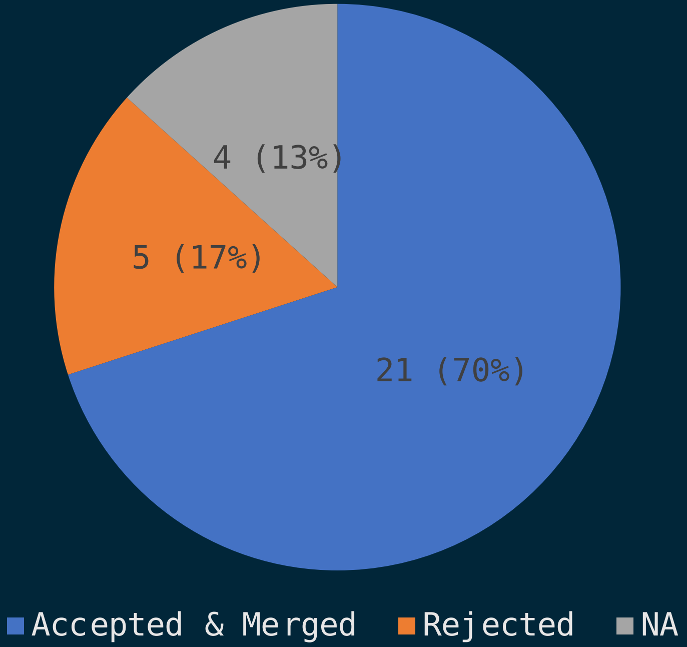


“A Comprehensive Study of Bloated Dependencies in the Maven Ecosystem” (accepted for publication in EMSE 2021)

Results

30 pull requests in 30 notable open source projects



“A Comprehensive Study of Bloated Dependencies in the Maven Ecosystem” (accepted for publication in EMSE 2021)

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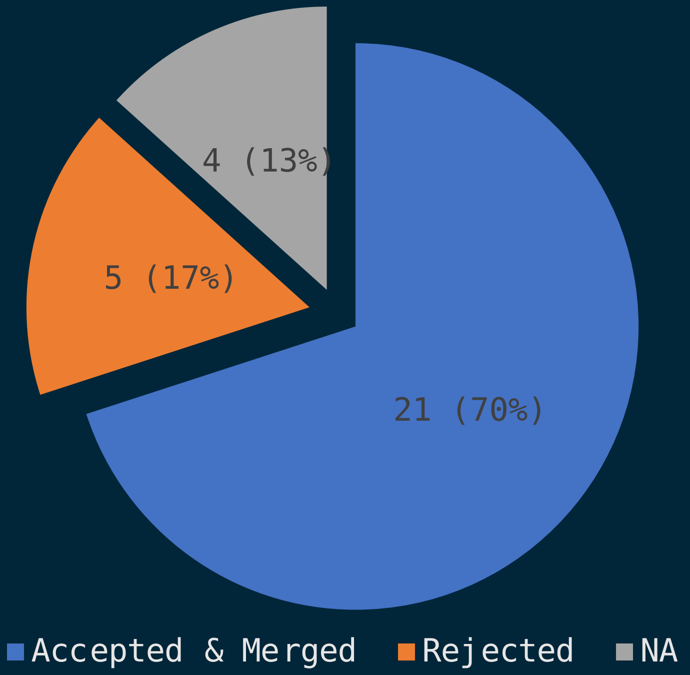

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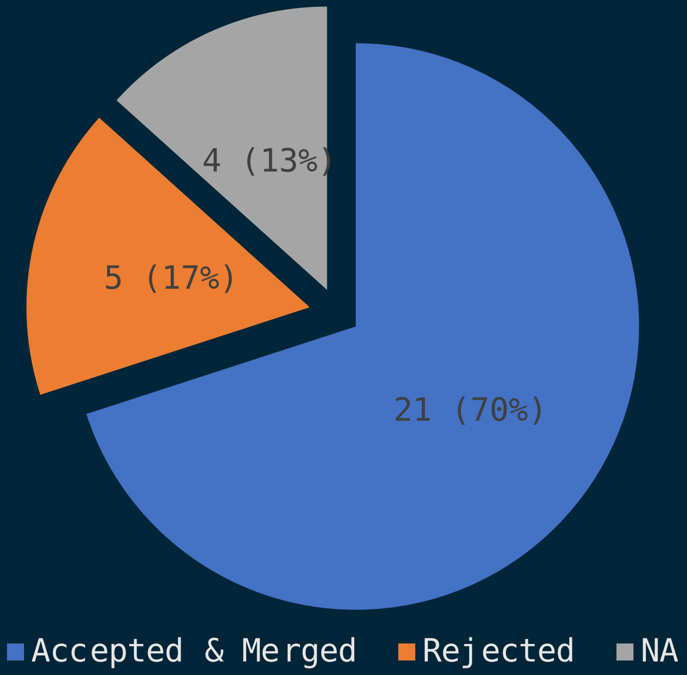

Removed 140 bloated dependencies in 21 projects thanks to DepClean

“A Comprehensive Study of Bloated Dependencies in the Maven Ecosystem” (accepted for publication in EMSE 2021)

Example: Jenkins

Bloated dependencies detected by DepClean:

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https://github.com/jenkinsci/jenkins/pull/4378

Developers’ comments

jenkins-core

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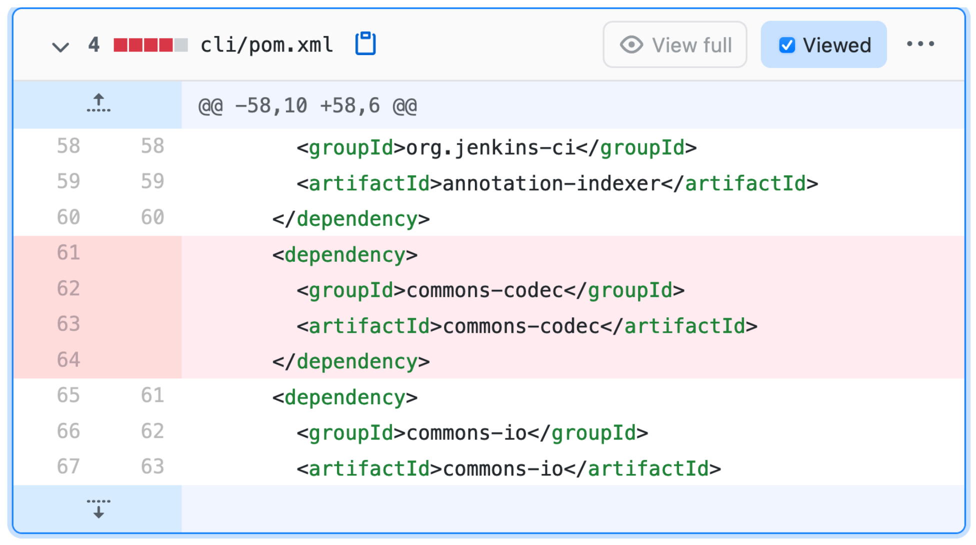
“Past experiences removing unused dependencies have consistently shown that some code will have depended on that inclusion and will be broken by it.”

“We're not precluded from removing an unused dependency, but I think that the project values compatibility more than removal of unused dependencies, so we need to be careful that removal of an unused dependency does not cause a more severe problem than it solves.”

Code change

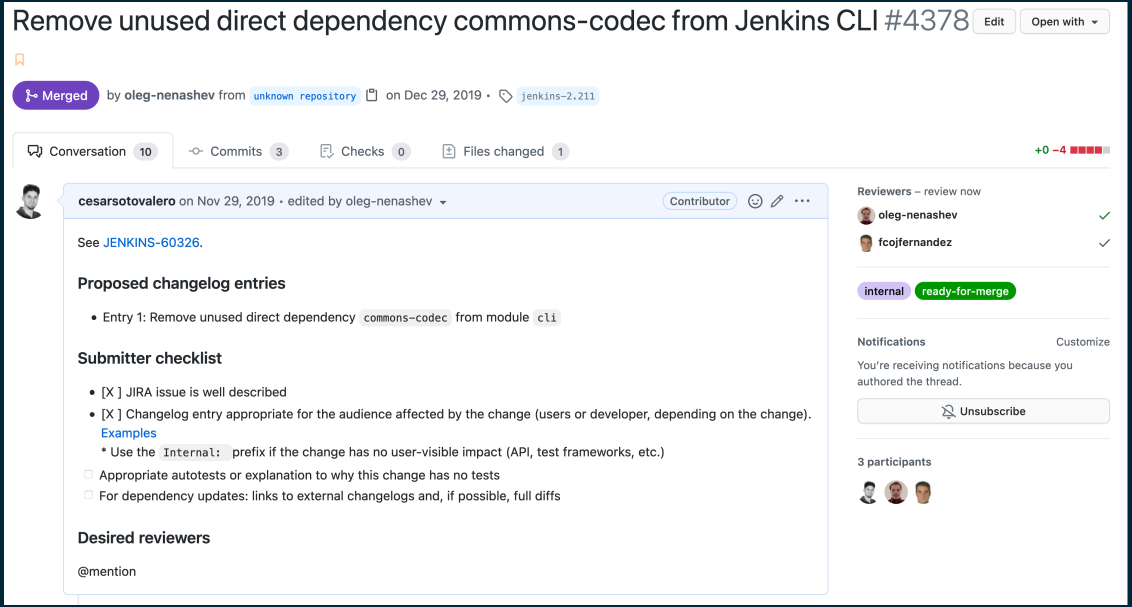
jenkins-cli



```
@@ -58,10 +58,6 @@
            <groupId>org.jenkins-ci</groupId>
            <artifactId>annotation-indexer</artifactId>
          </dependency>
          <dependency>
            <groupId>commons-codec</groupId>
            <artifactId>commons-codec</artifactId>
          </dependency>
          <dependency>
            <groupId>commons-io</groupId>
            <artifactId>commons-io</artifactId>
```

https://github.com/jenkinsci/jenkins/pull/4378

Merged pull request



Remove unused direct dependency commons-codec from Jenkins CLI #4378

Merged by **oleg-nenashev** from `unknown repository` on Dec 29, 2019 • `jenkins-2.211`

cesarsotovalero on Nov 29, 2019 • edited by oleg-nenashev

See JENKINS-60326.

Proposed changelog entries

- Entry 1: Remove unused direct dependency `commons-codec` from module `cli`

Submitter checklist

- [X] JIRA issue is well described
- [X] Changelog entry appropriate for the audience affected by the change (users or developer, depending on the change). Examples
  * Use the `Internal:` prefix if the change has no user-visible impact (API, test frameworks, etc.)

□ Appropriate autotests or explanation to why this change has no tests

□ For dependency updates: links to external changelogs and, if possible, full diffs

Desired reviewers

@mention

Reviewers – review now

- oleg-nenashev ✓
- fcojfernandez ✓

Notifications Customize

You're receiving notifications because you authored the thread.

3 participants

https://github.com/jenkinsci/jenkins/pull/4378

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Conclusion

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  - Caused by the induced transitive dependencies
  - Caused by the heritage mechanism of multi-module projects
  - Caused by software development practices
- Software developers care
  - For security
  - For performance
- DepClean
  - Automatically detects and removes bloated dependencies

Demo time!

DepClean in action

Thanks!