Android Security Code Smell Quickfixes

BSc Thesis – Final Presentation

Dominik Briner

19 January 2021

Software Composition Group

University of Bern

Android

“Easy” to develop apps

Powerful

Omnipresent

Sophisticated **IDE support & guides**

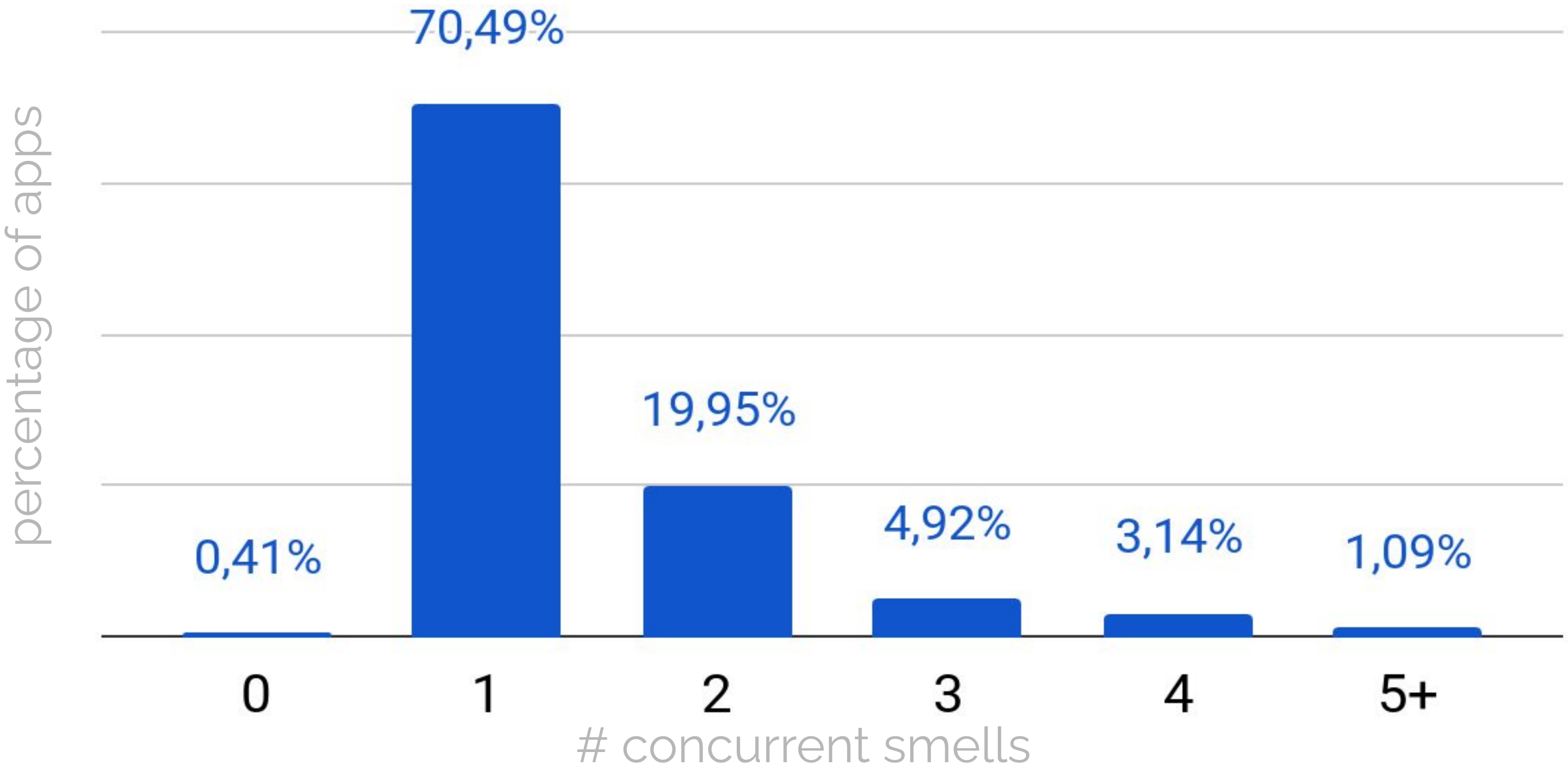
Android app security

Complicated!

Knowledge is spread!
no centralized comprehensive help resource

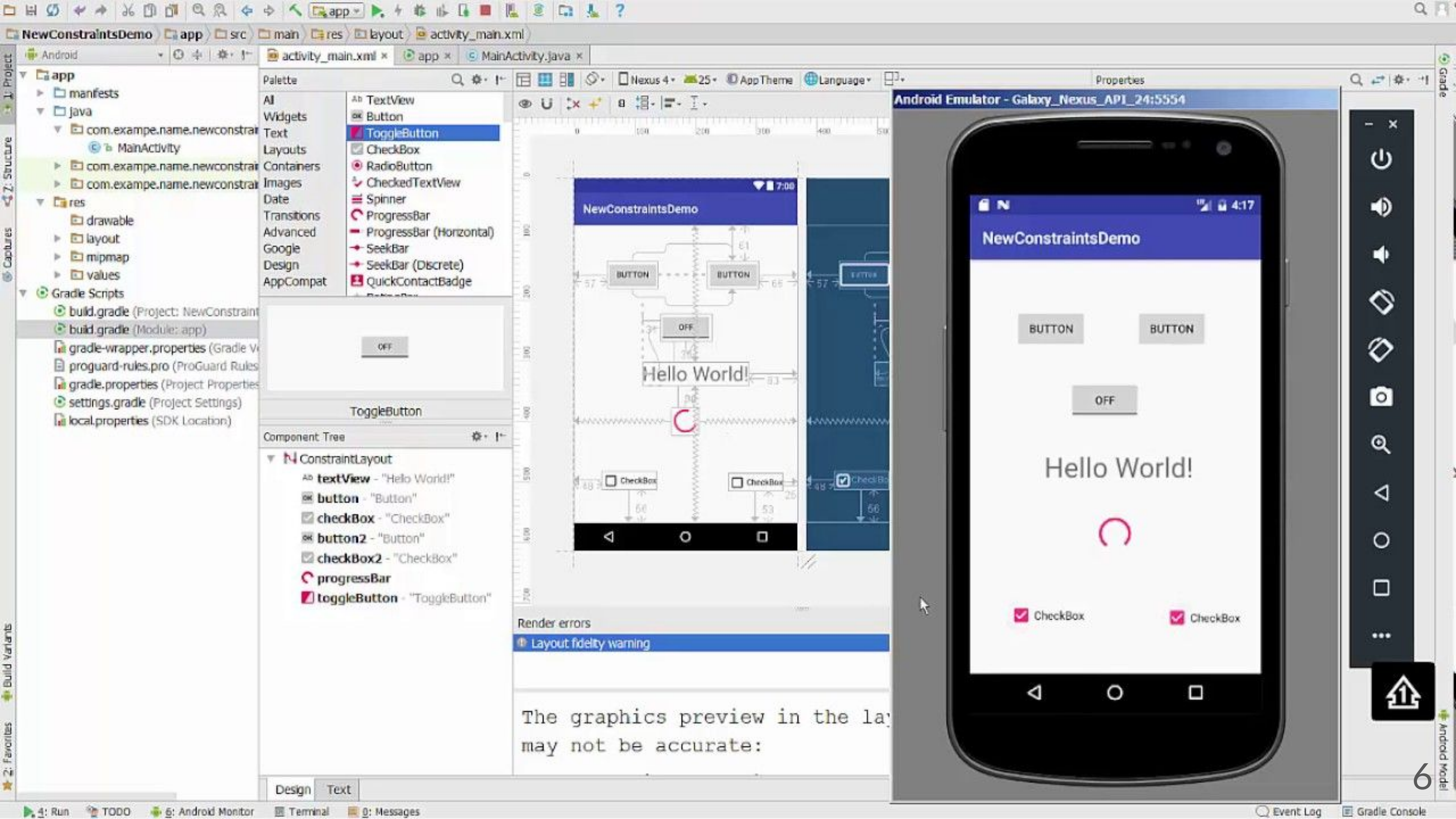
Numerous threats!
privacy leak, data theft, denial of service, ...

Android security code smells



The solution?

Build all the knowledge into the Android Studio IntelliJ IDE!



The graphics preview in the lay
may not be accurate:

The solution?

Build all the knowledge into the Android Studio IntelliJ IDE!

… but is that really a good idea?

The solution?

Build all the knowledge into the Android Studio IntelliJ IDE!

… but is that really a good idea?

Yes, but the IDE must assist the developer!

Smell reports

+

Interactive feedback

=

Quickfixes

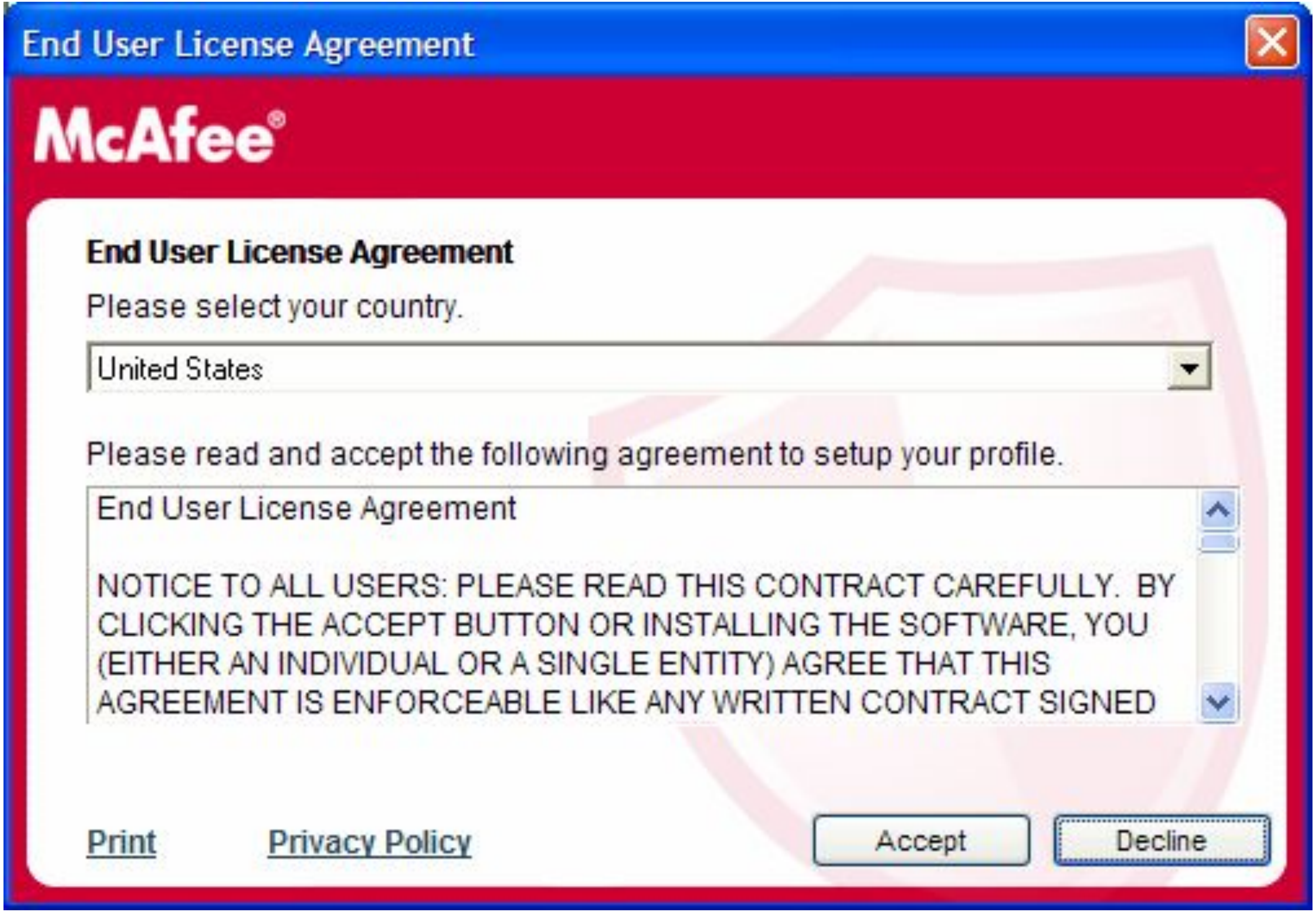
Not as easy as it seems

How to ....

... gather contextual information?

... design the UI?

... create reasonable workflows?



End User License Agreement

Please select your country.

United States

Please read and accept the following agreement to setup your profile.

End User License Agreement

NOTICE TO ALL USERS: PLEASE READ THIS CONTRACT CAREFULLY. BY CLICKING THE ACCEPT BUTTON OR INSTALLING THE SOFTWARE, YOU (EITHER AN INDIVIDUAL OR A SINGLE ENTITY) AGREE THAT THIS AGREEMENT IS ENFORCEABLE LIKE ANY WRITTEN CONTRACT SIGNED

Example #01 - Missing Protection Level

Use case:

1) Permission limits access to feature

2) Another app requests permission to use that feature

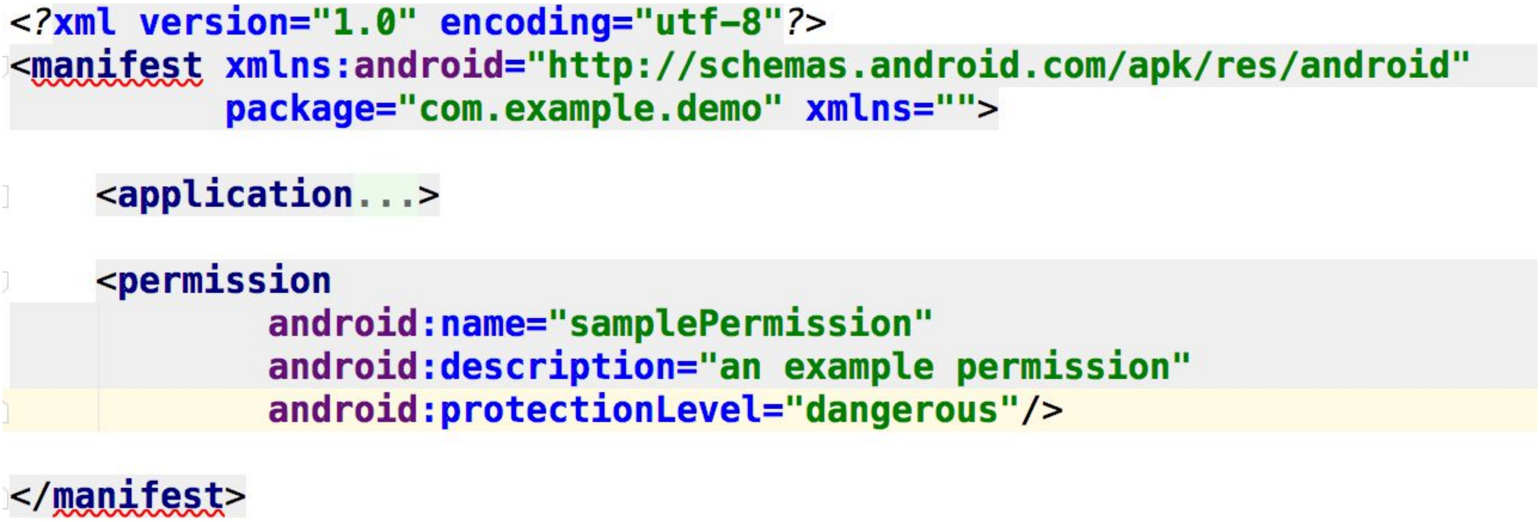
A permission's protection level defines the access scope:

normal = automatically grants everything (default!)

dangerous = user grants or denies permission

Example #01 - Missing Protection Level

Example:



```xml
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
          package="com.example.demo" xmlns="">

    <application...>

    <permission
            android:name="samplePermission"
            android:description="an example permission"
            android:protectionLevel="dangerous"/>

</manifest>
```

Example #01 - Missing Protection Level

Necessary considerations for the mitigation:

1) Detect missing protection level

   How to detect incorrect protection levels?

2) Protection level is a developer decision

   Ask developer for context? How?

Example #02 - Implicit Pending Intent

(Intent → task to be performed by other app)

Use case:

1) An app creates a background task

2) Background task will be executed later

There exist different kinds of intents:

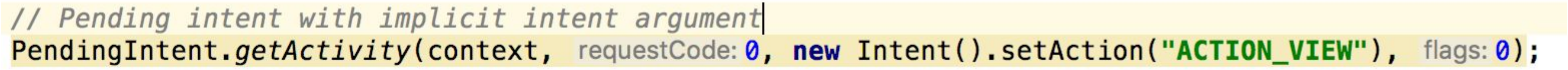
implicit → no target app specified

pending → intent receiver gets permissions of sender

implicit pending → security risk

Example #02 - Implicit Pending Intent

Example:



```
// Pending intent with implicit intent argument
PendingIntent.getActivity(context,  requestCode: 0, new Intent().setAction("ACTION_VIEW"),  flags: 0);
```

Example #02 - Implicit Pending Intent

Necessary considerations for the mitigation:

1) Make intent explicit

   What if target app cannot be inferred?

   How to explain the security risk to the developer?

There are more quickfixes...

Persisted Dynamic Permission

Incorrect Protection Level

Unauthorized Intent

Sticky Broadcast

Implicit Pending Intent

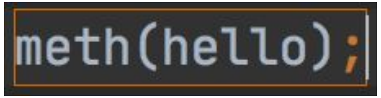
Common Task Affinity

IntelliJ in practice…

DEMO!

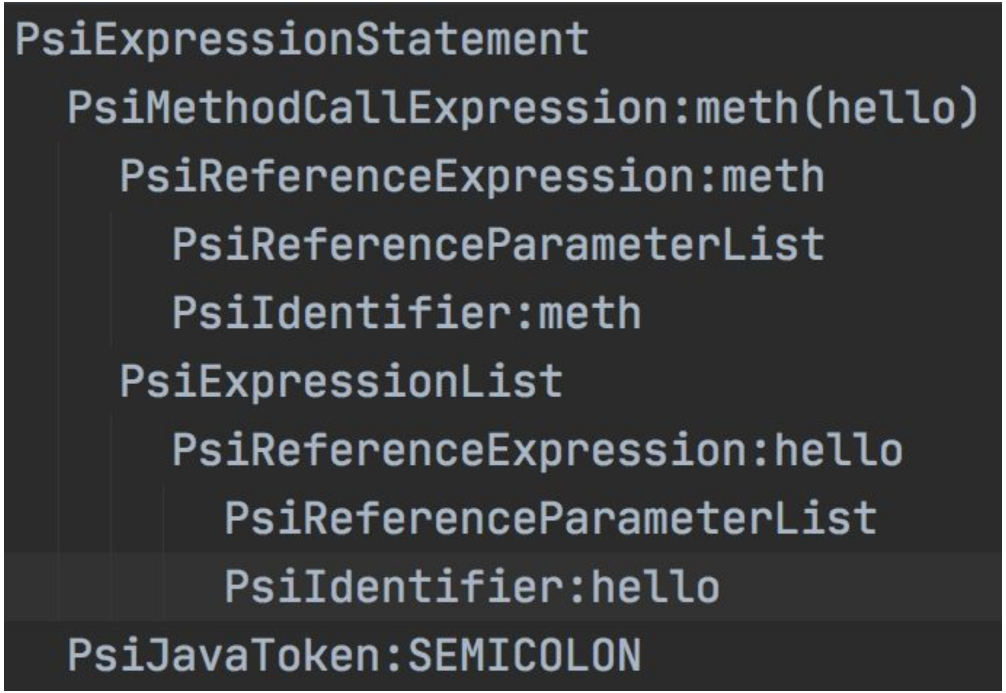
IntelliJ syntax trees

code



```
meth(hello);
```

internal representation



```
PsiExpressionStatement
  PsiMethodCallExpression:meth(hello)
    PsiReferenceExpression:meth
      PsiReferenceParameterList
      PsiIdentifier:meth
    PsiExpressionList
      PsiReferenceExpression:hello
        PsiReferenceParameterList
        PsiIdentifier:hello
  PsiJavaToken:SEMICOLON
```

IntelliJ syntax trees

AST

Lowest level representation

PSI

Interface to facilitate file manipulations

Inspections, quick fixes

UAST

Unifies Kotlin and Java

Hardly documented

IntelliJ challenges

Lack of documentation

Internal bugs / behavior

→ Debugging the IntelliJ system

IntelliJ architecture

→ Threading rules, ...

Frequent updates

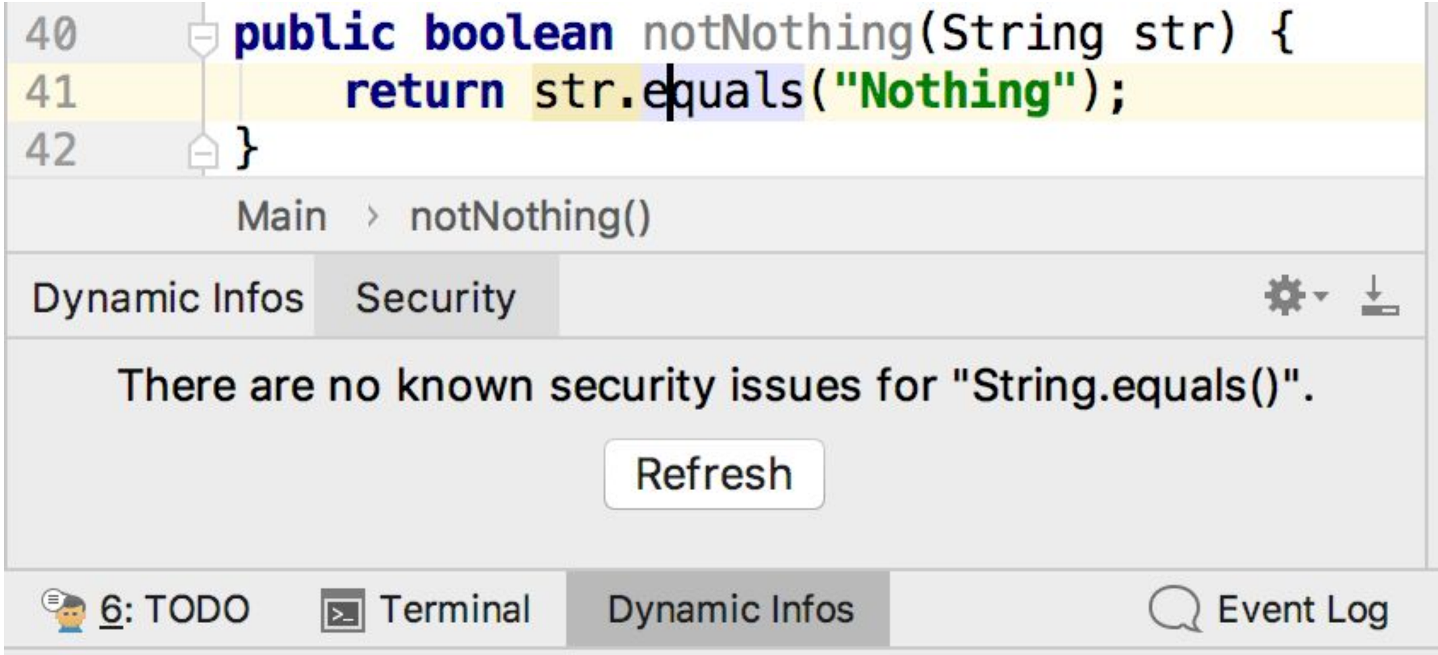
Quickfix evaluation

Still in progress

1) We let the tool run on existing apps
2) We investigate the false positives

Lessons learned

#01: Scope is important!



```
public boolean notNothing(String str) {
    return str.equals("Nothing");
}
```

There are no known security issues for "String.equals()".

Lessons learned

#02: Start with the essentials, then extend

#03: Know-how takes time

#04: Importance of documentation

Summary

Smell reports

+

Interactive feedback

=

Quickfixes

Example #01 - Missing Protection Level

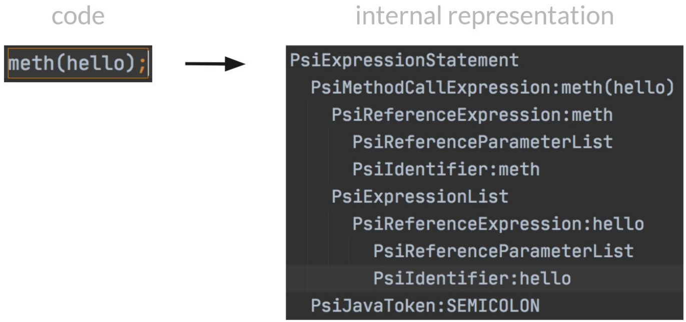
Use case:

1) Permission limits access to feature

2) Another app requests permission to use that feature

A permission's protection level defines the access scope:
normal = automatically grants everything (default!)
dangerous = user grants or denies permission

IntelliJ syntax trees



```
meth(hello);
```

```
PsiExpressionStatement
  PsiMethodCallExpression:meth(hello)
    PsiReferenceExpression:meth
      PsiReferenceParameterList
      PsiIdentifier:meth
    PsiExpressionList
      PsiReferenceExpression:hello
        PsiReferenceParameterList
        PsiIdentifier:hello
  PsiJavaToken:SEMICOLON
```

Lessons learned

#02: Start with the essentials, then extend

#03: Know-how takes time

#04: Importance of documentation