Low Hanging Fruit On Android

Zezadas

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https://peidei.me

https://sefod.eu

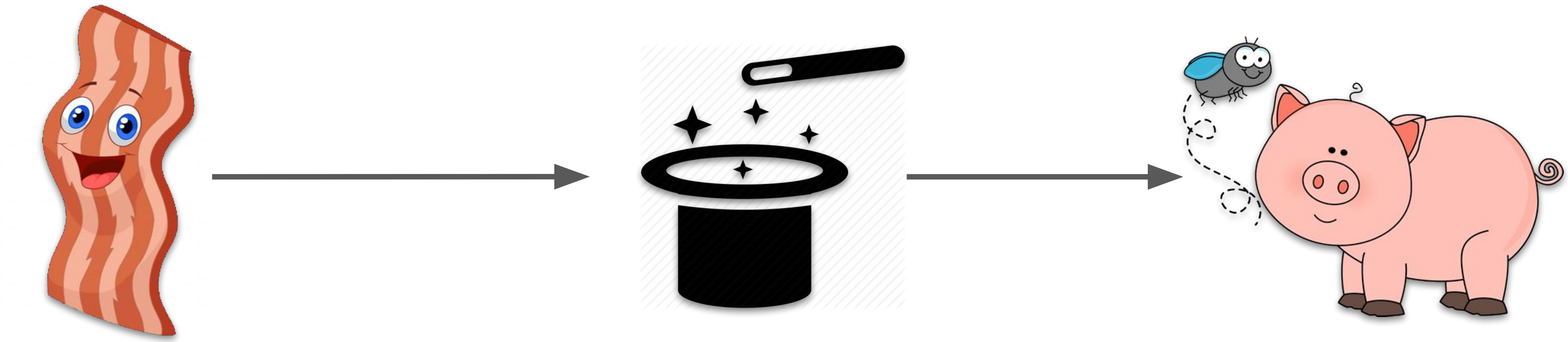
@0xz3z4d45

Reverse, patch, repack, repeat

1. Obtain and unpack APK
2. Analyze code, resources, files
3. Patch smali code
4. Rebuild and sign APK
5. Install into device / emulator
6. ???
7. PROFIT!

Reversing Android - 101

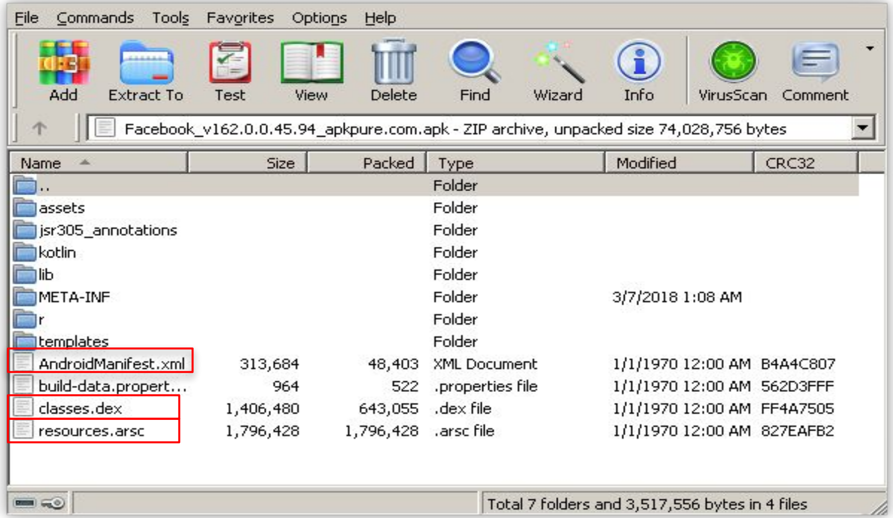
What is reversing?



APK

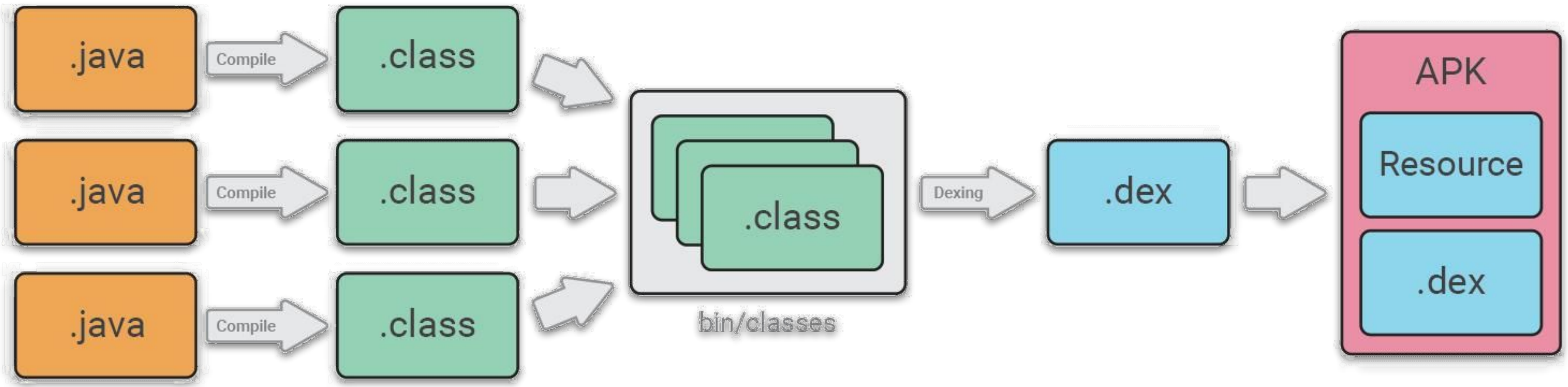
APK

APK

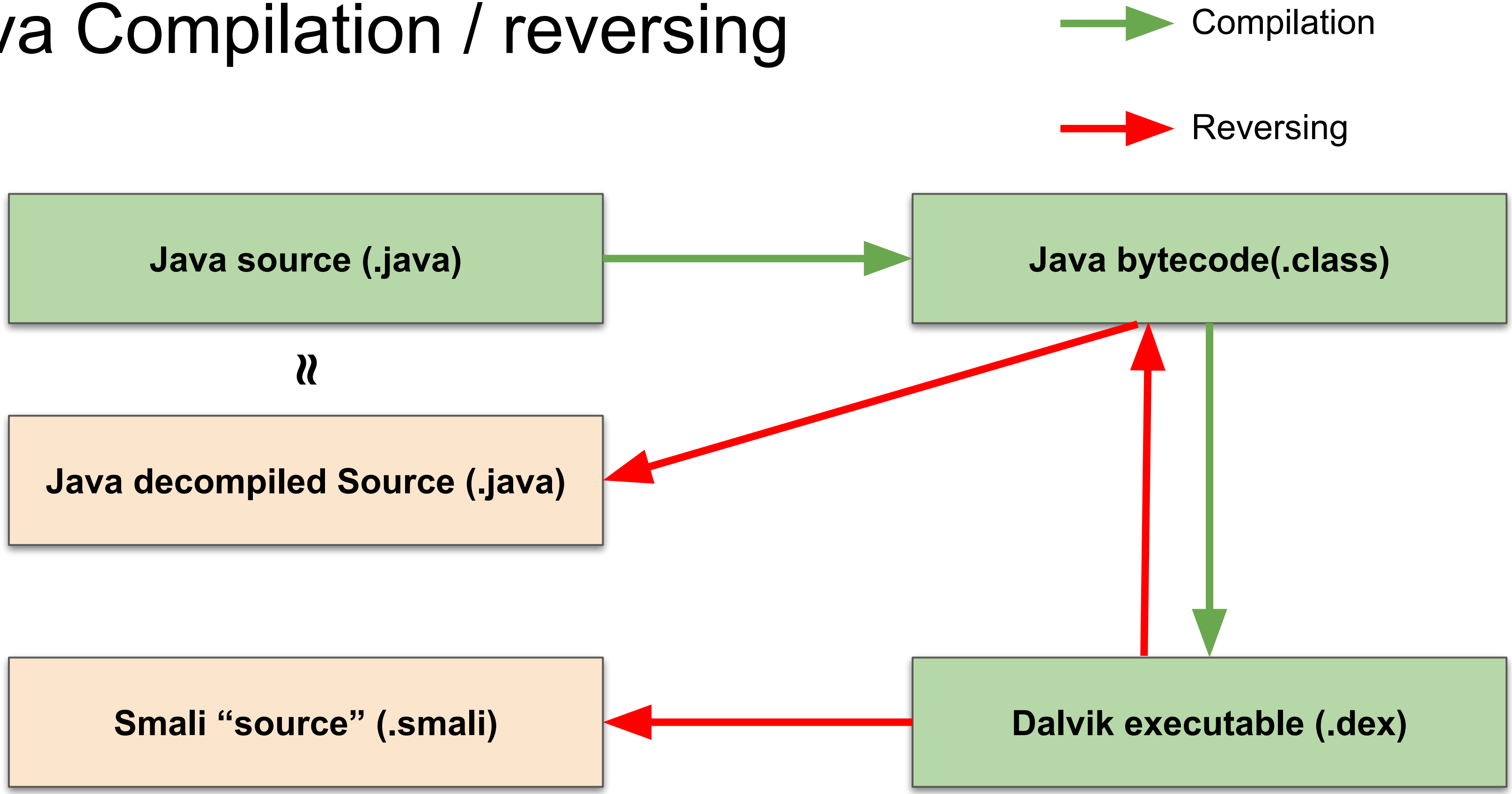


File Commands Tools Favorites Options Help
Add
Extract To
Test
View
Delete
Find
Wizard
Info
VirusScan
Comment
Facebook_v162.0.0.45.94_apkpure.com.apk - ZIP archive, unpacked size 74,028,756 bytes
Name Size Packed Type Modified CRC32
.. Folder
assets Folder
jsr305_annotations Folder
kotlin Folder
lib Folder
META-INF Folder 3/7/2018 1:08 AM
r Folder
templates Folder
AndroidManifest.xml 313,684 48,403 XML Document 1/1/1970 12:00 AM B4A4C807
build-data.propert... 964 522 .properties file 1/1/1970 12:00 AM 562D3FFF
classes.dex 1,406,480 643,055 .dex file 1/1/1970 12:00 AM FF4A7505
resources.arsc 1,796,428 1,796,428 .arsc file 1/1/1970 12:00 AM 827EAFB2
Total 7 folders and 3,517,556 bytes in 4 files

Android compilation (simplified)



Java Compilation / reversing



Java Vs Smali Vs Byte Code

Java code:

```
import java.io.PrintStream;

public class HelloWorld
{
  public static void main(String[] paramArrayOfString)
  {
    System.out.println("Hello World!");
  }
}
```

Java Bytecode:

???

Dalvik Bytecode:

???

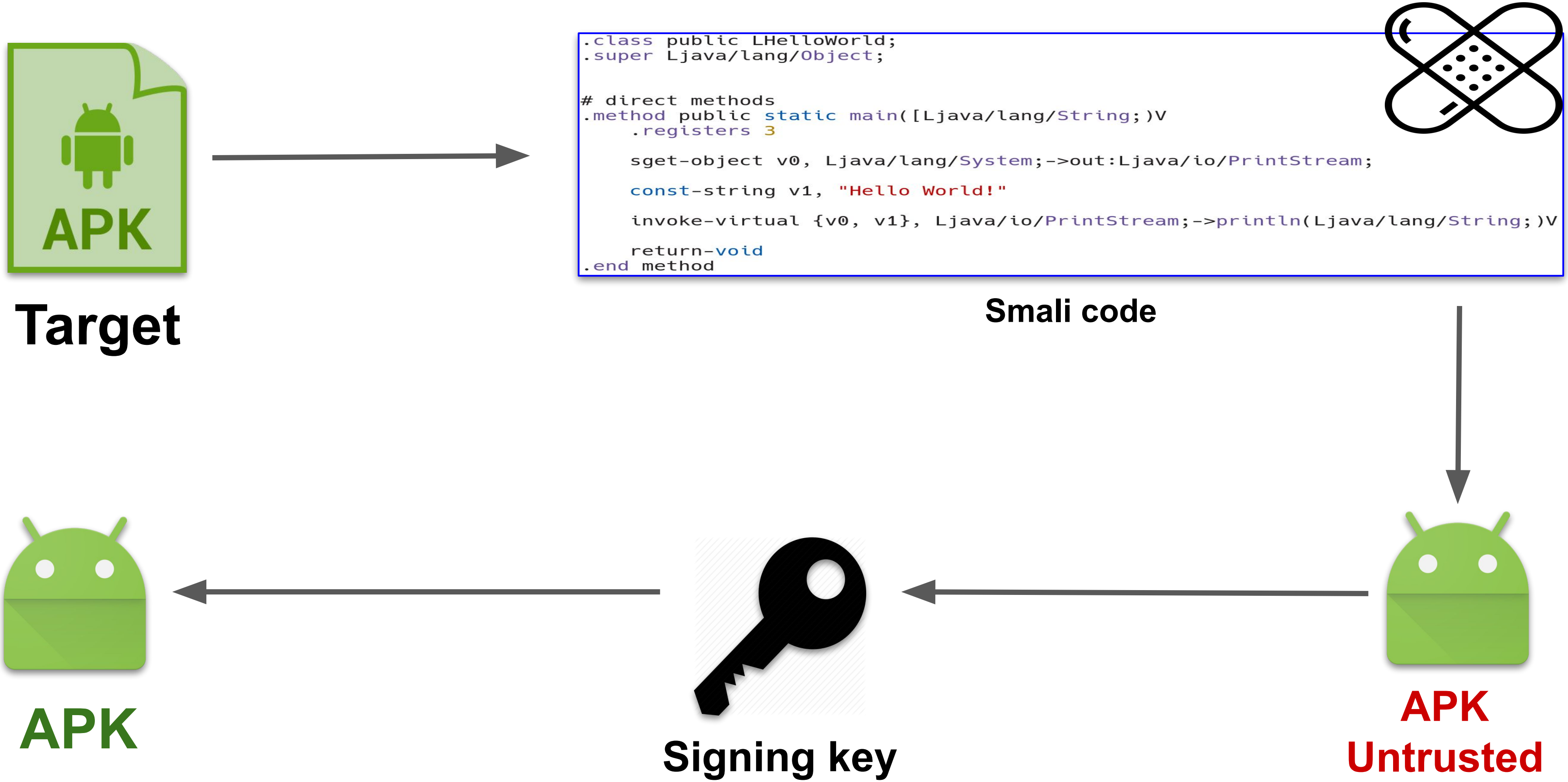
Decompiled Java bytecode:

```
public class HelloWorld {

    public static main(java.lang.String[] arg0) { //([Ljava/lang/String;)V
            getstatic java/lang/System.out:java.io.PrintStream
            ldc "Hello World!" (java.lang.String)
            invokevirtual java/io/PrintStream println((Ljava/lang/String;)V);
            return
    }
}
```

Smali code:

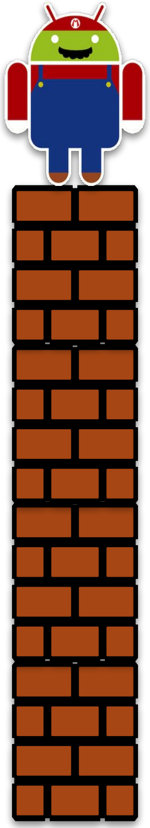
```
.class public LHelloWorld;
.super Ljava/lang/Object;


# direct methods
.method public static main([Ljava/lang/String;)V
    .registers 3

    sget-object v0, Ljava/lang/System;->out:Ljava/io/PrintStream;

    const-string v1, "Hello World!"

    invoke-virtual {v0, v1}, Ljava/io/PrintStream;->println(Ljava/lang/String;)V

    return-void
.end method
```

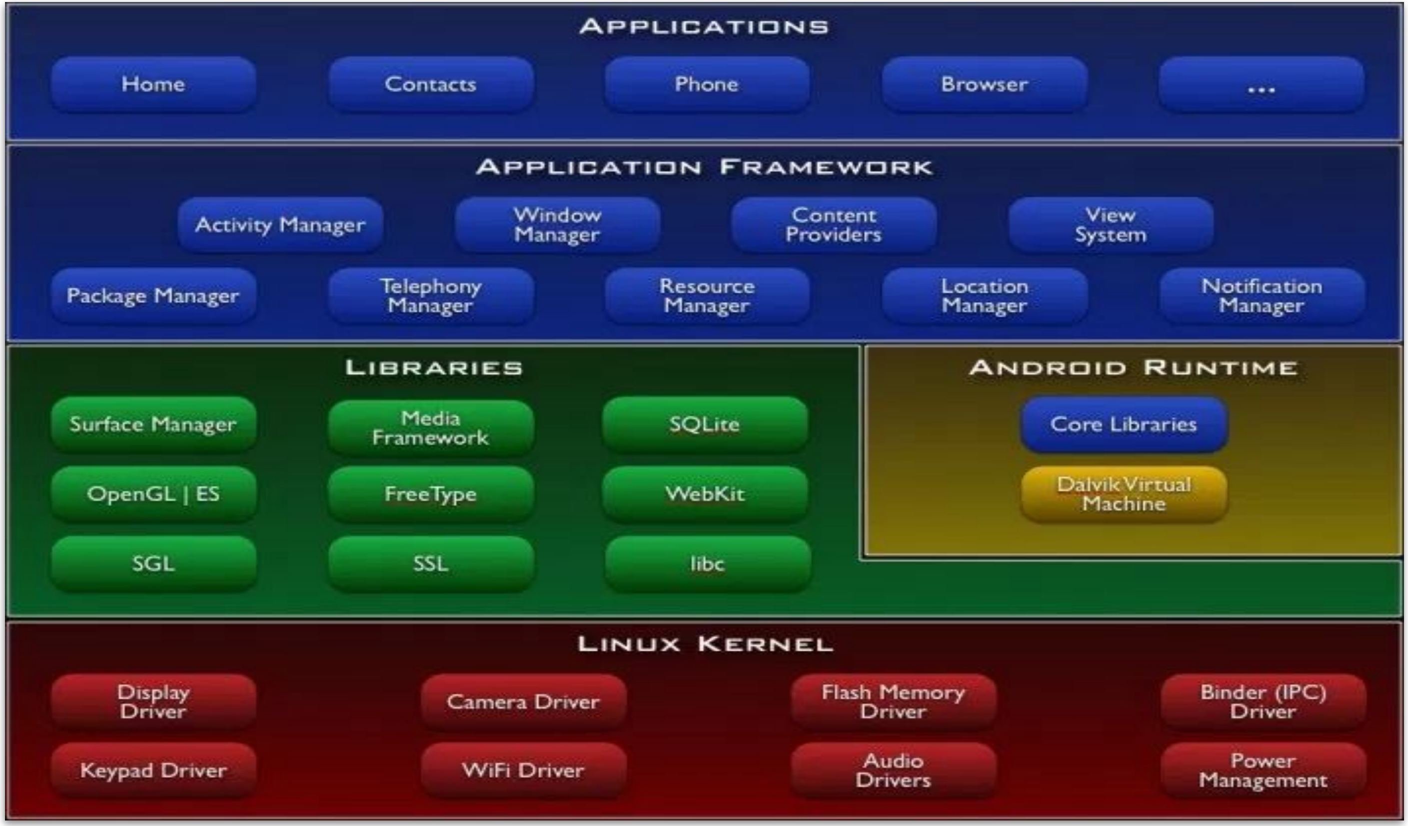
Patching Android - 101



APK
Target
.class public LHelloWorld;
.super Ljava/lang/Object;
direct methods
.method public static main([Ljava/lang/String;)V
.registers 3
sget-object v0, Ljava/lang/System;->out:Ljava/io/PrintStream;
const-string v1, "Hello World!"
invoke-virtual {v0, v1}, Ljava/io/PrintStream;->println(Ljava/lang/String;)V
return-void
.end method
Smali code
APK
Untrusted
Signing key
APK

Android Stack





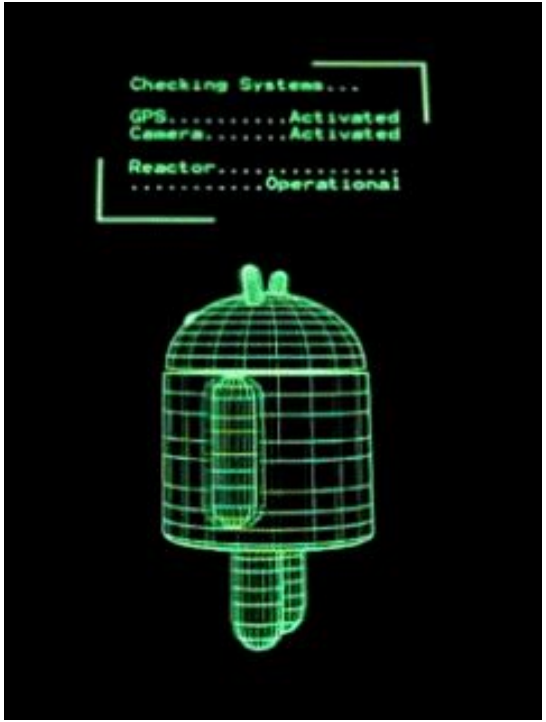
START HACKING! - Tools

- Install:
  - Android Studio (emulator && platform-tools) - https://developer.android.com/studio
  - JDK - https://jdk.java.net/
  - APKtool - https://ibotpeaches.github.io/Apktool/
  - Burp - https://portswigger.net/burp
  - Dex2jar - https://github.com/pxb1988/dex2jar
  - Bytecodeviewer - https://github.com/Konloch/bytecode-viewer
  - jadx-gui - https://github.com/skylot/jadx

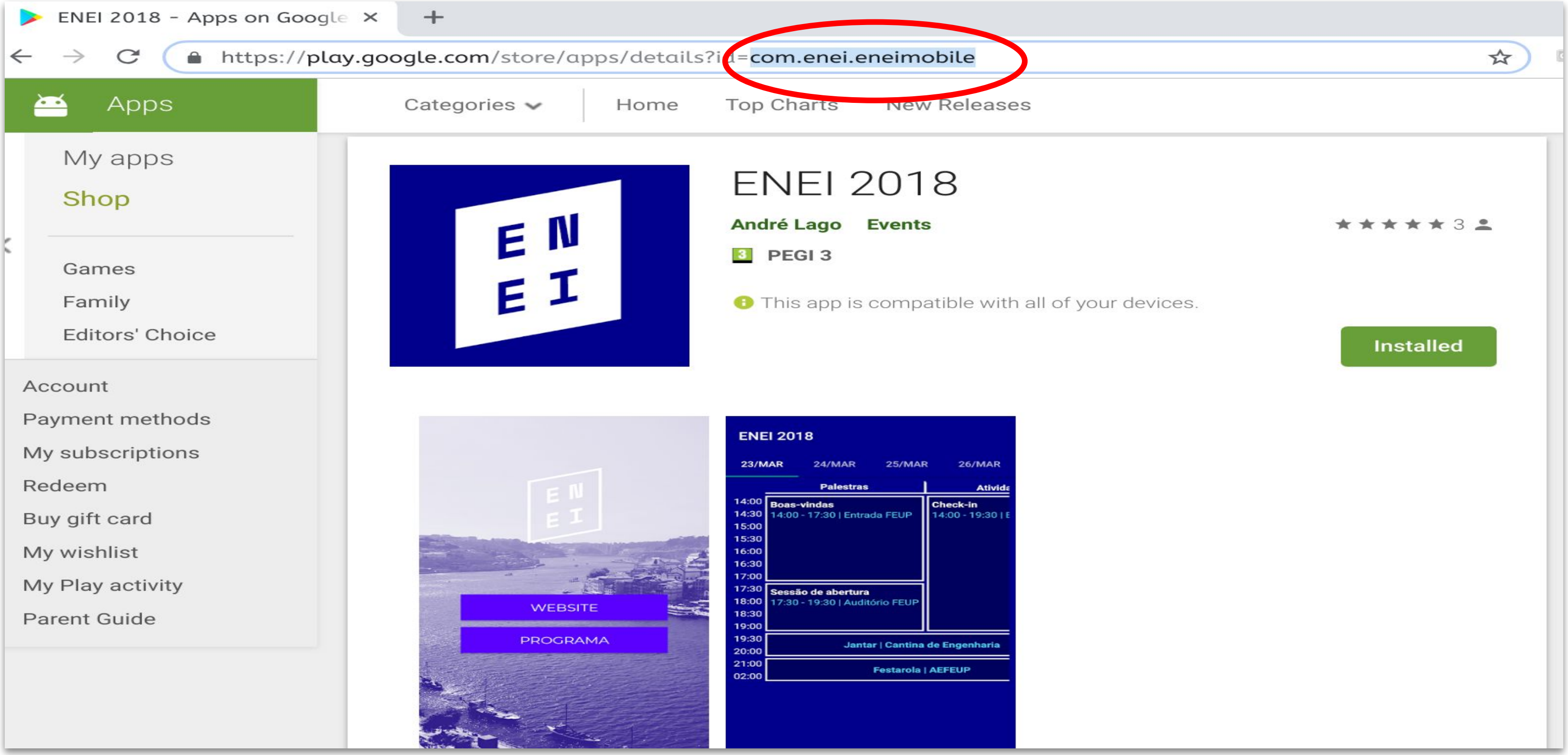
Practical - ENEI App 2018

Ways to obtain APKs:

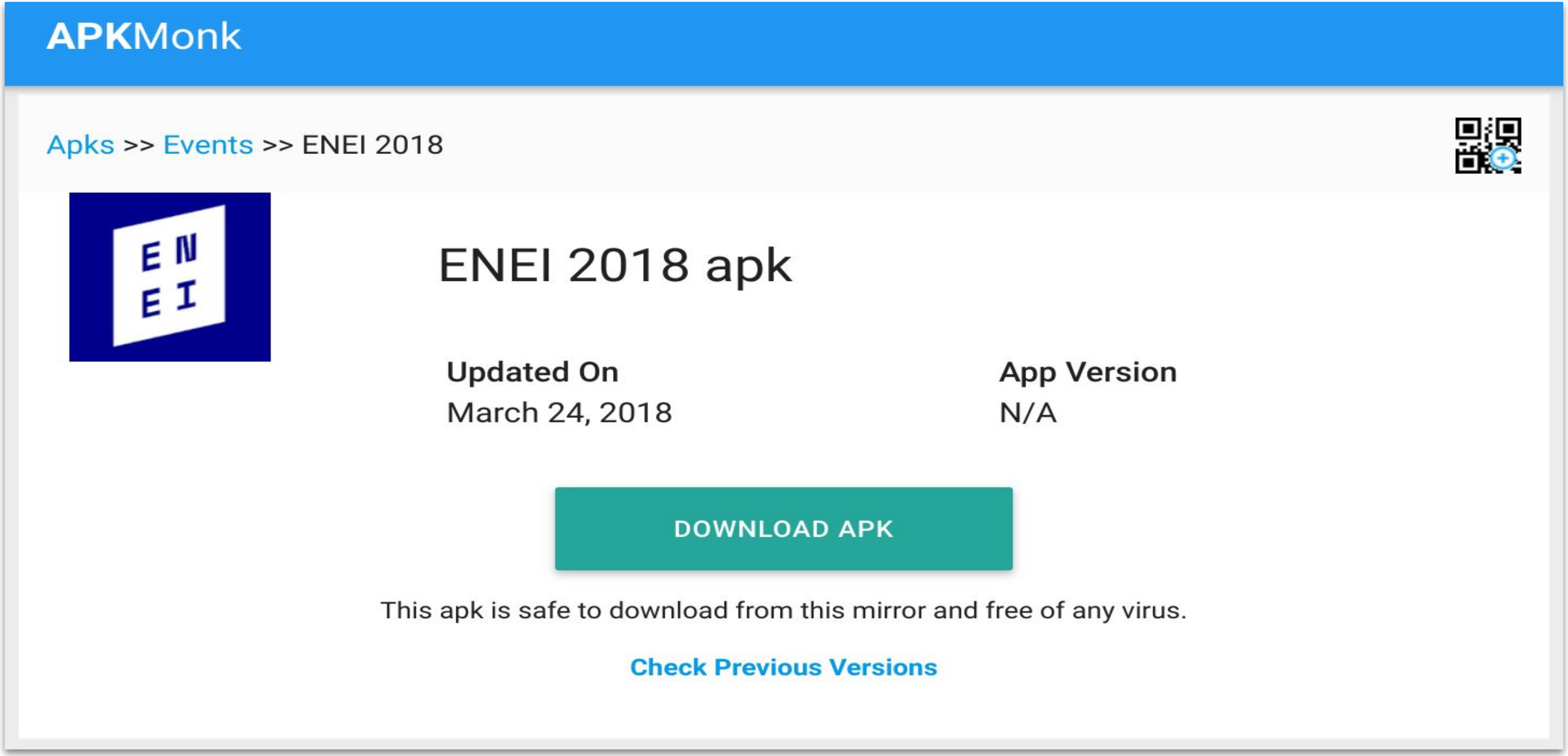
- https://apk-dl.com
- http://www.aptoide.com/
- https://www.apkmonk.com/
- Pull from android phone:
  - `$ adb shell pm list packages`
  - `$ adb shell pm path com.package.name`
  - `$ adb pull /full/path/to/apk`



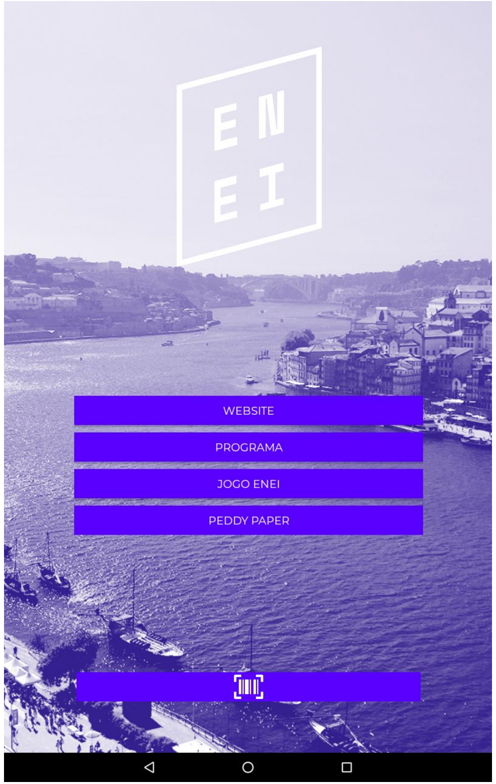
ENEI 2019 - App



Google + APKMonk



ENEI 2018 App



Extract && Decompile

```
File  Edit  View  Bookmarks  Settings  Help
anon@unknown  ~/oposec/enei  apktool d com.enei.eneimobile_2018-03-24.apk
I: Using Apktool 2.3.4 on com.enei.eneimobile_2018-03-24.apk
I: Loading resource table...
I: Decoding AndroidManifest.xml with resources...
I: Loading resource table from file: /home/anon/.local/share/apktool/framework/1.apk
I: Regular manifest package...
I: Decoding file-resources...
I: Decoding values */* XMLs...
I: Baksmaling classes.dex...
I: Copying assets and libs...
I: Copying unknown files...
I: Copying original files...
anon@unknown  ~/oposec/enei  _
```

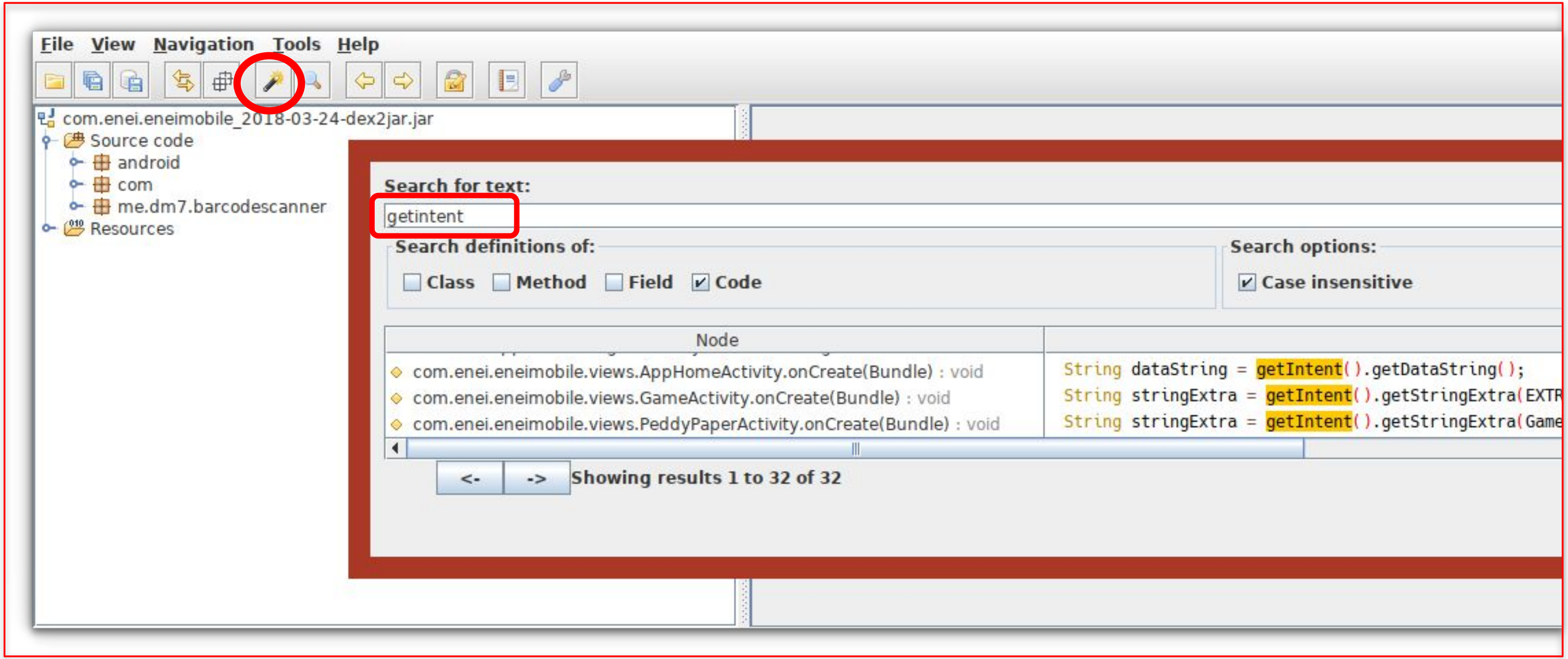
AndroidManifest.XML

```xml
<?xml version="1.0" encoding="utf-8" standalone="no"?><manifest xmlns:android="http://schemas.android.com/apk/res/android"
package="com.enei.eneimobile">
    <uses-permission android:name="android.permission.INTERNET"/>
    <uses-permission android:name="android.permission.CAMERA"/>
    <application android:allowBackup="true" android:icon="@mipmap/ic_logo" android:label="@string/app_name"
    android:roundIcon="@mipmap/ic_logo_round" android:supportsRtl="true" android:theme="@style/AppTheme.NoActionBar">
        <activity android:name="com.enei.eneimobile.views.AppHomeActivity">
            <intent-filter>
                <action android:name="android.intent.action.VIEW"/>
                <category android:name="android.intent.category.DEFAULT"/>
                <category android:name="android.intent.category.BROWSABLE"/>
                <data android:scheme="enei"/>
            </intent-filter>
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <activity android:name="com.enei.eneimobile.views.WebViewActivity">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
            </intent-filter>
        </activity>
        <activity android:label="@string/title_activity_schedule" android:name="com.enei.eneimobile.views.ScheduleActivity"
        android:theme="@style/AppTheme.NoActionBar"/>
        <activity android:name="com.enei.eneimobile.views.GameActivity"/>
        <activity android:name="com.enei.eneimobile.views.PeddyPaperActivity"/>
        <activity android:name="com.enei.eneimobile.views.CameraActivity"/>
        <meta-data android:name="android.support.VERSION" android:value="26.1.0"/>
        <meta-data android:name="android.arch.lifecycle.VERSION" android:value="27.0.0-SNAPSHOT"/>
        <meta-data android:name="com.android.vending.derived.apk.id" android:value="1"/>
    </application>
</manifest>
```

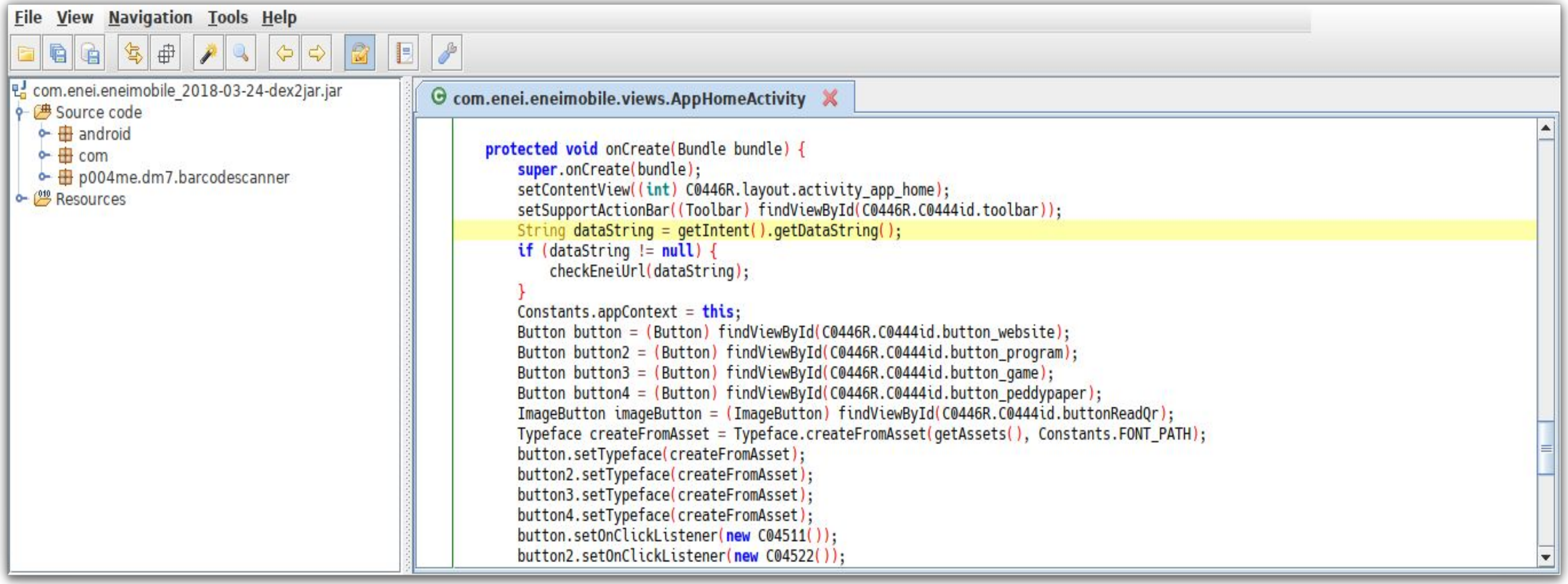
Dex2Jar && Jadx-GUI

```
File  Edit  View  Bookmarks  Settings  Help
anon@unknown  ~/oposec/enei  d2j-dex2jar com.enei.eneimobile_2018-03-24.apk
dex2jar com.enei.eneimobile_2018-03-24.apk -> ./com.enei.eneimobile_2018-03-24-dex2jar.jar
anon@unknown  ~/oposec/enei  jadx-gui com.enei.eneimobile_2018-03-24-dex2jar.jar
INFO  - output directory: com.enei.eneimobile_2018-03-24-dex2jar
INFO  - loading ...
INFO  - converting to dex: com.enei.eneimobile_2018-03-24-dex2jar.jar ...
```

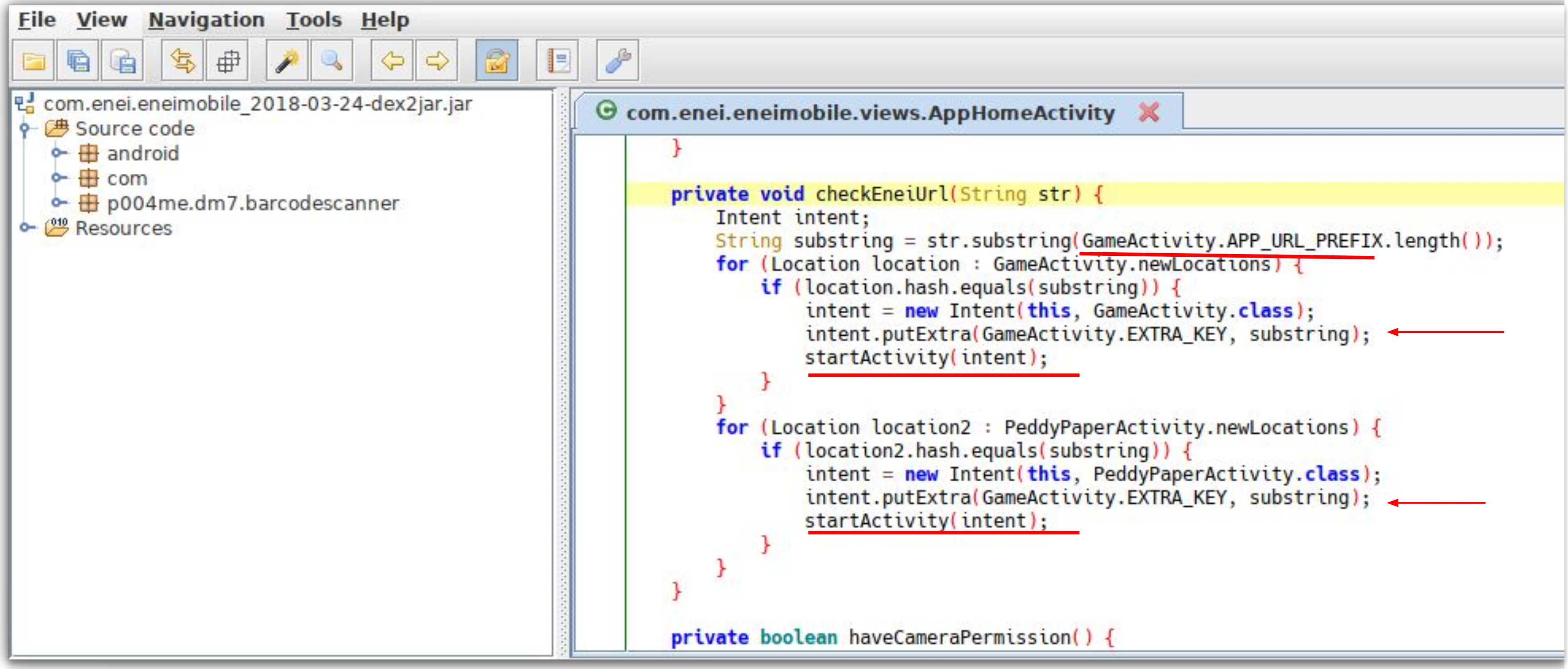
Jadx-GUI (1/5)- Search Intents



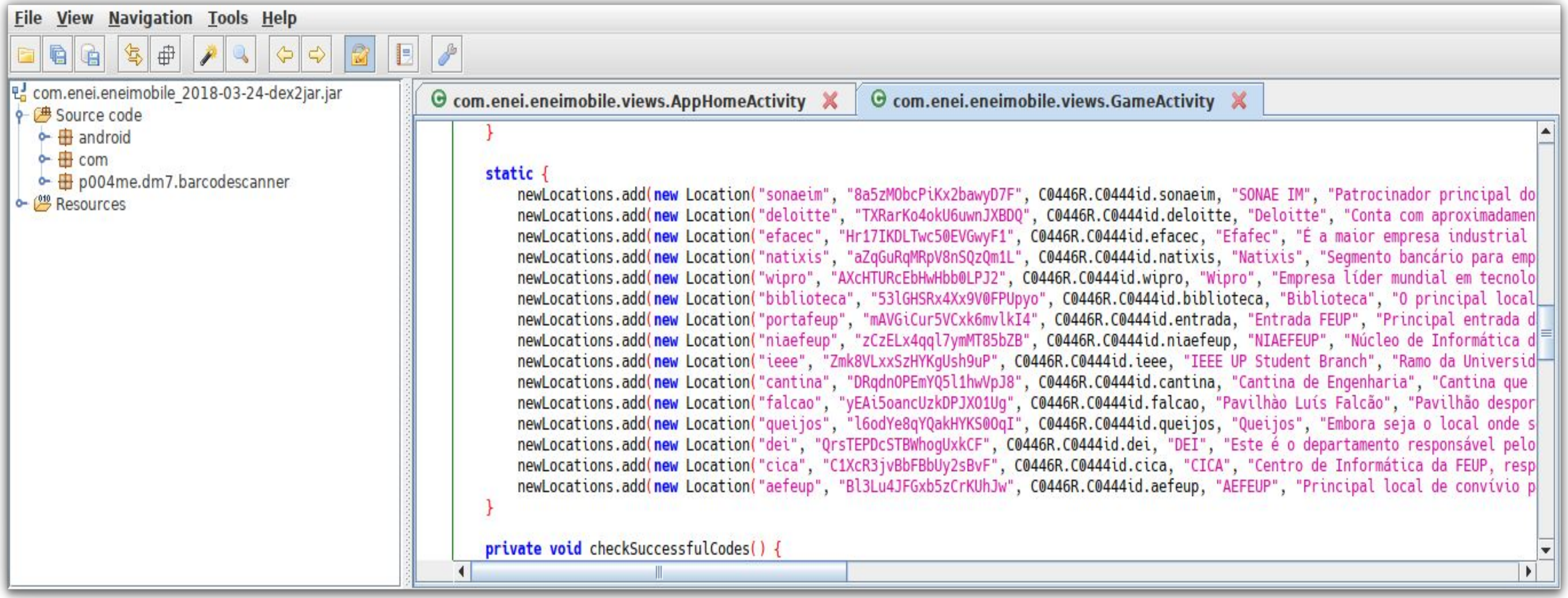
Jadx-GUI (2/5)- Code Analysis



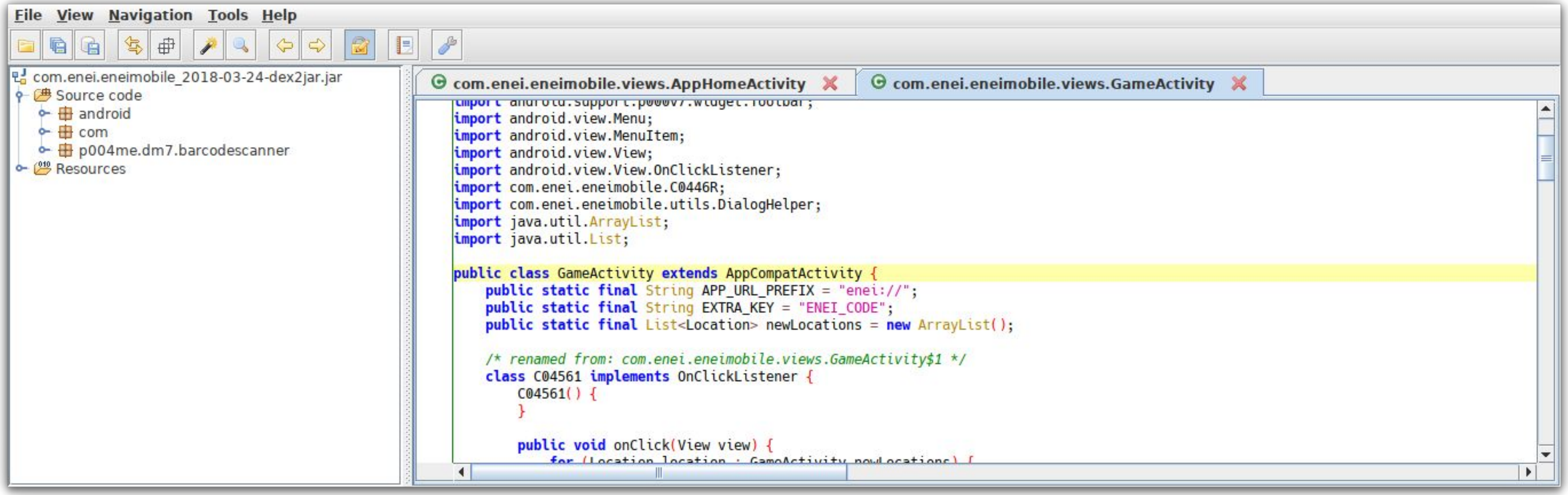
Jadx-GUI (3/5)- Code Analysis



Jadx-GUI (4/5)- Code Analysis

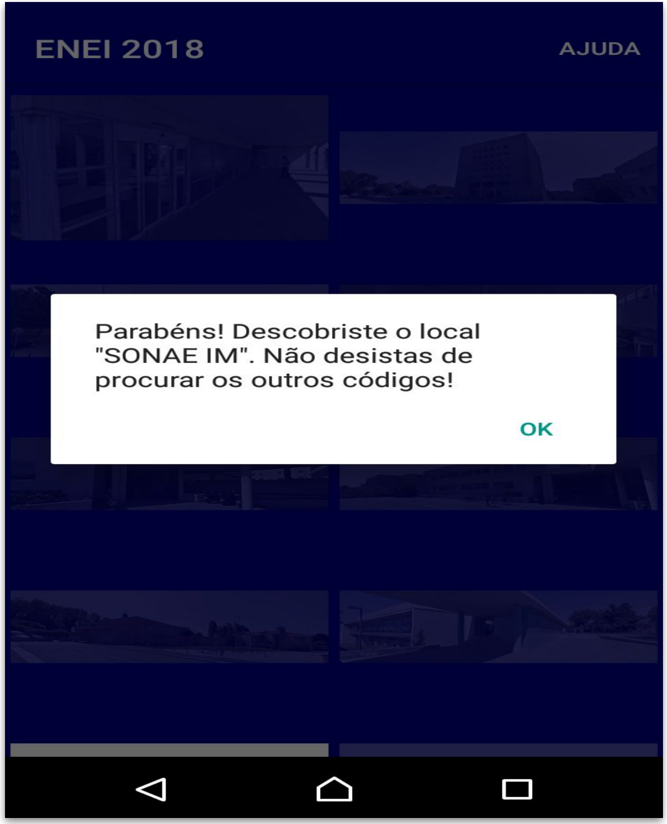


Jadx-GUI (5/5)- Code Analysis



Exploit 1 - enei://8a5zMObcPiKx2bawyD7F

Solve 1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Parabéns! Descobriste o local "SONAE IM". Não desistas de procurar os outros códigos!
OK


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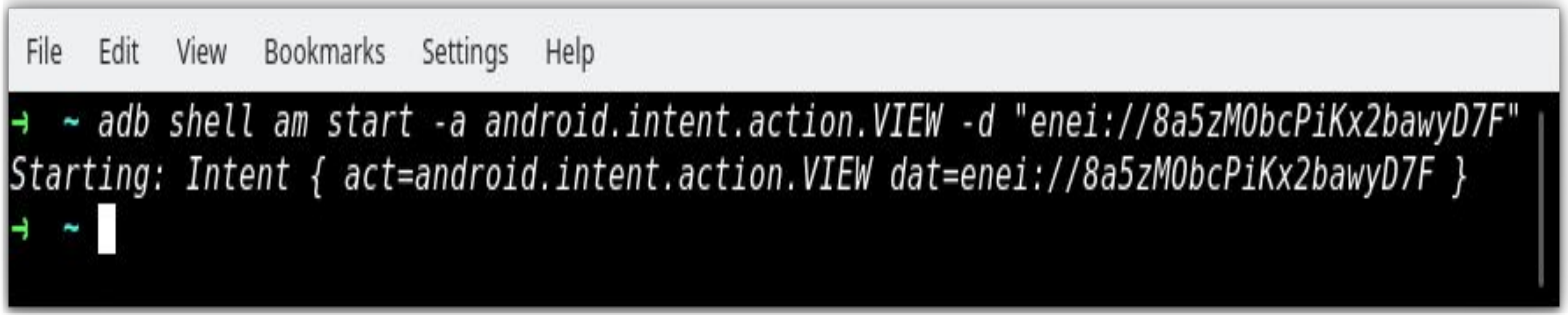
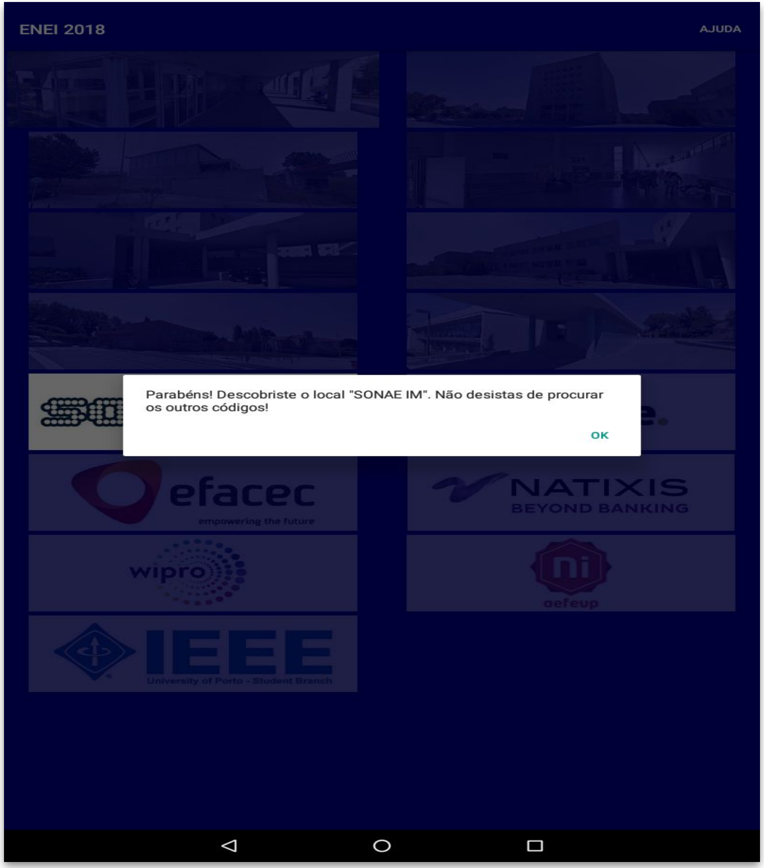
Exploit 2 - Stealth



adb shell am start -a android.intent.action.VIEW -d "enei://8a5zMObcPiKx2bawyD7F"

Solve 2


ENEI 2018
AJUDA
Parabéns! Descobriste o local "SONAE IM". Não desistas de procurar os outros códigos!
OK
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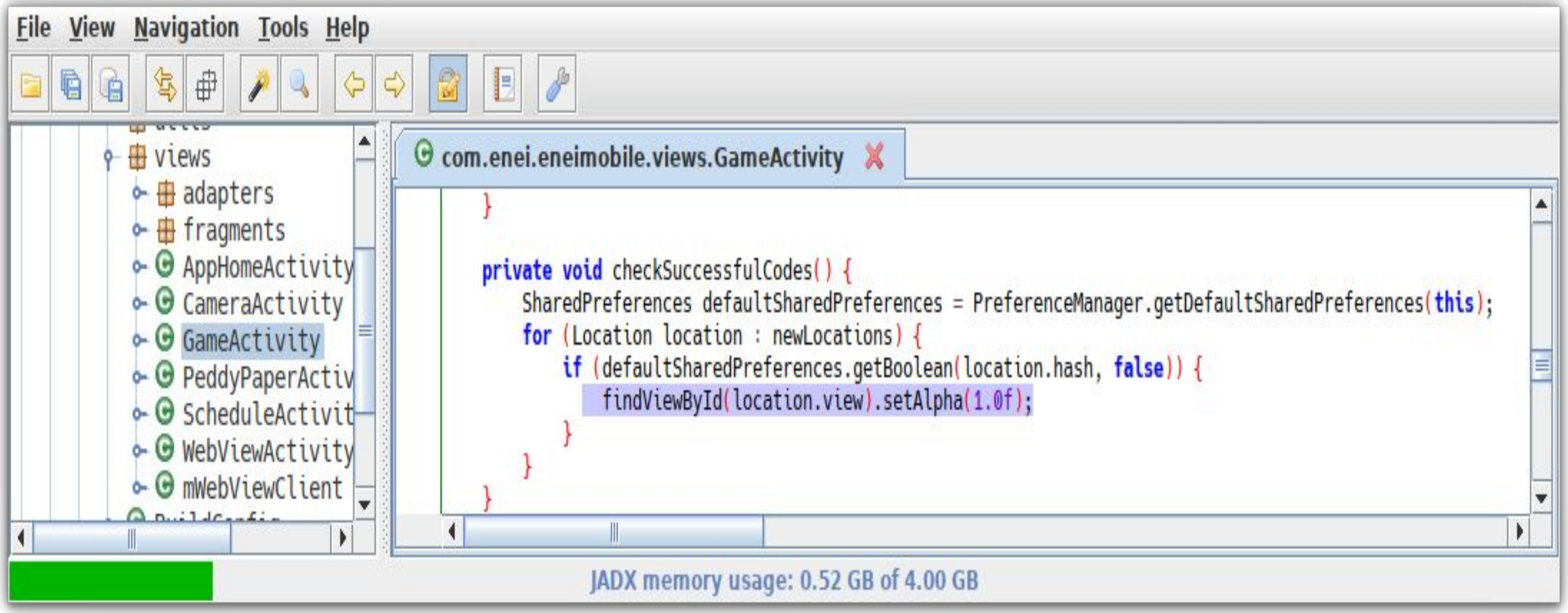
Exploit 3 - Analysing



Exploit 3 - Patching

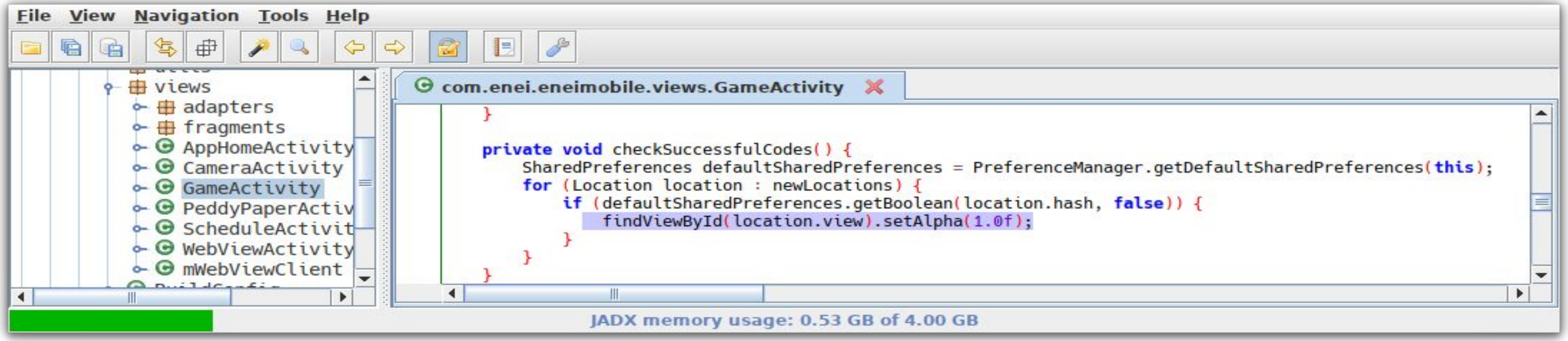
```
    move-result-object v2

    :cond_0
    :goto_0
    invoke-interface {v2}, Ljava/util/Iterator;->hasNext()Z

    move-result v3

    if-eqz v3, :cond_1

    invoke-interface {v2}, Ljava/util/Iterator;->next()Ljava/lang/Object;

    move-result-object v0

    check-cast v0, Lcom/enei/eneimobile/views/GameActivity$Location;

    .line 140
    .local v0, "location":Lcom/enei/eneimobile/views/GameActivity$Location;
    iget-object v3, v0, Lcom/enei/eneimobile/views/GameActivity$Location;->hash:Ljava/lang/String;

    const/4 v4, 0x0

    invoke-interface {v1, v3, v4}, Landroid/content/SharedPreferences;->getBoolean(Ljava/lang/
String;Z)Z

    move-result v3

    #if-eqz v3, :cond_0

    .line 141
    iget v3, v0, Lcom/enei/eneimobile/views/GameActivity$Location;->view:I

    invoke-virtual {p0, v3}, Lcom/enei/eneimobile/views/GameActivity;->findViewById(I)Landroid/view/
View;
```

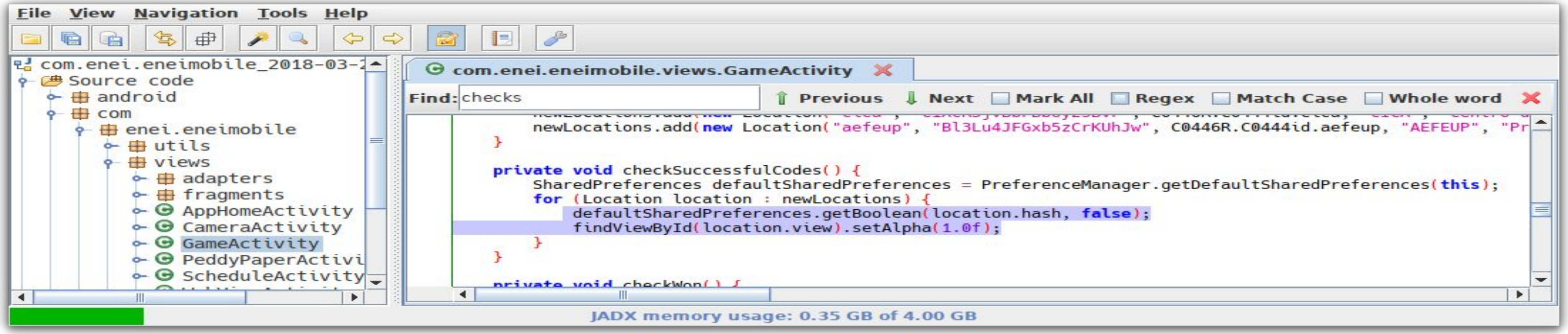
Exploit 3 - Recompile

File Edit View Bookmarks Settings Help

```
➜  oposeczadas apktool b com.enei.eneimobile_2018-03-24
I: Using Apktool 2.3.4
I: Checking whether sources has changed...
I: Smaling smali folder into classes.dex...
I: Checking whether resources has changed...
I: Building resources...
S: WARNING: Could not write to (/home/anon/.local/share/apktool/framework), using /tmp i
nstead...
S: Please be aware this is a volatile directory and frameworks could go missing, please
utilize --frame-path if the default storage directory is unavailable
I: Building apk file...
I: Copying unknown files/dir...
I: Built apk...
➜  oposeczadas
```

Exploit 3 - Compare





Exploit 3 - Sign && Install

File Edit View Bookmarks Settings Help

```
➜  dist sign_apk com.enei.eneimobile_2018-03-24.apk
jar signed.

Warning:
The signer's certificate is self-signed.
➜  dist adb install com.enei.eneimobile_2018-03-24.apk
Success
➜  dist
```

Solve 3

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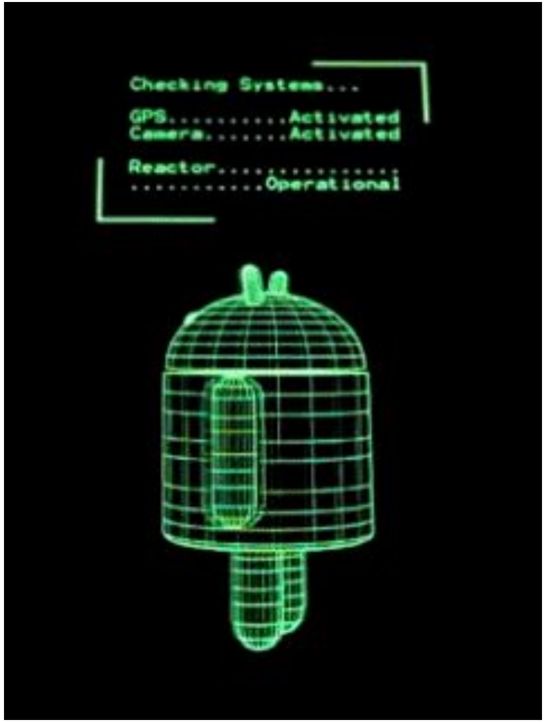
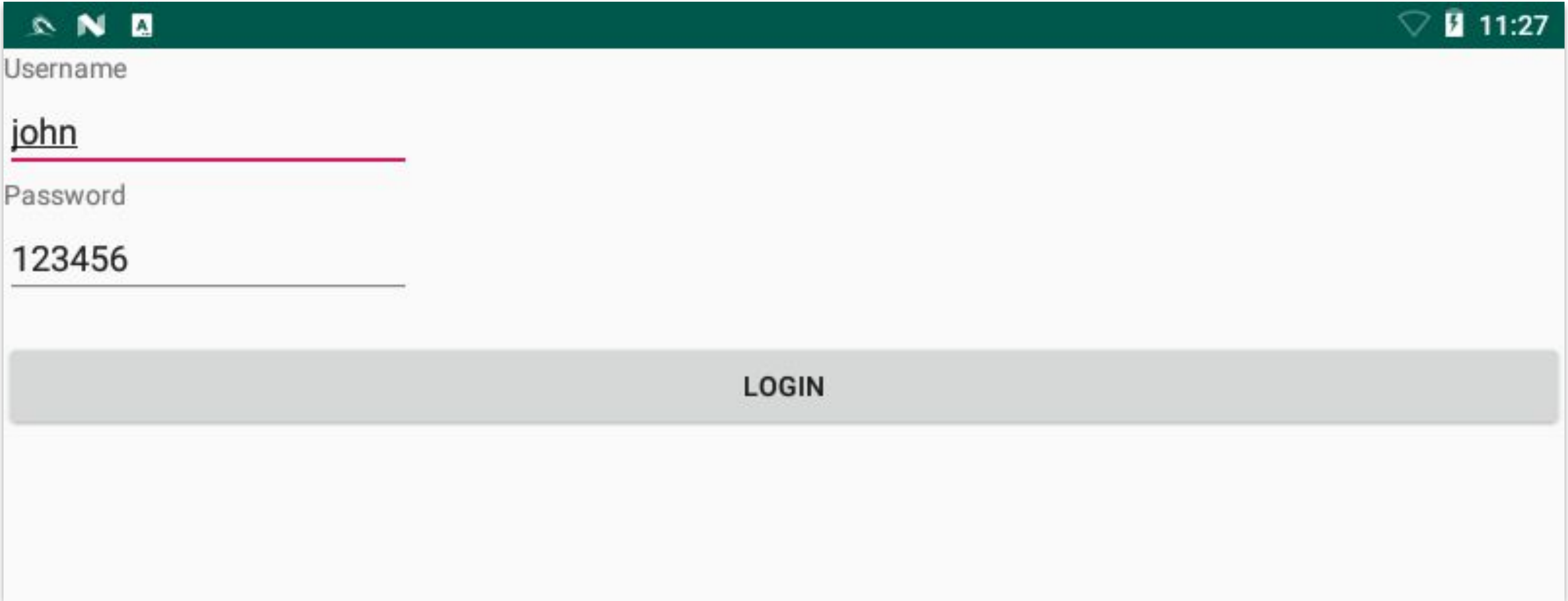
Practical - Vuln App

Ways to obtain APKs:

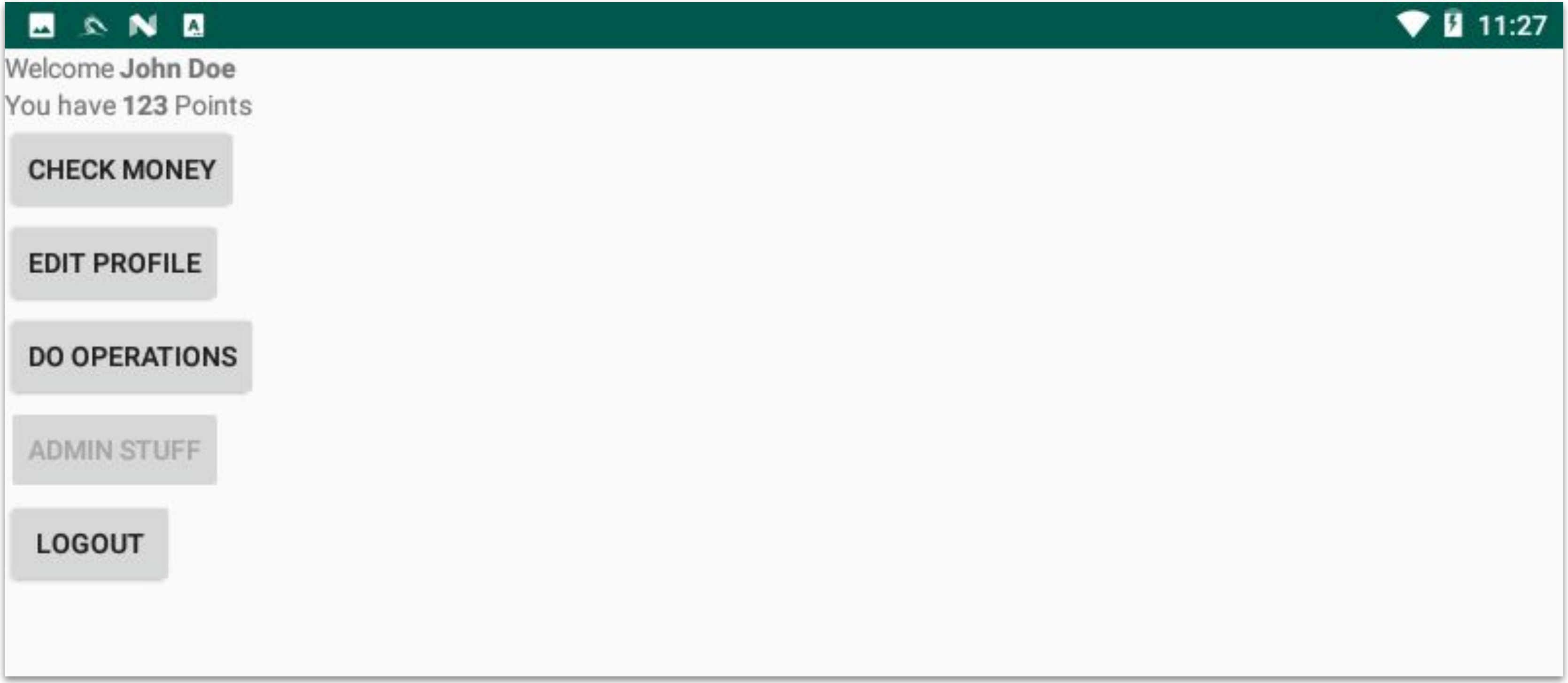
- Source:
  - https://github.com/zezadas/0xOPOSEC_0x73_VulnApp_Android
- Pull from android phone:
  - `$ adb shell pm list packages | grep -i vulnapp`
  - `$ adb shell pm path pt.oposec.vulnapp`
  - `$ adb pull /data/app/pt.oposec.vulnapp-1/base.apk`



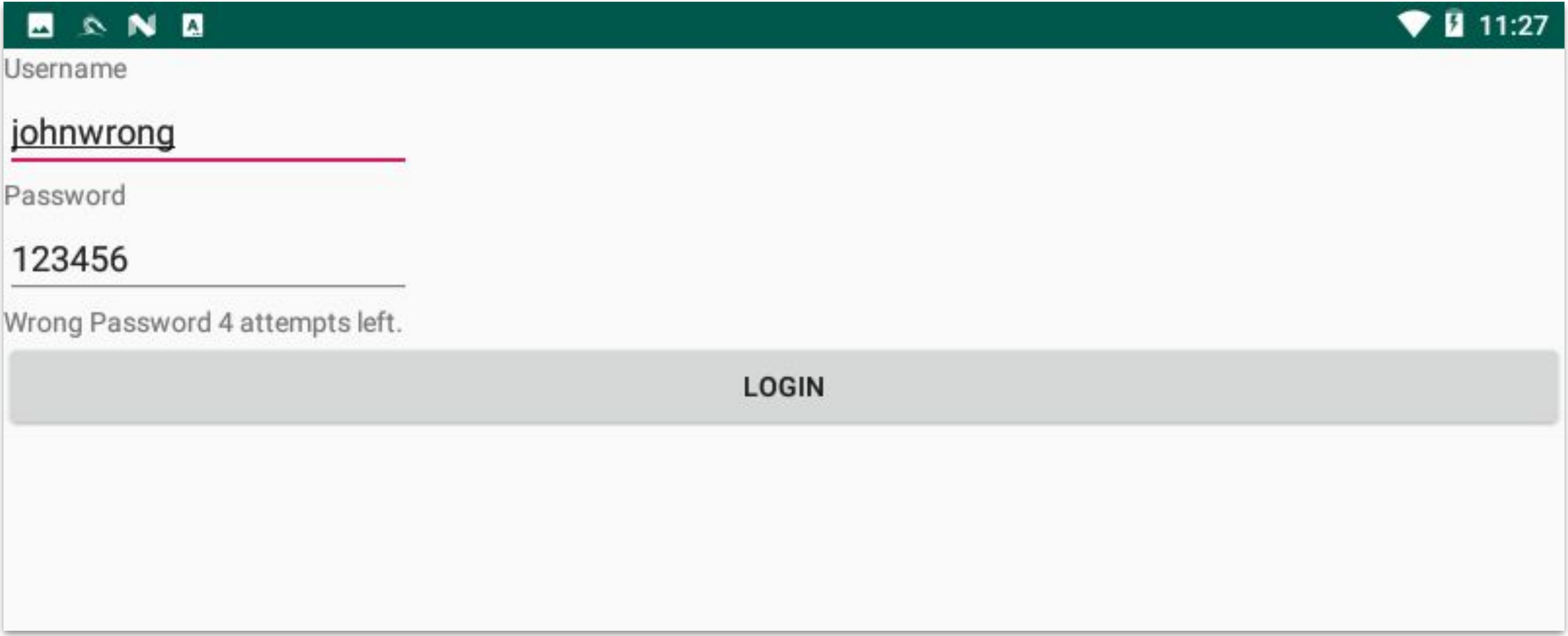
VulnApp



VulnApp - Valid User



VulnApp - Wrong User



VulnApp - AndroidManifest.xml

File Edit View Projects Bookmarks Sessions Tools Settings Help

Documents

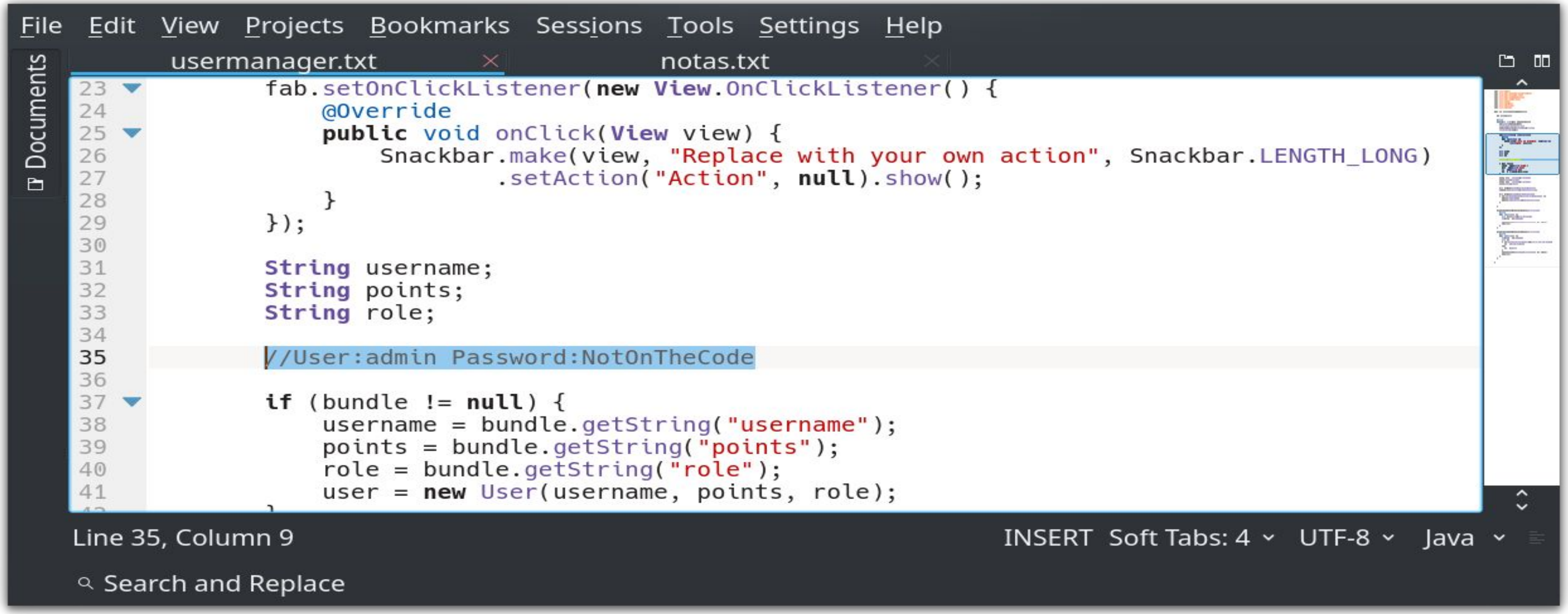
AndroidManifest.xml | notas.txt

```xml
<?xml version="1.0" encoding="utf-8" standalone="no"?><manifest xmlns:android="http://schemas.android.com/apk/res/android"
android:compileSdkVersion="28" android:compileSdkVersionCodename="9" package="pt.oposec.vulnapp" platformBuildVersionCode="1"
platformBuildVersionName="1.0">
    <uses-permission android:name="android.permission.INTERNET"/>
    <application android:allowBackup="true" android:appComponentFactory="android.support.v4.app.CoreComponentFactory" android:debuggable="true"
    android:icon="@mipmap/ic_launcher" android:label="@string/app_name" android:roundIcon="@mipmap/ic_launcher_round" android:supportsRtl="true"
    android:testOnly="true" android:theme="@style/AppTheme">
        <activity android:label="@string/app_name" android:name="pt.oposec.vulnapp.MainActivity" android:theme="@style/AppTheme.NoActionBar">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <activity android:exported="true" android:label="@string/title_activity_user" android:name="pt.oposec.vulnapp.UserActivity"
        android:theme="@style/AppTheme.NoActionBar"/>
    </application>
</manifest>
```

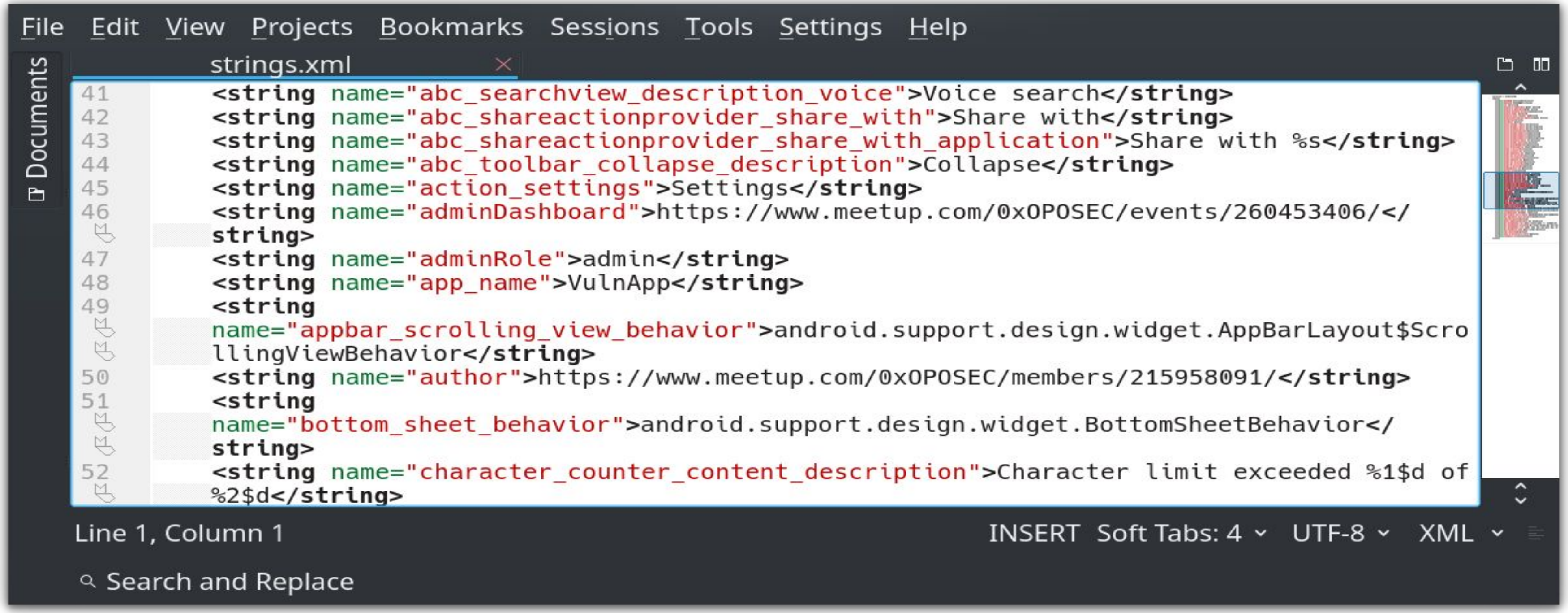
Line 12, Column 12 INSERT Soft Tabs: 4 UTF-8 XML

Search and Replace

VulnApp - Information left inside APK

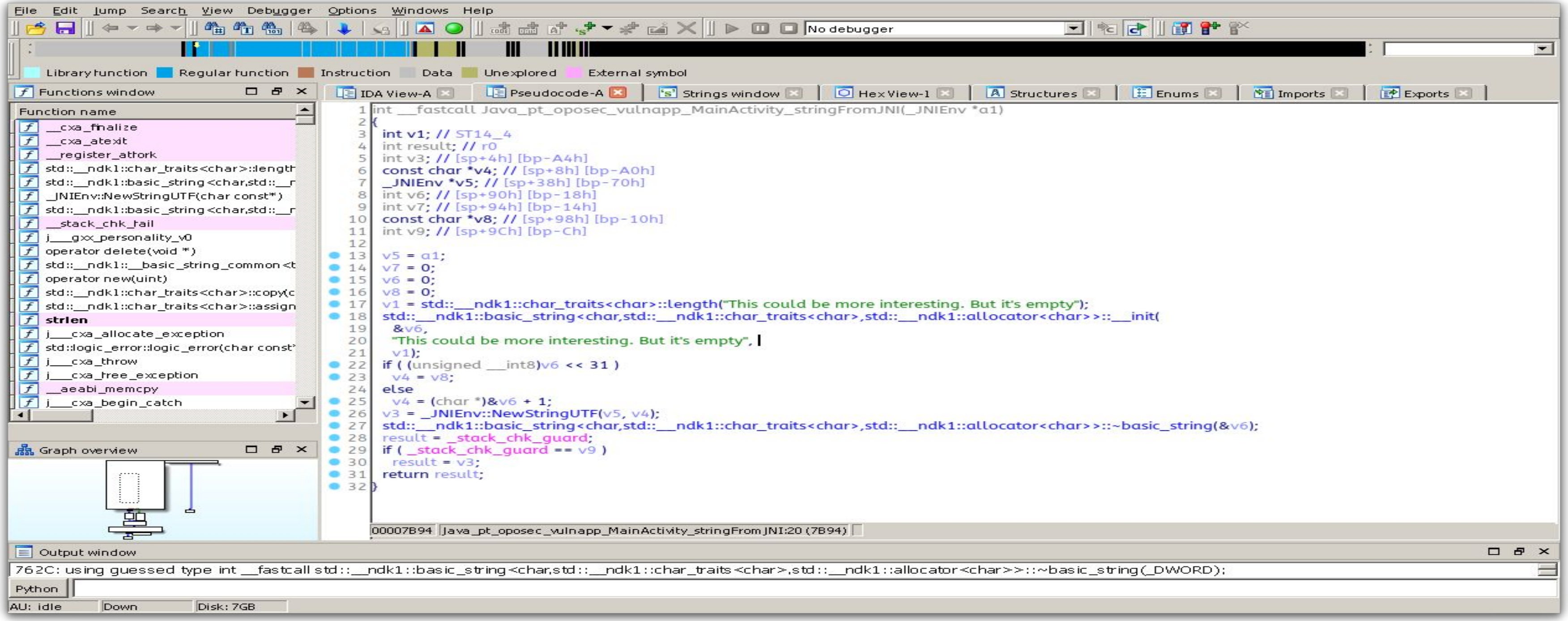


VulnApp - Information left inside APK

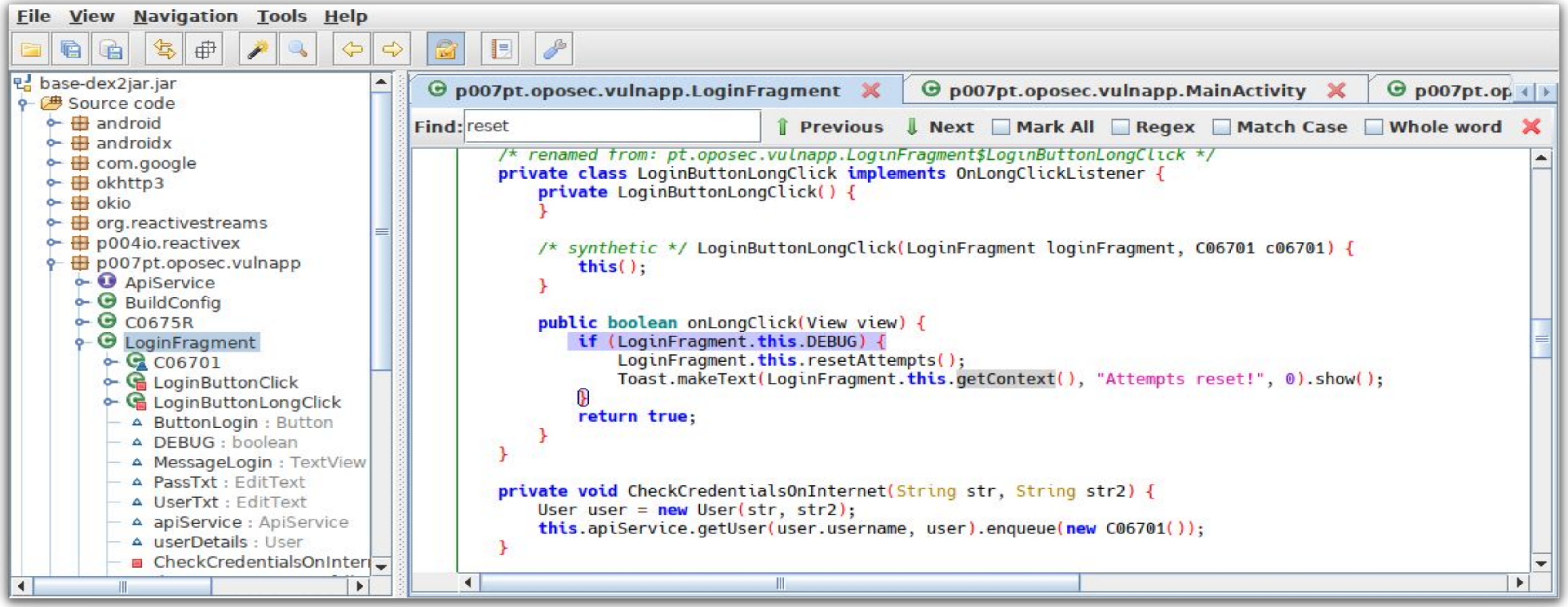



```xml
<string name="abc_searchview_description_voice">Voice search</string>
<string name="abc_shareactionprovider_share_with">Share with</string>
<string name="abc_shareactionprovider_share_with_application">Share with %s</string>
<string name="abc_toolbar_collapse_description">Collapse</string>
<string name="action_settings">Settings</string>
<string name="adminDashboard">https://www.meetup.com/0xOPOSEC/events/260453406/</string>
<string name="adminRole">admin</string>
<string name="app_name">VulnApp</string>
<string name="appbar_scrolling_view_behavior">android.support.design.widget.AppBarLayout$ScrollingViewBehavior</string>
<string name="author">https://www.meetup.com/0xOPOSEC/members/215958091/</string>
<string name="bottom_sheet_behavior">android.support.design.widget.BottomSheetBehavior</string>
<string name="character_counter_content_description">Character limit exceeded %1$d of %2$d</string>
```

VulnApp - Information left inside APK

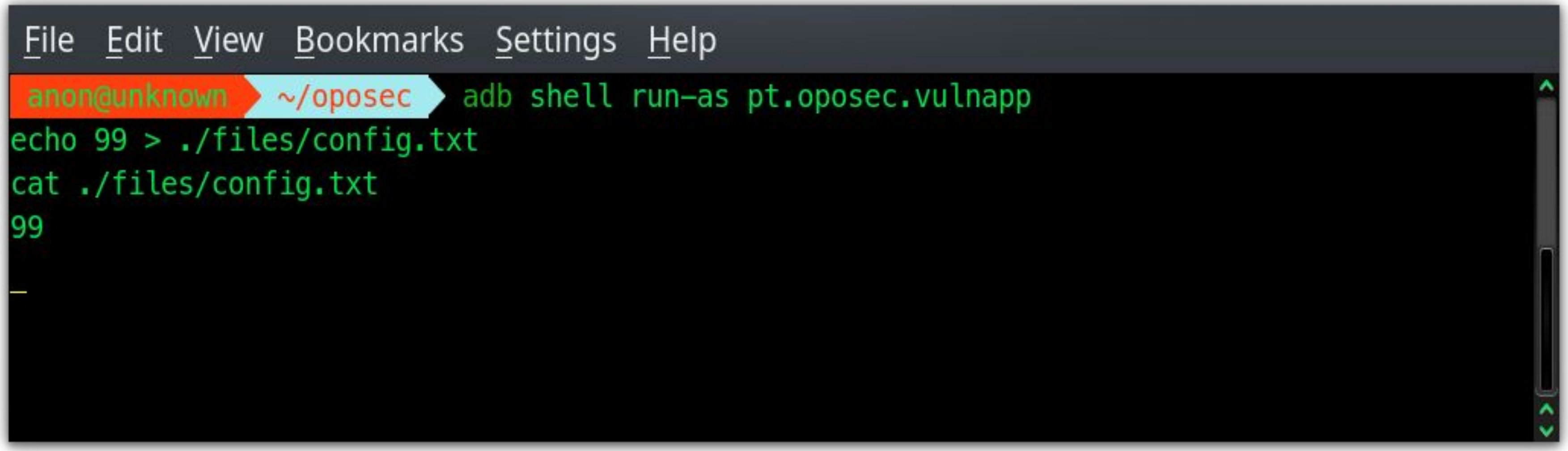


VulnApp - Dev features

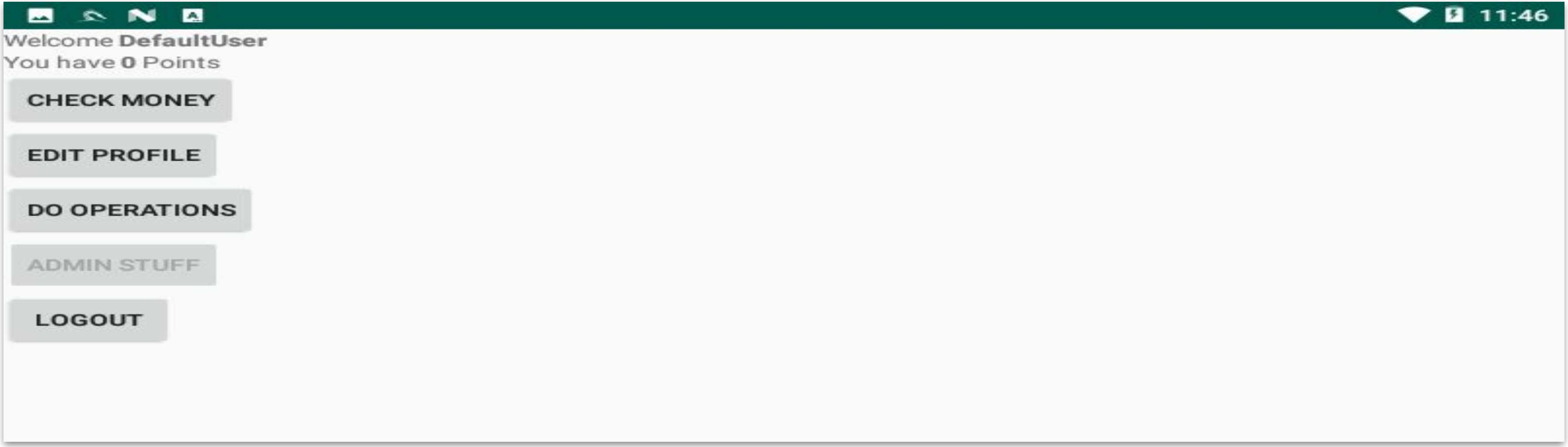


VulnApp - Debuggable Feature (1/2)

VulnApp - Debuggable Feature (2/2)



VulnApp - Exported Activity



adb shell am start -n pt.oposec.vulnapp/.UserActivity

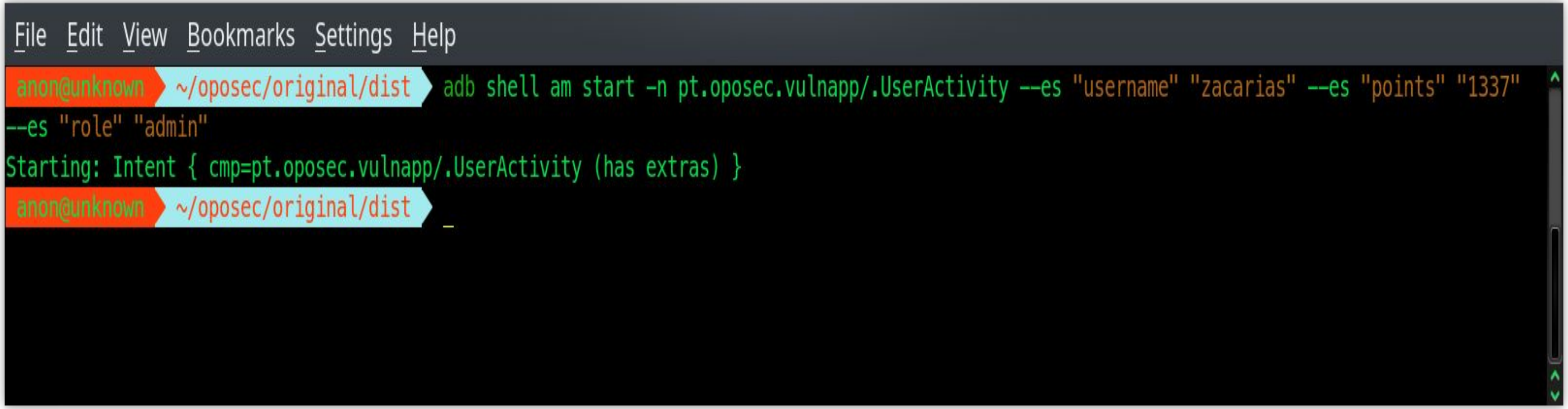
VulnApp - Backup/Restore Feature (1/2)

```
File  Edit  View  Bookmarks  Settings  Help
anon@unknown  ~/oposec  adb backup -f backup.ab pt.oposec.vulnapp
Now unlock your device and confirm the backup operation...
anon@unknown  ~/oposec  abe unpack backup.ab backup_opo.tar 123456
Calculated MK checksum (use UTF-8: true): 764D23C2736F81C0787764034E17492E27BDE03A3DDDF395A36B80B8A237A476
43% 53%
3584 bytes written to backup_opo.tar.
anon@unknown  ~/oposec  x backup_opo.tar
apps/pt.oposec.vulnapp/_manifest
apps/pt.oposec.vulnapp/f/config.txt
anon@unknown  ~/oposec  _
```

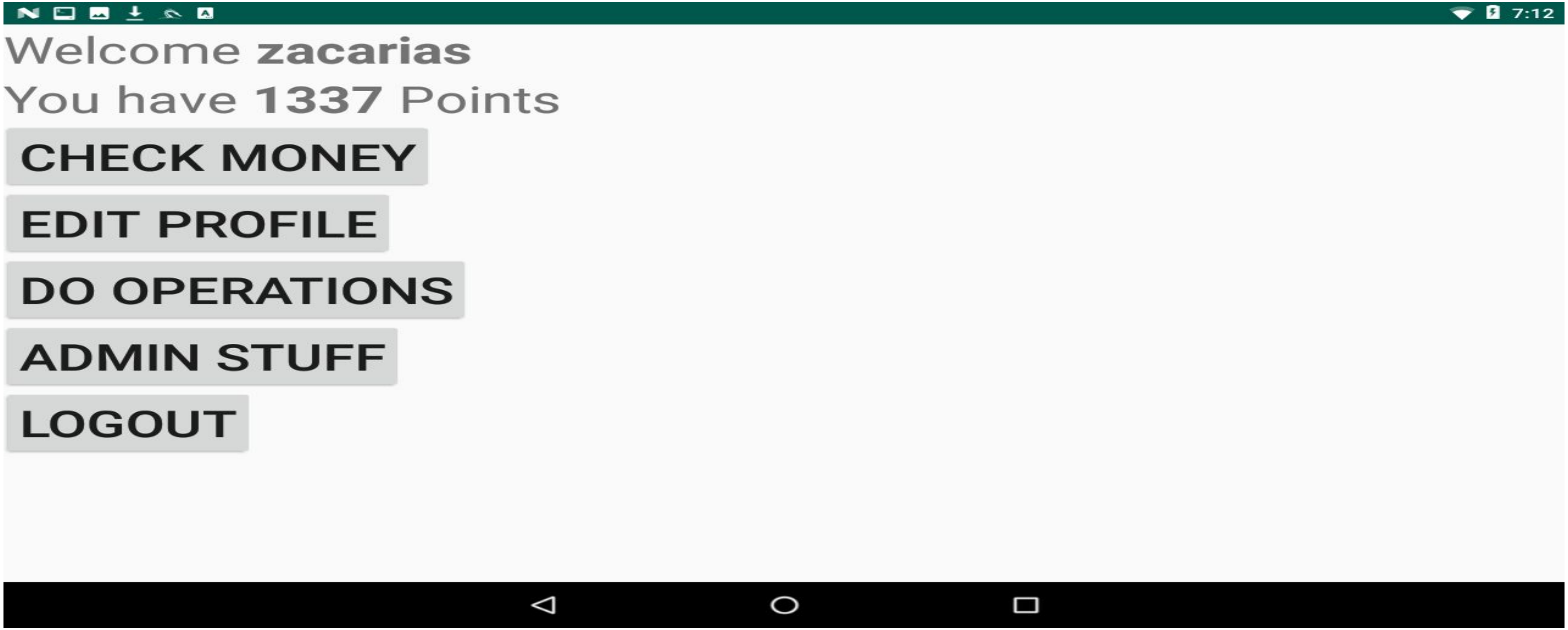
VulnApp - Backup/Restore Feature (2/2)

```
File  Edit  View  Bookmarks  Settings  Help
anon@unknown  ~/oposec  echo 99 > apps/pt.oposec.vulnapp/f/config.txt
anon@unknown  ~/oposec  tar -tf backup_opo.tar > backup_opo.list
anon@unknown  ~/oposec  cat backup_opo.list | grep pt.oposec.vulnapp > vulnapp.list
anon@unknown  ~/oposec  cat vulnapp.list | pax -wd > vulnapp.tar
anon@unknown  ~/oposec  abe pack vulnapp.tar vulnapp.ab 123456
10240 bytes written to vulnapp.ab.
anon@unknown  ~/oposec  adb restore vulnapp.ab
Now unlock your device and confirm the restore operation.
anon@unknown  ~/oposec  _
```

VulnApp - Exported Activity (1/2)



VulnApp - Exported Activity (2/2)



VulnApp - Patch & Recompile (1/2)

File Edit View Projects Bookmarks Sessions Tools Settings Help

Documents

LoginFragment...ngClick.smali

```

# virtual methods
.method public onLongClick(Landroid/view/View;)Z
    .locals 4
    .param p1, "v"    # Landroid/view/View;

    .line 238
    const-string v0, "I\'m a lazy dev, I leave debug features on my app"

    .line 239
    .local v0, "aaa":Ljava/lang/String;
    iget-object v1, p0, Lpt/oposec/vulnapp/LoginFragment$LoginButtonLongClick;->this$0:Lpt/oposec/vulnapp/LoginFragment;

    iget-boolean v1, v1, Lpt/oposec/vulnapp/LoginFragment;->DEBUG:Z

    #if-eqz v1, :cond_0

    .line 240
    iget-object v1, p0, Lpt/oposec/vulnapp/LoginFragment$LoginButtonLongClick;->this$0:Lpt/oposec/vulnapp/LoginFragment;

    invoke-static {v1}, Lpt/oposec/vulnapp/LoginFragment;->access$200(Lpt/oposec/vulnapp/LoginFragment;)V

    .line 241
    const-string v1, "Attempts reset!"

    .line 242
```

Line 62, Column 24

INSERT Soft Tabs: 4 UTF-8 Normal

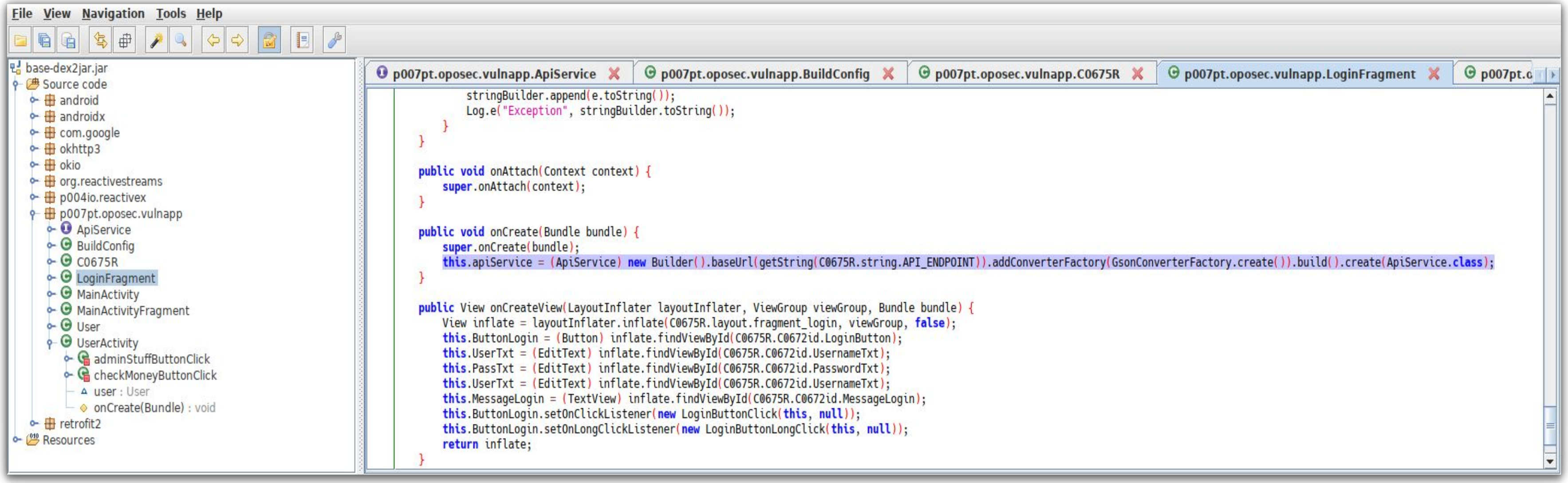
Search and Replace

VulnApp - Patch & Recompile (2/2)

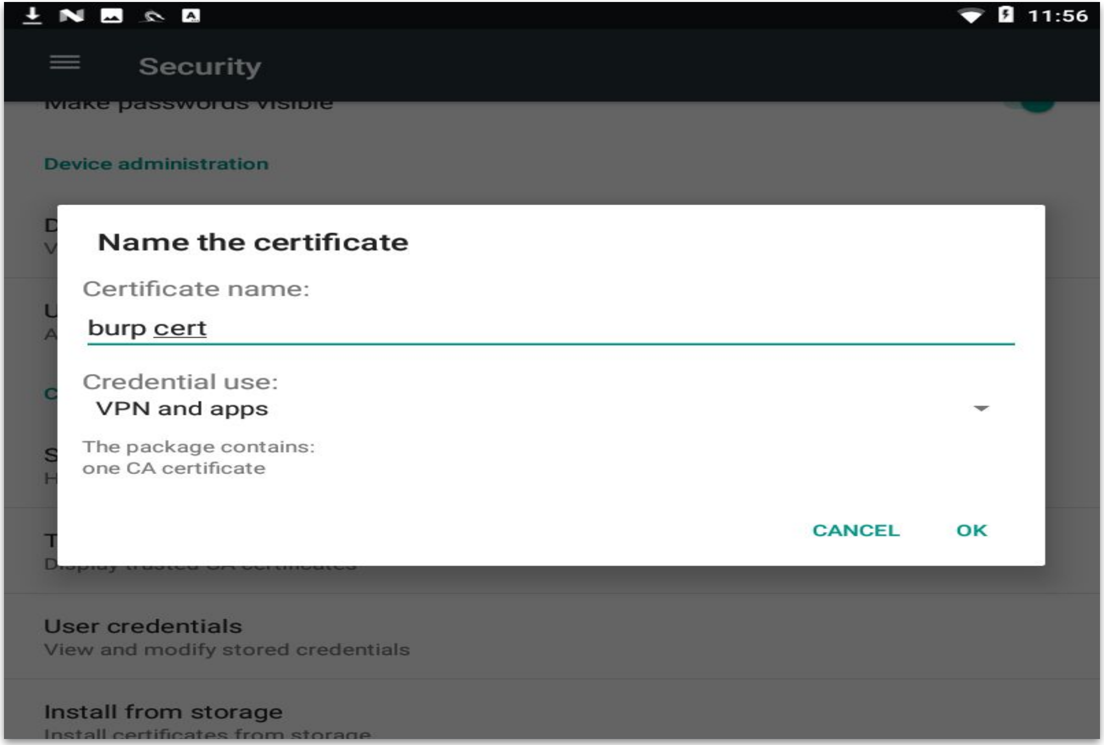
```
File  Edit  View  Bookmarks  Settings  Help
anon@unknown  ~/oposec  apktool b original
I: Using Apktool 2.3.4
I: Checking whether sources has changed...
I: Smaling smali folder into classes.dex...
I: Checking whether sources has changed...
I: Checking whether resources has changed...
I: Building apk file...
I: Copying unknown files/dir...
I: Built apk...
anon@unknown  ~/oposec  cd original/dist
anon@unknown  ~/oposec/original/dist  assina original.apk
jar signed.

Warning:
The signer's certificate is self-signed.
No -tsa or -tsacert is provided and this jar is not timestamped. Without a timestamp, users may not be able to validate this jar after
the signer certificate's expiration date (2045-01-01) or after any future revocation date.
anon@unknown  ~/oposec/original/dist  adb install original.apk
Success
anon@unknown  ~/oposec/original/dist  _
```

VulnApp - No certificate Pinning



Traffic Interception - Install CA must have SDK < 23



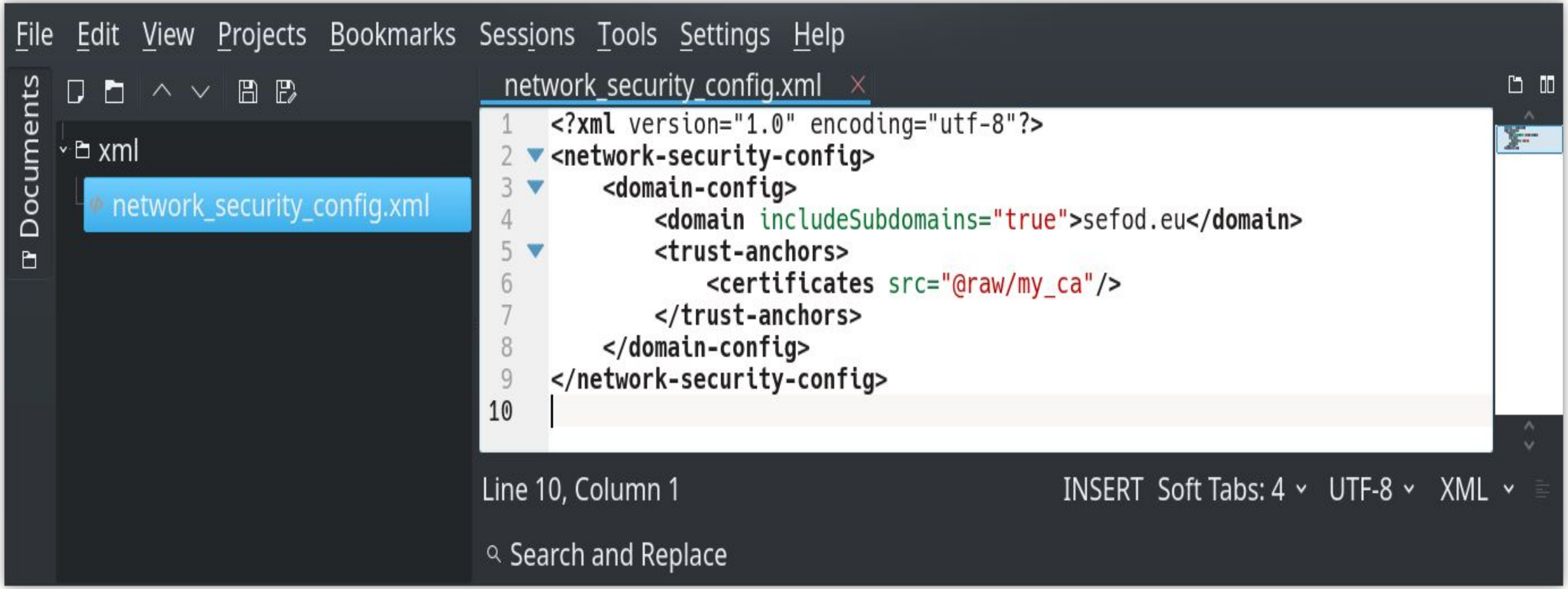
Traffic Interception - Install CA must have SDK >= 23 (1/4)

AndroidManifest.xml

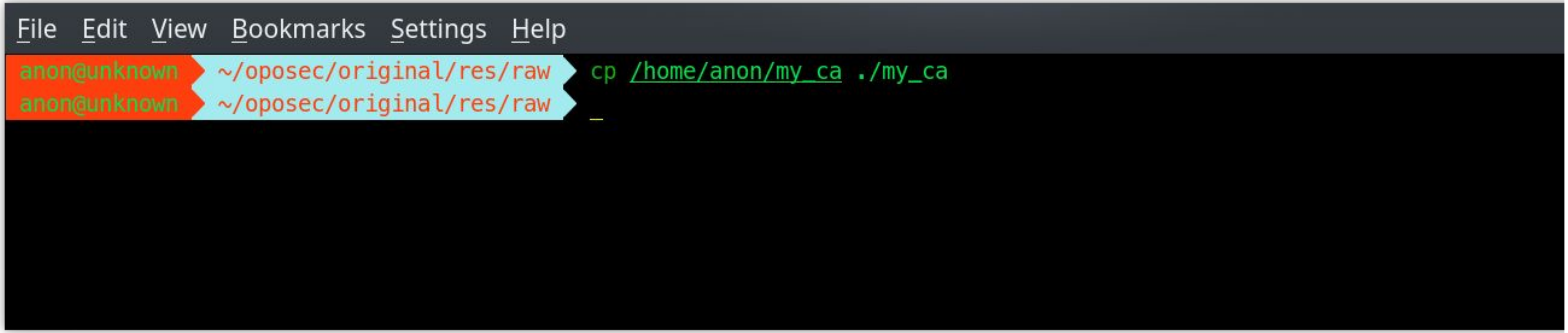
```xml
<?xml version="1.0" encoding="utf-8" standalone="no"?><manifest xmlns:android="http://schemas.android.com/apk/res/android"
android:compileSdkVersion="28" android:compileSdkVersionCodename="9" package="pt.oposec.vulnapp" platformBuildVersionCode="1"
platformBuildVersionName="1.0">
    <uses-permission android:name="android.permission.INTERNET"/>
    <application android:networkSecurityConfig="@xml/network_security_config" android:allowBackup="true"
    android:appComponentFactory="android.support.v4.app.CoreComponentFactory" android:debuggable="true" android:icon="@mipmap/
    ic_launcher" android:label="@string/app_name" android:roundIcon="@mipmap/ic_launcher_round" android:supportsRtl="true"
    android:theme="@style/AppTheme">
        <activity android:label="@string/app_name" android:name="pt.oposec.vulnapp.MainActivity" android:theme="@style/
        AppTheme.NoActionBar">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <activity android:exported="true" android:label="@string/title_activity_user" android:name="pt.oposec.vulnapp.UserActivity"
        android:theme="@style/AppTheme.NoActionBar"/>
    </application>
</manifest>
```

Line 3, Column 18 INSERT Soft Tabs: 4 UTF-8 XML

Traffic Interception - Install CA must have SDK >= 23 (2/4)



Traffic Interception - Install CA must have SDK >= 23 (3/4)



Traffic Interception - Install CA must have SDK >= 23 (4/4)

```
File  Edit  View  Bookmarks  Settings  Help
anon@unknown  ~/oposec  apktool b original
I: Using Apktool 2.3.4
I: Checking whether sources has changed...
I: Smaling smali folder into classes.dex...
I: Checking whether sources has changed...
I: Checking whether resources has changed...
I: Building apk file...
I: Copying unknown files/dir...
I: Built apk...
anon@unknown  ~/oposec  cd original/dist
anon@unknown  ~/oposec/original/dist  assina original.apk
jar signed.

Warning:
The signer's certificate is self-signed.
No -tsa or -tsacert is provided and this jar is not timestamped. Without a timestamp, users may not be able to validate this jar after
the signer certificate's expiration date (2045-01-01) or after any future revocation date.
anon@unknown  ~/oposec/original/dist  adb install original.apk
Success
anon@unknown  ~/oposec/original/dist  _
```

OWASP - Mobile Top 10 2016

- M1-Improper Platform Usage
- M2-Insecure Data Storage
- M3-Insecure Communication
- M4-Insecure Authentication
- M5-Insufficient Cryptography
- M6-Insecure Authorization
- M7-Poor Code Quality
- M8-Code Tampering
- M9-Reverse Engineering
- M10-Extraneous Functionality

OWASP
Open Web Application
Security Project

Other Resources

- Qark - https://github.com/linkedin/qark
- Drozer - https://github.com/mwrlabs/drozer
- Frida - https://github.com/frida/
- Android-security-awesome - https://github.com/ashishb/android-security-awesome
- OWASP ASVS - https://www.owasp.org/index.php/Category:OWASP_Application_Security_Verification_Standard_Project
- OWASP Mob Testing Guide - https://www.owasp.org/index.php/OWASP_Mobile_Security_Testing_Guide

END