

NullSpy

Where did this null come from ?

SCG Bachelor Project

Lina Tran

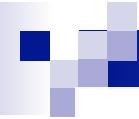
20.12.2016

```
9 public class Ideone {
10
11     public static List<Integer> numbers;
12     public static BufferedReader reader;
13
14*    public static void main(String[] args) {
15        makeReader();
16        readNumbers();
17        closeReader();
18        System.out.println(numbers);
19    }
20
21*    private static void makeReader() {
22        try {
23            reader = new BufferedReader(new FileReader(new File("file.txt")));
24        } catch (FileNotFoundException e) {
25            reader = null;
26        }
27    }
28
29*    private static List<Integer> readNumbers() {□
30
31    private static void closeReader() {
32        try {
33            reader.close();
34        } catch (IOException e) {
35            e.printStackTrace();
36        }
37    }
38}
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```
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11     public static List<Integer> numbers;  
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14*    public static void main(String[] args) {  
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18        System.out.println(numbers);  
19    }  
20    private static void makeReader() {  
21        try {  
22            reader = new BufferedReader(new  
23                InputStreamReader(  
24                    new FileInputStream("numbers.txt")));  
25        } catch (FileNotFoundException e) {  
26            reader = null;  
27        }  
28    }  
29*    private static List<Integer> readNumbers() {  
30        List<Integer> numbers = new ArrayList<Integer>();  
31        String line;  
32        try {  
33            while ((line = reader.readLine()) != null) {  
34                numbers.add(Integer.parseInt(line));  
35            }  
36        } catch (IOException e) {  
37            e.printStackTrace();  
38        }  
39    }  
40    private static void closeReader() {  
41        try {  
42            reader.close();  
43        } catch (IOException e) {  
44            e.printStackTrace();  
45        }  
46    }  
47}  
48}  
49 }
```

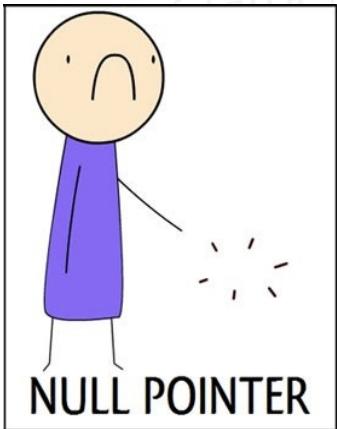
Exception in thread "main" java.lang.NullPointerException
at Ideone.closeReader(Ideone.java:44)
at Ideone.main(Ideone.java:17)

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36        }
37    }
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```

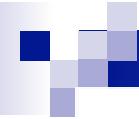


```
 9 public class Ideone {  
10  
11     public static List<Integer> numbers;  
12     public static BufferedReader reader;  
13  
14     public static void main(String[] args) {  
15         add();  
16         readNumbers();  
17         closeReader();  
18         System.out.println(numbers);  
19     }  
20  
21     private static void add() {  
22         try {  
23             reader = new BufferedReader(new FileReader(new File("file.txt")));  
24         } catch (FileNotFoundException e) {  
25             reader = null;  
26         }  
27     }  
28  
29     public static List<Integer> readNumbers() {  
30         return numbers;  
31     }  
32  
33     public static void closeReader() {  
34         if (reader != null) {  
35             try {  
36                 reader.close();  
37             } catch (IOException e) {  
38                 e.printStackTrace();  
39             }  
40         }  
41     }  
42  
43     public static void main(String[] args) {  
44         Ideone ideone = new Ideone();  
45         ideone.readNumbers();  
46         ideone.closeReader();  
47     }  
48 }  
49 }
```

Where is the variable *reader* assigned null ?



The illustration shows a simple cartoon character with a yellow oval head and a purple rectangular body. A speech bubble originates from the character's mouth, pointing towards the word "NULL POINTER" which is enclosed in a black-bordered box at the bottom left.



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NullSpy

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Field this.reader at line 25 is null: (Ideone.java:25)  
Exception in thread "main" java.lang.NullPointerException  
        at Ideone.closeReader(Ideone.java:44)  
        at Ideone.main(Ideone.java:17)  
25            reader = null;  
26        }  
27    }  
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29*    private static List<Integer> readNumbers() {  
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```



- Bytecode
- High level overview
- Process flow
- Validation
- Demo



■ **Bytecode**

- High level overview
- Process flow
- Validation
- Demo



Bytecode

```
4 public void say() {  
5     String result = hello;  
6     System.out.println(result);  
7 }
```

```
public void say();  
0  aload_0 [this]  
1  getfield HelloWorld.hello : java.lang.String [14]  
4  astore_1 [result]  
5  getstatic java.lang.System.out : java.io.PrintStream [21]  
8  aload_1 [result]  
9  invokevirtual java.io.PrintStream.println(java.lang.String) :  
    void [27]  
12 return  
Line numbers:  
    [pc: 0, line: 5]  
    [pc: 5, line: 6]  
    [pc: 12, line: 7]  
Local variable table:  
    [pc: 0, pc: 13] local: this index: 0 type: HelloWorld  
    [pc: 5, pc: 13] local: result index: 1 type: java.lang.  
        String
```

- Bytecode

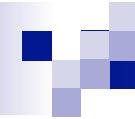
■ **High level overview**

- Process flow

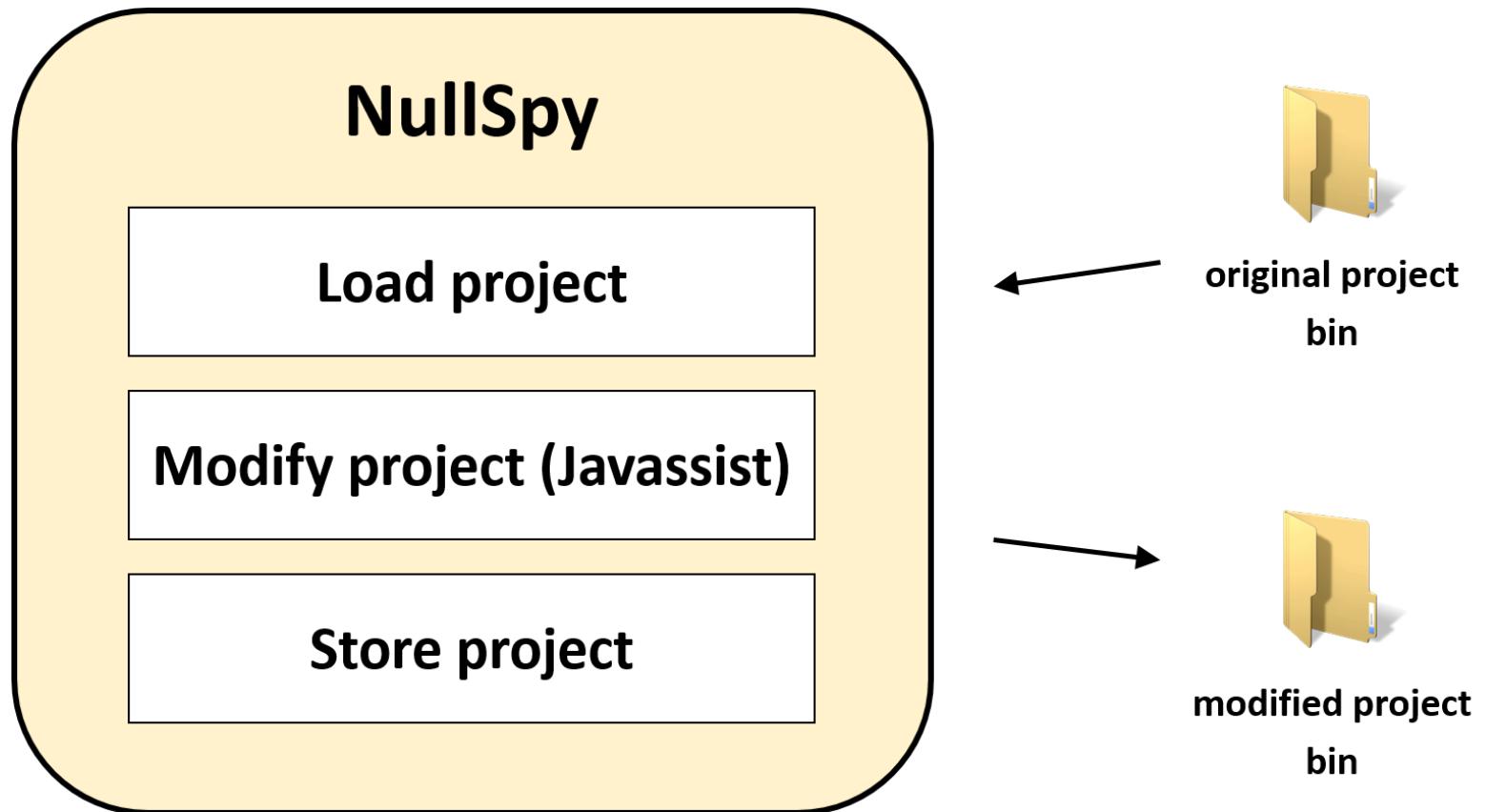
- Validation

- Demo



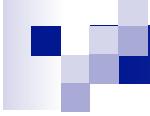


High level overview

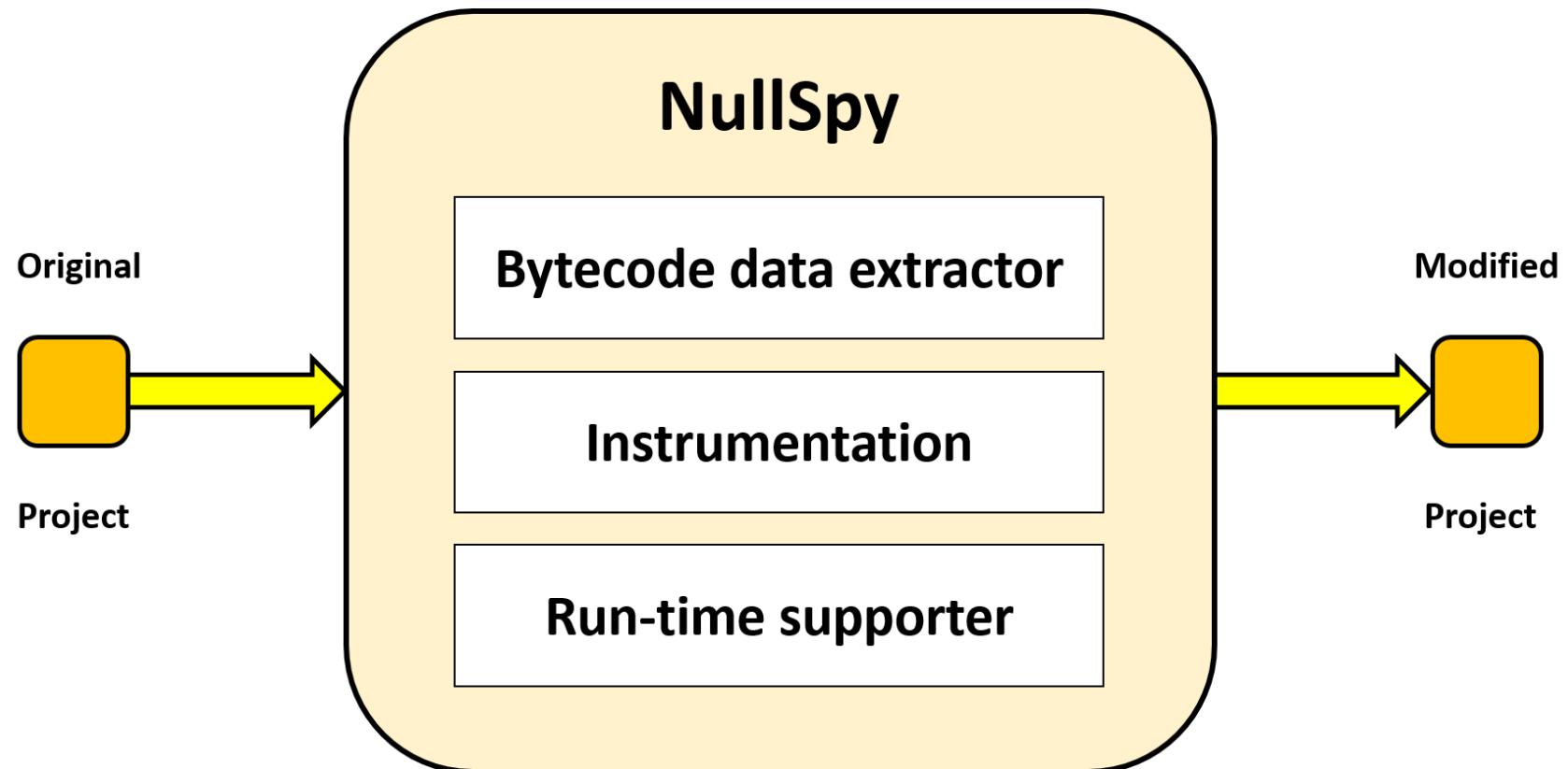


- Bytecode
- High level overview
- Process flow**
- Validation
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Process flow



1. Extract information about

1. Target variable
2. Variable assignment

2. Instrumentation

1. Variable assignment
2. Wrap «Main()» method with
try-catch-block

3. Add run-time supporter package

“Target variable”

```
public class DrawApplication {  
  
    private ToolButton fToolBar;  
  
    protected void open(final DrawingView newDrawingView) {  
        ...  
        fToolBar.tool();                      // field access  
        fToolBar.myIcon.toString();           // field access  
  
        JPanel activePanel = ...;  
        activePanel.add((Component) getDesktop(), BorderLayout.CENTER);  
            // local variable as a target variable  
        ...  
    }  
}
```

- Insert our bytecode after each variable assignment

```
JPanel activePanel = ...;
activePanel.add( (Component) getDesktop() ,BorderLayout.CENTER);
    DrawApplication", "open", "(Lorg/jhotdraw/framework/
    DrawingView;)V", "localVariable_3", "activePanel", "Ljavax/
    swing/JPanel;", activePanel, 3, 254, 136, 143, 144);
activePanel.add( (Component) getDesktop() ,BorderLayout.CENTER);
```

- **Catch-block of «Main()» method:**

- Extract information from NPE stack trace
- Identifier comparisons
- Adds direct “link” to null assignment of NPE culprit variable

```
Field this.reader at line 25 is null: (Ideone.java:25)
Exception in thread "main" java.lang.NullPointerException
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- Process flow
- Validation**
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- **JHotDraw**
 - GUI framework for technical and structured Graphics
- **Execution time difference**
 - JHotDraw tests
 - Time: ~7.20s → ~7.57s

~5%

- Bytecode
- High level overview
- Process flow
- Validation
- **Demo**



Summarize

1. Load original class files
2. Extract information about
 1. Target variable
 2. Variable assignment
3. Instrumentation
4. Add run-time supporter package
5. Store modified class files



Original class files

```
public void say() {
    0  aload_0 [this]
    1  getfield HelloWord.hello : java.lang.String [14]
    4  astore_1 [result]
    5  getstatic java.lang.System.out : java.io.PrintStream [21]
    8  aload_1 [result]
    9  invokevirtual java.io.PrintStream.println(java.lang.String) :
        void [27]
   12  return
Line numbers:
  [pc: 0, line: 5]
  [pc: 5, line: 6]
  [pc: 12, line: 7]
Local variable table:
  [pc: 6, pc: 13] local: this index: 0 type: HelloWorld
  [pc: 5, pc: 13] local: result index: 1 type: java.lang.String
```

Javassist

```
| JPanel activePanel = ...;
activePanel.add((Component)getDesktop(),BorderLayout.CENTER);
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activePanel.add((Component)getDesktop(),BorderLayout.CENTER);
```



Run-time supporter



Modified class files

```
Field this.reader at line 25 is null: (Ideone.java:25)
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  at Ideone.closeReader(Ideone.java:44)
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