

软件测试与质量保证

5.1 智能化的软件测试

张宇霞 副研究员



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软件测试碰上人工智能

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基于智能技术的软件测试

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■ 人工智能

- 人工智能是研究、开发用于模拟、延伸和扩展人的智能的理论、方法、技术及应用系统的一门新的技术科学。

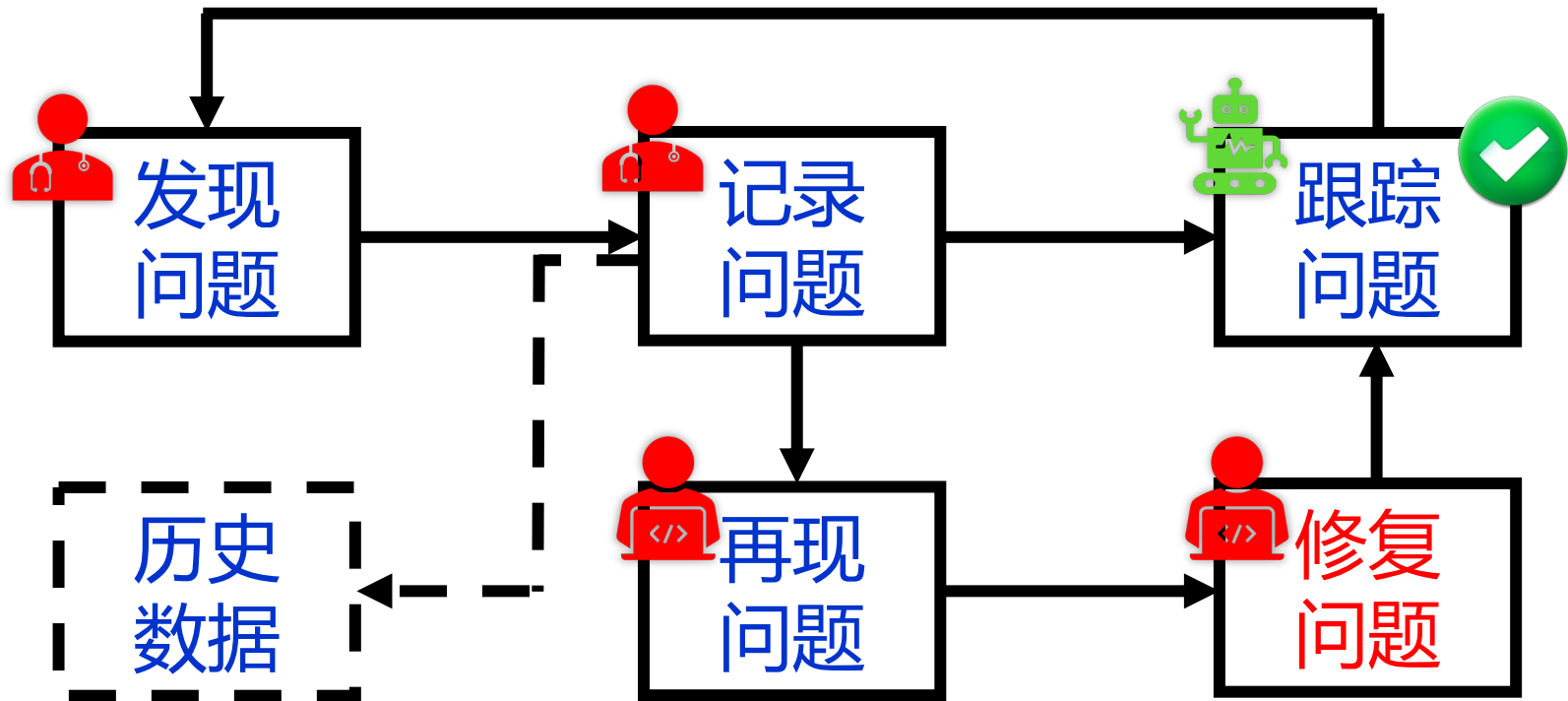


■ 软件测试

➤ 软件测试是发现并指出软件中存在缺陷的过程。



■ 软件测试面临的困难和挑战



■ 如何利用人工智能实现测试自动化

- 自动判定测试运行结果的对错
- 自动验证测试报告
- 挑选测试报告
- 进行程序修复



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基于智能技术的软件测试

■如何自动判定测试用例运行结果对错

- 设计测试用例
- 运行测试用例
- 判定测试用例是否通过

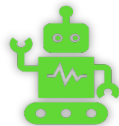


■如何自动判定测试用例运行结果对错

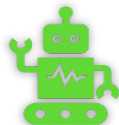
➤ 设计测试用例



➤ 运行测试用例



➤ 判定测试用例是否通过



//手工编写测试类

```
import static org.junit.Assert.assertEquals;
import org.junit.Test;
public class CalculatorTest {
    Calculator cal=new Calculator();
    @Test
    public void testAdd ()
    {
        System.out.println("JUnit测试");
        assertEquals(3,cal.add(1,2));
    }
}
```



■如何自动判定测试用例运行结果对错

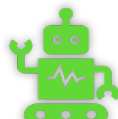
➤ 设计测试用例



➤ 运行测试用例



➤ 判定测试用例是否通过



//自动生成测试类

```
import static org.junit.Assert.assertEquals;
import org.junit.Test;
public class CalculatorTest {
    Calculator cal=new Calculator();
    @Test
    public void testAdd ()
    {
        System.out.println("JUnit测试");
        cal.add(1,2);
    }
}
```



■如何自动判定测试用例运行结果对错

➤ 蜕变测试

$\text{add}(n,m)=?$

$\text{add}(n,m) < \text{add}(n+1,m)$

$\text{Assert}(\text{cal.add}(1,2) - \text{add}(2,2) < 0)$

$\text{Assert}(\text{cal.add}(1,2) == \text{add}(2,1))$

//自动生成测试类

```
import static org.junit.Assert.assertEquals;
import org.junit.Test;
public class CalculatorTest {
    Calculator cal=new Calculator();
    @Test
    public void testAdd ()
    {
        System.out.println("JUnit测试");
        cal.add(1,2);
    }
}
```



■如何自动判定测试用例运行结果对错

➤ 常识

姓名：张三

姓名：1234



■如何自动验证错误报告

Mon Sep 14 2020 02:23:50 PDT

Component: about:logins Product: Firefox Resolution: ---

124 bugs found.

ID	Type	Summary	Product	Comp	Assignee▲	Status▲	Resolution
1636466	⚙️	Show passwords in about:logins asks for wrong Windows credentials (smart card instead of user-password)	Firefox	about:logins	nobody	UNCO	---
1658766	⚙️	Page load for about:logins is slow on Windows	Firefox	about:logins	nobody	UNCO	---
1324394	+	Allow origins to be edited in the Password Manager	Firefox	about:logins	nobody	UNCO	---
1567822	+	about:logins should re-use an already open tab	Firefox	about:logins	nobody	UNCO	---
1604642	+	about:logins "Sort by: Name (A-Z)" sorts by domain name only -- should then sort by login A-Z within each domain	Firefox	about:logins	nobody	UNCO	---
1617658	+	When searching about:logins, select and show the search results' first login.	Firefox	about:logins	nobody	UNCO	---
524899	⚙️	Firefox should ask for master password when viewing list of sites for which passwords are saved	Firefox	about:logins	nobody	UNCO	---
1599910	+	Lockwise - Do filter based in opened page when open the tool from browser hamburger menu	Firefox	about:logins	nobody	UNCO	---
1651061	+	Record `auto_admin` and `require_signon` macOS equivalents for pwmgr.reauthenticate telemetry	Firefox	about:logins	nobody	UNCO	---
1649940	+	Login CSV import report / log page	Firefox	about:logins	nobody	NFW	---



■如何自动验证错误报告

Description

When I edit any of the preferences for lawnchair, then go back to its home screen, icons and widgets are gone. #step #oracle They cannot be restored using the save/restore tool. #step #oracle

Expected Behavior

The home screen setup should be remembered. #oracle

Actual Behavior

All icons are gone. #oracle

Steps to Reproduce

See description

tianxiaogu commented on Nov 1, 2017

Reproduced in Android Studio Emulator and Android Nexus 5 Phone (6.0.1)

Steps:

1. Install v1.4 from FDroid.
2. Launch app.
3. Disable `automatically refresh`
4. Change server address to an invalid one, e.g., `xyyyzz`.
5. Click `refresh`.



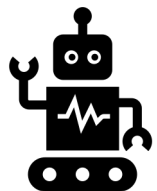
■如何自动验证错误报告

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Steps:

1. Install v1.4 from FDroid.
2. Launch app.
3. Disable automatically refresh
4. Change server address to an invalid one, e.g., xxyyzz.
5. Click refresh.



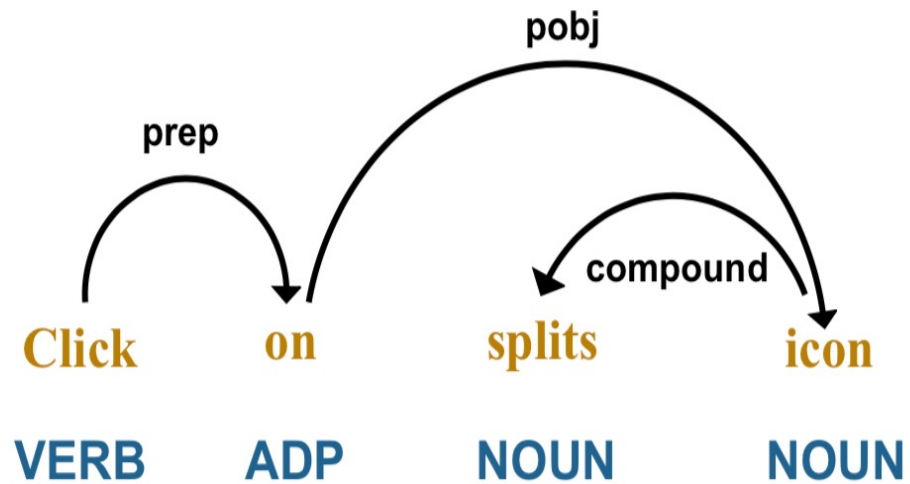
```
//自动生成测试类
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import org.junit.Test;
public class CalculatorTest {
    Calculator cal=new Calculator();
    @Test
    public void testAdd ()
    {
        System.out.println("JUnit测试");
        cal.add(1,2);
    }
}
```



click refresh



■如何自动验证错误报告



■如何自动验证错误报告

1. **Select** the second tab on the Bottom Navigation View;
2. **Click** the button with the text 'Click Me';
3. **Press** the hardware back button

click



■如何自动验证错误报告

2. Build project with Debug then with Release variant
3. Changed Device language to Arabic language that

1. Diff from 61.1 -> 0.62
2. Change app name in settings

2. Notice that scrolling in the list works fine
3. Change orientation a few times

change



■如何挑选测试报告

Mon Sep 14 2020 02:23:50 PDT

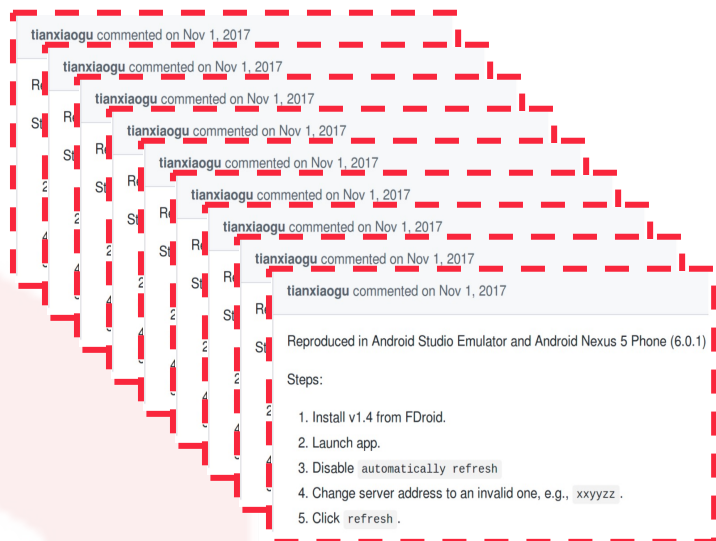
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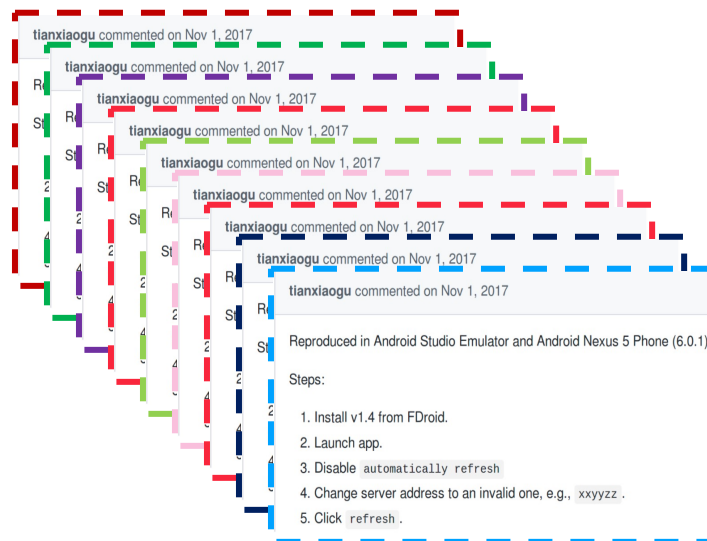
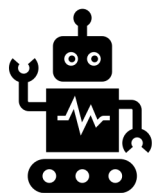
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1649940	+	Login CSV import report / log page	Firefox	about:logins	nobody	NFW	---



■如何挑选测试报告



SVM
CNN
LSTM
贝叶斯
逻辑回归



■如何自动修复软件缺陷

- 通过测试用例获知软件有缺陷
- 通过分析测试用例进行错误定位
- 如何修复可疑语句？



■如何自动修复软件缺陷

➤ 随机大法（基于变异的修复方法）

```
1 package dubo;
2 public class Triangle {
3     public TriType ReturnTriangleType(int x, int y, int z) {
4         if (x >= y + z)
5             return TriType.noTriangle;
6         if (y >= x + z)
7             return TriType.noTriangle;
8         if (z >= x + y)
9             return TriType.noTriangle;
10        if (x >= y)
11            if (x == z)
12                return TriType.equilateralTriangle;
13            else
14                return TriType.isoscelesTriangle;
15        else if (y == z)
16            return TriType.isoscelesTriangle;
17        else if (x == z)
18            return TriType.isoscelesTriangle;
19        else
20            return TriType.triangle;
21    }
22    public static void main(String[] args) {
23        // TODO Auto-generated method stub
24        Triangle tri=new Triangle();
25        TriType type=tri.ReturnTriangleType(12, 10, 15);
26        System.out.println(type.toString());
27    }
28 }
29 }|
30 enum TriType {
31     equilateralTriangle, isoscelesTriangle, triangle, noTriangle
32 }
33 }
```

Problems Javadoc Declaration Search Console

<terminated> Triangle [Java Application] C:\Program Files\Java\jre1.8.0_251\bin\javaw.exe (2020年9月5日 11:11:11)
isoscelesTriangle

■基于变异的修复方法

- 变异算子：给定数学符号替换为其他数学符号
- 从本项目内部其他地方拷贝一个条件替换
- 从其他开源软件随机拷贝替换
- 基于测试用例验证补丁的有效性

```
1 package dubo;
2 public class Triangle {
3     public TriType ReturnTriangleType(int x, int y, int z) {
4         if (x >= y + z)
5             return TriType.noTriangle;
6         if (y >= x + z)
7             return TriType.noTriangle;
8         if (z >= x + y)
9             return TriType.noTriangle;
10        if (x >= y)
11            if (x == z)
12                return TriType.equilateralTriangle;
13            else
14                return TriType.isoscelesTriangle;
15        else if (y == z)
16            return TriType.isoscelesTriangle;
17        else if (x == z)
18            return TriType.isoscelesTriangle;
19        else
20            return TriType.triangle;
21    }
22    public static void main(String[] args) {
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24        Triangle tri=new Triangle();
25        TriType type=tri.ReturnTriangleType(12, 10, 15);
26        System.out.println(type.toString());
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28 }
29 }
30 enum TriType {
31     equilateralTriangle, isoscelesTriangle, triangle, noTriangle
32 }
33 }
```

Problems Javadoc Declaration Search Console

<terminated> Triangle [Java Application] C:\Program Files\Java\jre1.8.0_251\bin\javaw.exe (2020年9月5日 11:11:11)
isoscelesTriangle



■基于模式的修复

- 获取大量的程序缺陷以及补丁（修复代码）
- 利用数据挖掘/AI的方法学习缺陷修复的模式
- 给定一个缺陷，AI可预测该使用哪个修复模式

模式1：如果可疑语句是函数调用语句，那么可以替换其参数来修复



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软件测试面临诸多挑战

AI技术是解决软件测试难题的有效途径之一

AI技术已初步应用于测试结果判定、缺陷报告验证、缺陷自动修复等



谢谢

