ISCAS 中国科学院软件研究所学术年会’2023
暨计算机科学国家重点实验室开放周

科研奖励

**WOODPECKER** 全球总决赛冠军

# Woodpecker: Identifying and Fixing Android UI Display Issues
# 啄木鸟：自动化识别并修复移动应用程序的界面显示缺陷

Zhe Liu, ACM Student Research Grand Finalists Award - 1st Place
*In ACM Student Research Competition Grand Finalists (ACM SRC’23)*
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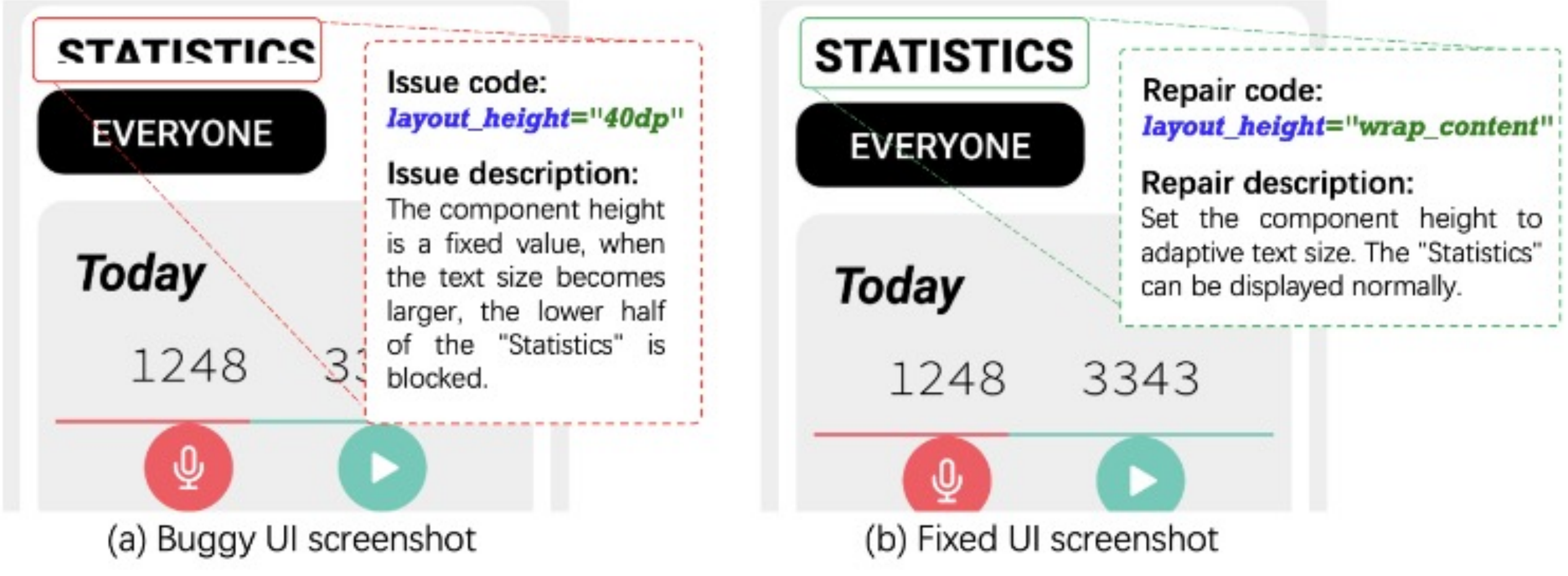
Demo video: *https://www.bilibili.com/video/BV1YS4y1p7mx*

## Background

- **Mobile Application**
  - *Focus on human computer interaction*
  - *Different screen resolution & device*
  - *UI issues impact on user experience*
  - *Manual testing cost is high*
- **Automated Testing & Repairing**
  - *Mainly functional testing*
  - *Spot critical crash bugs*
  - *Less attention on UI display issues*
  - *Cumbersome repair process*

## Motivation

- **Empirical Study of UI display issues**
  - *4,230 bug reports from Github*
  - *10 root causes of UI display issues*
  - *16 repair strategies of UI display issues*



**Issue code:**
*layout_height="40dp"*
**Issue description:**
The component height is a fixed value, when the text size becomes larger, the lower half of the "Statistics" is blocked.

**Repair code:**
*layout_height="wrap_content"*
**Repair description:**
Set the component height to adaptive text size. The "Statistics" can be displayed normally.

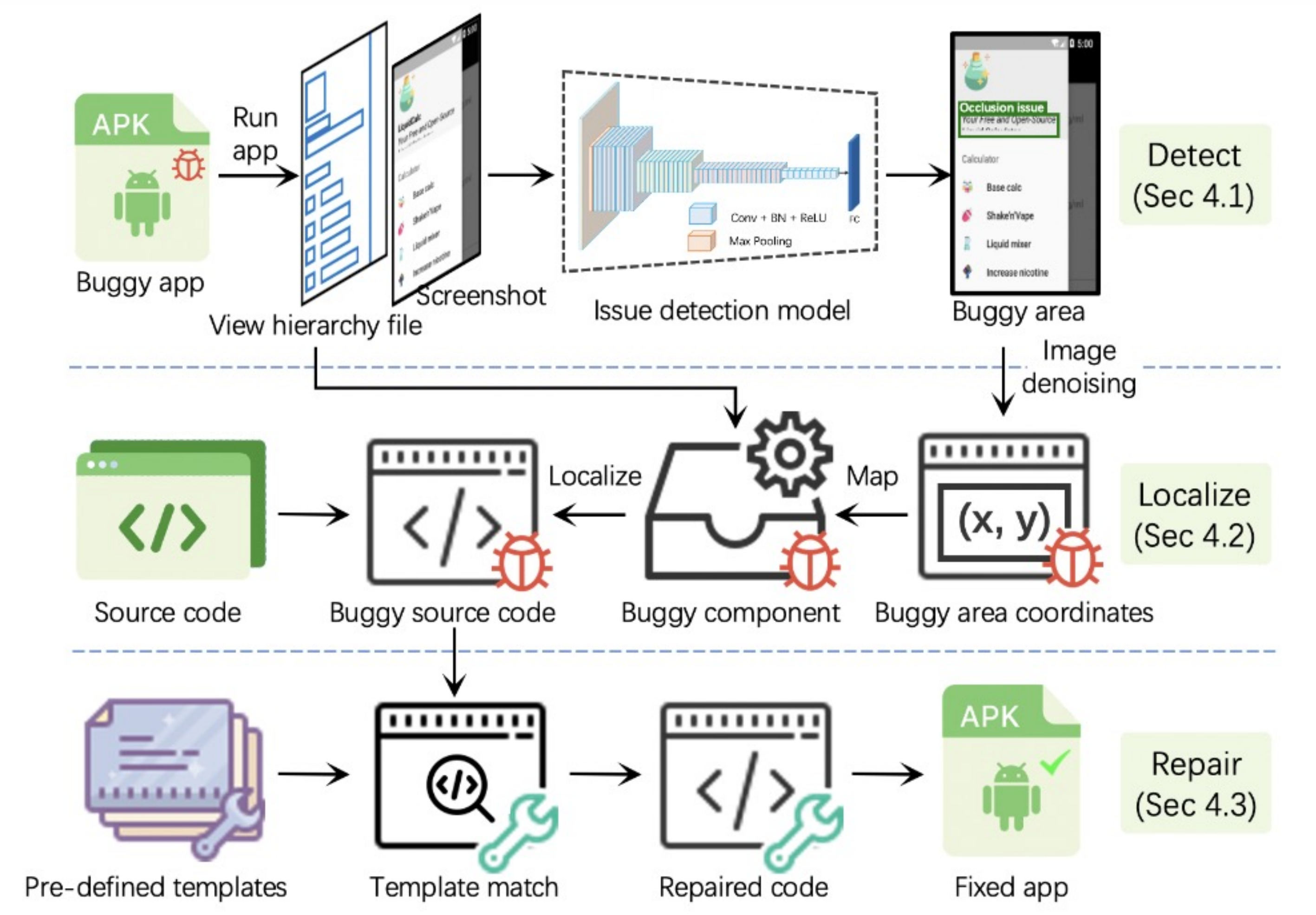
(a) Buggy UI screenshot　(b) Fixed UI screenshot

**Figure 2: Example of UI display issue repair**

## Approach

***Woodpecker*** *is an approach to automate the whole process to detect and repair UI display issues for reducing developers' burden. It can find the bugs from the screenshot and repair them, just likes the Woodpecker catches the bugs in the tree.*

- **Detect Issues in Screenshots**
  - *Feature extraction network*
  - *Regional proposal network*
  - *GAN-based training data generation approach*
- **Localize Issues in Source Code**
  - *Localize buggy component in the view hierarchy file*
  - *Localize buggy code snippet in the source code*
- **Repair Issues with Templates**
  - *Templates from our empirical study*
  - *9 repair Templates: Apply scroll view, Apply self-adjusting text setting, Apply adaptive boundary setting, Change pixel density, Turn on hardware acceleration, etc.*



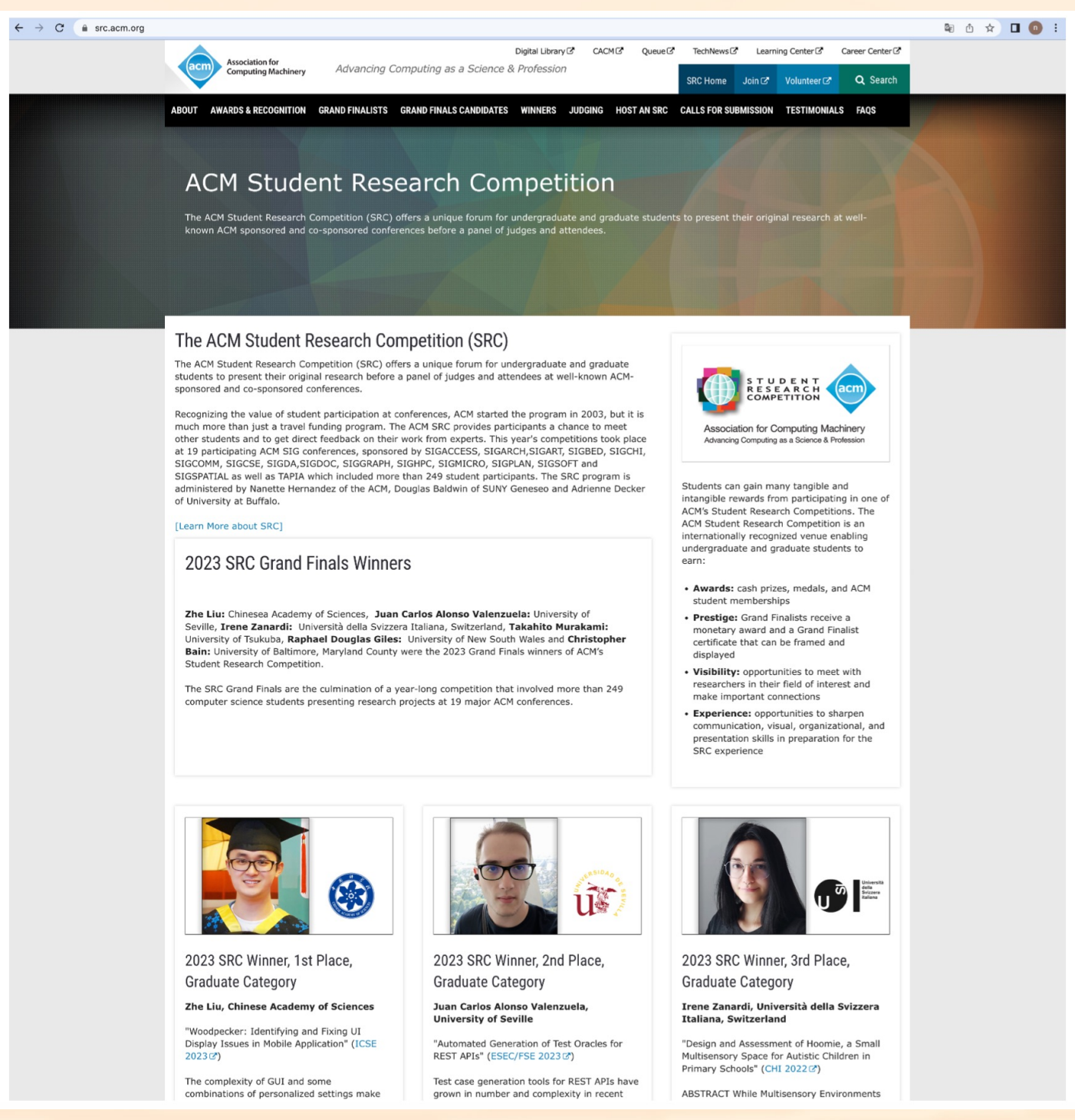
```
-    android:layout_width = "([\w\W]*)"
-    android:layout_height = "([\w\W]*)"
+    android:layout_width = "wrap_content"
+    android:layout_height = "wrap_content"
```

**Table 1: Samples of GitHub merged pull requests**

| No. | Commit ID | APP Name | Category | Version | Download |
|---|---|---|---|---|---|
| 1 | 8a76280 | AlarmClock | System | 3.09.01 | 1M+ |
| 2 | 37c437c | GPSLogger | Navig | 112 | 1M+ |
| 3 | 5482728 | Syncthing | Internet | 1.18.0 | 1M+ |
| 4 | 66c9c05 | J2MELoader | Game | 1.7.0 | 1M+ |
| 5 | 195b5ed | Openfood | Health | 3.6.8 | 1M+ |
| 6 | e5b359d | Goodtime | Time | 2.2.7 | 500K+ |
| 7 | 703a262 | PDFConverter | Media | 8.8.1 | 100K+ |
| 8 | 8767e55 | AppInt | Plugin | 1.6.0 | 100K+ |
| 9 | 85b1ea7 | Commons | Internet | 3.0.3 | 50K+ |
| 10 | 5a3fb30 | Openboard | System | 1.4.3 | 50K+ |
| 11 | eda6be6 | EVMap | Navig | 0.8.3 | 10K+ |
| 12 | 867b6e2 | Hendroid | Reading | 1.15.0 | 10K+ |
| 13 | 1eceeec | Minesweep | Games | 12.4.2 | 10K+ |
| 14 | d23ae3b | Democracy | Media | 4.2.0 | 10K+ |
| 15 | 757a286 | Easer | System | 0.8.2 | 10K+ |
| 16 | 9567661 | Watomatic | Internet | 1.2.0 | 10K+ |
| 17 | 5225479 | ChessClock | Games | 2.5.0 | 10K+ |
| 18 | e7a3b34 | Look4Sat | Science | 2.5.3 | 10K+ |
| 19 | 076f8e8 | Frost | Media | 2.1.2 | 10K+ |
| 20 | eb6cfb1 | Acrtions | Media | 2.0.0 | 10K+ |

## Evaluation

- **Effectiveness Evaluation**
  - ***Dataset:*** *30 issues from 30 open-source Android apps.*
  - ***Result:*** *detection as 87%, localization as 85%, repair as 91%.*
- **Usefulness Evaluation**
  - ***Dataset:*** *316 Android apps from F-droid and Google play*
  - ***Repair Result:*** *repair 116 (94%) new UI display issues and submit pull requests, 106 of them are merged, other are pending.*



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[Learn More about SRC]

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**Zhe Liu:** Chinesea Academy of Sciences, **Juan Carlos Alonso Valenzuela:** University of Seville, **Irene Zanardi:** Università della Svizzera Italiana, Switzerland, **Takahito Murakami:** University of Tsukuba, **Raphael Douglas Giles:** University of New South Wales and **Christopher Bain:** University of Baltimore, Maryland County were the 2023 Grand Finals winners of ACM's Student Research Competition.

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2023 SRC Winner, 1st Place, Graduate Category
**Zhe Liu, Chinese Academy of Sciences**
"Woodpecker: Identifying and Fixing UI Display Issues in Mobile Application" (ICSE 2023)
The complexity of GUI and some combinations of personalized settings make

2023 SRC Winner, 2nd Place, Graduate Category
**Juan Carlos Alonso Valenzuela, University of Seville**
"Automated Generation of Test Oracles for REST APIs" (ESEC/FSE 2023)
Test case generation tools for REST APIs have grown in number and complexity in recent

2023 SRC Winner, 3rd Place, Graduate Category
**Irene Zanardi, Università della Svizzera Italiana, Switzerland**
"Design and Assessment of Hoomie, a Small Multisensory Space for Autistic Children in Primary Schools" (CHI 2022)
ABSTRACT While Multisensory Environments

*Association for Computing Machinery*

*ACM Student Research Competition*
*Grand Finals 2023*
*Presented to*
*Zhe Liu*
*Chinese Academy of Sciences*
*First Place*
*Graduate*