

南京大学

计算机科学与技术系

软件工程实验报告

实验名称: GUI 测试代码修复

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实验地点: 基础实验楼乙区 208

实验时间: 2021.12.16 ~ 2021.12.18

一、 实验名称

GUI 测试代码修复

二、 实验目的

1、实验四编写的测试代码只能在开源 app 上运行，而不能在实验三修改后的开源 app 上运行。因此需要为实验三修改后的开源 app 生成相同语义的测试代码。

三、 实验要求

1、实验部分（三选一）

- (1) 使用助教提供的 app、测试代码完成实验并符合结果要求。可得 20 分。
- (2) 使用助教提供的 app，自行编写测试代码完成实验，符合 app、测试代码、结果的要求。可得 40 分。
- (3) 使用自己实验三修改的 app、实验四编写的测试代码完成实验，符合 app、测试代码、结果的要求。可得 60 分。

2、报告部分

- (1) 按照格式编写实验报告。可得 40 分。





四、 实验环境

1、软件：

testscript_repair_tool

Android 11.0 (Google APIs) x86_64

2、硬件：

Type	Name	Play Store	Resolution	API	Target	CPU/ABI	Size on Disk	Actions
	Pixel 2 API 30		1080 × 1920: 420dpi	30	Android 11.0 (Goo...	x86_64	9.5 GB	  

五、 实验内容

- 1、使用脚本修复工具为实验三修改的开源 app 修复测试代码
- 2、修复的测试代码与原代码对比
- 3、脚本修复工具的理解

六、 实验结果与说明

- 1、脚本修复工具的运行过程、输入、输出。

- ① 在虚拟环境下，输入修复工具运行指令

```
(venv_win64) C:\南\大三上\软件工程\实验\实验5\testscript_repair_tool\src>python .\Main.py -a SimpleExplorer -c sourceScript -r C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南瞳_SimpleExplorer -o C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南瞳_SimpleExplorer\SimpleExplorer_old.apk -n C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南瞳_SimpleExplorer\SimpleExplorer_new.apk -v 11 -l guider
```

- ② 卸载掉现有 app 并安装旧 app 后，开始第一个步骤：记录旧 app 中测试场景下的控件信息和过程截图

```
uninstall the existing app...
Success
process 1----record screenshot and element in the old version n
=====test case 0 start=====
waiting...

=====
test step 1 start
=====
test step 2 start
screen capture before test step 2
perform test step 2: el = driver.find_elements_by_id("com.dnielfe.manager:id/row_image")[0]
record test element x,y,w,h: 0,340,144,144
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
```

- ③ 第一个步骤结束

```
=====
test step 20 start
screen capture before test step 20
perform test step 20: el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")
record test element x,y,w,h: 828,73,126,126
=====
test step 21 start
=====test case 0 end=====
```

- ④ 卸载旧 app 并安装新 app 后开始第二个步骤：修复测试脚本，使其能在新 app 上正确运行

```
process 2----repair the broken tests in the updated version n+1; once the app is started, manually set the app into the target page.
```

```
uninstall the existing app...
```

```
Success
```

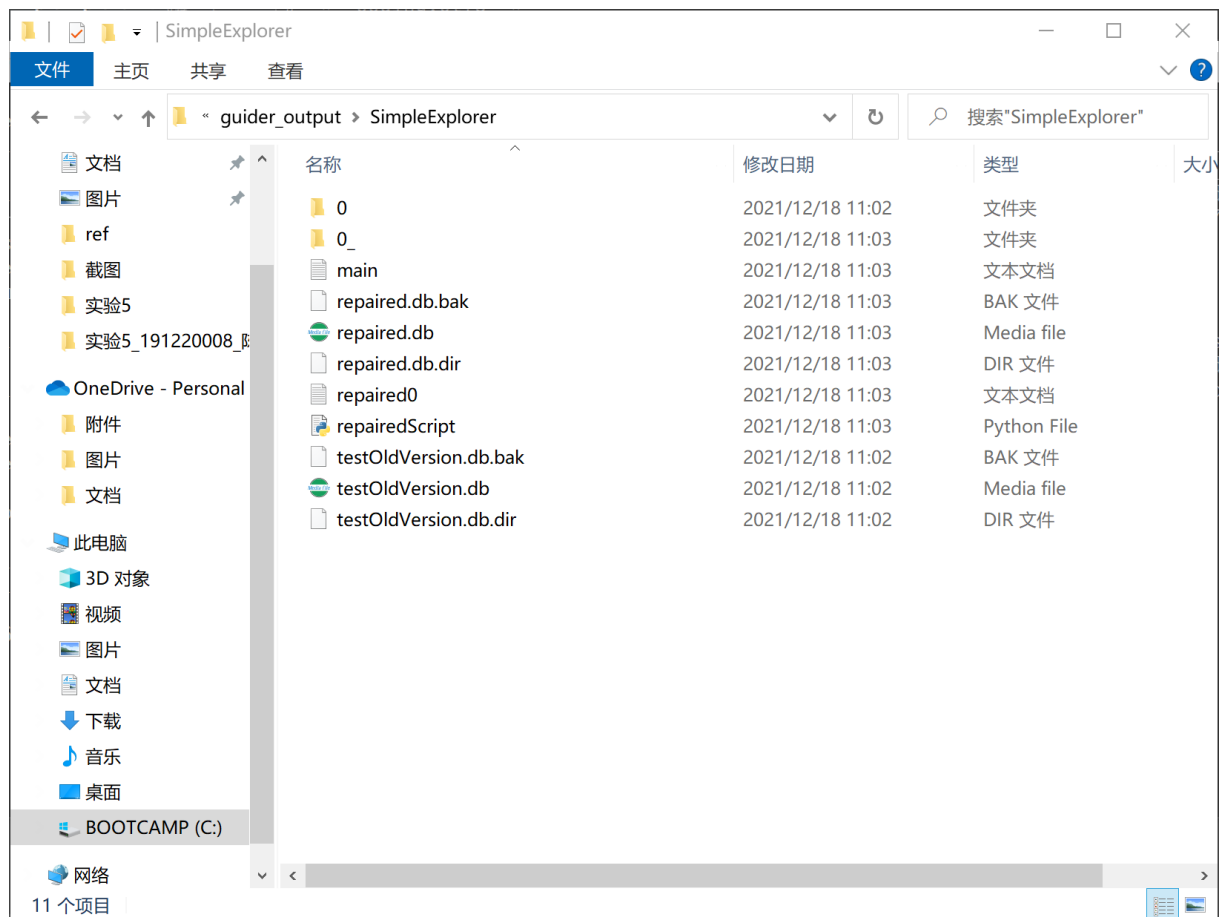
⑤ 开始修复

```
el = driver.find_element_by_id("com.dnielfe.manager:id/search")
('isChild', '[954,73][1080,199]', 'isSureMatch')
cannot find candidates!!!!!!
getCandidateByMatchType
True
[954,73][1080,199]
isSureMatch
targetElement :
{'index': 'l', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Search', 'resource-id': 'com.dnielfe.manager:id/search_modify', 'checkable': 'false', 'checked': 'false', 'clickable': 'true', 'enabled': 'true', 'focusable': 'true', 'focused': 'false', 'long-clickable': 'true', 'password': 'false', 'scrollable': 'false', 'selected': 'false', 'bounds': '[954,73][1080,199]', 'displayed': 'true', 'parent': None, 'x': 954, 'y': 73, 'w': 126, 'h': 126, 'classIndex': 2, 'idIndex': 0, 'content-descIndex': 0, 'textIndex': 10}
rid idName:com.dnielfe.manager:id/search
[2021-12-18 11:02:50] [INFO] candidate here is: {'index': 'l', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Search', 'resource-id': 'com.dnielfe.manager:id/search_modify', 'checkable': 'false', 'checked': 'false', 'clickable': 'true', 'enabled': 'true', 'focusable': 'true', 'focused': 'false', 'long-clickable': 'true', 'password': 'false', 'scrollable': 'false', 'selected': 'false', 'bounds': '[954,73][1080,199]', 'displayed': 'true', 'parent': None, 'x': 954, 'y': 73, 'w': 126, 'h': 126, 'classIndex': 2, 'idIndex': 0, 'content-descIndex': 0, 'textIndex': 10}
targetElement :
{'index': 'l', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Search', 'resource-id': 'com.dnielfe.manager:id/search_modify', 'checkable': 'false', 'checked': 'false', 'clickable': 'true', 'enabled': 'true', 'focusable': 'true', 'focused': 'false', 'long-clickable': 'true', 'password': 'false', 'scrollable': 'false', 'selected': 'false', 'bounds': '[954,73][1080,199]', 'displayed': 'true', 'parent': None, 'x': 954, 'y': 73, 'w': 126, 'h': 126, 'classIndex': 2, 'idIndex': 0, 'content-descIndex': 0, 'textIndex': 10}
rid idName:com.dnielfe.manager:id/search
[Deprecated] Please use 'find_element' with 'AppiumBy.ACCESSIBILITY_ID' instead.
isChecked
time.sleep(1)
```

⑥ 修复结束，输出成功修复的信息

```
[2021-12-18 11:03:42] [INFO] =====test case 0 is tried=====
[2021-12-18 11:03:42] [INFO] isRepaired: True
```

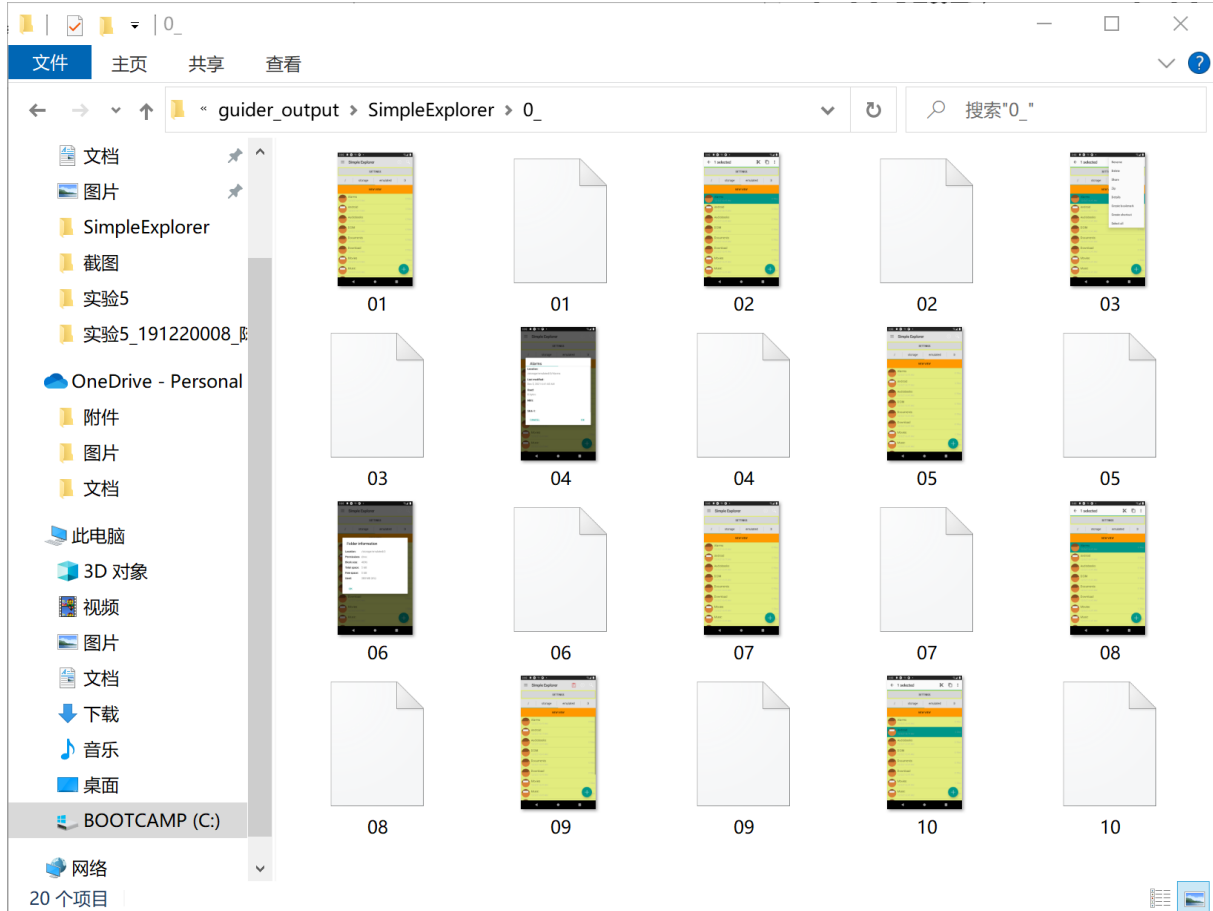
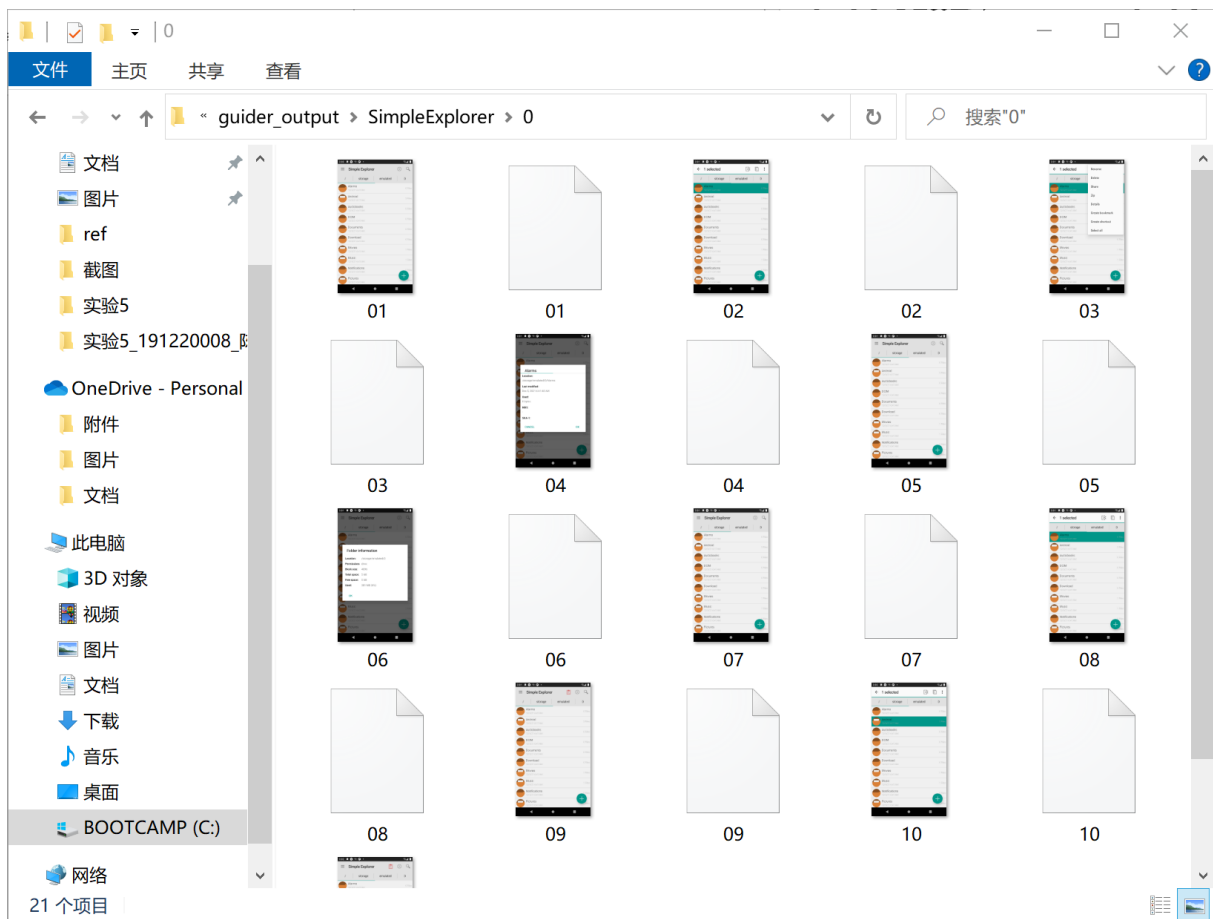
⑦ 查看输出文件



在路径：“[-r 参数的值]\guider_output\[-a 参数的值]”下存放了输出文件：

- 文件夹 0：旧 app 中的功能场景截图和布局文件
- 文件夹 0_：新 app 中的功能场景截图和布局文件
- main.txt：新 app 中运行过程中的控件信息
- repaired0.txt：测试脚本中具体语句的修复信息
- repairedScript.py：修复后的测试脚本
-

具体如下：



```
main - 记事本
文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)
[2021-12-18 11:02:35] [INFO] candidate here is:{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.ImageView', 'text': '', 'resource-id': 'com.dnielfe.n
[2021-12-18 11:02:50] [INFO] candidate here is:{'index': '1', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Search', 'resou
[2021-12-18 11:02:54] [INFO] oldWidget:{'x': 555, 'y': 577, 'w': 515, 'h': 126}
[2021-12-18 11:02:54] [INFO] candidate here is:{'index': '4', 'package': 'com.dnielfe.manager', 'class': 'android.widget.LinearLayout', 'text': '', 'checkable': 'false', 'check
[2021-12-18 11:02:57] [INFO] candidate here is:{'index': '1', 'package': 'com.dnielfe.manager', 'class': 'android.widget.Button', 'text': 'OK', 'resource-id': 'android:id/but
[2021-12-18 11:03:01] [INFO] candidate here is:{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Folder inform
[2021-12-18 11:03:04] [INFO] candidate here is:{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.Button', 'text': 'OK', 'resource-id': 'android:id/but
[2021-12-18 11:03:07] [INFO] candidate here is:{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.ImageView', 'text': '', 'resource-id': 'com.dnielfe.n
[2021-12-18 11:03:22] [INFO] candidate here is:{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Move', 'resou
[2021-12-18 11:03:24] [INFO] candidate here is:{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.ImageView', 'text': '', 'resource-id': 'com.dnielfe.n
[2021-12-18 11:03:40] [INFO] candidate here is:{'index': '1', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Folder inform
[2021-12-18 11:03:42] [INFO] =====test case 0 is tried=====
[2021-12-18 11:03:42] [INFO] isRepaired: True

repaired0 - 记事本
文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)
=====line: 26; test action3=====
-----el = driver.find_element_by_id("com.dnielfe.manager:id/search")+self.driver.find_element_by_accessibility_id("Search")
=====line: 39; test action9=====
-----el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")+self.driver.find_element_by_accessibility_id("Folder information")
=====line: 52; test action15=====
-----el = driver.find_element_by_id("com.dnielfe.manager:id/actionmove")+self.driver.find_element_by_accessibility_id("Move")
=====line: 61; test action19=====
-----el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")+self.driver.find_element_by_accessibility_id("Folder information")
```

2、实验四生成的测试代码在原 app、实验三修改后的 app 上的运行情况

(1) 在旧 app 上的运行情况：

```
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:22: DeprecationWarning: find_elements_by_* commands are deprecated.
    el = driver.find_elements_by_id("com.dnielfe.manager:id/row_image")[0]
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:26: DeprecationWarning: find_element_by_* commands are deprecated. P
    el = driver.find_element_by_id("com.dnielfe.manager:id/search")
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:30: DeprecationWarning: find_elements_by_* commands are deprecated.
    el = driver.find_elements_by_class_name("android.widget.LinearLayout")[4]
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:34: DeprecationWarning: find_element_by_* commands are deprecated. P
    el = driver.find_element_by_id("android:id/button1")
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:39: DeprecationWarning: find_element_by_* commands are deprecated. P
    el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:43: DeprecationWarning: find_element_by_* commands are deprecated. P
    el = driver.find_element_by_id("android:id/button3")
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:48: DeprecationWarning: find_elements_by_* commands are deprecated.
    el = driver.find_elements_by_id("com.dnielfe.manager:id/row_image")[0]
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:52: DeprecationWarning: find_element_by_* commands are deprecated. P
    el = driver.find_element_by_id("com.dnielfe.manager:id/actionmove")
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:57: DeprecationWarning: find_elements_by_* commands are deprecated.
    el = driver.find_elements_by_id("com.dnielfe.manager:id/row_image")[1]
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南晴_SimpleExplorer\sourceScript.py:61: DeprecationWarning: find_element_by_* commands are deprecated. P
    el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")

Process finished with exit code 0
```

可见测试脚本在旧 app 上能够正确运行

(2) 在新 app 上的运行情况


```

C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\sourceScript.py:22: DeprecationWarning: find_elements_by_* commands are deprecated.
  el = driver.find_elements_by_id("com.dniefle.manager:id/row_image")[0]
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\sourceScript.py:26: DeprecationWarning: find_element_by_* commands are deprecated.
  el = driver.find_element_by_id("com.dniefle.manager:id/search")
Traceback (most recent call last):
  File "C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\sourceScript.py", line 26, in <module>
    el = driver.find_element_by_id("com.dniefle.manager:id/search")
  File "C:\Users\92469\AppData\Local\Programs\Python\Python39\lib\site-packages\selenium\webdriver\remote\webdriver.py", line 472, in find_element_by_id
    return self.find_element(by=By.ID, value=id_)
  File "C:\Users\92469\AppData\Local\Programs\Python\Python39\lib\site-packages\appium\webdriver\webdriver.py", line 408, in find_element
    return self.execute(RemoteCommand.FIND_ELEMENT, {'using': by, 'value': value})['value']
  File "C:\Users\92469\AppData\Local\Programs\Python\Python39\lib\site-packages\selenium\webdriver\remote\webdriver.py", line 424, in execute
    self.error_handler.check_response(response)
  File "C:\Users\92469\AppData\Local\Programs\Python\Python39\lib\site-packages\appium\webdriver\errorhandler.py", line 31, in check_response
    raise wde
  File "C:\Users\92469\AppData\Local\Programs\Python\Python39\lib\site-packages\appium\webdriver\errorhandler.py", line 26, in check_response
    super().check_response(response)
  File "C:\Users\92469\AppData\Local\Programs\Python\Python39\lib\site-packages\selenium\webdriver\remote\errorhandler.py", line 247, in check_response
    raise exception_class(message, screen, stacktrace)
selenium.common.exceptions.NoSuchElementException: Message: An element could not be located on the page using the given search parameters.
Stacktrace:
NoSuchElementException: An element could not be located on the page using the given search parameters.
    at AndroidUiautomator2Driver.findEls (C:\Users\92469\AppData\Local\Programs\Appium\resources\app\node_modules\appium\node_modules\appium-android-driver\lib\commands\find.js:85:5)
    at processTicksAndRejections (internal/process/task_queues.js:85:5)
Process finished with exit code 1

```

可见测试脚本在新 app 上无法正确运行

3、修复的测试代码在实验三修改后的 app 上的运行情况

(1) 一开始会报错

```

SyntaxError: Non-UTF-8 code starting with '\xc4' in file C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\guider_output\SimpleExplorer\sourceScript.py:19: (UnicodeError: 'utf-8' codec can't decode byte 0xc4 in position 0, invalid continuation byte)
Process finished with exit code 1

```

(2) 查阅后发现是编码的问题，不属于代码问题，在文件开头添加下列代码即可

```
# coding=gbk
```

(3) 修复后的测试脚本在 xinapp 上能够正确运行

```

C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\guider_output\SimpleExplorer\repairedScript.py:19: DeprecationWarning: find_elements_by_* commands are deprecated.
  el = driver.find_elements_by_id("com.dniefle.manager:id/row_image")[0]
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
[Deprecated] Please use 'find_element' with 'AppiumBy.ACCESSIBILITY_ID' instead.
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\guider_output\SimpleExplorer\repairedScript.py:29: DeprecationWarning: find_elements_by_* commands are deprecated.
  el = driver.find_elements_by_class_name("android.widget.LinearLayout")[4]
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\guider_output\SimpleExplorer\repairedScript.py:34: DeprecationWarning: find_element_by_* commands are deprecated.
  el = driver.find_element_by_id("android:id/button1")
[Deprecated] Please use 'find_element' with 'AppiumBy.ACCESSIBILITY_ID' instead.
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\guider_output\SimpleExplorer\repairedScript.py:44: DeprecationWarning: find_element_by_* commands are deprecated.
  el = driver.find_element_by_id("android:id/button3")
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\guider_output\SimpleExplorer\repairedScript.py:49: DeprecationWarning: find_elements_by_* commands are deprecated.
  el = driver.find_elements_by_id("com.dniefle.manager:id/row_image")[0]
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
[Deprecated] Please use 'find_element' with 'AppiumBy.ACCESSIBILITY_ID' instead.
C:\南\大三上\软件工程\实验\实验5\实验5_191220008_陈南曦_SimpleExplorer\guider_output\SimpleExplorer\repairedScript.py:59: DeprecationWarning: find_elements_by_* commands are deprecated.
  el = driver.find_elements_by_id("com.dniefle.manager:id/row_image")[1]
[Deprecated] 'TouchAction' action is deprecated. Please use W3C actions instead.
[Deprecated] Please use 'find_element' with 'AppiumBy.ACCESSIBILITY_ID' instead.
Process finished with exit code 0

```


4、修改的测试代码的正确性检验

(1) 在修复后的测试脚本运行时，可以在虚拟机中观察到，功能场景完全复现，控件操作相同，说明修改代码的正确性。

(2) 修复的测试代码与原代码对比

=====line: 26; test action3=====

Old: el = driver.find_element_by_id("com.dnielfe.manager:id/search")

New: el = driver.find_element_by_accessibility_id("Search")

=====line: 39; test action9=====

Old: el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")

New: el = driver.find_element_by_accessibility_id("Folder information")

=====line: 52; test action15=====

Old: el = driver.find_element_by_id("com.dnielfe.manager:id/actionmove")

New: el = driver.find_element_by_accessibility_id("Move")

=====line: 61; test action19=====

Old: el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")

New: el = driver.find_element_by_accessibility_id("Folder information")

由上述对比可知，由于控件的 id 改变了，修复工具将定位控件的方式由 find_element_by_id 变为了 find_element_by_accessibility_id。

Find By	Selector	Time (ms)
accessibility id	Folder information	Get Timing

在 Appium 中获取相关控件信息可知，控件的 accessibility id 未发生改变，故修改后的测试代码仍能定位到相同的控件，测试语义不变，说明了修改代码的正确性。

5、对脚本修复过程的理解

根据 ppt 中的内容可知

脚本修复基本思路：

- ① 记录旧版本 app 与测试代码的运行时信息
- ② 尝试在新版本 app 上为每个操作寻找对应
- ③ 构建新测试代码

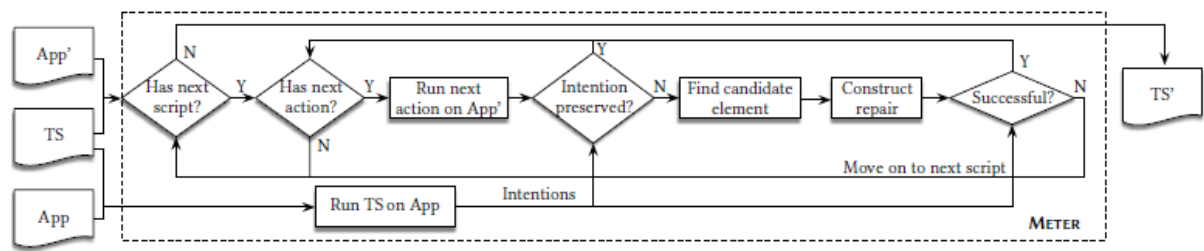


Figure 2: Overview of the METER approach.

我们以测试代码中对查看文件属性的控件的修复为例：

- (1) 第一个步骤是记录旧 app 中的控件信息和截屏

```
process 1----record screenshot and element in the old version n
```

- (2) 控件的位置大小等信息被记录下来，同时被截屏

```
test step 10 start
screen capture before test step 10
perform test step 10: el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")
record test element x,y,w,h: 828,73,126,126
```

PURPOSE	ID	PREDICATE	RULE ¹
contour identification	R1	isTooSmall(c)	$c.h < 10 \vee c.w < 10$
	R2	isTooLarge(c)	$c.h > 0.75H \vee c.w > 0.75W \vee c.h \times c.w > 0.75H \times W$
	R3	isTooSlim(c)	$c.w/c.h < 0.1$
	R4	isTooFat(c)	$c.h/c.w < 0.1$
	R5	isCovered(c, C)	$\exists c' \in C : (c \cap c').area/c'.area > 0.8 \wedge c'.area > c.area$
word grouping	R6	areAdjacent(c ₁ , c ₂)	$vDifference(c_1, c_2) < 15 \wedge hDistance(c_1, c_2) < 50$
	R7	isLikelyTextual(c, C)	$\exists c' \in C : (c'.isTextual() \wedge areAdjacent(c, c'))$

- (3) 第二个步骤是修复测试代码

```
process 2----repair the broken tests in the updated version n+1; once the app is started, manually set the app into the target page.
```

(4) 修复过程

```

el = driver.find_element_by_id("com.dnielfe.manager:id/folderinfo")
('isChild', '[828, 73][954, 199]', 'isSureMatch')
cannot find candidates!!!!!!
getCandidateByMatchType
True
[828, 73][954, 199]
isSureMatch
targetElement :
{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Folder
information', 'resource-id': 'com.dnielfe.manager:id/folderinfo_modify', 'checkable': 'false', 'checked': 'false', 'cli
ckable': 'true', 'enabled': 'true', 'focusable': 'true', 'focused': 'false', 'long-clickable': 'true', 'password': 'fals
e', 'scrollable': 'false', 'selected': 'false', 'bounds': '[828, 73][954, 199]', 'displayed': 'true', 'parent': None, 'x':
828, 'y': 73, 'w': 126, 'h': 126, 'classIndex': 1, 'idIndex': 0, 'content-descIndex': 0, 'textIndex': 9}
rid idName:com.dnielfe.manager:id/folderinfo
[2021-12-18 11:03:01] [INFO] candidate here is: {'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget
.TextView', 'text': '', 'content-desc': 'Folder information', 'resource-id': 'com.dnielfe.manager:id/folderinfo_modify',
'checkable': 'false', 'checked': 'false', 'clickable': 'true', 'enabled': 'true', 'focusable': 'true', 'focused': 'fals
e', 'long-clickable': 'true', 'password': 'false', 'scrollable': 'false', 'selected': 'false', 'bounds': '[828, 73][954, 1
99]', 'displayed': 'true', 'parent': None, 'x': 828, 'y': 73, 'w': 126, 'h': 126, 'classIndex': 1, 'idIndex': 0, 'conten
t-descIndex': 0, 'textIndex': 9}
targetElement :
{'index': '0', 'package': 'com.dnielfe.manager', 'class': 'android.widget.TextView', 'text': '', 'content-desc': 'Folder
information', 'resource-id': 'com.dnielfe.manager:id/folderinfo_modify', 'checkable': 'false', 'checked': 'false', 'cli
ckable': 'true', 'enabled': 'true', 'focusable': 'true', 'focused': 'false', 'long-clickable': 'true', 'password': 'fals
e', 'scrollable': 'false', 'selected': 'false', 'bounds': '[828, 73][954, 199]', 'displayed': 'true', 'parent': None, 'x':
828, 'y': 73, 'w': 126, 'h': 126, 'classIndex': 1, 'idIndex': 0, 'content-descIndex': 0, 'textIndex': 9}
rid idName:com.dnielfe.manager:id/folderinfo
[Deprecated] Please use 'find_element' with 'AppiumBy.ACCESSIBILITY_ID' instead.
isChecked

```

① 根据在旧 app 中获取的控件信息找到对应位置的相关控件

② 然后进行控件信息的比对，（根据控件信息的相似度）找出信息匹配的对应控件

$$\begin{aligned}
 MT_{E_1, E_2} &= \frac{|\{e \in E_1^t : \exists e' \in E_2^t \rightarrow e \sim e'\}|}{|E_1^t| + |E_2^t|}, \\
 MG_{E_1, E_2} &= \frac{|\{e \in E_1^g : \exists e' \in E_2^g \rightarrow e \sim e'\}|}{|E_1^g| + |E_2^g|}.
 \end{aligned}$$

③ 最后用相关算法选择合适的语句进行替换

Algorithm 2 Test script repairing.

```

Input:  $\mathcal{P}$ : base version app;  $\mathcal{P}'$ : updated version app;
 $\mathcal{K}$ : list of original test scripts, with each test action associated
with its intention on  $\mathcal{P}$ ;
Output:  $\mathcal{M}$ : Map from each test action  $\alpha$  in  $\mathcal{K}$  to a triple
 $(\tau, src, dest)$ , where  $\tau$  is the sequence of test actions
derived from  $\alpha$  for  $\mathcal{P}'$  and it transits  $\mathcal{P}'$  from screen  $src$ 
to screen  $dest$ .

1: init( $\mathcal{M}$ )
2: for  $K \in \mathcal{K}$  do
3:   while  $K.hasNext()$  do
4:      $\alpha \leftarrow K.next()$ ;
5:      $\iota \leftarrow \alpha.intention()$ ;
6:      $curS \leftarrow \mathcal{M}(\alpha.pre).dest$   $\triangleright \alpha.pre$  is the test action before  $\alpha$ .
7:      $\varepsilon \leftarrow ELE(\iota.src, \alpha.loc)$ 
8:     if  $ELE(curS, \alpha.loc) \sim \varepsilon \wedge DEST(curS, \alpha) \sim \iota.dest$  then
9:        $\mathcal{M}(\alpha) \leftarrow ([\alpha], curS, DEST(curS, \alpha))$ 
10:    continue
11:   end if
12:    $\mathcal{E} \leftarrow \emptyset$ 
13:   if  $\exists e' \in curS : e' \sim \varepsilon$  then  $\mathcal{E}.append([e'])$  end if
14:    $\mathcal{E}.append(CANDSORTED(curS, \iota.src, \varepsilon))$ 
15:    $\mathcal{E}.append(CANDSORTED(\mathcal{P}', \mathcal{P}, \varepsilon))$ 
16:    $isFound \leftarrow false$ 
17:   for  $e \in \mathcal{E}$  do
18:      $preK \leftarrow SCRIPTTOEQUAL(\mathcal{P}', curS, e.containingS())$ 
19:      $midS \leftarrow DEST(e.containingS(), (e.locator(), \alpha.evt))$ 
20:      $(postK, destS) \leftarrow SCRIPTTOMATCHING(\mathcal{P}', midS, \iota.dest)$ 
21:     if  $preK == null \vee midS == null \vee postK == null$  then
22:       BACKTRACK( $K, \alpha, \mathcal{M}$ )
23:     continue
24:   end if
25:   if  $preK.isEmpty() \vee postK.isEmpty()$  then
26:      $\mathcal{M}(\alpha) \leftarrow$ 
27:        $(preK + (e.locator(), \alpha.evt) + postK, curS, destS)$ 
28:      $isFound \leftarrow true$ 
29:   break
30:   end if
31: end for
32: if not  $isFound$  then
33:   break
34: end if
35: end while
36: end for
37: return  $\mathcal{M}$ 

39:  $ELE(src, locator) \triangleright$  Return GUI element selected by  $locator$  on  $src$ .
40:  $DEST(src, \alpha) \triangleright$  Return destination screen of executing  $\alpha$  on  $src$ .
41:  $CANDSORTED(S, S', ele) \triangleright$  Return GUI elements from  $S$  that are
 $\triangleright$  not matched with any element from  $S'$ .
 $\triangleright$  Sorted in decreasing order of similarity to  $ele$ .
42:  $SCRIPTTOEQUAL(P, src, dest) \triangleright$  Return confirmed sequence of test
 $\triangleright$  actions in  $P$  that transits  $P$  from  $src$  to  $dest$ . Return empty
 $\triangleright$  sequence if  $src = dest$ , or null if no such sequence is found.
43:  $SCRIPTTOMATCHING(P, src, dest) \triangleright$  Return  $(l, dest')$ , where  $l$  is a
 $\triangleright$  confirmed sequence of test actions,  $dest'$  is a screen in  $P$ 
 $\triangleright (dest' \sim dest)$ , and  $l$  transits  $P$  from  $src$  to  $dest'$ .
 $\triangleright l$  is empty if  $src \sim dest$ , or null if none is found.
44:  $BACKTRACK(K, \alpha, \mathcal{M}) \triangleright$  Backtrack by killing the current testing
 $\triangleright$  process and executing the partial repair constructed for  $K$  so
 $\triangleright$  far, i.e., the repairs stored in  $\mathcal{M}$  for  $K$ 's test actions until  $\alpha$ .

```

七、 结果分析与结论

在本次的实验中，尝试使用了老师和学长们开发的 GUI 测试自动修复工具，以达到在之前修改控件后的 app 上成功测试的目的。在大多场景下，修复工具能在较短的时间内便能实现测试脚本的修复，并且测试语义不变，但在部分功能场景上修复工具无法修复，或者修复后的测试脚本无法正确运行。

阅读了论文后更能感到开发此工具的不易，并且可以看出 GUI 测试自动化还有很长的路需要走，祝愿可以有更大的突破。

实验评分：_____

指导教师签字：_____

年 月 日