1、学位论文中文题目：安卓异步组件 AsyncTask 缺陷的动态检测方法研究

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3、学位论文中文摘要：

作为智能移动设备的操作系统之一，安卓系统的使用量以其绝对的占比优势位居第一，安卓应用程序也成为市场上使用最广泛的移动应用程序。安卓系统基于 UI 线程和事件驱动模式，UI 线程主要用于和用户交互并调度事件，异步线程用于处理耗时的任务。为了方便异步编程，Android 提供了六种异步组件，其中 AsyncTask 异步组件使用量最多。

AsyncTask 操作简单、适用于短时任务，因此被应用在多种场景。但是开发者在使用 AsyncTask 进行异步编程时会出现很多不规范的操作，进而引发一系列问题，比如程序崩溃、内存泄漏、资源浪费和运行结果丢失等。目前相关的检测工作均基于静态分析方法，这类工作没有进行严格的符号执行和约束求解，一些不可达的路径仍然被视为错误点。因此导致检测结果有一定数量的误报。

本文提出一种基于动态分析技术的检测方法 AD2Check，用于检测异步类 AsyncTask 的误用缺陷。该方法可以检测的误用缺陷类型包括：StrongReference 、 NotCancel 、 NotTerminate 、 EarlyCancel 、 RepeatStart。AD2Check 方法思路如下：将五种误用缺陷模式转换成含有 AsyncTask 关键操作信息的执行序列，并在日志中收集相关操作的执

行信息，接着进行分析和匹配缺陷。AD2Check 方法根据 AsyncTask 的异步特性提出了 LoF 模型，将日志区分成单独的 AsyncTask 执行日志序列，有效解决了多线程日志交织问题。同时提出了适用性更强的缺陷匹配算法，算法的时间复杂度是线性的。此外，我们还提出了构建动态执行路径的方法，将路径以树型结构输出，并提供更详细的路径信息（如分支、循环、方法参数等）以便用户定位缺陷发生的位置。基于该方法的检测流程降低了误报率且可提供更详细的缺陷报告。此外，我们还基于该方法实现了工具 AD2Checker。

本文选取了 32 个真实应用来验证 AD2Checker 的有效性，工具检测到 233 个缺陷，同时可以触发真实应用的崩溃，并收集相关崩溃日志。我们还将 AD2Checker 工具和相关工具进行比较，结果表明，基于动态分析的 AD2Check 方法可以有效提高结果精度，同时可以提供包括执行路径等信息的详细报告。

4、学位论文中文关键词：安卓异步类，AsyncTask，动态分析，缺陷检测，日志分析

5、学位论文英文题目：Research on Dynamic Detection of Android Asynchronous Component AsyncTask Related Defects

6、学位论文作者英文姓名：Liu Qing

7、学位论文英文摘要：

As one of the operating systems of smart mobile devices, the usage of Android system ranks first with its absolute advantage, and Android applications have also become the most widely used mobile applications on the market. The Android system is based on the UI thread and event-driven model. The UI thread is mainly used to interact with users and schedule events, and the asynchronous thread is used to process time-consuming tasks. In order to facilitate asynchronous programming, Android provides six types of asynchronous components, of which the AsyncTask asynchronous component is the most used.

AsyncTask has the characteristics of simple operation and suitable for short operations, so it is used in a variety of scenarios. However, when developers use AsyncTask for asynchronous programming, many irregular operations will occur, which will cause a series of problems, such as program crashes, memory leaks, waste of resources and loss of results. At present, related work is based on static analysis methods. This type of work does not carry out strict symbolic execution and constraint solving, and some unreachable paths are still regarded as error points. This leads to a certain number of false positives in the detection results.

This paper proposes a detection method AD2Check based on dynamic analysis technology to detect misuse defects of asynchronous AsyncTask. The types of misuse defects that can be detected by this method include: StrongReference, NotCancel, NotTerminate, EarlyCancel, RepeatStart. The idea of the AD2Check method is as follows: convert the five misuse defect modes into an execution sequence containing the key operation information of AsyncTask, and collect the execution information of the related operations in the log, and then analyze and match the defects. The AD2Check method proposes a LoF model based on the asynchronous characteristics of AsyncTask, and divides the log into AsyncTask execution log sequence, which effectively solves the problem of multi-threaded log interleaving. At the same time, a more applicable defect matching algorithm is proposed, and the time complexity of the algorithm is linear. In addition, we also proposed a method of constructing a dynamic execution path, outputting the path in a tree structure, and providing more detailed path information (such as branches, loops, method parameters, etc.) so that users can locate the defect. The detection process based on this method reduces the false alarm rate and can provide more detailed defect reports. In addition, we also implemented the tool AD2Checker based on this method.

We selected 32 real applications to verify the effectiveness of AD2Checker. The tool detects 233 defects and can trigger the crash of real applications and collect related crash logs. We also compared the AD2Checker tool with related tools. The results show that the AD2Check method based on dynamic analysis can effectively improve the accuracy of the results, and at the same time can provide detailed reports including information such as execution paths.

8、学位论文英文关键词：Android Asynchronous Class, AsyncTask, Dynamic Analysis, Defect Detection, Log Analysis

9、所获相关成果列表：

[1] Qing Liu, Linjie Pan, Baoquan Cui, Jun Yan, Jian Zhang. Dynamic Detection of AsyncTask Related Defects. QRS 2021. Accepted.