VU University Amsterdam
Faculty of Sciences
Department of Computer Sciences

Internet & Web Technologies
Master thesis

Dynamic Analysis of Android Malware

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Dynamic Analysis Of Android Malware Tracedroid

Utkarsh Raghav

Dynamic Analysis Of Android Malware Tracedroid:

Wireless Algorithms, Systems, and Applications Lei Wang,Michael Segal,Jenhui Chen,Tie Qiu,2022-11-17 The three volume set constitutes the proceedings of the 17th International Conference on Wireless Algorithms Systems and Applications WASA 2022 which was held during November 24th 26th 2022 The conference took place in Dalian China The 95 full and 62 short papers presented in these proceedings were carefully reviewed and selected from 265 submissions The contributions in cyber physical systems including intelligent transportation systems and smart healthcare systems security and privacy topology control and coverage energy efficient algorithms systems and protocol design **Mobile Internet Security** Ilsun You,Hwankuk Kim,Pelin Angin,2023-07-19 This book constitutes the refereed proceedings of the 6th International Conference on Mobile Internet Security MobiSec 2022 held in Jeju South Korea in December 15 17 2022 The 24 full papers included in this book were carefully reviewed and selected from 60 submissions They were organized in topical sections as follows 5G advanced and 6G security AI for security cryptography and data security cyber security and IoT application and blockchain security **Targeted Dynamic Analysis for Android Malware** Michelle Yan Yi Wong,2015

The Android Malware Handbook Qian Han,Salvador Mandujano,Sebastian Porst,V.S. Subrahmanian,Sai Deep Tetali,2023-11-07 Written by machine learning researchers and members of the Android Security team this all star guide tackles the analysis and detection of malware that targets the Android operating system This groundbreaking guide to Android malware distills years of research by machine learning experts in academia and members of Meta and Google s Android Security teams into a comprehensive introduction to detecting common threats facing the Android eco system today Explore the history of Android malware in the wild since the operating system first launched and then practice static and dynamic approaches to analyzing real malware specimens Next examine machine learning techniques that can be used to detect malicious apps the types of classification models that defenders can implement to achieve these detections and the various malware features that can be used as input to these models Adapt these machine learning strategies to the identifica tion of malware categories like banking trojans ransomware and SMS fraud You ll Dive deep into the source code of real malware Explore the static dynamic and complex features you can extract from malware for analysis Master the machine learning algorithms useful for malware detection Survey the efficacy of machine learning techniques at detecting common Android malware categories The Android Malware Handbook s team of expert authors will guide you through the Android threat landscape and prepare you for the next wave of malware to come Improving the Effectiveness of Automatic Dynamic Android Malware Analysis □□□,2013 *Static Analysis for Android Malware Detection Using Document Vectors* Utkarsh Raghav,2023 The prevalence of smart mobile devices has led to an upsurge in malware that targets mobile platforms The dominant market player in the sector Android OS has been a favourite target for malicious actors Various feature engineering techniques are used in the current machine learning and deep learning approaches for Android malware

detection In order to correctly identify dependable features feature engineering for Android malware detection using multiple AI algorithms requires a particular level of expertise in Android malware and the platform itself The majority of these engineered features are initially extracted by applying different static and dynamic analysis approaches These allow researchers to obtain various types of information from Android application packages APKs such as required permissions opcode sequences and control flow graphs to name a few This information is used as is or in vectorised form for training supervised learning models Researchers have also applied Natural Language Processing techniques to the features extracted from APKs In order to automatically create feature vectors that can describe the data included in Android manifests and Dalvik executable files inside an APK this study focused on developing a novel method that uses static analysis and the NLP technique of document embeddings We designed a system that takes Android APK files as input documents and generates the feature embeddings This system removes the need for manual identification extraction of features We use these embeddings to train various Android Malware detection models to experimentally evaluate the effectiveness of these automatically generated features The experiments were done by training and evaluating 5 different supervised learning models We did our experiments on APKs from two well known datasets DREBIN and AndroZoo We trained and validated our models with 4000 files training set We had kept separate 700 files test set which were not used during training and validation We used our trained models to predict the classes of the unseen file embeddings from the test set The automatically generated features allowed training of robust detection models The Android malware detection models performed best with Android manifest file embeddings concatenated with Dalvik executable file embeddings with some of the models achieving Precision Recall and Accuracy values above 99% consistently during development and over 97% against unseen file embeddings The prediction accuracy of the detection model trained on our automatically generated features was equivalent to the accuracy achieved by one of the most cited research works known as DREBIN which was 94% We also provided a simple method to directly utilise the file present in Android APK to create feature embeddings without scouring through Android application files to identify reliable features The resulting system can be further improved against new emerging threats and be better trained by just gathering more samples *Android Malware Detection using Machine Learning* ElMouatez Billah Karbab,Mourad Debbabi,Abdelouahid Derhab,Djedjiga Mouheb,2021-07-10 The authors develop a malware fingerprinting framework to cover accurate android malware detection and family attribution in this book The authors emphasize the following 1 the scalability over a large malware corpus 2 the resiliency to common obfuscation techniques 3 the portability over different platforms and architectures First the authors propose an approximate fingerprinting technique for android packaging that captures the underlying static structure of the android applications in the context of bulk and offline detection at the app market level This book proposes a malware clustering framework to perform malware clustering by building and partitioning the similarity network of malicious applications on top of this

fingerprinting technique Second the authors propose an approximate fingerprinting technique that leverages dynamic analysis and natural language processing techniques to generate Android malware behavior reports Based on this fingerprinting technique the authors propose a portable malware detection framework employing machine learning classification Third the authors design an automatic framework to produce intelligence about the underlying malicious cyber infrastructures of Android malware The authors then leverage graph analysis techniques to generate relevant intelligence to identify the threat effects of malicious Internet activity associated with android malware The authors elaborate on an effective android malware detection system in the online detection context at the mobile device level It is suitable for deployment on mobile devices using machine learning classification on method call sequences Also it is resilient to common code obfuscation techniques and adaptive to operating systems and malware change overtime using natural language processing and deep learning techniques Researchers working in mobile and network security machine learning and pattern recognition will find this book useful as a reference Advanced level students studying computer science within these topic areas will purchase this book as well **Android Malware Detection Through Permission and App Component Analysis Using Machine Learning Algorithms** Keyur Milind Kulkarni,2018 Improvement in technology has inevitably altered the tactic of criminals to thievery In recent times information is the real commodity and it is thus subject to theft as any other possessions cryptocurrency credit card numbers and illegal digital material are on the top If globally available platforms for smartphones are considered the Android open source platform AOSP emerges as a prevailing contributor to the market and its popularity continues to intensify Whilst it is beneficiary for users this development simultaneously makes a prolific environment for exploitation by immoral developers who create malware or reuse software illegitimately acquired by reverse engineering Android malware analysis techniques are broadly categorized into static and dynamic analysis Many researchers have also used feature based learning to build and sustain working security solutions Although Android has its base set of permissions in place to protect the device and resources it does not provide strong enough security framework to defend against attacks This thesis presents several contributions in the domain of security of Android applications and the data within these applications First a brief survey of threats vulnerability and security analysis tools for the AOSP is presented Second we develop and use a genre extraction algorithm for Android applications to check the availability of those applications in Google Play Store Third an algorithm for extracting unclaimed permissions is proposed which will give a set of unnecessary permissions for applications under examination Finally machine learning aided approaches for analysis of Android malware were adopted Features including permissions APIs content providers broadcast receivers and services are extracted from benign 2 000 and malware 5 560 applications and examined for evaluation We create feature vector combinations using these features and feed these vectors to various classifiers Based on the evaluation metrics of classifiers we scrutinize classifier performance with respect to specific feature combination Classifiers such as SVM Logistic Regression

and Random Forests spectacle a good performance whilst the dataset of combination of permissions and APIs records the maximum accuracy for Logistic Regression **Android Malware and Analysis** Ken Dunham,Shane Hartman,Manu Quintans,Jose Andre Morales,Tim Strazzere,2014-10-24 The rapid growth and development of Android based devices has resulted in a wealth of sensitive information on mobile devices that offer minimal malware protection This has created an immediate need for security professionals that understand how to best approach the subject of Android malware threats and analysis In Android Malware and Analysis Ken Dunham renowned global malware expert and author teams up with international experts to document the best tools and tactics available for analyzing Android malware The book covers both methods of malware analysis dynamic and static This tactical and practical book shows you how to use to use dynamic malware analysis to check the behavior of an application malware as it has been executed in the system It also describes how you can apply static analysis to break apart the application malware using reverse engineering tools and techniques to recreate the actual code and algorithms used The book presents the insights of experts in the field who have already sized up the best tools tactics and procedures for recognizing and analyzing Android malware threats quickly and effectively You also get access to an online library of tools that supplies what you will need to begin your own analysis of Android malware threats Tools available on the book s site include updated information tutorials code scripts and author assistance This is not a book on Android OS fuzz testing or social engineering Instead it is about the best ways to analyze and tear apart Android malware threats After reading the book you will be able to immediately implement the tools and tactics covered to identify and analyze the latest evolution of Android threats Updated information tutorials a private forum code scripts tools and author assistance are available at AndroidRisk com for first time owners of the book **Deep Dynamic Analysis of Android Applications** Eric David Gustafson,2014 The smartphone revolution has brought about many new computing paradigms which aim to improve upon the computing landscape as we knew it Chief among these is the app packetizing and trivializing the distribution and installation of software This has led to a boom in the mobile software industry but also an increased burden on security researchers to ensure the millions of apps available do not harm users This paper presents a partial solution to that problem Pyandrazzi a practical dynamic analysis system for Android applications Pyandrazzi aims to be more scalable more compatible and more thorough than any existing system and to provide more in formative data to analysts than was previously thought possible The system is a true black box solution and is able to perform this analysis without any source code or prior knowledge of the application whatsoever Unlike other similar systems which rely heavily on unrealistic modifications to Android our system employs the original Android virtual machine and libraries to provide a more natural environment for apps and to ease portability to new Android versions Novel contributions include an algorithm for more thoroughly exploring application modeled on common user interface design patterns a platform version independent means of obtaining method trace data and a method of using this data to calculate the method coverage of an application

execution To evaluate the performance and coverage of the system we used 1750 of the top applications from the dominant Google Play app market and executed them under a variety of conditions We demonstrate that the algorithm we developed is more effective than random user interface interactions at achieving method coverage of an application We then discuss the performance of the system which can execute all 1750 apps for two minutes of run time each under heavy instrumentation in about 7 hours We then explore two practical applications of the system The first is a Host based Intrusion Detection System HIDS concept implemented using application re writing techniques The system uses signatures based on high level API call activity as opposed vii to binary fingerprints or system call traces used in other systems In our tests we were able to reliably detect three families of malware for which we created signatures with zero false positives Secondly we explore Pyandrazzi s role in a recent study of advertising fraud on Android covering over 130 000 Android applications The system was used to analyze those apps that did not generate ad related traffic without user interaction Of the 7 500 apps without such traffic we found that 12 8% of applications would have generated ad traffic if they had been properly interacted with via their user interfaces We then explore augmenting Pyandrazzi to avoid interacting with advertising so that fraudulent behaviors can be better detected Using a set of rules based on advertising industry standards and common design patterns we were able to avoid ad related interactions in 97 6 percent of a test set of 1 000 apps **Android Malware Detection and Adversarial Methods** Weina Niu,Xiaosong Zhang,Ran Yan,Jiacheng Gong,2024-05-23 The rise of Android malware poses a significant threat to users information security and privacy Malicious software can inflict severe harm on users by employing various tactics including deception personal information theft and device control To address this issue both academia and industry are continually engaged in research and development efforts focused on detecting and countering Android malware This book is a comprehensive academic monograph crafted against this backdrop The publication meticulously explores the background methods adversarial approaches and future trends related to Android malware It is organized into four parts the overview of Android malware detection the general Android malware detection method the adversarial method for Android malware detection and the future trends of Android malware detection Within these sections the book elucidates associated issues principles and highlights notable research By engaging with this book readers will gain not only a global perspective on Android malware detection and adversarial methods but also a detailed understanding of the taxonomy and general methods outlined in each part The publication illustrates both the overarching model and representative academic work facilitating a profound comprehension of Android malware detection *Detecting Android Malicious Applications Using Static and Dynamic Analysis Techniques* ,2018 Smartphones and tablets have become some of the most consumed electronic devices because they revolutionize many aspects of our lives For instance Android is one of the most popular mobile operating systems that are used in mobile landscape which captures more than 85 percent of the market share in 2017 Smartphones store a vast amount of valuable data ranging from personal information e g text messages and contacts to

company information for when companies apply bring your own device BYOD policy Those devices become a target for most of the malicious applications that form the base of many cybercrimes such as identity theft transaction fraud hacking etc Malware authors are motivated by financial gain Therefore they attempt to evade current security tools by exploiting new techniques Security professionals have worked hard trying to safeguard mobile platforms particularly Android They proposed several techniques and solutions to detect and prevent malicious applicataions However many of those solutions have crippling limitations that may invalidate their results For example many efforts use an Android emulator for detecting malware However advanced malware can determine the existence of the analysis environment and not exhibit any malicious behavior We designed and developed a framework that aims to detect malicious applications in Android OS called AndroiD Defender DDefender DDefender is a system that detects Android malicious applications on devices It utilizes static and dynamic analysis techniques to extract features from the user s device then applies different machine learning algorithms to detect malicious applications We use dynamic analysis to extract system calls system information network traffic and requested permissions of an inspected application Then we use static analysis to extract significant features from the inspected application such as application s components By utilitizng several machine learning algorithms and a large feature set of 1007 features we evaluated our system with 24 100 applications 19 100 benign applications and 5000 malicious applications We were able to achieve up to 99% detection accuracy with 1 36% false positive rate and 0 68% false negative rate After performing the analysis users can obtain full reports of all new installed applications in their devices This will help them to stay safe and aware of any malicious behavior Based on the classification results users will be able to distinguish benign applications from malicious applications to take the appropriate action Moreover we designed and developed the DDefender web service tool which allows users to submit and analyze any Android application before installing it on their devices HYBRID ANALYSIS OF ANDROID APPLICATIONS FOR SECURITY VETTING Dewan Chaulagain,2019 The phenomenal growth in use of android devices in the recent years has also been accompanied by the rise of android malware This reality created the need to develop tools and techniques to analyze android apps in large scale for security vetting Most of the state of the art vetting tools are either based on static analysis analysis without executing apps or on dynamic analysis running them on an emulation platform Static analysis suffers from high rate of false positives and it has limited success if the app developer utilizes sophisticated evading features Dynamic analysis on the other hand overcomes the problems associated with static analysis but may not find all the code execution paths which prevents us from detecting some malware Moreover the existing static and dynamic analysis vetting techniques require extensive human interaction To address the above issues we design a deep learning based hybrid analysis technique which combines the complementary strengths of each analysis paradigm to attain better accuracy Moreover automated feature engineering capability of the deep learning framework addresses the human interaction problem In particular using standard static and dynamic analysis procedure we

obtain multiple artifacts and train the deep learner with the artifacts to create independent models and then combine their results using a hybrid classifier to obtain the final vetting decision malicious apps vs benign apps The experiments show that our best deep learning model with hybrid analysis achieves an area under the precision recall curve AUC of 0 9998 Furthermore the time to test an app is significantly less compared to traditional static analysis tools In this thesis we also do a comparative study of the accuracy and performance measures of the various variants of the deep learning framework

Tweet Analysis for Android Malware Detection in Google Play Store Zhiang Fan,2019 There are many approaches to detect if an app is malware or benign for example using static or dynamic analysis Static analysis can be used to look for APIs that are indicative of malware Alternatively emulating the app s behavior using dynamic analysis can also help in detecting malware Each type of approach has advantages and disadvantages To complement existing approaches in this report I studied the use of Twitter data to identify malware The dataset that I used consists of a large set of Android apps made available by AndroZoo For each app AndroZoo provides information on vt detection which records number of anti virus programs in VirusTotal that label the app as malware As an additional source of information about apps I crawled a large set of tweets and analyzed them to identify patterns of malware and benign apps in Twitter Tweets were crawled based on keywords related to Google Play Store app links A Google Play Store app link contains the corresponding app s ID which makes it easy to link tweets to apps Certain fields of the tweets were analyzed by comparing patterns in malware versus benign apps with the goal of identifying fields that are indicative of malware behavior The classification label from AndroZoo was considered as ground truth *Android Malware Analysis & Defensive Exploitation 2025 (Hinglish Edition)* A. Clarke,2025-10-07 Android Malware Analysis Defensive Exploitation 2025 Hinglish Edition by A Clarke ek practical aur responsible guide hai jo Android apps aur mobile threats ko analyse detect aur mitigate karna sikhata hai sab Hinglish Hindi English mix mein **BPFroid** Yaniv Agman,2021 We present a novel dynamic analysis framework for Android that useseBPF technology of the Linux kernel to continuously monitor events of userapplications running on a real device

Targeted Security Analysis of Android Applications with Hybrid Program Analysis Michelle Yan Yi Wong,2021 Mobile devices are prevalent in everyday society and the installation of third party applications provide a variety of services such as location tracking messaging and financial management The trove of sensitive information and functionality on these devices and their large user base attract malware developers who want to exploit this functionality for monetary gain or to cause harm To protect the security and privacy of mobile device users we wish to analyze applications to extract the types of actions they perform and to determine whether they can be trusted Program analysis techniques have commonly been used to perform such analysis and are primarily static or dynamic in nature Static analysis operates on the code of the application and provides good analysis coverage but is imprecise due to the lack of run time information Dynamic analysis operates as the application is executing and is more precise due to the availability of the execution trace but is often limited by low code

coverage since only the parts of the application that are actually executed can be analyzed In this thesis we explore the use of hybrid program analysis techniques that use the strengths of both static and dynamic analysis to achieve more effective security analysis of applications on the Android mobile platform We propose and develop the idea of targeted execution in which analysis resources are focused on the specific code locations that are of interest to a security analyzer We dynamically execute the application at these locations to enable precise security analysis of the behaviors To target the locations we preface the dynamic analysis with a static phase that performs a conservative search for potential behaviors of interest and extracts the code paths that lead to them It then determines how these code paths can be executed such that the target behavior can be analyzed We show how the use of both static and dynamic analysis can enable more effective execution and analysis of applications than the existing state of the art techniques We further show how hybrid program analysis can enable the deobfuscation of applications a challenge that often plagues security analysis tools **Mobile OS Vulnerabilities** Shivi Garg,Niyati Baliyan,2023-08-17 This is book offers in depth analysis of security vulnerabilities in different mobile operating systems It provides methodology and solutions for handling Android malware and vulnerabilities and transfers the latest knowledge in machine learning and deep learning models towards this end Further it presents a comprehensive analysis of software vulnerabilities based on different technical parameters such as causes severity techniques and software systems type Moreover the book also presents the current state of the art in the domain of software threats and vulnerabilities This would help analyze various threats that a system could face and subsequently it could guide the securityengineer to take proactive and cost effective countermeasures Security threats are escalating exponentially thus posing a serious challenge to mobile platforms Android and iOS are prominent due to their enhanced capabilities and popularity among users Therefore it is important to compare these two mobile platforms based on security aspects Android proved to be more vulnerable compared to iOS The malicious apps can cause severe repercussions such as privacy leaks app crashes financial losses caused by malware triggered premium rate SMSs arbitrary code installation etc Hence Android security is a major concern amongst researchers as seen in the last few years This book provides an exhaustive review of all the existing approaches in a structured format The book also focuses on the detection of malicious applications that compromise users security and privacy the detection performance of the different program analysis approach and the influence of different input generators during static and dynamic analysis on detection performance This book presents a novel method using an ensemble classifier scheme for detecting malicious applications which is less susceptible to the evolution of the Android ecosystem and malware compared to previous methods The book also introduces an ensemble multi class classifier scheme to classify malware into known families Furthermore we propose a novel framework of mapping malware to vulnerabilities exploited using Android malware s behavior reports leveraging pre trained language models and deep learning techniques The mapped vulnerabilities can then be assessed on confidentiality integrity and availability on different Android components and sub

systems and different layers *Identification of Malicious Android Applications Using Kernel Level System Calls* Dhruv Jariwala,2015 With the advancement of technology smartphones are gaining popularity by increasing their computational power and incorporating a large variety of new sensors and features that can be utilized by application developers in order to improve the user experience On the other hand this widespread use of smartphones and their increased capabilities have also attracted the attention of malware writers who shifted their focus from the desktop environment and started creating malware applications dedicated to smartphones With about 1 5 million Android device activations per day and billions of application installation from the official Android market Google Play Android is becoming one of the most widely used operating systems for smartphones and tablets Most of the threats for Android come from applications installed from third party markets which lack proper mechanisms to detect malicious applications that can leak users private information send SMS to premium numbers or get root access to the system In this thesis our work is divided into two main components In the first one we provide a framework to perform off line analysis of Android applications using static and dynamic analysis approaches In the static analysis phase we perform de compilation of the analyzed application and extract the permissions from its AndroidManifest file Whereas in dynamic analysis we execute the target application on an Android emulator where the starce tool is used to hook the system calls on the zygote process and record all the calls invoked by the application The extracted features from both the static and dynamic analysis modules are then used to classify the tested applications using a variety of classification algorithms In the second part our aim is to provide real time monitoring for the behavior of Android application and alert users to these applications that violate a predefined security policy by trying to access private information such as GPS locations and SMS related information In order to achieve this we use a loadable kernel module for tracking the kernel level system calls The effectiveness of the developed prototypes is confirmed by testing them on popular applications collected from F Droid and malware samples obtained from third party and the Android Malware Genome Project dataset *AndroSAT* Saurabh Oberoi,2014

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