
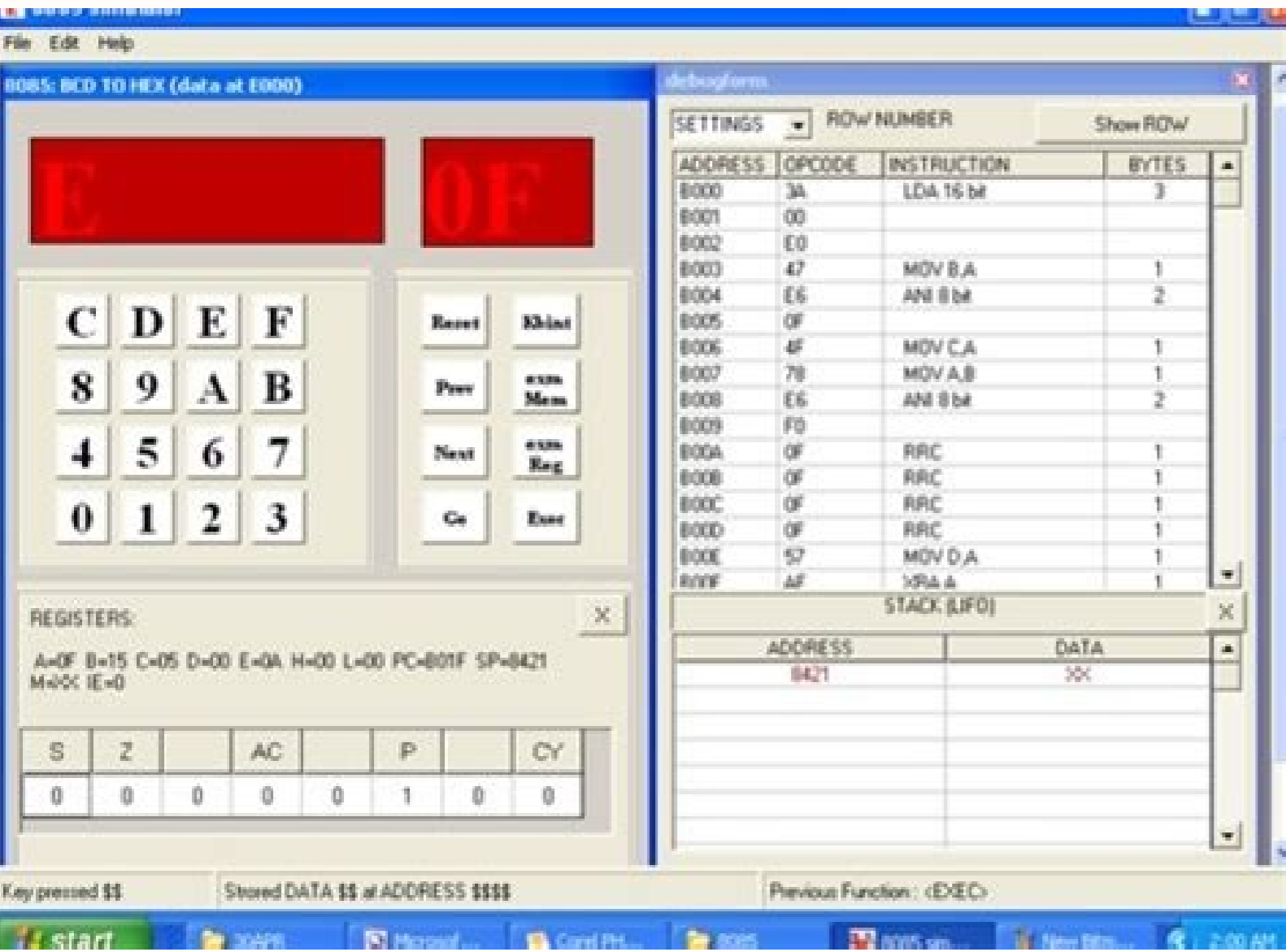
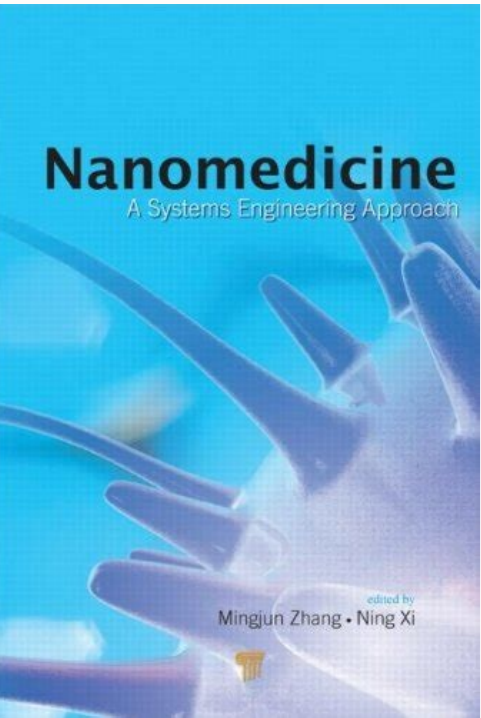
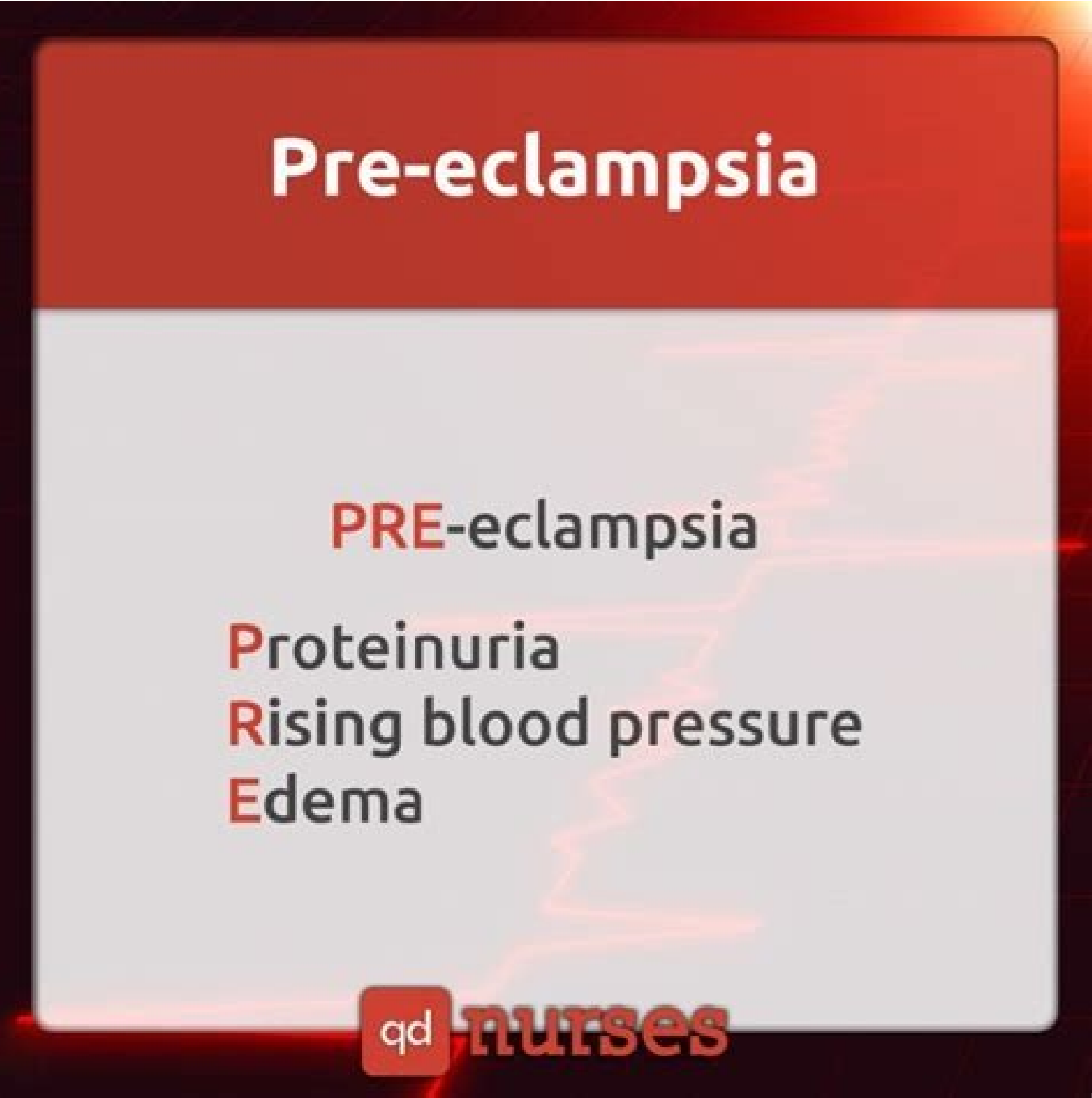
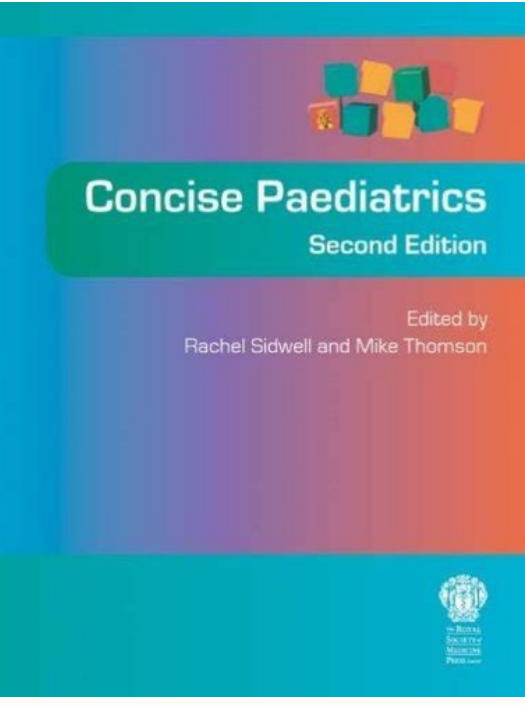


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Such methods are based on mutual information, statistical test (t-test, F-test). Sensors 2019, 19, 4312. We prepare four datasets (a) the first dataset (dataset-I) comprises malicious executables collected from VX-Heavens [35] along with legitimate files, (b) the second dataset (dataset-II), which is the collection of malicious files including ransomware's downloaded from virusshare [36] along with goodware gathered from diverse sources finally, (c) malicious Android applications acquired from the Drebin project [37] and benign apps (dataset-III), and (d) synthetic malware samples created using virus generation kits. Droiddetector: Android malware characterization and detection using deep learning. arXiv 2017, arXiv:1712.08996. For extracting APIs, Veratrace mandates unpacking the samples. Deep Android malware detection. For VX-Heavens samples, the executable files were made to run on a hardware virtualized machine such as Xen [39]. We also conclude that models trained on static features did not attain good results due to the sparse vectors. Comparison of existing techniques. © 2021 by the authors. Department of Computer Science and Engineering, SCMS School of Engineering and Technology, Ernakulam 682011, India Department of Computer Science and Engineering, Cochin University of Science and Technology, Cochin 682001, India Institute for Informatics and Telematics, National Research Council of Italy, 56124 Pisa, Italy Department of Medicine and Health Sciences "Vincenzo Tiberio", University of Molise, 86100 Campobasso, Italy Author to whom correspondence should be addressed. Mostly freely downloadable software's are a primary source of malware, which include freeware comprising of games, web browsers, free antivirus, etc. Malware obfuscation techniques: A brief survey, 2020, 10, 8351. Variation in data can be due to two critical aspects (a) variation within the group and (b) variation between the group. arXiv 2018, arXiv:1801.08115. It was observed that distinguishing feature vectors were obtained by considering two consecutive system calls. It can trace all calls made by a process to the imported functions from a DLL. We would also like to experiment on multi-class classification, i.e., labeling malware to its respective family. A total of 320 viruses were generated with virus constructors and used as training samples. Machine Learning-Based Techniques/AuthorApproach/DrawbackM. Table 5. J. Replacement of opcodes for malware generator (NGVCK, G2, PSMPC, and MPGEN). [Google Scholar] [CrossRef] [Alzaylaee, M.K.; Yerima, S.Y.; Sezer, S. Overlapping families of real malware with other families. Ether: Malware analysis via hardware virtualization extensions. We obtained these outcomes after classifying the samples using SVM, AdaBoost, Random Forest, and J48. Evaluation of machine learning classifiers for mobile malware detection. Constructors/Number of Families/Number of Variants/NGVCK521G2521PSMPC521MPGEN521Real Malware Samples115-77 Table 8. Thus the generalization ability could be limited.To expand the representative power of the attribute set, features while maintaining minimum pair-wise correlation, the minimum redundancy criterion supplements the maximum relevance criteria such as mutual information with target class. The generation of feature space of features like mnemonic, instruction opcode, API calls [38], and 4-gram mnemonic are extracted after unpacking the files. The Droiddetector tool [14] discriminates between legitimate and malicious samples in an Android environment by exploiting a deep learning network, relying on required permissions, sensitive APIs, and dynamic behaviors features. In this context, it refers to the various features obtained with feature extraction, as shown in Figure 2. The complete data set was divided such that 80% of samples are used for training and the remaining 20% are used as a test set. We observe that the best results are obtained with a deep neural network, followed by one-dimensional convolutional neural network and XGBOOST. Figure 3. The feature set may represent one or several dominant characteristics of an unknown sample, but it could also be a narrow region of relevant space. 2021, 105, 102198. Largely financial transactions are performed using the Internet, these have caused huge financial losses for organizations and individuals. Learn. Moreover, Alde analyses gives insight into what private information can be leaked by apps that use the same analytics library. Besides, we show that machine learning algorithms can precisely separate instances generated through virus kits using generic features like an opcode bigram.The rest of the paper is organized as follows: In the next section we provide an overview about the current state of the art in the malware detection context; in Section 3 we present the proposed method for malware detection; experimental analysis is discussed in Section 4; and, finally, in Section 5 a conclusion and future research plan are presented.To highlight the novelty of our work, we examine malware detection techniques topics for which the proposed method is related: The technique for malware detection and classification through machine learning and deep learning algorithms, and other techniques.Krugel et al. [Google Scholar] [CrossRef] [Ni, S.; Qian, Q.; Zhang, R. For the above-mentioned five-feature length, mRMR(MIQ) produces the best result with over 96% accuracy for feature-length 120 with Random Forest. We have designed a parser to parse all the traces and filter out API names without argument, which is considered a feature in our work.We performed static analysis using the open-source ObjDump tool to obtain assembly language code. The feature space is extended in increments of 50 opcodes at a time. This solution is based on utilizing the relationship existing between the various features of the data available. [Google Scholar] [CrossRef] [FahdaviFar, S.; Ghorbani, A.A. Application of deep learning to cybersecurity: A survey, Available online: (accessed on 6 July 2021). Windows API Library. [Google Scholar] [CrossRef] [Damodaran, A.; Di Troia, F.; Visaggio, C.A.; Austin, T.H.; Stamp, M., 2020, 89, 101663. We found that NGVCK samples are appropriately detected by using a simple feature, such as opcode bigram. [Google Scholar] [CrossRef] [VX Heavens. Performance of classifier trained on opcode features. ClassifierAccuracyF1-MeasureTPRaucRandom Forest97.80%97.8%97.7%0.998AdaBoostM197.37%96.4%96.8%0.974895.12%95.1%96.0%0.965SVM95.02%95.3%95.1%0.963XGBoost99.82%99.82%99.71%0.998 Table 5. Feature extraction. Support-vector networks. Sample 1Sample 2pushpushretn# -mov# -subandandleamovmovmov# -popa# -subjmpjmp* incmov* shrand* rormov* cmpdc Table 9. In all intermediate layers, we use ReLU activation function and randomly drop some neurons (i.e., dropout) to attain the best outcome for a particular neural network configuration. In this experiment, we identify malicious Android applications (also known as app.) using machine learning and deep learning techniques. 51-62. System call sequence. In Proceedings of the 8th Workshop on Enabling Technologies on Infrastructure for Collaborative Enterprises, Palo Alto, CA, USA, 16-18 June 1999; IEEE Computer Society: Washington, DC, USA, 1999; pp. At the same time, 4-grams do exhibit some merits as it partially depicts the behavioral snapshot of a program and sometimes produces comparable results to other approaches.Finally, we derived the opcode-based feature set and reduced these features with mRMR (MID), mRMR (MIQ), and ANOVA, where the performance of the model is evaluated over a feature-length between 40 and 120 in increments of 20 as shown in Figure 7. Available online: (accessed on 6 July 2021).Virusshare. Available online: (accessed on 6 July 2021).You, I., Yim, K. Comput. Each neuron act as a processing unit to output complex features of input data. Available online: (accessed on 6 July 2021).Drebin. The basic idea of dynamic analysis is to monitor the program while in execution. SVM produces poor results among the four classifiers, which can be explained by SVM's tendency to over-fitting when the number of features is higher than the number of samples. We further evaluate the performance of machine learning models generated by combining different feature categories. For this purpose we created four datasets discussed below-Dataset-1 (VX-Dataset). A total of 2000 Portable Executables were collected which consists of 1000 malware samples gathered from sources VXHeaven (650) [35], User Agency (250), and Offensive Computing (100), and benign samples were collected from Windows XP System32 Folder (450), Windows7 System32 Folder (100), MikTex/Matlab Library (400), and Games (50).Dataset-2 (Virusshare-Dataset): A total of 622 executables were downloaded from virusshare [36], these belong to malware families like Mediyes, Locker, Yan et al. [30]DroidScope, an Android analysis platform that continues the tradition of virtualization-based malware analysis.Overall performance of the model is less, compared to others.G. Canfora et al. [34]Method for detecting malware based on the occurrences of a specific subset of system calls, a weighted sum of a subset of permissions.Precise patterns and sequences of system calls that could be recurrent in malicious code fragments were ignored.D. Su et al. [32]Automated community detection method for Android malware apps by building a relation graph based on their static features.This method for malware app family classification is not as precise as supervised learning approaches.X. Liu et al. [33]Collect and analyze users action (API) on an Android platform to detect privacy leakage.Fail when tracking APIs used by other apps that are not listed in the configure file.R. Casolare et al. [34]Static approach, based on formal methods, which exploit the model checking technique.Limitations of method is that the generation of the first heuristic is not automatic. Software de-armoring. This is because the opcode attribute in combined attribute space does not contribute towards classification, as they introduce more sparsity in feature vectors. Since the ensemble classifier was developed by concatenating prominent features from various feature sets, it is evident from the results that each modality considered for fusion has contributed to the overall performance of the classifier. Traditionally, anti-malware products use signatures for detecting known malware. Another reason to choose Windows XP Service Pack 2 is that the ether patched version of Xen has been tested with XP SP2 as guest OS and Debian Lenny as host OS.Running Ether Patched Xen: Once we have installed the Operating System on Ether patched Xen, we run the machine using the vncviewer [41].Unpacking using Ether Patched Xen: To analyze the malware dynamically, the malware is executed on the DomU machine (XP SP2) and its footprints are recorded on the Dom0 system (Debian Lenny).Ether dumps the sample by finding the Original Entry Point using the memory writes a program does. Malware identification using visualization images and deep learning. The advantage of using an emulator is that the actual host machine is not infected by the viruses during the dynamic API tracing step. We use a deep neural network with an input layer consisting of 500 neurons and the second layer contains 250 neurons. 2016, 21, 114-123. The individual tuples making up the training set are referred to as training tuples and are randomly selected from the dataset. Data set description is given in Table 7.Mnemonics are extracted from each malware sample and aligned using the global and local sequence alignment method. [Google Scholar] [CrossRef] [McLaughlin, N.; Martinez del Rincon, J.; Kang, B.; Yerima, S.; Miller, P.; Sezer, S.; Safaei, Y.; Trichel, E.; Zhao, Z.; Doupé, A.; et al. Malware analysis is the process aimed to inspect and understand a malicious behavior [3]. We developed a classification model using different algorithms such as J48, AdaBoostM1 with J48 as a base classifier, and Random Forest. The term modality means the particular mode in which something is expressed. Alzaylaee et al. Figure 7. We found variants generated from MPGEN are similar to G2 and PSMPC, where x, y is the feature, namely mnemonic, instruction opcode, api call, 4-gram mnemonic, P (x | , y |) is the joint probabilistic distribution of feature x and y, P (x |) , P (y |) are the marginal probabilities, I (x , y) is the mutual information between feature x and y, i indicates the level of state of feature x and j indicates the state of feature y, and S is the set obtained from cross product of set of states of x and y. [19]Detecting worms and other malware by using sequences of WinAPI calls.Approach is limited to the detection of worms and exploits the use of hard-coded addresses of API calls.]. Bergeron et al. [20]Proposed a slicing algorithm for disassembling binary executables.Graphs created are huge in size, thus the model is not computationally feasible.Q. Zhang et al. [21]Approach for recognizing metamorphic malware by using fully automated static analysis of executables.Absence of analysis of the parameters passed to library or system functions.V. S. Ether in particular is based on the application of a hardware virtualization extension, such as Intel VT [6] and resides entirely outside of the target OS environment. In Proceedings of the 21st Annual Network and Distributed System Security Symposium (NDSS), San Diego, CA, USA, 23-26 February 2014. While running applications, system calls are recorded using trace utility, during this event we employ Android Monkey (a utility in Android SDK for fuzz testing application) to simulate the collection of events (e.g., changing the location, battery charging status, sending SMS, dialling to a number, swiping, clicking on widgets of an app, etc.). We found that an increase in bigrams had a marginal influence on the classifier performance. In our work, we utilized various machine learning and deep learning algorithms, such as Support Vector Machine (SVM) [45,48], Naïve Bayes [49], J48 [50], Random Forest (RF) [51], and XGBoost [52]. Mob. Prominent features are extracted using Minimum Redundancy and Maximum Relevance (mRMR) and Analysis of Variance (ANOVA). We demonstrate the efficacy of APIs and system call sequence in identifying samples. Detecting Android malicious apps and categorizing benign apps with ensemble of classifiers. [Google Scholar]Factorial Anova. Performance metrics of machine learning models. An empirical study of the naive Bayes classifier. It creates a hash-table for all the memory maps, and whenever there is a write to a slot in the hash table, it reports that as the Original Entry Point, which is the starting point of execution of a packed executable.In our approach, we used API calls (dynamic malware analysis), and mnemonic/opcode, instruction opcode, and 4-gram mnemonic (static malware analysis). However, this result is obtained with an extra effort i.e., feature engineering which is a critical task in the machine learning pipeline. In Proceedings of the the 6th Joint Meeting of the European Software Engineering Conference and the ACM SIGSOFT Symposium on the Foundations of Software Engineering, Dubrovnik, Croatia, 3-7 September 2007; ACM: New York, NY, USA, 2007; pp. Furthermore, this demonstrates that multimodal learning can be promising for increasing the detection in the malware detection task.Summary: Experiments on VX-dataset demonstrates that combining prominent mRMR features results in improved results on comparing individual features. [Google Scholar] [CrossRef] [Alaieyan, M.; Parsa, S.; Conti, M. To extract these features the various open-source tools used are listed below:API Call tracing using Veratrace. We conclude that malware kits generate metamorphic variants which employ simple obfuscation transformation easily identified using the local sequence alignment approach. 2018, 14, 1-20. [16]Android malware detection using deep learning on API method sequences.Less affected by the obfuscation techniques because they only consider the API method calls.G. Iadarola et al. Malware or malicious code is harmful code injected into legitimate programs to perpetrate illicit intentions. This program can trace API calls of only de-armored programs obtained from Ether. Table 4. However, this feature set is not a comprehensive representation of the characteristics of the target variable due to two essential aspects, as cited in [47]:Efficiency: If a feature set of 50 samples contains many mutually highly correlated features, the representative features are very few, say 30, which means

20 features are redundant, increasing the computational cost. Breadth: According to their discriminative powers, we select some attributes, but such feature space is not maximally representative of the original space covered by the entire data set. [Tinghua Sci. We also studied the impact of varying feature lengths beginning with 50 bigram until 250 bigrams are included. False Negative (FN) is the number of malicious files misclassified as benign. The advantage of feature selection is listed below: Dimensionality Reduction: Reducing the number of features helps in reducing the computational cost. Reduction of noise to boost the classification accuracy. Reducing the number of irrelevant features can help identify and monitor the unknown sample. We observe that the initial feature space obtained contained irrelevant attributes. [Google Scholar] [CrossRef]Rabek, J.C., Khazan, R.I., Lewandowski, S.M., Cunningham, R.K. Detection of injected, dynamically generated, and obfuscated malicious code. 194-189. [8] used dynamic analysis to detect obfuscated malicious code using a mining algorithm. Prisc: Comparison of symmetric key algorithms for IoT devices. The shallow network has a limited generalization capability. Here, we investigate the performance of models trained on independent attribute categories and unifying static and dynamic features. [Google Scholar] [CrossRef]Arp, D., Spreitzerbarth, M., Huebner, M., Gascon, H., Rieck, K. Available online: (accessed on 6 July 2021).Ding, C., Peng, H. The transition from Ether to an alternative sandbox (Parsa sandbox) arrived as many executables crashed while running in Ether. We use Ether as a tool for de-armoring since it is not signature-based and also due to its transparency to malware. Before executing samples in the system, we freshly installed the operating system and a snapshot of virtual environment was taken. In Proceedings of the 2019 International Conference on Electrical and Computing Technologies and Applications (ICECTA), Ras Al Khaimah, United Arab Emirates, 19-21 November 2019; pp. In Proceedings of the 33rd IEEE Symposium on Security and Privacy (Oakland 2012), San Francisco, CA, USA, 21-23 May 2012. Performance matrix of machine learning classifiers on system call sequence. [17]Deep learning model for mobile malware detection and family identification.Model needs to be trained with large sets of labeled data. Figure 1. TechniquesAuthorApproachDrawbackB. In general, classification is a two step process as discussed below.In the first step, we built a classifier describing a predetermined set of classes or concepts, also known as the learning step (or training phase). We consider such a feature space as a multimodal attribute set. "F-Statistic" has its tailored distribution and is always positive. Some examples of class sequence are shown in Figure 10. We considered 40% of top system calls from the list of unique calls extracted from entire training set. From Table 4, we can visualize the best outcome for the XGBoost classifier. A separate test set is considered which includes 95 viruses (20 viruses from each generator and 15 real metamorphic) and 20 benign samples. For experimenting on Dataset-1 and Dataset-4, we used a machine installed with Debian Linux (Debian 5.0.8) as the host operating system, Windows XP Service Pack 2 as the guest operating system, 17 processor with 8GB RAM and 1TB HDD. In Table 9, prominent mismatch opcodes are shown for four generators as the rest has shown a similar trend. Table 2 compares the average of the results of different models. Detecting Colluding Inter-App Communication in Mobile Environment. In Proceedings of the 13th Australasian Conference on Information Security and Privacy, Wollongong, Australia, 7-9 July 2008; Springer: Berlin/Heidelberg, Germany, 2008; pp. If packed, the import table would be populated with API calls like GetProcAddress() and LoadLibrary(), which are also common to legitimate executables. Archit. [26] proposed a method to find the metamorphism in malware constructors like NGVCK, G2, IL, SMG, and MPCGEN by executing each malware sample in a controlled environment like OEMU and monitoring API calls using STRaceNTX. True Negative (TN) is the count of files identified as legitimate. While a program is executing, we log all APIs, extract call names, and select prominent calls using mRMR to create a machine learning model. Feature selection process. MalDozer [16] is a tool aimed at Android malware detection and family identification by analyzing API method calls. Table 5 is the results obtained at varying values of dropout, the best results are obtained with a dropout rate of 0.1. Malware constructors generate variants from the base virus by inserting equivalent instructions, reordering, and subroutine permutations as code obfuscation techniques. We have achieved multimodal fusion in our experiment by carrying out feature selection (as shown in Figure 3) on the relevant attributes from diverse categories (4-gram, mnemonics, API, and opcodes) and then fusing them as shown in Figure 8.As each feature has a different representation and correlation structure, the fusion of all these relevant features helps to extract maximum performance. Signature Generation and Detection of Malware Families. The labels corresponding to the class attribute x is discrete valued and unordered. For all generators, mov, push, pop, and jmp instructions are replaced. 41-46. [Google Scholar] [CrossRef]Nair, V.P.; Jain, H.; Golecha, Y.K.; Gaur, M.S.; Laxmi, V. N. et al. Due to software armoring, malware writers can defeat malicious applications from detection. Before beginning with the analysis of the malware, we should check whether the malware is armored or not. Zhang, et al. Figure 6. We chose Windows XP Service Pack 2 as most of the viruses, written for, Windows environments only. This means the greater the distance of a sample from the base malware, the lesser the similarity. The lower layers extract features that are gradually amplified in the subsequent layers (higher layers). In Proceedings of the 1st Reversing and Offensive-Oriented Trends Symposium, Vienna, Austria, 16-17 November 2017; pp. However, if we further increase the features beyond a certain limit there is a drop in accuracy, primarily due to the addition of noise. 336-349. The mutual information of two features x and y is defined as the joint probabilistic distribution $P(x,y)$ and their respective marginal probabilities $P(x)$ and $P(y)$ (refer to Equation (1)). Secur. [Google Scholar]Iadarola, G.; Martinielli, F.; Mercurio, F.; Santone, A. They highlight that most research papers on Android malware detection are focused on outdated repositories, such as the MalGenome project [28] and the Drebin [29] datasets.DroidScope [30] uses a customized Android kernel to reconstruct semantic views to collect detailed application execution traces. [Google Scholar] [CrossRef]Canfora, G.; Medvet, E.; Mercurio, F.; Visaggio, C.A. Detecting Android malware using sequences of system calls. In particular, we consider a set of features obtained from benign and malicious executables like mnemonics, instruction opcodes, and API/system calls for automatically discriminating legitimate and malicious samples. Intallcore, CyptoRansom, Citadel Zeus, and APT1. 293. To unpack samples, we used Ether patched XEN. Using Fuzzy Pattern Recognition to Detect Unknown Malicious Executables Code. With the rapid growth of the Internet and heterogeneous devices connected over the network, the attack landscape has increased and has become very dynamic, affecting the privacy of users [1]. Figure 12. Authors in [25] used Hidden Markov Models (HMMs) to represent the statistical properties of a set of metamorphic virus variants. In our process, we followed these steps-Disk Image Creation: We created a disk image, this disk image works as a separate hard disk/Windows XP Installation: Once the disk image was created, we installed Windows XP on that disk image. Future Gener. In Proceedings of the 8th International Symposium on Visualization for Cyber Security, Pittsburgh, PA, USA, 20 July 2011; pp. Generally, Post Hoc tests such as "F" statistics is performed to analyze the results of experiments. Considering that the cause of a problem is often best understood by studying the structural aspects of a program like the mnemonics, instruction opcode, API Call, etc. A custom-developed parser transforms the sample to FVT of mnemonics and instruction opcode. In the following paragraphs, we briefly introduce the features extracted from malware and legitimate executables.The Windows API, informally WinAPI, is Microsoft's core set of application programming interfaces (APIs) available in the Microsoft Windows operating systems. Figure 4. In the process of alignment, two opcode sequence gaps may be inserted. [14]An online deep learning-based Android malware detection engine (DroidDetector).The semantic-based features of Android malware were not considered.N. McLaughlin et al. Here, we use system calls as a feature for representing each application. For obtaining better results, the shallow networks must be presented with features that are handpicked or suitably chosen after several iterations of the feature selection algorithms. Academic Editor: Suleiman Yerima Electronics 2021, 10(14), 1694; Received: 19 April 2021 / Revised: 7 July 2021 / Accepted: 9 July 2021 / Published: 15 July 2021 Malware is one of the most significant threats in today's computing world since the number of websites distributing malware is increasing at a rapid rate. The motivation behind using the aforesaid sandboxes are to stop side-effects induced to the host environment and to permit malware to exhibit its capabilities, which can be used as features for developing detection models. Sun et al. In Proceedings of the 2nd International Workshop on Security of Mobile Applications, In Conjunction with the International Conference on Availability, Reliability and Security, Regensburg, Germany, 2-6 September 2013. [Google Scholar]Zhou, Y., Jiang, X. Data set description with samples, number of families, and number of variants of each family. Eventually, the performance of the model on a given test set is estimated, generally evaluated as the percentage of 10 test set tuples that are correctly classified by the classifier. We used following evaluation metrics: True Positive Rate (TPR) or Recall (R) = $T \cdot P / T + P$ and F1 Score = $2 \cdot P \cdot R / (P + R)$ and Precision (P) = $T \cdot P / T + P$ and F2 Score = $2 \cdot P \cdot R / (2P + R)$ and F3 Score = $3 \cdot P \cdot R / (2P + R + F)$ and F4 Score = $4 \cdot P \cdot R / (3P + R + F)$ and F5 Score = $5 \cdot P \cdot R / (4P + R + F)$ and F6 Score = $6 \cdot P \cdot R / (5P + R + F)$ and F7 Score = $7 \cdot P \cdot R / (6P + R + F)$ and F8 Score = $8 \cdot P \cdot R / (7P + R + F)$ and F9 Score = $9 \cdot P \cdot R / (8P + R + F)$ and F10 Score = $10 \cdot P \cdot R / (9P + R + F)$ and F11 Score = $11 \cdot P \cdot R / (10P + R + F)$ and F12 Score = $12 \cdot P \cdot R / (11P + R + F)$ and F13 Score = $13 \cdot P \cdot R / (12P + R + F)$ and F14 Score = $14 \cdot P \cdot R / (13P + R + F)$ and F15 Score = $15 \cdot P \cdot R / (14P + R + F)$ and F16 Score = $16 \cdot P \cdot R / (15P + R + F)$ and F17 Score = $17 \cdot P \cdot R / (16P + R + F)$ and F18 Score = $18 \cdot P \cdot R / (17P + R + F)$ and F19 Score = $19 \cdot P \cdot R / (18P + R + F)$ and F20 Score = $20 \cdot P \cdot R / (19P + R + F)$ and F21 Score = $21 \cdot P \cdot R / (20P + R + F)$ and F22 Score = $22 \cdot P \cdot R / (21P + R + F)$ and F23 Score = $23 \cdot P \cdot R / (22P + R + F)$ and F24 Score = $24 \cdot P \cdot R / (23P + R + F)$ and F25 Score = $25 \cdot P \cdot R / (24P + R + F)$ and F26 Score = $26 \cdot P \cdot R / (25P + R + F)$ and F27 Score = $27 \cdot P \cdot R / (26P + R + F)$ and F28 Score = $28 \cdot P \cdot R / (27P + R + F)$ and F29 Score = $29 \cdot P \cdot R / (28P + R + F)$ and F30 Score = $30 \cdot P \cdot R / (29P + R + F)$ and F31 Score = $31 \cdot P \cdot R / (30P + R + F)$ and F32 Score = $32 \cdot P \cdot R / (31P + R + F)$ and F33 Score = $33 \cdot P \cdot R / (32P + R + F)$ and F34 Score = $34 \cdot P \cdot R / (33P + R + F)$ and F35 Score = $35 \cdot P \cdot R / (34P + R + F)$ and F36 Score = $36 \cdot P \cdot R / (35P 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