Apps Data Management

University of Texas at Dallas

Big Data Analytics and Management Lab

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Overview

With the recent emergence of mobile platforms capable of executing increasingly complex software and the rising ubiquity of such platforms in sensitive domains such as banking, military operations, healthcare, and law enforcement, user privacy and data security have become major concerns. This attracted researchers to study various methods to perform Traffic Analysis (TA) on mobile apps that connect to remote hosts or app servers through cloud service providers.

The focus of this project is to identify an app by listening to the encrypted TCP traffic as illustrated in Figure 1. The attacker passively gathers encrypted packets, extracts features, and uses data analytics/machine learning to predict the name of the app. This is known as *App Fingerprinting,* which helps the adversary achieve targeted attacks involving known vulnerabilities in apps (e.g. bank apps). It is important to note that the app server IP address cannot be used to reveal the name of the app as multiple apps may be hosted on the same cloud server with the same IP.

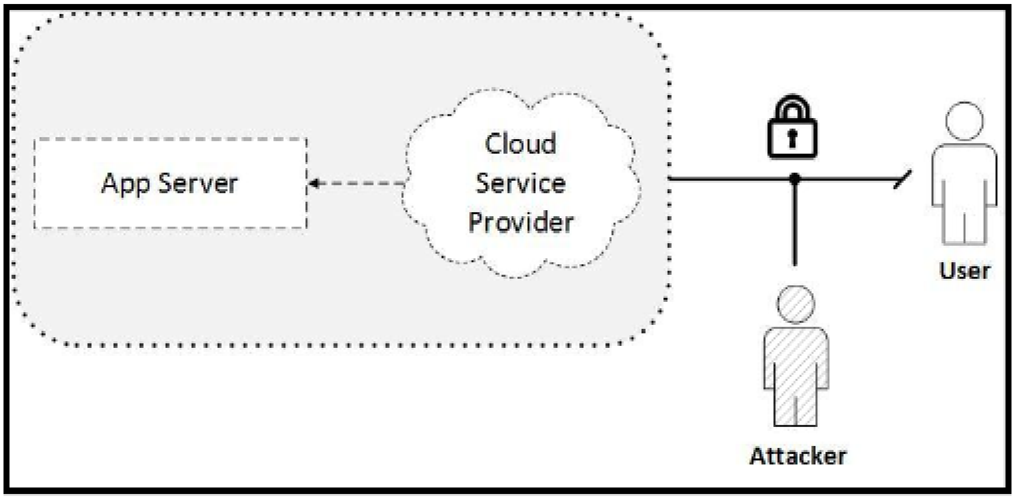


Figure 1. An illustration of App Fingerprinting.

To help researchers study the effect of such adversarial attacks, the web application tool introduced in this manual has two objectives, mobile **Dynamic Analysis** and **Data Analytics**.

The first part of our project is **Dynamic Analysis** which has been implemented through apps **Data Collection**. We build our own data set by executing multiple Android apps. As part of the process, the tool allows web browser clients to demo data collection using an Android emulator.

Figure 2 illustrates the actual data collection process over a period of one month using an Android phone.

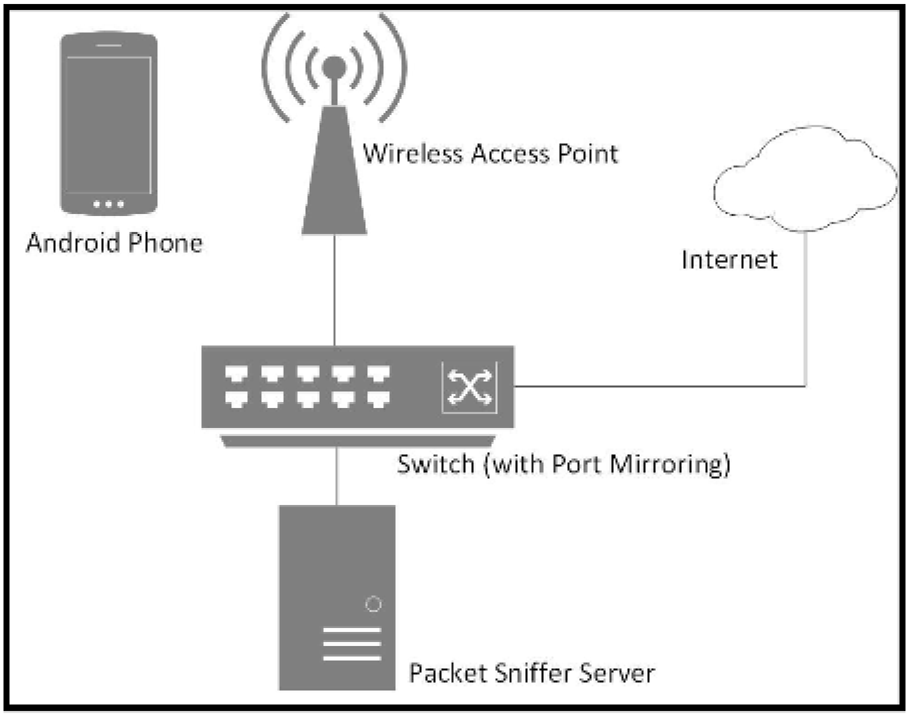


Figure 2. Data Collection Process.

The dataset was collected by executing multiple Android apps on a Samsung Galaxy S device, running Android version 4.3.1. We randomly select 2000 financial apps from Google Play Store. We then install and launch these apps on the phone which is connected to the Internet via a wireless router. Each trace per app is collected over a 30-sec period passively using a mirroring switch at the wireless router. These traces from such apps are then used to perform data analytics. It is important to note that we uninstall each app as soon as we complete capturing a trace to avoid any background noise during further trace generation.
Using this web application, the clients will experience this dynamic analysis process as will be explained in more detail in subsequent sections.

The second part of the project is **Data Analytics**. We use the traces from Data Collection to determine patterns which are used for app fingerprinting. Various features from network packets are extracted and then used alongside machine learning techniques to train a model that can identify an app from its network traffic. We evaluate this method in various environments to test its efficacy. The web application will help the client experience the effect of various machine learning algorithms with different feature extraction techniques.

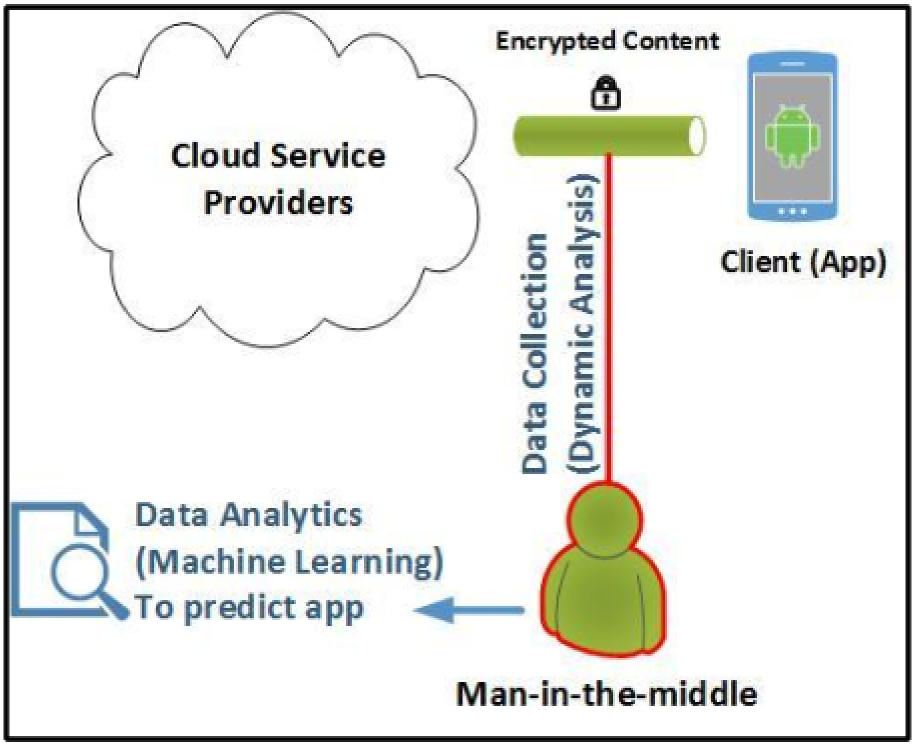

Cloud Service Providers
Encrypted Content
Client (App)
Data Collection (Dynamic Analysis)
Data Analytics (Machine Learning) To predict app
Man-in-the-middle

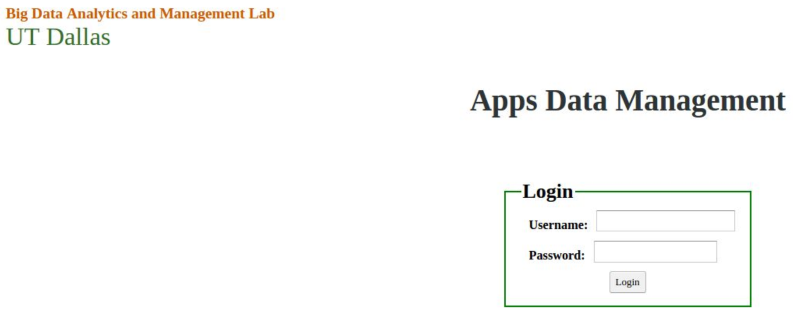
Figure 3. Dynamic Analysis and Data Analytics.

Figure 3 depicts the big picture of the app fingerprinting attack scenario. The attacker (man-in-the-middle) eavesdrops passively and collects app traces. Using feature extraction methods, these traces are converted to vectors that machine learning algorithms take as input for the classification/prediction task.

This manual shows how to implement the data collection/dynamic analysis process using an Android emulator. It also shows how to implement the data analytics part using various machine learning approaches for the fingerprinting task.

Part 1: Login

When you first access the website, the login screen appears.



Big Data Analytics and Management Lab
UT Dallas

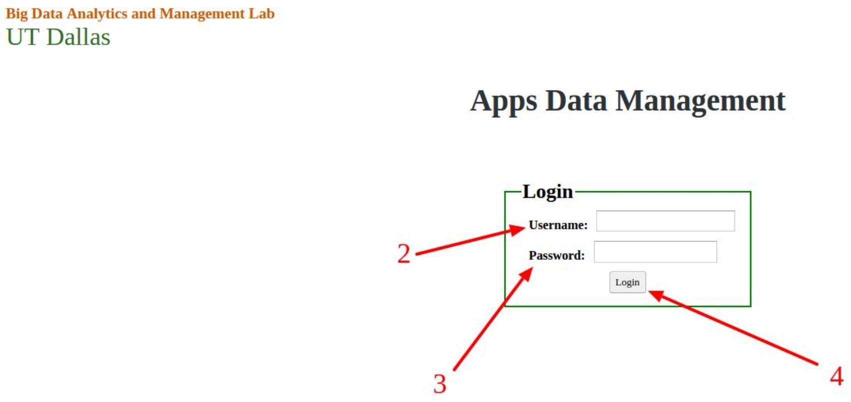
Apps Data Management

Login

Username:

Password:

1. To obtain a username and password, contact the Big Data Analytics and Management Lab at UTD at dml.utd@gmail.com.



Big Data Analytics and Management Lab
UT Dallas

Apps Data Management

Login

Username:

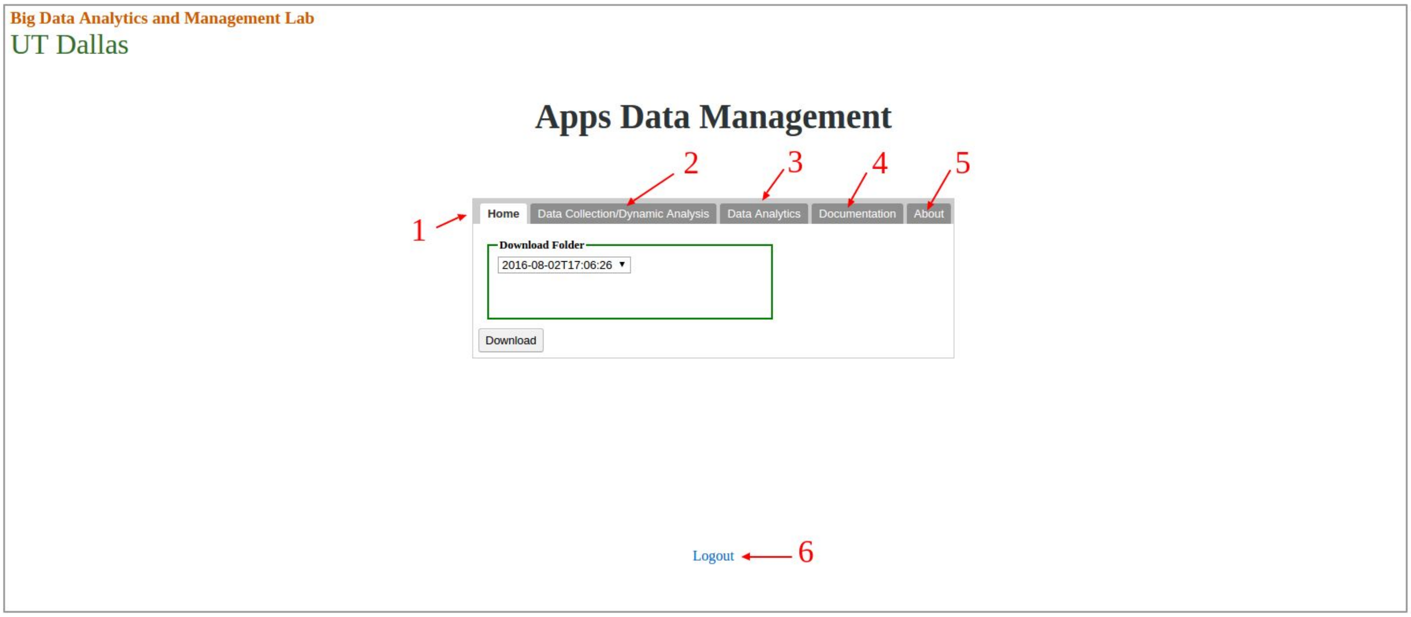
Password:

2. Enter the username in the “Username: “ field.
3. Enter the password in the “Password: “ field.
4. Click the “Login” button or hit the Enter key on your keyboard.

Part 2: Navigating the Main Page

Once logged in, the main page loads. All functions can be accessed from this page.

1. The “***Home***” tab is open when the page loads. It hosts the “*Download*” button which will be used later, after tests have been run. Ignore this for now.

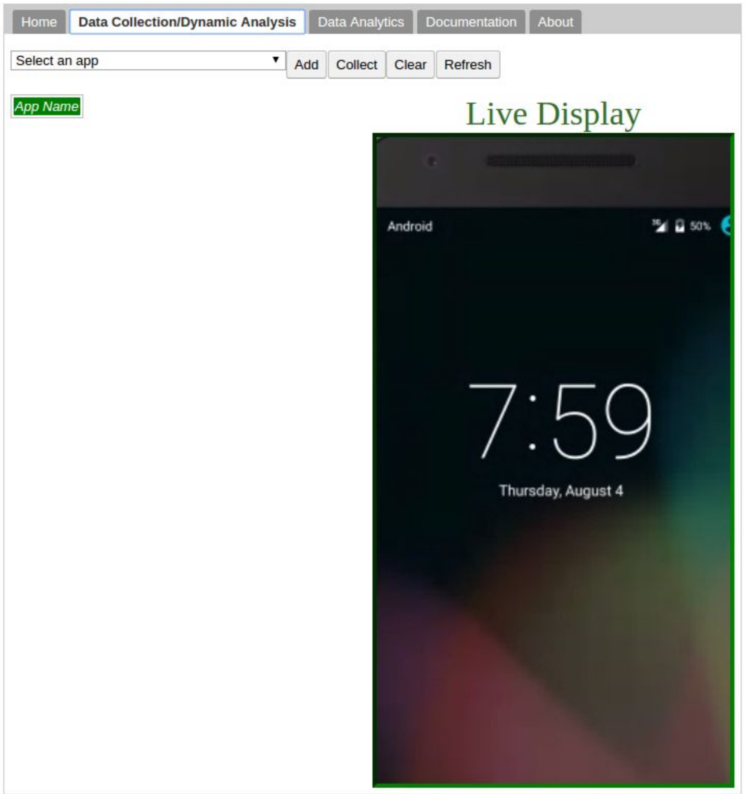


Big Data Analytics and Management Lab
UT Dallas

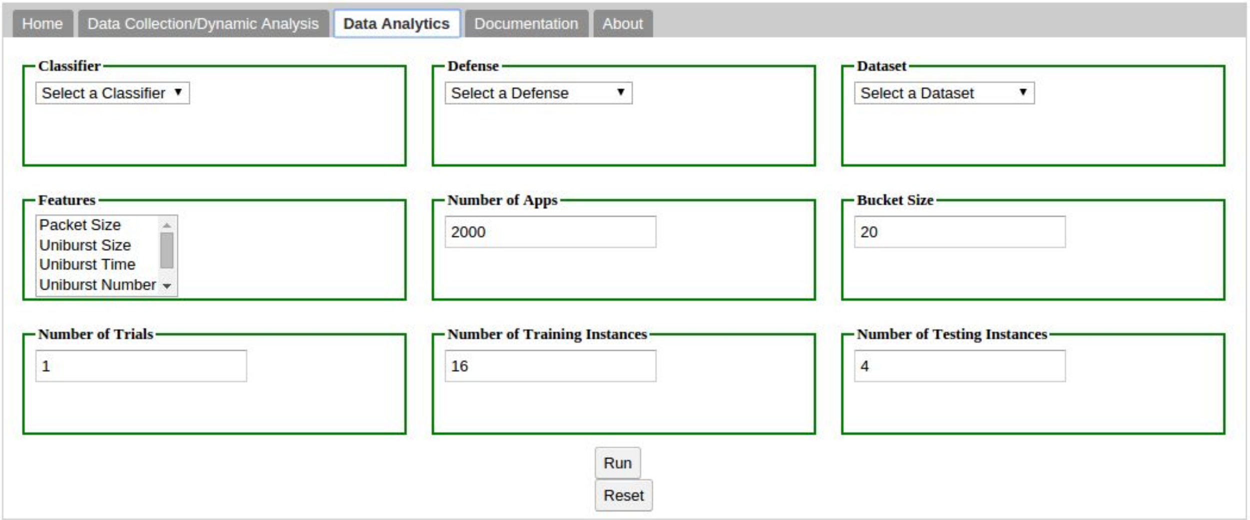
Apps Data Management

Download Folder: 2016-08-02T17:06:26

2. The “***Data Collection/Dynamic Analysis***” tab is where you can run tests to determine what websites an app accesses when it runs. As part of the process, the tool allows you to demo data collection using an Android emulator.



3. The “***Data Analytics***” tab is where you can run app fingerprinting tests by setting specific parameters. The web application will help you experience the effect of various machine learning algorithms with different feature extraction techniques.



Classifier: Select a Classifier

Defense: Select a Defense

Dataset: Select a Dataset

Features: Packet Size, Uniburst Size, Uniburst Time, Uniburst Number

Number of Apps: 2000

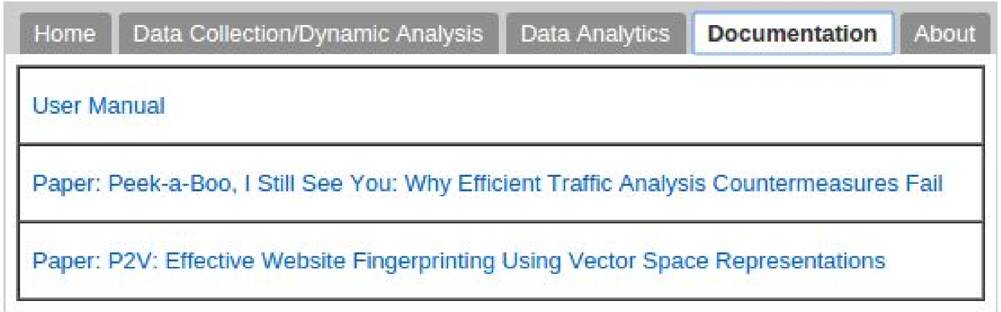
Bucket Size: 20

Number of Trials: 1

Number of Training Instances: 16

Number of Testing Instances: 4

4. The “***Documentation***” tab contains helpful links. These include relevant papers, website documentation, etc.

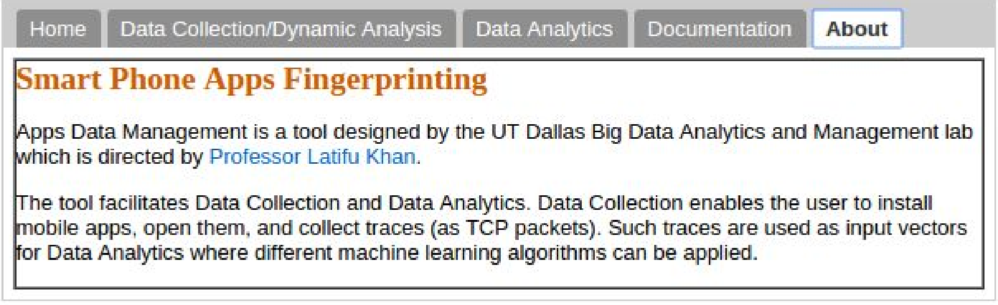


User Manual

Paper: Peek-a-Boo, I Still See You: Why Efficient Traffic Analysis Countermeasures Fail

Paper: P2V: Effective Website Fingerprinting Using Vector Space Representations

5. The “***About***” tab contains a brief overview of the project.



Smart Phone Apps Fingerprinting

Apps Data Management is a tool designed by the UT Dallas Big Data Analytics and Management lab which is directed by Professor Latifu Khan.

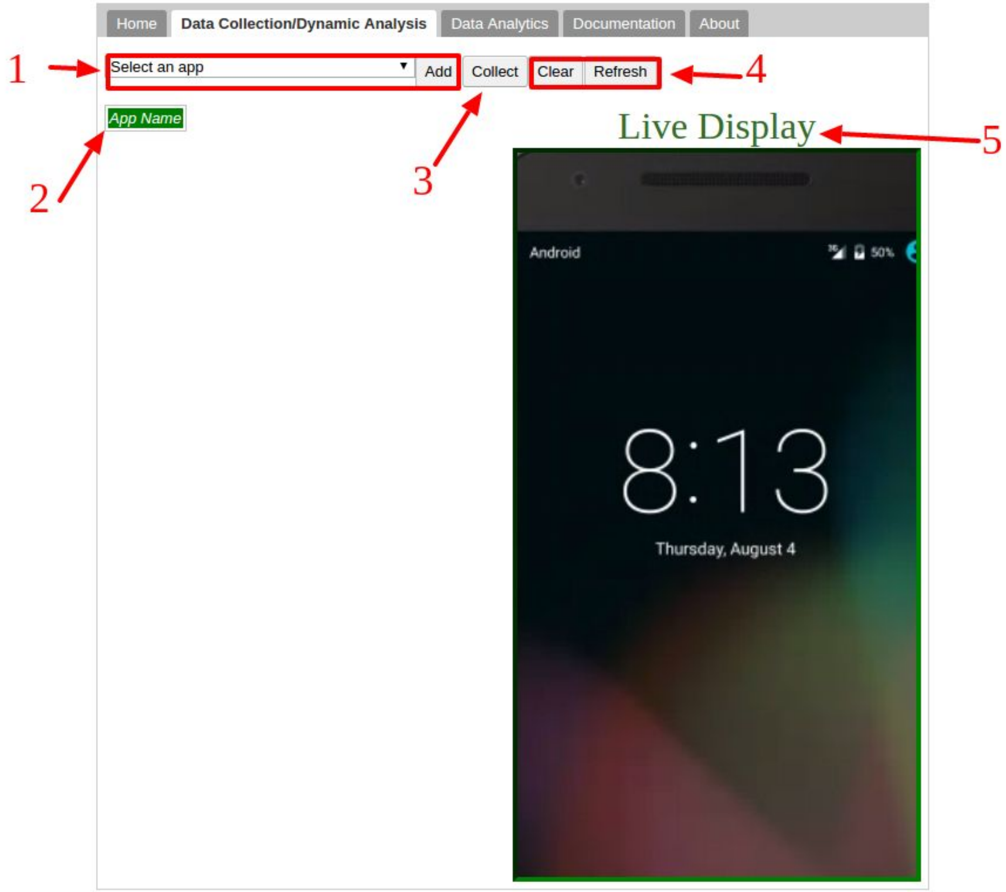
The tool facilitates Data Collection and Data Analytics. Data Collection enables the user to install mobile apps, open them, and collect traces (as TCP packets). Such traces are used as input vectors for Data Analytics where different machine learning algorithms can be applied.

6. The “***Logout***” link at the bottom of the page allows you to logout and return to the login screen. It is available with any tab selected.

Part 3: Data Collection/Dynamic Analysis

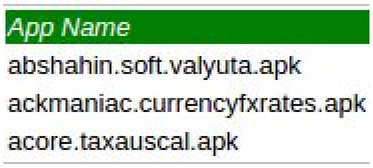
This tab hosts the mechanism to run app specific tests.

When apps run, they access a number of remote services in the background that a user is not aware of. These tests determine which services are being accessed.
Data Collection enables the user to install mobile apps, open them, and collect traces (as TCP packets). As part of the process, the tool allows you to demo data collection using an Android emulator.



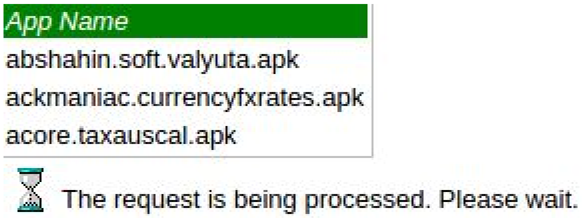
1. The drop down menu is used to select an app to test. Click on the app in the menu and click the "**Add**" button. The apps selected will be tested to determine what remote services they access.

2. Once an app has been added, its name will appear in the table under the green ***"App Name"*** heading. You can add/test multiple apps.



App Name
abshahin.soft.valyuta.apk
ackmaniac.currencyfxrates.apk
acore.taxauscal.apk

3. When you are done adding apps, click the "***Collect***" button. The tests will start running. A message will appear letting you that the process has begun.



App Name
abshahin.soft.valyuta.apk
ackmaniac.currencyfxrates.apk
acore.taxauscal.apk

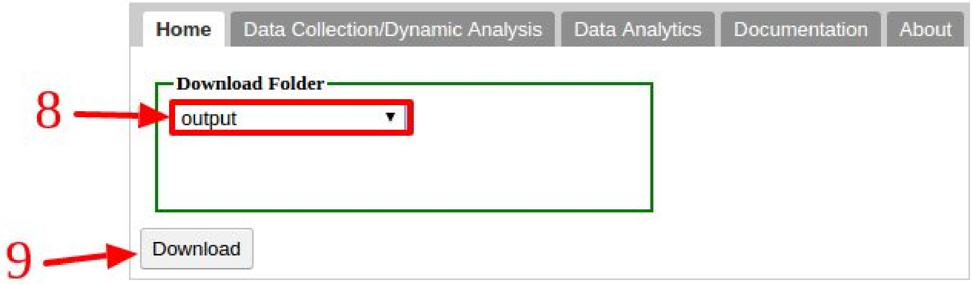
The request is being processed. Please wait.

4. If you would like to clear the list of apps you want to test, hit the "***Clear***" button. If you want to refresh the tests, hit the "***Refresh***" button.

5. The "Live Display" screen shows the process that occurs when the tests are running. Ex: apps opening, closing, etc.

6. When the process is complete, a pop up window will appear.

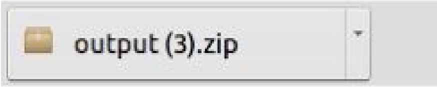
7. To obtain the results, go to the ***"Home"*** tab.



Download Folder: output

8. In the drop down menu in the “***Download Folder***” box, select “**output**”, or the relevant folder (date and time).

9. Click the **“Download”** button. A link will appear at the bottom left of your screen like the image below.



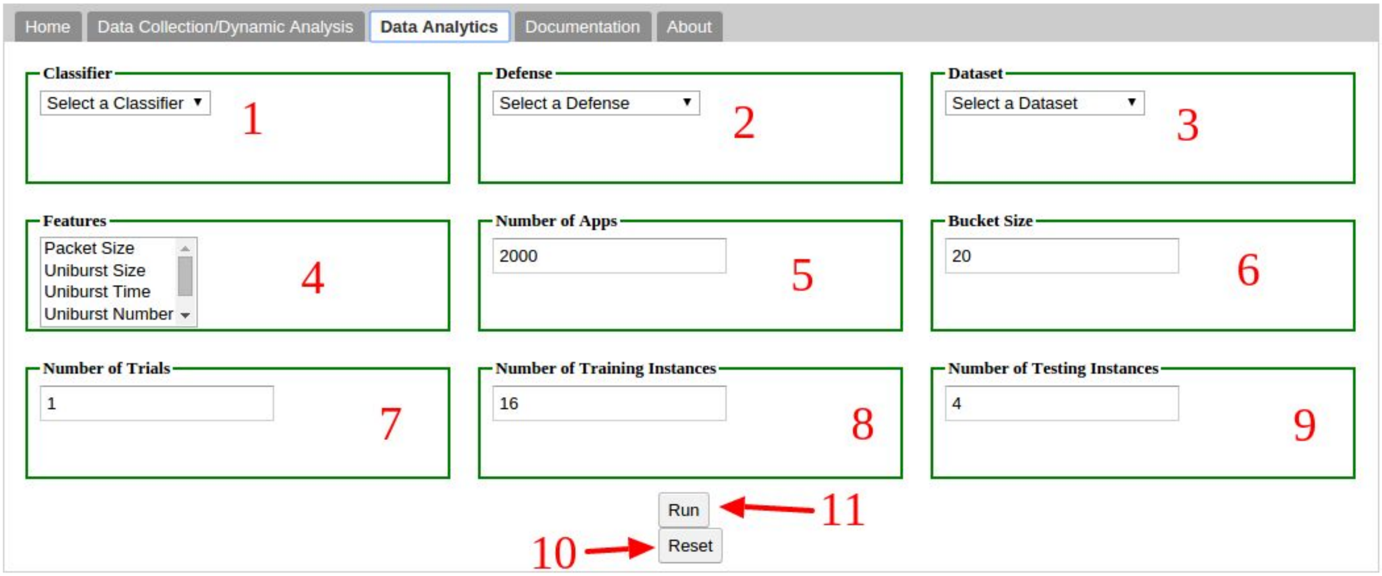
output (3).zip

10. Click the link and follow the file path *</home/dml_utd/tomcat/webapps/appfin/appsData/output/>* and the results will be there.

Part 4: Data Analytics

This tab hosts the mechanism to run feature specific app tests.

When a user opens an app, it accesses remote servers. Sometimes, these servers cannot be readily identified and certain features they have must be extracted and used to identify them. Such traces are used as input vectors for Data Analytics where different machine learning algorithms can be applied. The web application will help you experience the effect of various machine learning algorithms with different feature extraction techniques.



Classifier: Select a Classifier

Defense: Select a Defense

Dataset: Select a Dataset

Features: Packet Size, Uniburst Size, Uniburst Time, Uniburst Number

Number of Apps: 2000

Bucket Size: 20

Number of Trials: 1

Number of Training Instances: 16

Number of Testing Instances: 4

1. Use the drop down menu to select a **Classifier** under which the tests will be run.

2. Use the drop down menu to select a **Defense**, if any, that will be applied to the apps that are being being fingerprinted.

3. Use the dropdown menu to select a **Dataset** from which websites will be selected for the tests.

4. Use the multi-select **Features** bar to select the features, if any, you want the tests to take into account. To select multiple features, press and hold the ctrl key

as you select features. The features you select will be the ones used to fingerprint the websites and will be the focus of the tests.

5. Enter the **Number of Apps** you want the test to use.

6. Enter the **Bucket Size** you want the test to use.

7. Enter the **Number of Trials** you want to tests to have.

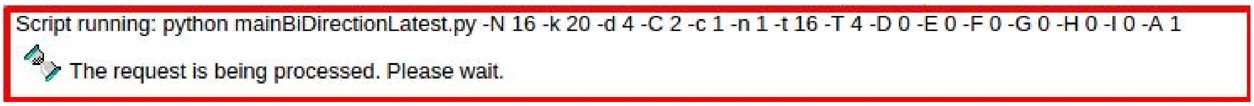
8. Enter the **Number of Testing Instances** you want to tests to have.

9. Enter the **Number of Training Instances** you want to tests to have.

10. If you want to reset the fields, click the "***Reset***" button.

11. When you are done filling out all the fields, click the "***Collect***" button.

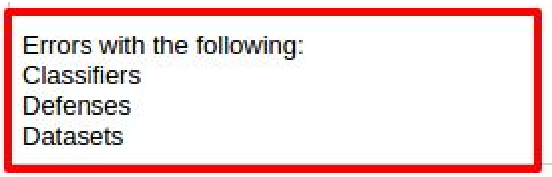
12. If all the fields were correctly filled in, a message will appear letting you know that the process has begun, as shown in the image below.



```
Script running: python mainBiDirectionLatest.py -N 16 -k 20 -d 4 -C 2 -c 1 -n 1 -t 16 -T 4 -D 0 -E 0 -F 0 -G 0 -H 0 -I 0 -A 1
```

The request is being processed. Please wait.

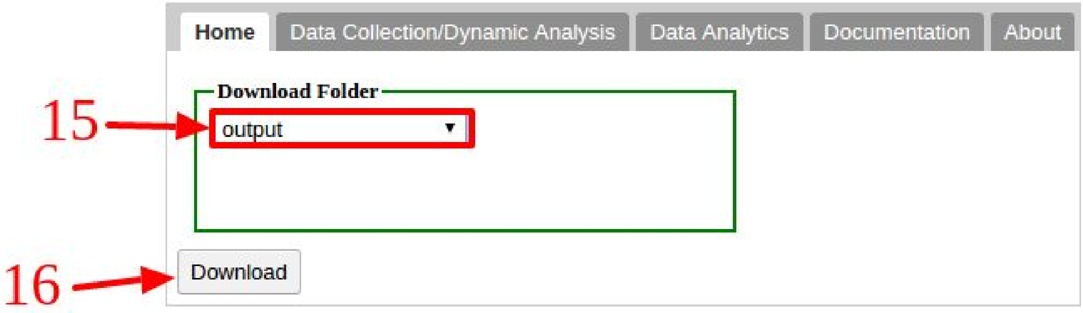
If they were not correctly filled in, a message will appear letting you know which ones to correct, as shown in the image below. Correct them, and hit "***Collect***" again.



Errors with the following:
Classifiers
Defenses
Datasets

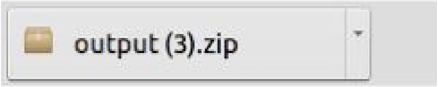
13. When the tests are done running, a pop up window will appear.

14. To obtain the results, go to the ***"Home"*** tab.



15. In the drop down menu in the "***Download Folder***" box, select "**output**", or the relevant folder (date and time).

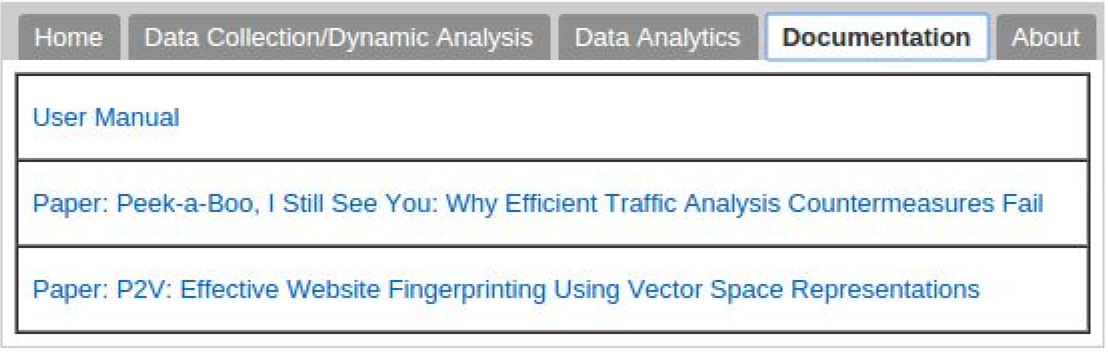
16. Click the **"Download"** button. A link will appear at the bottom left of your screen like the image below.



17. Click the link and follow the file path */home/dml_utd/tomcat/webapps/appfin/appsData/output/* and the results will be there.

Part 5: Documentation

This tab hosts useful links.



User Manual

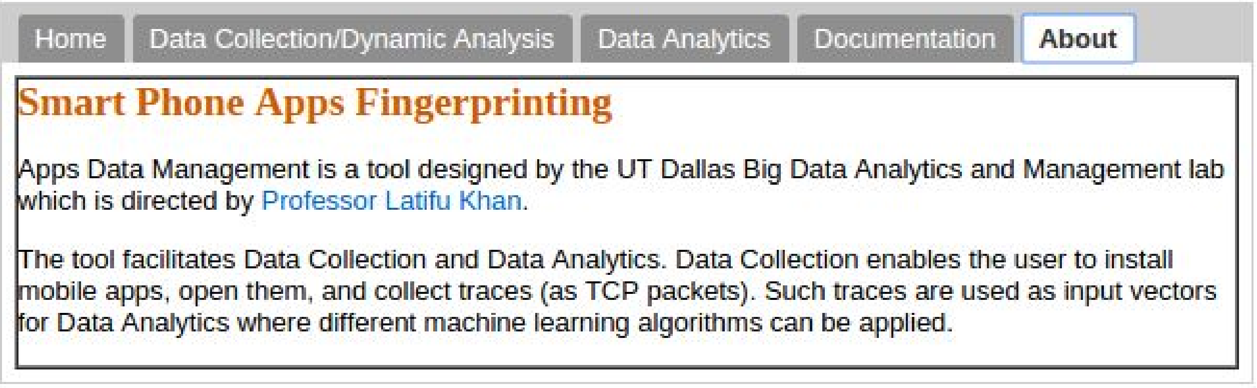
Paper: Peek-a-Boo, I Still See You: Why Efficient Traffic Analysis Countermeasures Fail

Paper: P2V: Effective Website Fingerprinting Using Vector Space Representations

There are links to useful papers relative to app fingerprinting, user manual, etc.

Part 6: About

This tab has a brief description of the project.



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There is a link to Dr. Khan's page and a brief overview of the project. For more information, look to the Overview section of this manual.