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Part II: Data collection / feature extraction

Deadline: 13.11.2019

Study Project: Adversarial Machine Learning

Website Fingerprinting

Introduction

In the previous task you have implemented a script which automatically crawls websites. In this part, you extend this script to crawl a sequence of random sub-pages and store their raw TCP/IP traffic (corresponding fetches). Therefore you use the tool *tcpdump* from the *net-tools* package. The tool *tcpdump* captures headers and contents of packets on a given network interface. From this raw traffic data we will extract the TLS records. Although the payloads of the TLS packets are encrypted, the headers contain useful meta-information that can be used in the context of traffic analysis. For example, they include the length of the TLS record.
The *tcpdump* tool allows to store the packet information into a specified output file for later processing. The idea of this project part is to store this TCP/IP dump to a file and map the contents of the dump to the corresponding fetch. Thereby it is important to have a clean dump that only consists out of packets resulting from the automated website fetch.

Preliminaries

Please consider the following preliminaries before starting the actual implementation.

a) If not already installed, install the net-tools package; especially *tcpdump*.

b) Consider possible side effects in your TCP/IP dump and limit them (if not already done in part I)

c) Which additionally information do you need to map the TCP/IP dump to a given fetch? If necessary extend your browser automation script from part I to provide this information.

Subtask 01: Collection of TLS Traces

Extend your browser automation script such that the following requirements are fulfilled. On a given list of URL, your script behaves in the following way:

a) The website with the given URL is visited automatically without the need of human interaction.

b) Your script should parse the html content of the website and selects randomly a link which yields to a sub-page of the main-site. From this sub-page we select the next sub-page, in a similar random way, still staying on sub-pages of the main page, until we reached a certain depth, controlled by a given parameter.

c) Each website and its corresponding randomly selected sub-pages should be called/fetched multiple times which is specified by a parameter `num_instances`.

d) The complete raw TCP/IP traffic transmitted during the load of the website / sub-page is saved to a file called $identifier\_runnumber\_website.pcap$. The identifier should be unique. It is mandatory to use the given format for file naming.

e) The saved file *identifier_runnumber_website.pcap* only contains traffic corresponding the website; every side-effecting data before and after the page loading should be truncated.

f) On error occurrence, the script should report this and reject the collected traffic dump. (How do you notice an error?)

g) Your script should read TLS headers and parse the TLS records to extract the size of all TLS records used in fetching the website. This should be stored to a file called *identifier_runnumber_website.tls*.

Now run your extended Website Fingerprinting script on the given list of URLs containing 100 different websites. Collect the TLS traces for every website at least 40 times crawling for a depth of 4 sub-pages. Save the resulting traffic corresponding to their run-number and target website in a separate file. Make sure that there are no errors during the fetching process which may yield in negative side-effects in the TLS dump and thus the website fingerprinting attack executed later.

Subtask 02: Feature Extraction & Visualization

This task concerns the extraction of useful meta-data from TLS records for which the necessary features will be provided. Please visualize your extracted features to ensure that your fetching algorithm is working properly. Please consider the following preparations before starting with the actual implementation:

a) The features to be extracted are the number of outgoing TLS records, the number of incoming TLS records, the sum (length) of all outgoing TLS records, the sum (length) of all incoming TLS records and the cumulative chronical TLS record sequence (normalised).

b) Think about a reasonable way to calculate the sampling rate for each cumulative chronological packet sequence.

c) Choose a library to read pcap-files and to extract the requested data.

d) Choose a tool to visualize your extracted features. You should visualize all instances of the same website on one plot.

e) How can you identify corrupted data in your data set?

Now implement a piece of code that extracts all requested features from your collected data and fulfills the following requirements:

a) All the cumulative chronological records sequences are supposed to be of the same length (50 records).

b) The extracted features shall be stored in a file.

The second subtask is to visualize your extracted features by implementing a piece of code that fulfills the following requirements:

a) For each website visualize all cumulative chronological packet sequences in a separate diagram.

b) Save each diagram in a separate file. Use the same naming convention as for pcap-files.

Check your diagrams for corrupted data. Could this task be handled automatically?

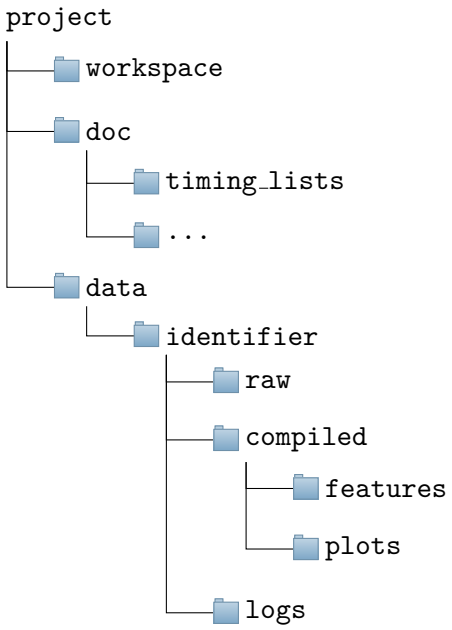
Subtask 03: Framework implementation

The last task for this part of the project is to combine all your previous implemented scripts to a framework. Your framework has to be controlled via command line parameter. Therefore implement at least the following parameters:

Option	Parameter	Description
-h	-	Shows an overview with all implemented command line parameters.
-l	-	Shows the log-file. If more than one exists, list all existing logs.
-v	input file	Shows the diagram of extracted features of input file.
-c	input file	Calls all web pages containing in given input file.
-n	number	Defines how often a web pages shall be called. Default 30.
-s	network interface	Defines network interface on which *tcpdump* shall listen.
-o	output folder	Defines folder, where pcap-files shall be stored.
-e	input folder	Extracts features from all pcap-files containing in input folder.
-o	output folder	Defines folder, where extracted features shall be stored.

Directory tree

Use the following directory tree for your git repository:



Hint

Please note that the effort for this project is calculated for three persons. Therefore it makes sense to distribute the workload.

Preparation of consultation

Prepare yourself for a short consultation of about 15 minutes. You shall give a short overview of libraries, scripts or already existing tools you have used. Furthermore present and explain your implementations. Give a proof of work through a demonstration of your program/scripts.

Good luck!