Normalizing Empire's Traffic to Evade Anomaly-Based IDS

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TEAR
SECURITY

Outline

- Current state of defense and assume breach scenarios
- Signature/Anomaly based NIDS and evasion
- A brief information about Empire project
- Anomaly based NIDS and Empire
- Proposed solutions
- firstorder tool

A Basic Network

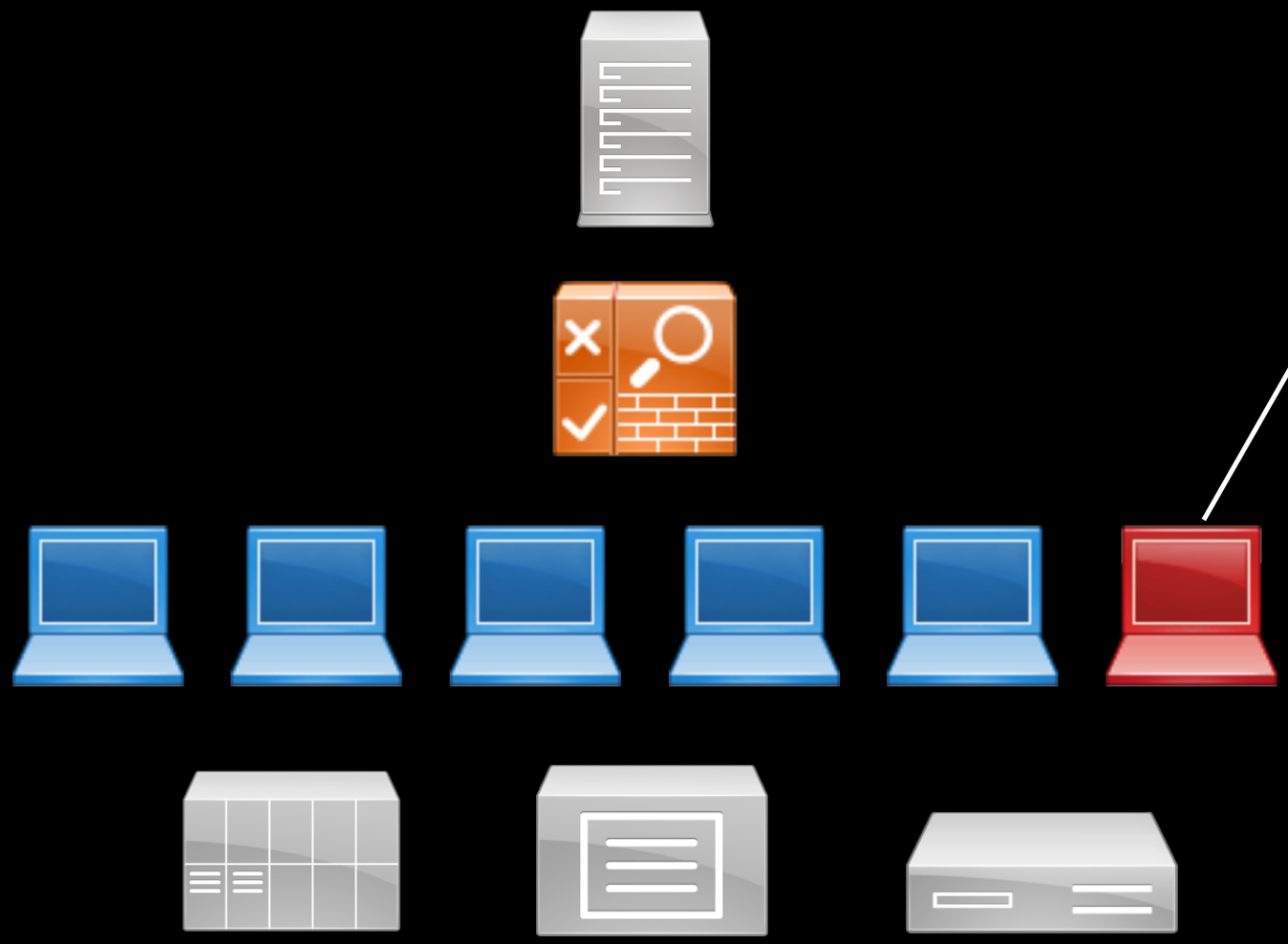
Perimeter Defenses (Firewall)

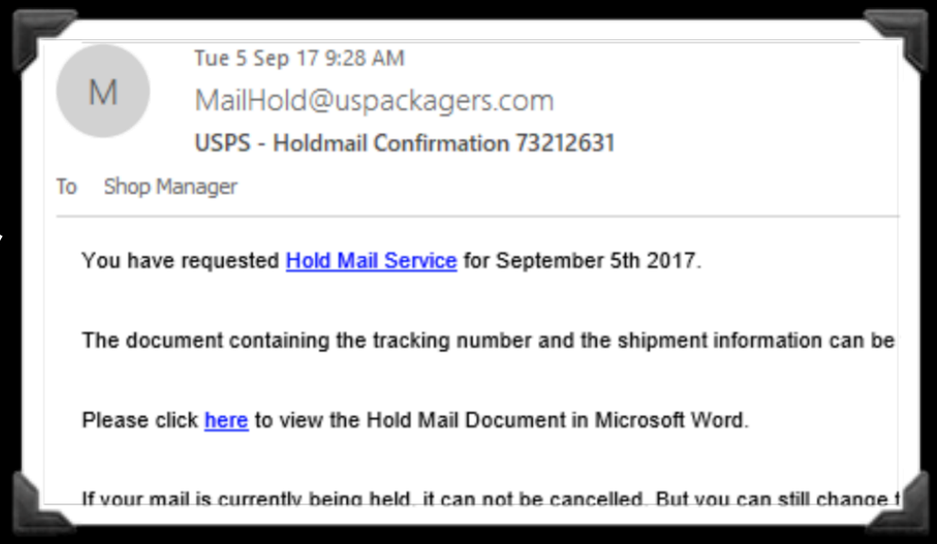
NIDS (Network Intrusion Detection System)

Clients

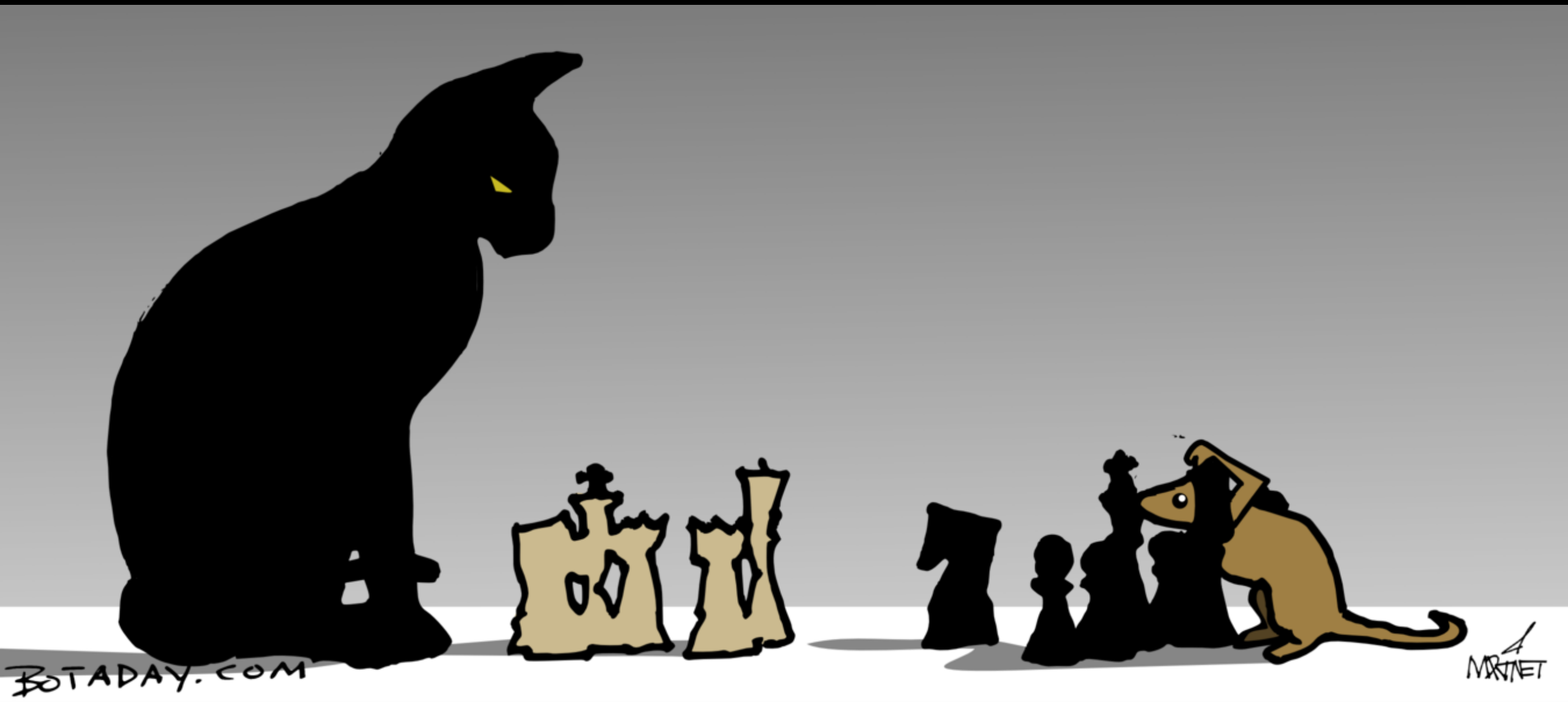
Some Other Assets

A Basic Network

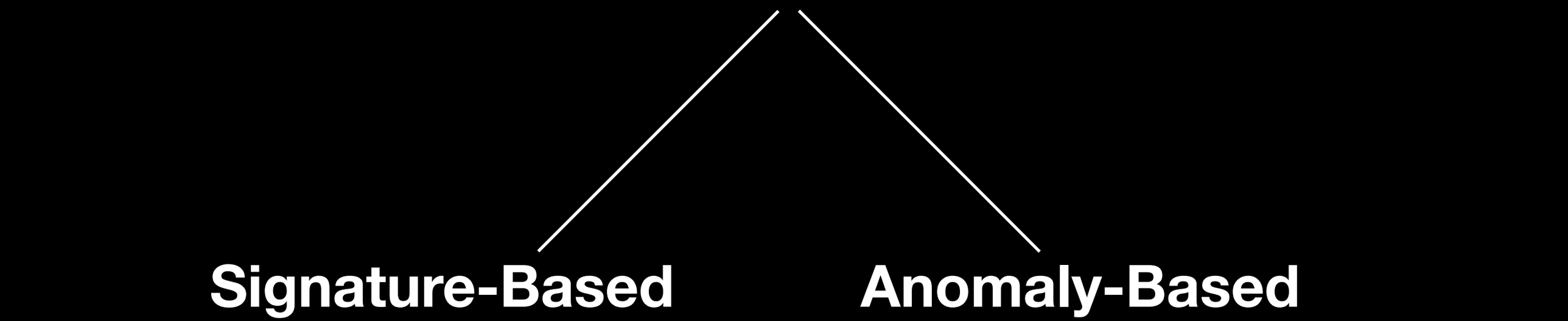




Assume Breach



NIDS (Network Intrusion Detection System)



Signature-based NIDS

- Looks for pre-defined patterns of previously known attacks.
- Doesn’t require a training phase.
- Highly available and popular.
- Can’t catch zero-day/new attacks.

Evasion

- Not complex but not super easy.
- Change traffic elements.
- Don’t match with any signatures.

```
alert tcp $HOME_NET any -> $EXTERNAL_NET $HTTP_PORTS (msg:"Metasploit Meterpreter";
flow:to_server,established; content:"RECV"; http_client_body; depth:4; fast_pattern; isdataat:!
0,relative; urilen:23<>24,norm; content:"POST"; pcre:"/^V[a-z0-9]{4,5}_[a-z0-9]{16}V$/Ui";
classtype:trojan-activity; sid:1618008; rev:1;)
```

Anomaly based NIDS

- Builds a statistical model describing the normal network traffic, and flagging the abnormal traffic.
- Requires training phase.
- Uses math, machine-learning and various sophisticated thing.
- Expensive $$
- Might catch zero-day/new attacks.

Anomaly based NIDS

New Traffic

POST /read.php HTTP/1.1

Cookie: session=VAGyTO1KBPO0BxJ45BZrcm3BinO

{'Utku Sen':'122-124-12424'}

Recorded Daily Traffic

-HTTP - vice.com/ai-hackers-coming-in-2022.html

-SMTP - mail.acme.com/ Subject: Meeting notes

-HTTPS - youtube.com / (8 hours active traffic)

-SSH - development.acme.com

LEARNING ALGORITHM

PATTERN (NORMAL TRAFFIC PROFILE)

NORMAL

ANORMAL

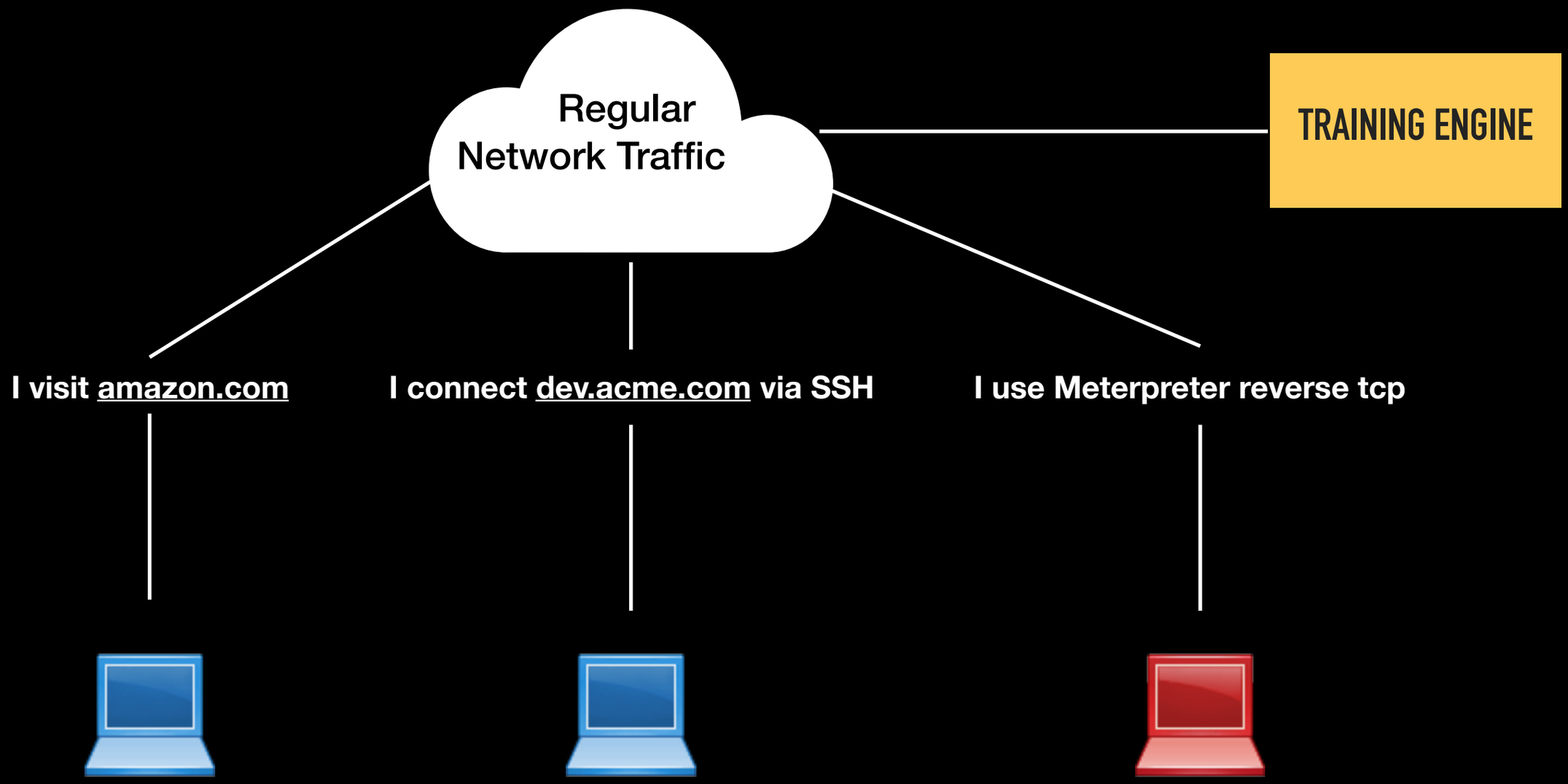
Evasion

Pre-training

Post-training

Pre-Training Evasion

- Generate malicious traffic on the network.
- Algorithm will accept it as regular network traffic.



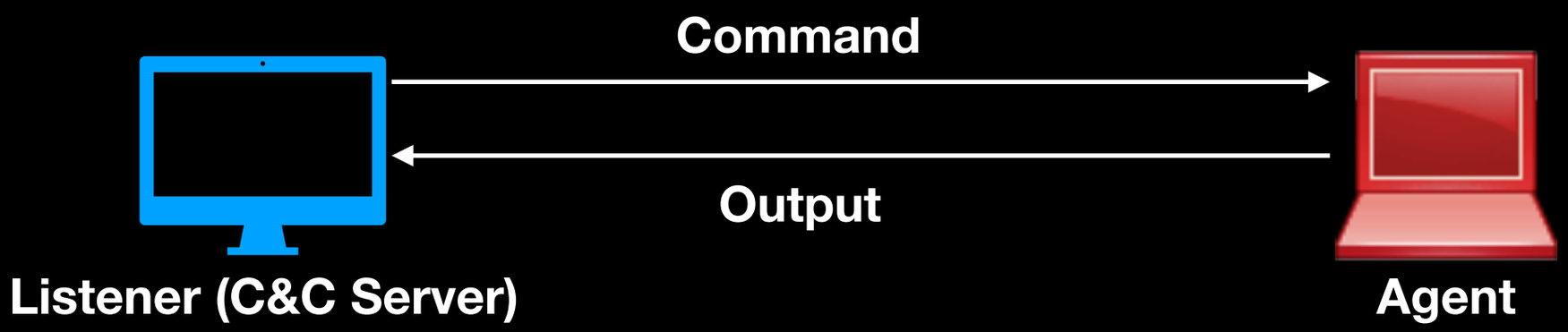
“It’s not realistic.”

–Anyone

A Realistic Scenario?

- Anomaly-detection engine is trained by -real- regular traffic.
- Watches the whole network.
- Attacker should gain a foothold on the network and exfiltrate data without causing any anomaly alert.

Empire



Key Traits of HTTP Listener

- KillDate: Date for the listener to exit
- DefaultDelay: Agent delay/reach back interval
- WorkingHours: Hours for the agent to operate
- DefaultProfile: User-agent value and URI specification for the agent
- DefaultJitter: Jitter in agent reachback interval
- Port: Listening port of the C2 server
- StagingKey: Staging key for initial agent negotiation
- ServerVersion: Server header for the C2 server.

C2-Agent Communication

- ”Client Data” is symmetrically encrypted with AES algorithm where encryption key is client’s session key.
- ”Metadata/Routing Data” is symmetrically encrypted with RC4 algorithm where encryption key is ”StagingKey” of the listener.

NIDS on Empire's HTTP Listener

- Request URI
- User-agent value
- Server header
- Default HTML Content
- Port
- Connection Interval (DefaultDelay)

```
GET /read.php HTTP/1.1
Cookie: session=VAGyTO1KBPOOBxJ45BZrcm3BinQ
User-Agent: Mozilla/5.0 (Windows NT 6.1)
    AppleWebKit/537.36 (KHTML, like Gecko)
    Chrome/41.0.2228.0 Safari/537.36
Host: 192.168.1.26
Connection: close
```

```
HTTP/1.0 200 OK
Content-Type: text/html; charset=utf-8
Content-Length: 208
Cache-Control: no-cache, no-store, must-
    revalidate
Pragma: no-cache
Expires: 0
Server: Microsoft-IIS/7.5
Date: Thu, 08 Feb 2018 17:57:40 GMT

<html><body><h1>It works!</h1><p>This is
    the default web page for this server.</
    p><p>The web server software is running
     but no content has been added.</p></
    body></html>
```

NIDS on Empire's HTTP Listener

- Post Request Body

```
HTTP/1.0 200 OK
Content-Type: text/html; charset=utf-8
Content-Length: 1454
Cache-Control: no-cache, no-store, must-revalidate
Pragma: no-cache
Expires: 0
Server: Microsoft-IIS/7.5
Date: Fri, 20 Jul 2018 11:05:40 GMT

...g...6.e....bg.............. ..o.E..a.....I.....2.C.7,."..`...,C.......&...=.+
$,q1..A...f..}....B.5.....A.4...T  ..v....D.3"g.N....p.3..
{................*}.*>...Q.>...Y._..Q.......&W..      ........S.
4.Nv.....p.&...w2.....rbH..#/....K/m.g].'......~..u...<..Za..*....h......
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.6......oR@.+I.9.2...G.~.....=..=...hGMZz.%  ....~M%.\...P.....K.F..wQ<G.."".2Q.......?
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$).....U.......2....I....R5'.SI..........MSsB gW
...>...i..8.<....0mA..i.VV..M#..q.U.,}..3...~-.8... ............S1\#..X<.B.<.
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```

Traits

Can be Changed in Options Menu

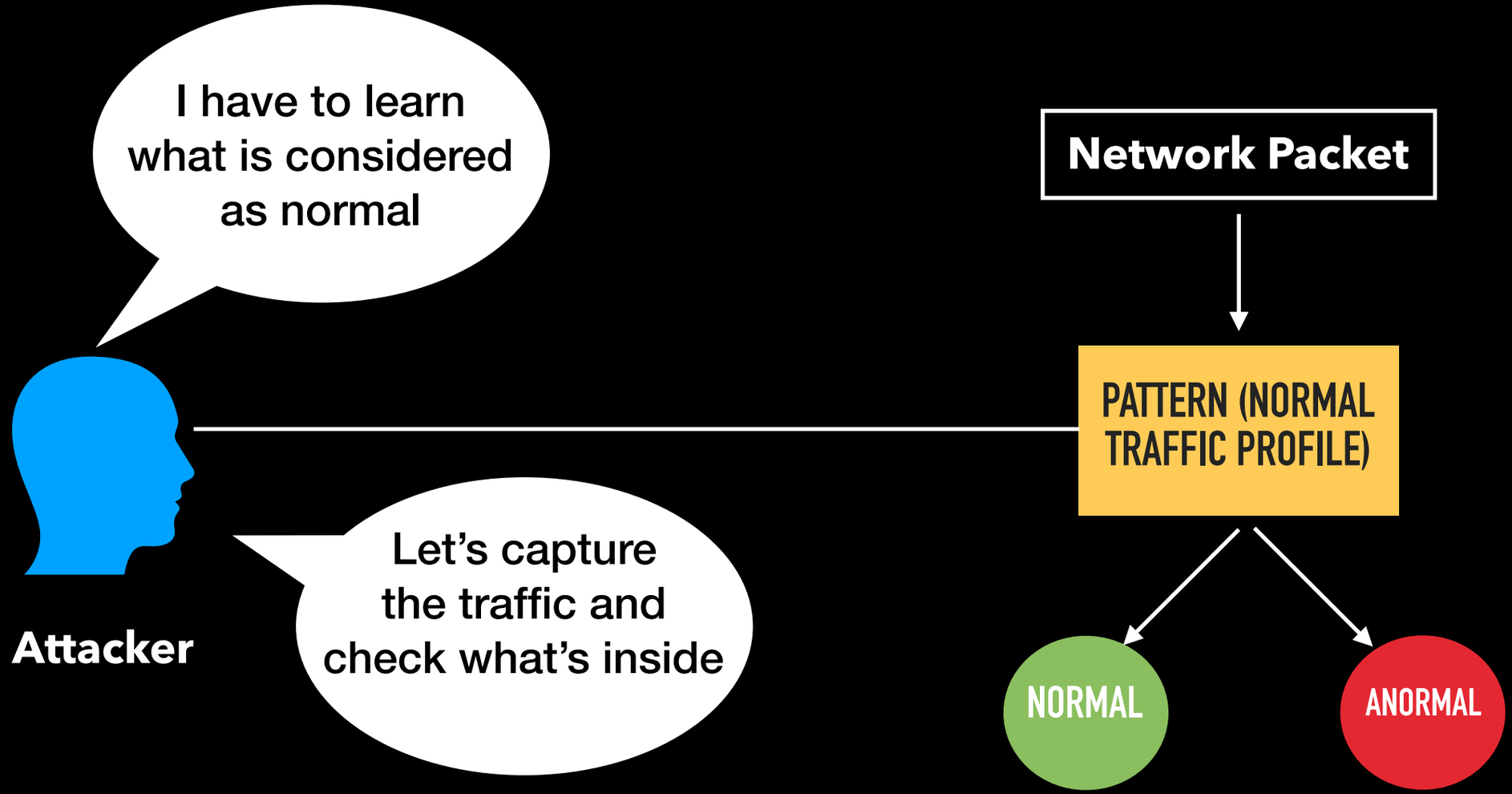
- Request URI
- User-agent value
- Server header
- Port
- Connection interval

Requires Source Code Change

- Default HTML content
- POST request body

Proposed Solution

- **Polymorphic Blending Attack (PBA):** Creating attack packets which are matches to normal traffic profile



Steps For The First Group of Traits

- Get traffic capture data of a normal traffic and define normal behaviour of users. (Request URI, User-agent, Server header, Port)
- Change Empire’s listener traits according to first step.
- Start the C2-agent communication.

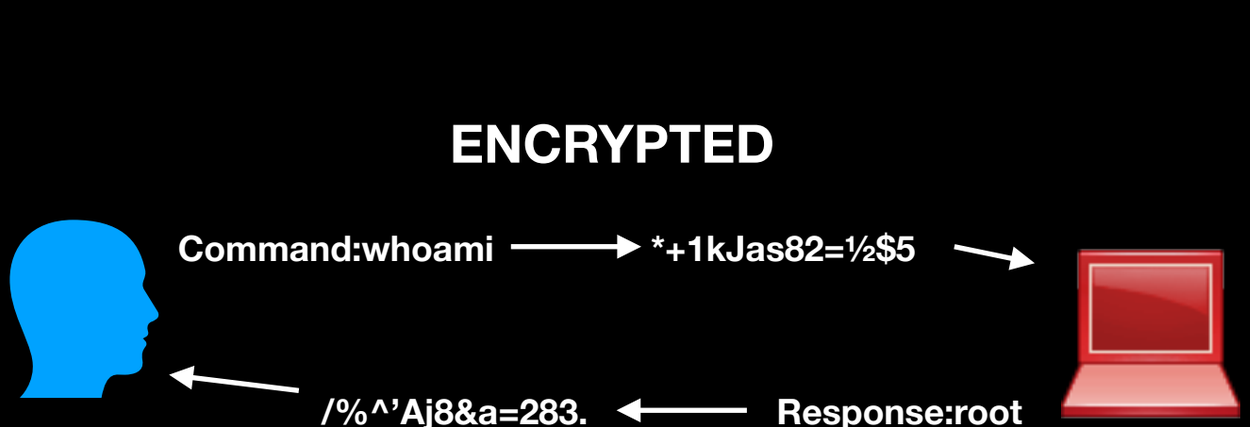
Adjusting The Connection Interval

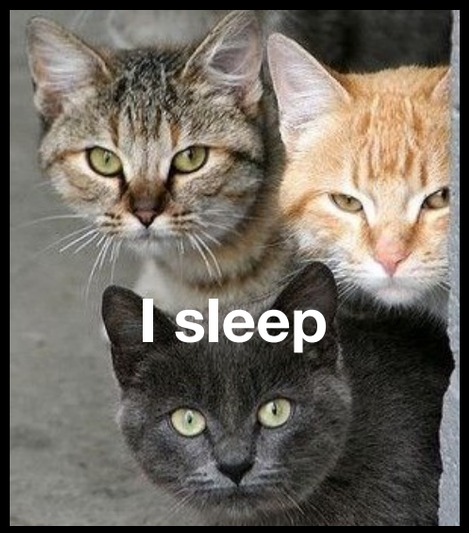
- False-positive rate of an anomaly detection system has a positive correlation with the size of the network.
- More computers = less connection interval
- Less computers = more connection interval
- More connection interval is better in most cases.

Steps For The Second Group of Traits

- Get traffic capture data of a normal traffic and define normal behaviour of users. (Default HTML Content)
- Change Empire’s listener traits according to first step.
- Start the C2-agent communication.

Post Request Body



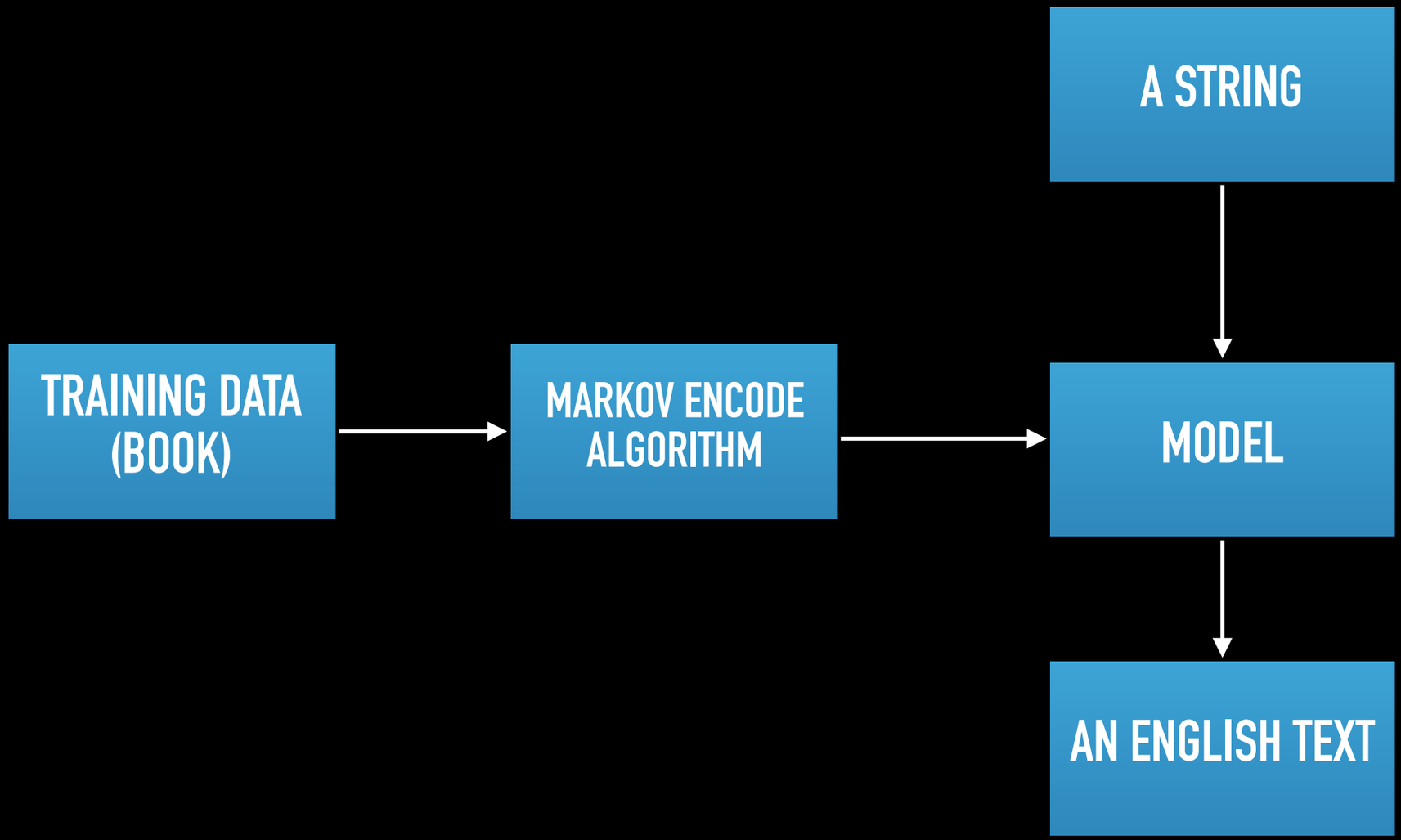


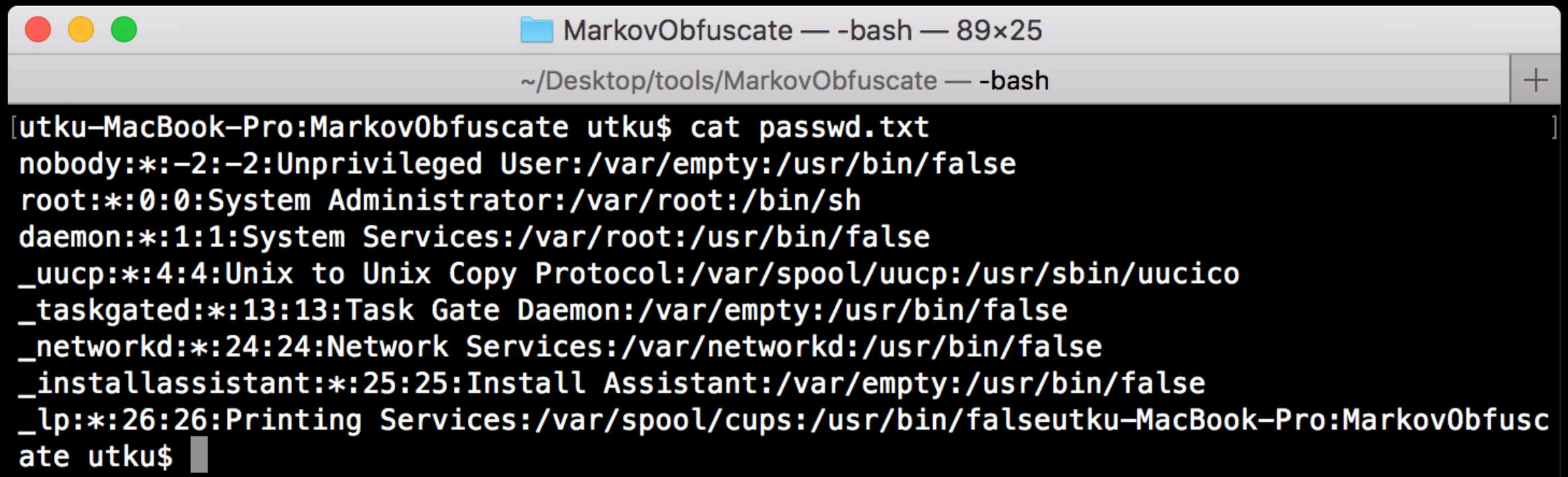
Anomaly-based

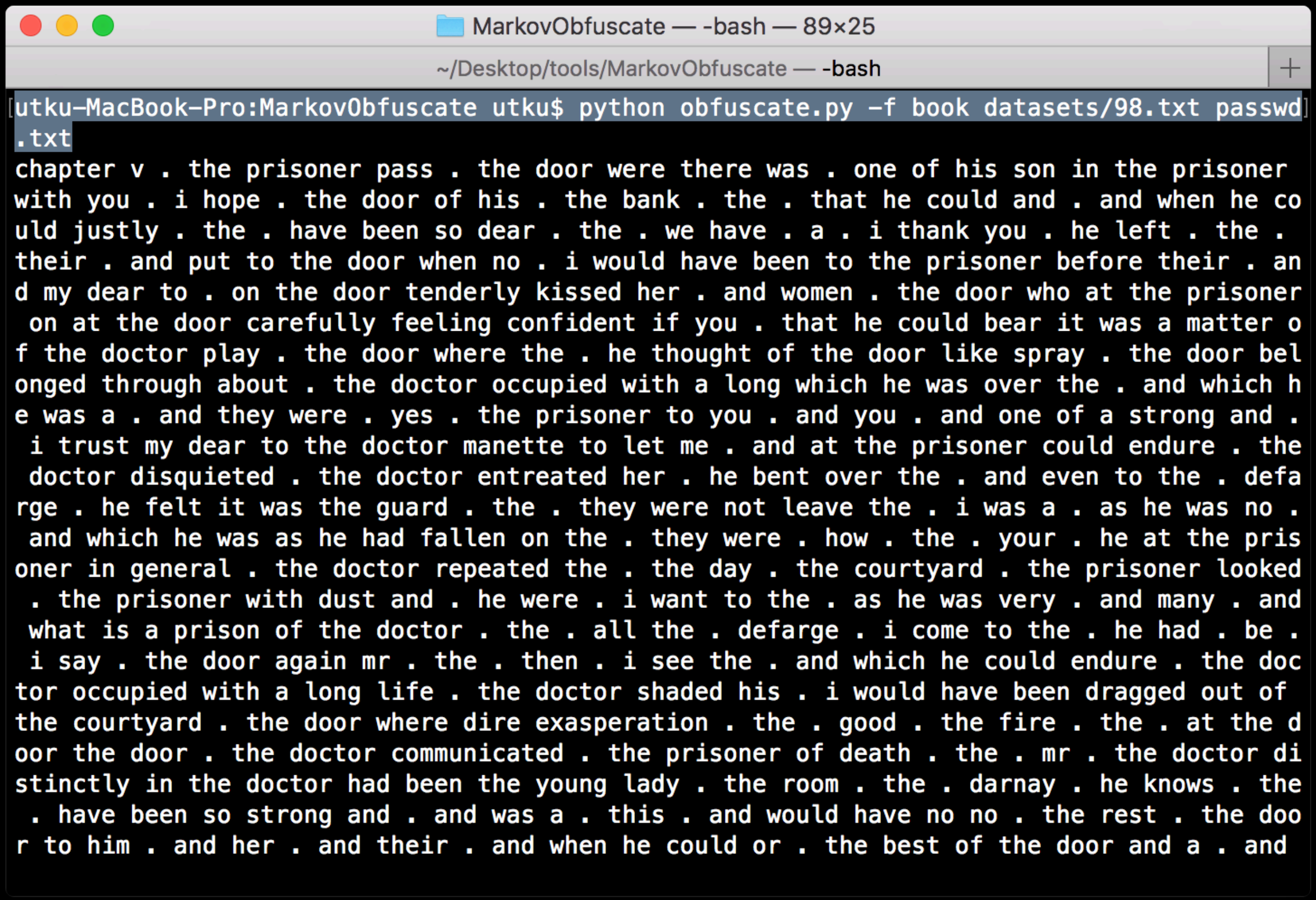
Signature-based

Markov Obfuscation

- Published by Cylance SPEAR Team (https://github.com/CylanceSPEAR/MarkovObfuscate)




MarkovObfuscate — -bash — 89×25
~/Desktop/tools/MarkovObfuscate — -bash
utku-MacBook-Pro:MarkovObfuscate utku$ cat passwd.txt
nobody:*:-2:-2:Unprivileged User:/var/empty:/usr/bin/false
root:*:0:0:System Administrator:/var/root:/bin/sh
daemon:*:1:1:System Services:/var/root:/usr/bin/false
_uucp:*:4:4:Unix to Unix Copy Protocol:/var/spool/uucp:/usr/sbin/uucico
_taskgated:*:13:13:Task Gate Daemon:/var/empty:/usr/bin/false
_networkd:*:24:24:Network Services:/var/networkd:/usr/bin/false
_installassistant:*:25:25:Install Assistant:/var/empty:/usr/bin/false
_lp:*:26:26:Printing Services:/var/spool/cups:/usr/bin/falseutku-MacBook-Pro:MarkovObfusc
ate utku$


MarkovObfuscate — -bash — 89×25
~/Desktop/tools/MarkovObfuscate — -bash
utku-MacBook-Pro:MarkovObfuscate utku$ python obfuscate.py -f book datasets/98.txt passwd.txt
chapter v . the prisoner pass . the door were there was . one of his son in the prisoner with you . i hope . the door of his . the bank . the . that he could and . and when he could justly . the . have been so dear . the . we have . a . i thank you . he left . the . their . and put to the door when no . i would have been to the prisoner before their . and my dear to . on the door tenderly kissed her . and women . the door who at the prisoner on at the door carefully feeling confident if you . that he could bear it was a matter of the doctor play . the door where the . he thought of the door like spray . the door belonged through about . the doctor occupied with a long which he was over the . and which he was a . and they were . yes . the prisoner to you . and you . and one of a strong and . i trust my dear to the doctor manette to let me . and at the prisoner could endure . the doctor disquieted . the doctor entreated her . he bent over the . and even to the . defarge . he felt it was the guard . the . they were not leave the . i was a . as he was no . and which he was as he had fallen on the . they were . how . the . your . he at the prisoner in general . the doctor repeated the . the day . the courtyard . the prisoner looked . the prisoner with dust and . he were . i want to the . as he was very . and many . and what is a prison of the doctor . the . all the . defarge . i come to the . he had . be . i say . the door again mr . the . then . i see the . and which he could endure . the doctor occupied with a long life . the doctor shaded his . i would have been dragged out of the courtyard . the door where dire exasperation . the . good . the fire . the . at the door the door . the doctor communicated . the prisoner of death . the . mr . the doctor distinctly in the doctor had been the young lady . the room . the . darnay . he knows . the . have been so strong and . and was a . this . and would have no no . the rest . the door to him . and her . and their . and when he could or . the best of the door and a . and

Operation Steps

- Encode Empire’s encrypted data with Base64 to get rid of non-printable characters.
- Download the dataset from an external source.
- Train the encoded data with dataset.
- Send Markov encoded data with dataset to C2 server.

dailynews.com

Get lots of English texts

Local Network

Attacker

encoded payload+dataset

Anomaly Based IDS

encoded payload+dataset

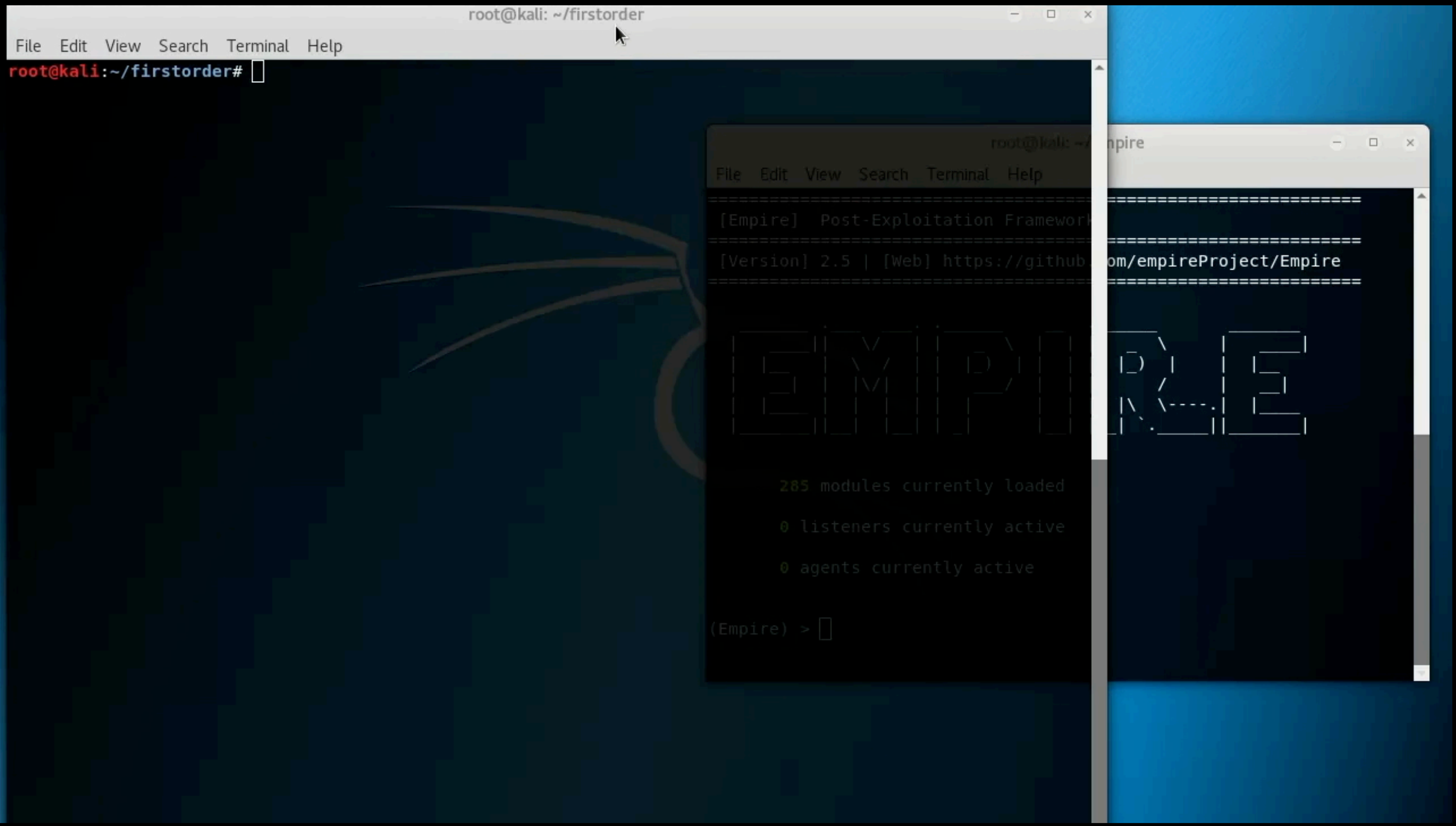
Agent deployed

Drawbacks

- Data training will consume time and resource.
- You need to implement the Markov Obfuscation code inside the agent.

firstorder Tool

- Extracts valuable information from a PCAP file and configures Empire’s listener.
- Most used ports, URI, server headers, user-agents, number of machines etc.
- Configures Empire’s listener automatically.


root@kali: ~/firstorder
File Edit View Search Terminal Help
root@kali:~/firstorder#
File Edit View Search Terminal Help
[Empire] Post-Exploitation Framework
[Version] 2.5 | [Web] https://github.com/empireProject/Empire
285 modules currently loaded
0 listeners currently active
0 agents currently active
(Empire) >
mpire
om/empireProject/Empire

github.com/tearsecurity/firstorder

Conclusions

- Defense mechanisms are getting smarter.
- Attackers should create smarter methods which can mislead an AI.