Identifying Novel Malware at Scale

Pedram Amini | InQuest.net

Who I be.

🗽New York City native. Austin Texas since 2005.🤠

Self taught in the 90's through SoftICE & phreaking.

iDEFENSE VCP 2002-2005, TippingPoint ZDI 2005-2010.

OpenRCE.org, PaiMei, Sulley, Fuzzing (book).

Jumpshot 2010-2014, InQuest 2014+.

Threat hunting/intelligence and automation.

🍋 Low Hanging Fruit 🍊

There are some beautiful exploits out there…

But how are people getting owned?

- 📄 Invoice scams.
- 🎣 Phishing.
- 📂 Open S3 buckets and Elastic databases.
- 📃 **Carrier lures…**

A Formula for Success

1. Construct novel carrier(s). Exploit(s) optional.
2. Own, pwn, or utilize shared hosting in the ☁️.
3. Seed via some SPAM and… 🤑.


2018	2019	2020
[O] CVE-2012-0158	[O] CVE-2012-0158	[J] CVE-2012-4681
[A] CVE-2015-1805	[O] CVE-2015-1641	[W] CVE-2014-6352
[I] CVE-2016-0189	[O] CVE-2017-0143	[W] CVE-2016-7255
[O] **CVE-2017-0199**	[O] CVE-2017-0199	[O] CVE-2016-7262
[O] **CVE-2017-11882**	[O] **CVE-2017-11882**	[O] **CVE-2017-0199**
[O] CVE-2017-8570	[O] **CVE-2017-5638**	[O] **CVE-2017-11882**
[O] CVE-2017-8750	[O] CVE-2017-8759	[P] CVE-2018-4893
[F] CVE-2018-4878	[F] CVE-2018-4878	[I] CVE-2019-1367
[I] CVE-2018-8174	[O] CVE-2018-7600	[W] CVE-2019-1405
[I] CVE-2018-8373	[O] CVE-2019-0604	[W] CVE-2020-0601

Adobe **[F]**lash / **[P]**DF | Google **[A]**ndroid | Oracle **[J]**ava | Microsoft **[I]**E / **[O]**ffice / **[W]**indows

Microsoft Excel Macrosheets

There's *always* something with Microsoft Office.

Tens of millions of lines of code, decades of features.

Deep dive into the breaking wave of XLM carriers:

- 2019-01-29: Extracting "Sneaky" Excel XLM Macros
- 2020-03-18: Getting Sneakier: Hidden Sheets & Data Connections
- 2020-05-06: ZLoader 4.0 Macrosheets Evolution

Tool: XLMMacroDeobfuscator YARA Rules: Github/InQuest

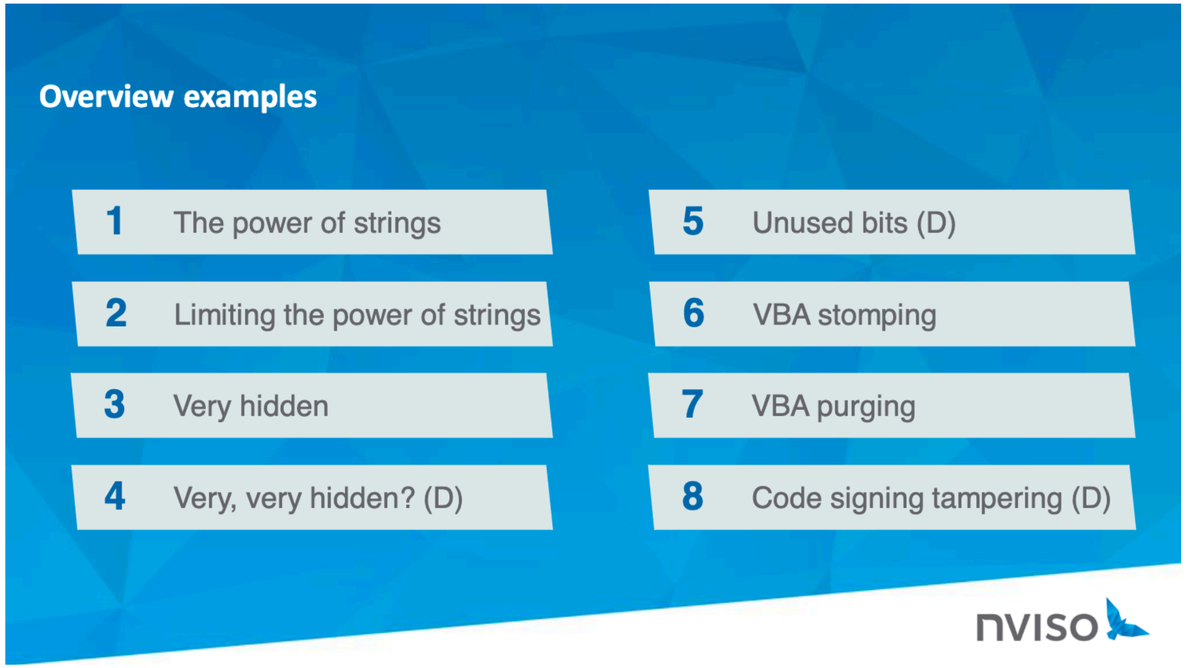
More on #maldoc's

Didier Stevens, NVISO

Maldocs Tips for Red Teamers

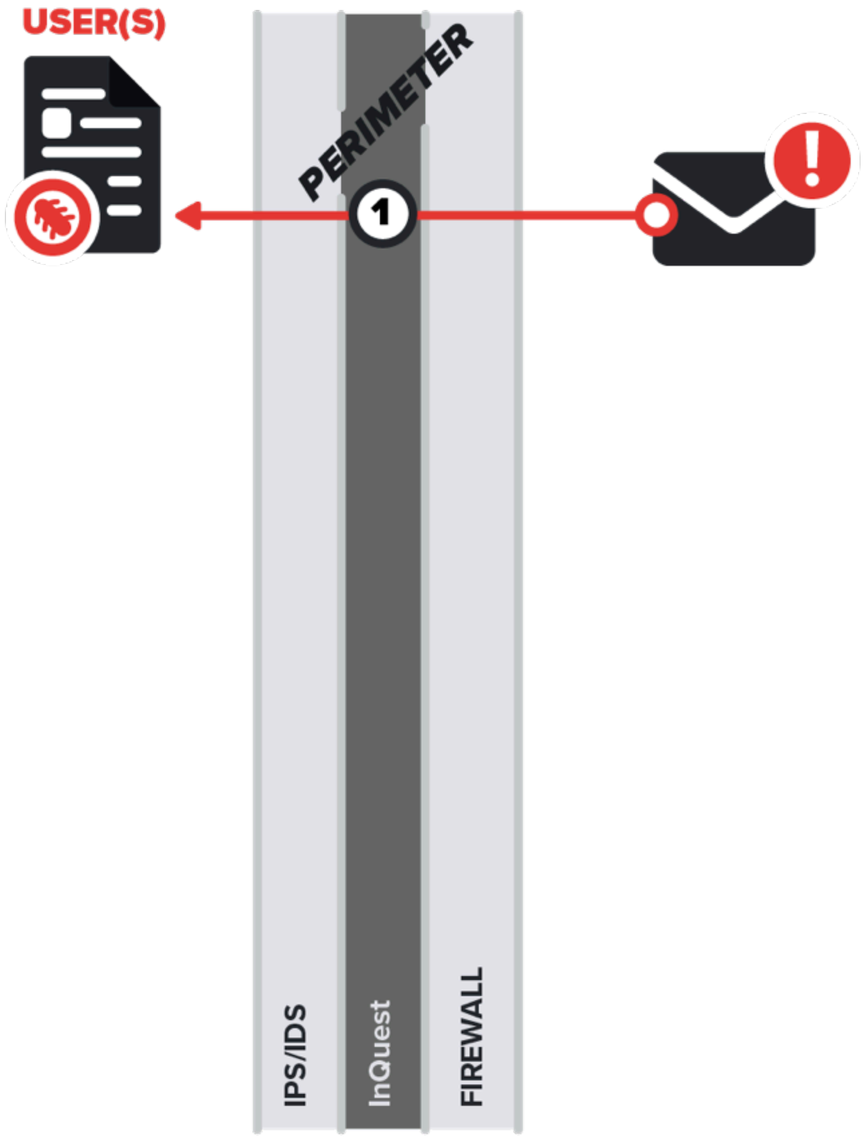
@didierstevens

blog

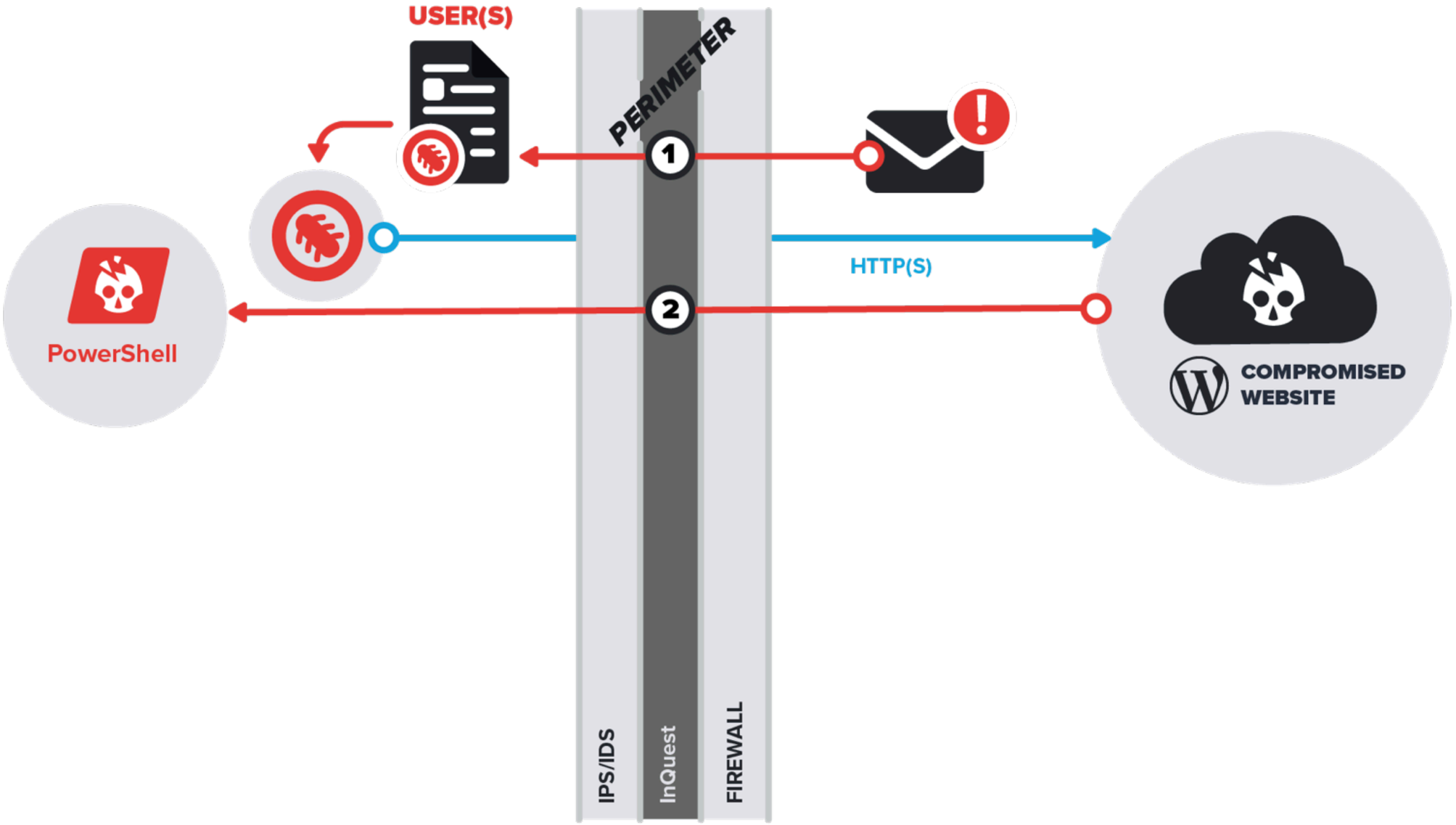


(D) = Disclosure

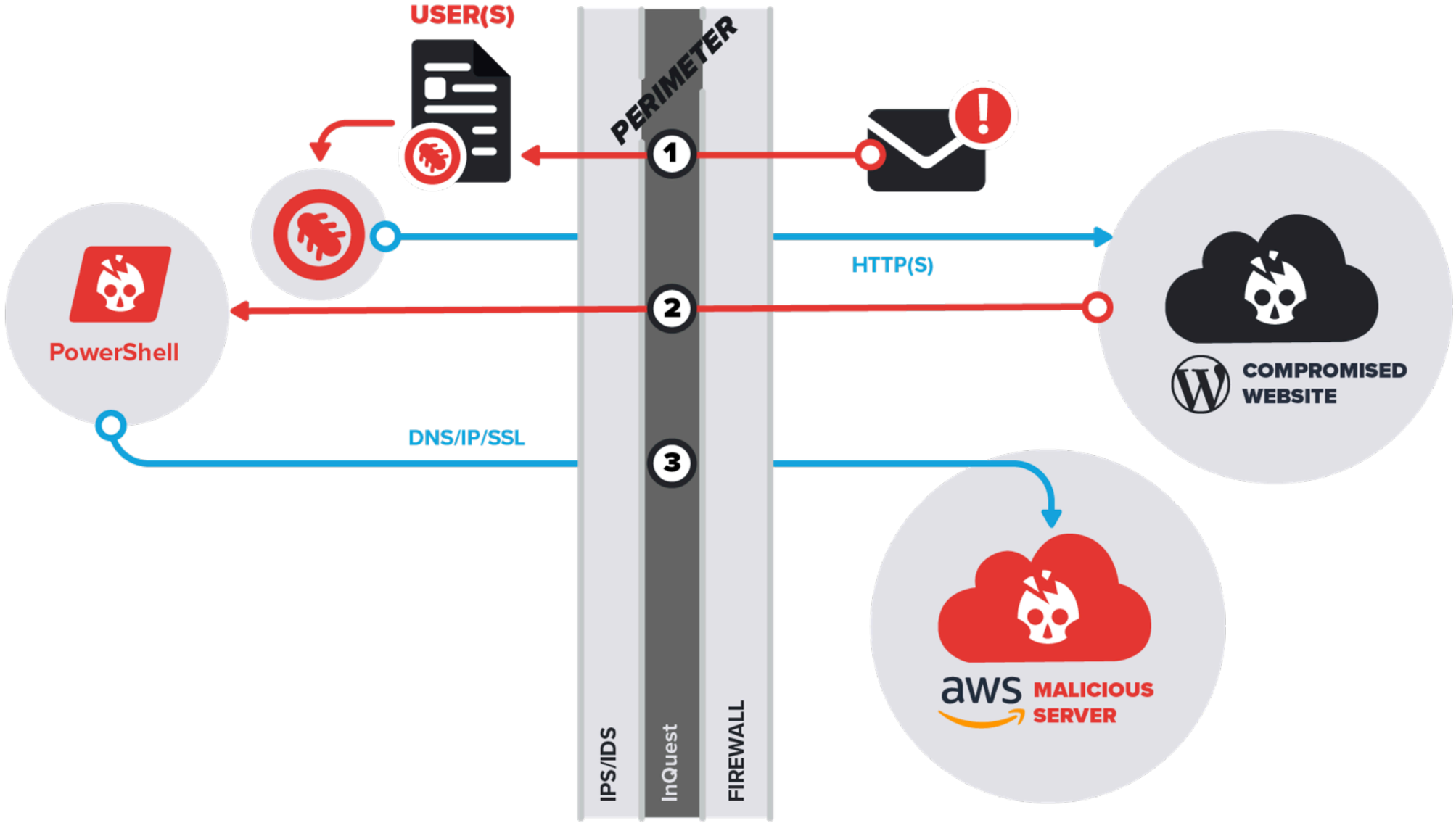
Common Malware Campaign



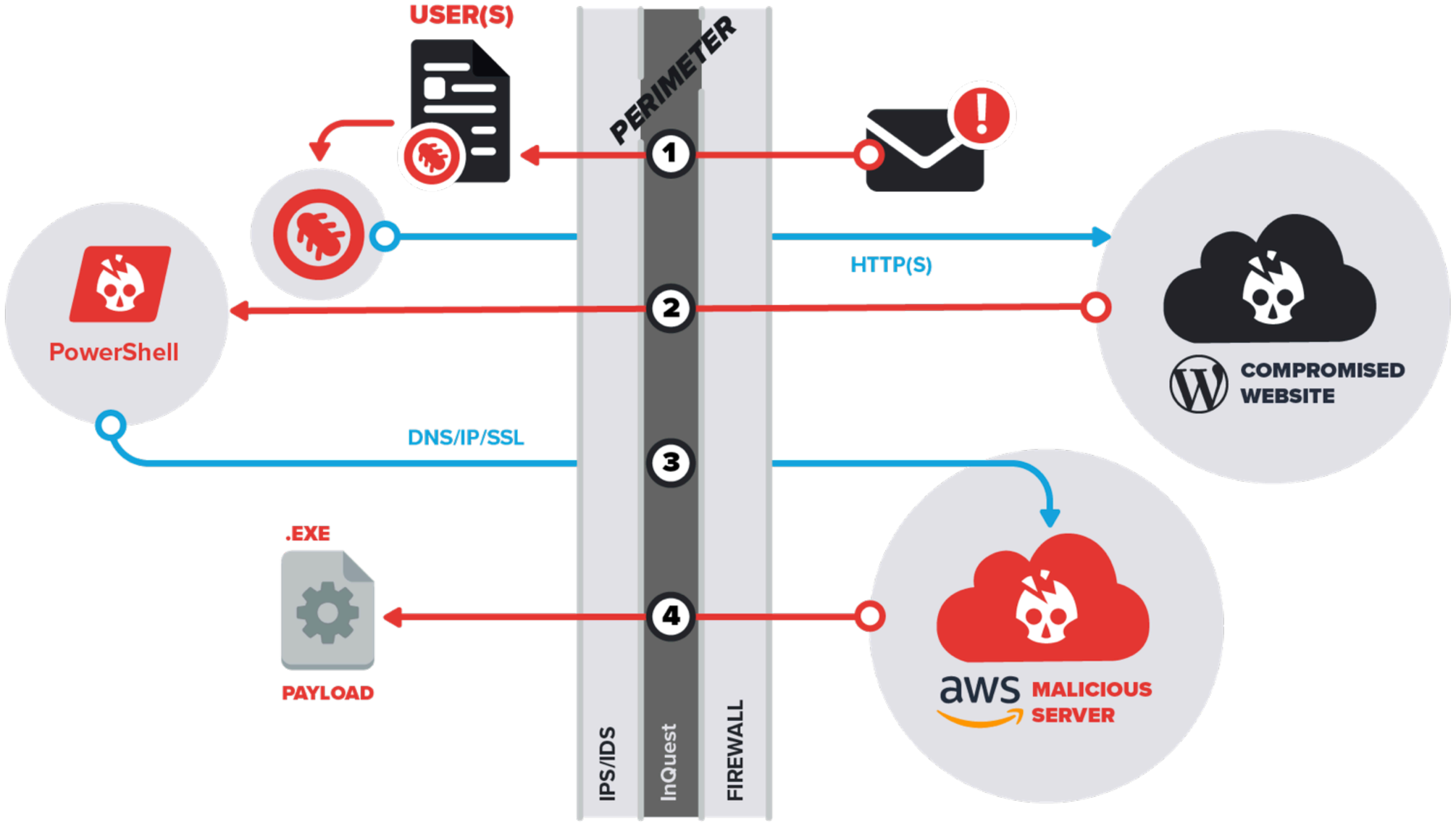
Common Malware Campaign



Common Malware Campaign



Common Malware Campaign



Infrastructure Pivots

Domain -> IP -> Domain(s)

Domain -> DNS -> Domain(s)

Domain -> Pattern -> Domain(s)

Domain -> Registrant -> Domain(s)

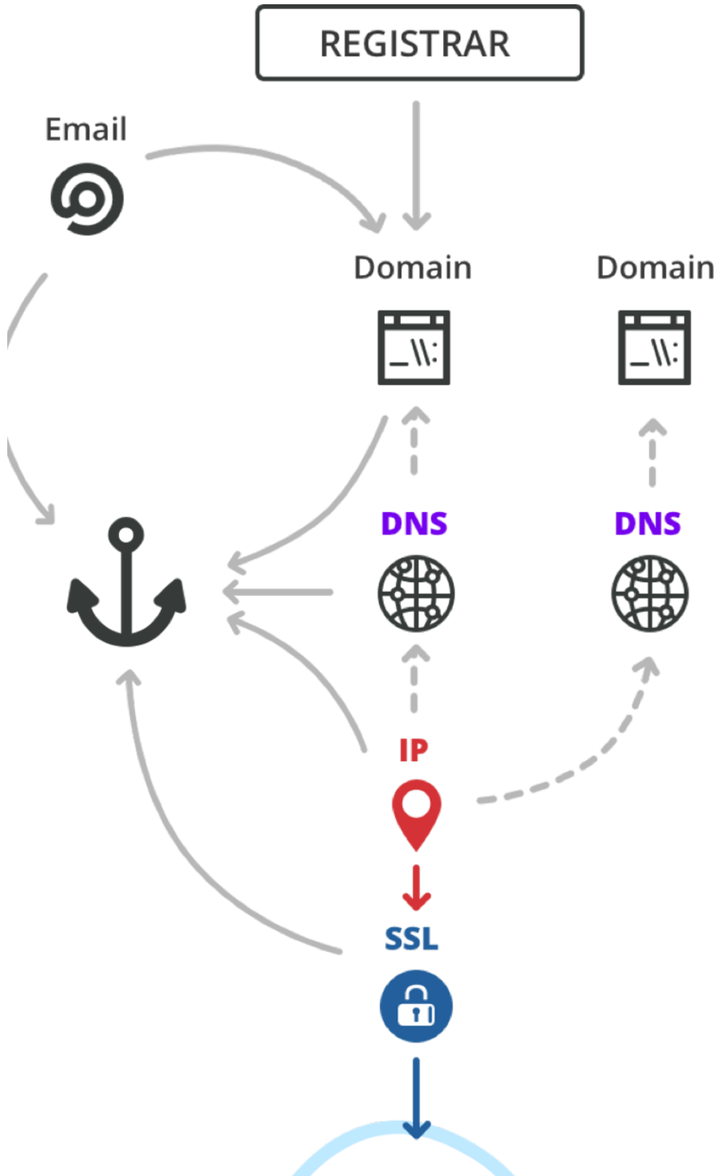
Domain -> Sub Domains(s)

IP -> ASN -> IP(s)

SSL Certificates

Google Analytics IDs

…and more…



Infrastructure Pivots

IP Pivots:

- https://reverseip.domaintools.com/search/?q={ip}
- https://www.shodan.io/host/{ip}
- https://viz.greynoise.io/ip/{ip}
- https://www.virustotal.com/#/ip-address/{ip}

DNS Pivots:

- http://whois.domaintools.com/{domain}
- https://www.virustotal.com/#/domain/{domain}

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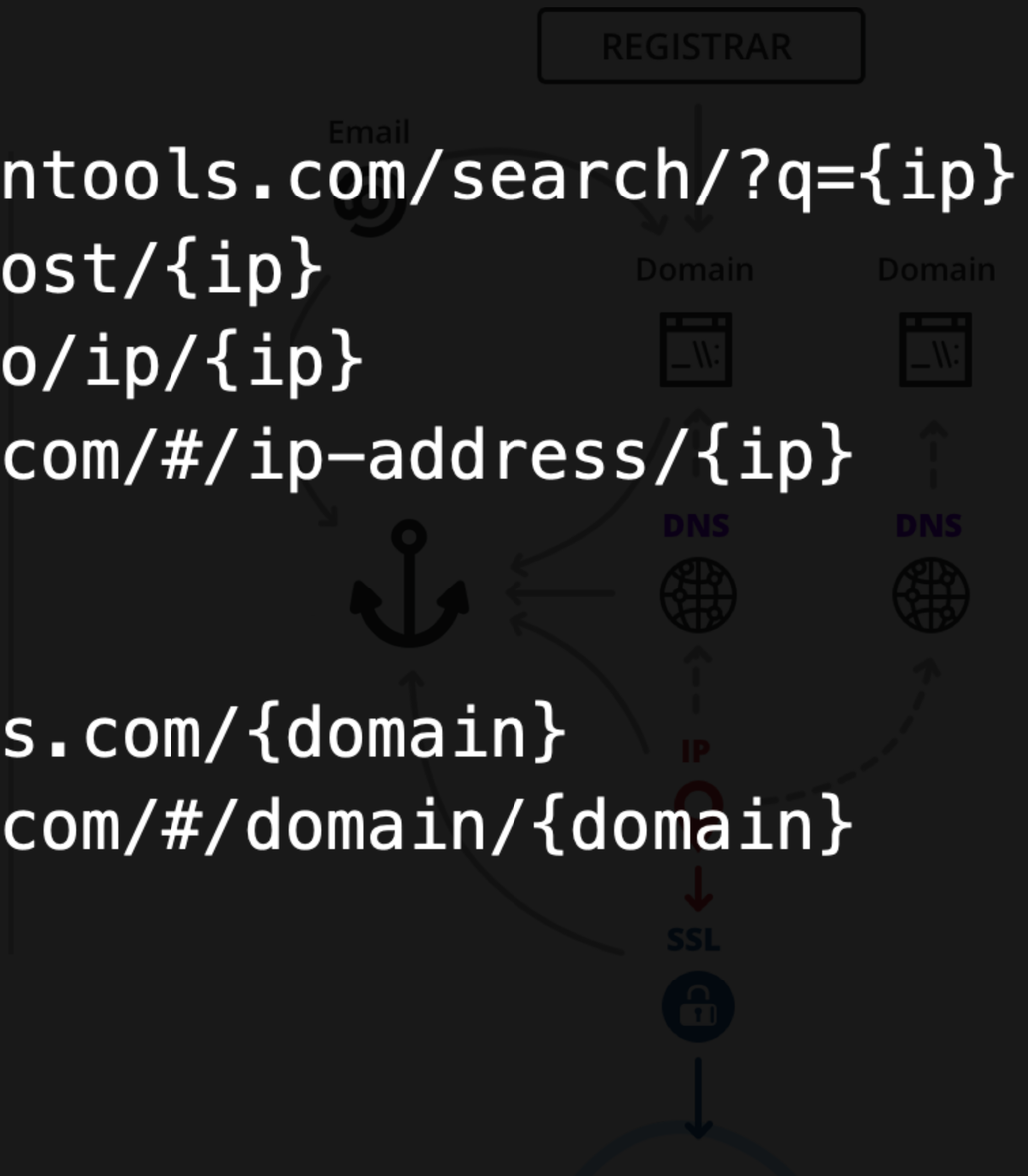
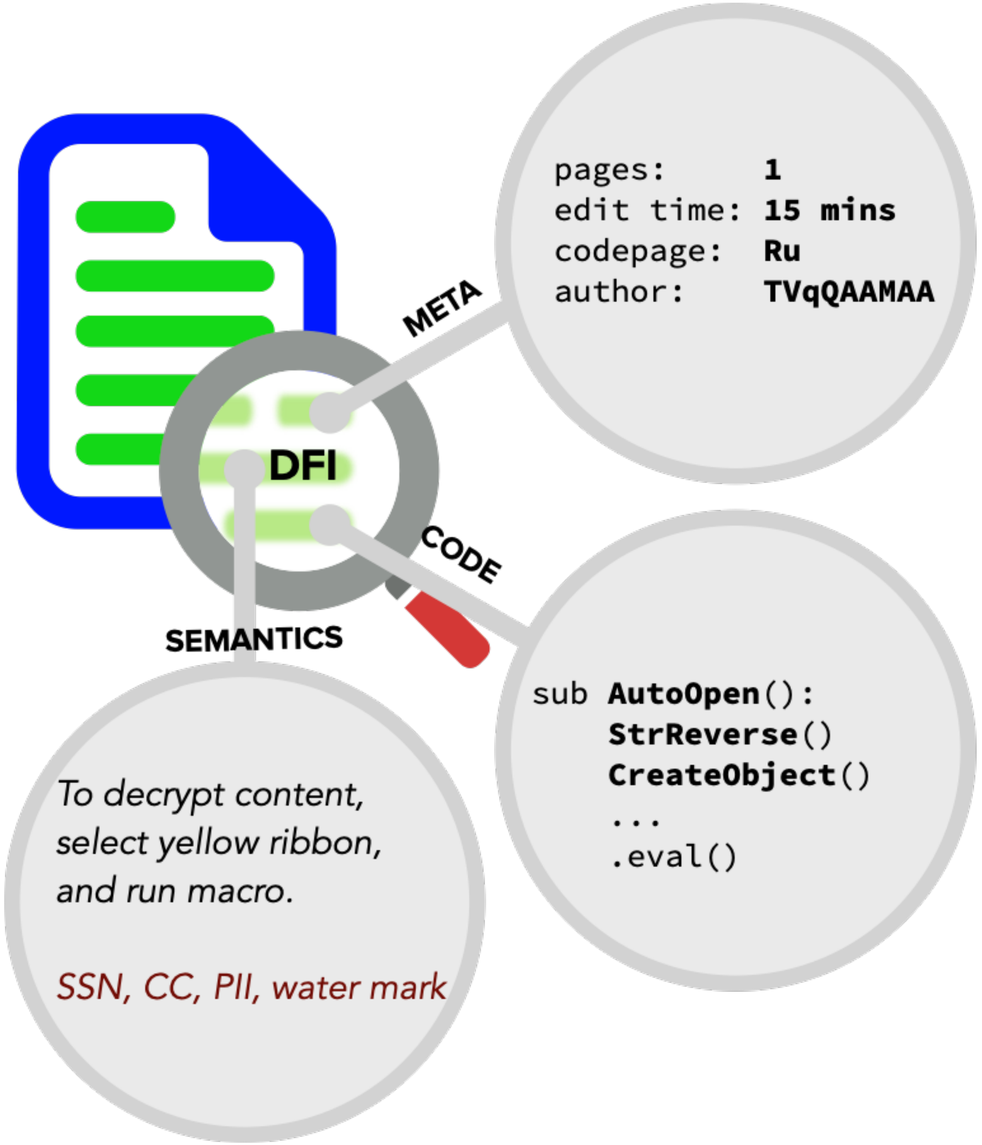


File Pivots



IP Address

Domain Name

URL

Email Address

File Name / Pattern

Adobe XMP ID

AV Labels

Graphical Lure

…

File Pivots

IP Address

Domain Name

URL

Email Address

File Name / Pattern

Adobe XMP ID

AV Labels

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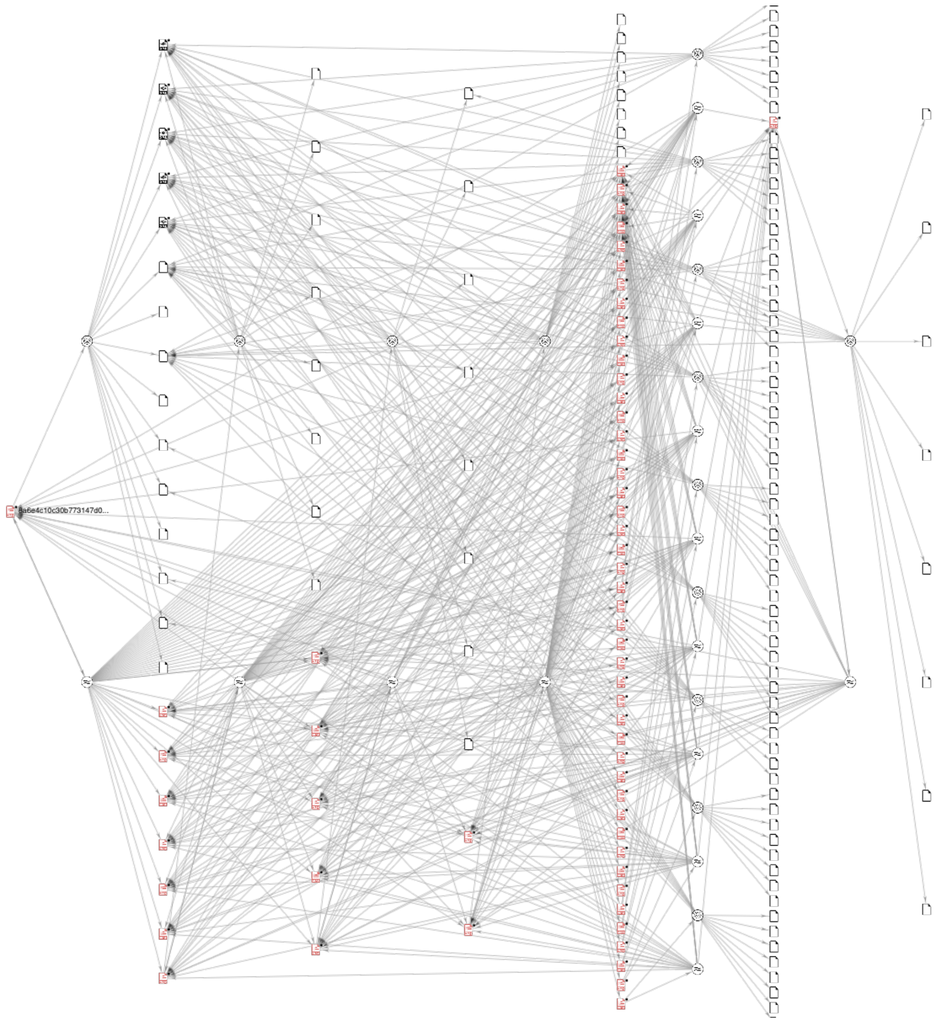
…



Pivoting on XMP IDs

Adobe **E**xtensible **M**etadata **P**latform (XMP).

Defines a standard of mapping asset relationships.

XML parent-to-child and revision tracking.

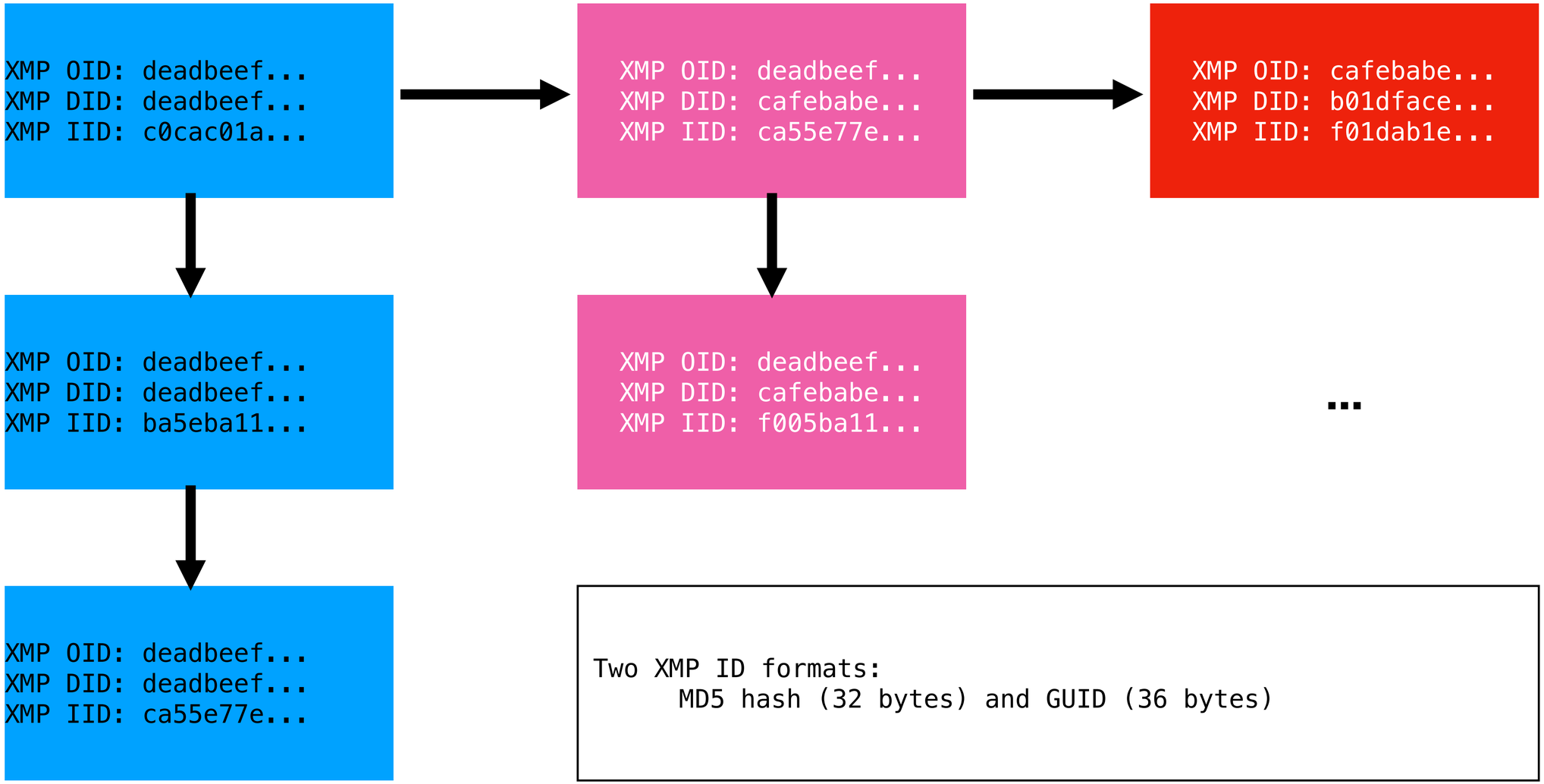
Original (OID), Document (DID), and Instance (IID).

Data updated on save/copy and embedded within the asset.

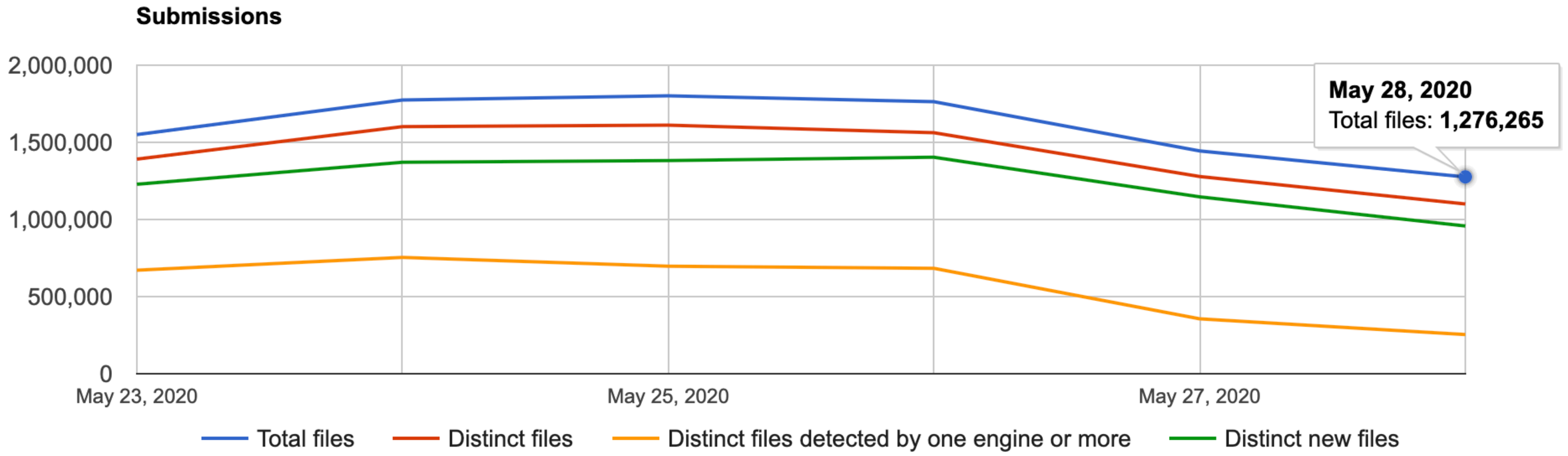
reference: http://wwwimages.adobe.com/content/dam/acom/en/products/xmp/Pdfs/XMPAssetRelationships.pdf

Adobe

XMP ID Family Trees

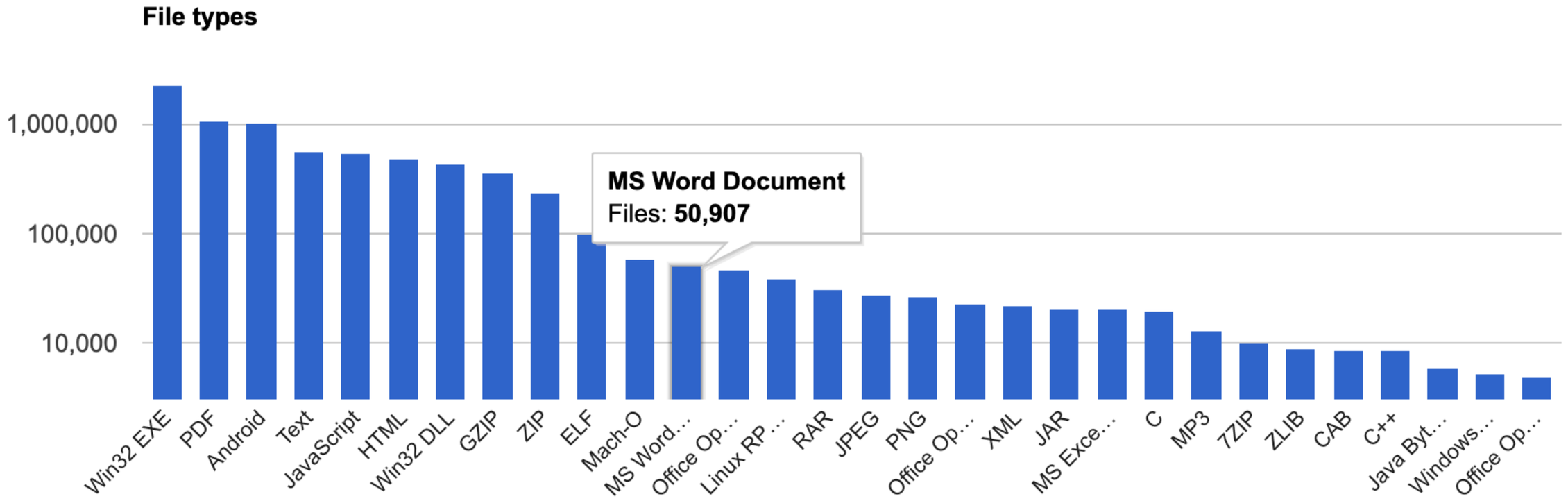


reference: http://wwwimages.adobe.com/content/dam/acom/en/products/xmp/Pdfs/XMPAssetRelationships.pdf



VTI: Daily Uploads

~1.3M total < ~1M distinct < ~900k new < ~400k malicious



VTI: File Distribution

~1M PDF < ~50k Office < ~20k Java < ~15k Excel…

Reducing the Volume

- https://github.com/InQuest/yara-rules
- Layered carriers, Matryoshka: 🪆
- Evasive characteristics.
- ~5k samples a day, <1%.
- Clustering…

Thu Jun 4 00:00:00

research.vt_hunt_ingestor.phish_hunter	2,113
research.vt_hunt_ingestor.maldoc_hunter	1,743
research.vt_hunt_ingestor.maljar_hunter	675
research.vt_hunt_ingestor.macro_hunter	419
research.vt_hunt_ingestor.pdfjs_hunter	164
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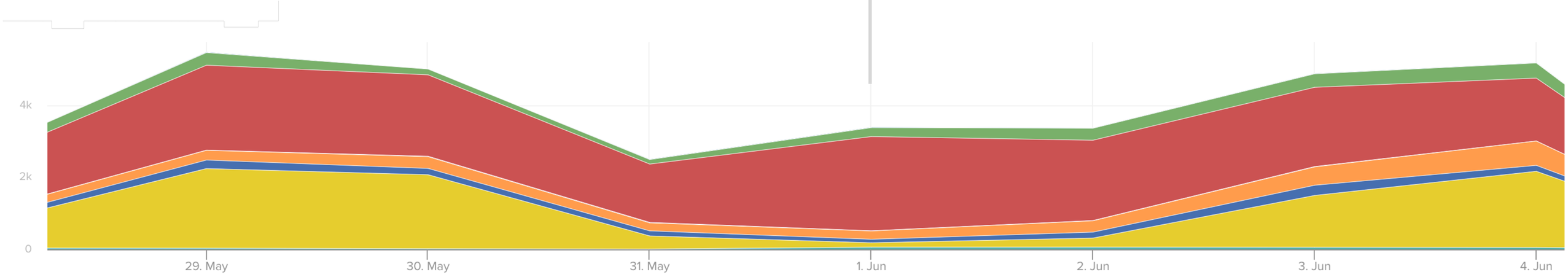

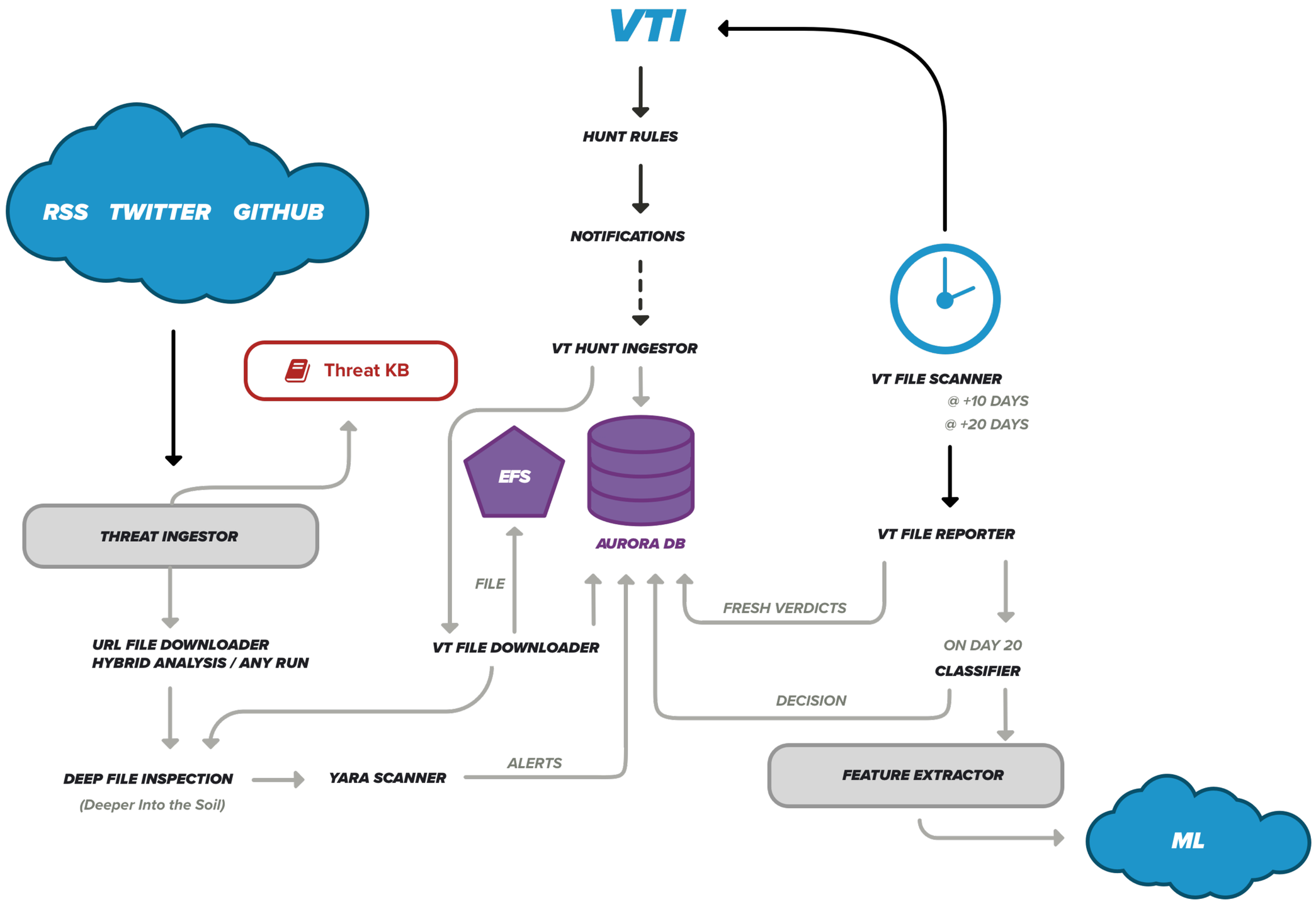
VTI
HUNT RULES
NOTIFICATIONS
RSS TWITTER GITHUB
VT HUNT INGESTOR
Threat KB
VT FILE SCANNER
@ +10 DAYS
@ +20 DAYS
EFS
AURORA DB
THREAT INGESTOR
VT FILE REPORTER
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FRESH VERDICTS
URL FILE DOWNLOADER
HYBRID ANALYSIS / ANY RUN
VT FILE DOWNLOADER
ON DAY 20
CLASSIFIER
DECISION
DEEP FILE INSPECTION
(Deeper Into the Soil)
YARA SCANNER
ALERTS
FEATURE EXTRACTOR
ML

🔥 Burning Your Warez 🔥

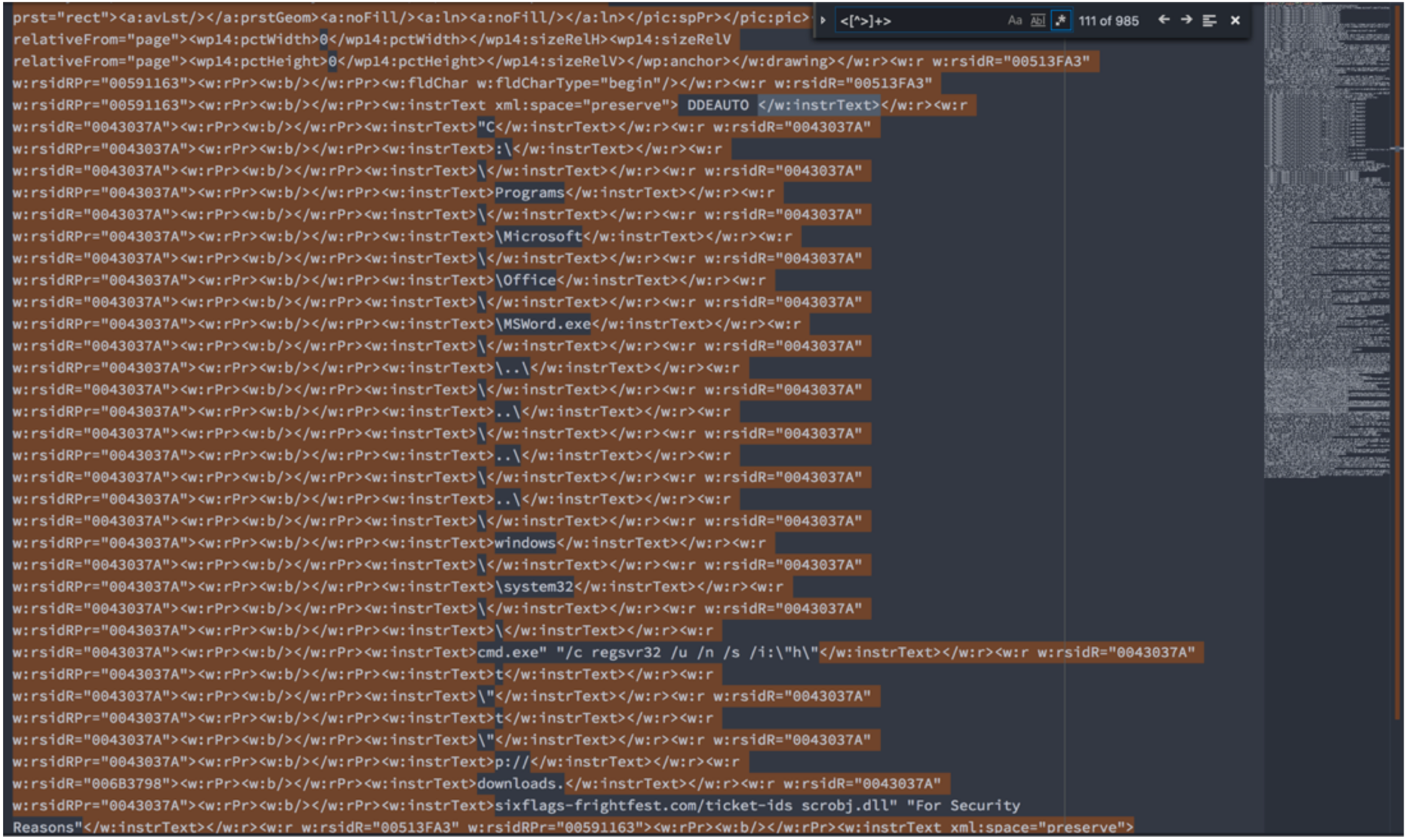
🕵️ MIME evasions … "**{\rt**" vs "**{\rtf1**" … "**%PDF**" not at 0.

🤦 Burning your 0day via symbols:

"shellcode", "exploit", "heapspray", etc.

💣 UTF-8 Byte Order Mark (BOM), 0xEFBBBF, from 2013!

🌽 **Chaff…**



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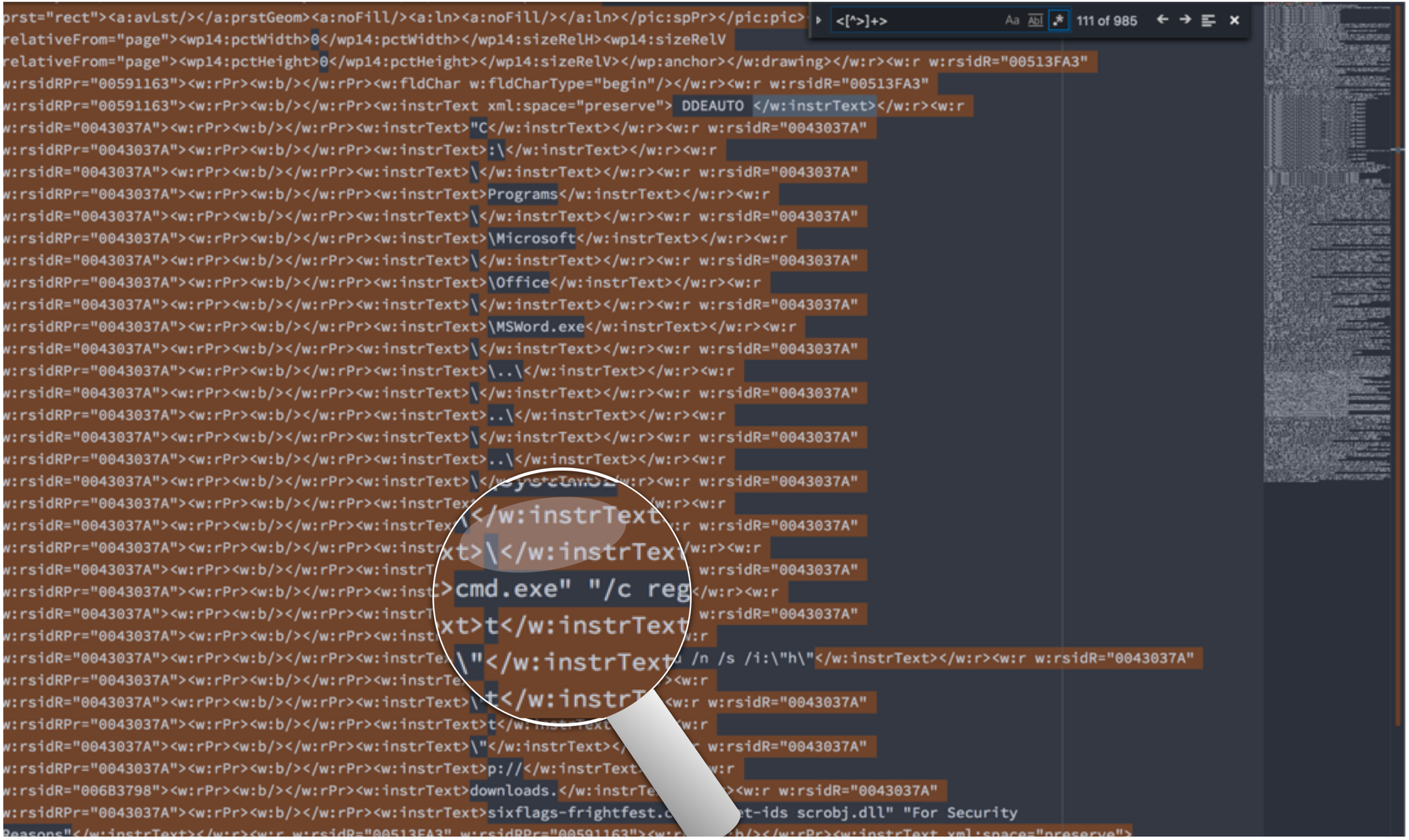
111 of 985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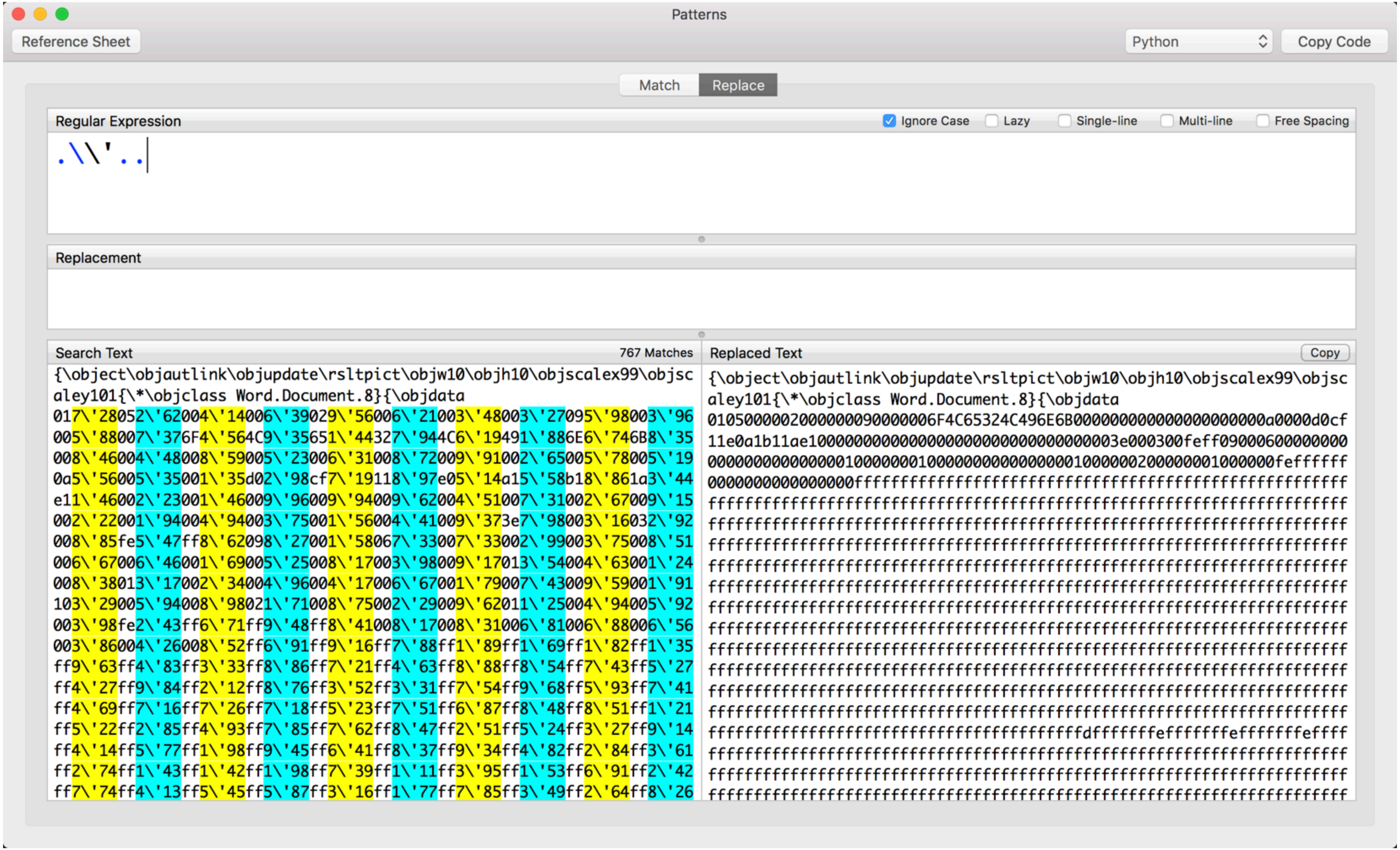
😬 **RTF Byte-Nibble, utilized by CVE-2018-8174 ITW 0day…**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Python
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Replace
Regular Expression
Ignore Case
Lazy
Single-line
Multi-line
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ff7\'74ff4\'13ff5\'45ff5\'87ff3\'16ff1\'77ff7\'85ff3\'49ff2\'64ff8\'26
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🔍 Feature Selection 🔎

Data -> Features -> Algorithm(s)

ML models are primarily driven by the features you select.

The tunables per algorithm, can be "fuzzed" via grid search.

Our feature vector contains ~150 data points.

Split 75/25 between "visual" and semantic.

BoW and TF/IDF

Given a corpus of text, find all the unique tokens, jumble them together.

Rank the words by Term Frequency / Inverse Document Frequency (TF/IDF).

In other words, times the term is seen in a document vs all documents.

This text mining process can identify unique anchors for filtering.

Clustering

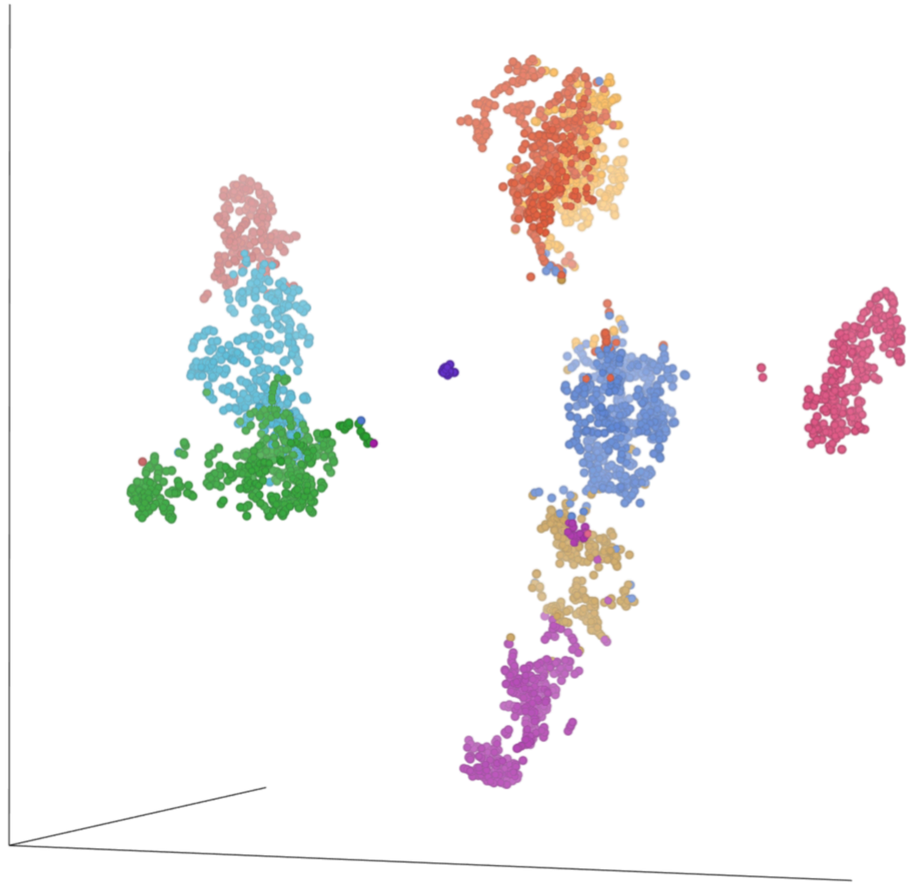
Inputs: Raw Macro and Feature Vector

Macro -> Bag-of-Words (BoW) -> TF/IDF

Macro hashing w/ SSDeep and TLSH.

K-Means (BoW and Features).

DBSCAN / OPTICS (BoW and Features).



🐇 Fuzzy Hashes #️⃣

Context Triggered Piecewise Hash (CTPH), aka "fuzzy hashes".

SSDeep, the ubiquitous option and it's SQL query-able!

Trend **M**icro **L**ocality **S**ensitive **H**ash (TLSH), the newer option, gaining traction, included in STIX v2.1.

Input is raw macro. Distance between samples is calculated.

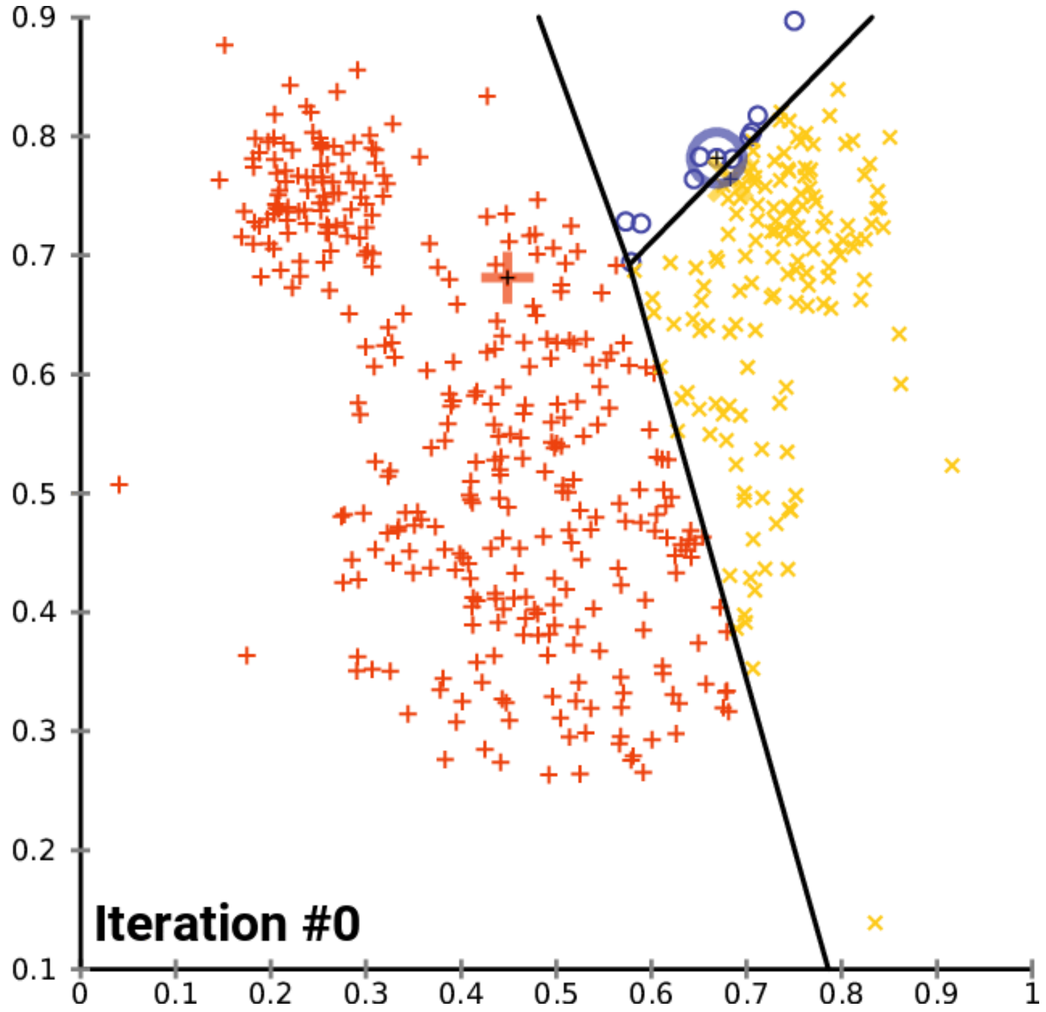
🤔 *You must choose a threshold for clustering.*

K-Means Clustering

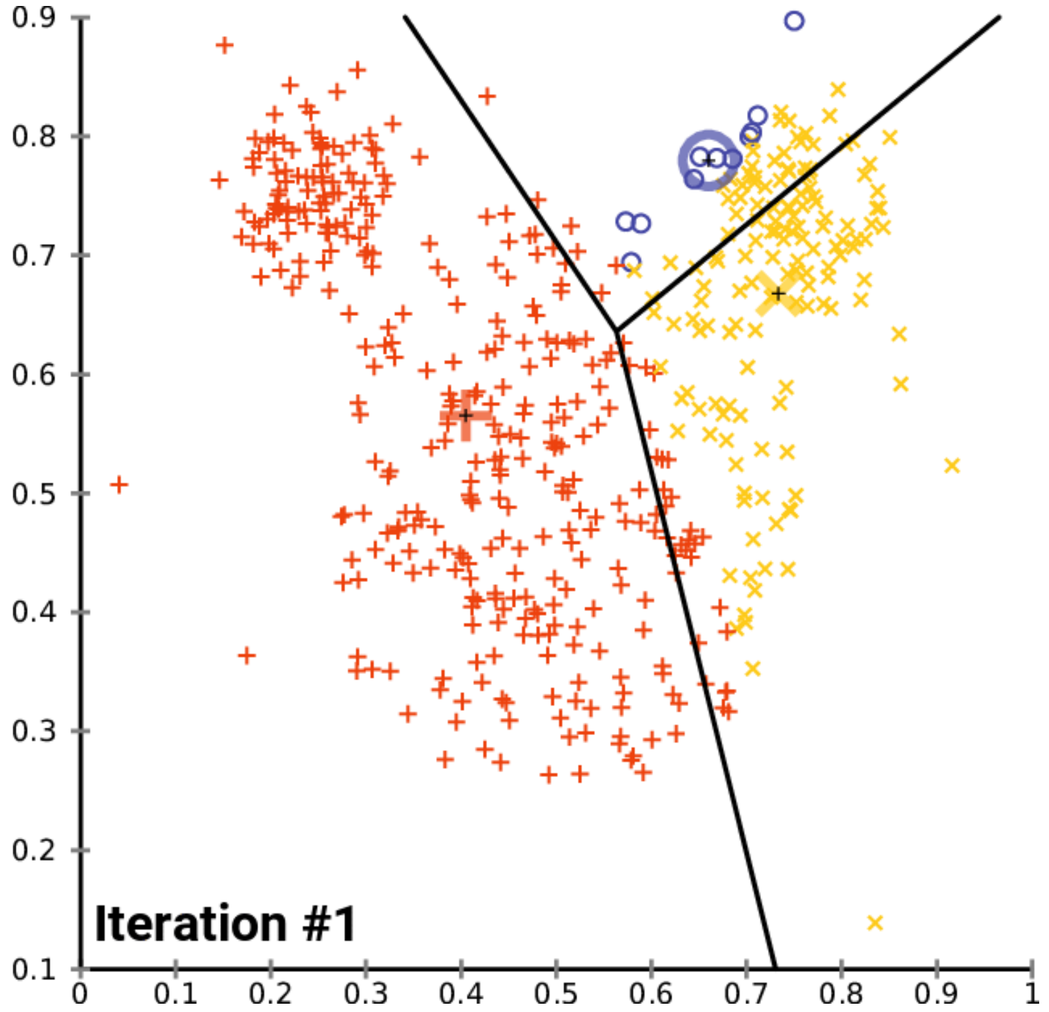
1. Randomly choose dummy points, measure distance from dummy point to every other point.
2. Move the dummy points towards a denser area.
3. Repeat the process until improvements can not be made.

🤔 *You must choose the number of clusters.*

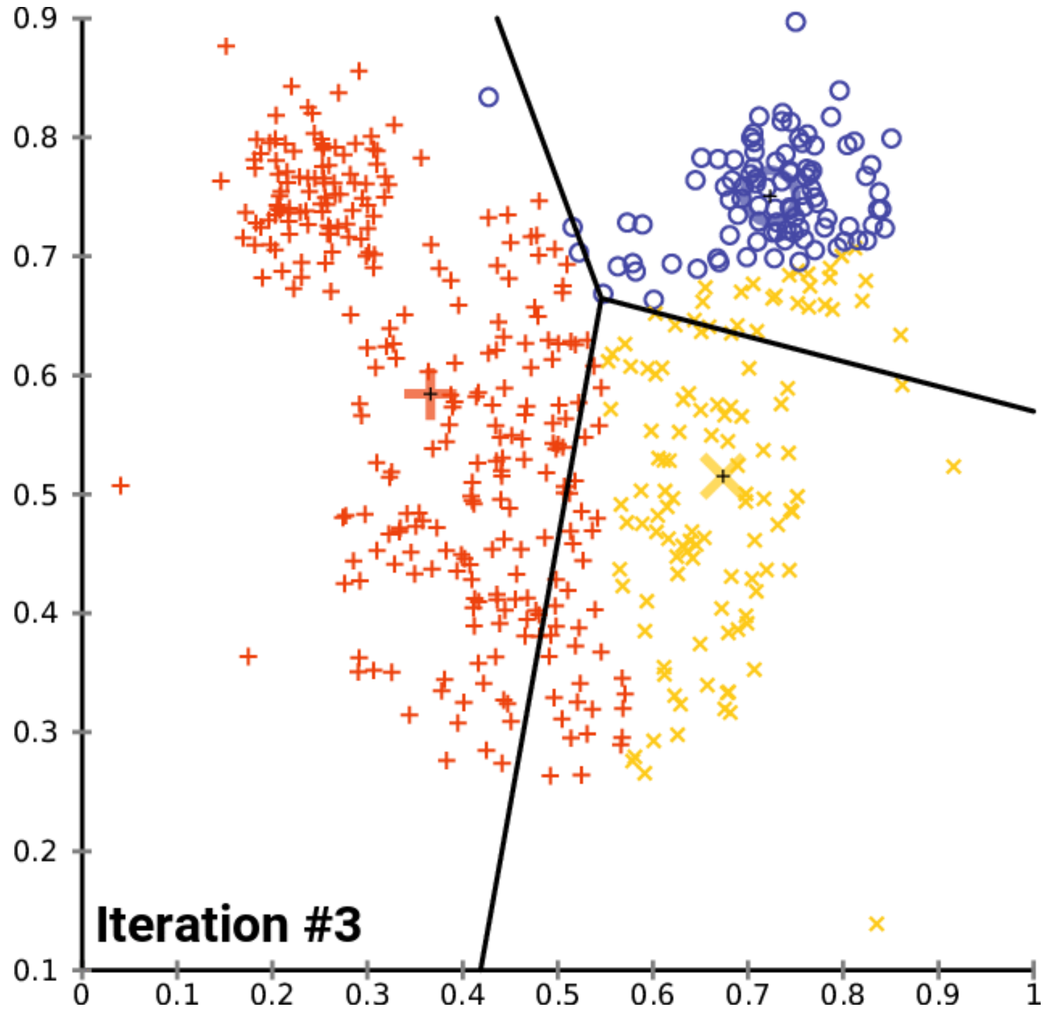
K-Means Clustering



K-Means Clustering



K-Means Clustering



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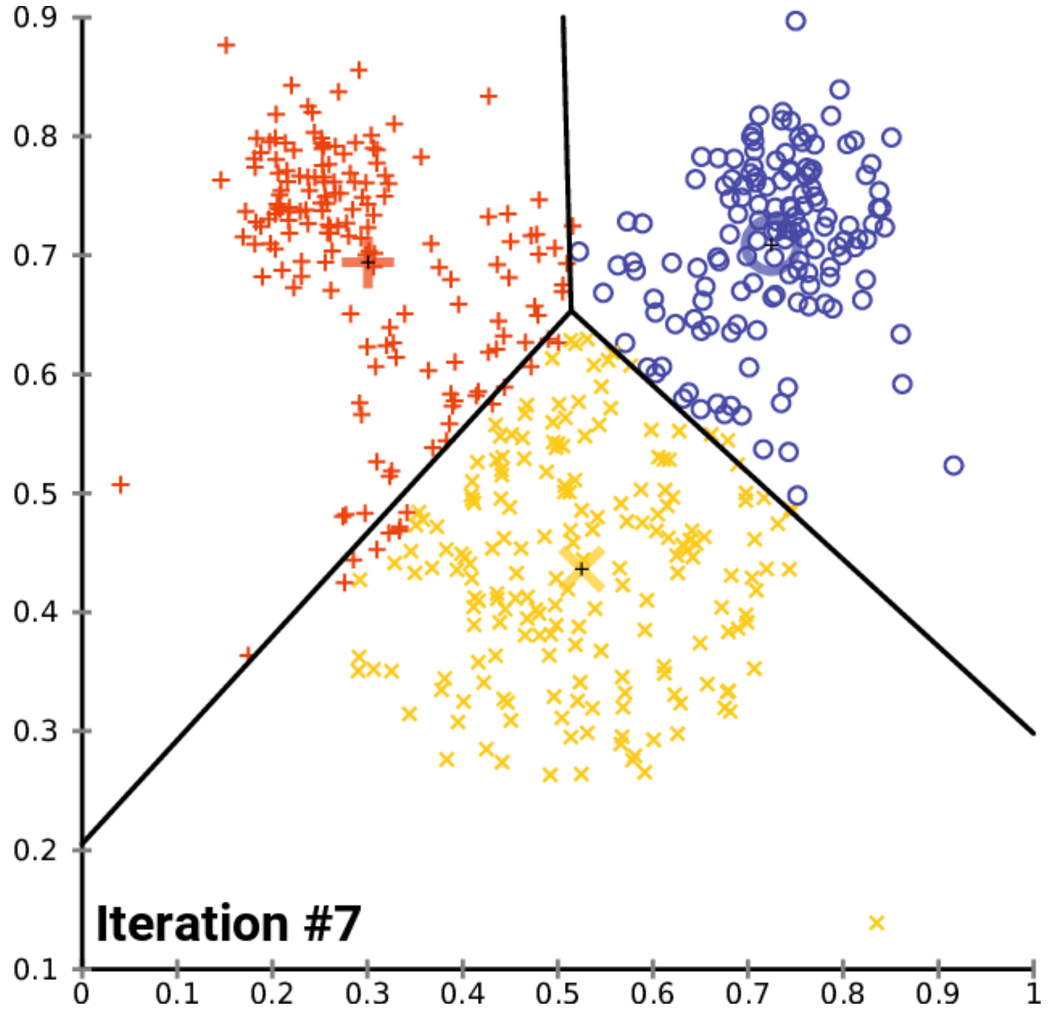
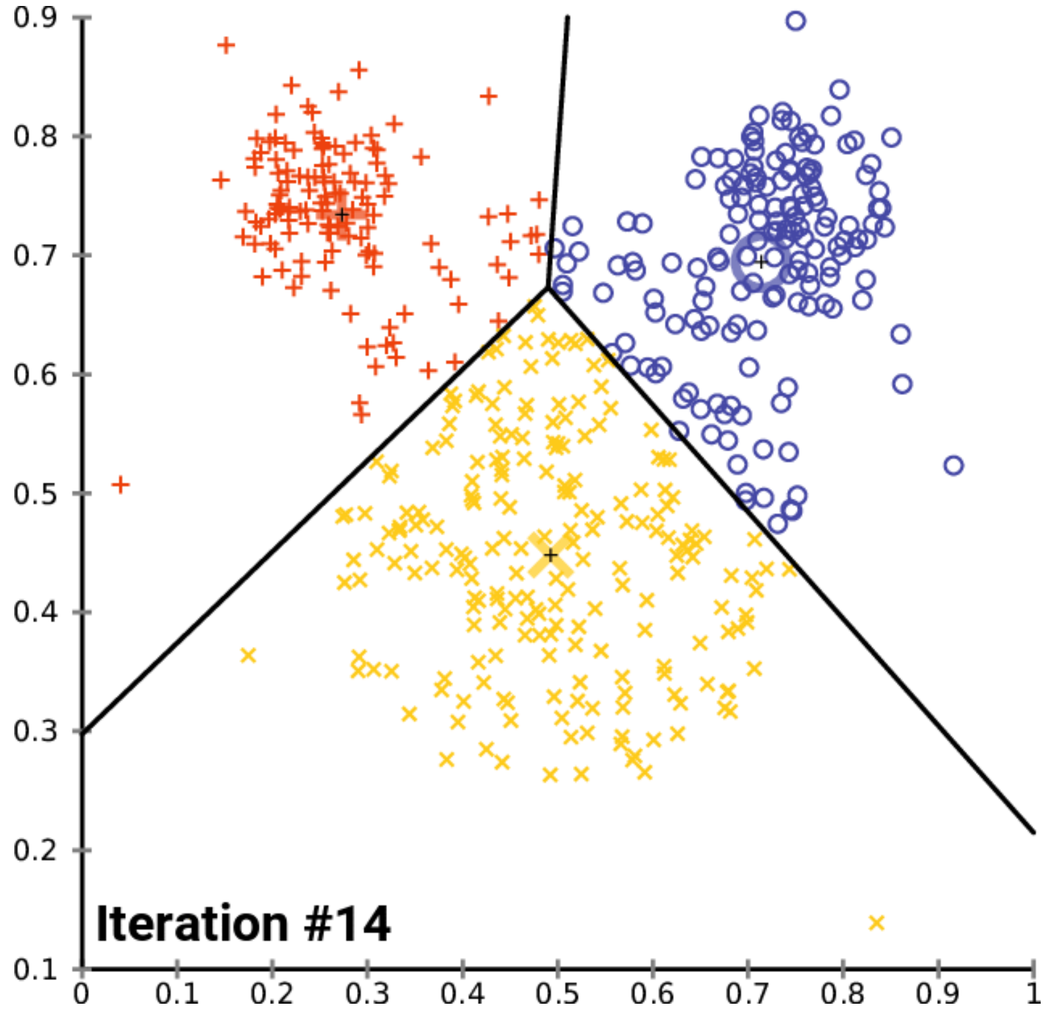


K-Means Clustering



DBSCAN / OPTICS

Density-**B**ased **S**patial **C**lustering of **A**pplications with **N**oise (DBSCAN)

Ordering **P**oints **T**o **I**dentify the **C**lustering **S**tructure (OPTICS)

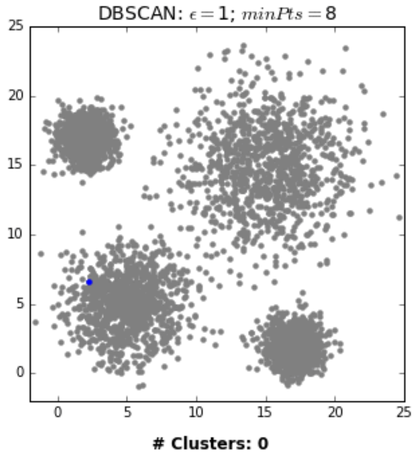
Uniform density-> DBSCAN, Varying density -> OPTICS.

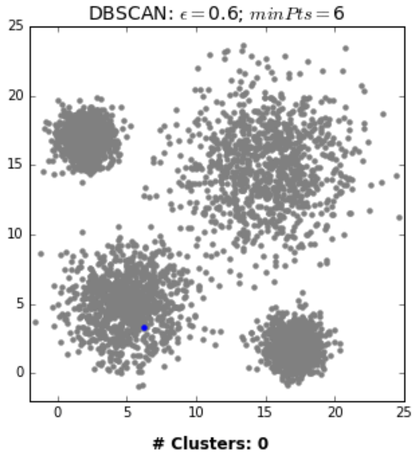
1. For each point, determine which other points live within epsilon distance.
2. If that number of points > *min_points*, then it's a "core point". Otherwise, it's an "edge point".
3. Points without neighbors are "noise".

🤔 *You must choose your epsilon and min_points threshold.*

DBSCAN / OPTICS

1





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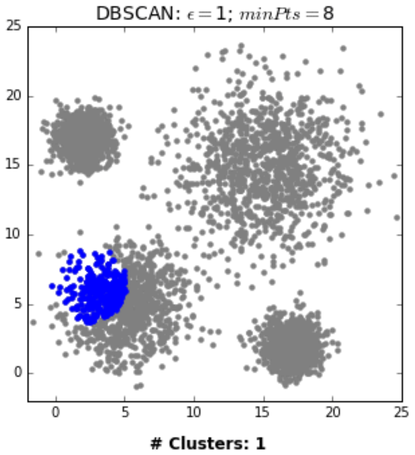

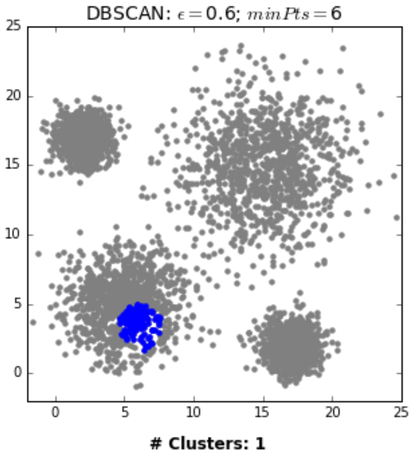

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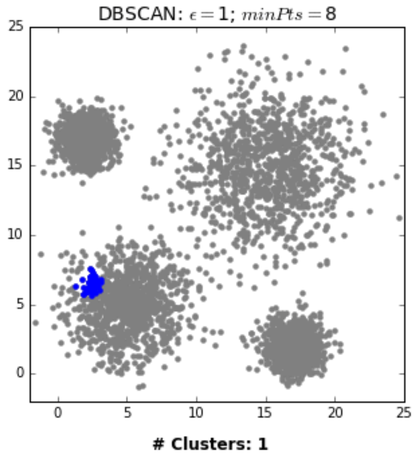

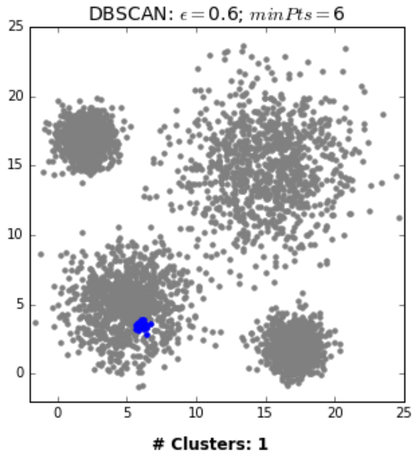

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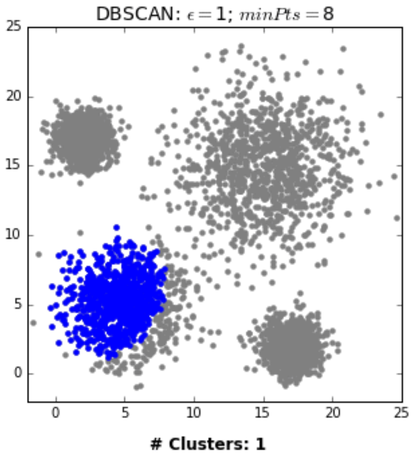

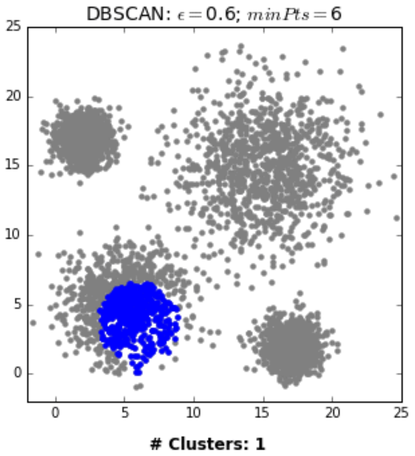

DBSCAN / OPTICS

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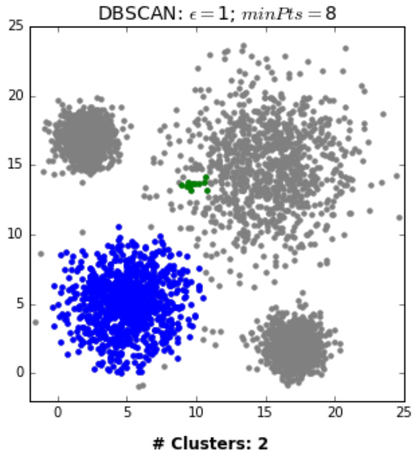

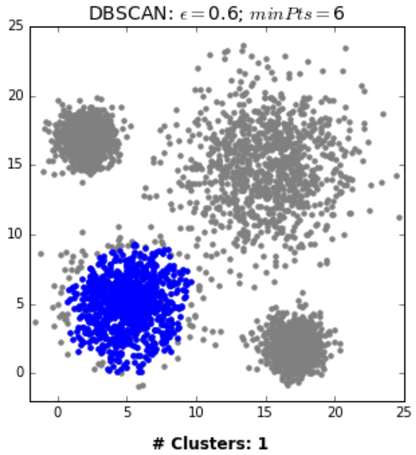

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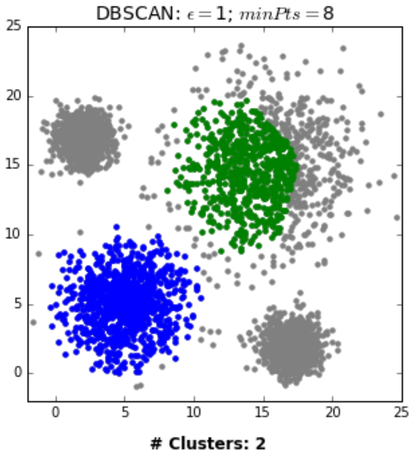

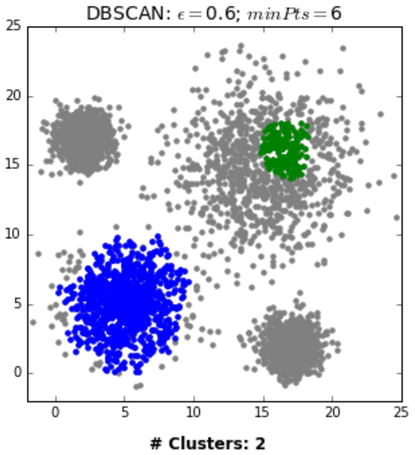

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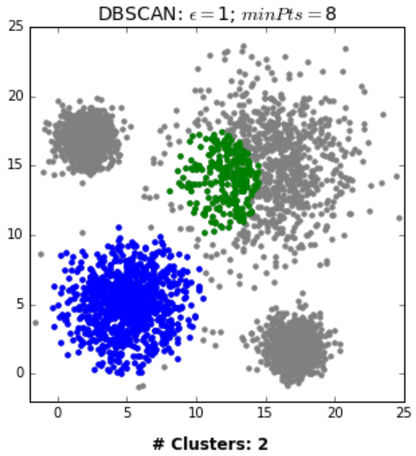

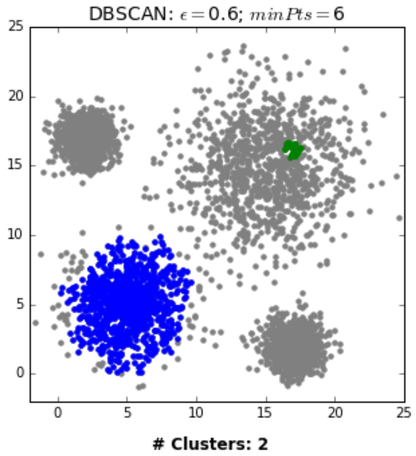

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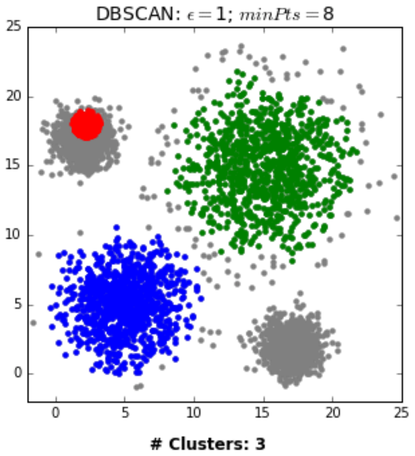

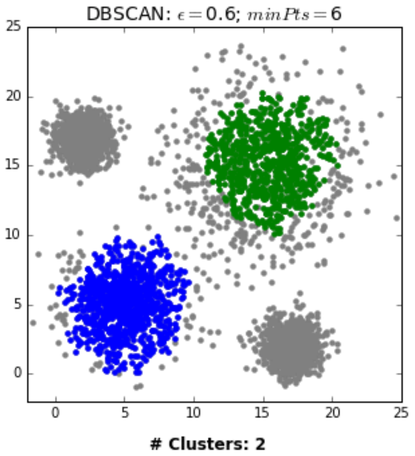

DBSCAN / OPTICS

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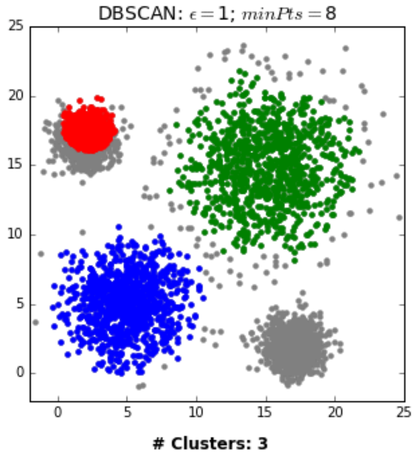

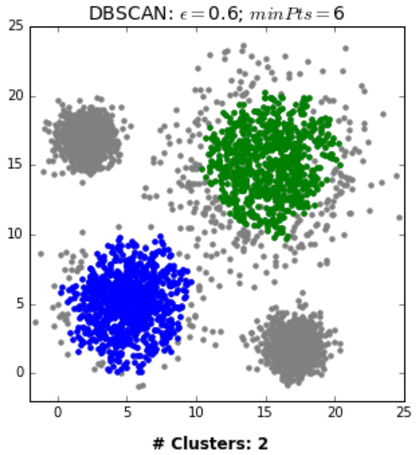

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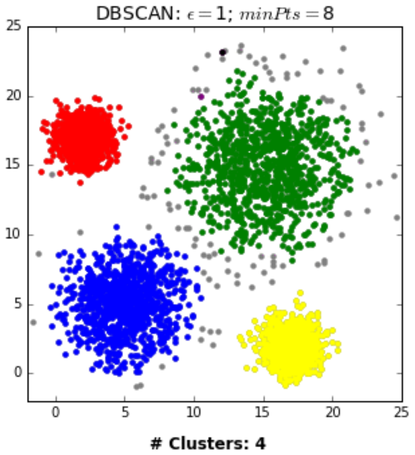

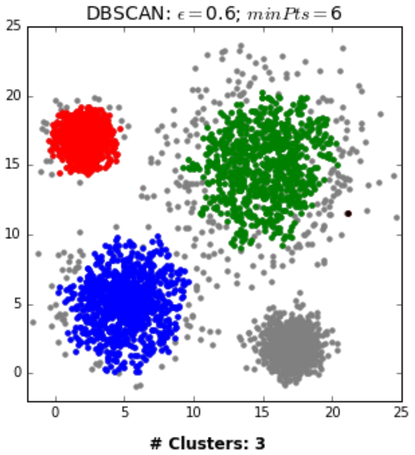

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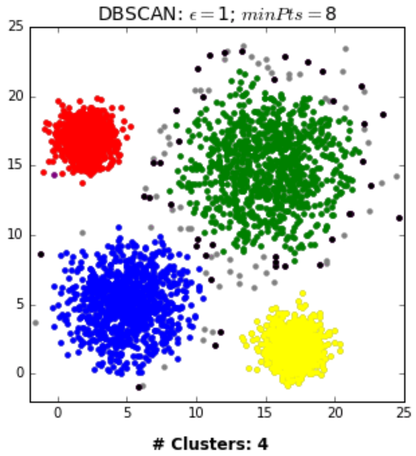

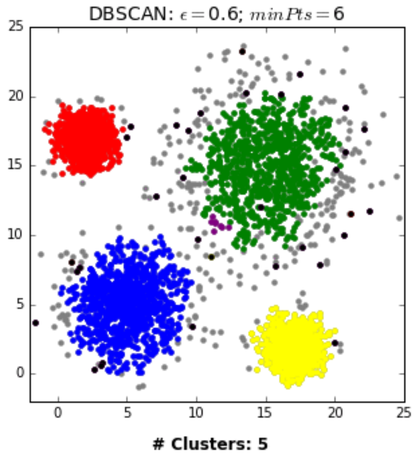

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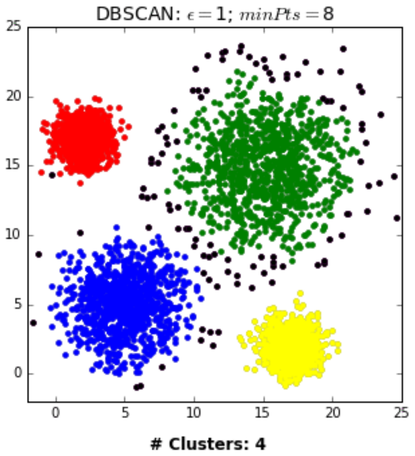

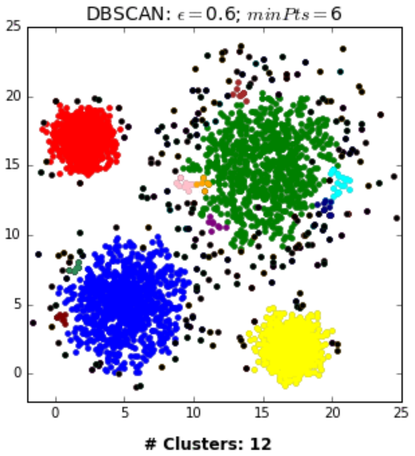

Clustering Results

Method	+Malicious	+Benign	Contribution
SSDeep	917	161	10.78%
TLSH	478	102	5.8%
K-Means-TFIDF	238	2	2.4%
K-Means-Features	285	3	2.88%
DBSCAN-TFIDF	795	4	7.99%
DBSCAN-Features	-	-	-
OPTICS-TFIDF	349	12	3.61%
OPTICS-Features	390	22	4.12%
Total / Unique	**1789**	**95**	**18.84%**

Corpus consists of 10,000 unique (macro hash) carrier documents, ~20% labeled.

👀 Looking for Outliers 👀

1. Discard the clusters.
2. Dynamic analysis, especially on bare metal.
3. Manual analysis with a focus on the suspect but undetected.

Identify an anchor and RetroHunt to expand the sample set.

⚓'s include: constant, asset, metadata, network header, etc.


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- Explore common carriers.
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- YARA helpers.
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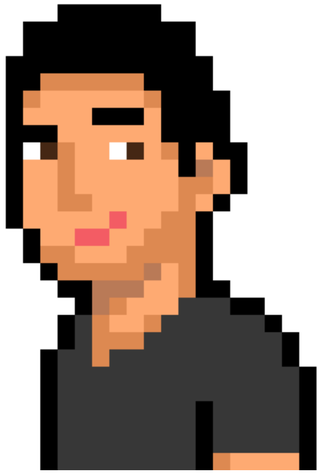
  - base64 regex generator
- Reputation aggregation
  - ~25 open sources
- IOC aggregration
  - Twitter, RSS, Github…
- Open API
- *Cluster data impending…*

Get in touch.



pedram@inquest.net

@pedramamini

@InQuest