Automated Generation of YARA Classifier for Malware

Using Code Similarity

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About Me

Professor of Computer Science

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Automated malware deobfuscation and indexing
Automated YARA generation

PSA - Invitation to share your knowledge for posterity

acm Association for Computing Machinery

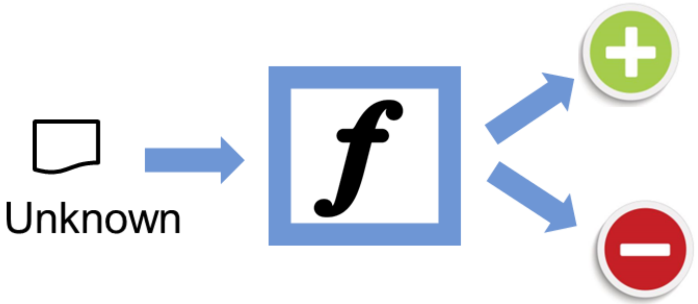
Digital Threats: Research and Practice

Promoting Science in Digital Threats Research

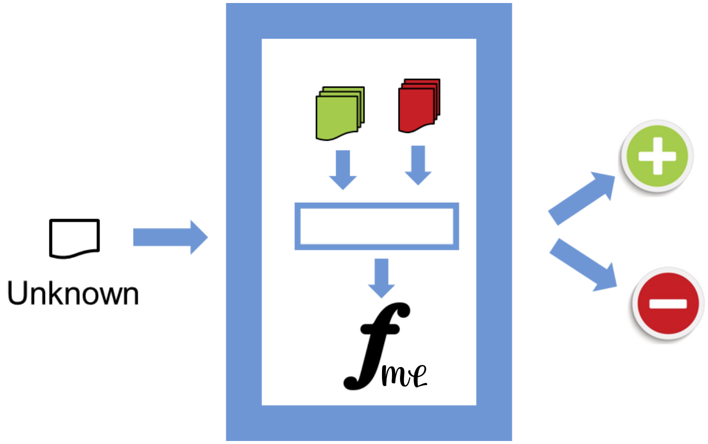
Field Notes: Capture knowledge of practitioners

- A short case report (1000-1500 words) about emerging threats and defenses.
- Accurately document factual data as well as the settings, actions, behaviors, and consequences that are observed.
- May contain thoughts, ideas, questions, and concerns that arise as the observation is conducted.
- Provide perspectives on a single phenomenon that, when accumulated over time, suggest new avenues of research.

Classifiers

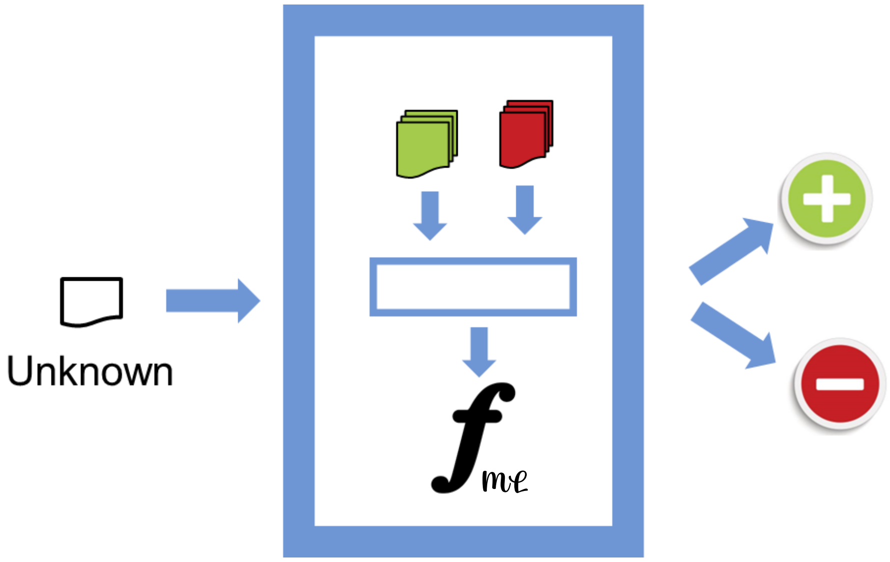


ML Classifiers



- Requirements for ML Classifiers:
  - Distribution of +ves and –ves is identical and independent
  - Availability of +ves and –ves samples
  - Available samples represent population

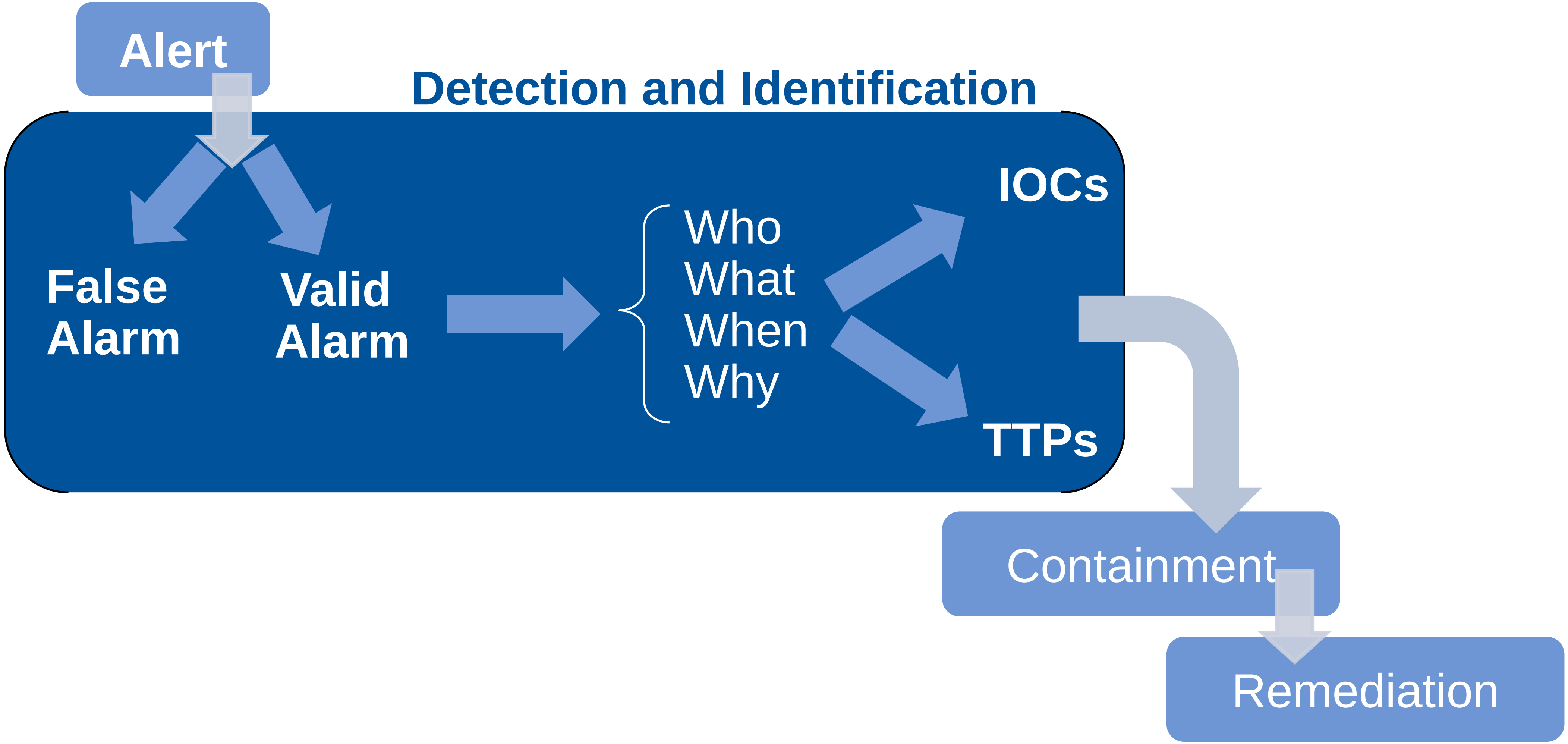
ML Classifiers for Malware



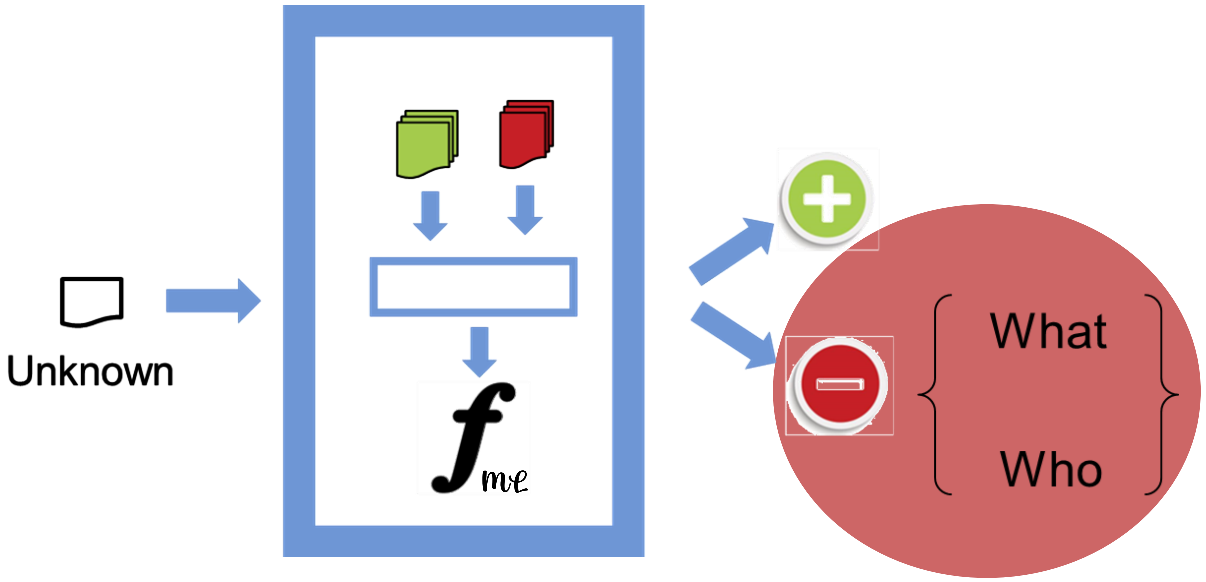
Practical Challenges

- Concept drift
  - – +ves and –ves are not static
- Adversarial
  - – +ves transform to defeat classifiers
- Labels are noisy
  - – Crowdsourced
  - – Industry consensus

New Use Case: Incident Response Workflow



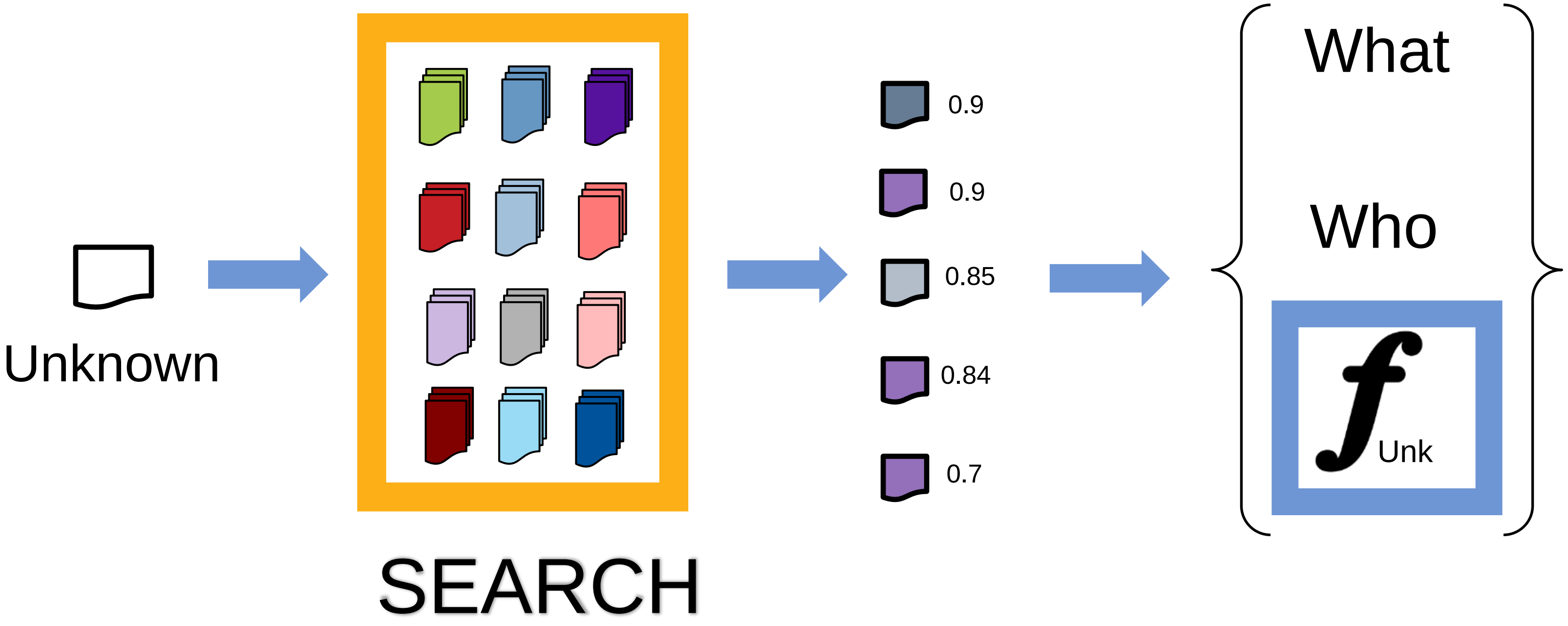
ML Classifiers for Malware



New Challenges

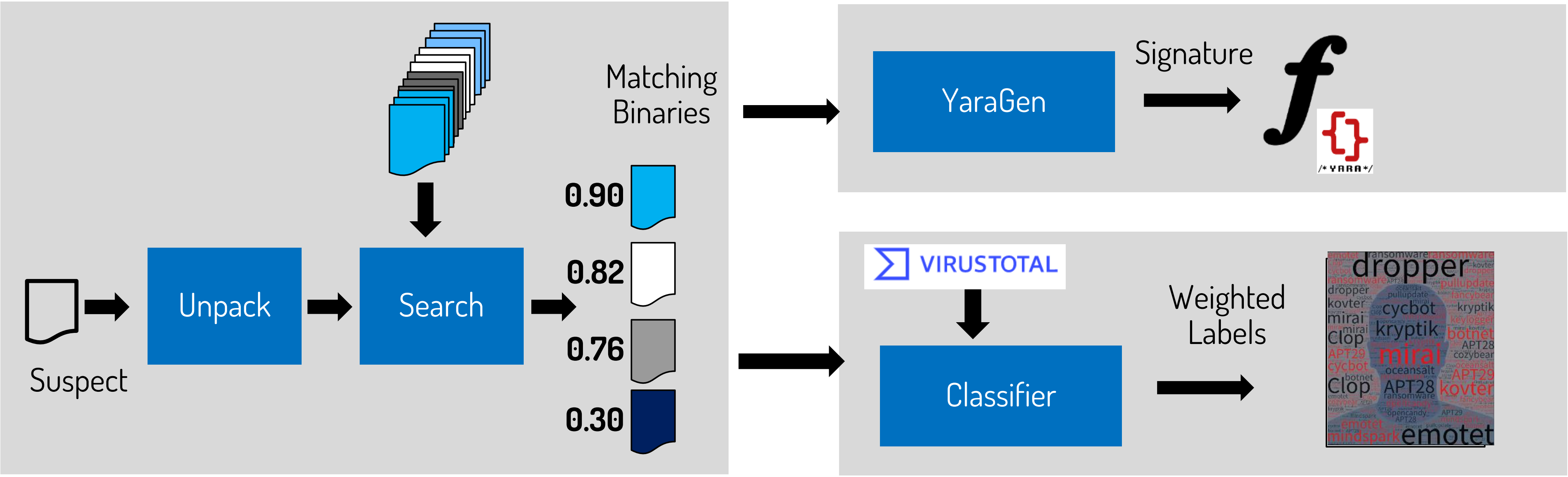
- Knowing a suspect is malware is not sufficient
  - Need to know the stage of the attack
    - What the malware does?
    - Who is behind it?
- Need multi-classifiers
  - Type of malware
  - Family of malware

A New Architecture for Generating Malware Classifiers

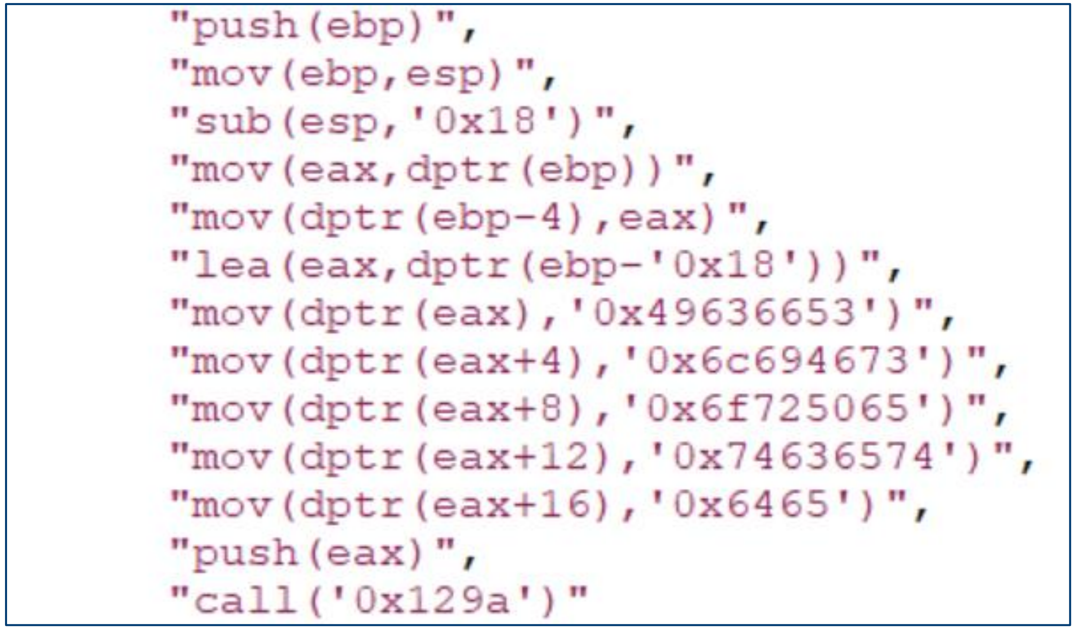


- Match Unknown to Known
- Extract characteristics from Known
- Create specialized classifier for the Unknown

Cythereal MAGIC – Malware Genomic Classifier



How to Search for Similar Binaries?



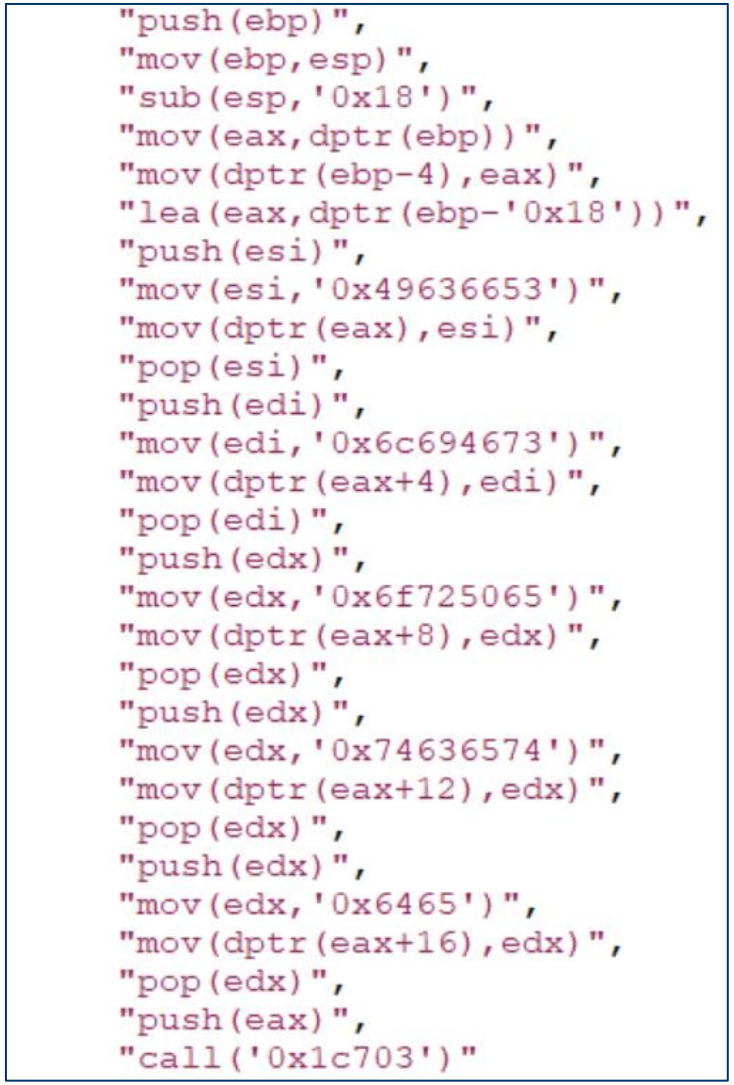
```
"push(ebp)",
"mov(ebp,esp)",
"sub(esp,'0x18')",
"mov(eax,dptr(ebp))",
"mov(dptr(ebp-4),eax)",
"lea(eax,dptr(ebp-'0x18'))",
"mov(dptr(eax),'0x49636653')",
"mov(dptr(eax+4),'0x6c694673')",
"mov(dptr(eax+8),'0x6f725065')",
"mov(dptr(eax+12),'0x74636574')",
"mov(dptr(eax+16),'0x6465')",
"push(eax)",
"call('0x129a')"
```

Bytes

≠

Semantics

=



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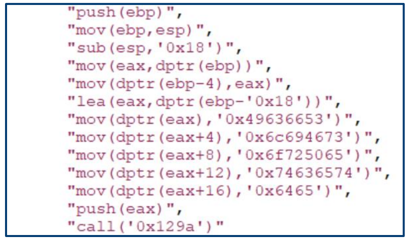
"sub(esp,'0x18')",
"mov(eax,dptr(ebp))",
"mov(dptr(ebp-4),eax)",
"lea(eax,dptr(ebp-'0x18'))",
"push(esi)",
"mov(esi,'0x49636653')",
"mov(dptr(eax),esi)",
"pop(esi)",
"push(edi)",
"mov(edi,'0x6c694673')",
"mov(dptr(eax+4),edi)",
"pop(edi)",
"push(edx)",
"mov(edx,'0x6f725065')",
"mov(dptr(eax+8),edx)",
"pop(edx)",
"push(edx)",
"mov(edx,'0x74636574')",
"mov(dptr(eax+12),edx)",
"pop(edx)",
"push(edx)",
"mov(edx,'0x6465')",
"mov(dptr(eax+16),edx)",
"pop(edx)",
"push(eax)",
"call('0x1c703')"
```

- Need to define similarity on semantics

Features from Semantics

Code



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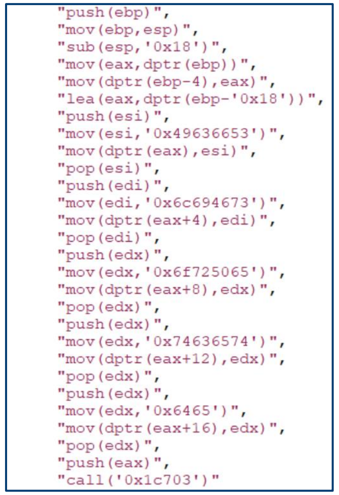
```



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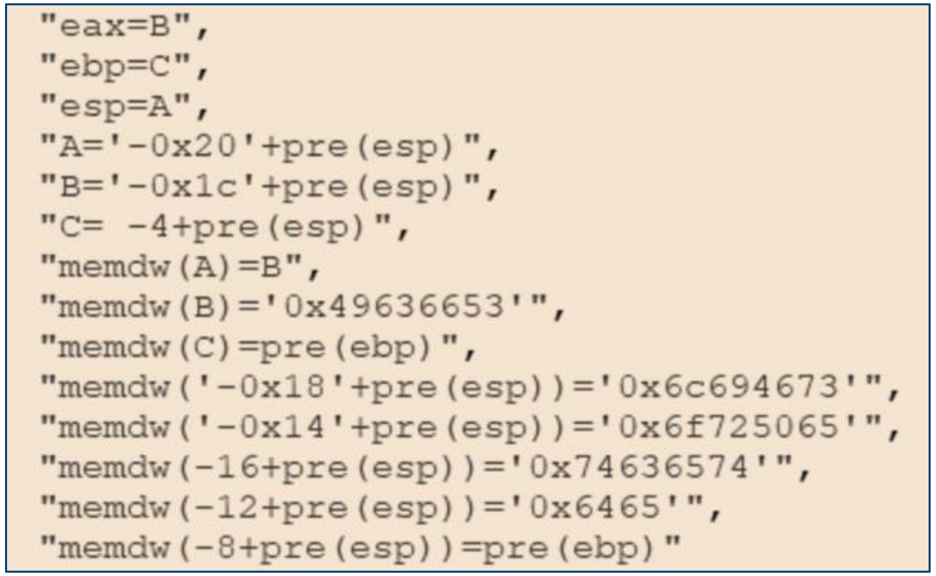
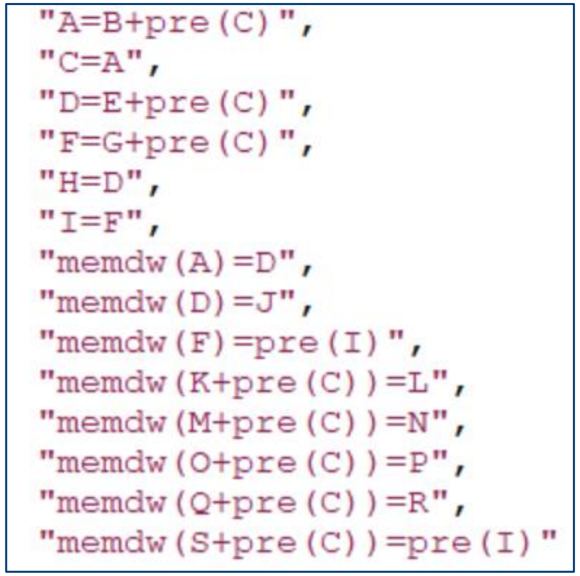
"sub(esp,'0x18')",
"mov(eax,dptr(ebp))",
"mov(dptr(ebp-4),eax)",
"lea(eax,dptr(ebp-'0x18'))",
"push(esi)",
"mov(esi,'0x49636653')",
"mov(dptr(eax),esi)",
"pop(esi)",
"push(edi)",
"mov(edi,'0x6c694673')",
"mov(dptr(eax+4),edi)",
"pop(edi)",
"push(edx)",
"mov(edx,'0x6f725065')",
"mov(dptr(eax+8),edx)",
"pop(edx)",
"push(edx)",
"mov(edx,'0x74636574')",
"mov(dptr(eax+12),edx)",
"pop(edx)",
"push(edx)",
"mov(edx,'0x6465')",
"mov(dptr(eax+16),edx)",
"pop(edx)",
"push(eax)",
"call('0x1c703')"
```

Semantics



```
"eax=B",
"ebp=C",
"esp=A",
"A='-0x20'+pre(esp)",
"B='-0x1c'+pre(esp)",
"C=  -4+pre(esp)",
"memdw(A)=B",
"memdw(B)='0x49636653'",
"memdw(C)=pre(ebp)",
"memdw('-0x18'+pre(esp))='0x6c694673'",
"memdw('-0x14'+pre(esp))='0x6f725065'",
"memdw(-16+pre(esp))='0x74636574'",
"memdw(-12+pre(esp))='0x6465'",
"memdw(-8+pre(esp))=pre(ebp)"
```

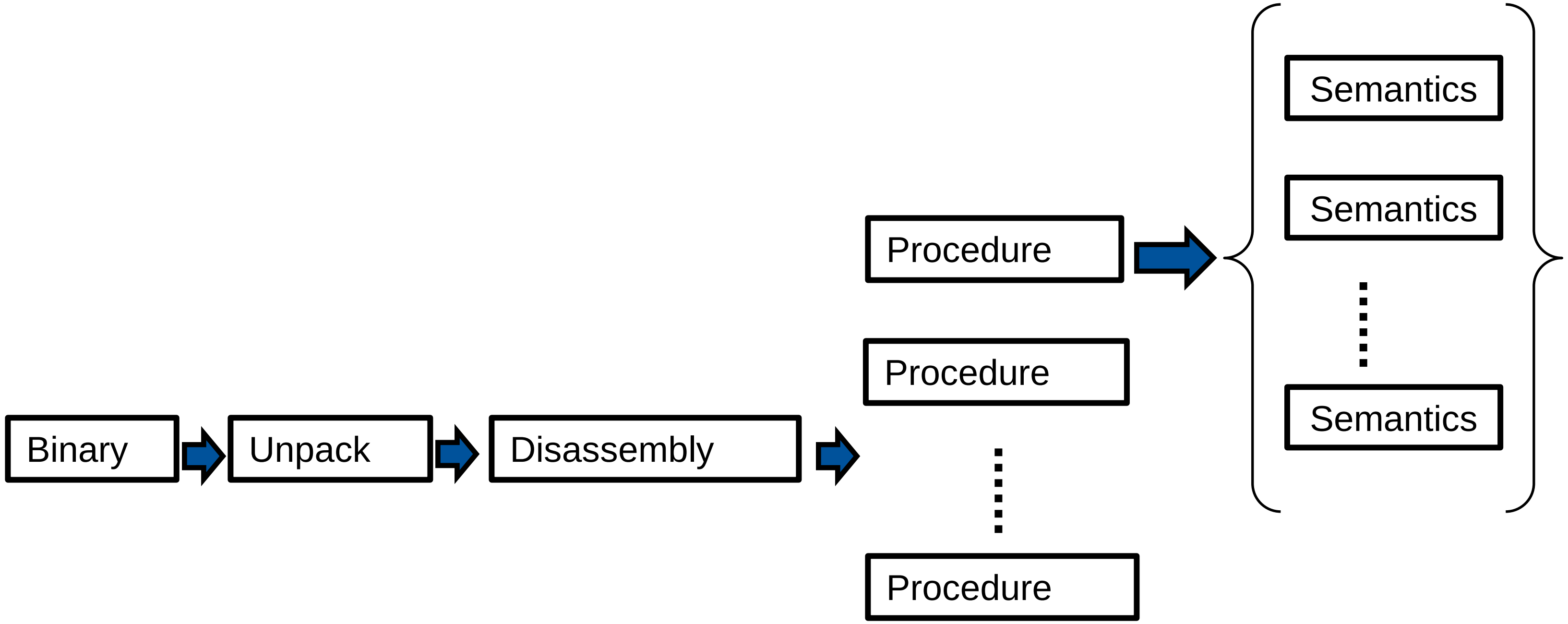
Generalized Semantics



```
"A=B+pre(C)",
"C=A",
"D=E+pre(C)",
"F=G+pre(C)",
"H=D",
"I=F",
"memdw(A)=D",
"memdw(D)=J",
"memdw(F)=pre(I)",
"memdw(K+pre(C))=L",
"memdw(M+pre(C))=N",
"memdw(O+pre(C))=P",
"memdw(Q+pre(C))=R",
"memdw(S+pre(C))=pre(I)"
```

- Interpret
- Normalize
- Generalize
- Index

Translating Binary to Feature Vector using Semantics



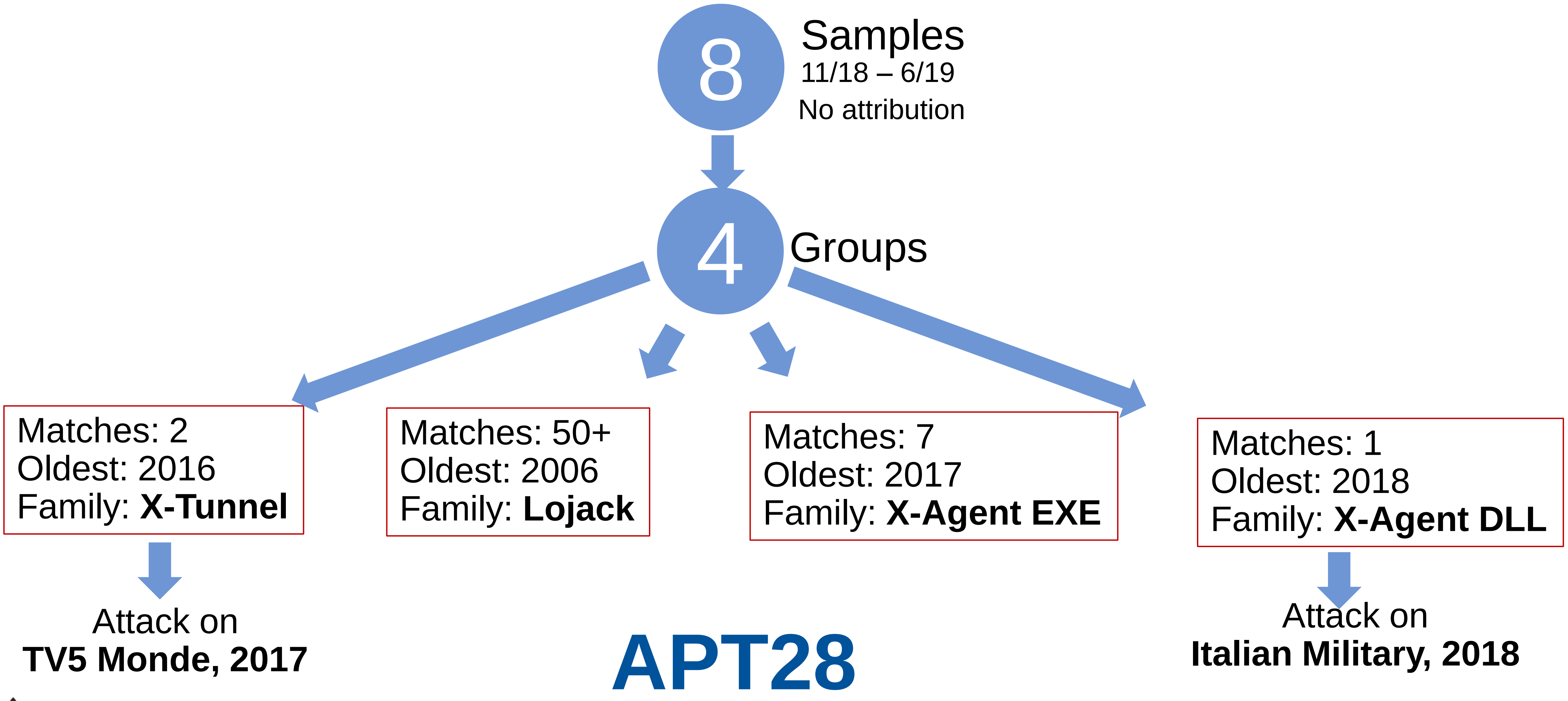
Binary

Feature Vector

Bag of Bag of Semantics

Demo: https://Beta.Magic.Cythereal.Com

Case Study: CYBERCOM CNMF Malware



8 Samples
11/18 – 6/19
No attribution

4 Groups

Matches: 2
Oldest: 2016
Family: **X-Tunnel**

Attack on
TV5 Monde, 2017

Matches: 50+
Oldest: 2006
Family: **Lojack**

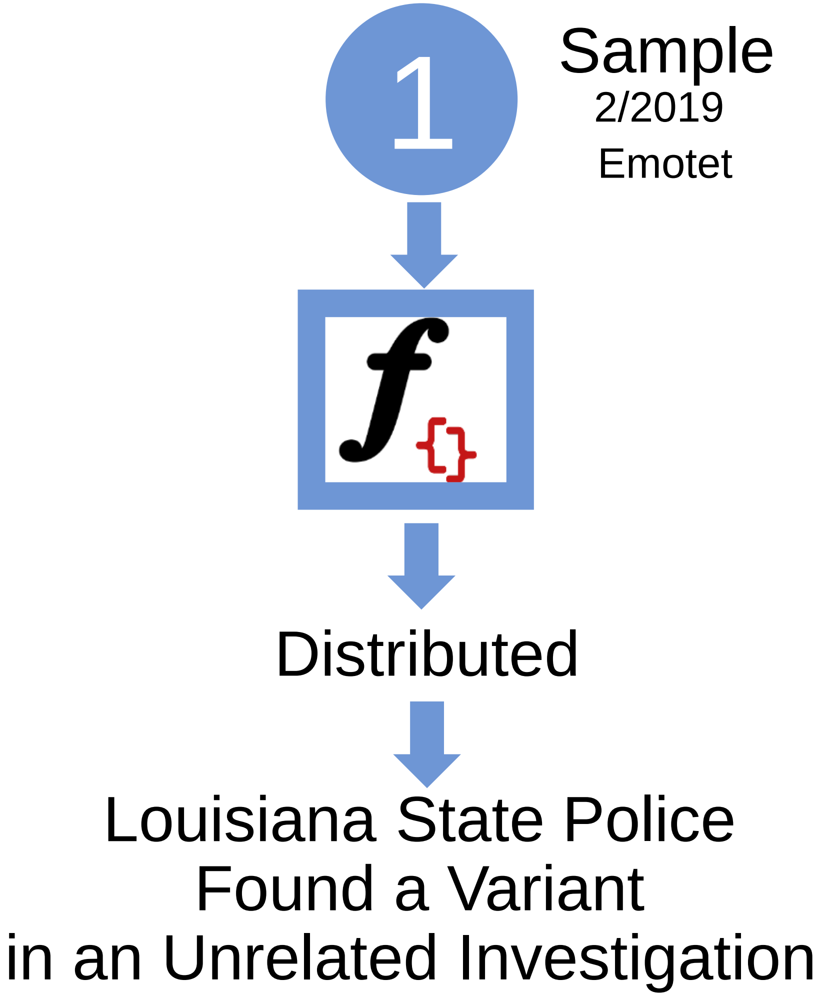
Matches: 7
Oldest: 2017
Family: **X-Agent EXE**

Matches: 1
Oldest: 2018
Family: **X-Agent DLL**

Attack on
Italian Military, 2018

APT28

Case Study: Louisiana State Police



Sample
2/2019
Emotet

Distributed

Louisiana State Police
Found a Variant
in an Unrelated Investigation

Power of Genome (data from 2019)

Executable Binaries in MAGIC Repository

# Binaries	3,413,184
# Genomically Unique	1,457,393
Genomic Compression	**57.3%**

Two binaries are genomically identical if ALL their procedures have the same genome.

Procedures Extracted from Binaries

# Procedures	1,658,759,504
# Genomically Unique	27,732,888
% Genomic Compression	**98.33%**

Two procedures are unique if they have the same same abstracted semantics

Binary Similarity (> 0.7)

# Similarity Binary Nodes	3,978,430
# Similarity relationships	426,121,442
Avg number of similar binaries	**107**

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Hybrid Analysis Search

- Free Automated Malware Analysis Service - powered by Falcon Sandbox - Search results from HA Community Files (hybrid-analysis.com)