NEXT-GENERATION OF EXPLOIT KIT DETECTION BY BUILDING SIMULATED OBFUSCATORS

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Palo Alto Networks

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Agenda

- Background and Motivation
- Challenges
- Our Approach and Lessons We learned
- Result and Our Observation

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Motivation

www.jsDarwin.com

Similarity-based Detection on malicious Exploit Kit JavaScript

Large Number of Samples Required

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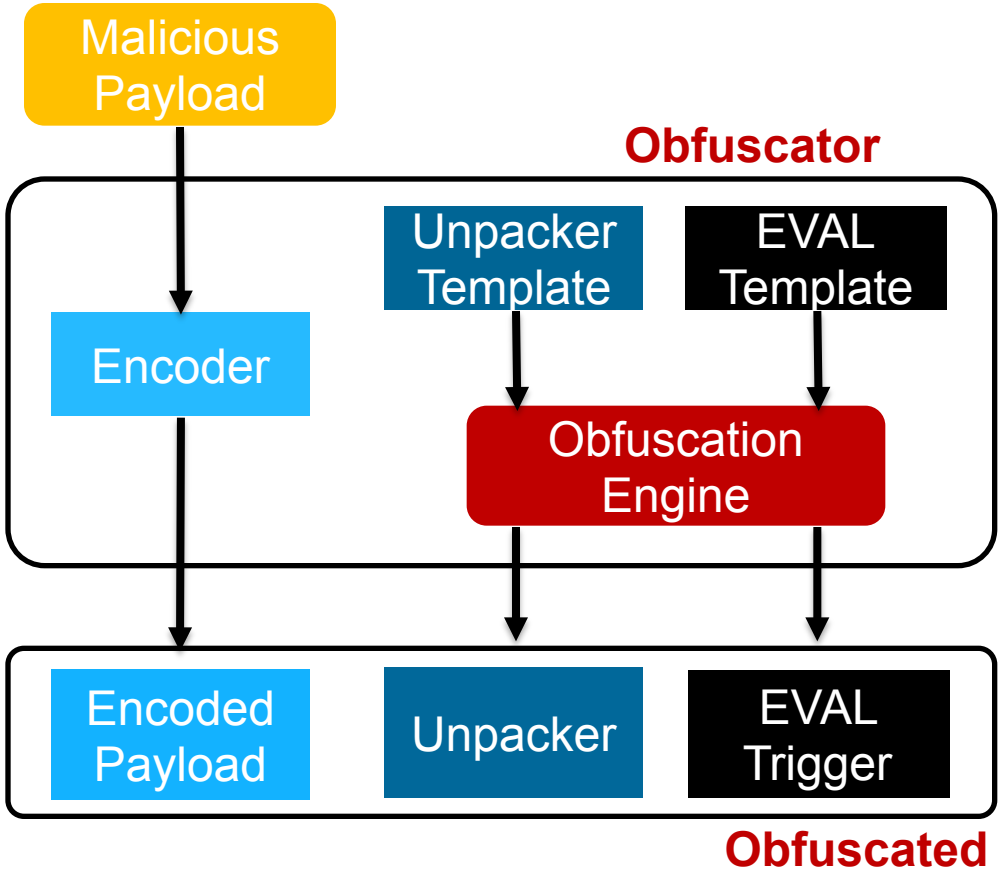
Exploit Kit Obfuscator



Reconstruct Encoder

Identify Template From Obfuscated Page

Reproduce Engine Logic

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Obfuscator Reverse-Engineering

```
window [‘e’+’v’+’a’+’l’]
                [wsq(xyz, fxj)];
```

```
window [‘ev’+’al’]
                [zxh(abc, sih)];
```

```
window [‘aevala’.substr(1,4)]
                [zxh(abc, sih)];
```

Obfuscation Engine
(variant)

```
“window [“ + $[eval_ctr] + “] [”
                + $v[0] +”(“ v[1]
                    + ”,” + v[2] + ”)” + “]”
```

EVAL Template
(version)

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Challenges

1. Code Complexity

```
<script>
function pDA(AUT){ ... }
ZzF ="lnFloa";
function vzLh(Hpv){gEao="oi"+""+"n",aOC=window,SLVmg="e"+"x",
bUdR="R"+"e"+""+"g",FMwVS="o"+""+"u"+""+"te"+"rH
",HjEn="u"+"s"+""+"e"+"r",Wyc="b"+"o",Wbf="e"+"R"+""+"x";var qVa=new
aOC[bUdR+'Exp']('MSIE (\d+\.\d+);');var xngS=navigator[HjEn+'Agent'];var
prC=qVa[(Wbf+'ec').replace("R","")](xngS);var
$mrh=!prC,ryG;$mrh=!$mrh;if($mrh){ryG=prC[1]}GcSX='.*'+'>(.'+'*?)'+'<\/p';
if( ... ){GcSX='.'+ '?>('+'.*'+'?)'+'<\/p'}else { ... } VdZW =
["r"+"e"+"p"+"l"+"a"+"c"+"e"]["j"+gEao]();var UkP=document[Wyc+'dy'],
yh$f=UkP[FMwVS+'TML'],wvnV="", El=new aOC[bUdR+'Exp'](ZzF+Hpv+GcSX,'gi');wvnV=
El[SLVmg+'ec'] (yh$f);wvnV=wvnV [1];var WMK =
wvnV[VdZW](/[-]/g,"/")[VdZW](/[_]/g,"+");function asafas(a){return a}function
GKcx(s) { ... }if(!pDA(GKcx(WMK)))alert("Error");}vzLh("dNTvXuVoyq");
vzLh("xWgaeJKYcclAu");</script>
```

Hundred lines of code
Random variables

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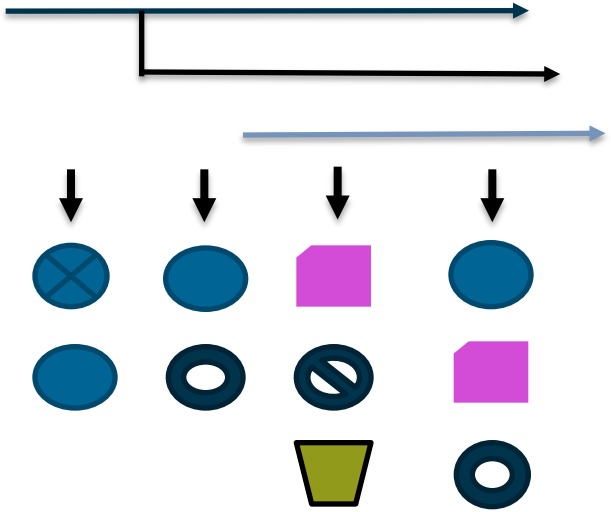
Challenges

2. Data Complexity



Big data set (~20000 Samples over 2 year period)
Mixed versions and variants

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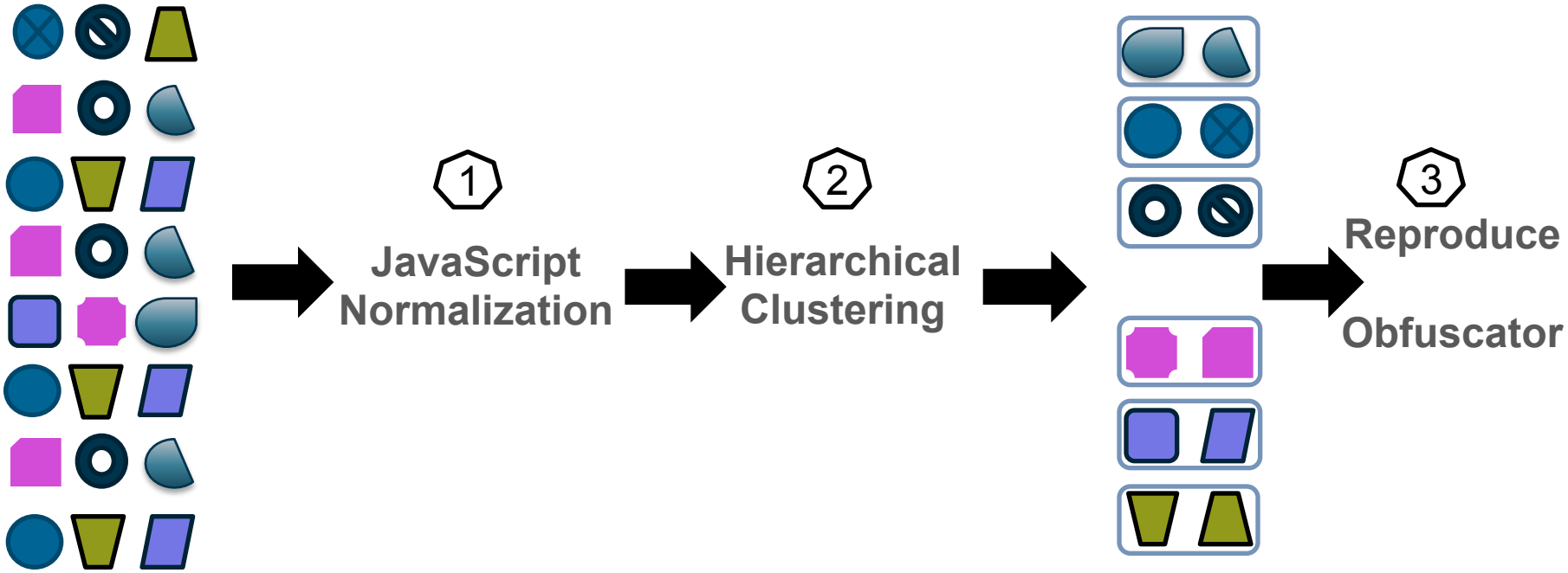
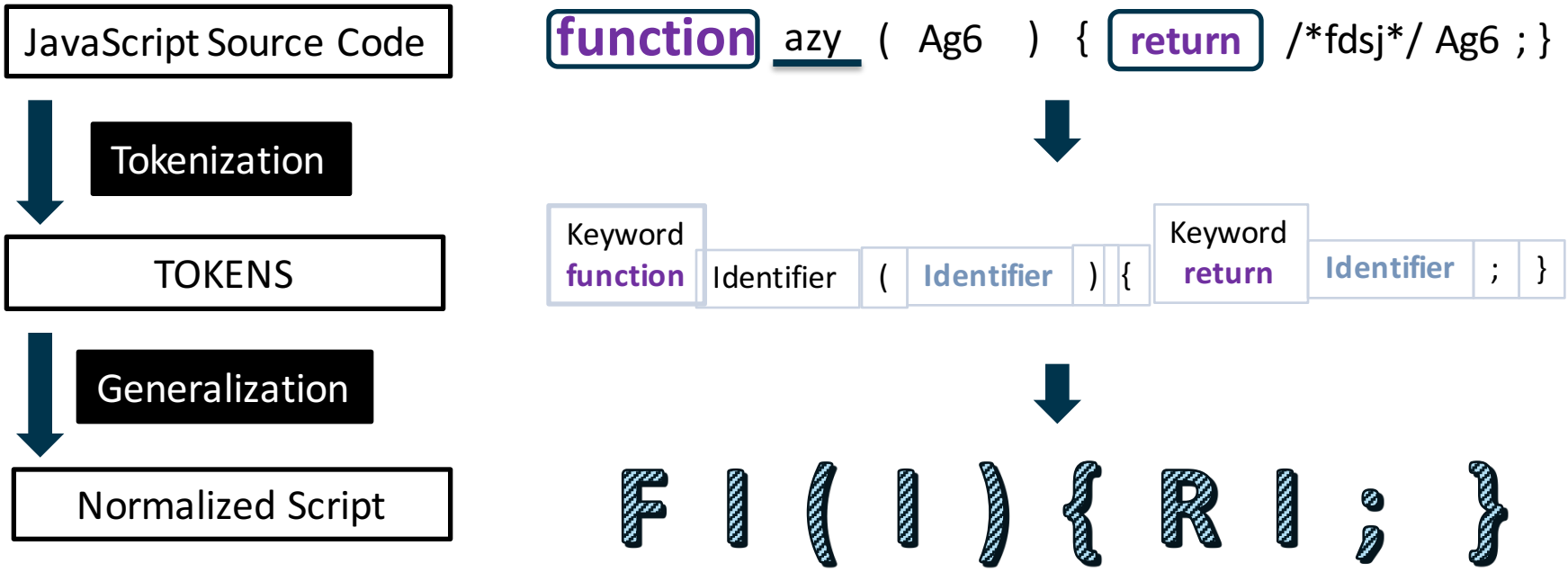
Overview of Our Approach



JavaScript Normalization



- Ignore Superficial Obfuscation (e.g. Randomized variable names)
- Normalized Script ⇔ Structure of the Code

Statistics

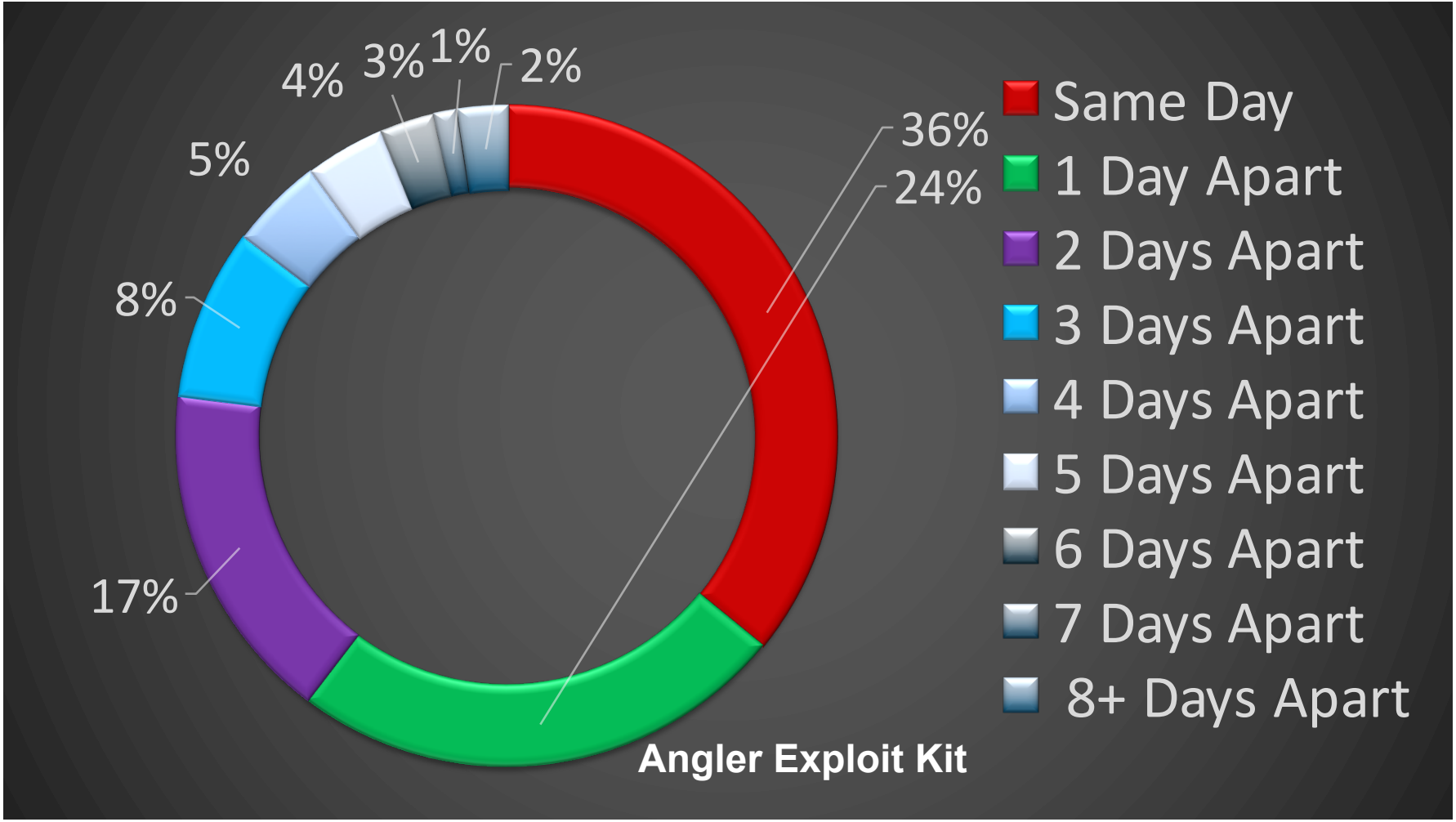
Total Number of samples we collected

Family	Angler	Nuclear	Rig	KaiXin	Fiesta
TOTAL #	7834	1303	1793	10291	79
UNIQUE #	613	107	344	1543	48

Total Number of samples
With Unique Normalized script

```
function azy ( Ag6 ) { return Ag6 ; }
function F$x3j( k2c5x ) { return k2c5x ; }
```

```
F I ( I ) { R I ; }
```

Statistics on Normalized Samples

Clustering

- Goal: Cluster Samples based on their obfuscator
- Observation: Similar Structure ➔ Generated by Similar Obfuscator
- Define Similarity.

$$SimScore(norm1, norm2) = 1 - \frac{EditDist(norm1, norm2)}{max(len(norm1), len(norm2))}$$

  - Similarity Score [0 , 1]
  - 1 = Identical, 0 = Different

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Hierarchical *vs* Flat

- Flat Model: (K-Means)
  - Easy and Efficient
  - Drawbacks
- Require predefined **K** as input
  - **K** ⇔ Number of Obfuscator Version
  - Hard to Predict, lack of knowledge
  - Will be Changed over time.

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Agglomerative (Bottom-Up) Hierarchical Clustering

Dendrogram

What is the proper Threshold to Identify Obfuscator Version/Variant?

[0.4 – 0.5]

Identify Obfuscator Version

[0.78 ~ 0.85]

Identify Obfuscator Variants

Threshold vs K

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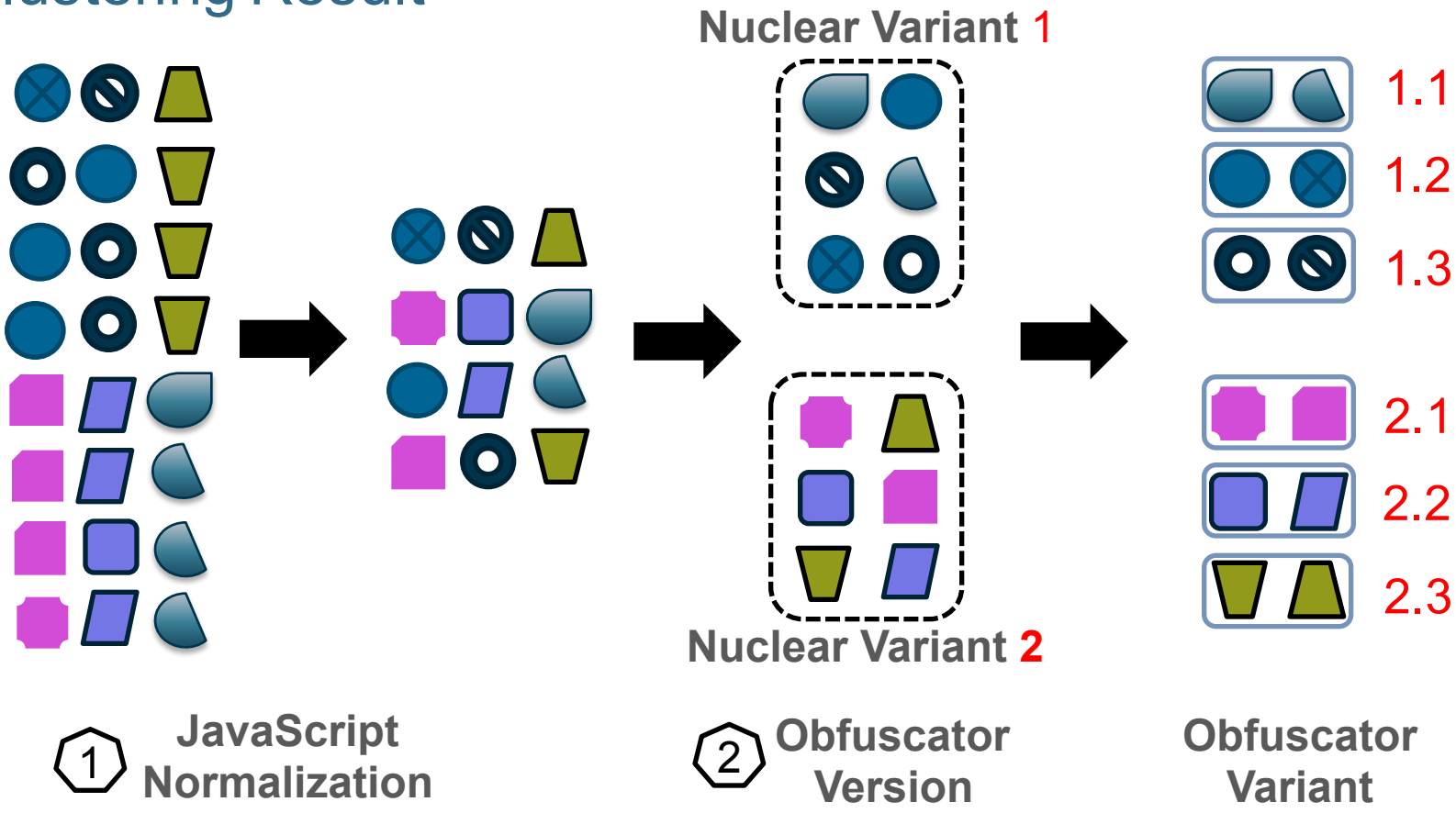
Clustering Result



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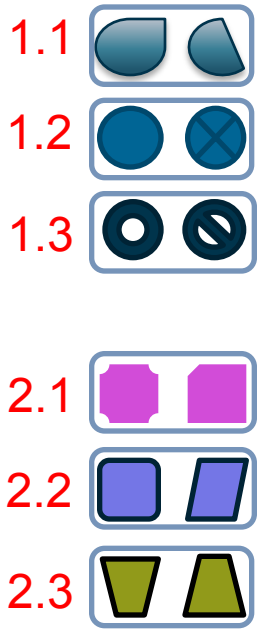
Reproduce Obfuscator for Each Cluster



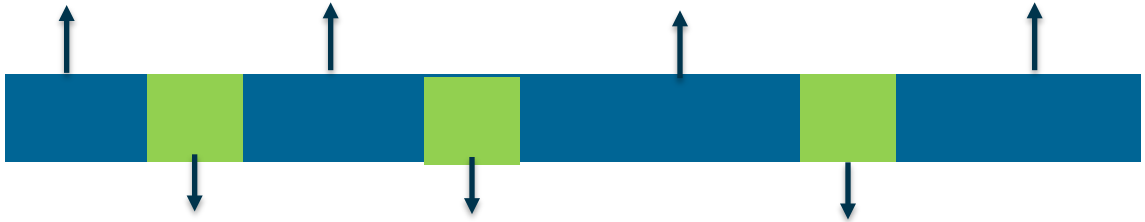
Obfuscator Variant

```
window ['e'+'v'+'a'+'l'][wsq(xyz,  fxj)];
window ['ev'+'al'] [zxh(abc, sih)];
window [l28f + i8d4][zxh(abc, sih)];
```

```
I['S'+'S'+'S'+'S'][I(I,I)];
I['S'+'S'                ][I(I,I)];
I[  I +I                 ][I(I,I)];
```

Threshold 0.80 ➔
80% Similar Within Cluster

Template



Obfuscator Engine

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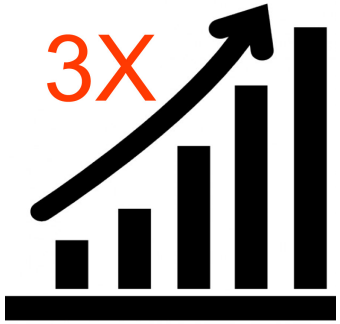
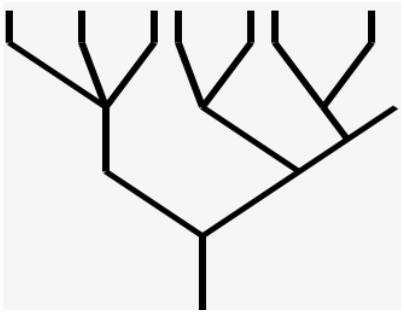
Why This Research



Boost
Samples
Set

Improve
Detection
Rate



Better
Understanding
on Obfuscator

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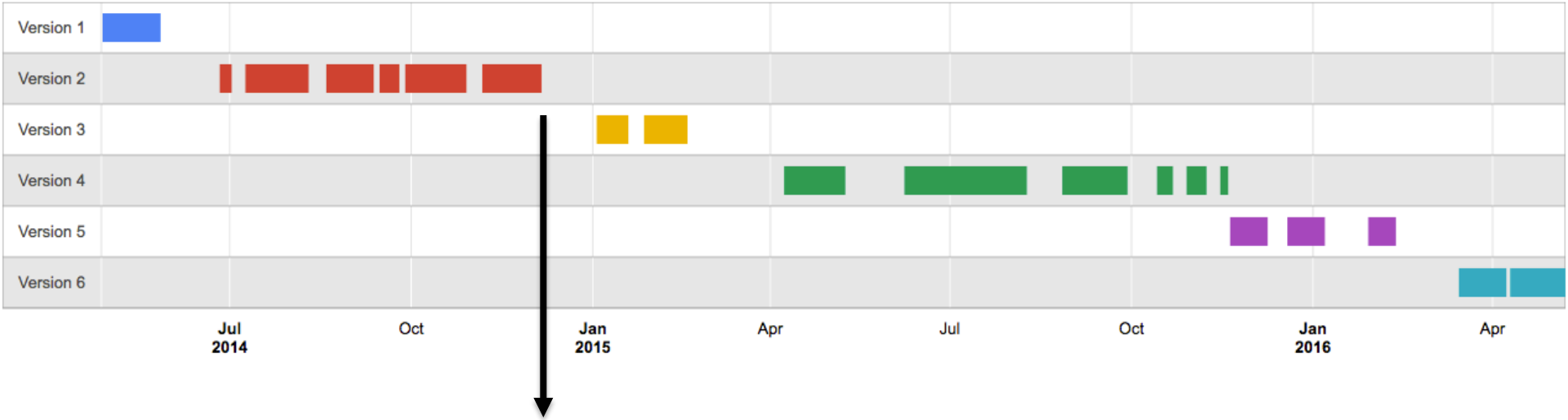
Life Cycle of Nuclear Exploit Kit Obfuscator



During **December 2014**, a new version of Nuclear Pack emerged. … new version will **completely replace the old** version.

http://community.websense.com/blogs/securitylabs/archive/2015/01/15/evolution-of-an-exploit-kit-nuclear-pack.aspx

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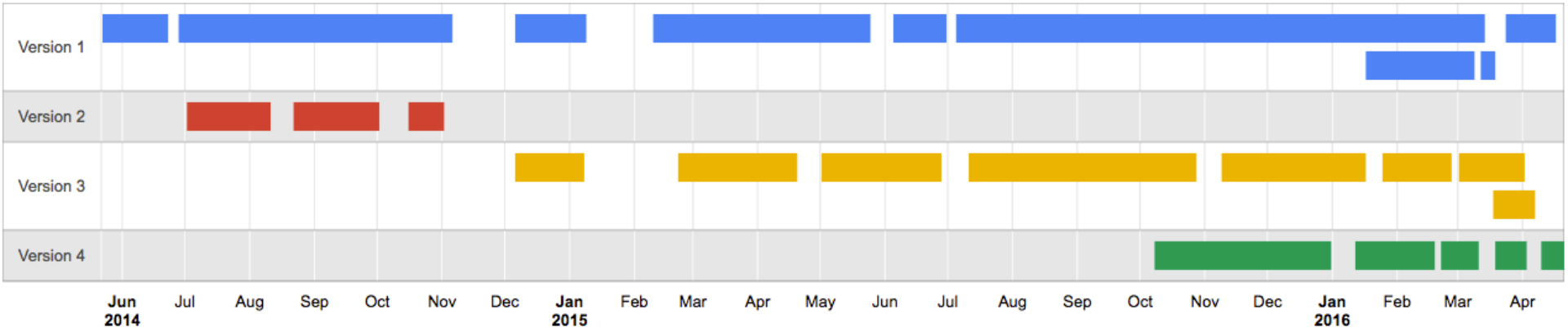
Life Cycle of Angler Exploit Kit Obfuscator



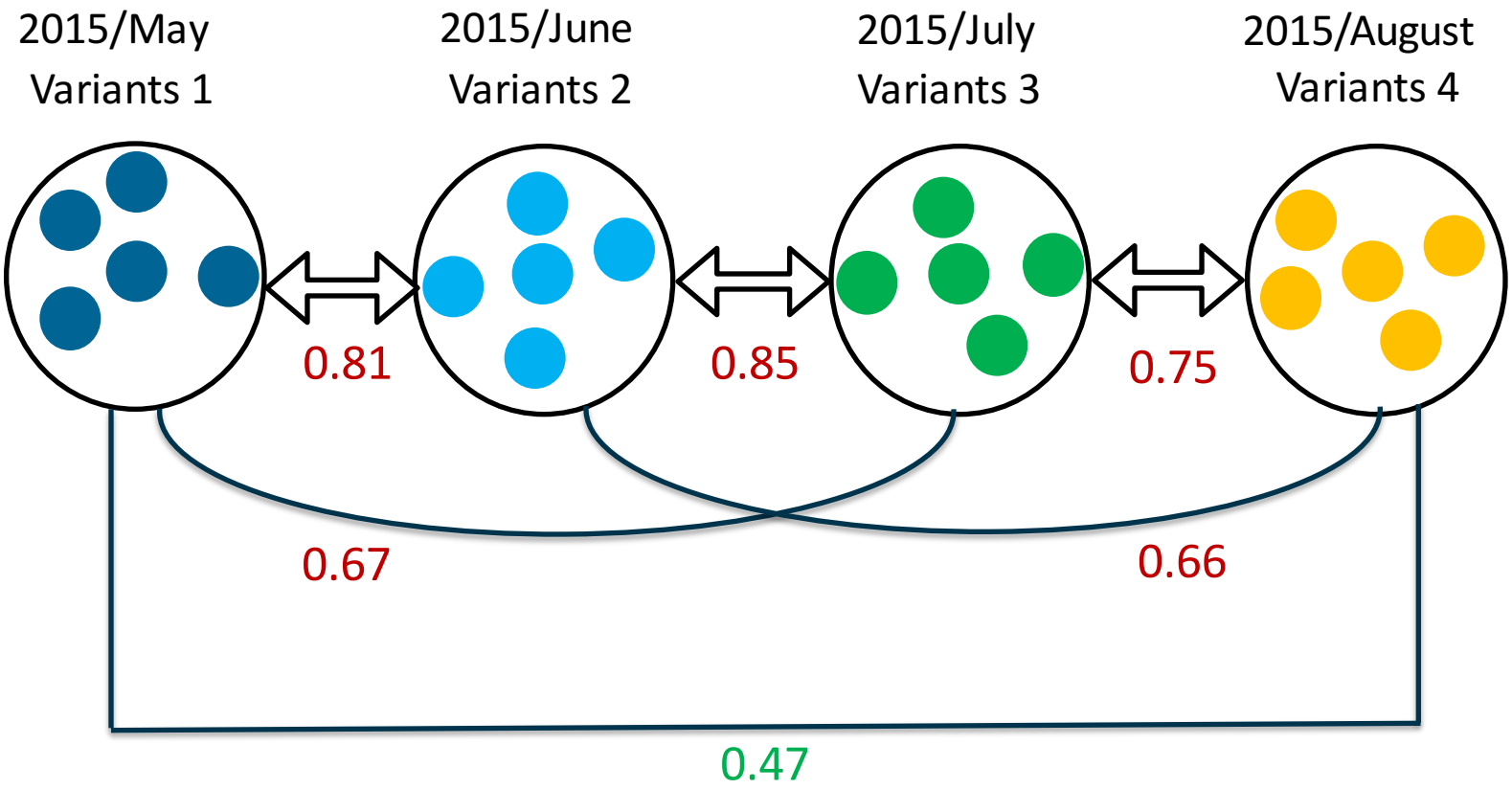
- Extremely Prevalent
- Aggressive tactics for evading detection
- **Only few Obfuscator Versions / Variants.**

# of Domains Deployed

Version 1: 519
Version 2: 89
Version 3: 753
Version 4: 68
Version 5: 234

Evolution of Variants

Nuclear Obfuscator Version 2



TAKEAWAY

- A new Angle to Explore Exploit-Kit
- The novel method to boost sample set and improve detection rate by reproducing obfuscator.
- The Evolution of Obfuscator in the wild

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Q & A

https://github.com/irobert-tluo/rebuild_obfuscator

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