Building a Better Botnet DGA Mousetrap

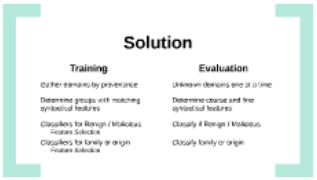
Separating Rats, Mice and Cheese in DNS Data

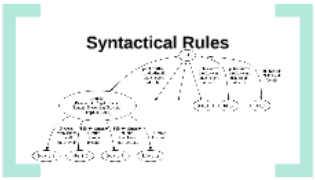
Josiah Hagen

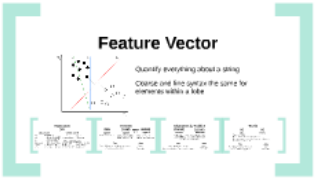
Hewlett Packard Enterprise TippingPoint

Miranda Mowbray & Prasad Rao

Hewlett Packard Labs







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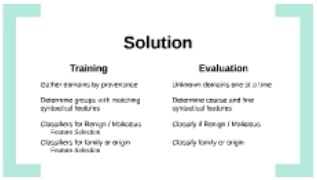
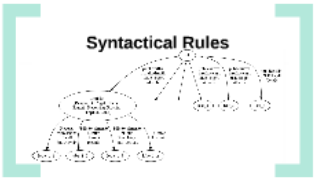
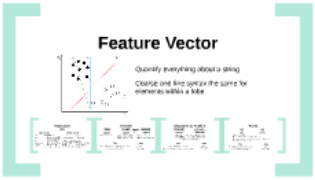






Goals

Classify domain names as benign and malicious

Minimize false positive classifications of malicious

Classify malicious domains according to DGA family

Not a Goal

Determine which hosts are infected with which malware

Solution

Training

Gather domains by provenance

Determine groups with matching syntactical features

Classifiers for Benign / Malicious
- Feature Selection

Classifiers for family or origin
- Feature Selection

Evaluation

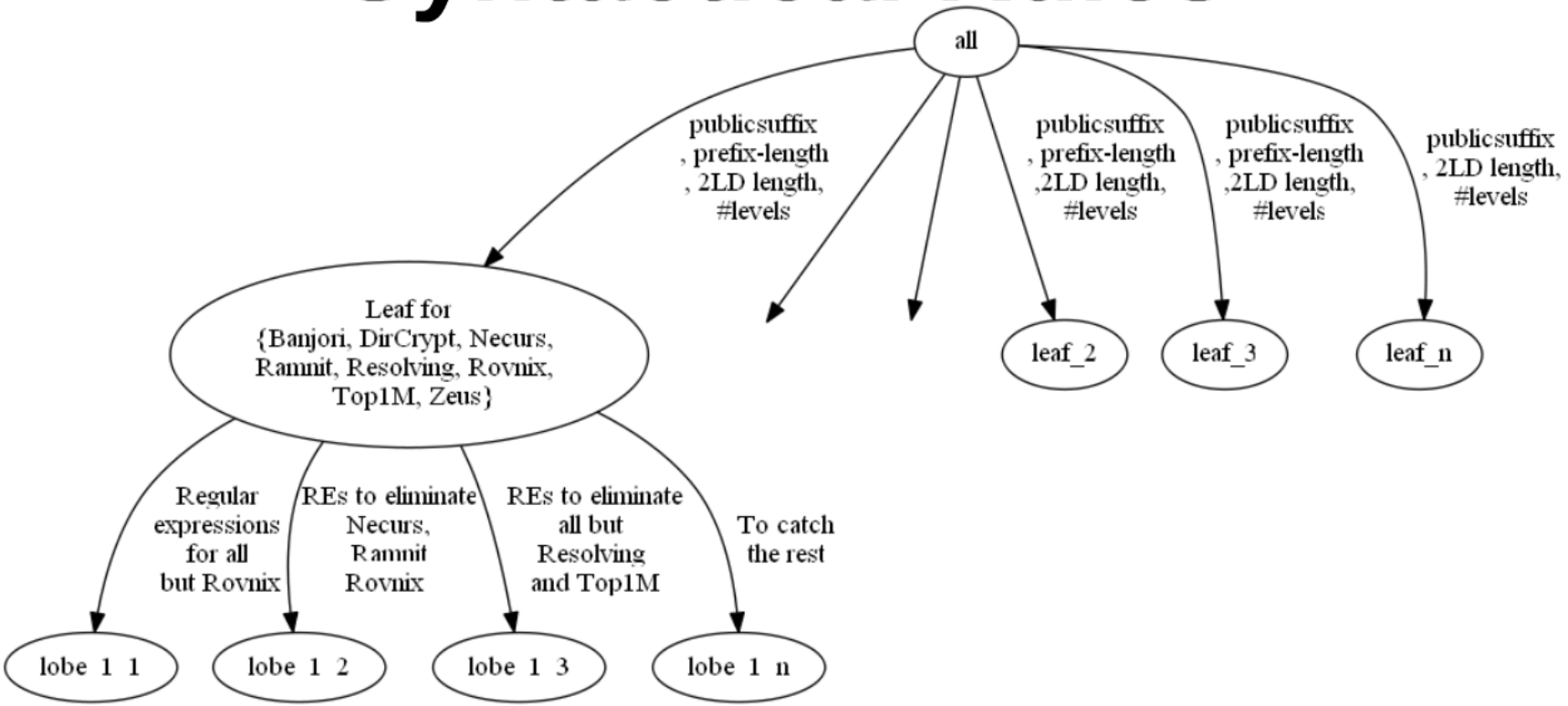
Unknown domains one at a time

Determine coarse and fine syntactical features

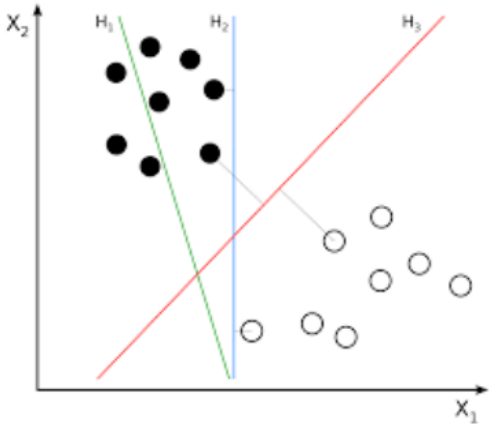
Classify if Benign / Malicious

Classify family or origin

Syntactical Rules



Feature Vector



Quantify everything about a string

Coarse and fine syntax the same for elements within a lobe

Aggregates
(22)

2LD Counts

A-F	consonants
G-Z	vowels
a-f	digits
g-z	

ISO-8859-1
- uppercase foreign
- lowercase foreign
- other printable
- other non-printable

doubles 'aa' - 'zz'
non-linguistic bigrams

Overall Counts

Dots Dashes
Dots, Dashes, & Underscores

RFC 1034 Violations

length > 254	labels not .*[a-z0-9]
labels > 63	empty labels '..'
labels not [a-z].*	invalid chars

N-Grams

(256) **1-grams** — Counts of characters

(1600) **2-grams** — Counts of character pairs: 'aa' 'ab'... 'zz'

Reduce to 40

(64000) **3-grams** — Counts of character triples: 'aaa', 'aab'...'zzz'

Pros	Cons
Separate linguistic / non-linguistic elements	Space
Catch bias in DGA PRNG	Overfitting

Characters by Position
(10240) **Forward**

(10240) **Backward**

Boolean slots for whether a given character occurs within a given position indexed from beginning and end of domain

Pros	Cons
Classifying fixed substrings	Space
Banjori, Bankpatch, Caphaw, Web Services	Overfitting

Words
(4) **2LD**

(4) **Prefix**

Counts of words
Max count of non-overlapping words
Max percentage of characters comprised of words
Length of the longest word

Pros	Cons
Classifying Benign vs Malicious	Time
Matsnu, Rovnix, Suppobox	Overfitting

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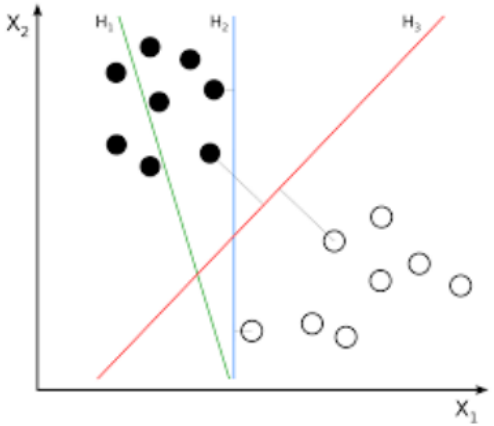

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Syntactical rules help

Unbalanced data hurts

Results worse on real data

Especially word based DGA FPs

Some features are good for classifiers

- Aggregates
- Linguistic or not (bigrams)
- Word based

Hash words to compress dictionary to reduce FP

Not a standalone solution

Build classifers for infected hosts

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