Web Security Research at Indiana University

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Our Adventures on the Web

- Privacy: get your health records, salary, investment secret from Web apps' side channel
  - Microsoft Buddies: Shuo Chen and Rui Wang
- Flaws: shop for free, log into your web account through 3rd-party Web APIs
  - Microsoft Buddies: Shuo Chen and Rui Wang
- Misdeeds: how to advertise infections and click frauds through the New York Times
  - Microsoft Buddies: Yinglian Xie and Fang Yu

Knowing Your Enemy: Understanding and Detecting Malicious Web Advertising

Zhou Li, Kehuan Zhang, Yinglian Xie,
Fang Yu and XiaoFeng Wang

The New York Times

Tuesday, November 29, 2011 Last Update: 1:49 AM ET

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Businesses Scramble as Credit Tightens Across Europe

By ERIC DASH and NELSON D. SCHWARTZ

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- Obama Meets Leaders of the European Union
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CAMPAIGN 2012

Barney Frank, a Top Liberal, Won't Seek Re-election

By ABBY GOODNOUGH

Mr. Frank, who first

Monica Lopossay for The New York Times

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OPINION »

EDITORIAL

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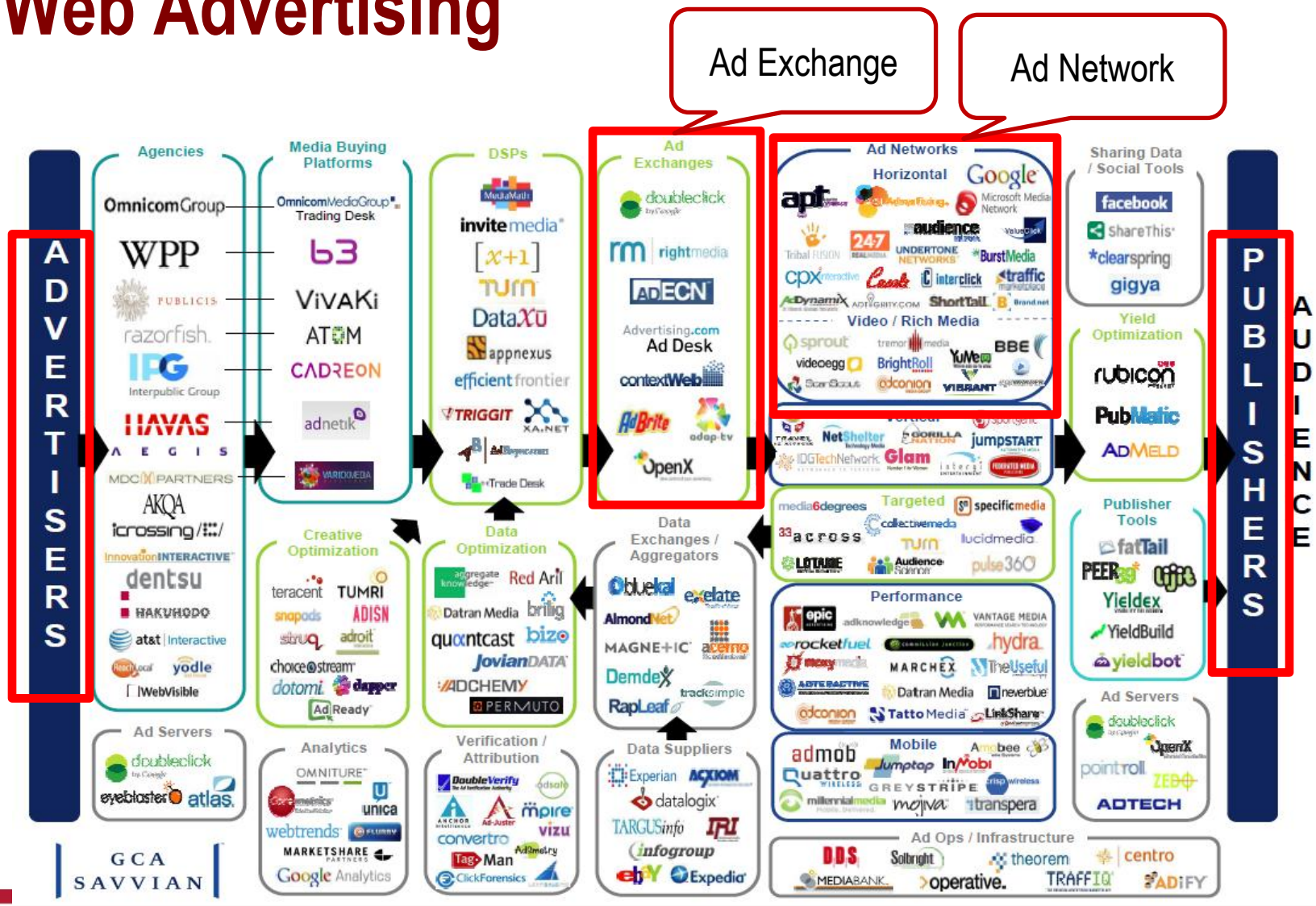
MARKETS » At 2:04 AM ET

JAPAN		CHINA
Nikkei	HangSeng	Shanghai
8,477.82	18,302.43	2,411.01
+190.33	+264.62	+27.98
+2.30%	+1.47%	+1.17%

Data delayed at least 15 minutes

Web Advertising



[http://www.adexchanger.com/pdf/Display-Advertising-Technology-Landscape-2010-05-03.pdf]

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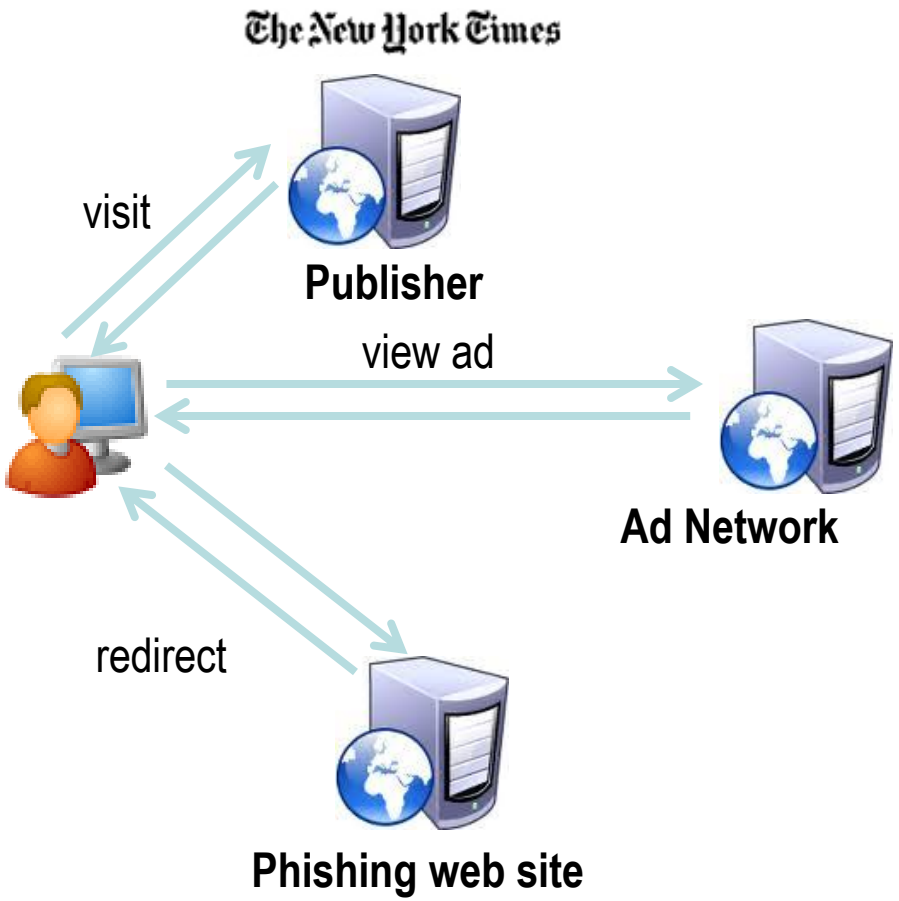
Malvertising via Nytimes



Defense: What has been done

- Ad behavior restriction [AdSafe, Finifter'10, Louw'10]
  - Limited applicability to different forms of attacks: drive-by-download, phishing, click-fraud
- URL features and domain reputations [Zhang'11, John'11]
  - URLs can be easily modified by attackers
  - Domains can be hijacked
- Code analysis [Cova'10]
  - Obfuscate code to evade detection
  - Leverage ad syndication to bypass the code checking

What hasn't been done

- Understanding:
  - How serious is the problem?
  - What does malcontent delivery path look like?
  - Roles of ad nodes? Topologies?
- Detection:
  - Complement existing techniques with infrastructure information?

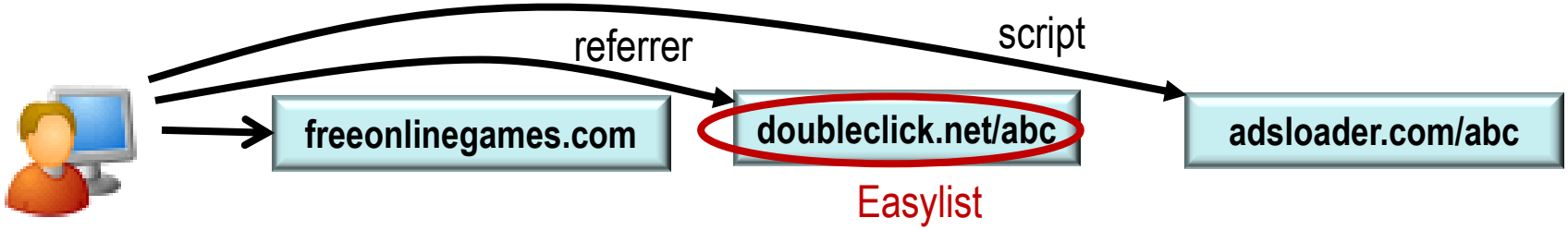
The First Step We Made

- Measurement of Malvertising
  - Malvertising: drive-by download, Scam, Click fraud
  - Scale, node/path features of malcontent delivery infrastructures
- Detection of Malvertising
  - Path segment based detection
  - It works: caught 15 times more cases than popular blacklist/malware scanners (Safe Browsing, Forefront)

Get down to the specifics: Data Collection

- From June 21st to September 30th
- 12 Virtual Machines with instrumented browser
- Alexa top 90,000 web sites visited regularly
- Extract ad redirection paths

Node: freeonlinegames.com doubleclick.net/abc, advertising.com/abc



Path: freeonlinegames.com -> doubleclick.net/abc -> adsloader.com/abc

Case: freeonlinegames.com -> doubleclick.net -> adsloader.com

Some Statistics

- 24 million ad paths
- 22 million nodes, >90% ad nodes

- Scanned with Forefront and Google Safebrowsing
- 543 malicious nodes, 263 domains
- 938 malicious cases
- 286 infected publishers (Ranked from 314 to 89184)
- Long-lived campaign (2 months) , short-lived domain (3 days)

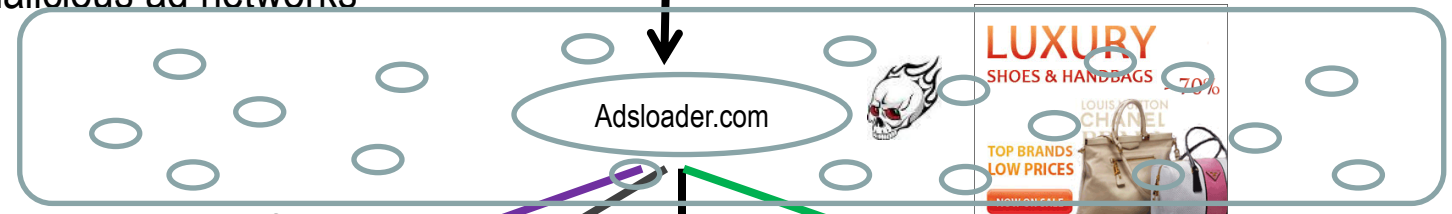
Example: a Fake AV Campaign

65 infected publishers
(highest ranked 400)

24 malicious ad networks

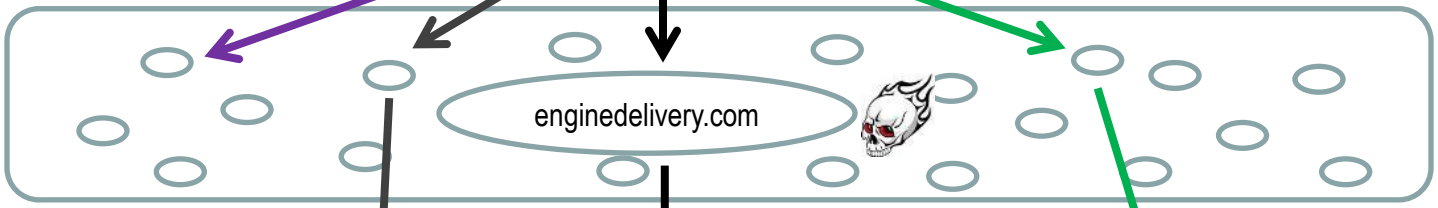
Attack Strategy:

- Set up malicious ad network
- Penetrate big ad network
- Multi-layers
- Rotation
- Cloaking

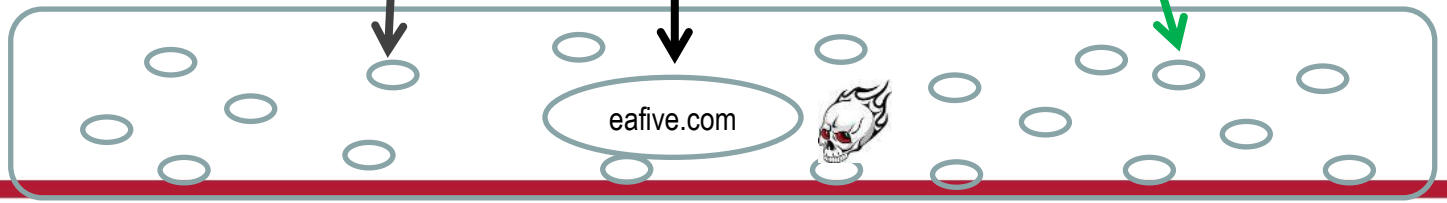


16 Redirectors

Cloaking



84 Scam sites

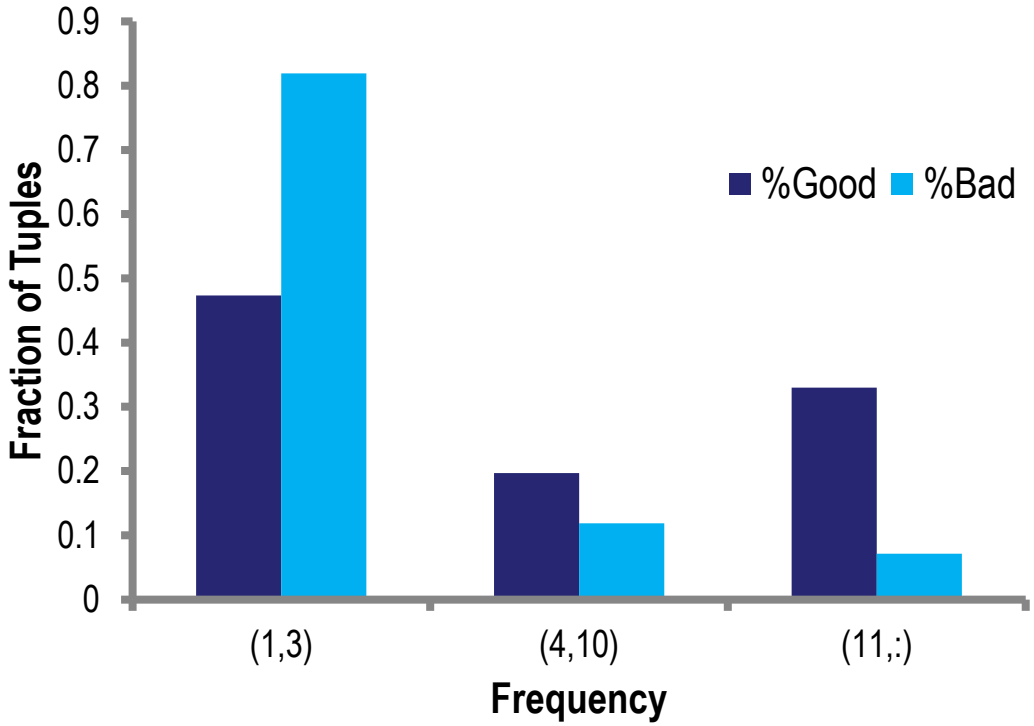


Node Features

- Most of malicious nodes have unknown roles
  - >90% malicious nodes, <8% legitimate nodes
- Registered within a year, expire in a year
  - >70% malicious domains, <20% legitimate domains
- Free domain providers like .co.cc used widely
- Follow URL patterns
  - /showthread.php\.php\?t=\d{8} matches 34 domains

Properties of Malicious Pairs

- Malicious node pairs appear less frequently

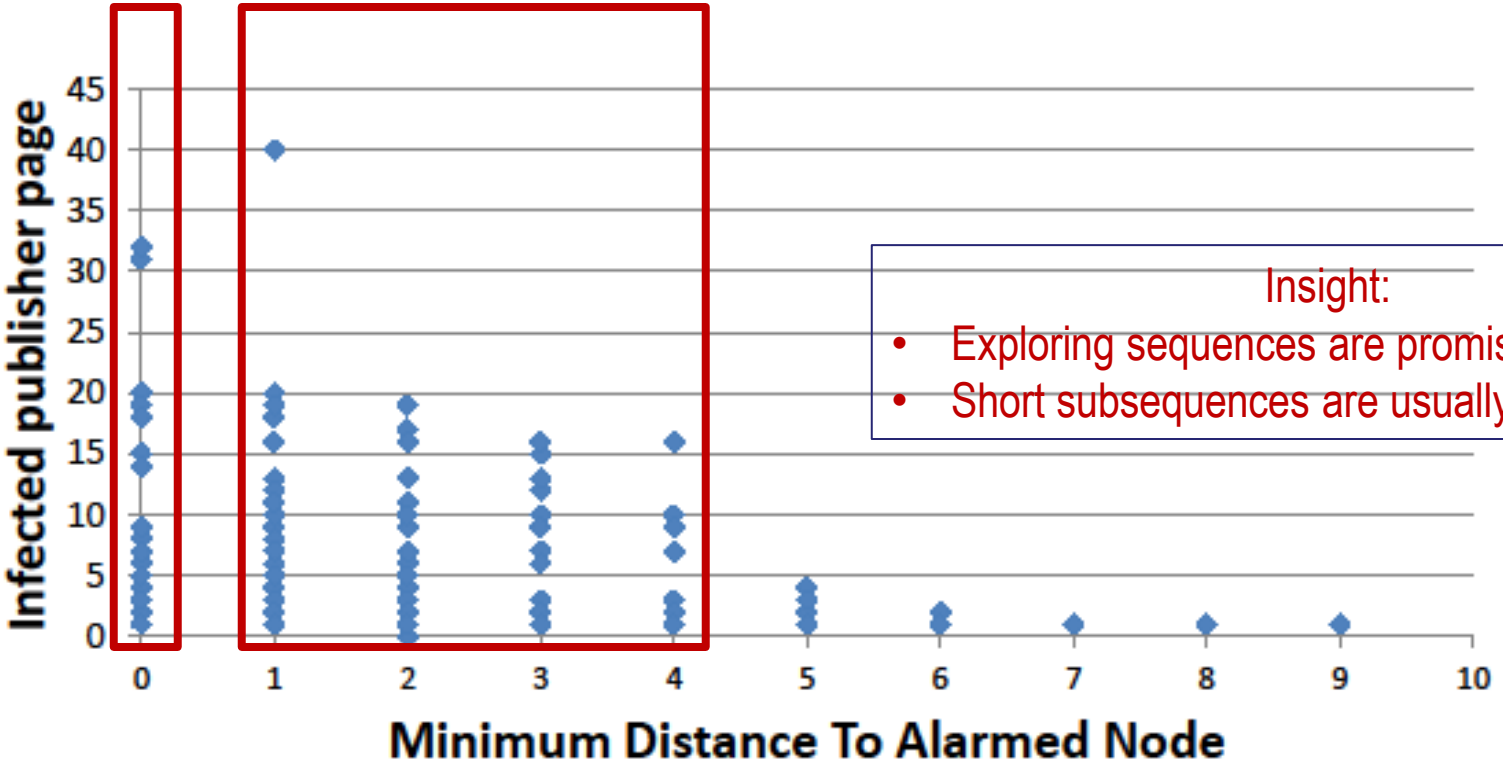


Insight:

- The relationships with other entities are not stable

Properties of Malicious Paths

- Longer path length (8.11 > 3.59 of legitimate paths)
- Ad syndication is the major problem (>60% cases)
- The closer to bad nodes, the more suspicious

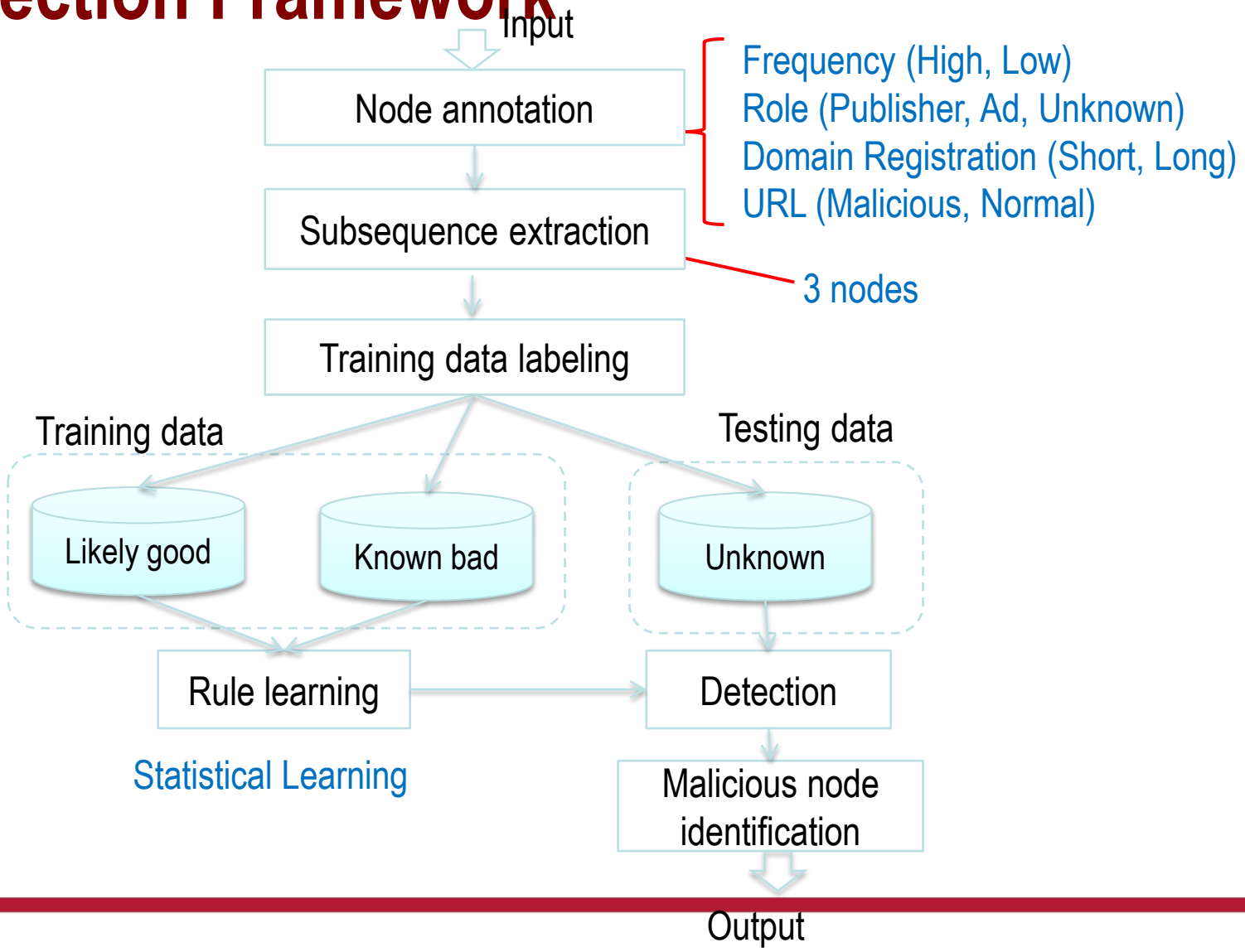


Insight:
- Exploring sequences are promising
- Short subsequences are usually good enough

Our Ideas for Detection

- Analyze ad-delivery sequences
  - Focus on short subsequences
  - Annotate nodes with rich attributes
- Use statistical learning to generate detection rules
  - Adapt to new, ever changing attacker strategies

Detection Framework



Results

Testing
June - September

phishing pages	56	0.00%
drive-by-download pages	172	9.88%
click-fraud pages	155	10.97%
all pages	326	8.90%
phishing cases	104	0.00%
drive-by-download cases	1171	6.23%
click-fraud cases	4221	4.10%
all cases	5496	4.48%

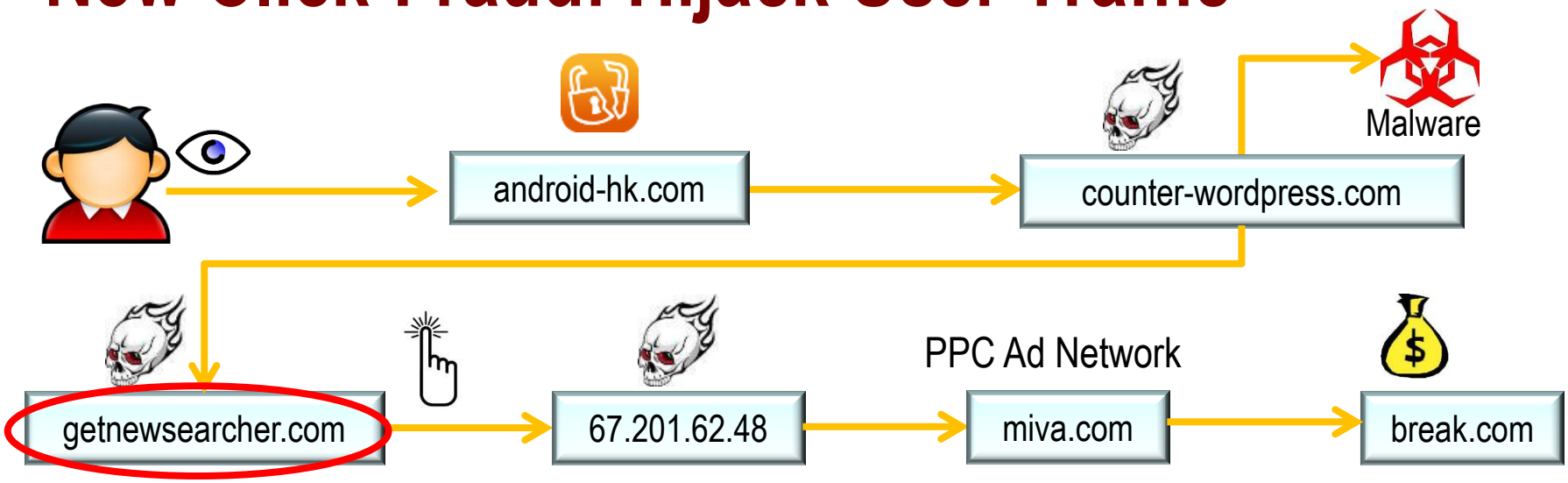
- 5% FDR
- 15x new findings
- 10.5 days early detection than safebrowsing

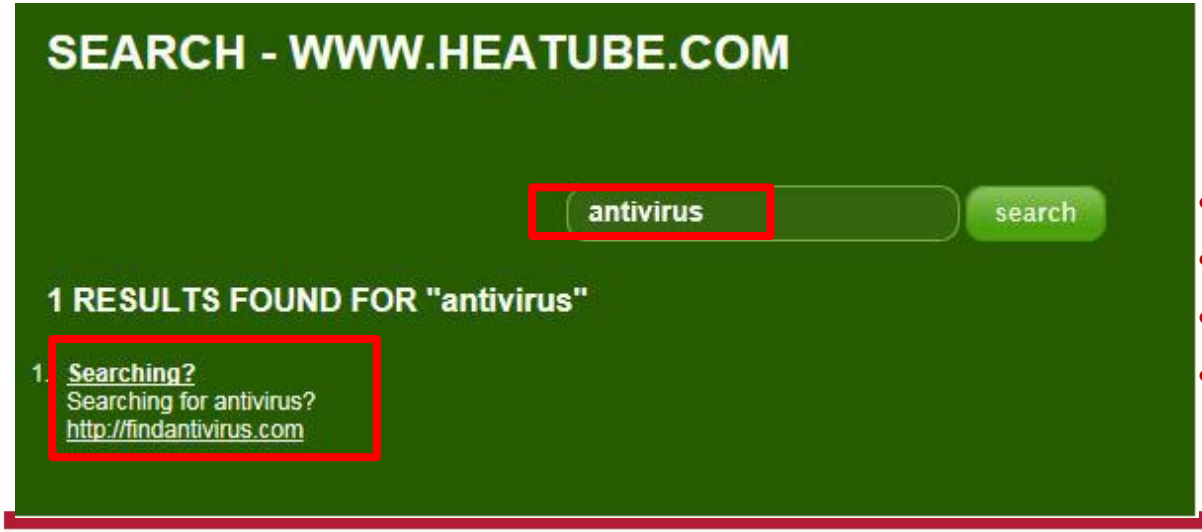
Testing
October

Safebrowsing & Forefront

	#MadTracer	#S&F	%FP	%New Findings
phishing pages	12	0	0.00%	100.00%
drive-by-download pages	216	104	9.26%	51.85%
click-fraud pages	89	7	14.61%	92.13%
all pages	291	111	11.00%	61.86%
phishing cases	23	0	0.00%	100.00%
drive-by-download cases	627	216	13.88%	65.55%
click-fraud cases	3422	42	3.65%	98.77%
all cases	4072	258	5.21%	93.66%

New Click-Fraud: Hijack User Traffic





Findings:

- Do not require botnets
- Use of doggy search engine
- Target 2nd-tier PPC ad networks
- High successful rate (72.5%)

Conclusion

- Malvertising is a big issue
  - 1% top publishers are infected
- Study on infrastructures can lead to a promising new direction
  - 15x more coverage, 5% false positive
  - Discover new attacks
- Usage and deployment
  - Ad exchange service (e.g., Ad-center): capture malicious and fraudulent ad entities
  - Anti-virus (e.g., ForeFront): provide new malware signatures
  - End users (you and me): detect and stop ongoing exploits


The End