THE UNCERTAIN RELATIONSHIP BETWEEN RESIDUAL DIGITAL FRAGMENTS, FILES, AND COMPUTER ACTIVITY

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THE CHALLENGE: CAN WE IDENTIFY PAST APPLICATION USE AFTER UNINSTALLATION?

Malicious Windows user installs wireshark...

...sniffs network, captures account passwords...

...deletes pcap file, uninstalls wireshark...

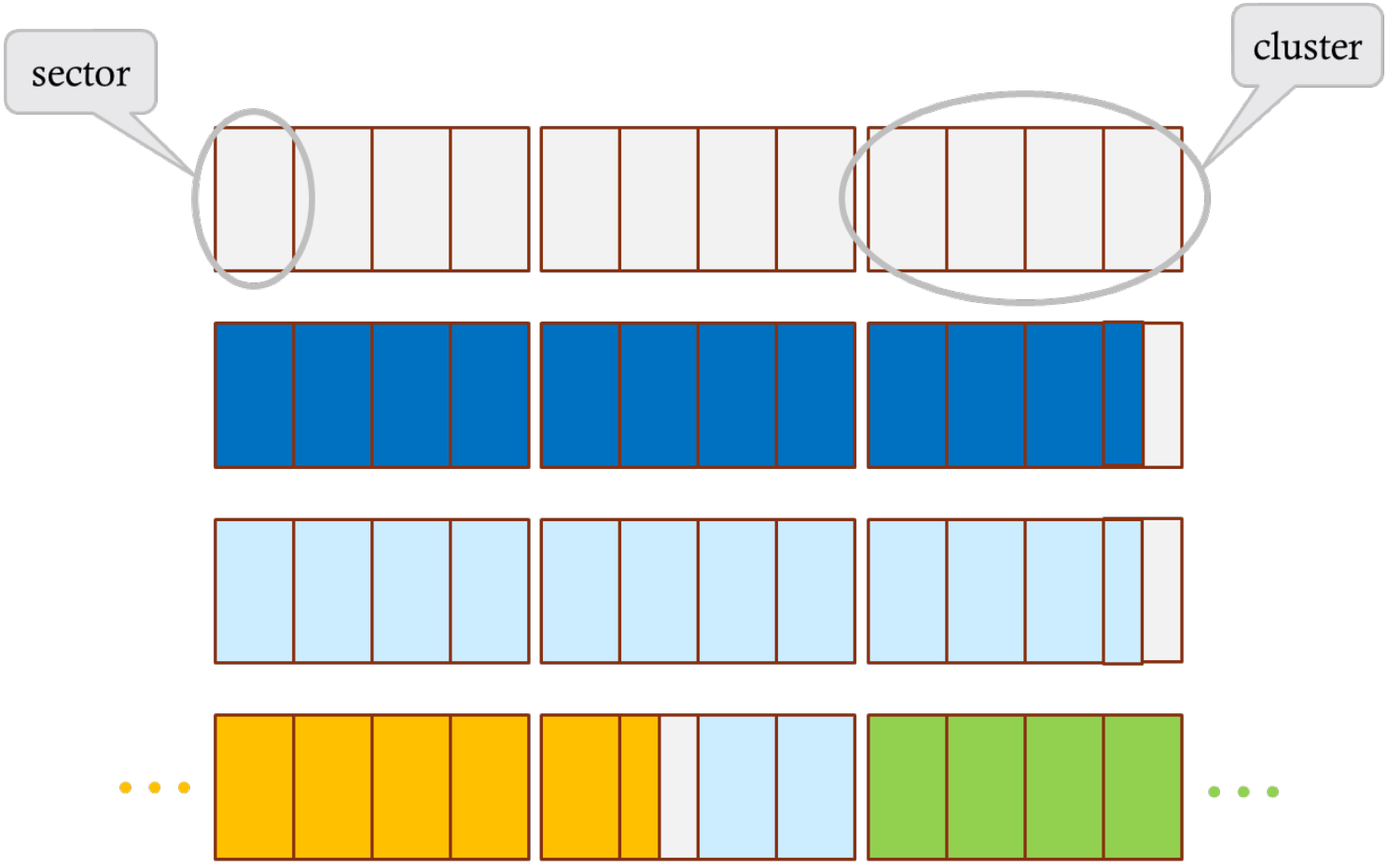
...uses account info to commit a crime such as impersonate another user or access sensitive information...

...law enforcement confiscates computer...

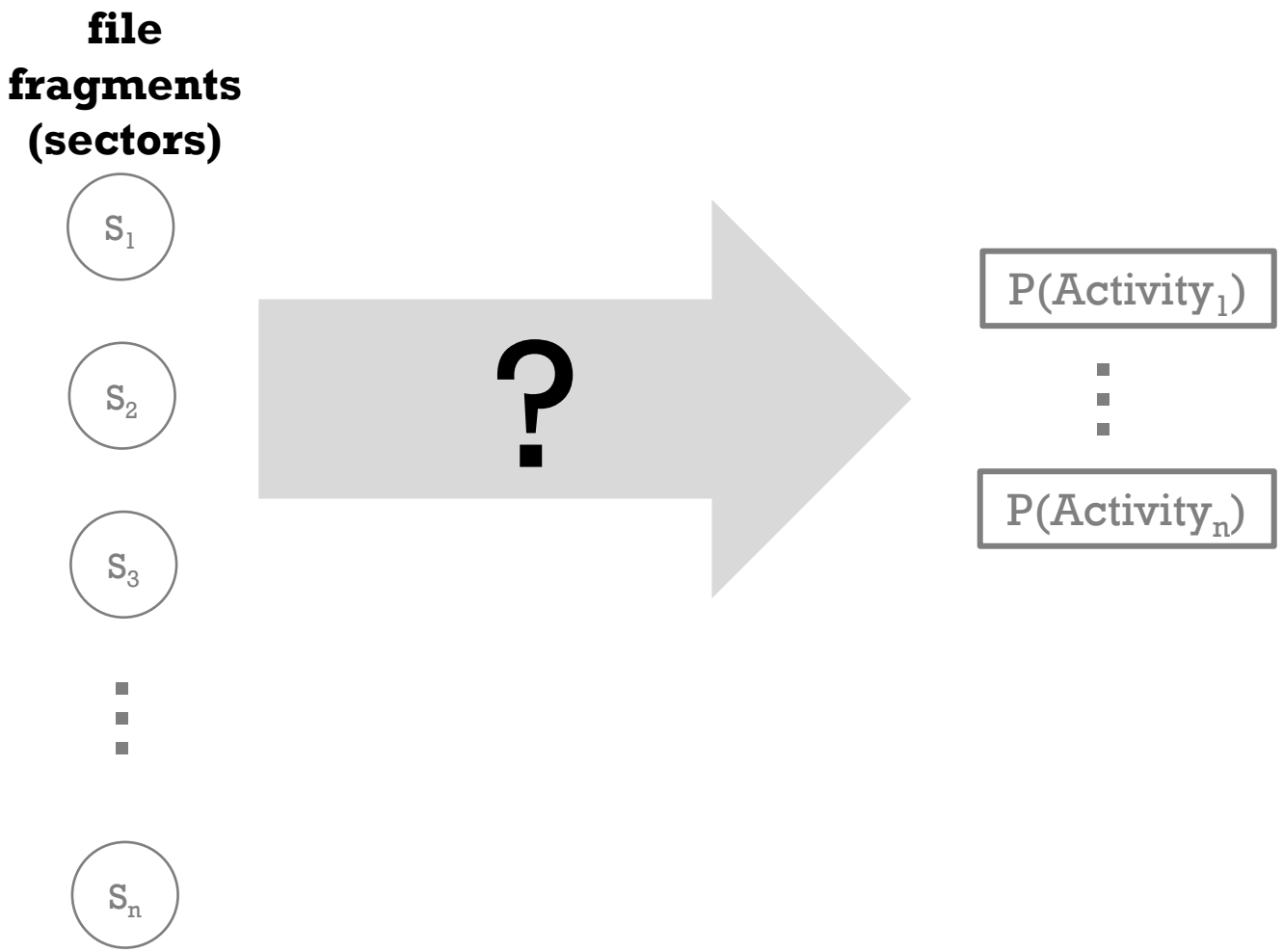
...can we show wireshark was used in the past?

Image credits:
http://school.discoveryeducation.com/clipart/clip/stk-fgr6.html
http://blog.deming.org/2014/10/the-target-is-irrelevant-without-a-method/
http://www.presentermedia.com/index.php?target=closeup&maincat=clipart&id=9771

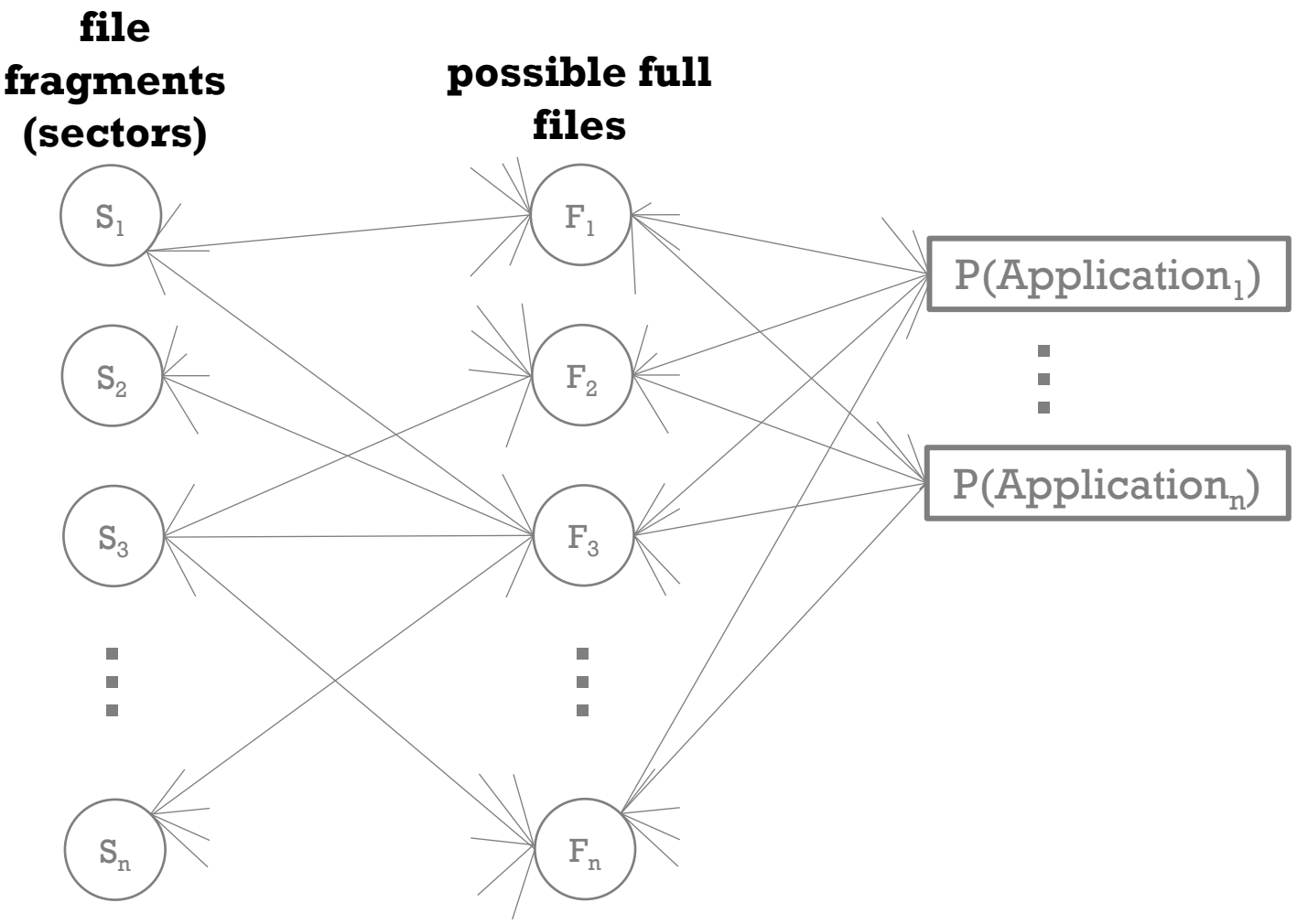
RESIDUAL FILE FRAGMENTS ARE CREATED AFTER A FILE IS DELETED



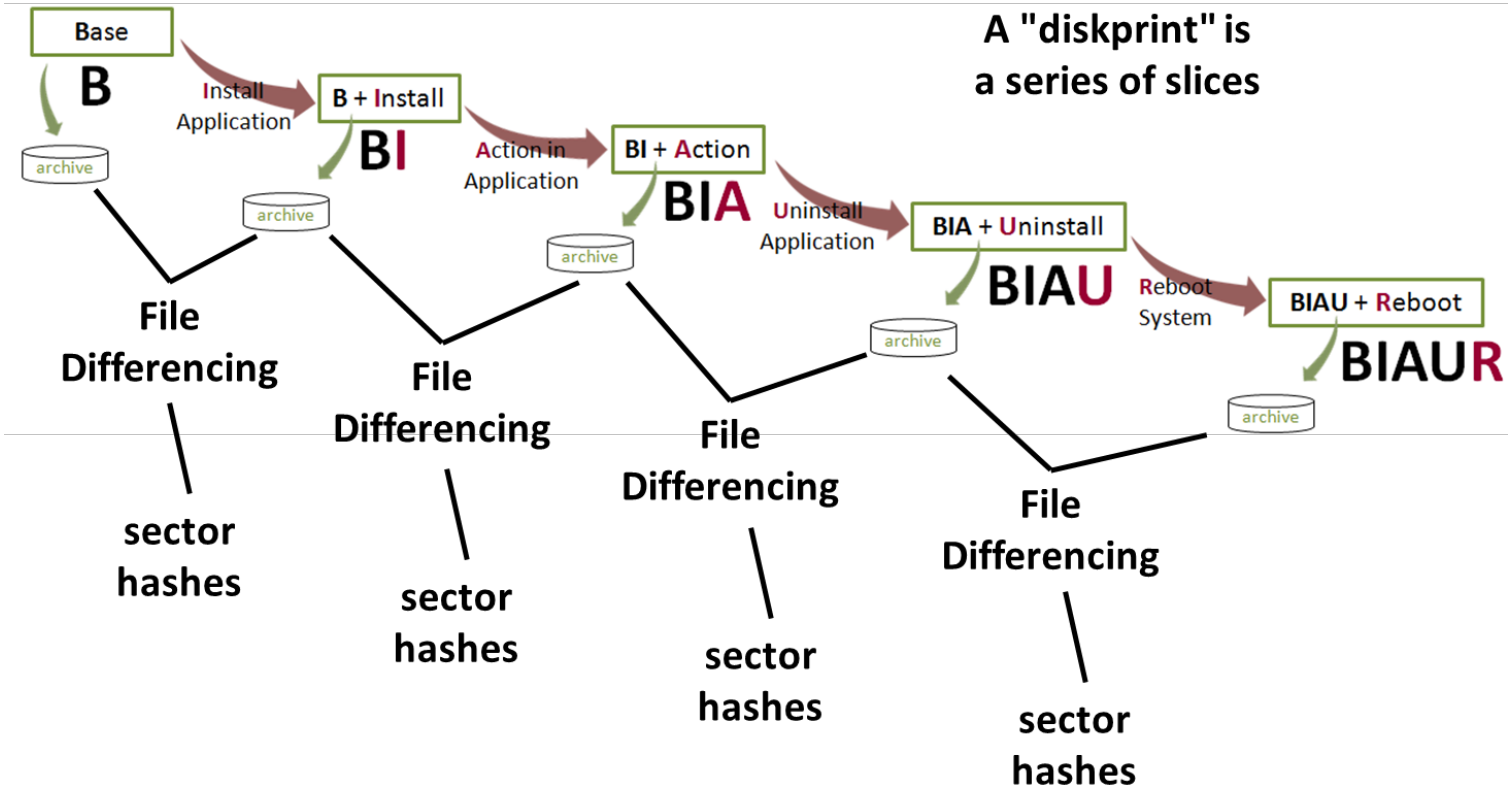
CAN WE INFER PAST APPLICATION USE FROM DELETED FILE FRAGMENTS?



APPROACH: REASON FROM FRAGMENTS TO FILES AND FILES TO APPLICATIONS



PRIOR KNOWLEDGE: APPLICATIONS TO FILES TO FRAGMENTS



FRAGMENTS TO FILES...

- Sector hits:
  - Original: sectors_found/ sectors_total
  - Weighted:

$$\text{weighted sector \%} = \left(\sum_{S=1}^{\text{num\_sec\_matches}} 1 / \text{freq}_S \right) / \text{sectors\_total}_{DP}$$

- Example:
  - Original: (1 + 1 + 1)/10 = 30%
  - Weighted: (1/1 + 1/4 + 1/2)/10 = 17.5%

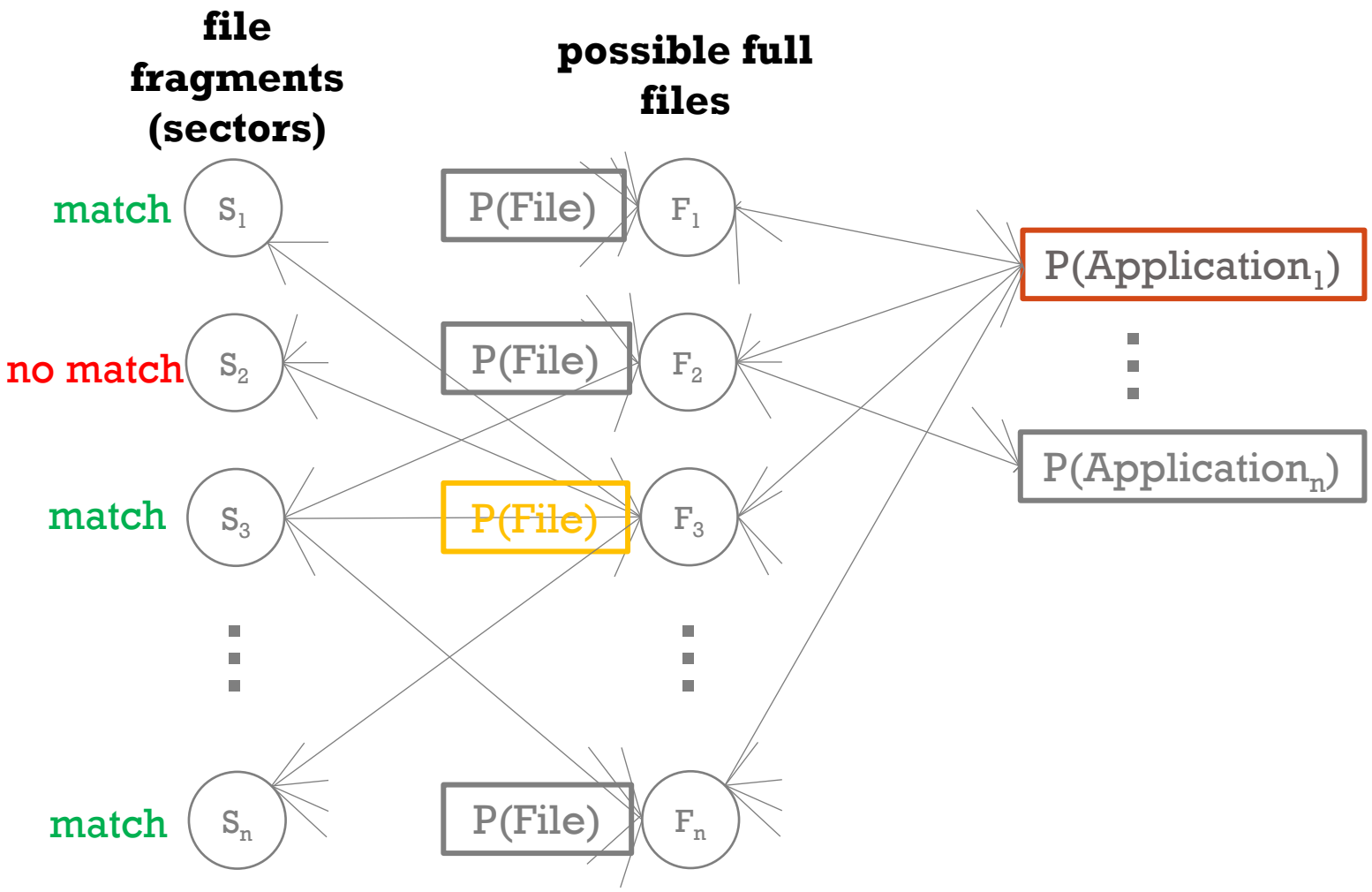
FILES TO APPLICATIONS…

- File hits:
  - Original: files_found/ files_total
  - Weighted:

$$\text{weighted file \%} = \left(\sum_{F=1}^{\text{num\_file\_matches}} \frac{\text{matched\_sectors}_F}{\text{total\_sectors}_F} \right) / \text{files\_total}_{DP}$$

- Example:
  - Original: (1 + 1)/5 = 40%
  - Weighted: (3/5 + 1/10)/5 = 14%

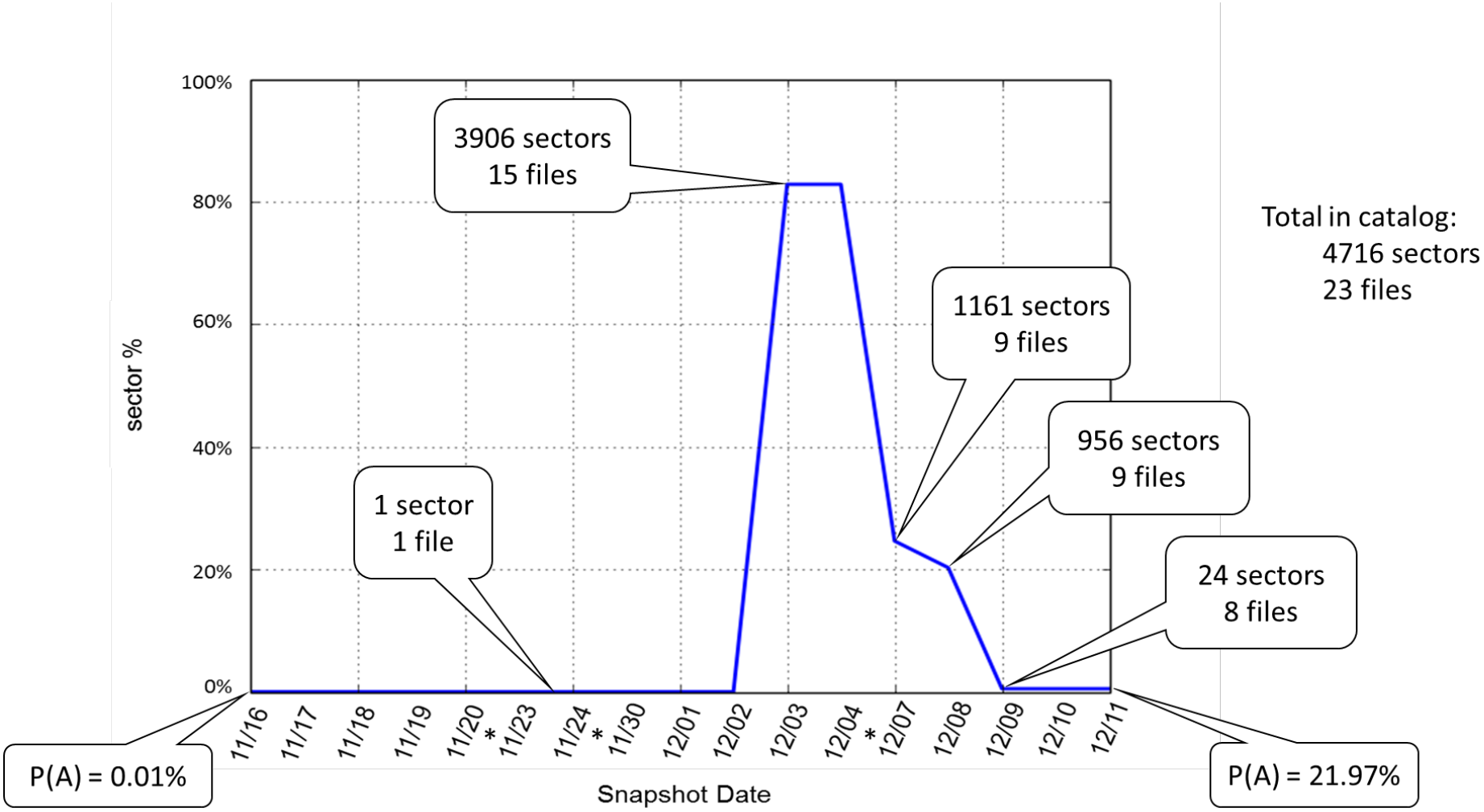
TBD: COMBINE BOTH WEIGHTED MEASURES



EXPERIMENTS: M57 PATENTS DATASET

	WinXP	Win7x32	Win7x64
Adv Keylogger	✓		
Chrome	✓	✓	✓
Eraser		✓	
Firefox	✓	✓	✓
HxD hex editor		✓	
Invisible Secrets	✓		
MS Office	✓	✓	✓
Python	✓		
Safari	✓	✓	✓
Sdelete		✓	✓
Thunderbird	✓		
TrueCrypt	✓		
UPX		✓	✓
WinRar		✓	✓
WinZip		✓	✓
Wireshark		✓	✓

ADVANCED KEYLOGGER EXAMPLE



Total in catalog:
4716 sectors
23 files

RESULTS

Charlie		Jo		Pat		Terry	
diskprintName	w_file%	diskprintName	w_file%	diskprintName	w_file%	diskprintName	w_file%
Python264-WinXP	98.98%	Python264-WinXP	98.83%	Python264-WinXP	98.91%	Python264-WinXP	85.52%
InvSecrets21-WinXP	63.16%	TrueCrypt63-WinXP	50.00%	Thunderbird2-WinXP	24.94%	Thunderbird2-WinXP	27.81%
Thunderbird2-WinXP	61.00%	Thunderbird2-WinXP	24.73%	AdvKeylogger-WinXP	21.97%	Winzip17pro-W7x64	10.37%
Safari157-W7x32	10.25%	Safari157-W7x32	11.35%	HxD171-W7x32	8.39%	Winzip17pro-W7x32	10.05%
Safari157-WinXP	10.16%	Safari157-WinXP	11.26%	Firefox19-WinXP	3.17%	HxD171-W7x32	8.37%
Safari157-W7x64	6.69%	Safari157-W7x64	7.37%	Firefox19-W7x64	2.93%	Safari157-W7x32	5.46%
Firefox19-WinXP	3.26%	Firefox19-WinXP	3.24%	Firefox19-W7x32	2.78%	Safari157-WinXP	5.35%
Firefox19-W7x32	2.77%	Firefox19-W7x32	2.74%	Winzip17pro-W7x64	2.03%	Chrome28-WinXP	4.83%
Firefox19-W7x64	2.50%	Firefox19-W7x64	2.62%	Chrome28-WinXP	1.64%	Chrome28-W7x64	4.81%
Chrome28-WinXP	2.11%	Chrome28-WinXP	2.15%	Chrome28-W7x64	1.63%	Firefox19-WinXP	3.59%
Winzip17pro-W7x64	2.08%	Chrome28-W7x64	2.03%	Winzip17pro-W7x32	1.50%	Chrome28-W7x32	3.59%
Chrome28-W7x64	2.02%	Chrome28-W7x32	1.52%	Chrome28-W7x32	1.22%	Firefox19-W7x64	3.56%
Chrome28-W7x32	1.52%	sdelete-W7x64	1.35%	TrueCrypt63-WinXP	1.22%	Firefox19-W7x32	3.55%
Winzip17pro-W7x32	1.51%	Winzip17pro-W7x64	1.26%	Winrar5beta-W7x64	0.85%	Safari157-W7x64	3.47%
sdelete-W7x64	1.35%	sdelete-W7x32	1.08%	Winrar5beta-W7x32	0.84%	Winrar5beta-W7x64	2.21%
sdelete-W7x32	1.08%	Winrar5beta-W7x64	0.95%	Safari157-WinXP	0.62%	Winrar5beta-W7x32	2.19%
TrueCrypt63-WinXP	0.73%	Winrar5beta-W7x32	0.94%	Safari157-W7x32	0.54%	TrueCrypt63-WinXP	0.97%
Winrar5beta-W7x32	0.64%	Winzip17pro-W7x32	0.72%	OfficePro2k3-WinXP	0.47%	OfficePro2k3-W7x32	0.39%
Winrar5beta-W7x64	0.64%	OfficePro2k3-WinXP	0.43%	OfficePro2k3-W7x32	0.45%	OfficePro2k3-WinXP	0.35%
OfficePro2k3-WinXP	0.37%	OfficePro2k3-W7x32	0.41%	OfficePro2k3-W7x64	0.42%	OfficePro2k3-W7x64	0.35%
OfficePro2k3-W7x32	0.32%	OfficePro2k3-W7x64	0.37%	Safari157-W7x64	0.39%	Wireshark-W7x32	0.09%
OfficePro2k3-W7x64	0.31%	Wireshark-W7x32	0.07%	Wireshark-W7x32	0.10%	eraser-W7x32	0.05%

CHALLENGES AND CURRENT WORK

- Combine weighted measures:
  - fragments to files to applications
- Weighting factors are incomplete:
  - relative location, file offset, match frequency, entropy, …
- We don't have the real "universe" of files:
  - NSRL, Google, Cloud providers, …
- Deleted file decay is inconsistent; depends (at least) on:
  - OS, filesystem, hardware, user and system activity, format, disk usage and fragmentation, file characteristics, …
  - time matters: can we use this to date the application uninstallation?
- Other scenarios:
  - mobile, malware, ICS, …

ANY QUESTIONS, IDEAS, OR SUGGESTIONS...?

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