Traditional AV is Dead?

Real-time Machine-Learning Detection of Modern Malware Downloads

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Who am I?

- M.Sc. In Computer Engineering, Ph.D. in System Security
- On top of things since 2002
- Sr. Research Scientist
  - Web, Malware, Privacy, Cybercrime, IoT, Threats
  - *http://www.madlab.it*

Traditional AV is Dead?

- Signature-based VS Statistical-based
- Signature-based malware detection is inefficient
  - Polymorphism, code obfuscation, packing
  - Analysis is time consuming (static , dynamic)
  - URL blacklists lag behind (DGA botnets)

Traditional AV is Dead?

- Local awareness VS Global awareness
- Local: Looks at one potential malicious file/URL at the time
- Global: Leverages a global situation awareness, e.g. relationships among files and machines

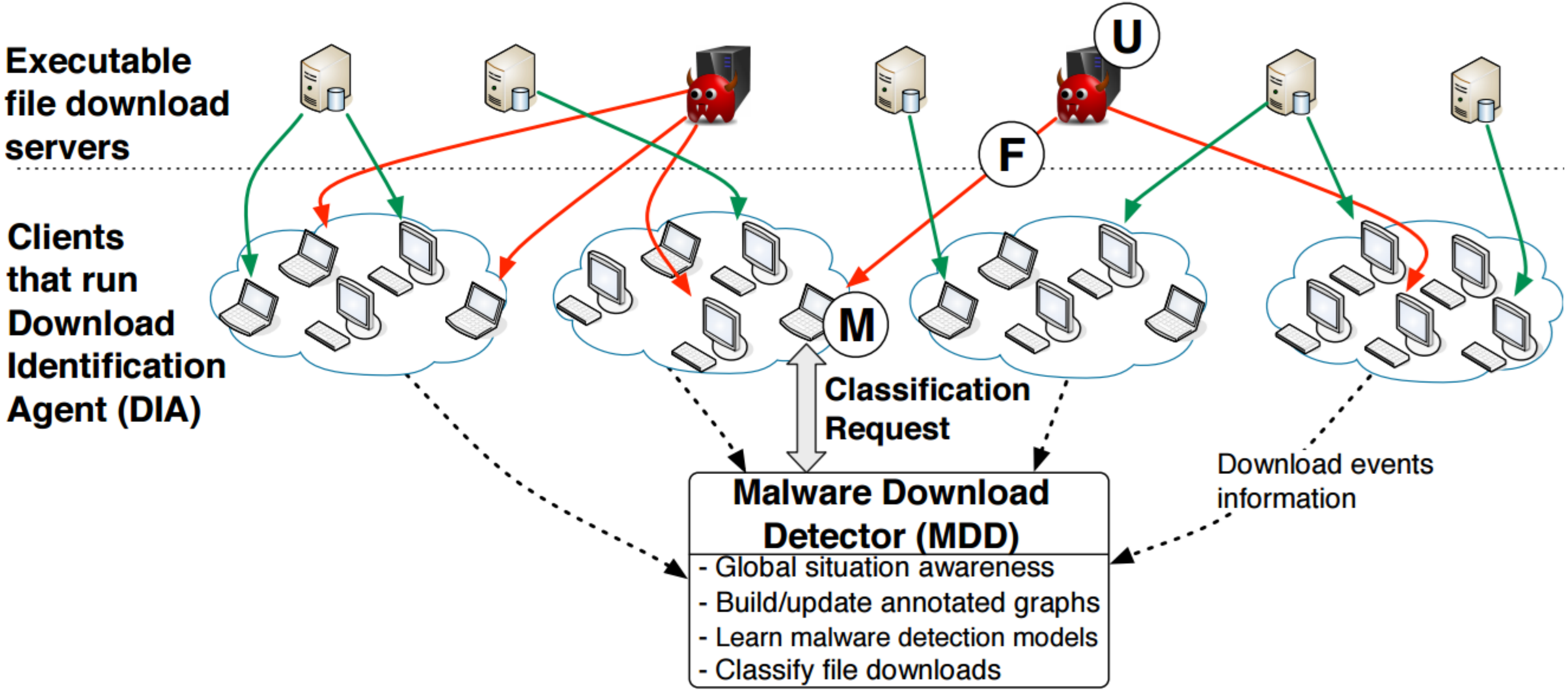
Our X-Gen Approach

- Content agnostic: Files’ or webpages’ content analysis is **not** needed
- Use of relationship patterns
  - 3W: “Who-What-Where” = who downloads what from where
  - Combination of system- and network-level informations
- Statistical-based detection
- Global situation awareness

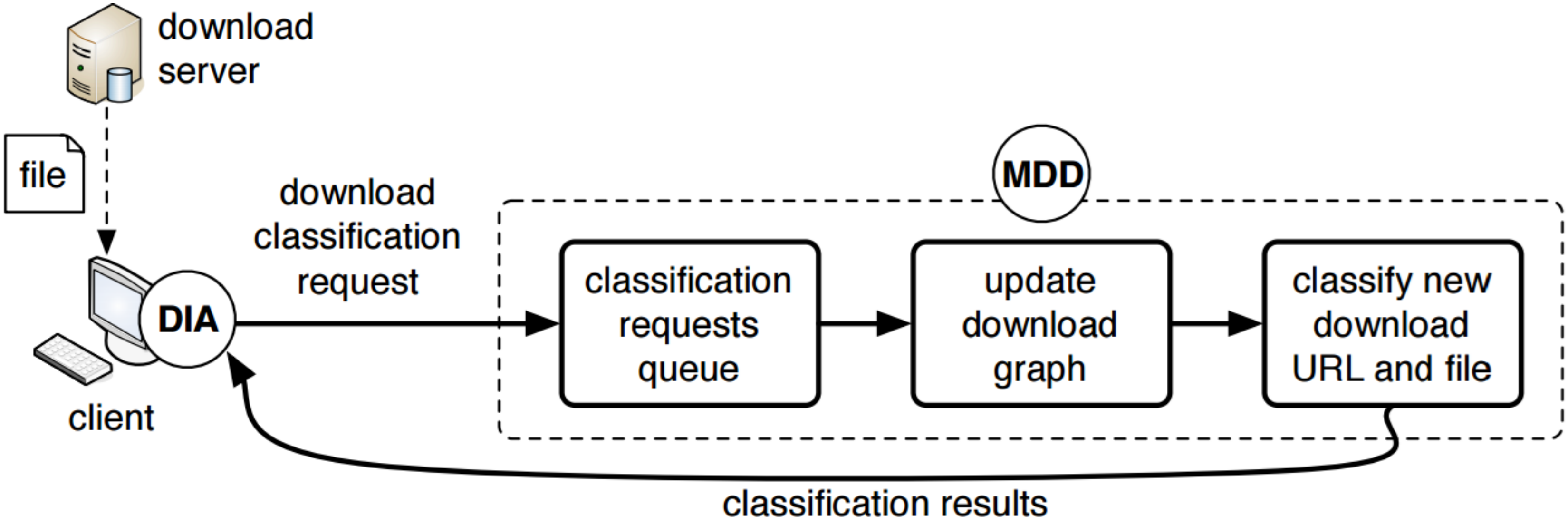
Benefits

- Concurrent detection of malicious download events, i.e. files and URLs
- Complementary approach to existing solutions, e.g. static and dynamic detection
- Efficiency, real-time detection against *unknown* and modern threats

System Overview

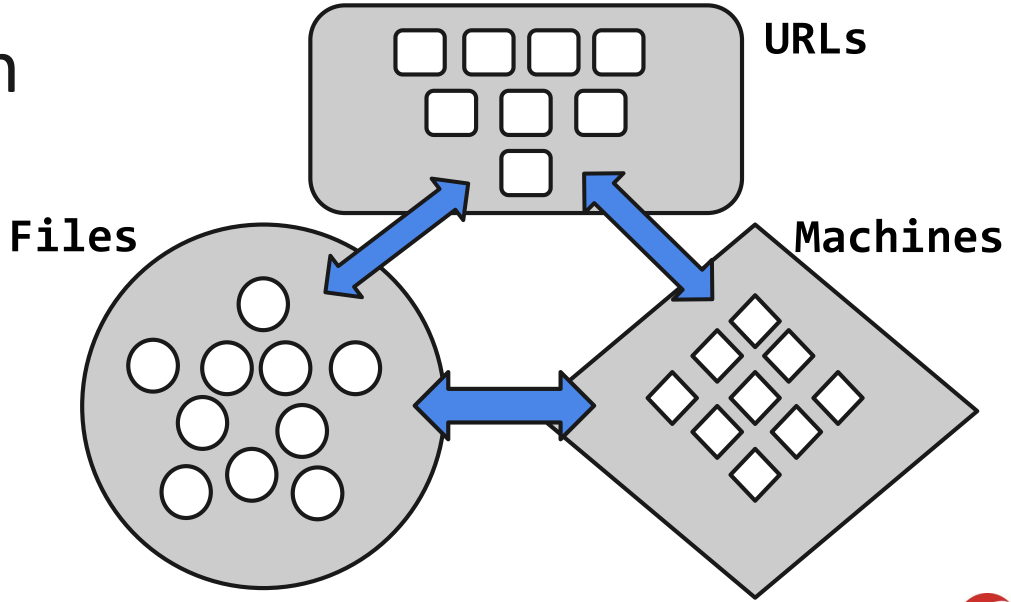


System Overview

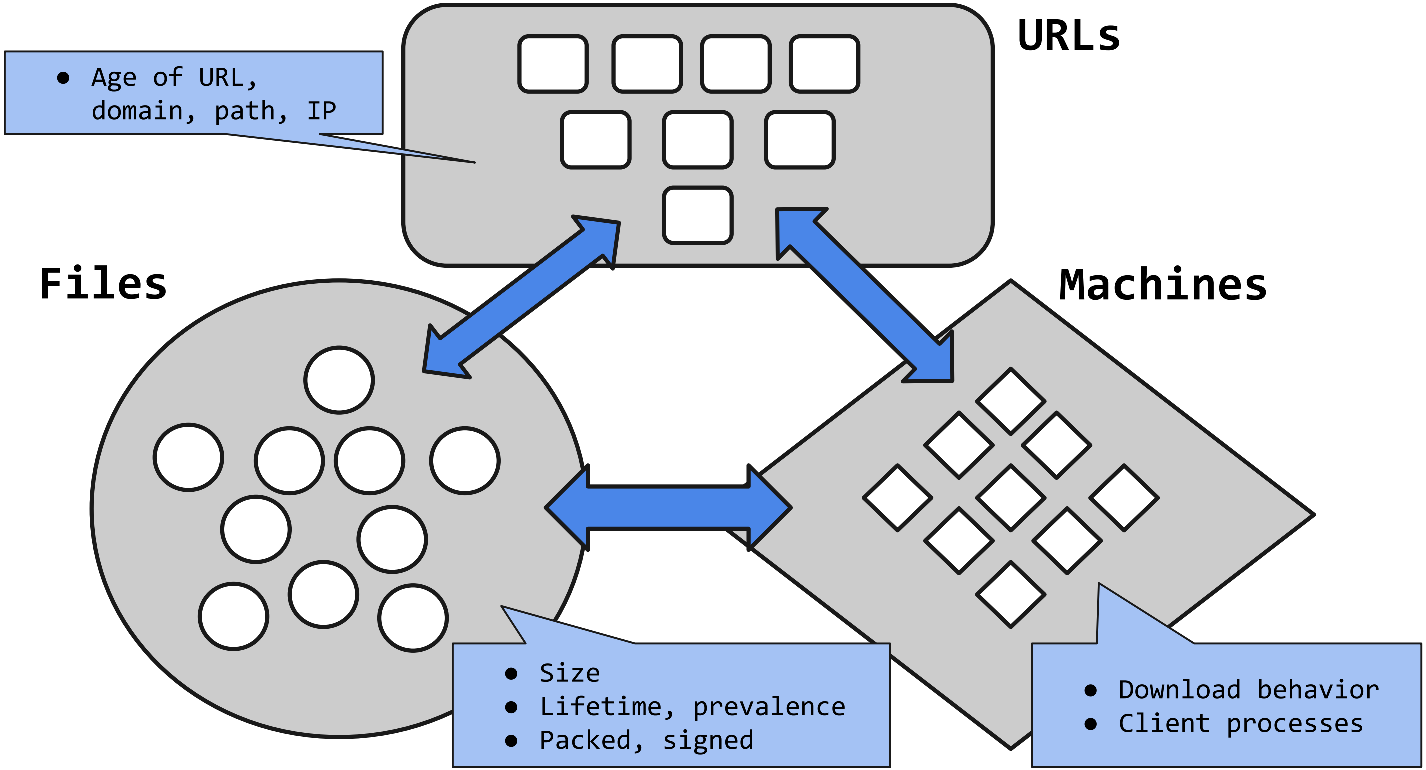


Download Graph

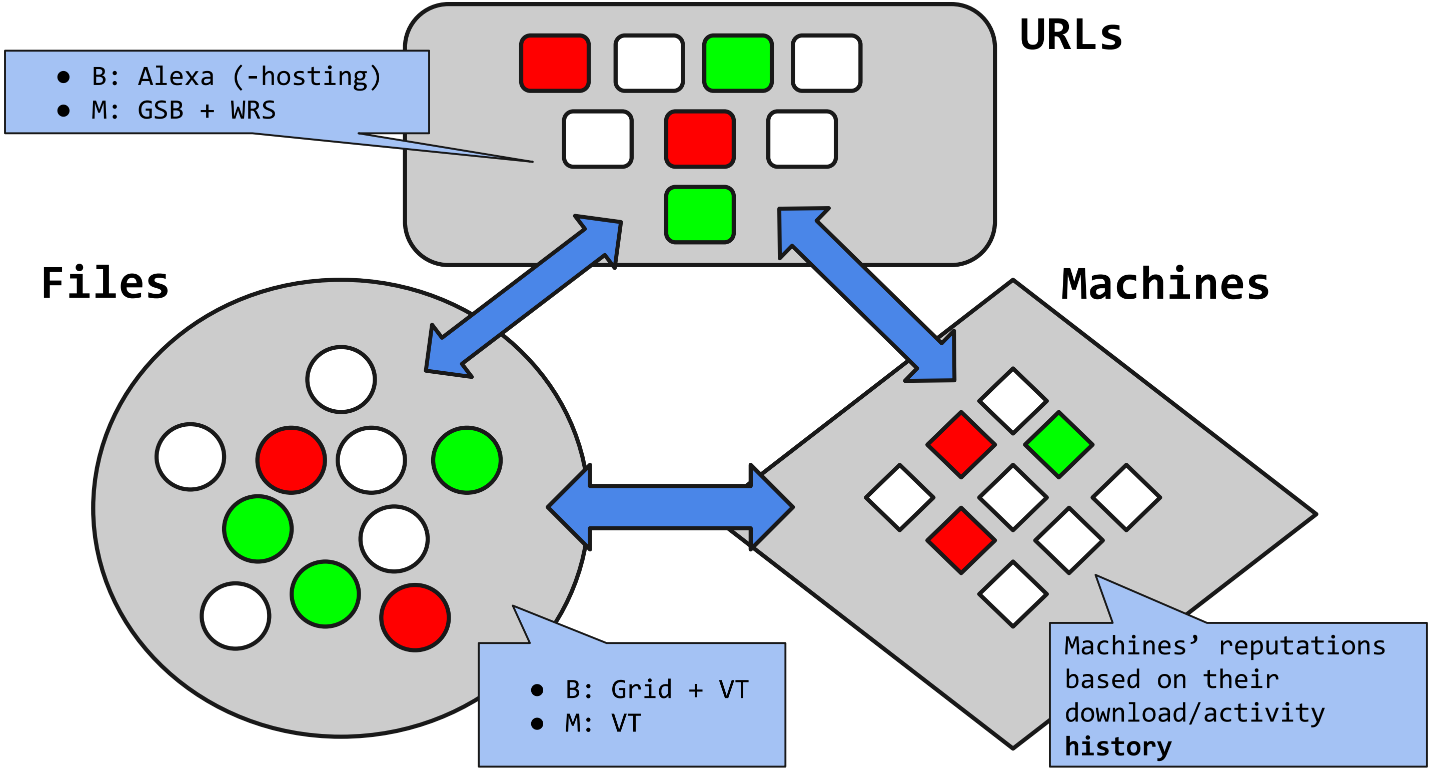
- A representation of a collection of download events
- Global situation



Intrinsic Features

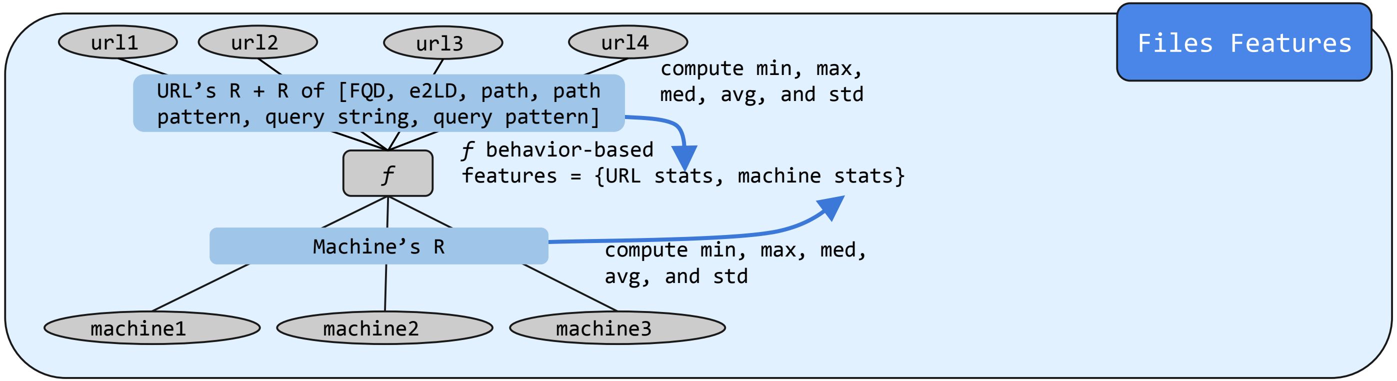


Labels

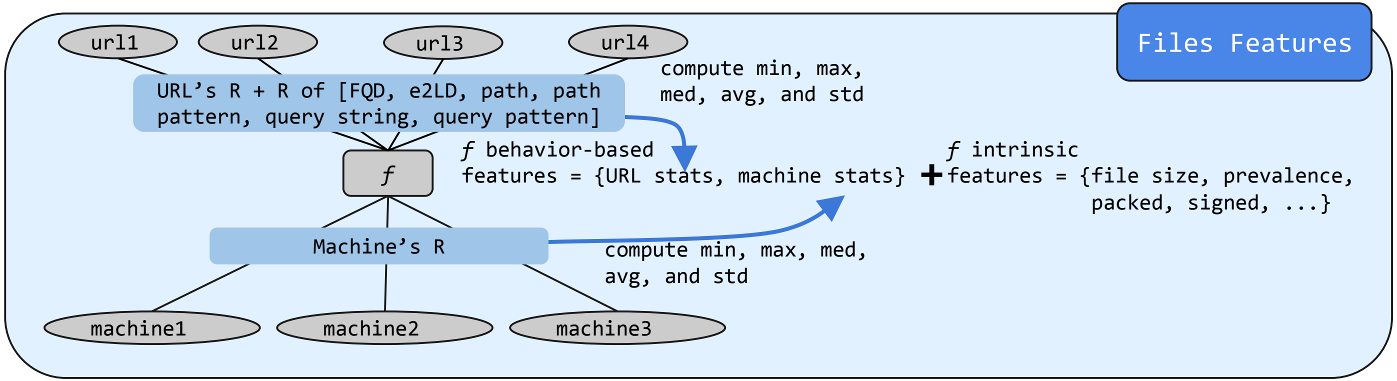


URLs
• B: Alexa (-hosting)
• M: GSB + WRS
Files
Machines
• B: Grid + VT
• M: VT
Machines' reputations based on their download/activity **history**

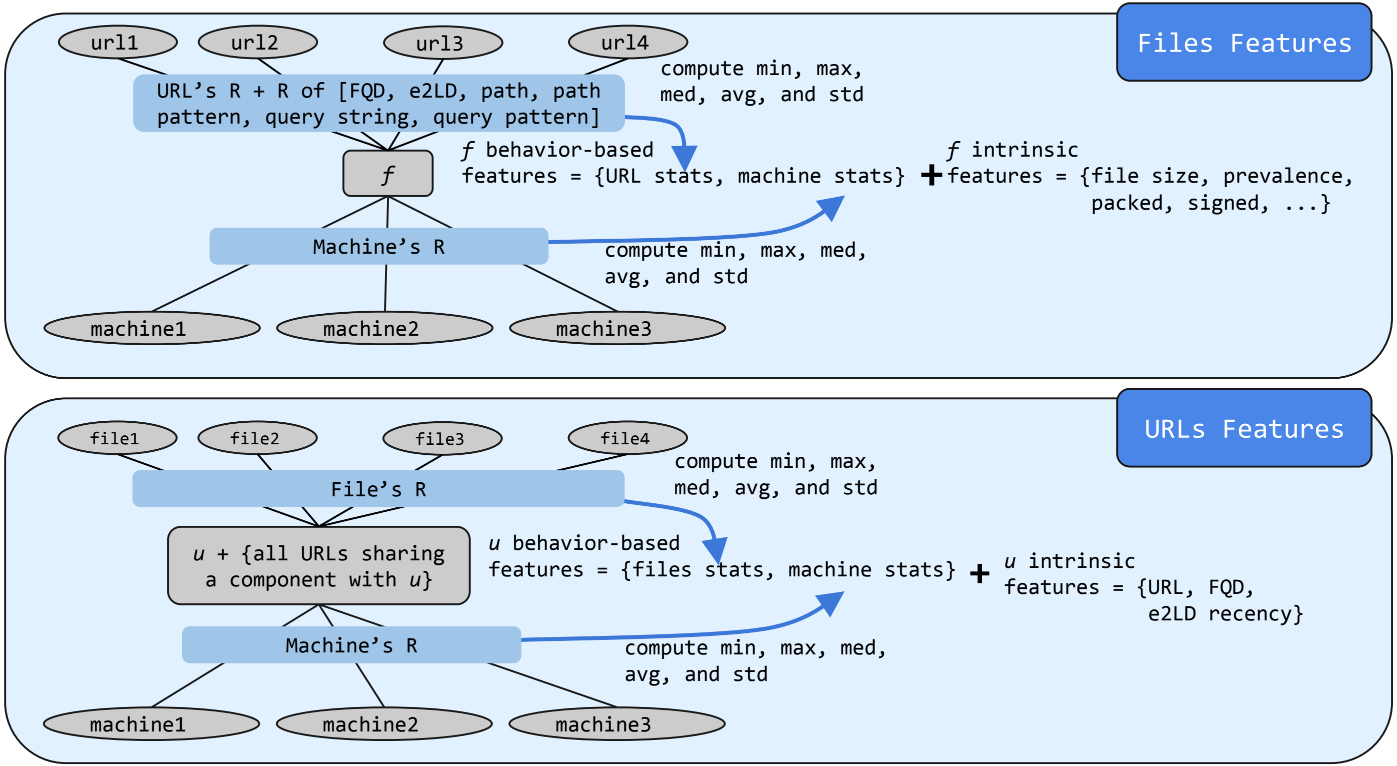
Features Engineering



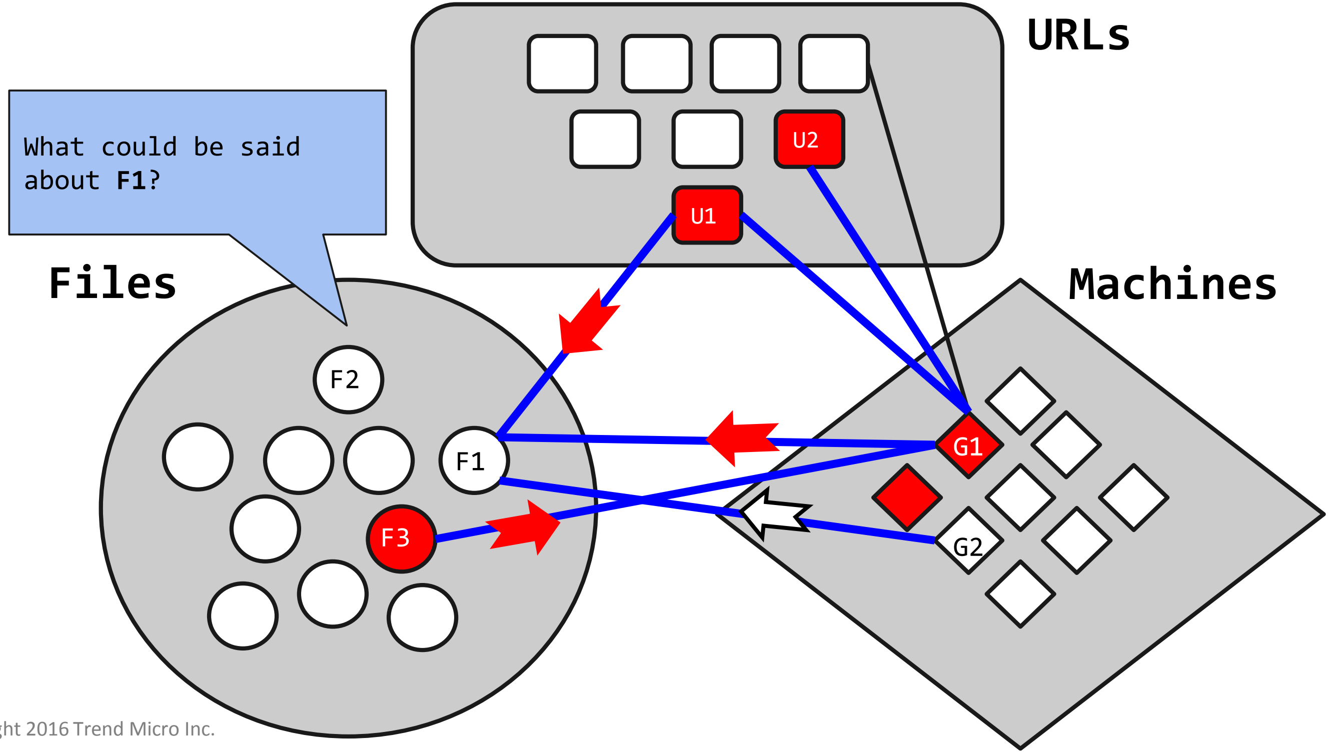
Features Engineering



Features Engineering



Statistical Classifier, example



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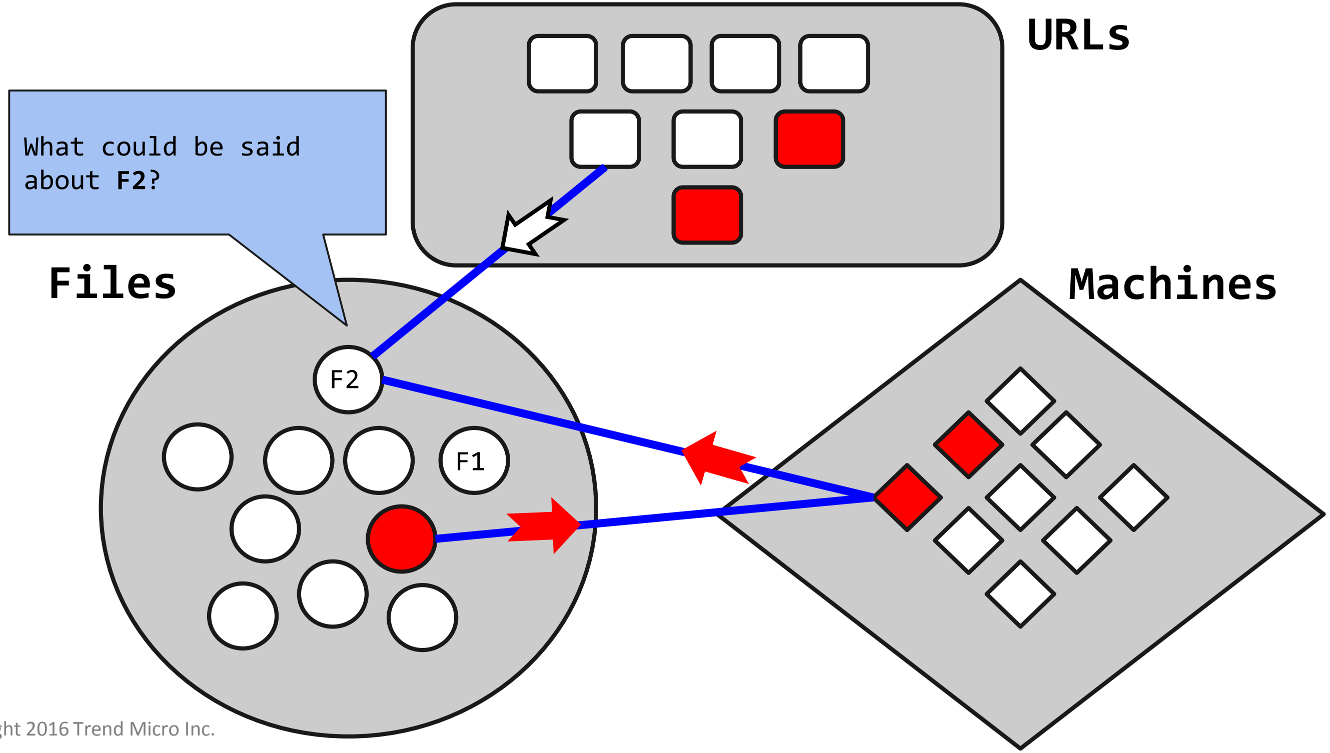

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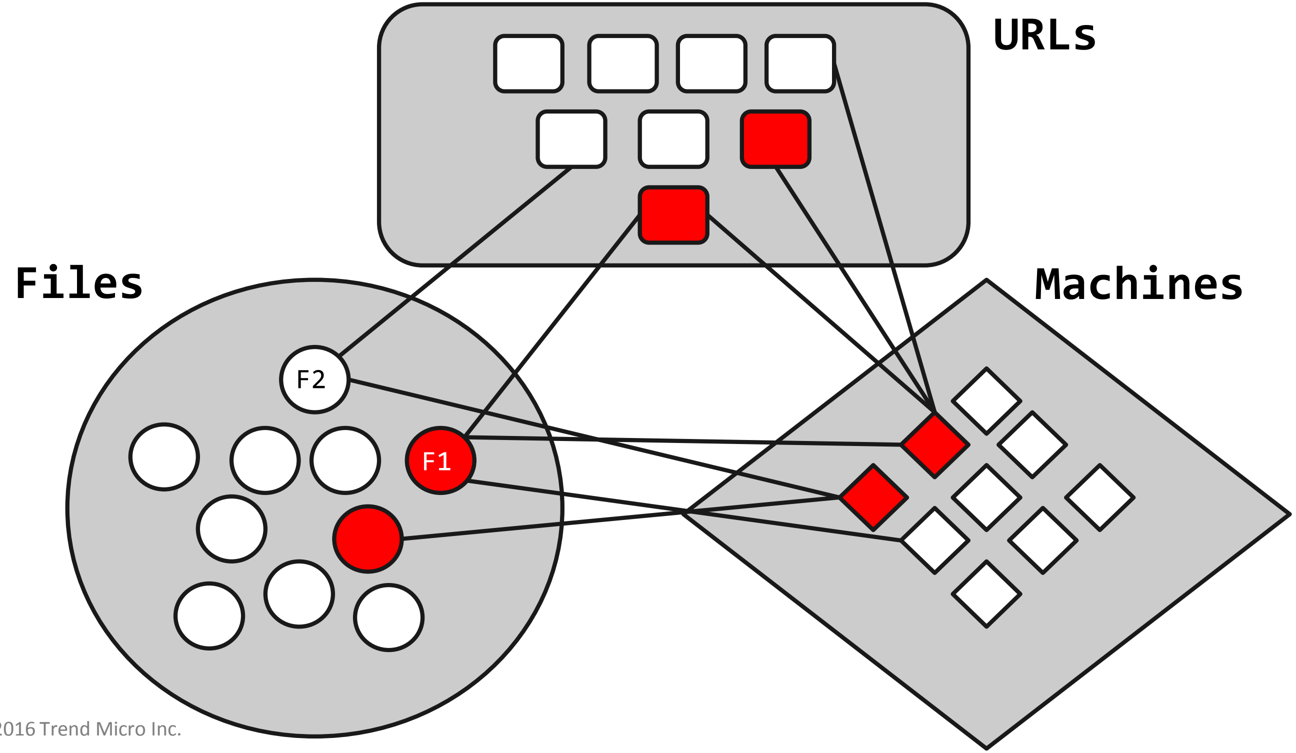

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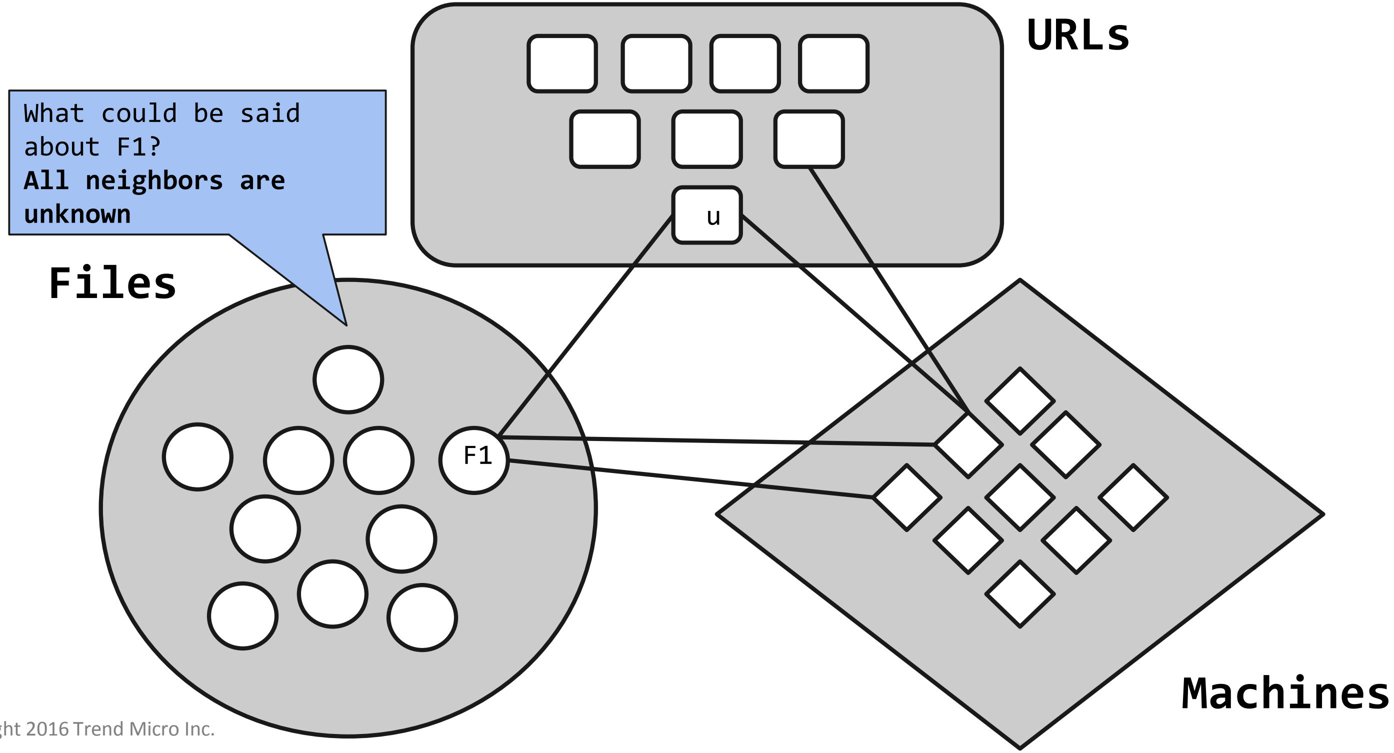

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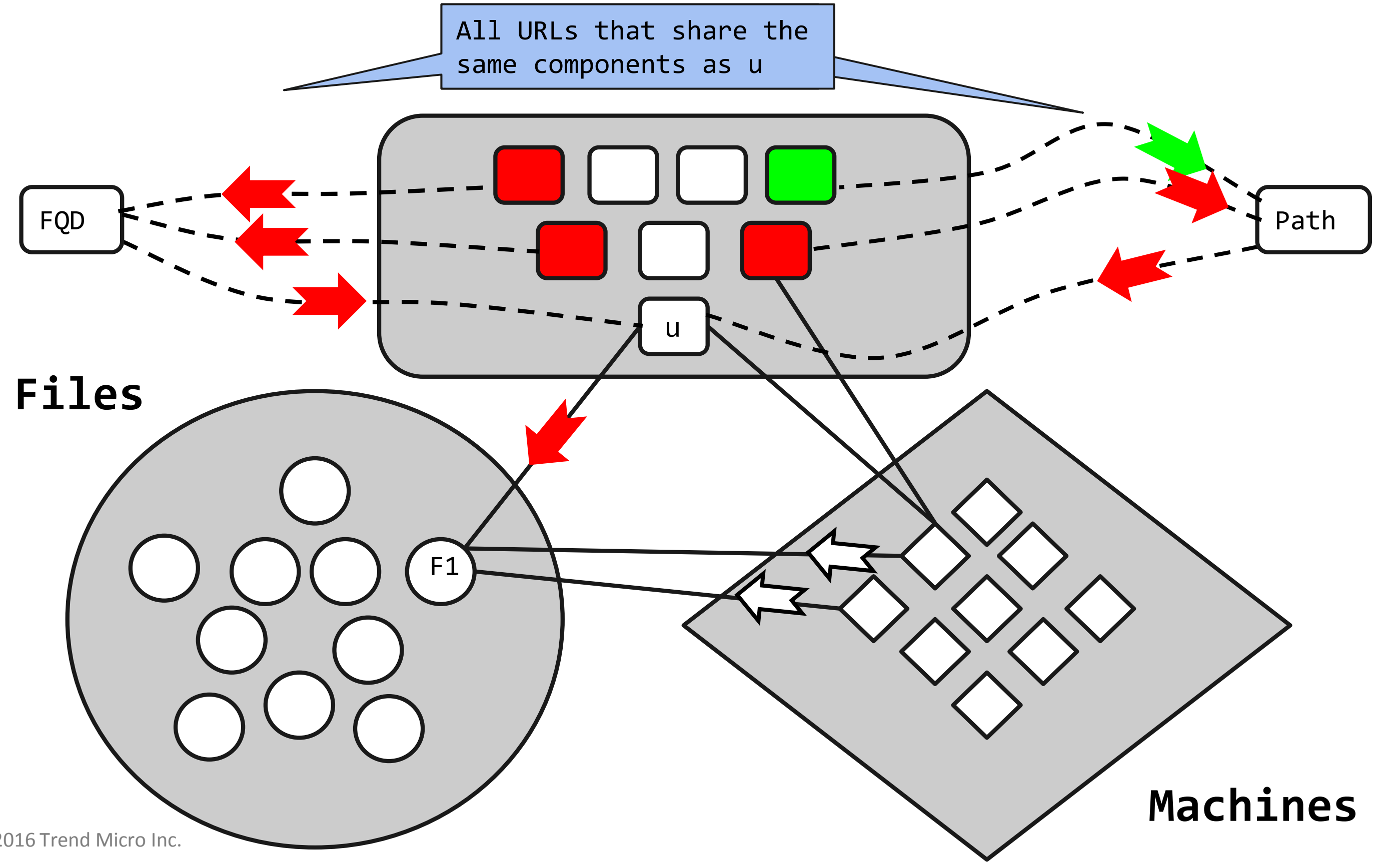

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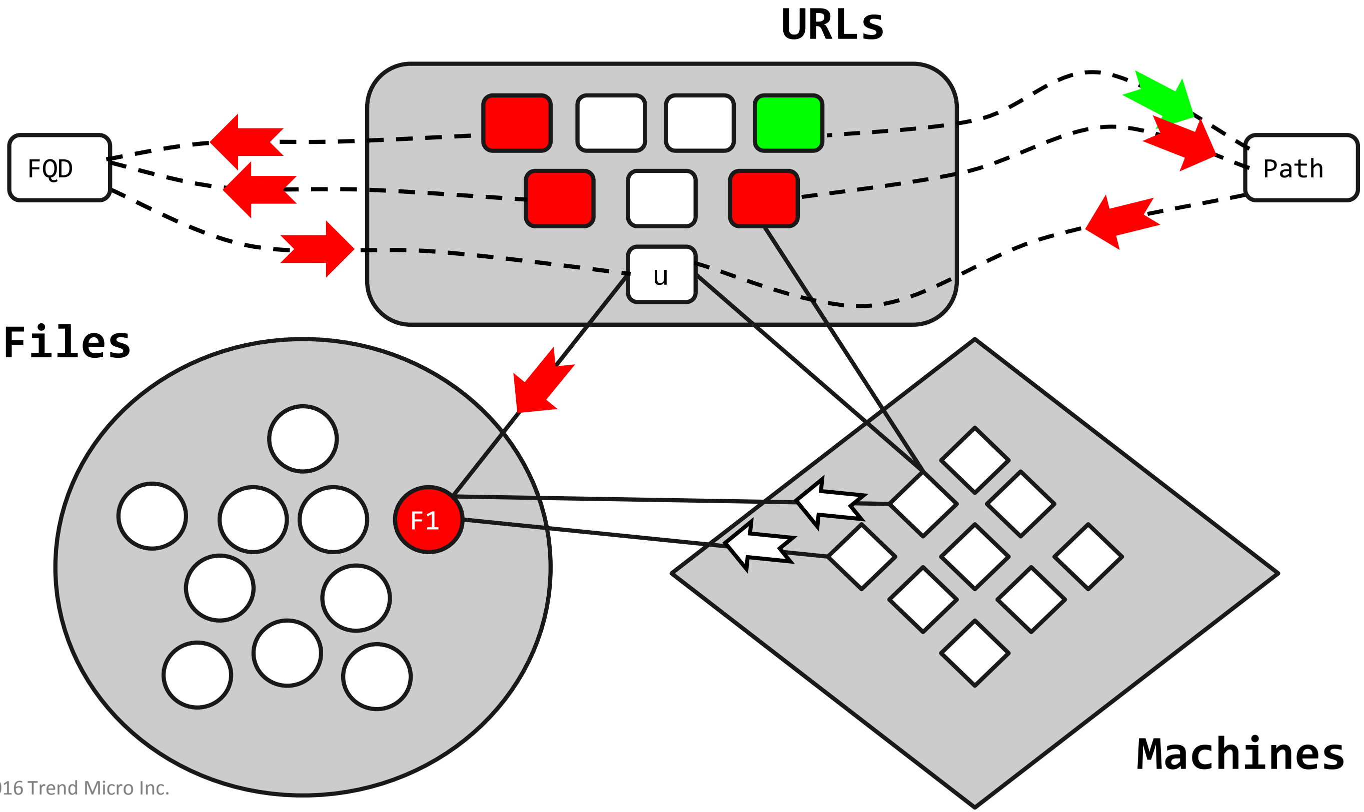
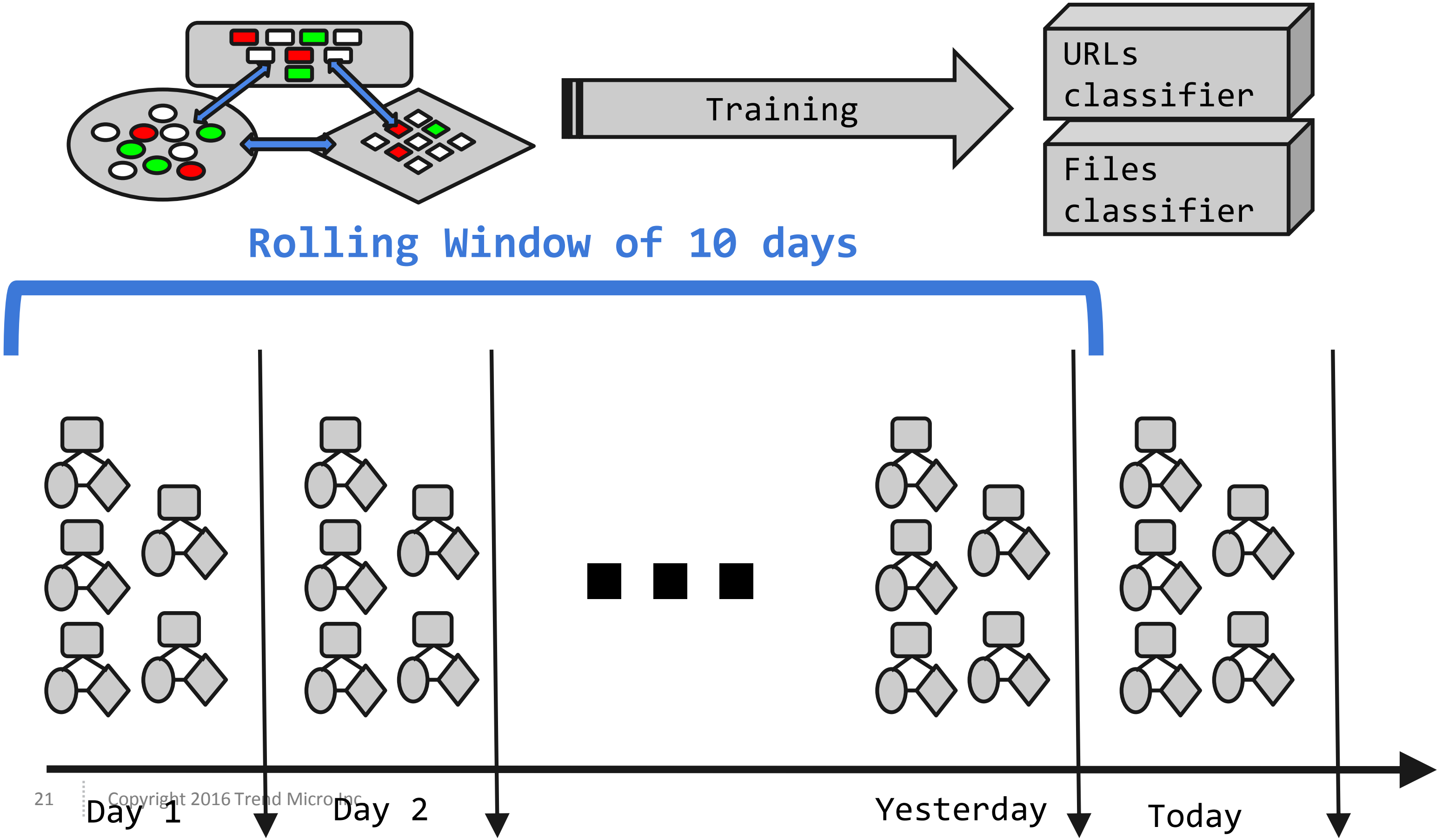
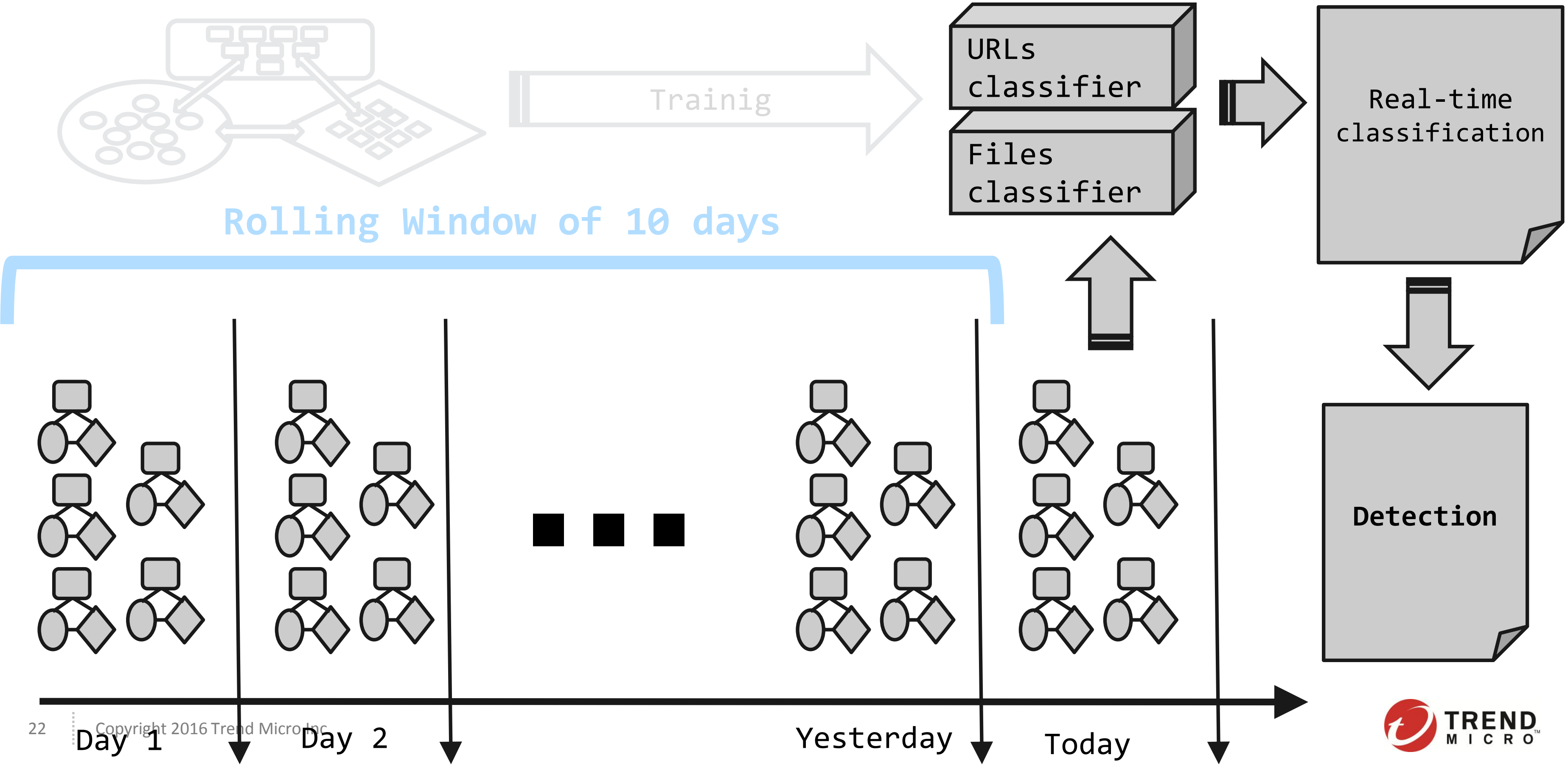


Deployment


Training
URLs classifier
Files classifier
Rolling Window of 10 days
Day 1
Day 2
Yesterday
Today

Deployment



Trainig
URLs classifier
Files classifier
Real-time classification
Rolling Window of 10 days
Detection
Day 1
Day 2
Yesterday
Today

Testing Results

- Detection

Month of Test Day	Events		
	test events	TP%	FP%
Feb	4,205	96.2	0.4
Mar	4,581	95.4	0.5
Apr	4,163	97.3	0.5
May	4,004	96.1	0.4
Jun	3,856	94.0	0.5

- Efficiency: requests are served in ~0.16 sec

Early Detection Experiment

- We did classification at t=0.
- We queried Virus Total 6 months after.

- We identified 84% future malware in advance.

Early Detection Experiment

- Droppers and downloaders, e.g. `Win32/InstallCore.MI, TrojanDropper:Win32/Rovnix, Downloader .ATW and MalSign.InstallC.4DB`
- Adware, bots, banking Trojans, key-loggers, e.g.: `Rogue:Win32/FakePAV, Win32:Crypt-QTG, PWS: Win32/Zbot, FakeAV_r.YE, Backdoor.Trojan, and Trojan .FakeAV`

Case Study 1, Wuachos Dropper

- Filename `file_saw.exe`
- Low prevalence
- Invalid signature
- URLs with **no** reputation, BUT path pattern with R of 0.72 (malicious)
  - `/f/1392240240/1255385580/2, /f/1392240120/4165299987/2 -> /H1/I10/I10/I1`
  - 1,445 URLs serving 182 polymorphic malware

Case Study 2, Somoto Adware

- Packed, short lifetime, low prevalence
- 1 graph-connected machines downloaded 1 labeled (known) sample

- Detected a campaign of 695 samples
  - Filename `FreeZipSetup-[\d].exe`
- 616 were unknown to VirusTotal
  - 61 unknown +6 months (10%)

Case Study 3, TTAWinCDM Spyware

- Machine and URL with **no** reputation ☹
- Low lifetime & prevalence & countries
- Mismatch on downloading process
  - Acrobat process + Unauthoritative domain
- Flash 0-day (+2 month)

Conclusions

- Traditional AV is not dead, but tends to become quickly obsolete and inefficient
- Complementary system
  - Content agnostic, statistical based
  - Global awareness
- 90% TP at 0.1% FP
- Detect unknown threats in real-time! ☺

Thanks!

- Questions?

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