BigData Security Analytics

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Context: **CyberThreats current situation**

- Cyber threats are on the rise…

More than **4 billion** records compromised in 2016
→ a 566% increase from 2015

- …they become more advanced…

Examples of recent cyber attacks:
- BlackEnergy (2015)
- MEDJACK (2016)
- Archimedes (2017)
- *Wannacry (2017)*
- *Meltdown & Spectre (2018)*

- …and the penalties are steep…

3.6$ Million avg cost of a single (!) data breach

Solution: **(Big Data) Security Analytics**

Definition: process of using data collection, aggregation, and analysis tools for (enterprise) security monitoring and threat detection

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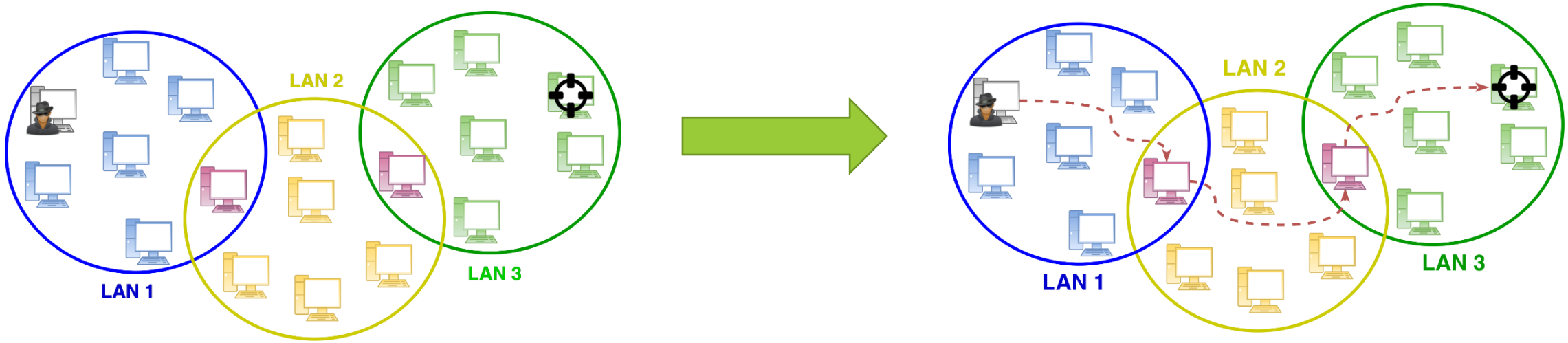
Early Work: **Graph Analysis for *Lateral Movement* Detection through *Pivoting***

Attackers want to control hosts with **higher privileges** or **more valuable data.**



Pivoting: any action in which a *command propagation tunnel* is created among three or more hosts

Intuition: pivoting activities can be modelled through *Flow-sequences*

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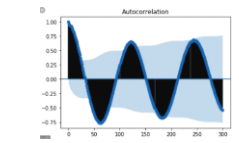
Shift to Machine Learning:
Time Series + Clustering to identify malicious external hosts

Novel malware variants are likely to evade detection...
...but some features of malware behavior persist and are shared even by novel variants

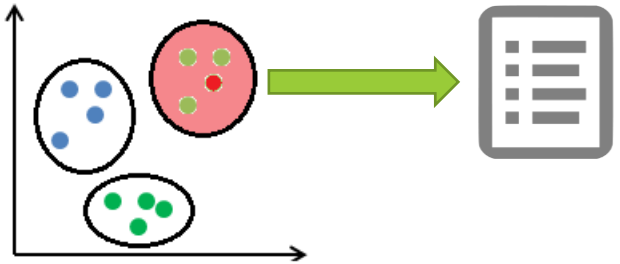
External hosts behaving similarly to a known malicious external host are likely to also be malicious

USE ONE TO FIND MANY:

- Generate temporal communication patterns
- Create clusters of similar communications
- Use NIDS alerts to find malicious external hosts
- Label as suspicious all clusters containing malicious external hosts
- Build *graylist* with external hosts belonging to suspicious clusters



Network communications



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Industrial Landscape of Machine Learning & CyberSecurity…

FORTINET

FortiGuard Artificial Intelligence (AI) Delivers Proactive Threat Detection at Machine Speed and Scale

JUNIPER NETWORKS

Machine learning moves to the front lines of defense against an expanding threat surface.

Machine Learning: New Frontiers in Advanced Threat Detection

Symantec

SOPHOS

Sophos Adds Advanced Machine Learning to Its Next-Generation Endpoint Protection Portfolio

MACHINE LEARNING HELPS US FIND NEW ATTACKS

F-Secure

KASPERSKY lab

Machine learning in Kaspersky Endpoint Security 10 for Windows

TREND MICRO

The truth is Trend Micro has been using machine learning since 2005.

CYBERARK

MACHINE LEARNING PREVENTS PRIVILEGE ATTACKS AT THE ENDPOINT

FireEye

McAfee is evolving its machine learning cybersecurity technology

McAfee

Rapid7 Attacker Behavior Analytics Brings Together Machine Learning and Human Security Expertise

RAPID7

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…but all that shines is not gold

Main issues of ML for CyberSecurity:

Model training
- Where and how to find high quality and labeled training dataset?

Model deployment
- Is a pre-trained model applicable to my environment?

Model evaluation and selection
- How to compare different ML approaches?

Evolution over time (concept drift)
- How frequently should the model be re-trained?

Explainability
- Results are not explainable (yet)

False positives and false negatives
- 1% false positive rate in large organization = **thousands** of daily false alarms

Adversarial attacks
- More on this later…

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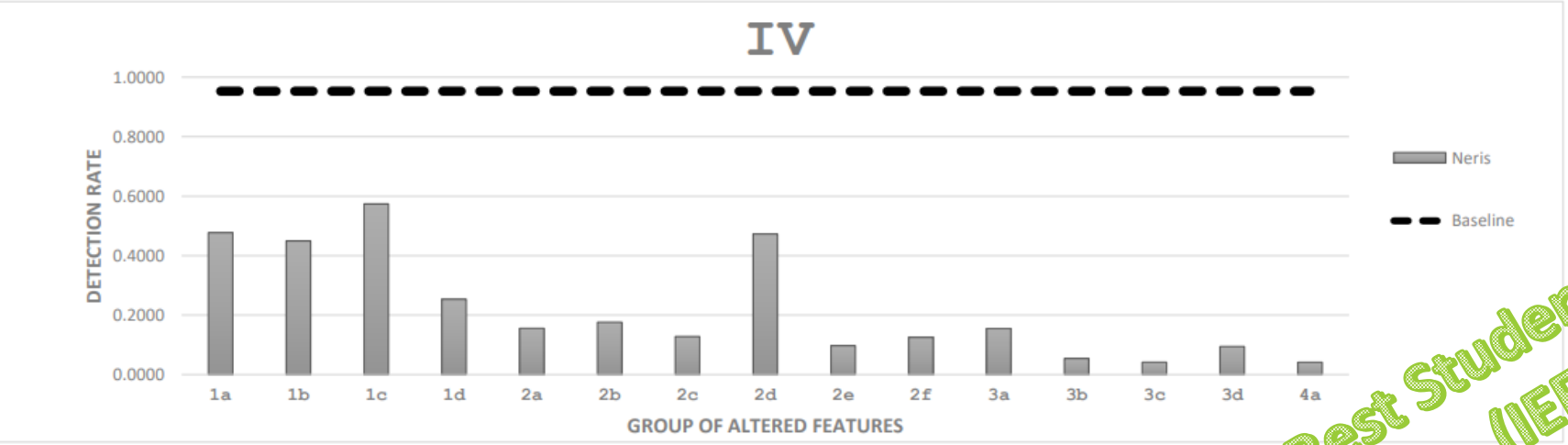
Last Year: **Adversarial Attacks against Cyber Detectors**

We performed extensive experimental evaluations showing that the *detection rate* of a random forest-based botnet detector drops to values **lower than 5%** just by introducing small and targeted modifications to the network communications of the infected machines.

Experiments outline

1. Develop a botnet detector with good performance
2. Generate **realistic** adversarial samples
3. Evaluate the detector against the generated adversarial samples



Best Student Paper Award (IEEE NCA18)

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Last Year: **Adversarial Attacks against Cyber Detectors**

Solutions?

- **Re-training with adversarial samples**

Requires the **availability** and **mainteance** of a **realistic** adversarial dataset

	Recall (before the attack)	Recall (after the attack)	Attack Severity
Random Forest	0.9684	0.3429	**0.6459**
Multi-layer Perceptron	0.9438	0.3012	**0.6809**
K-Nearest Neighbour	0.9375	0.3121	**0.6671**

- **Use feature-sets that cannot be modified by the attacker**

Decreases the performance of the detector against unmodified samples

	Precision		*Recall*		*F1-score*		*Accuracy*	
	Original	New	Original	New	Original	New	Original	New
Random Forest	0.9774	**0.8561**	0.9684	**0.8885**	0.9729	**0.8719**	0.9978	**0.9711**
Multi-layer Perceptron	0.9616	**0.7934**	0.9438	**0.7561**	0.9526	**0.7743**	0.9912	**0.9816**
K-Nearest Neighbour	0.9558	**0.8298**	0.9375	**0.8091**	0.9466	**0.8193**	0.9909	**0.9838**

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Why am I here?

Networking

Learning

Planning

Contact Information

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