Explainable Sequential ML for Cybersecurity: *A case of attacker strategy discovery*

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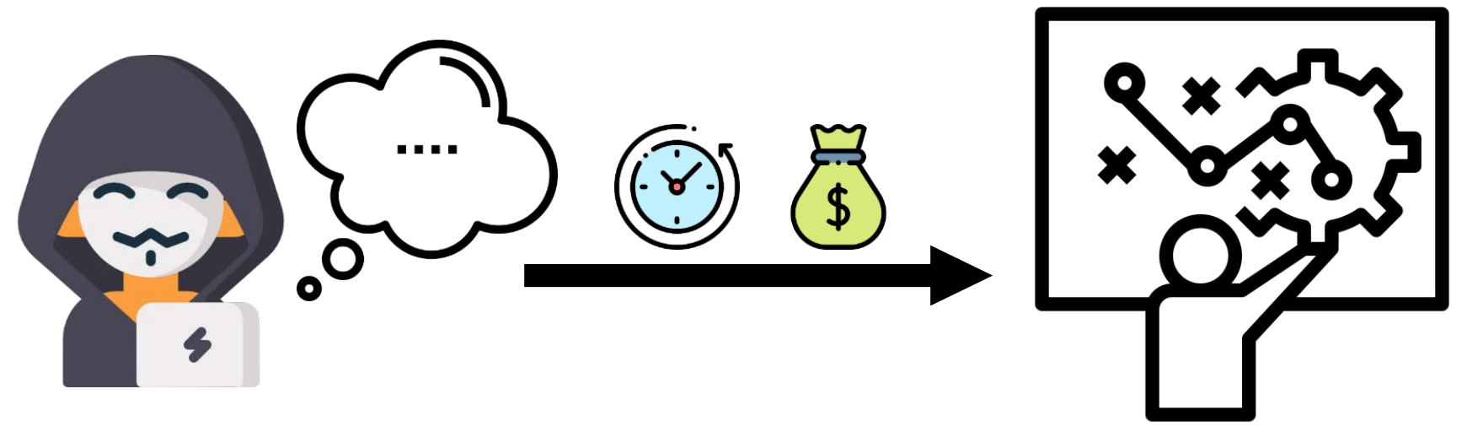
Background

How to discover & display attacker strategies from intrusion alerts?

Too many alerts → alert fatigue

1 million alerts/day!*

Attacker strategy identification is manual & labor-intensive

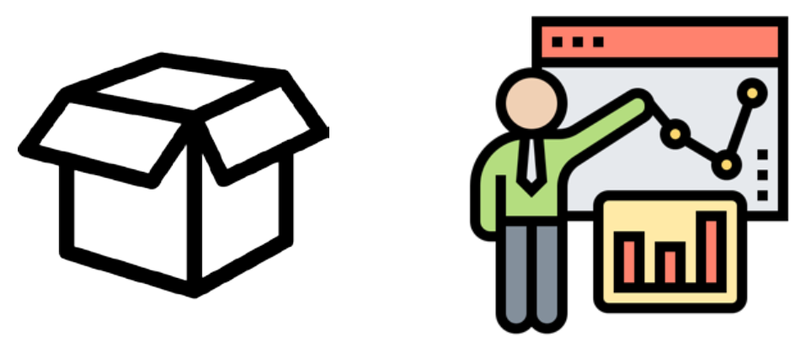


Want to answer questions like:

- How did an attack happen?
- Were multiple attackers involved?
- Were their strategies similar?

Design challenges

Need an explainable approach



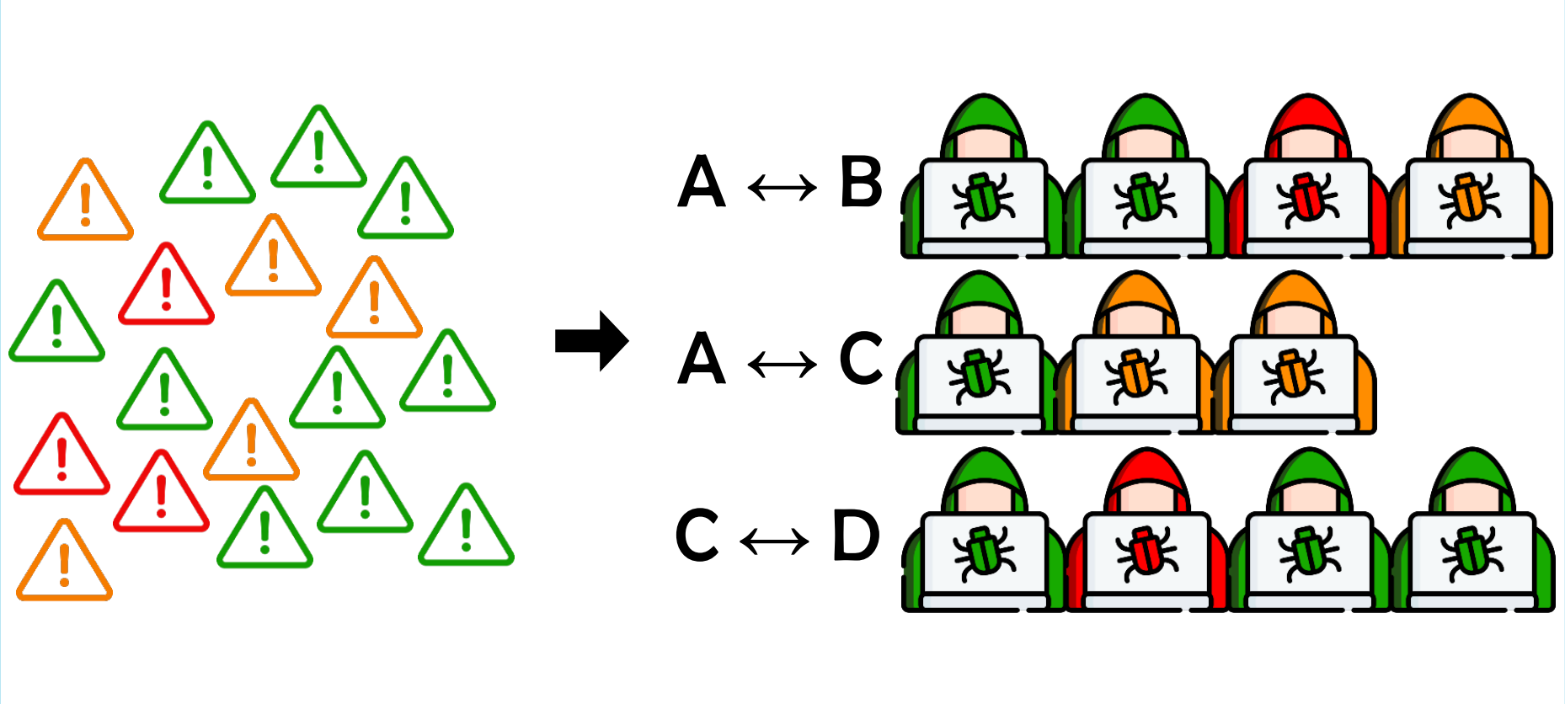
Severe alerts are rare; non-severe are frequent but also interesting

Same alert can have different semantics, depending on when it happened

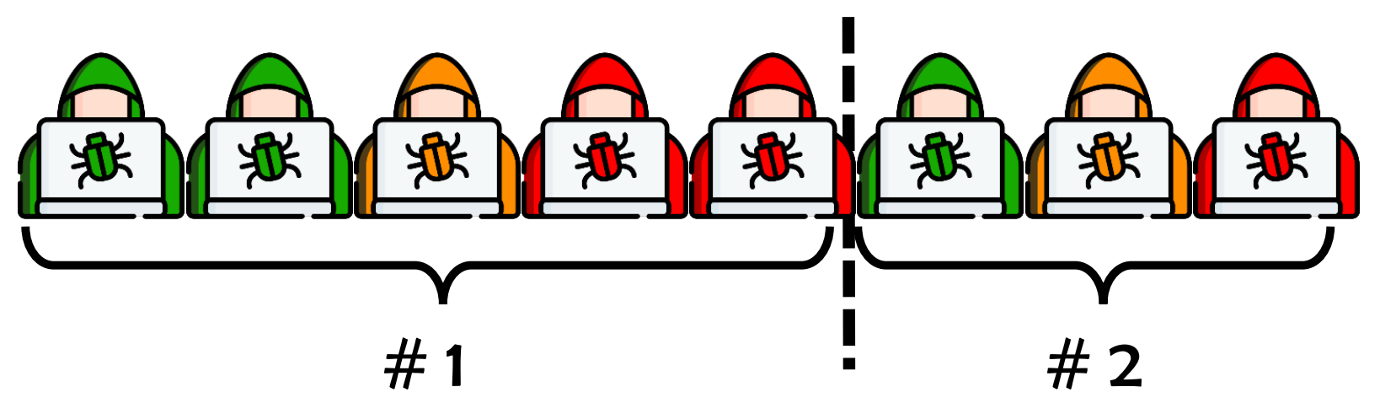
Proposed method

SAGE discovers attacker strategies from alerts, by learning a suffix probabilistic-DFA.

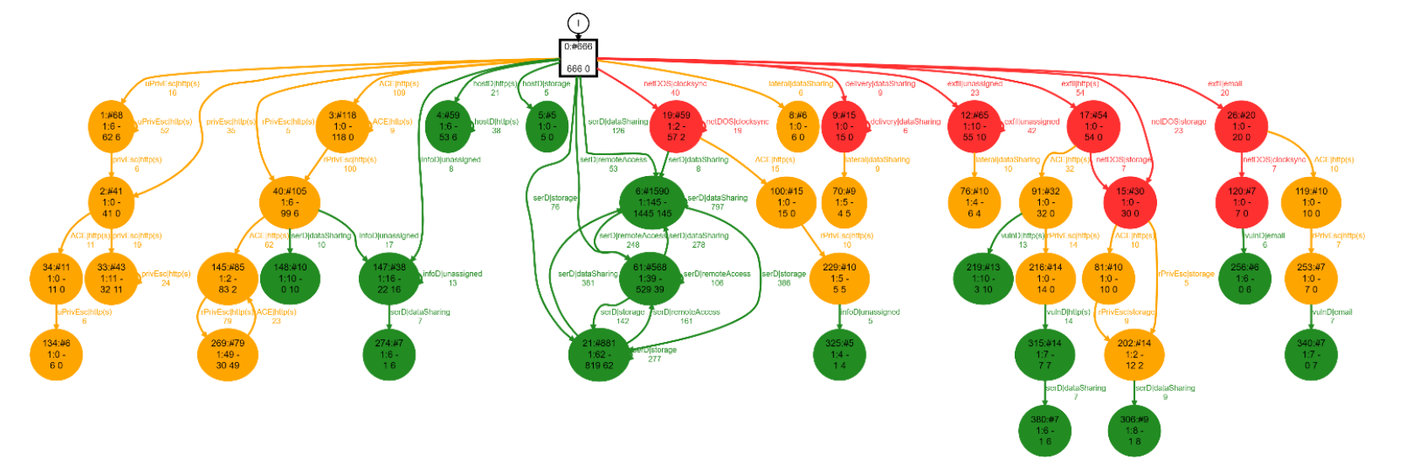
Alerts to Action sequences



Split each attack attempt

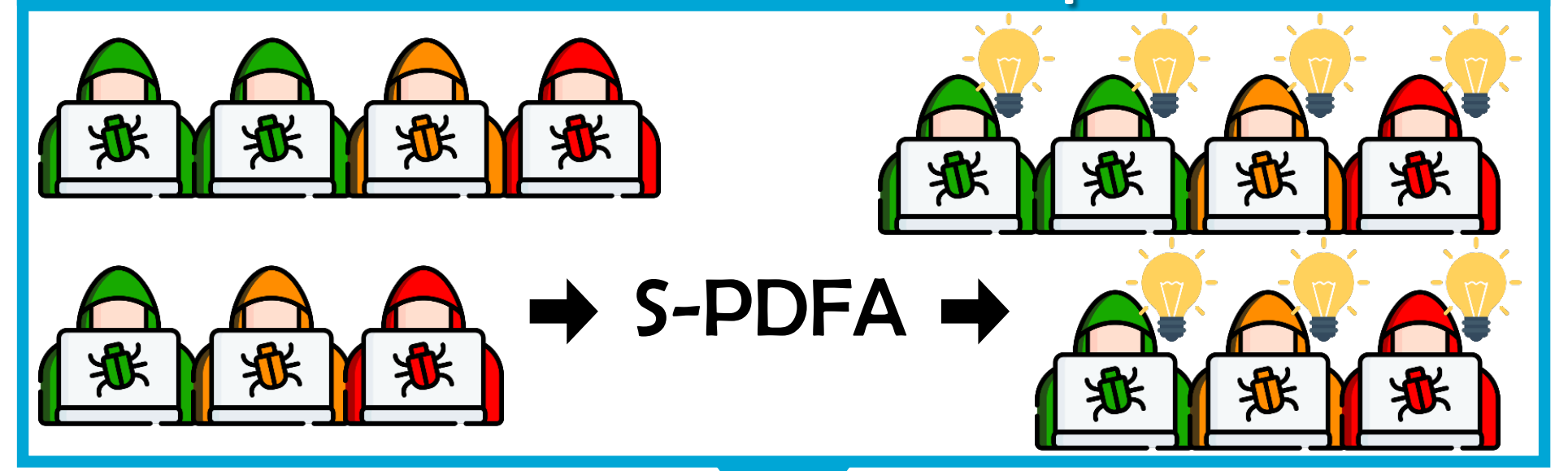


Suffix Probabilistic-DFA learning

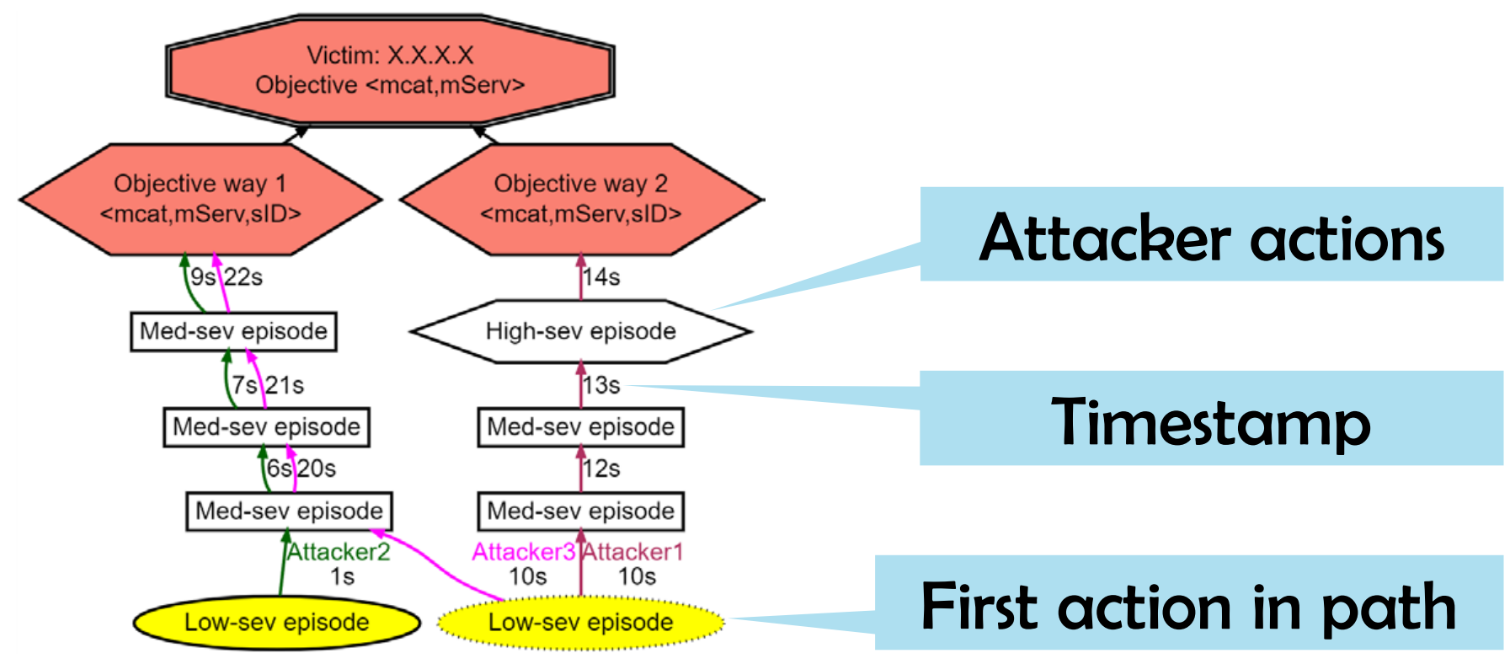


1. Highly interpretable
2. Highlights infrequent actions
3. Models semantics

Add semantics to sequences



Attack graph (AG) construction

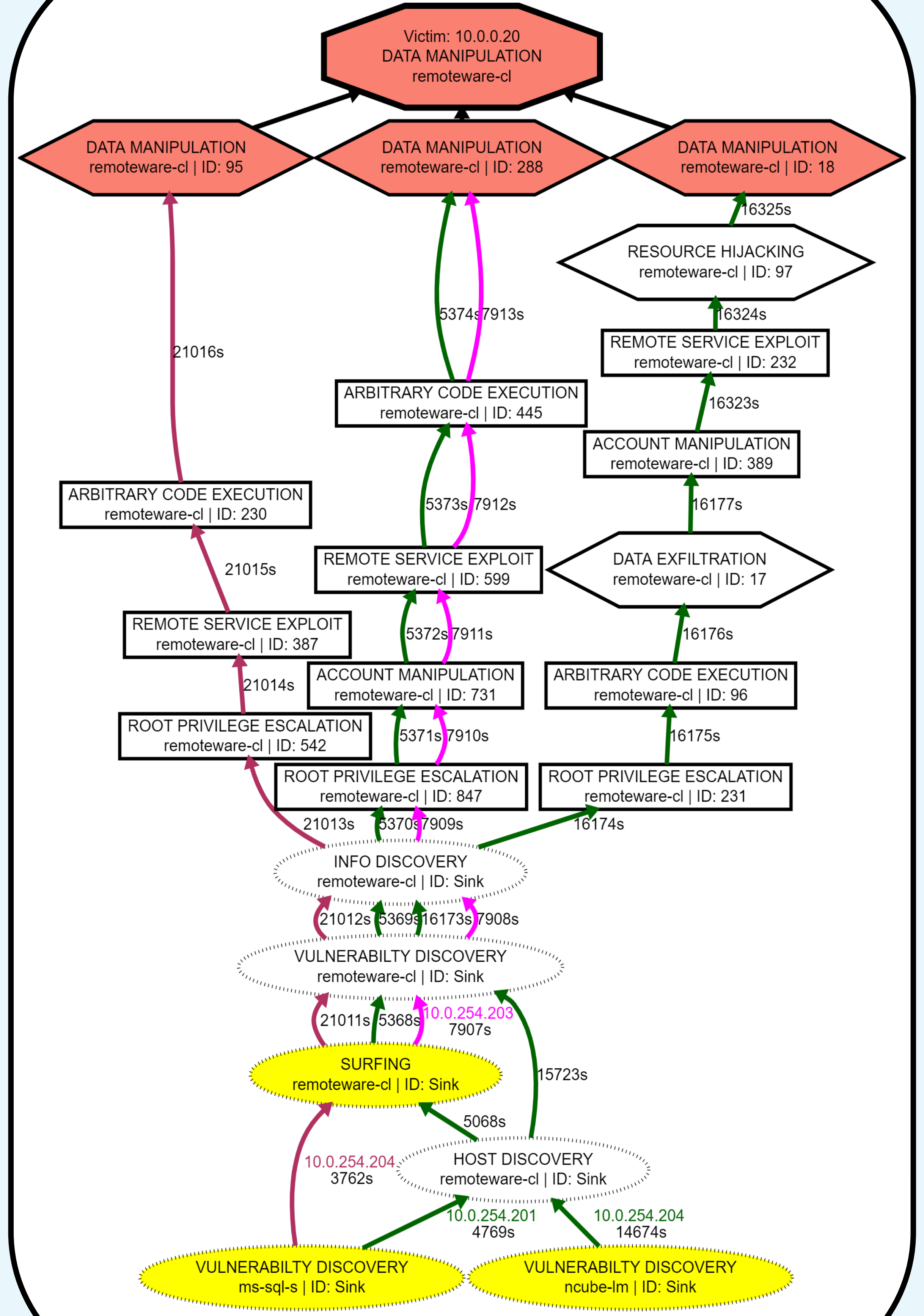


Attacker actions

Timestamp

First action in path

Key Results



On CPTC-2018, containing

300,270 alerts

SAGE generates

93 AGs in < 1 min

AGs show how an attack transpires

AGs show concrete similarities between attacker strategies

S-PDFA discovers 3 ways to reach the objective

SAGE finds 29 fingerprintable paths for attacker re-identification

Takeaways

SAGE extracts AGs without expert input!

S-PDFA is critical in modeling semantics & highlighting infrequent patterns.

SAGE is interpretable & transparent, enhancing analysts' productivity.

SAGE is open-source!

Code: https://github.com/tudelft-cda-lab/SAGE

Paper: https://arxiv.org/abs/2107.02783?context=cs.LG

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