The usage of Process Mining

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State of the Art – Process Mining domains

- Healthcare
- Manufacturing
- Finance
- Public sector
- Usability
- Robotics, industry 4.0
- Utility
- Advisory, audits
- Biology
- Agriculture
- ICT
- Education
- Logistics
- Security
- Call center
- Entertainment
- Garment
- Retail
- Hotel

More details: [1]

State of the Art – Cybersecurity domains

- Used in domains:
  - Network (IS, DNS, IDS, websites)
  - Smart grids (anomalous behaviour of energy usage)
  - Smartphones (social engineering attacks, malwares)
  - Banking (frauds, security deviations)
  - Industrial Control Systems (cyberattacks)
  - Business processes (anomalies, deviations)

State of the Art – Techniques

1. Target period of the analysis
   - past
   - present
2. Business process awareness
   - with business knowledge
   - without any business knowledge
3. Analysis of a discovered process model
   - visually
   - programmatically
4. Detection technique
   - outlier behavior detection
   - abnormal behavior detection (only in supervised analysis)
   - conformance checking

Process discovery: DNS traces

- Event log built from DNS traces (caseID, activity, timestamp)
- caseID= client, DNS Server
- activity = query/response, type
- Detection of spambots

Process discovery: DNS traces

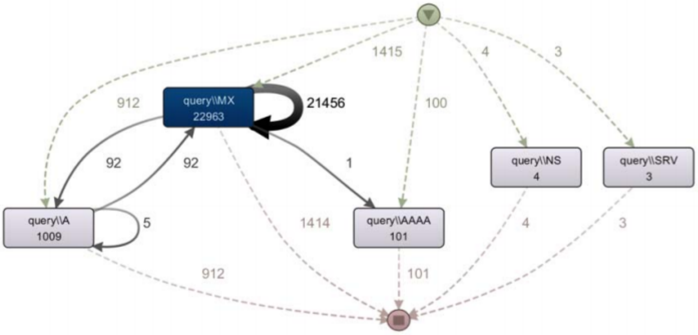


Fig. 6. Simplified graph of the attack shown in Figure 5. We show the model after filtering the 10% of most active IPs.

[2]

Model comparison: Smart Grids

- Anomaly detection of power consumption
- Classification of consumption to levels
- Then they discover graphs of consumption per short period
- Time-evolving graph approach: comparing consecutive graphs
- They chose Hamming distance and cosine similarity measure

Model comparison: Smart Grids

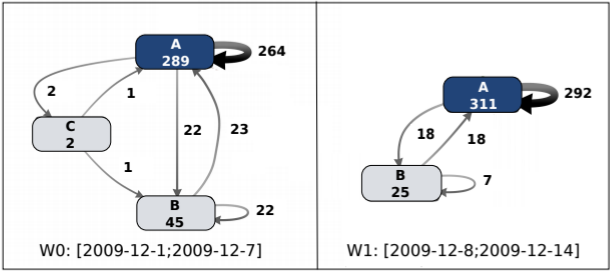


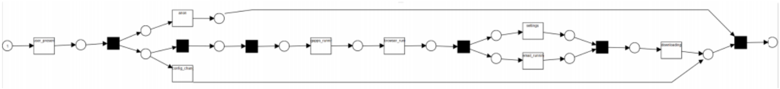
Figure 3. Consumption graphs of customer #1565 of two consecutive weeks.

[3]

Conformance checking: Smartphones

- Attack: user activated a malicious URL, which resulted in downloading personal user data via known vulnerability
- They designed a model of this attack from OS-generated information about performed actions, browser history, and network connection log
- Token-based replay with this model

Conformance checking: Smartphones



[4]

Demo: Find potential problems in the company

- From event logs, we get the model of real people's behavior from the past
- We then **replay** their behavior and find potential attacks or possible security threats
- For example, we can detect:
  - Abnormal behavior (something was done differently)
  - The absence of the action (e.g., someone forgot to pay)
- We only get **suspects**, so there is still a need for further investigation

What can WE do?

- Generally:
  - Discover the process from event logs
  - Replay the log on top of that model and visually detect deviations
  - Filter the event log and manually analyse the desired cases
  - Find the deviations in an event log from the existing model using conformance checking
  - Real-time conformance checking
- The biggest challenge might be to **find** a data to analyze and to **clean** them
- However, you can create your own prototype event logs (just like I did in the Demo)

What can WE do?

- Specifically:
  - Your project should be interesting for you
  - You need to achieve something that can be presented
- Real examples of a project:
  - Process discovery of a group of GitHub repositories (e.g., Big Data open source tools)
  - Process discovery from real datasets, for example: https://data.gov.cz/datové-sady, https://data.brno.cz/data/
  - Process analysis of the behavior of employees / students
  - Process analysis of the user behavior from a game
  - Process Mining on publicly available logs, for example: https://data.4tu.nl/repository/collection:event_logs
  - Real-time conformance checking using PM4Py

Resources

[1] C. dos Santos Garcia, A. Meincheim, E. R. F. Junior, M. R. Dallagassa,D. M. V. Sato, D. R. Carvalho, E. A. P. Santos, and E. E. Scalabrin,“Process mining techniques and applications - a systematic mappingstudy,”Expert Systems with Applications, vol. 133, pp. 260 – 295, 2019.doi: https://doi.org/10.1016/j.eswa.2019.05.003. [Online].

[2] J. Bustos-Jiménez, C. Saint-Pierre, and A. Graves, “Applying process mining techniques to dns traces analysis,” in 2014 33rd International Conference of the Chilean Computer Science Society (SCCC) , Nov 2014. doi: 10.1109/SCCC.2014.9. ISSN 1522-4902 pp. 12–16

[3] S. Bernardi, R. Trillo-Lado, and J. Merseguer, “Detection of integrity attacks to smart grids using process mining and time-evolving graphs,” in 2018 14th European Dependable Computing Conference (EDCC), Sep. 2018. doi: 10.1109/EDCC.2018.00032 pp. 136–139.

[4] L. Hluchý and O. Habala, “Enhancing mobile device security with process mining,” in 2016 IEEE 14th International Symposium on Intelligent Systems and Informatics (SISY) , Aug 2016. doi: 10.1109/SISY.2016.7601493. ISSN 1949-0488 pp. 181–184.