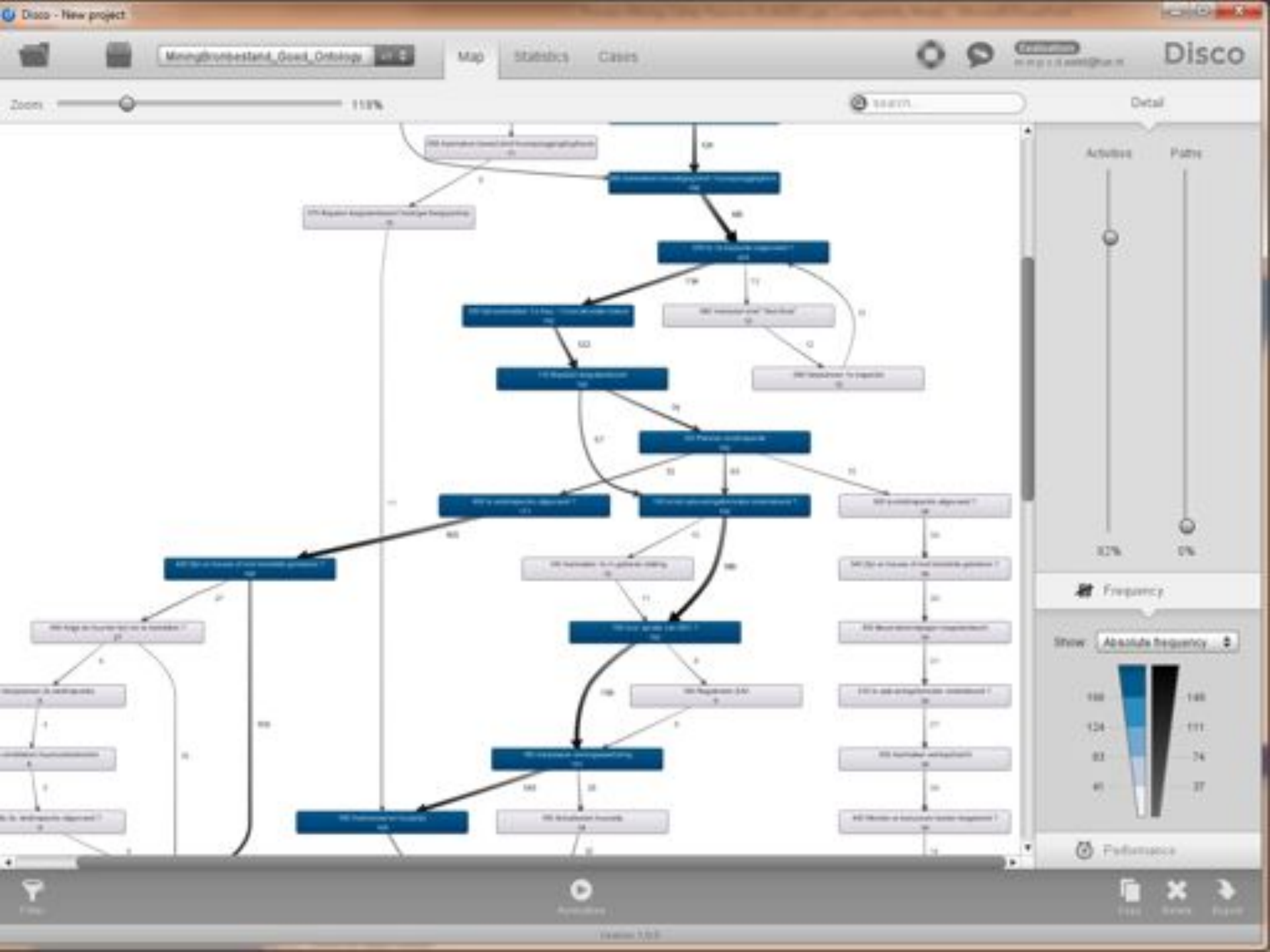
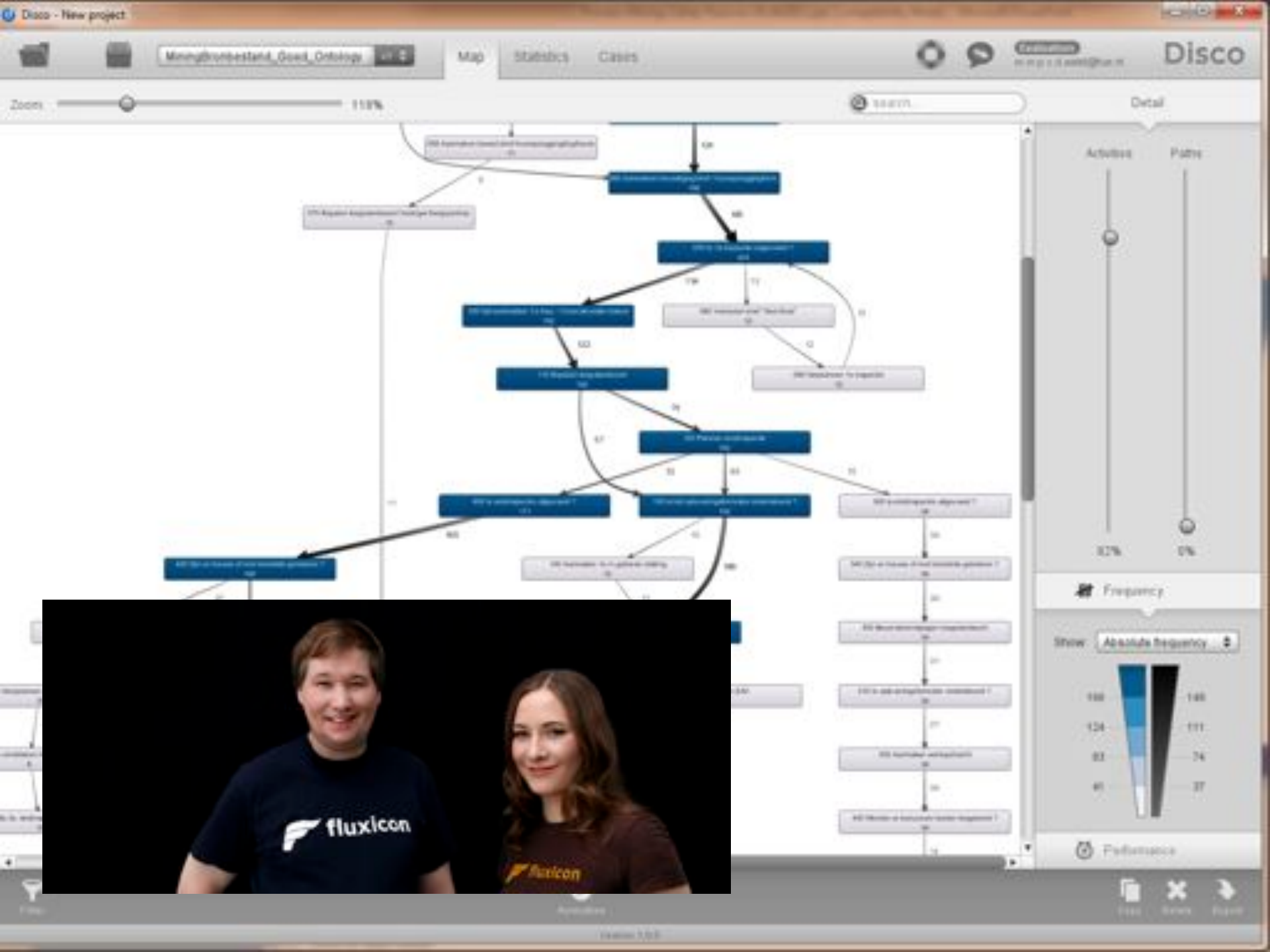

Disco - New project
Map
Statistics
Cases
Disco
Zoom
Detail
Activities
Paths
Frequency
Show
Absolute frequency
Performance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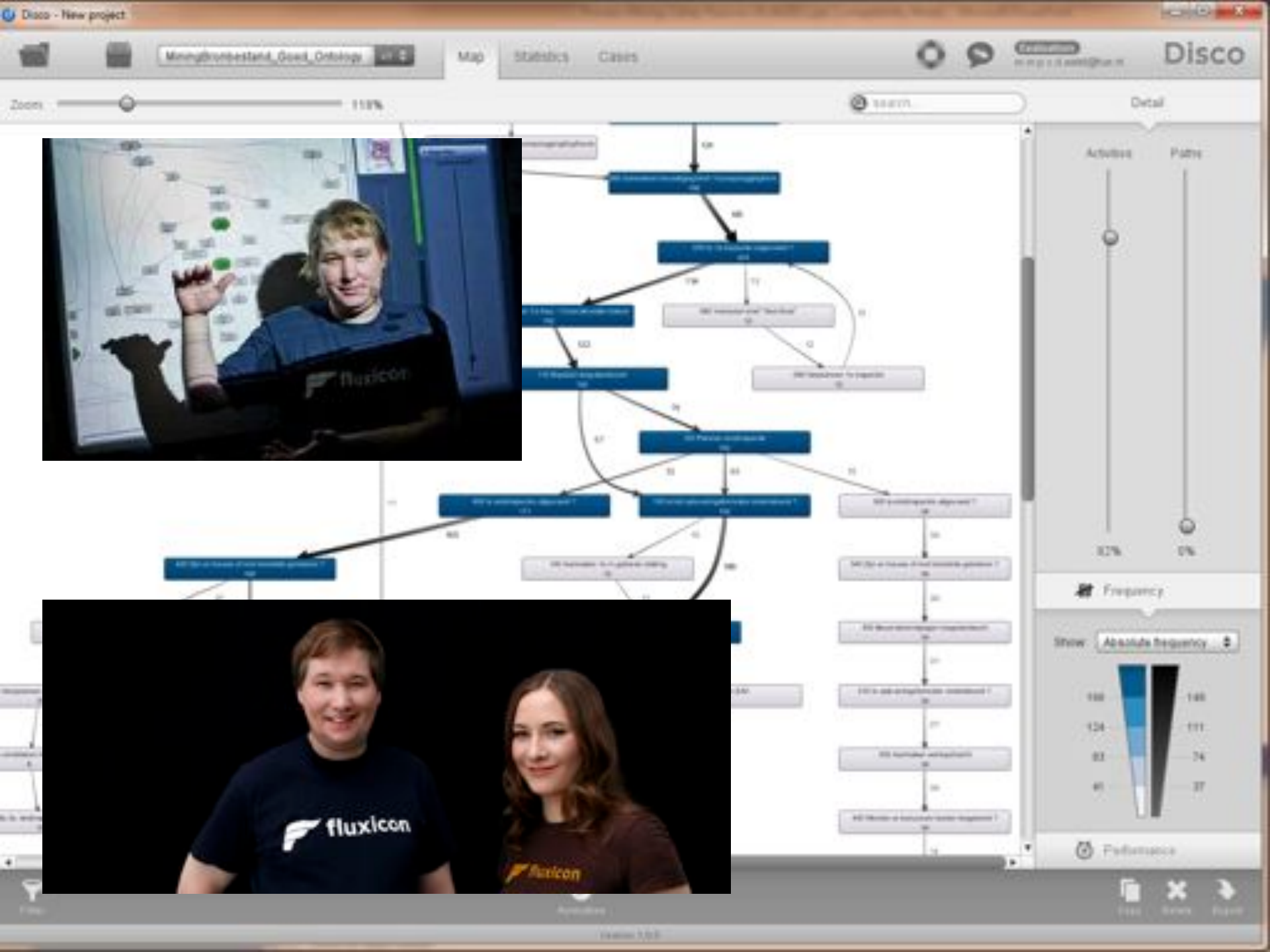
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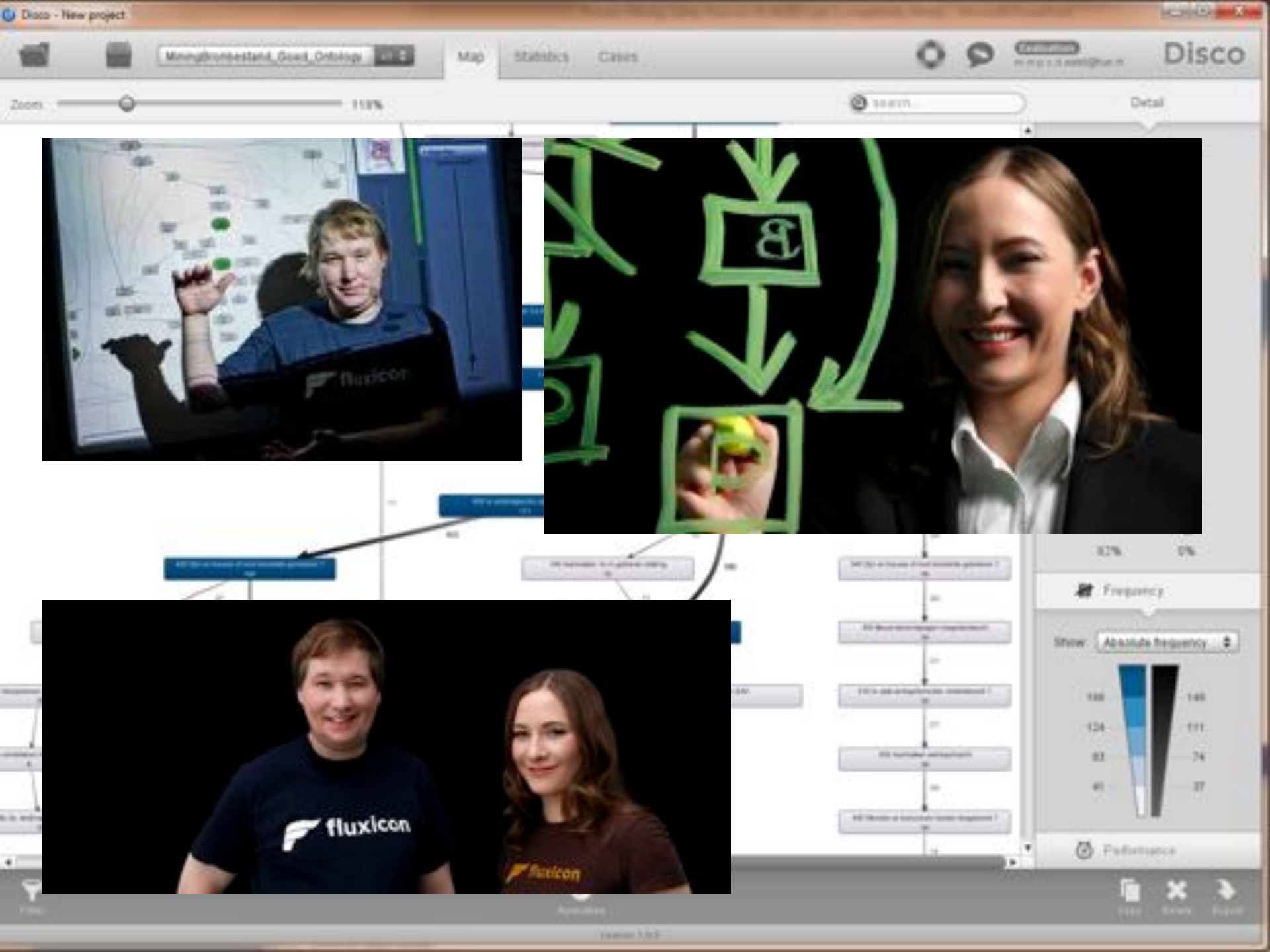

Disco - New project
Map
Statistics
Cases
Disco
Zoom
Detail
fluxicon
Frequency
Show
Absolute frequency
Performance

Vision

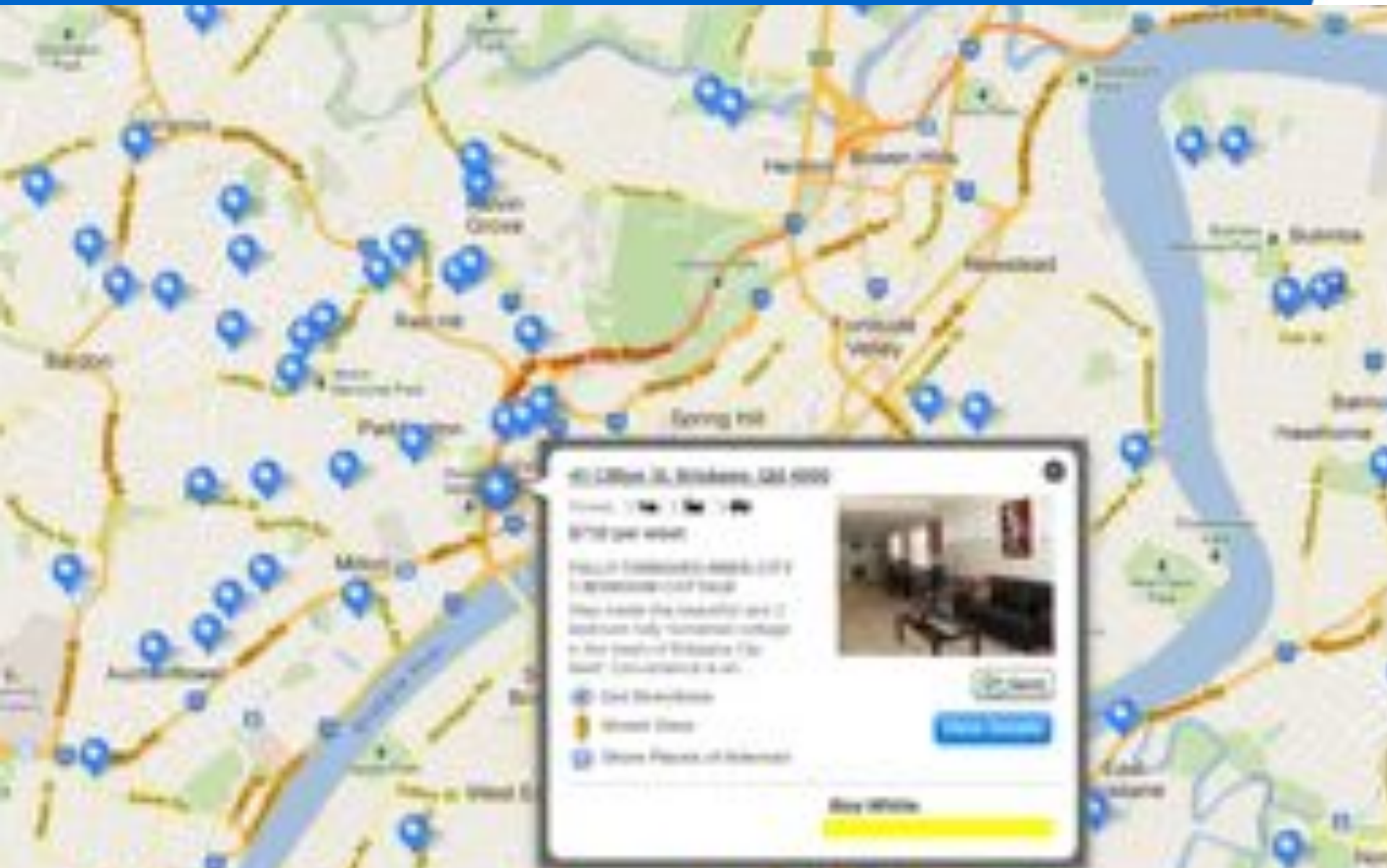
Desire Lines of Cow Paths?


www.olifantenpaadjes.nl
0100110010101010
0100110101010100

Desire Lines: Join Them or Fight Them
(but never ignore them …)

Google Maps and TomTom

Goal: Process Models as Good as Maps



“TomTom” functionality using process mining

Recommend: How to get home ASAP? Take a left turn!

Detect: You drive too fast!

Predict: When will I be home? At 11.26!

Recent and Ongoing Work at TU/e


Mining resource behavior (Joyce Nakatumba et al.)
Decomposing process mining problems (Wil van der Aalst et al.)
Data-aware process mining (Massimiliano de Leoni et al.)
Support for log/ model abstraction (JC Bose et al.)
Auditing (Elham Ramezani, Jan Martijn van der Werf, et al.)
Artifact-centric process mining (ACSI)
Alignments: conformance checking, performance analysis, and evaluating process discovery algorithms (Arya Adriansyah et al.)
Trace alignment (JC Bose et al.)

Genetic tree mining (Joos Buijs et al.)

Concept drift (JC Bose et al.)

Extended heuristics mining (Joel Ribeiro et al.)

Representational bias in process mining (Wil van der Aalst et al.)

Process mining in healthcare (Ronny Mans et al.)

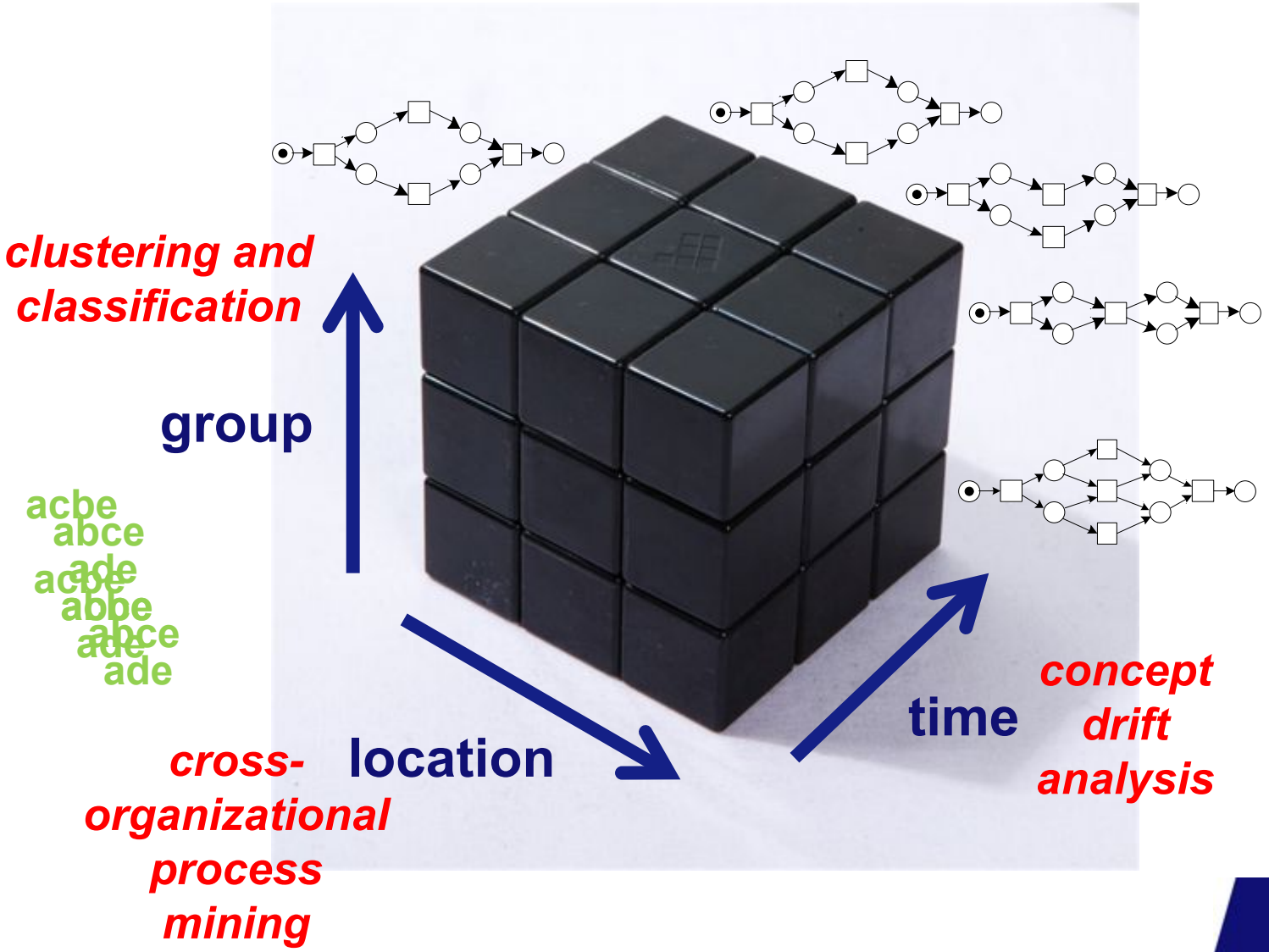
Model simplification and repair (Dirk Fahland et al.)

Cross-organizational process mining (Joos Buijs et al.)

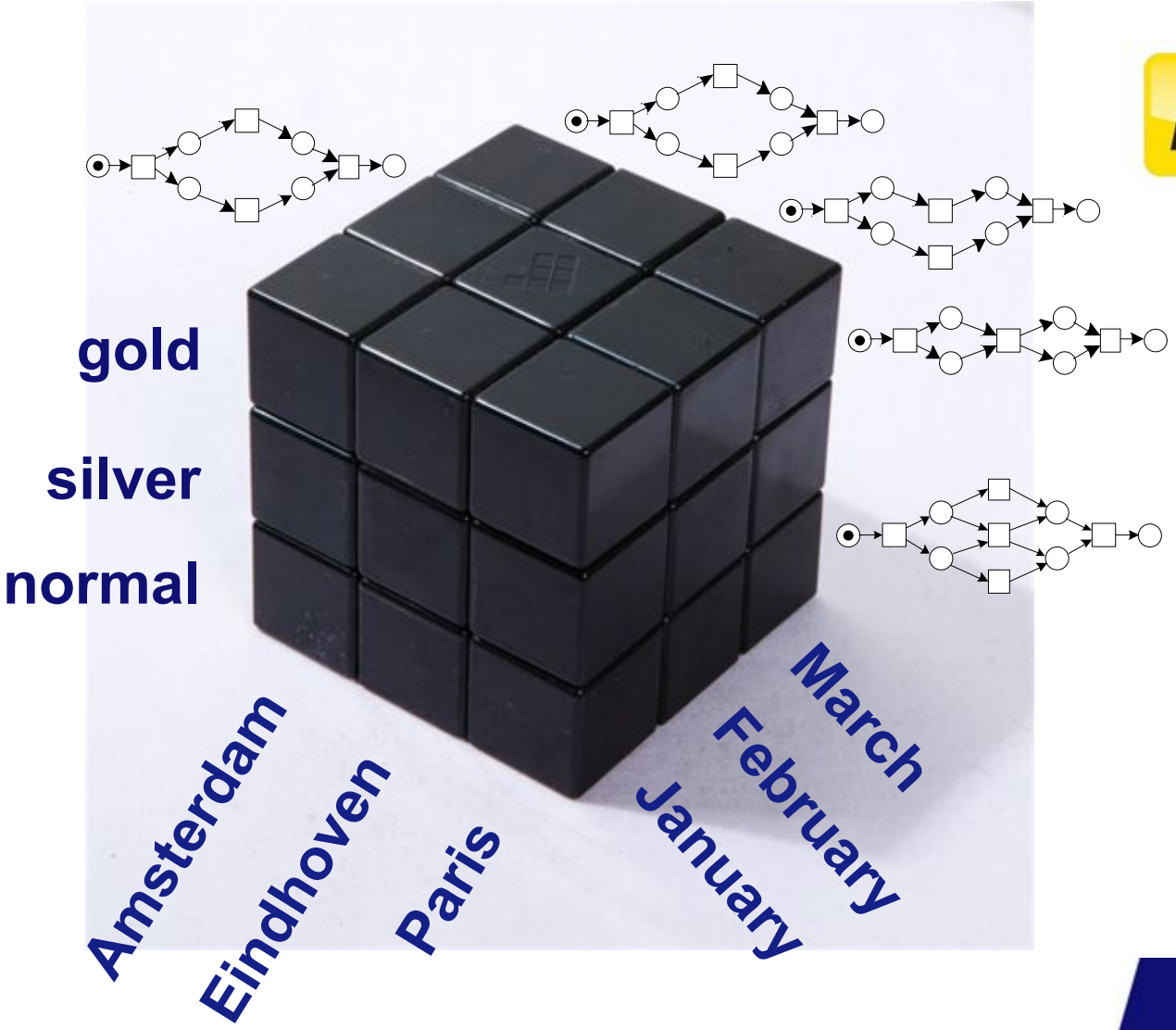
Process mining and visual analytics (Massimiliano de Leoni et al.)

From One to Many

Case Dimensions



Example


gold
silver
normal
Amsterdam
Eindhoven
Paris
January
February
March

Another Example

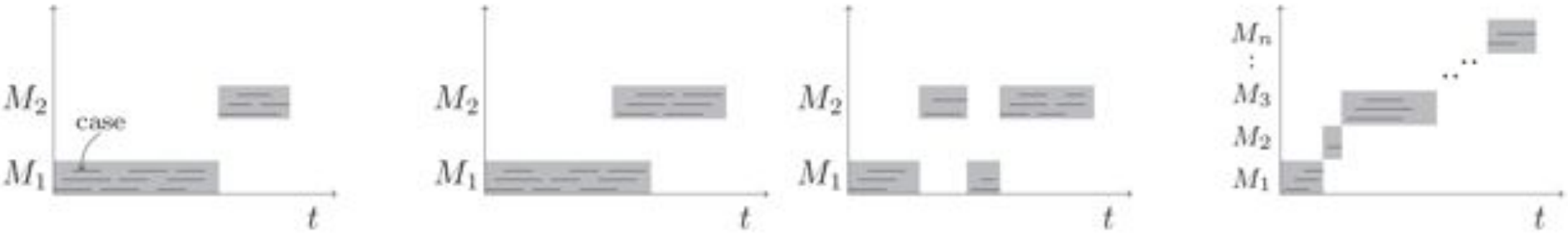
CoSeLoG Deelnemers

Another Example

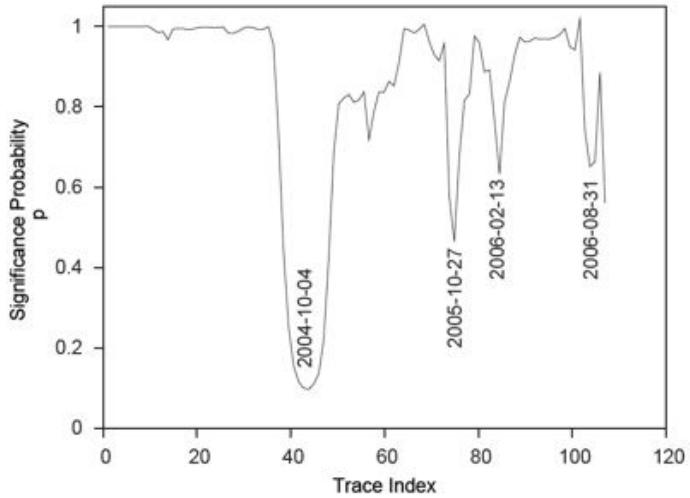
Questions

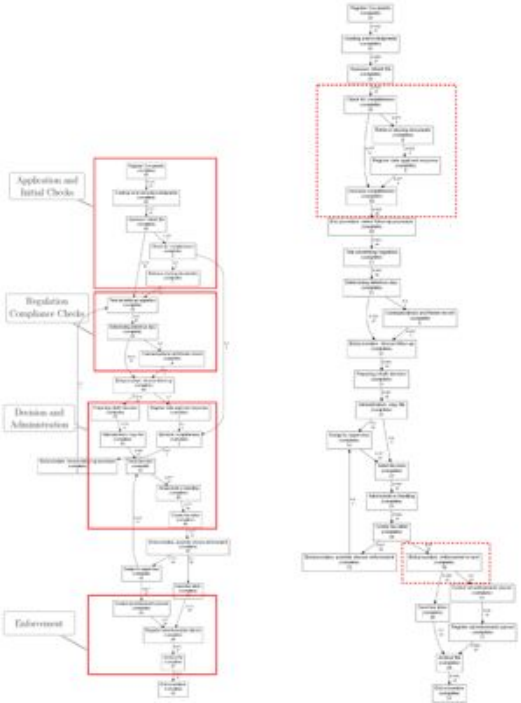
- How to detect changes over time (concept drift)?
- How to localize changes?
- How to discover and model second-order dynamics?
- How to detect process and performance-related differences between locations and groups?
- How to analyze these differences?
- How to discover homogeneous groups of cases?

Concept drift (work of JC Bose)



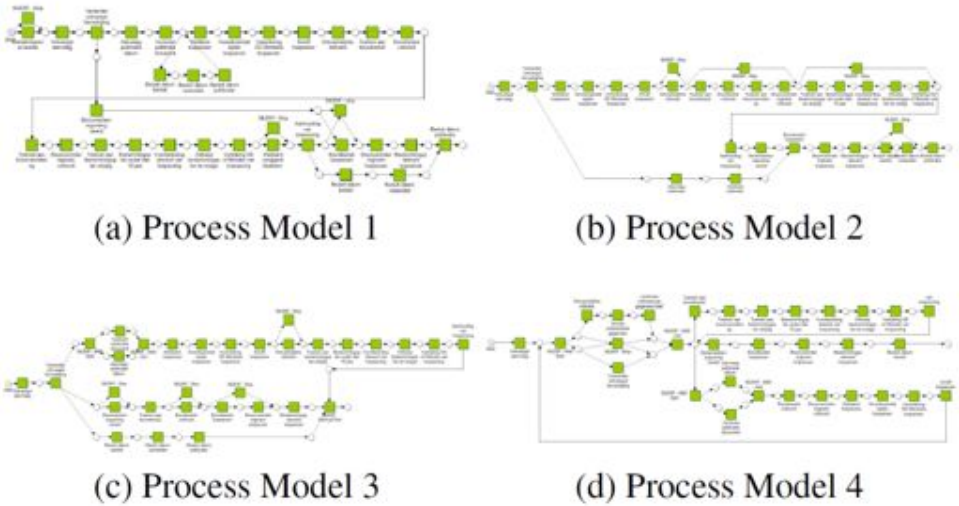
(a) Sudden drift (b) Gradual drift (c) Recurring drift (d) Incremental drift





Cross-organizational mining (work of Joos Buijs)

- 10 muncipalities: Coevorden, Emmen, Hellendoorn,Gemert-Bakel, Zwolle, Bergeijk, Bladel, Eersel, Reusel-De Mierden, and Oirschot.
- 8 processes: Gemeentelijke Basisadministratie Persoonsgegevens (GBA 3x), Melding Openbare Ruimte (MOR), Wet Algemene Bepalingen Omgevingsrecht (WABO 2x), Wet Maatschappelijke Ondersteuning (WMO), and Waardering Onroerende Zaken (WOZ).



	PM 1	PM 2	PM 3	PM 4	Average Throughput Time	C.V.	SLA
Log 1	0.8268 1.0000 0.9487	0.7788 1.0000 0.9915	0.9021 1.0000 0.9740	0.7232 0.9231 0.8735	190d 20h	0.9489	0.2624
Log 2	0.7611 0.9286 0.9662	0.8404 1.0000 0.9943	0.8300 1.0000 0.8990	0.7398 0.9231 0.7968	112d 17h	0.9900	0.4470
Log 3	0.7048 0.8571 0.9799	0.7045 0.9231 0.9929	0.8202 1.0000 0.9415	0.6920 0.8462 0.8882	267d 04h	1.6423	0.2787
Log 4	0.8288 0.8571 0.9718	0.7892 0.9231 0.9467	0.8642 0.9167 0.9047	0.8636 1.0000 0.7748	73d 23h	0.7215	0.8191
Activities	28	26	24	26			
AND split/join	2/3	1/1	2/2	2/2			
XOR split/join	5/4	4/4	4/4	3/4			

Ingredients:
- event logs
- models
- conformance checking
- key performance indicators

Questions:
- How similar?
- Why better?

Split or Forget

Big Data

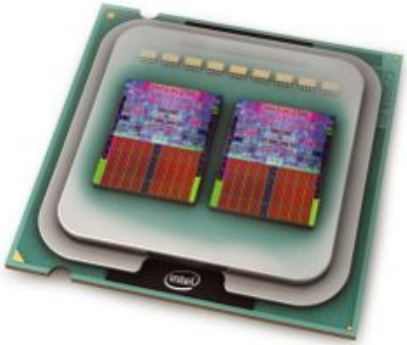
"All of the world's music can be stored on a $600 disk drive."

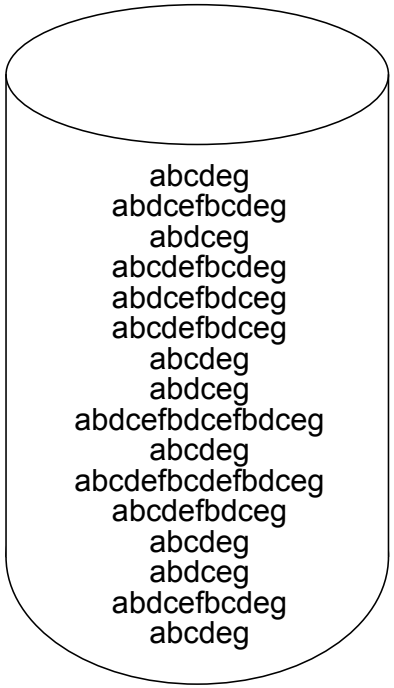
"Enterprises globally stored more than 7 exabytes of new data on disk drives in 2010, while consumers stored more than 6 exabytes of new data on devices such as PCs and notebooks."

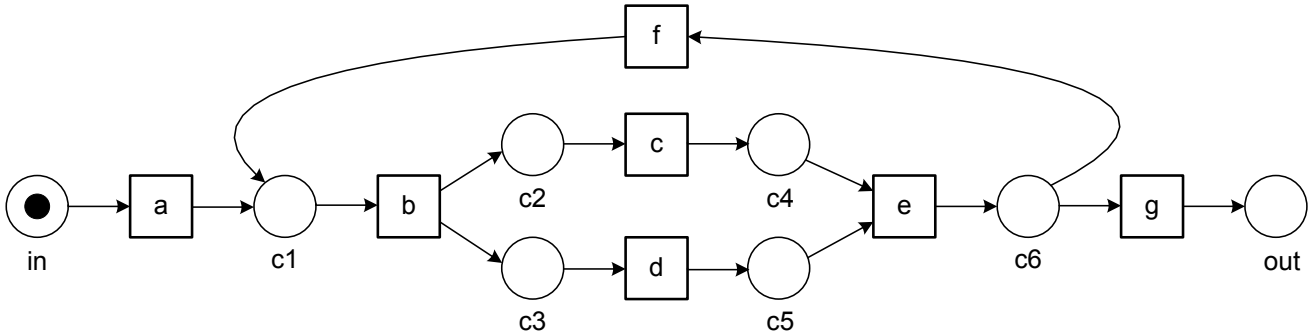
"Indeed, we are generating so much data today that it is physically impossible to store it all. Health care providers, for instance, discard 90 percent of the data that they generate."

Source: "Big Data: The Next Frontier for Innovation, Competition, and Productivity" McKinsey Global Institute, 2011.

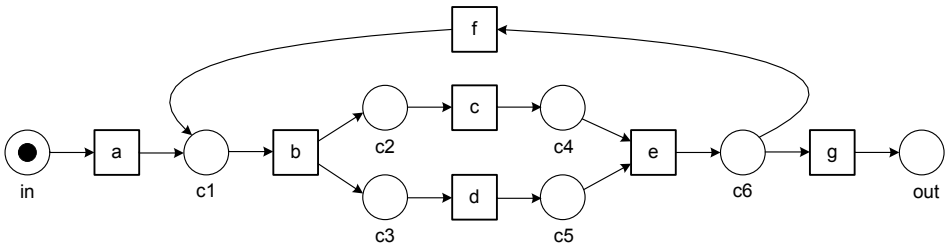
How to distribute process discovery?

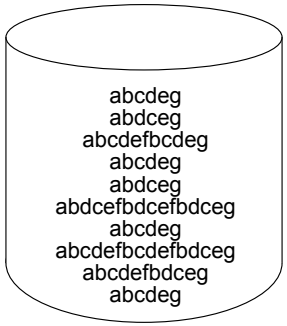


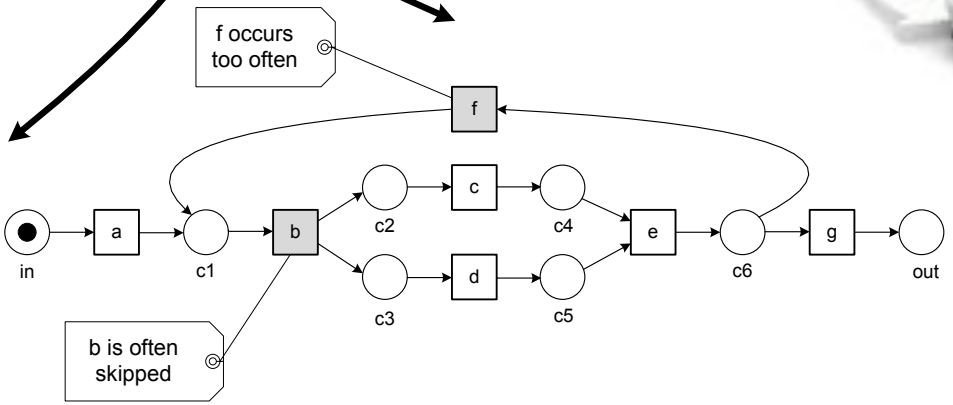




How to distribute conformance checking?

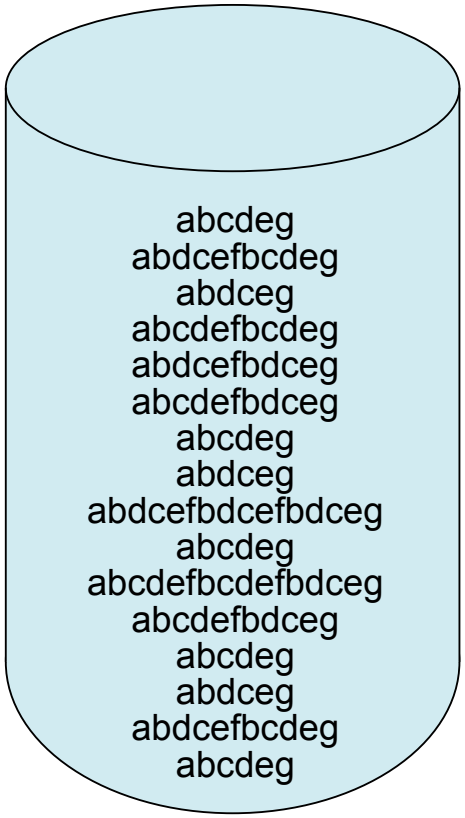


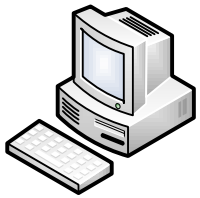


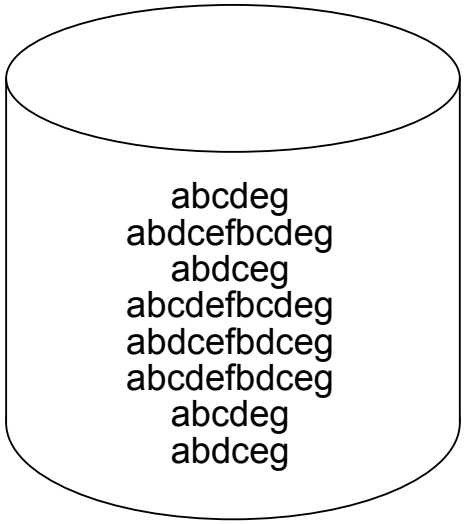


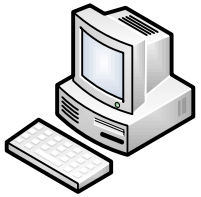
Vertical distribution

sets of cases







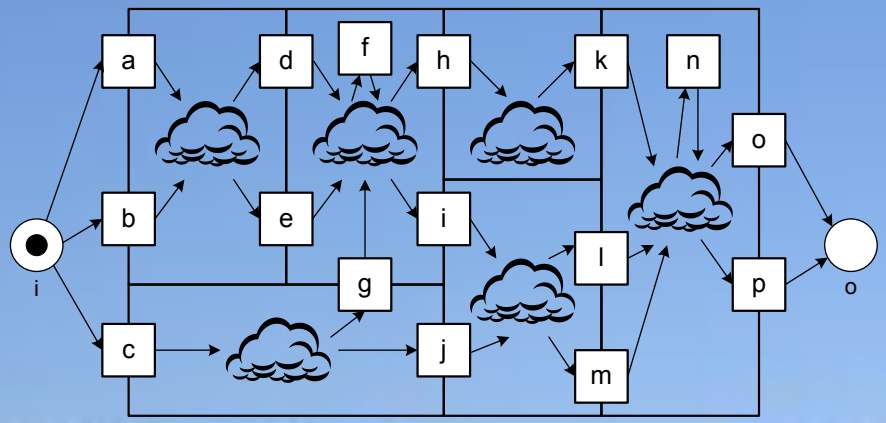


Horizontal distribution

sets of activities

abcdeg	abeg	bcde
abdcefbcdeg	abefbeg	bdcebcde
abdceg	abeg	bdce
abcdefbcdeg	abefbeg	bcdebcde
abdcefbdceg	abefbeg	bdcebdce
abcdefbdceg	abefbeg	bcdebdce
abcdeg	abeg	bcde
abdceg	abeg	bdce
abdcefbdcefbdceg	abefbefbeg	bdcebdcebdce
abcdeg	abeg	bcde
abcdefbcdefbdceg	abefbefbeg	bcdebcdebdce
abcdefbdceg	abefbeg	bcdebdce
abcdeg	abeg	bcde
abdceg	abeg	bdce
abdcefbcdeg	abefbeg	bdcebcde
abcdeg	abeg	bcde

Example: Passages



$$X \overset{G}{\bullet}= Y$$

$$X =\overset{G}{\bullet} Y$$

streaming event data

(sensors, RFID, messages, etc.)

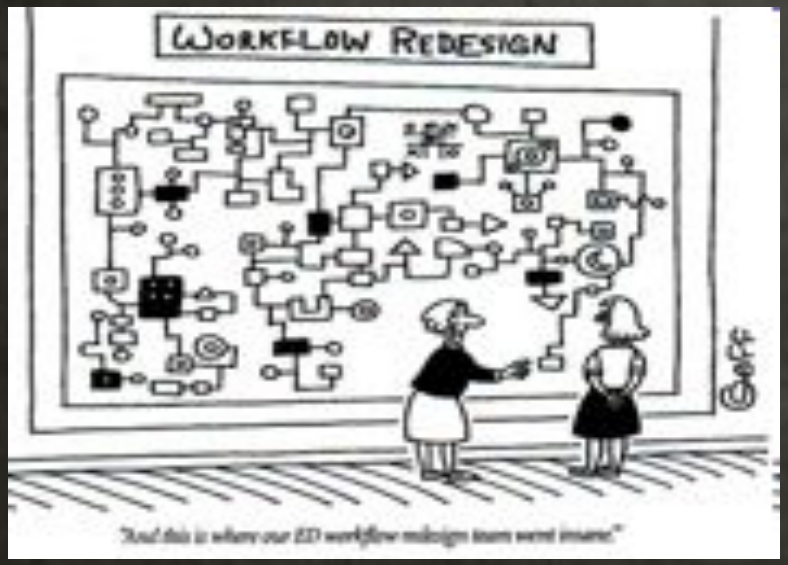
Streaming event data

- sampling (last 1000 events)
- aggregation (profiles)

related to concept drift!

Conclusion

Evidence-Based Business Process Management



REALITY

Worst game ever.

Process Mining Manifesto

A manifesto is a "public declaration of principles and intentions" by a group of people. This manifesto is written by members and supporters of the IEEE Task Force on Process Mining. The goal of this task force is to promote the research, development, education, implementation, evolution, and understanding of process mining.

Process mining is a relatively young research discipline that sits between computational intelligence and data mining on the one hand, and process modeling and analysis on the other hand. The idea of process mining is to discover, monitor and improve real processes (i.e., not assumed processes) by extracting knowledge from event logs readily available in today's (information) systems. Process mining includes (automated) process discovery (i.e., extracting process models from an event log), conformance checking (i.e., monitoring deviations by comparing model and log), social network/organizational mining, automated construction of simulation models, model extension, model repair, case prediction, and history-based recommendations.

Contents:

Process mining techniques are able to extract knowledge from event logs commonly available in today's information systems. These techniques provide new means to discover, monitor, and improve processes in a variety of application domains. There are two main drivers for the growing interest in process mining. On the one hand, more and more events are being recorded, thus, providing detailed information about the history of processes. On the other hand, there is a need to improve and support business processes in competitive and rapidly changing environments. This manifesto is created by the IEEE Task Force on Process Mining and aims to promote the topic of process mining. Moreover, by defining a set of guiding principles and listing important challenges, this manifesto hopes to serve as a guide for software developers, scientists, consultants, business managers, and end-users. The goal is to increase the maturity of process mining as a new tool to improve the (re)design, control, and support of operational business processes.

프로세스 마이닝 매니페스토

매니페스토는 어떤 단체의 "원칙과 목적을 나타낸 성명서"이다. 본 매니페스토는 IEEE Task Force on Process Mining의 회원과 지원자에 의해서 작성되었다. 본 태스크포스의 목표는 프로세스 마이닝에 대한 이해를 돕고, 프로세스 마이닝에 대한 연구 개발, 교육, 실제 적용 및 발전을 촉진하는 것을 목적으로 한다.

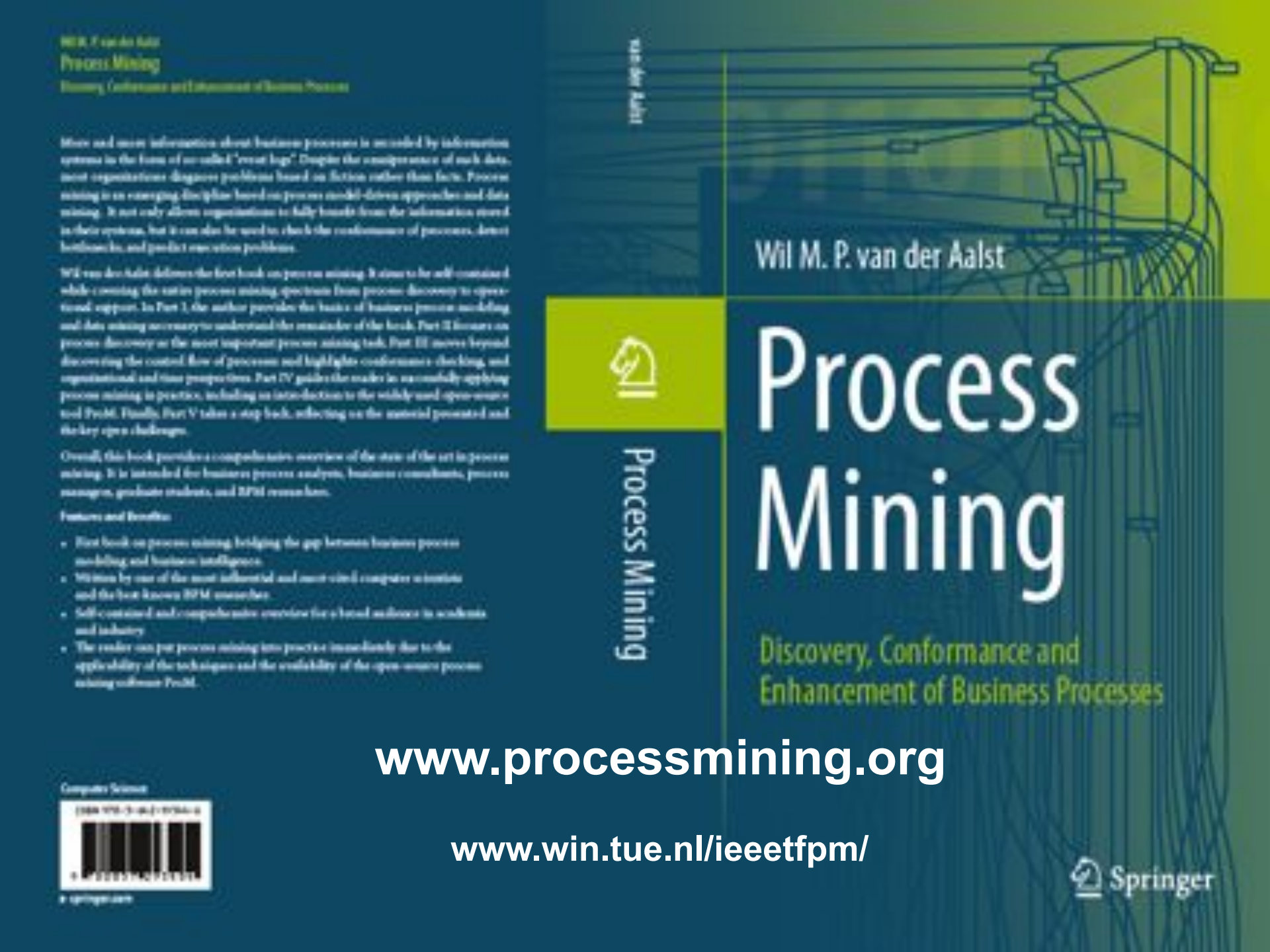
프로세스 마이닝 기술은 정보시스템에서 [illegible] (discovery), 모니터링(monitoring), 개선(improvement) [illegible] 하다. 프로세스 마이닝에 대한 관심은 [illegible] 기술성 측면에서 최근 트렌드를 보면, 정보시스템에서 [illegible] 자세한 정보를 제공하고 있다. 또한 비즈니스 [illegible] 한 요구가 지속적으로 증대하고 있다. 이 두 가지 [illegible] 페스토는 프로세스 마이닝 연구를 활성화하기 [illegible] 로세스 마이닝을 위한 가이드라인의 중요한 [illegible] 가 프로세스 마이닝을 이해하는 데 도움을 주[illegible] 할 수 있는 새로운 도구로서, 프로세스 마이닝

Process Mining Manifest

Ein *Manifest* ist eine "öffentliche Erklärung von Zielen und Absichten", getragen von einer Gruppe von Personen. Das vorliegende Manifest wurde von Mitgliedern und Unterstützern der *IEEE Task Force on Process Mining* verfasst. Das Ziel dieser Task Force ist die Förderung der Forschung, der Entwicklung, der Ausbildung, der Umsetzung, der Fortentwicklung und des Verständnisses rund um Process Mining.

Process Mining ist eine vergl[illegible] junge Wissenschaftsdisziplin, angesiedelt zwischen Compu[illegible] Intelligence und Data Mining [illegible] einen Seite und Prozessmode[illegible] und Analyse auf der anderen [illegible] Grundidee von Process Minin[illegible] *reale Prozesse* (im Gegensat[illegible] vermuteten oder angenomme[illegible] Prozessen) durch *Extrahieren* [illegible] Wissen aus Ereignislogs heut[illegible] (Informations-)systeme zu erk[illegible] überwachen und zu verbesse[illegible] Abbildung 1 skizziert diesen [illegible] Process Mining umfasst das [illegible] (automatische) Erkennen von [illegible] (d.h. die Konstruktion von Prozessmodellen für ein Ereig[illegible] die Übereinstimmungsprüfung [illegible] Überwachung von Abweichu[illegible] durch den Vergleich von Mo[illegible]

Mit Hilfe von Methoden des Process Mining können Einsichten aus Ereig[illegible] vielen Informationssystemen anfallen. Diese Methoden eröffnen neue M[illegible] Anwendungsszenarien zu erkennen, zu überwachen und zu verbessern [illegible] Interesse an Process Mining. Einerseits werden immer mehr Ereignisse i[illegible] Historie eines Prozesses im Detail aufgezeichnet. Andererseits besteht d[illegible] Wettbewerbsdynamik zu verbessern und zu unterstützen. Dieses Manif[illegible] verfasst. Es zielt darauf ab, den Bekanntheitsgrad von Process Mining z[illegible] Leitprinzipien und Herausforderungen als Anregung für Forscher, Entwi[illegible] Das Ziel ist dabei die Anwendbarkeit von Process Mining als Werkzeug [illegible] unterstützung weiter zu verbessern.



www.processmining.org

www.win.tue.nl/ieeetfpm/

Pointers to Recent Work (1/8)

General

- W.M.P. van der Aalst. *Process Mining: Discovery, Conformance and Enhancement of Business Processes*. Springer-Verlag, Berlin, 2011.
- IEEE Task Force on Process Mining. Process Mining Manifesto. In F. Daniel, K. Barkaoui, and S. Dustdar, editors, *Business Process Management Workshops*, volume 99 of *Lecture Notes in Business Information Processing*, pages 169-194. Springer-Verlag, Berlin, 2012.

Alignments: conformance checking, performance analysis, and evaluating process discovery algorithms (Arya Adriansyah et al.)

- W.M.P. van der Aalst, A. Adriansyah, and B. van Dongen. Replaying History on Process Models for Conformance Checking and Performance Analysis. *WIREs Data Mining and Knowledge Discovery*, 2(2):182-192, 2012.
- Adriansyah, B. van Dongen, and W.M.P. van der Aalst. Conformance Checking using Cost-Based Fitness Analysis. In C.H. Chi and P. Johnson, editors, *IEEE International Enterprise Computing Conference (EDOC 2011)*, pages 55-64. IEEE Computer Society, 2011.
- Adriansyah, B.F. van Dongen, W.M.P. van der Aalst. Cost-Based Conformance Checking using the A* Algorithm. In BPM Center Report BPM-11-11, BPMcenter.org, 2011.
- A. Adriansyah, J. Munoz-Gama, J. Carmona, B.F. van Dongen, W.M.P. van der Aalst. Alignment Based Precision Checking. BPM Center Report BPM-12-10, BPMcenter.org, 2012

Pointers to Recent Work (2/8)

Auditing (Elham Ramezani, Jan Martijn van der Werf, et al.)

- **W.M.P. van der Aalst, K.M. van Hee, J.M. van der Werf, and M. Verdonk. Auditing 2.0: Using Process Mining to Support Tomorrow's Auditor. IEEE Computer, 43(3):90-93, 2010.**
- **E. Ramezani, D. Fahland W.M.P. van der Aalst. Where Did I Misbehave? Diagnostic Information in Compliance Checking. . In *Business Process Management (BPM 2012)*, *Lecture Notes in Computer Science*. Springer-Verlag, Berlin, 2012.**
- **J.M. van der Werf, E. Verbeek, and W.M.P. van der Aalst, Context-Aware Compliance Checking. In *Business Process Management (BPM 2012)*, *Lecture Notes in Computer Science*. Springer-Verlag, Berlin, 2012.**

Trace alignment (JC Bose et al.)

- **R.P. Jagadeesh Chandra Bose and W.M.P. van der Aalst. Process Diagnostics Using Trace Alignment: Opportunities, Issues, and Challenges. *Information Systems*, 37(2):117-141, 2012.**

Mining resource behavior (Joyce Nakatumba et al.)

- **J. Nakatumba and W.M.P. van der Aalst. Analyzing Resource Behaviour Using Process Mining 5th Workshop on Business Process Intelligence (BPI' 09) 2009.**

Pointers to Recent Work (3/8)

Decomposing process mining problems (Wil van der Aalst et al.)

- W.M.P. van der Aalst. Decomposing Process Mining Problems Using Passages. In S. Haddad and L. Pomello, editors, *Applications and Theory of Petri Nets 2012*, volume 7347 of *Lecture Notes in Computer Science*, pages 72-91. Springer-Verlag, Berlin, 2012.
- W.M.P. van der Aalst. Distributed Process Discovery and Conformance Checking. In J. de Lara and A. Zisman, editors, International Conference on Fundamental Approaches to Software Engineering (FASE 2012), volume 7212 of Lecture Notes in Computer Science, pages 1-25. Springer-Verlag, Berlin, 2012.
- C. Bratosin, N. Sidorova, and W.M.P. van der Aalst. Distributed Genetic Process Mining Using Sampling. In V. Malyshkin, editor, *Parallel Computing Technologies (PaCT 2011)*, volume 6873 of *Lecture Notes in Computer Science*, pages 224-237. Springer-Verlag, Berlin, 2011.

Operational support (prediction and recommendation) (Michael Westergaard et al.)

- W.M.P. van der Aalst, M. Pesic, and M. Song. Beyond Process Mining: From the Past to Present and Future. In B. Pernici, editor, *CAiSE'10*, volume 6051 of *Lecture Notes in Computer Science*, pages 38-52. Springer-Verlag, Berlin, 2010.
- J. Nakatumba, M. Westergaard, and W. M. P. van der Aalst, “Testing Algorithms for Operational Support Using Colored Petri Nets,” in Proc. of Petri Nets, 2012.
- F. M. Maggi, M. Westergaard, M. Montali, and W. M. P. van der Aalst, “Runtime Verification of LTL-Based Declarative Process Models,” in Proc. of RV, 2011.
- W.M.P. van der Aalst, M.H. Schonenberg, and M. Song. Time Prediction Based on Process Mining. Information Systems, 36(2):450-475, 2011.

Pointers to Recent Work (4/8)

Discovery and conformance checking of declarative models (Fabrizio Maggi et al.)

- F.M. Maggi, R.P. Jagadeesh Chandra Bose, and W.M.P. van der Aalst. Efficient Discovery of Understandable Declarative Process Models from Event Logs. In *Caise 2012*, *Lecture Notes in Computer Science*, Springer-Verlag, Berlin, 2012.
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