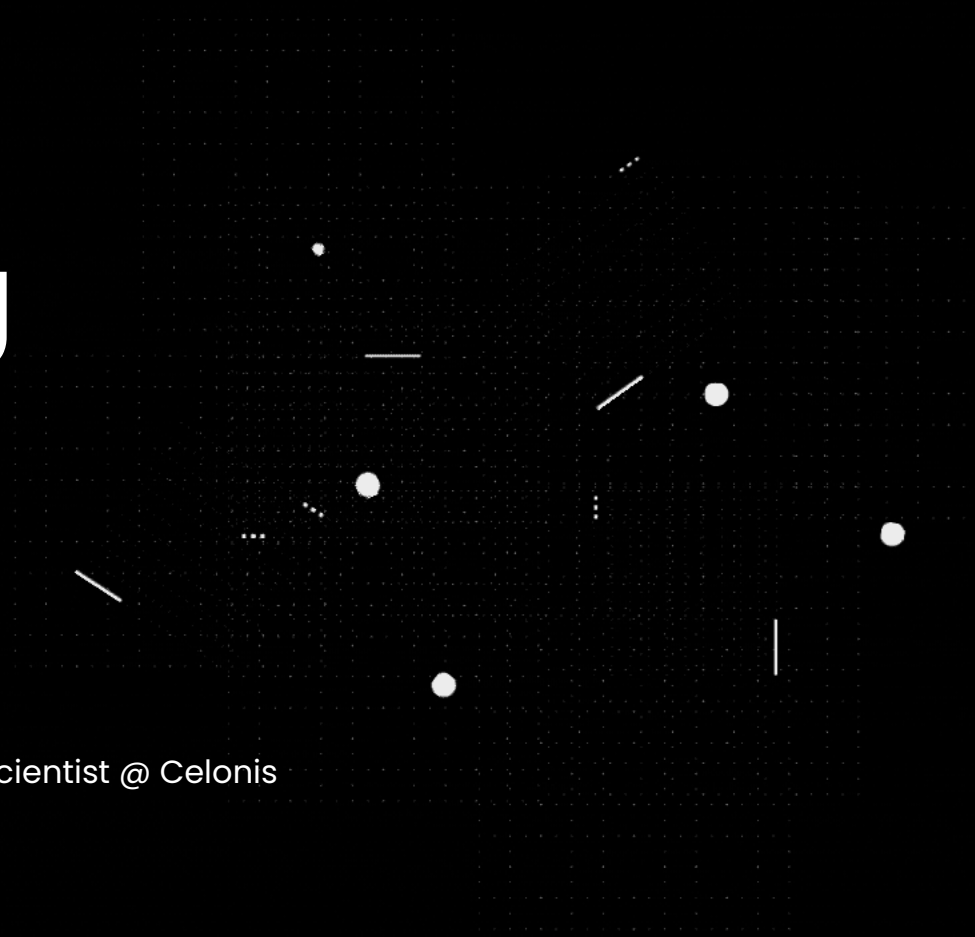# Process Mining What? How?

Wil van der Aalst, Professor @ RWTH Aachen and Chief Scientist @ Celonis

PADS Chair of Process and Data Science

RWTHAACHEN UNIVERSITY

Process Mining

- Any organization has processes, data, and often also many process-related problems (rework, delays, lost cases, lack of transparency, lack of responsiveness, compliance problems, etc.).
- Process mining is the technology to connect data and processes and address performance and compliance problems.
- Many of the larger organizations are already using process mining. It is a proven technology, but less visible in the media.
- PADS @ RWTH Aachen University is the leading research institute in this area.
- Celonis is the leading software vendor and opened an office in Aachen to be closer to RWTH. (Note that SAP, Microsoft, IBM, etc. all started to support process mining).
- Process mining is the enabler of AI and ML in organizations.
- Given challenges such as the aging society and bureaucracy, it is essential to improve and streamline processes. However, what you cannot see, you cannot improve!

Often, we only realize there is a process when things go wrong …

I applied for a new
identity card
weeks ago but did
not get a response.

I applied for this master's program, but my application got lost.

DALL·E3's take on university processes

We promised to start treating patients within two weeks after the first diagnosis, but they often need to wait for months. How can we provide a better care?
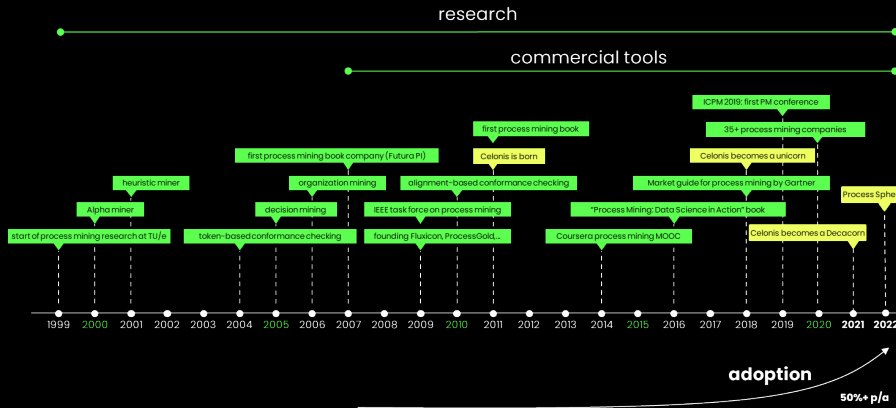

DALL·E3's take on healthcare processes

Which suppliers are causing delays and quality problems?

How to address these performance and compliance problems?

How did I get the idea 25 years ago?

research

commercial tools

ICPM 2019: first PM conference

35+ process mining companies

first process mining book

first process mining book company (Futura PI)

Celonis is born

Celonis becomes a unicorn

heuristic miner

organization mining

alignment-based conformance checking

Market guide for process mining by Gartner

Process Sphere

Alpha miner

decision mining

IEEE task force on process mining

"Process Mining: Data Science in Action" book

start of process mining research at TU/e

token-based conformance checking

founding Fluxicon, ProcessGold...

Coursera process mining MOOC

Celonis becomes a Decacorn

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 **2021 2022**

adoption

50%+ p/a

DIGITAL BULLETIN

Issue 34 | Nov '21

DevOps DEBATE
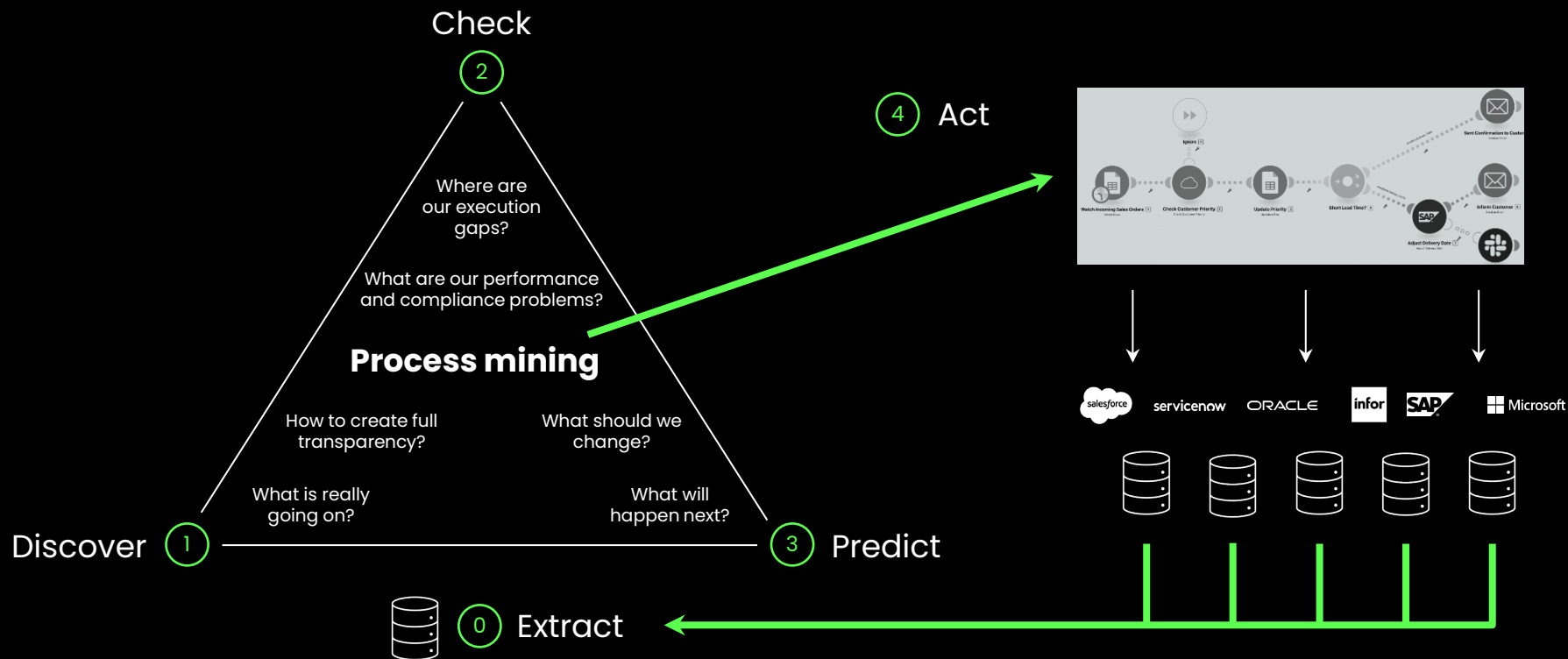Industry experts on how companies can instill a DevOps culture

BRIDGING THE GAP
Analysing IBM's plans to skill 30m people by 2030

THE GODFATHER

The creator of process mining, Professor Wil van der Aalst, on joining Celonis as Chief Scientist and why the technology has only fulfilled a fraction of its potential

High-level view of process mining

Check

②

④ Act

Where are
our execution
gaps?

What are our performance
and compliance problems?

Process mining

How to create full
transparency?

What should we
change?

What is really
going on?

What will
happen next?

Discover ① ③ Predict

⓪ Extract

salesforce   servicenow   ORACLE   infor   SAP   Microsoft

It all starts with event data

Case ID	Activity	Resource	Timestamp	Product	Prod-price	Quantity	Address
...	...	....	...	...		...	...
6350	place order	Aiden	2018/02/13 14:29:45.000	APPLE iPhone 6 16 GB	639,00 €	5	NL-7751DG-21
6283	pay	Lily	2018/02/13 14:39:25.000	SAMSUNG Galaxy S6 32 GB	543.99 €	3	NL-7828AM-11a
6253	prepare delivery	Sophia	2018/02/13 15:01:33.000	APPLE iPhone 6 16 GB	639,00 €	3	NL-7887AC-13
6257	prepare delivery	Aiden	2018/02/13 15:03:43.000	SAMSUNG Galaxy S6 32 GB	543.99 €	1	NL-9521KJ-34
6185	confirm payment	Emily	2018/02/13 15:05:36.000	SAMSUNG Galaxy S4	329,00 €	1	NL-9521GC-32
6218	confirm payment	Emily	2018/02/13 15:08:11.000	APPLE iPhone 6s Plus 64 GB	969,00 €	2	NL-7948BX-10
6245	make delivery	Michael	2018/02/13 15:14:04.000	APPLE iPhone 6 16 GB	639,00 €	3	NL-7905AX-38
6272	pay	Emily	2018/02/13 15:20:36.000	APPLE iPhone 6 16 GB	639,00 €	1	NL-7821AC-3
6269	pay	Charlotte	2018/02/13 15:25:21.000	SAMSUNG Galaxy S4	329,00 €	1	NL-7907EJ-42
6212	prepare delivery	Sophia	2018/02/13 15:43:39.000	HUAWEI P8 Lite	234,00 €	1	NL-7905AX-38
6323	send invoice	Alexander	2018/02/13 15:46:08.000	APPLE iPhone 6 16 GB	639,00 €	1	NL-7833HT-15
6246	confirm payment	Jack	2018/02/13 15:56:03.000	SAMSUNG Galaxy S4	329,00 €	3	NL-7833HT-15
6347	send invoice	Jack	2018/02/13 15:57:42.000	SAMSUNG Galaxy S4	329,00 €	3	NL-7905AX-38
6351	place order	Zoe	2018/02/13 16:17:37.000	APPLE iPhone 5s 16 GB	449,00 €	3	NL-9521GC-32
6204	prepare delivery	Sophia	2018/02/13 16:31:28.000	SAMSUNG Core Prime G361	135,00 €	1	NL-7828AM-11a
6204	make delivery	Kaylee	2018/02/13 16:51:54.000	SAMSUNG Core Prime G361	135,00 €	1	NL-7828AM-11a
6265	confirm payment	Lily	2018/02/13 16:55:55.000	SAMSUNG Galaxy S4	329,00 €	4	NL-9521GC-32
6250	confirm payment	Jack	2018/02/13 17:03:26.000	MOTOROLA Moto G	199,00 €	4	NL-7942GT-2
6328	send invoice	Lily	2018/02/13 17:30:16.000	APPLE iPhone 6s 64 GB	858,00 €	4	NL-9514BV-16
6352	place order	Aiden	2018/02/13 17:53:22.000	APPLE iPhone 6 16 GB	639,00 €	2	NL-9514BV-16
6317	send invoice	Jack	2018/02/13 18:45:30.000	APPLE iPhone 6s 64 GB	858,00 €	5	NL-7907EJ-42
6353	place order	Sophia	2018/02/13 20:16:20.000	APPLE iPhone 5s 16 GB	449,00 €	4	NL-7751AR-19
...	...	....	...	...	...	...	...

It all starts with event data

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6353	place order	Sophia	2018/02/13 20:16:20.000	APPLE iPhone 5s 16 GB	449,00 €	4	NL-7751AR-19
...	...	...	...	...	...		

**event =
case +
activity +
timestamp +**

...

Actual processes are very different from what stakeholders think !
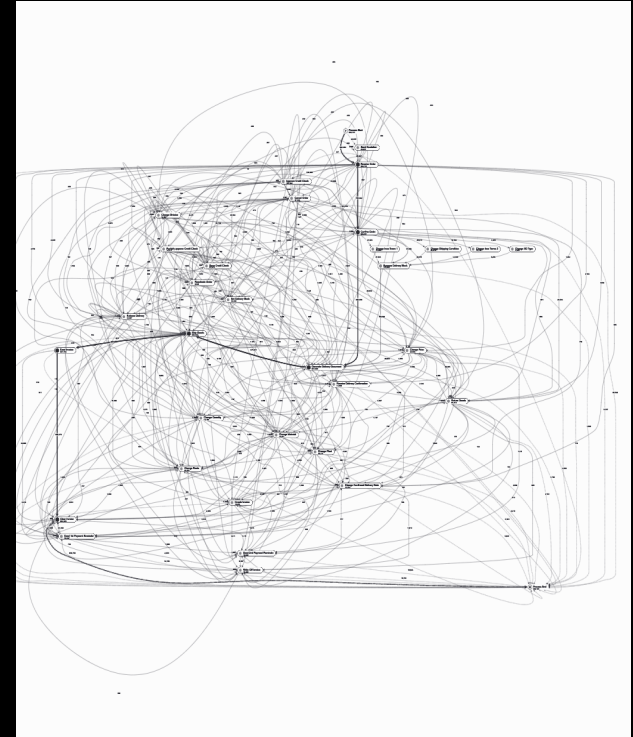
Happy path
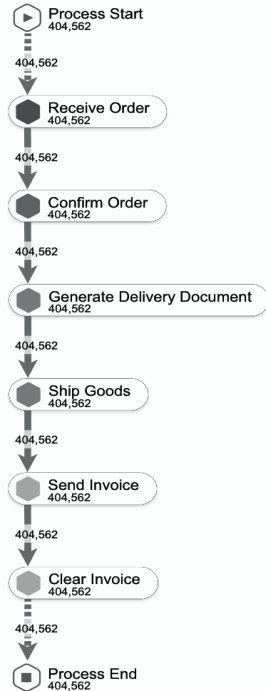
Expected paths
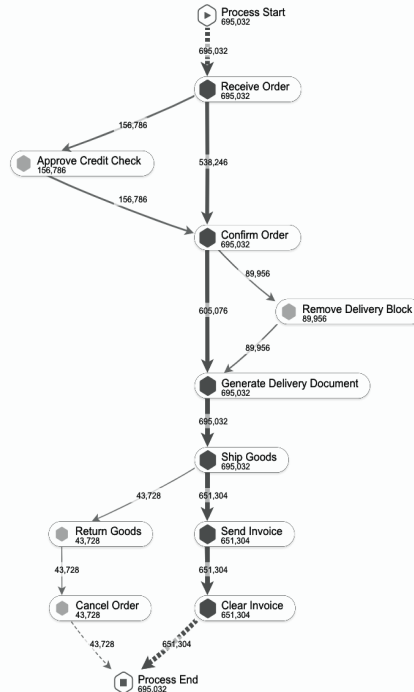
Reality

This is what we expect ...

traces

This is what we find ...

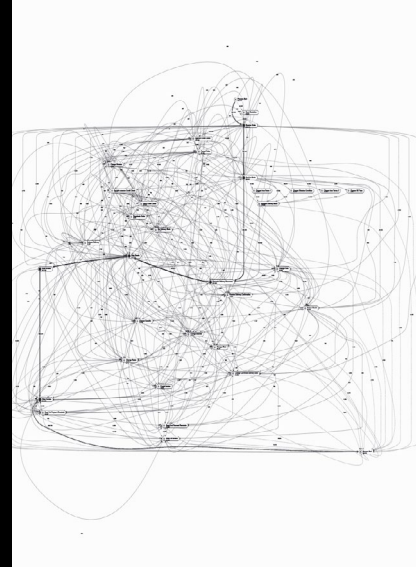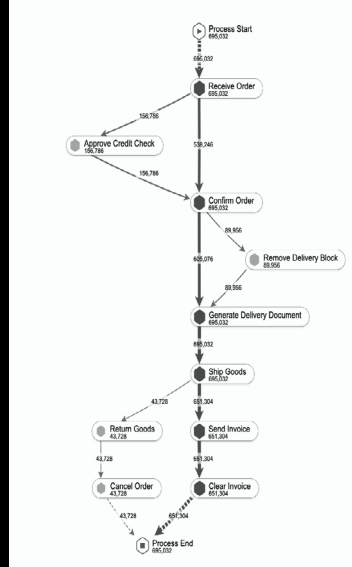Understanding this is the key to process improvement!

80/20 rule

80% of cases

20% of variants

20% of inefficiencies

20% of compliance problems

100% of cases

100% of variants

100% of inefficiencies

100% of compliance problems

Discover > Check > Predict > Act

Based on our research there are now over 50 providers of process mining software and it is considered a new product category already applied by half of the Fortune 500 companies

Celonis: Germany's only Decacorn
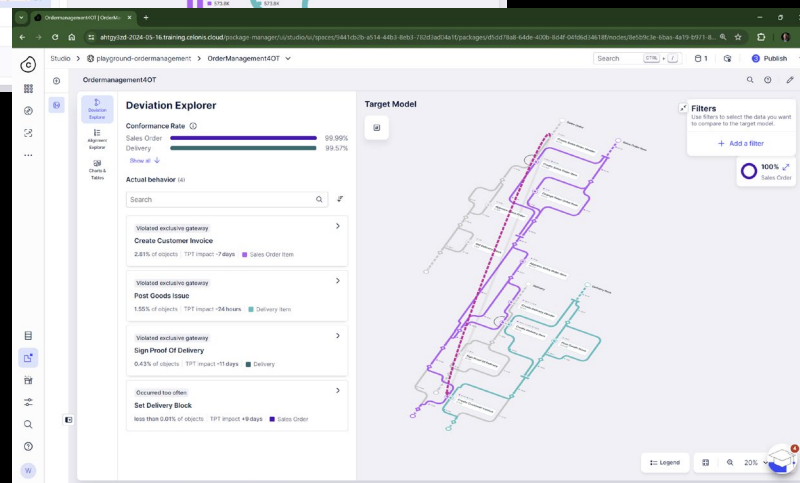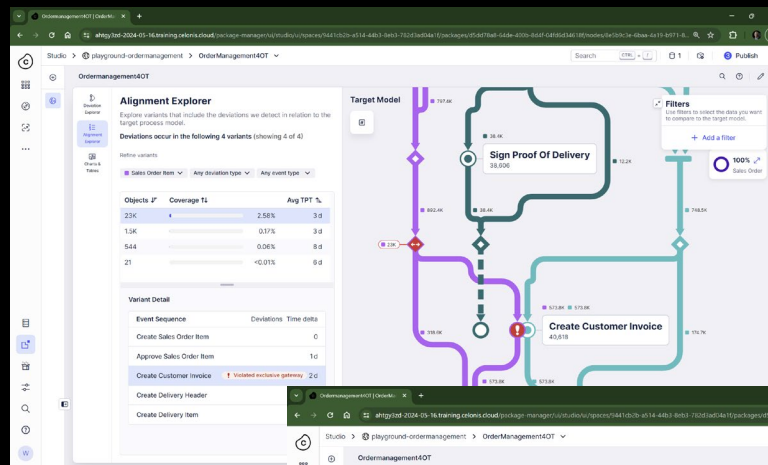
Any organization, any operational process, …

Technology

Qualcomm · IBM · servicenow · Uber · workday · CISCO · INGRAM · NOKIA · splunk> · salesforce · DELL · Tech Data

Financial Services & Insurance

citi · FARMERS INSURANCE · Deutsche Bank · ING · WELLS FARGO · THE HARTFORD · PostFinance · RHV · HomeEquity Bank

Life Sciences & Chemicals

lyondellbasell · SI Group · Chemours · Solenis · ASCEND · NOVARTIS · HEXION · AstraZeneca · FRESENIUS KABI · BAYER · Roche · AMGEN · gsk · DÖHLER · DOW · AkzoNobel

Consumer & Retail

The Coca-Cola Company · L'ORÉAL · Keurig DrPepper · Johnson&Johnson · Unilever · Kellogg's · MARS · CAMPARI · Kimberly-Clark · ABInBev · reckitt

Manufacturing

SIEMENS · molex · 3M · AIRBUS · VW · Whirlpool · Honeywell · ABB · sysmex · RATIONAL · BMI · BOSCH · GE · ZEISS · JOHN DEERE · LOCKHEED MARTIN

Telecommunications & Media

vodafone · VIACOMCBS · COMCAST · T·· · 1&1 · Telefónica · orange · MOTOROLA SOLUTIONS · Telia

Energy & Utilities

Statkraft · WIEN ENERGIE · enel · GENERAC · REWAG · EQUANS · uniper · EnBW · SaskPower Powering the future · e·on

Oil & Gas

ExxonMobil · Schlumberger · PHILLIPS 66 · cenovus · bp · andeavor · CHART · MOL · Canadian Natural · NESTE · REPSOL

Why do flights get delayed?
Where is my suitcase?
Etc.

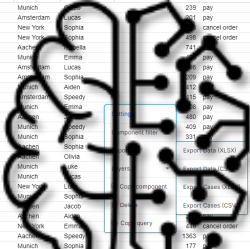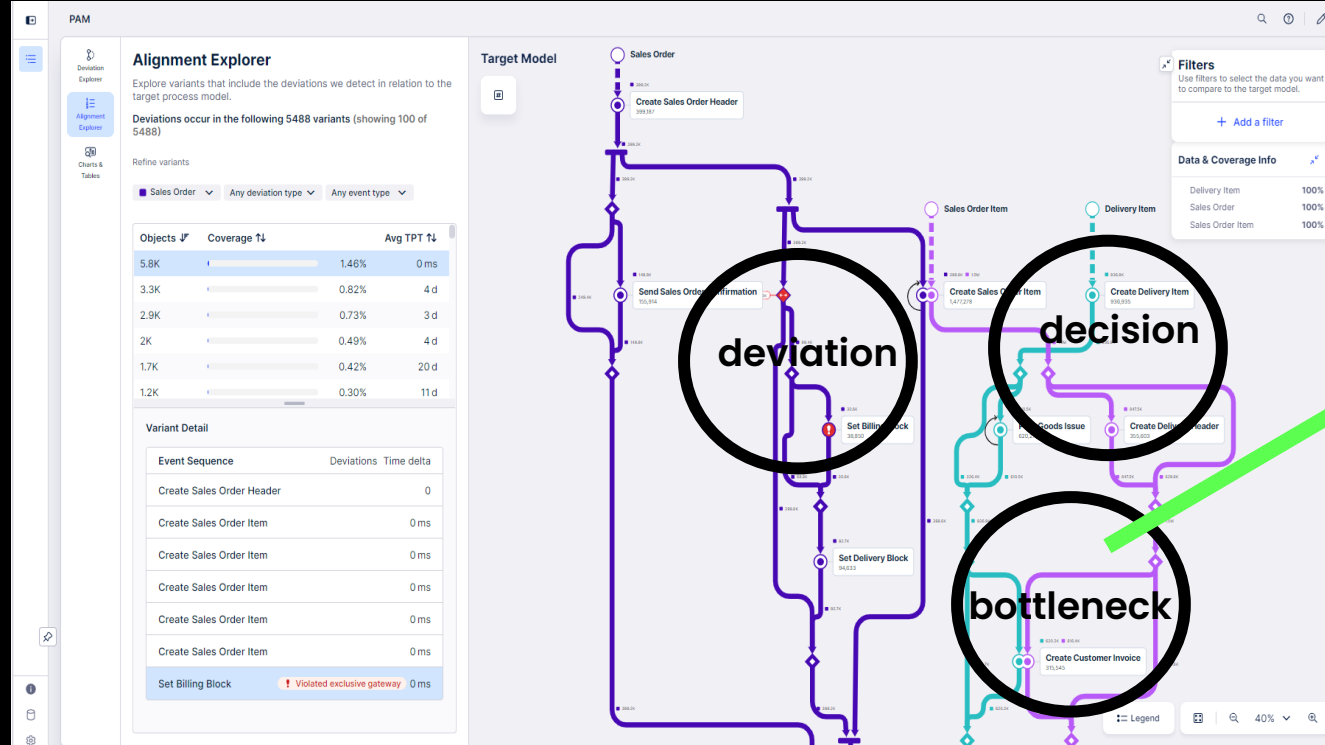# Process Mining Provides the Lens to Apply ML
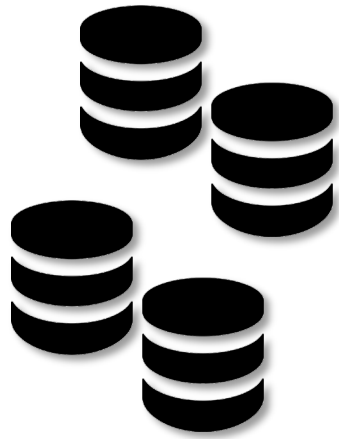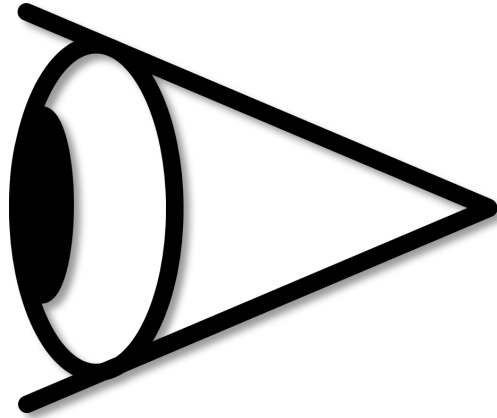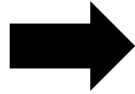
complex reality   event data and process models   machine learning
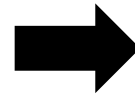
Process Mining Provides the Lens to Apply ML

- What is causing the bottleneck?
- Which orders are deviating?
- When will this product be delivered?
- Will we meet our SLA tomorrow?

How to get started?

- Select a process that has **process-related problems** (e.g., rework, delays, lost cases, lack of transparency, lack of responsiveness, compliance problems, etc.) such that you have **data** related to the key events in the process.

- Per events, you should have a **timestamp** (when did it happen, e.g., a date), an **activity name** (what happened, e.g., receive payment), and a case identifier (the "thing" that is processed, e.g., an application number).

- This is the **minimal information** needed, but more information is welcome (e.g., information related to resources or costs).

- After creating **transparency** by discovering the real process, the other process mining activities are enabled, e.g., root-cause analysis for the problems, suggestions for improvement, etc.

- It is important to have **support** from higher management. You will find problems and improvement opportunities. However, turning **data into insights** and **insights into actions** requires a willingness to improve things.

Mine your own business!

How process mining improves the things you do not see

- Process mining can be applied to any process
- It is affecting you every day and helps to make processes better (faster, more efficient, more sustainable, etc.)
- Very different from mainstream ML (but serves as an enabler for classic forms of ML)
- Unique example of transfer from university research to large-scale industrial application