

Continuous Process Improvement With Process Mining and Digital Process Twins

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UNIVERSITY OF TARTU



apromore

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Meet Tom



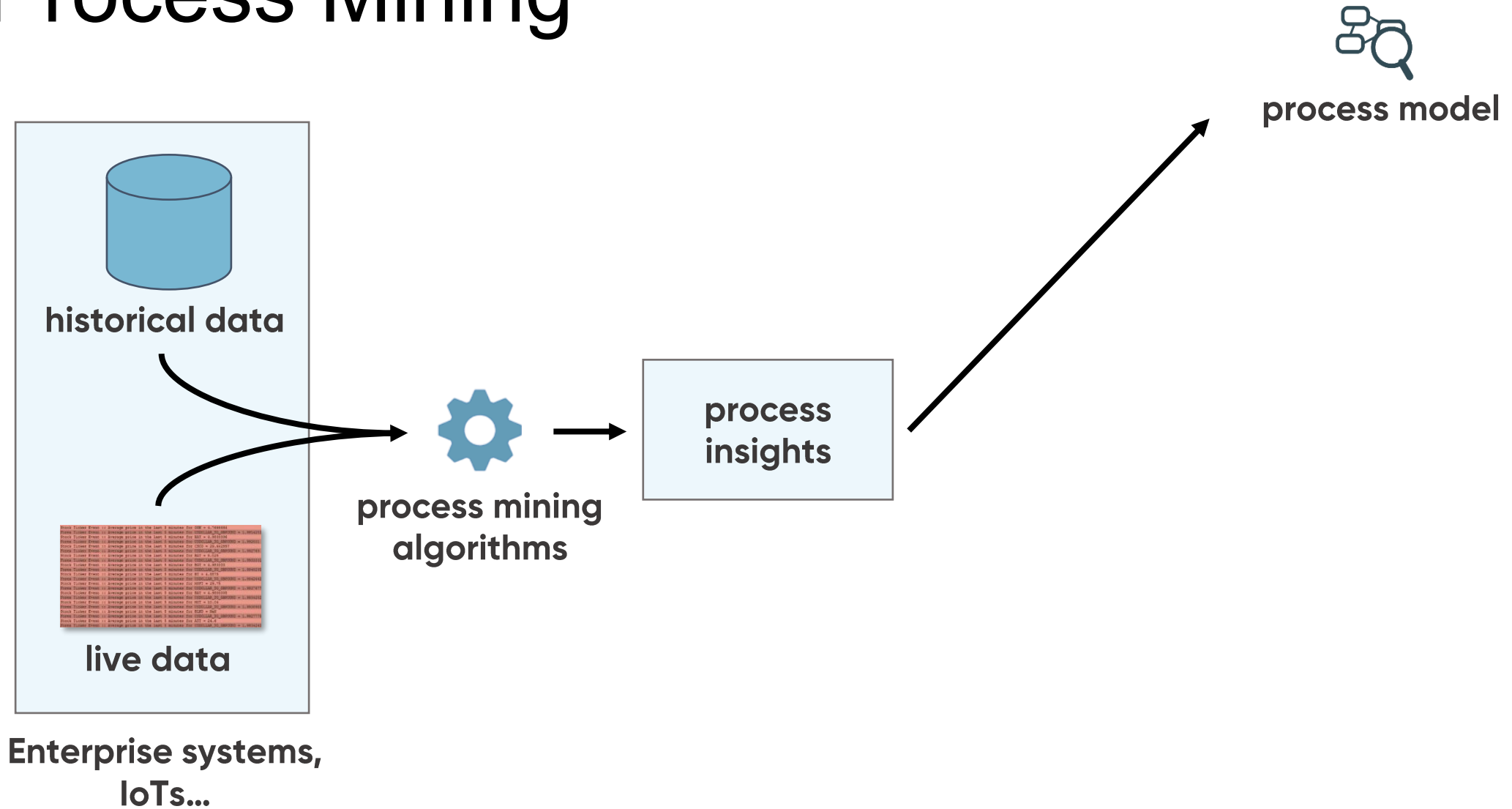
- Operations Excellence Manager @ a Manufacturing Company
- Tom cares about customers, sales, revenue, efficient delivery, op margins ...
- Every week, he has different questions:
 - Why do we have so many production delays in plant X?
 - Why is the number of product returns rising?
 - How to reduce delivery delays by 10%?
 - should I invest in RPA? (which tasks)
 - should I add resource capacity? (where?)
 - should I reduce batch sizes? (how much?)

Tom's company has tons of data in their systems!



- Request for quotes
- Orders (from receipt to fulfillment)
- Work orders (production)
- Shipments (from packaging to delivery)
- Product returns
- Customer complaints
- etc.

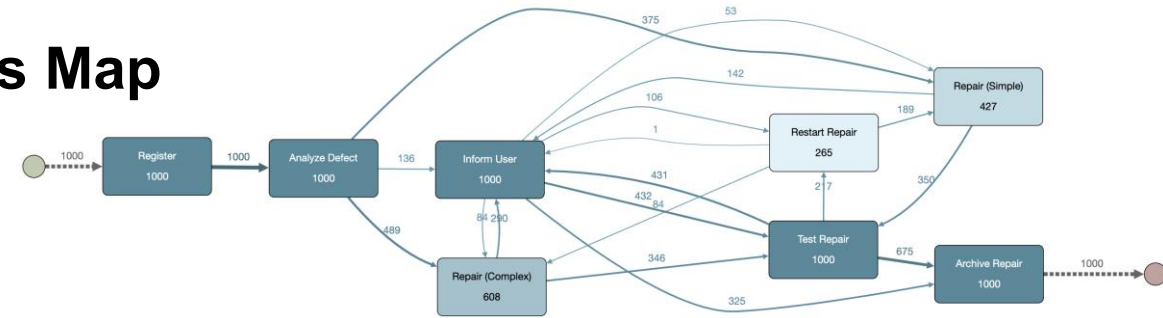
Process Mining



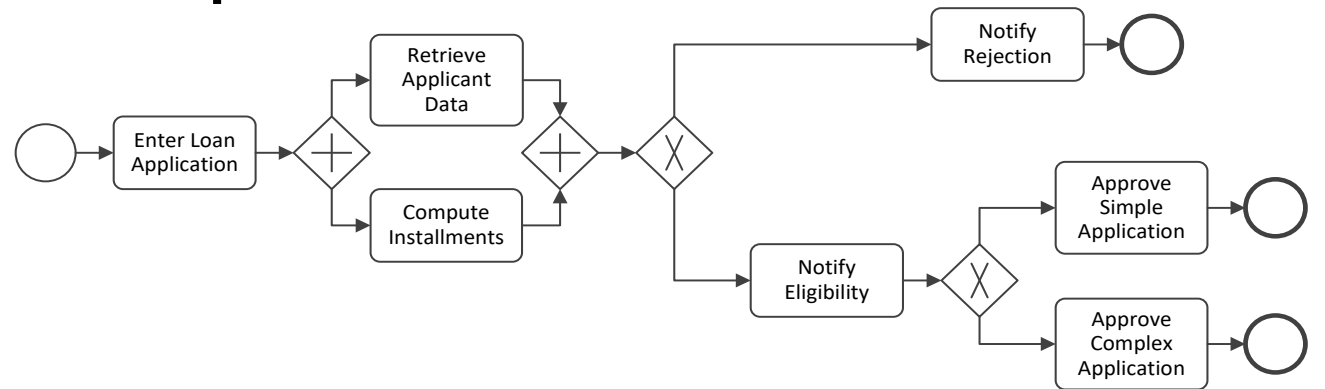
Automated Process Discovery

CID	Task	Time Stamp	...
13219	Enter Loan Application	2007-11-09 T 11:20:10	-
13219	Retrieve Applicant Data	2007-11-09 T 11:22:15	-
13220	Enter Loan Application	2007-11-09 T 11:22:40	-
13219	Compute Installments	2007-11-09 T 11:22:45	-
13219	Notify Eligibility	2007-11-09 T 11:23:00	-
13219	Approve Simple Application	2007-11-09 T 11:24:30	-
13220	Compute Installments	2007-11-09 T 11:24:35	-
...

Process Map



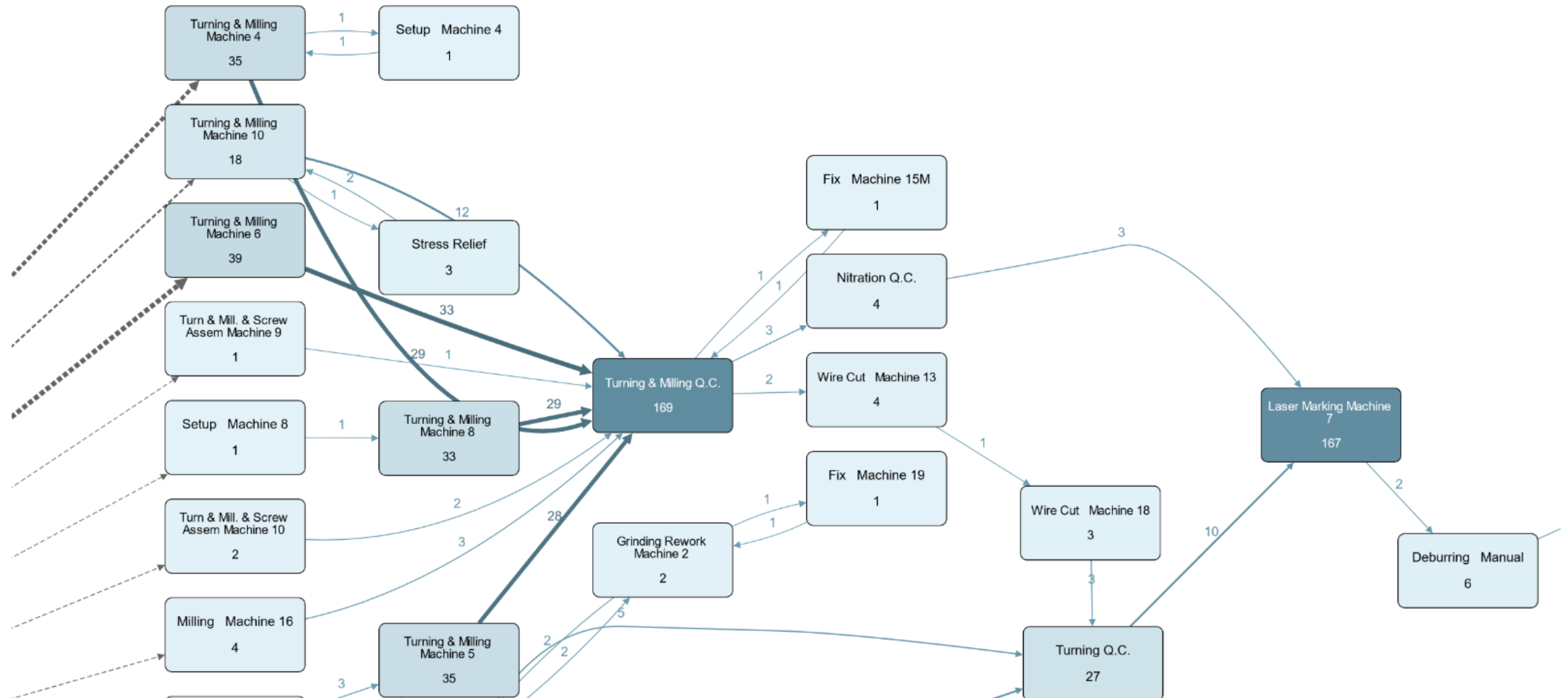
BPMN process model



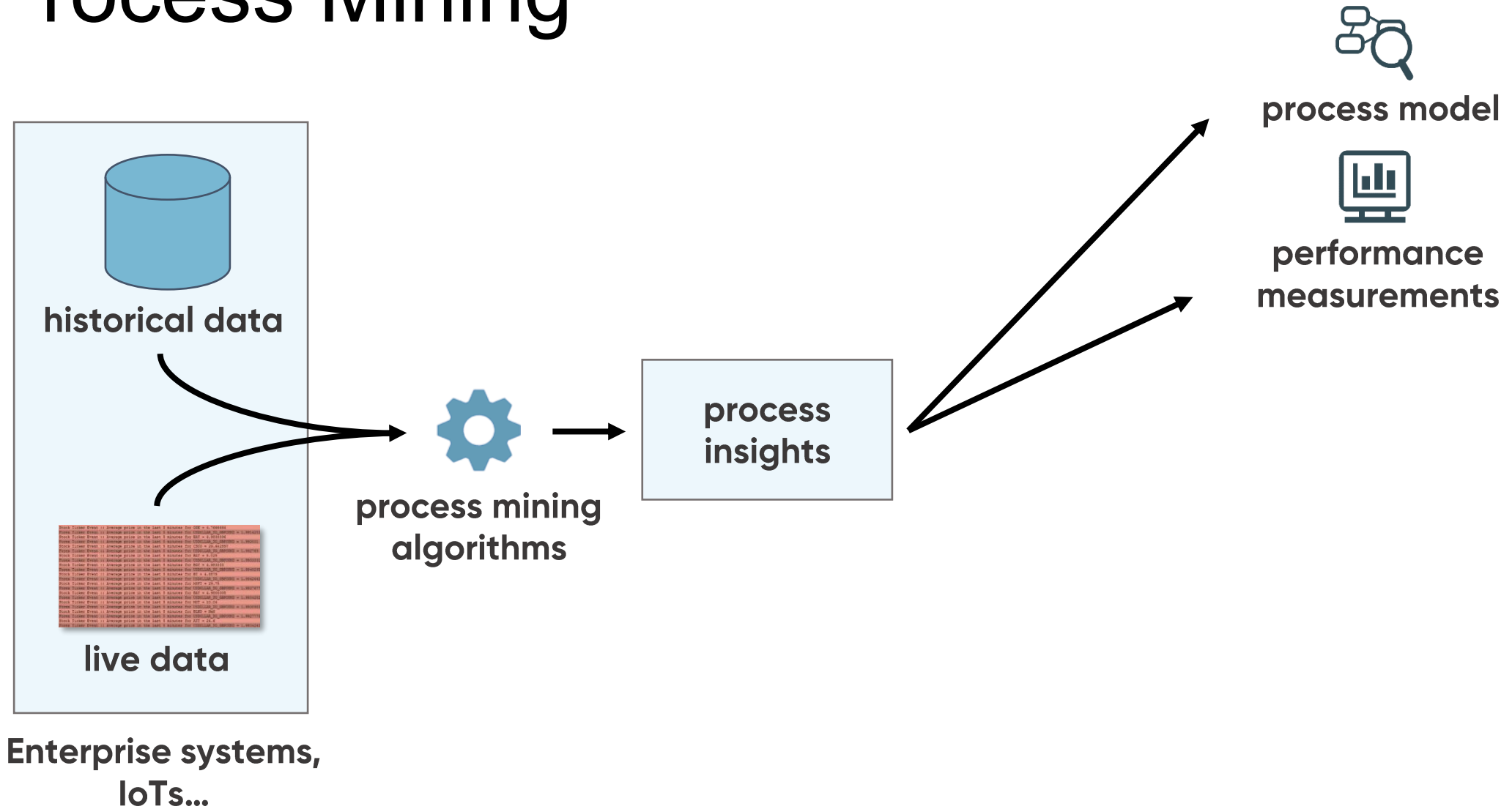
Process Map of Manufacturing Process

apomre Process Discoverer > Production_Data Dumas, Marlon

Search node

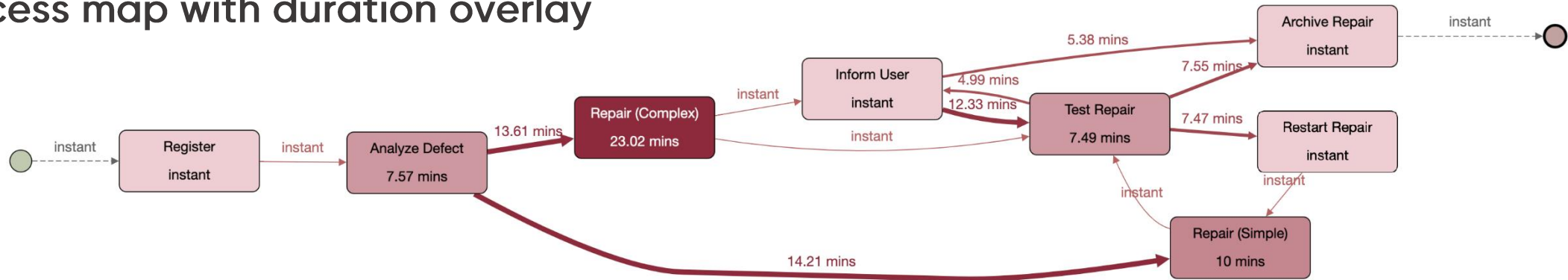


Process Mining

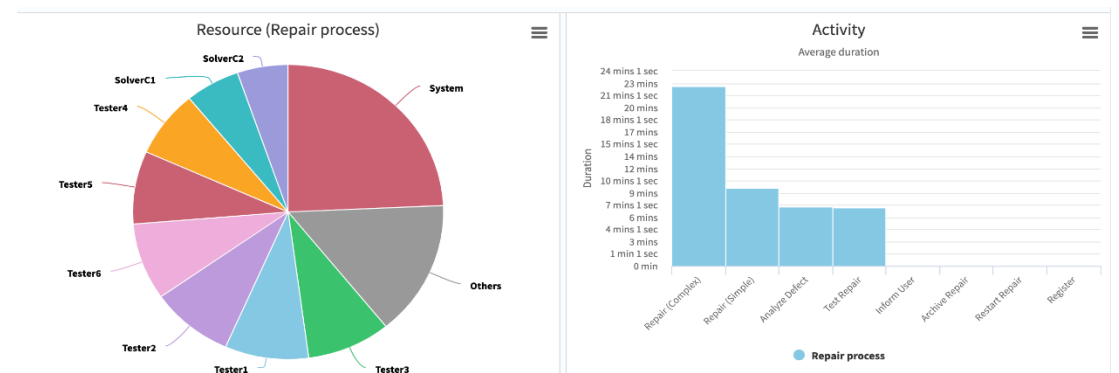
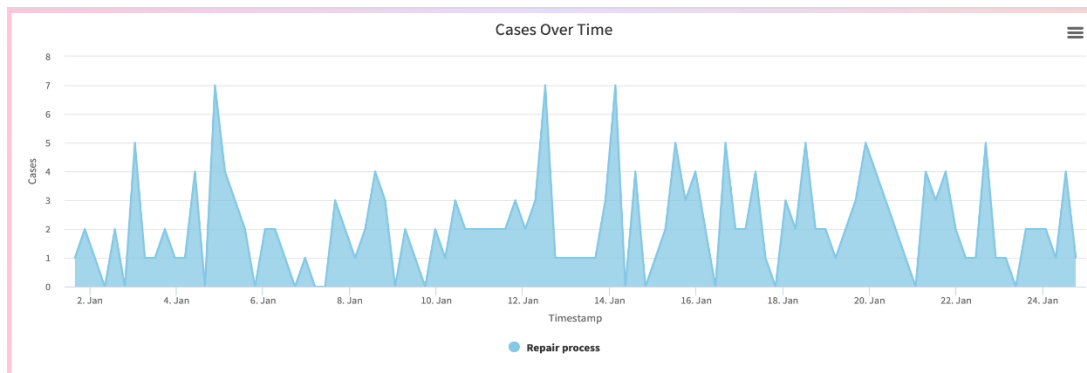


Performance Mining

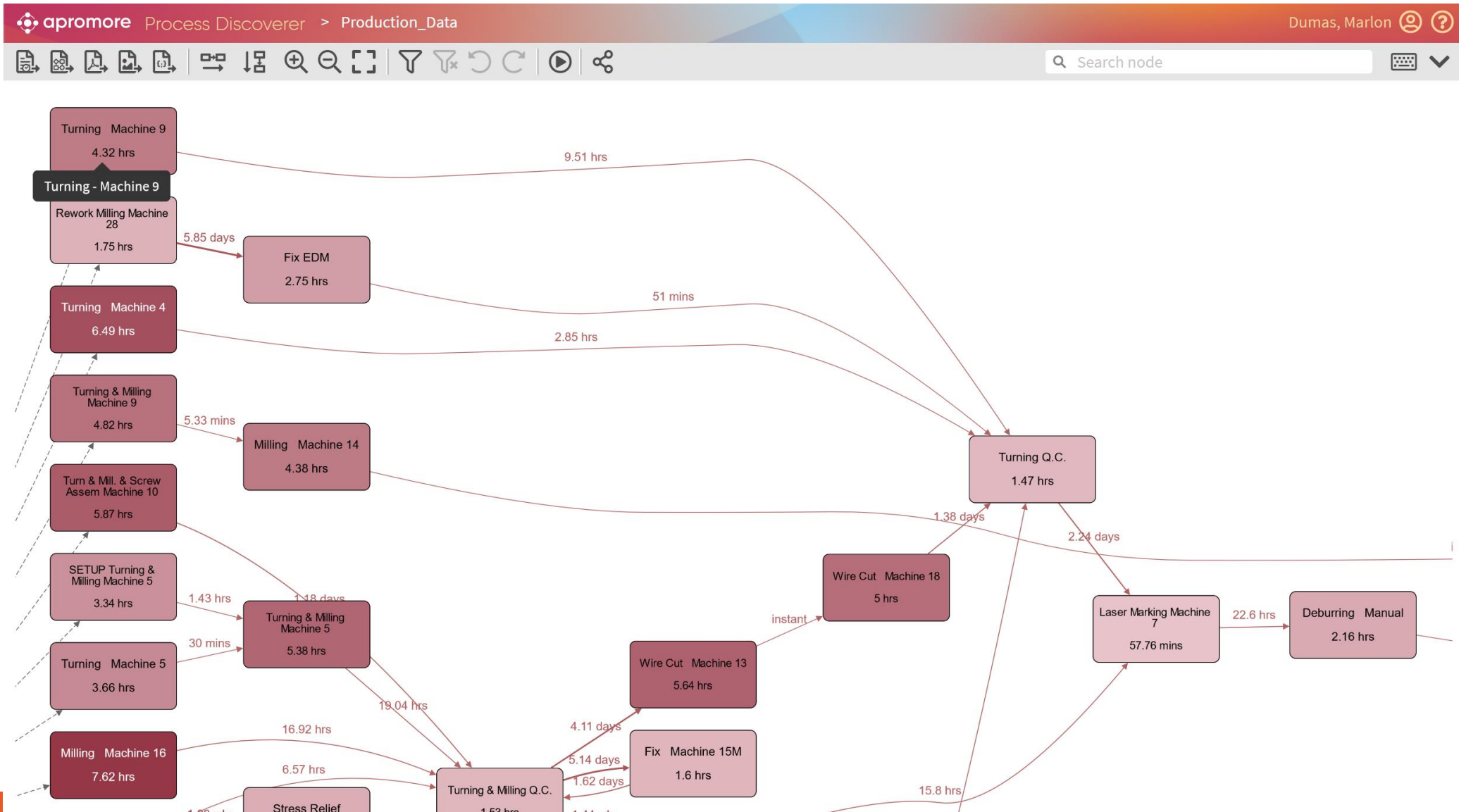
Process map with duration overlay



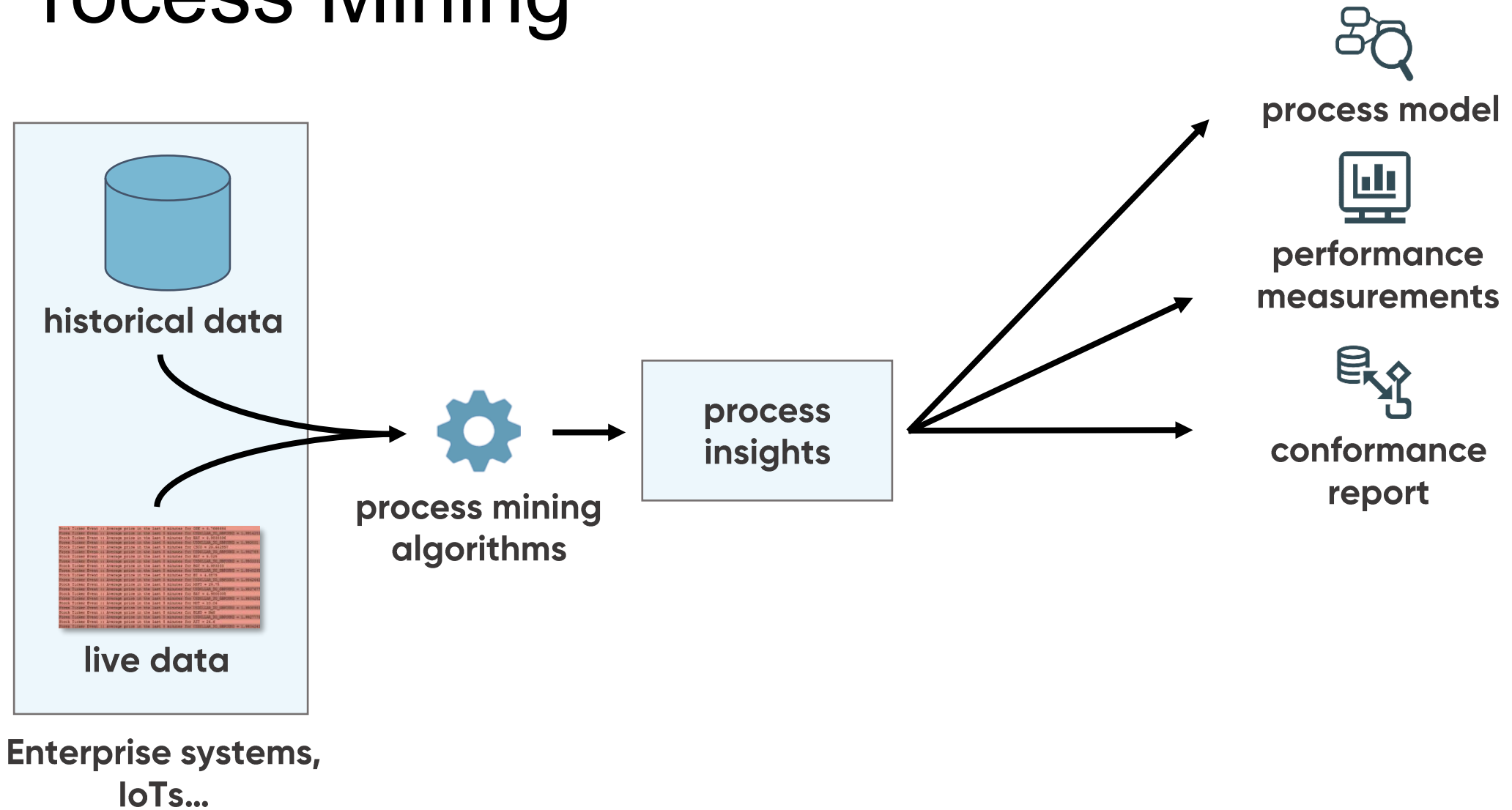
Process performance dashboards



Process Map of Manufacturing Process



Process Mining



Conformance Checking

apromore Conformance Checking User, Test

Case Variants

Case Variant	Count
1	100
2	50
3	33
4	25
5	20
6	16
7	14
8	12
9	11
10	10
11	9
12	8
13	7
14	7
15	6
16	6
17	5
18	5

Non-compliant pathways

This task was skipped, it should have been executed

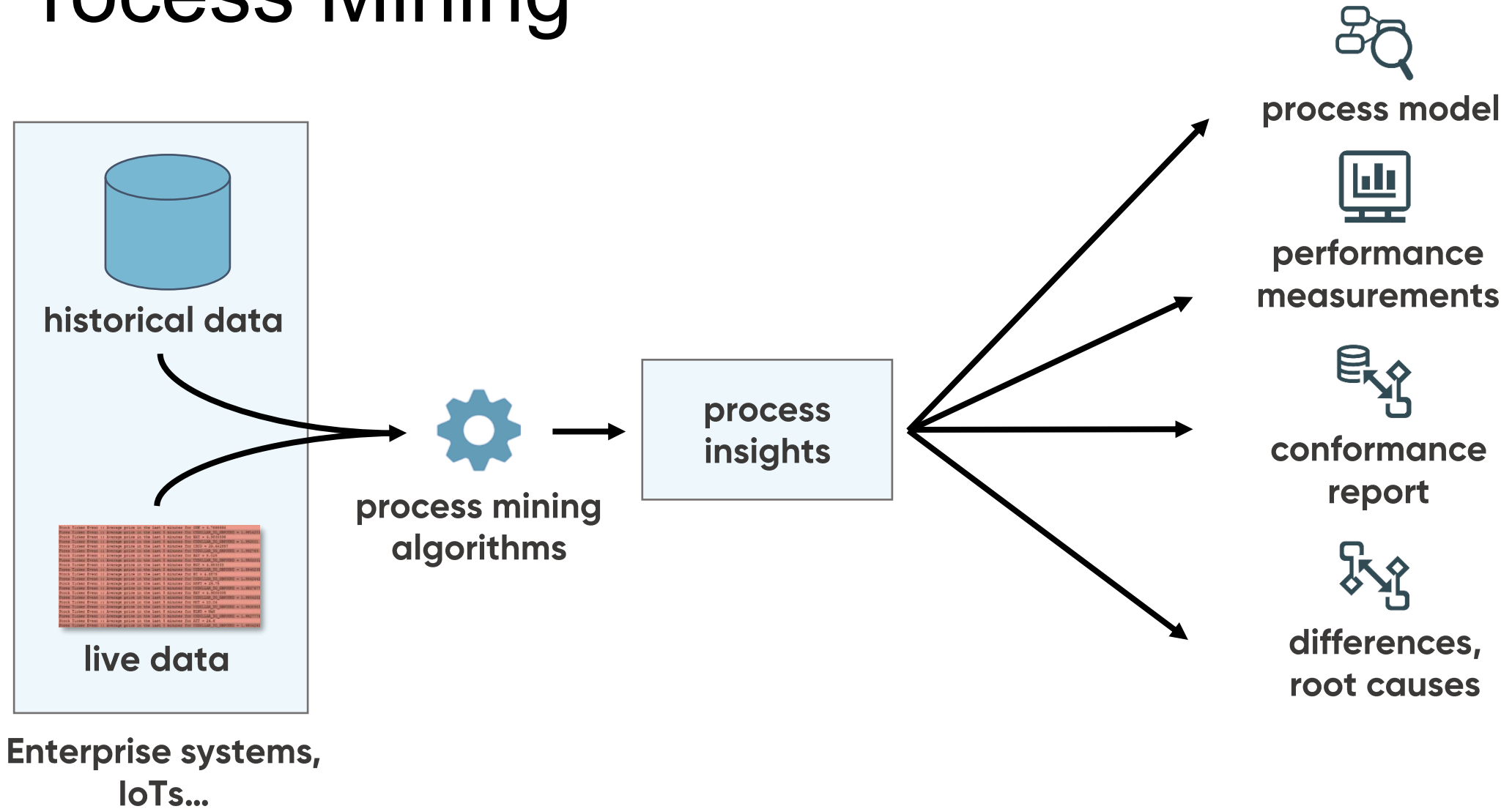
This task should not happen here

Legend

- Element did not appear in the model or appeared in the wrong place
- Element traversed in both the model and case variant
- Element not present in the case variant but was traversed in the model
- Element traversed in some iterations of a loop but not in others
- Element not traversed

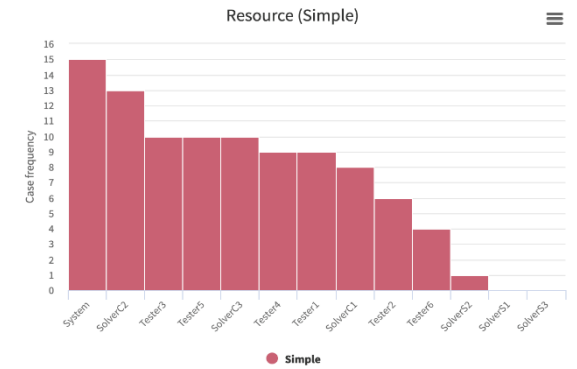
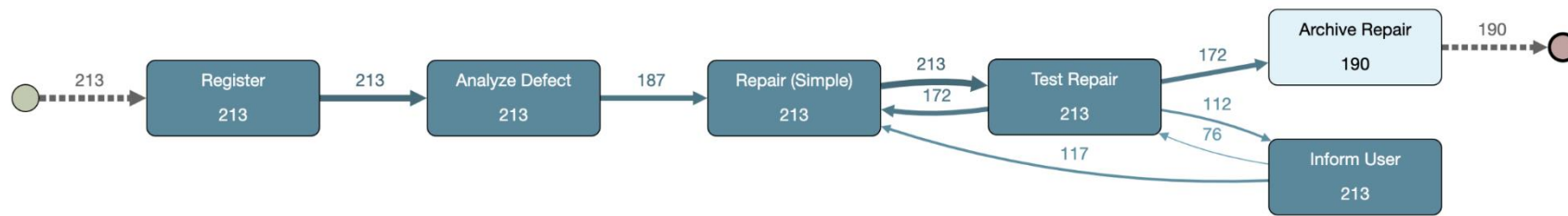
```
graph LR; Start(( )) --> a[a]; a --> X1{X}; a --> f[f]; X1 --> plus1{+}; X1 --> e[e]; plus1 --> b[b]; plus1 --> c[c]; b --> plus2{+}; c --> plus2; plus2 --> X2{X}; e --> X2; X2 --> d[d]; X2 --> e2[e]; d --> End(( )); e2 --> End; f --> X1; d --> e2; style a stroke:#008000; style plus1 stroke:#008000; style plus2 stroke:#008000; style X2 stroke:#008000; style d stroke:#008000; style e2 stroke:#008000; style f stroke:#800000; style X1 stroke:#800000; style e stroke:#800000; style b stroke:#800000; style c stroke:#800000; style X2 stroke:#800000;
```

Process Mining

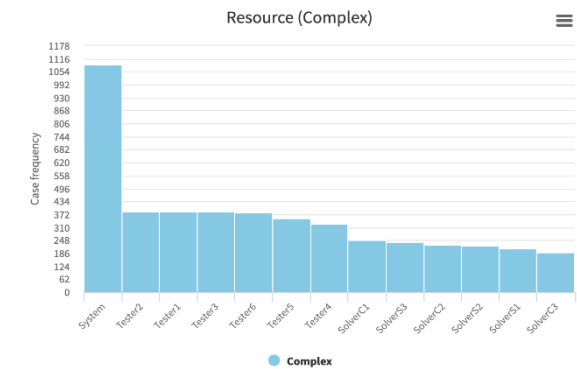
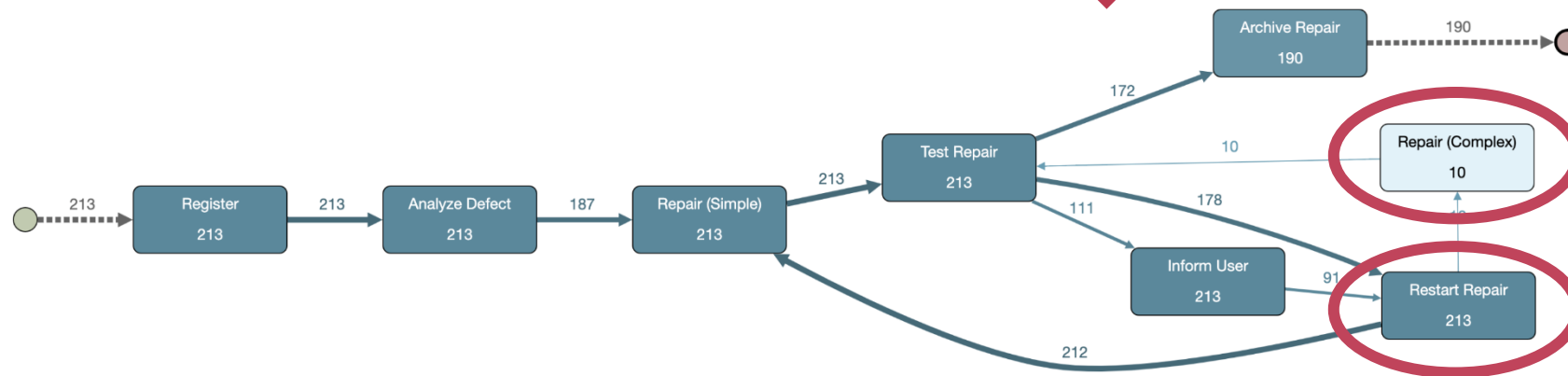


Variant Analysis

Simple repairs



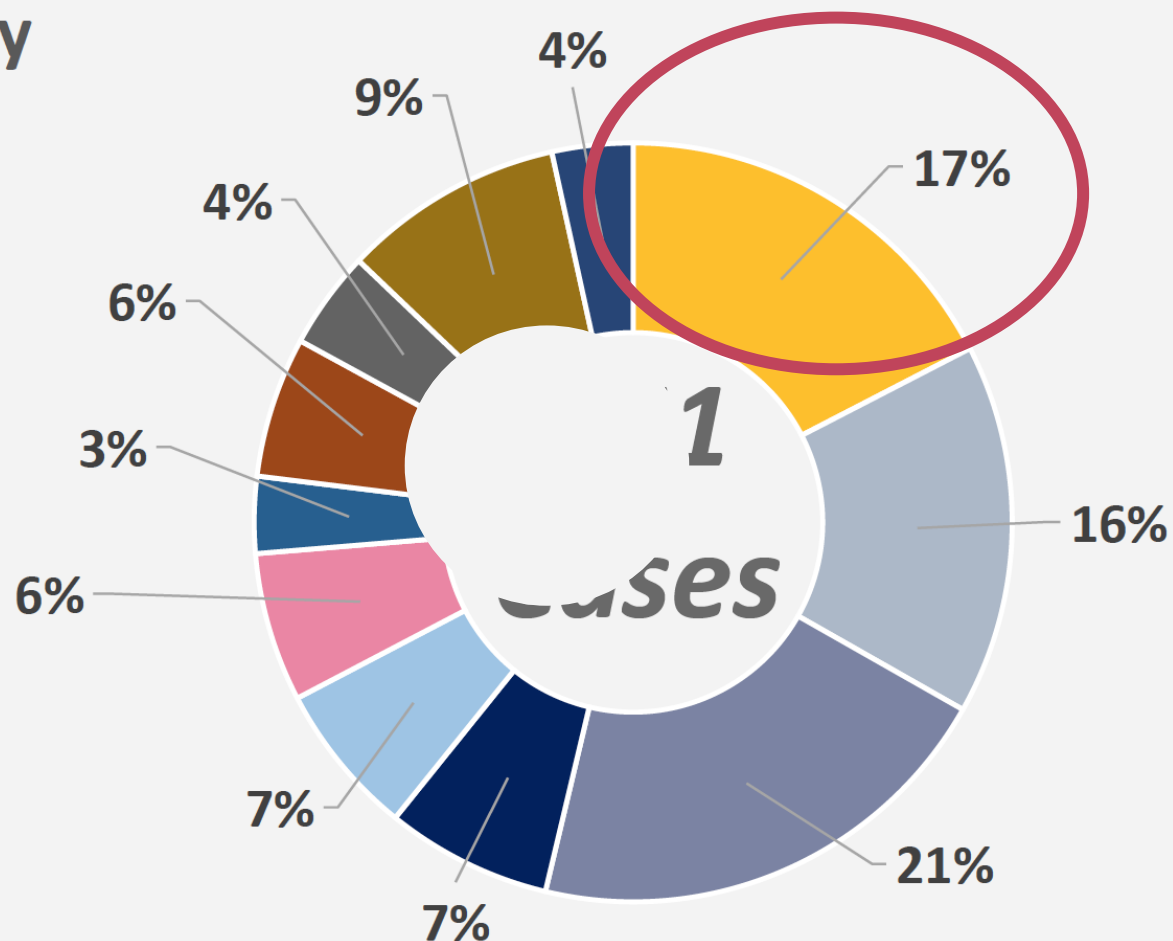
Complex repairs



Where is it used?

Case distribution per Industry

- Financials
- Healthcare
- Industrials
- Public
- Technology
- Consumer Services
- Utilities
- Basic Materials
- Consumer Goods
- Telecommunications
- Services



Process Mining @ Insurance Company

Organization

12,000+ employees

\$8.3 bn damage premiums

16M+ clients

A new claims management system was implemented to decrease the complexity of the claims handling process and speed it up.



Insurance Case Study: The Problem

European regulations state that claims must be handled within **30 days**



Despite the new claims management system, there were still too many cases that took longer than 30 days.

- Did the introduction of new incentives work?
- Does the new claims management system handle secondary cases correctly?
- Is the training provided to liquidators adequate?
- Are claims settled according to company policies?
- How much do the claim amount and damage type affect the claim processing time?

Case Study: Analysis of Claims Process

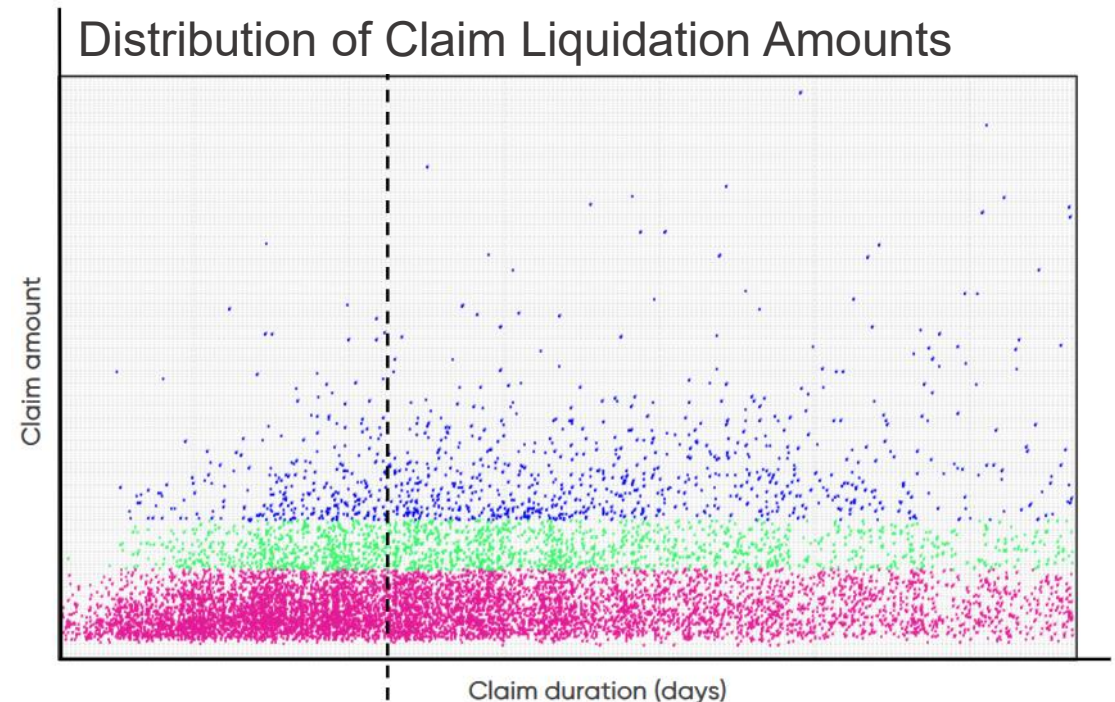
Automated discovery

Performance mining

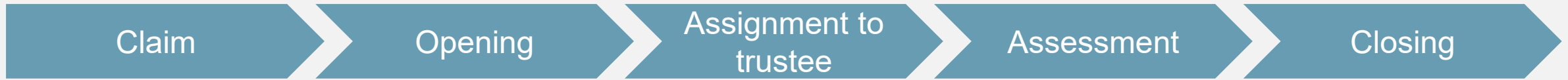
Variant analysis

Findings at a glance:

- The liquidation procedure was poorly standardized
- Over 1,800 unique case variants!!!
- The 5 most frequent pathways only covered 48% of all cases
- The most frequent pathway accounted for 35% of cases whereas the 5th most frequent variant only accounted for 1.5%



Case Study: Funnel Analysis of SLA Violations



If the claim is opened the day after the report date, it has a 55% probability of not being handled within 30 days.

If the claim includes a request for damage repair, in 70% of cases the claim is closed after 30 days.

Assignment refusal: 10 days for claims closed after 30 days vs. 3 days.

23 days for re-turning an appraisal for claims closed after 30 days.

Failure to assess the damage within 7 days often results in non-compliance.

For claims closed after 30 days, in 35% of cases this was due to violation of company procedures and/or settlement policies.

Identification of benchmarks and best practices.

Identification of best and worst performers among settlement offices.

Identification of complex claims.

Case Study: Results & Benefits



Compliance Improvements

1

- ✓ **-25%** violations of external legal terms
- ✓ **-37%** violations of internal liquidation policies



Significant Cost Savings

2

- ✓ - **\$18 Million** per year



Improvement of Handling Speed

3

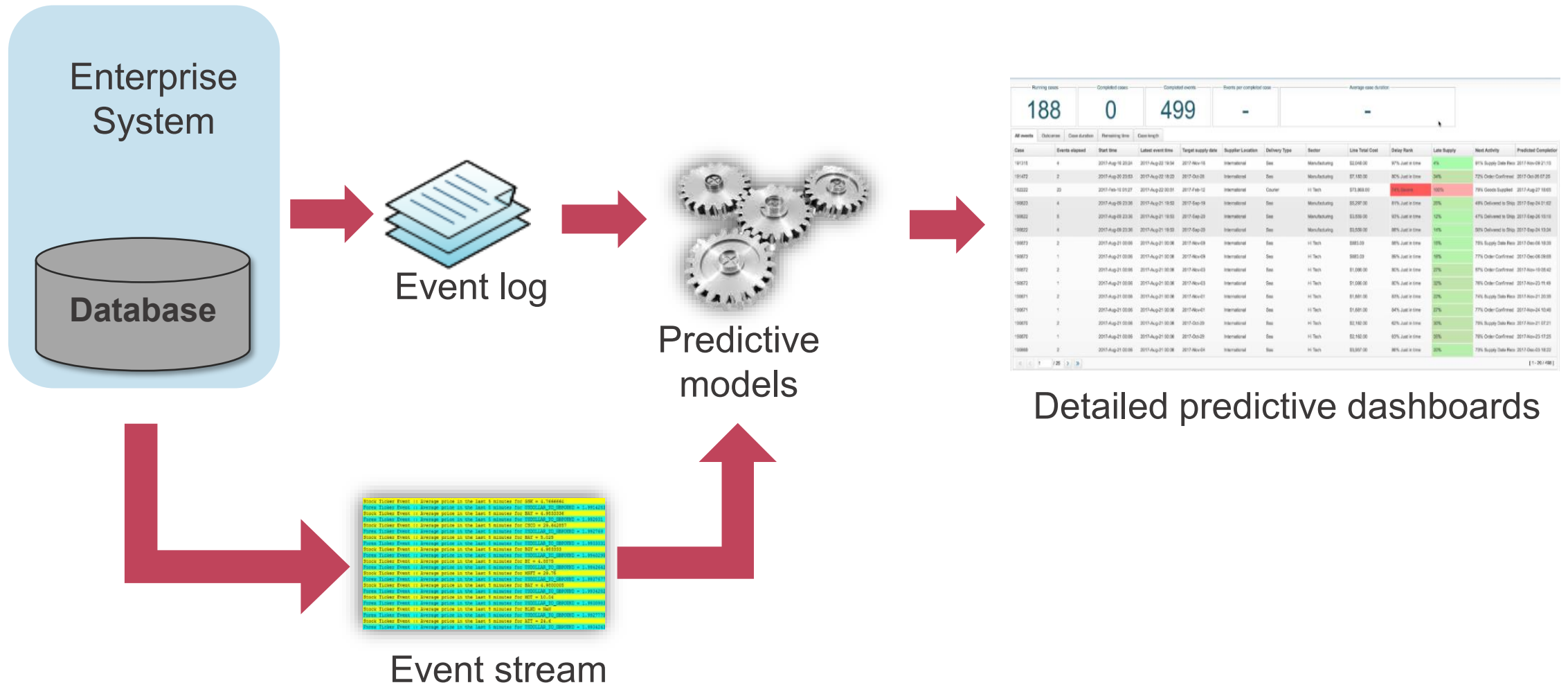
- ✓ Claims now handled within **10-15 days**

Case Study: What's next?



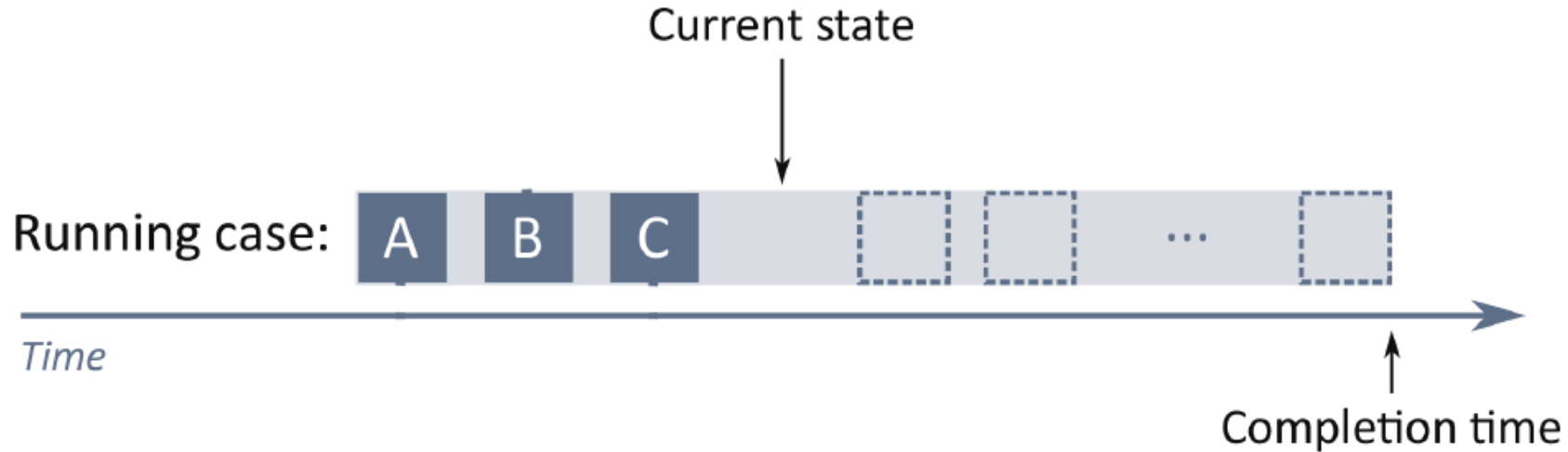
Creating guided support for the liquidator to reduce liquidation time through the generation / closure of automatic activities based on a claim's dynamic evolution.

Predictive Process Monitoring



Running cases		Completed cases		Completed events		Events per completed case		Average case duration				
188		0		499		-		-				
All events	Observed	Case duration	Remaining time	Case length								
Case	Events elapsed	Start time	Latest event time	Target supply date	Supplier Location	Delivery Type	Sector	Line Total Cost	Delay Risk	Late Supply	Next Activity	Predicted Completion
19135	1	2017-Aug-16 20:30	2017-Aug-22 19:34	2017-Nov-16	International	Sea	Manufacturing	\$2,048.00	97% Just in time	4%	91% Supply Date Risk	2017-Nov-29 21:13
19172	2	2017-Aug-22 20:53	2017-Aug-22 19:20	2017-Oct-26	International	Sea	Manufacturing	\$7,180.00	82% Just in time	24%	72% Order Confirmed	2017-Oct-26 07:28
19222	25	2017-Feb-16 19:27	2017-Aug-22 20:31	2017-Feb-12	International	Courier	IT Tech	\$73,868.00	100% On track	100%	79% Order Confirmed	2017-Aug-27 18:05
19923	4	2017-Aug-22 20:30	2017-Aug-21 19:52	2017-Sep-19	International	Sea	Manufacturing	\$2,287.00	81% Just in time	20%	49% Delivered to Ship	2017-Sep-24 21:02
19932	6	2017-Aug-22 20:30	2017-Aug-21 19:53	2017-Sep-20	International	Sea	Manufacturing	\$3,539.00	92% Just in time	12%	47% Delivered to Ship	2017-Sep-24 13:19
19932	4	2017-Aug-22 20:30	2017-Aug-21 19:53	2017-Sep-20	International	Sea	Manufacturing	\$3,539.00	88% Just in time	14%	30% Delivered to Ship	2017-Sep-24 13:24
19972	2	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Nov-09	International	Sea	IT Tech	\$883.00	88% Just in time	10%	79% Supply Date Risk	2017-Oct-04 19:39
19972	1	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Nov-09	International	Sea	IT Tech	\$883.00	88% Just in time	10%	77% Order Confirmed	2017-Oct-06 09:09
19972	2	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Nov-03	International	Sea	IT Tech	\$1,096.00	85% Just in time	20%	87% Order Confirmed	2017-Nov-10 06:42
19972	1	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Nov-03	International	Sea	IT Tech	\$1,096.00	85% Just in time	20%	76% Order Confirmed	2017-Nov-23 11:49
19971	2	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Nov-01	International	Sea	IT Tech	\$1,891.00	85% Just in time	22%	74% Supply Date Risk	2017-Nov-21 20:29
19971	1	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Nov-01	International	Sea	IT Tech	\$1,891.00	84% Just in time	23%	77% Order Confirmed	2017-Nov-24 10:46
19970	2	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Oct-20	International	Sea	IT Tech	\$2,182.00	82% Just in time	26%	79% Supply Date Risk	2017-Nov-21 07:21
19970	1	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Oct-20	International	Sea	IT Tech	\$2,182.00	83% Just in time	25%	78% Order Confirmed	2017-Nov-23 17:25
19968	2	2017-Aug-21 00:06	2017-Aug-21 00:06	2017-Nov-04	International	Sea	IT Tech	\$3,937.00	86% Just in time	20%	79% Supply Date Risk	2017-Oct-03 18:22

Predictive Process Monitoring



Predict Process Outcome

Is this loan offer going to be rejected?

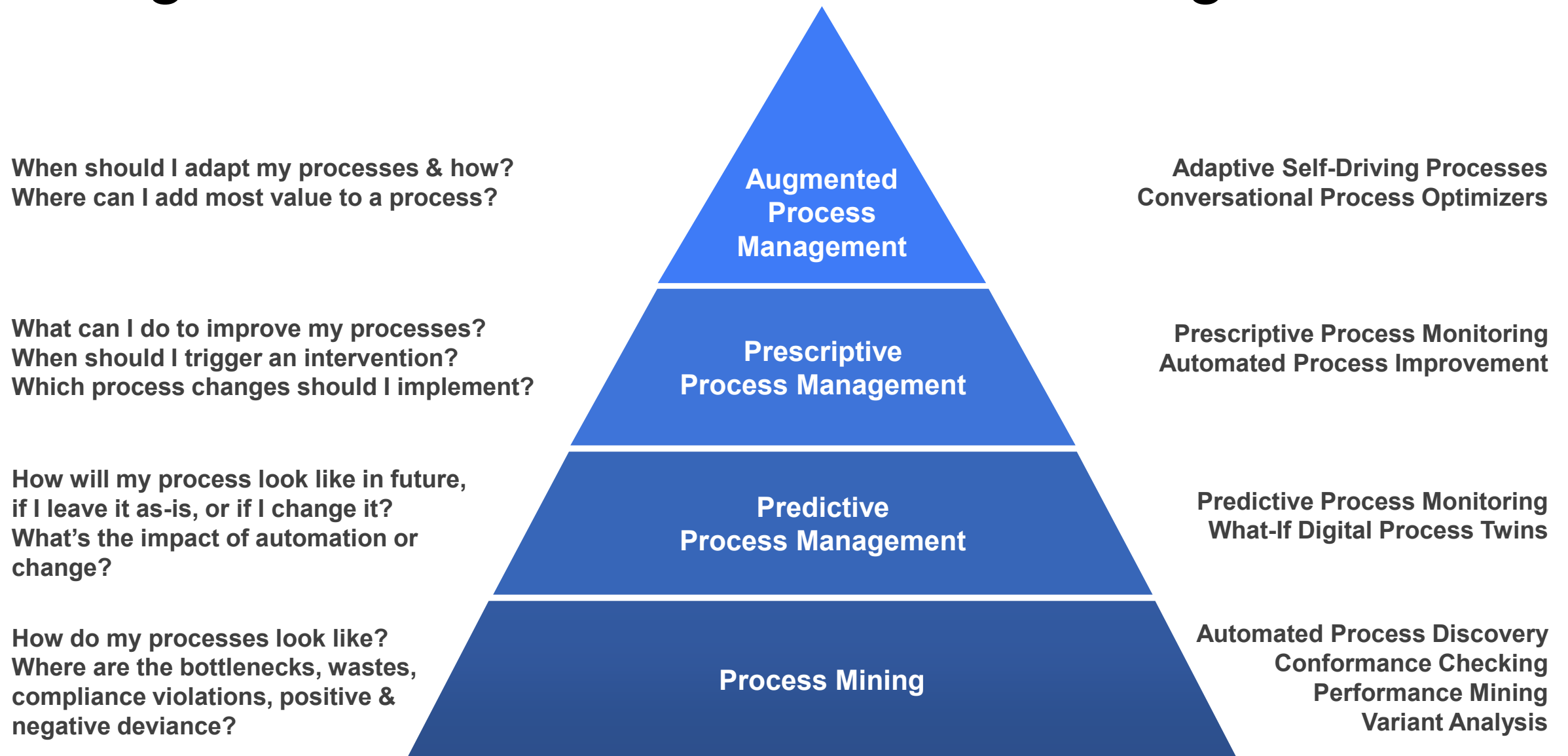
Predict Process Performance

Will this claim take more than 5 days to be handled?

Predict Future Events

What activity is likely to be executed next?
And after that?

Augmented Business Process Management



Predictive and Augmented BPM: Opportunities

Operational Level

Predictive Process Monitoring

Predicting future states, outcomes, or properties of a process instance or group of process instances

Prescriptive process monitoring

Recommending actions on-the-fly in order to optimize one or more performance indicators, taking into account their causal effect

Tactical Level

Digital Process Twins

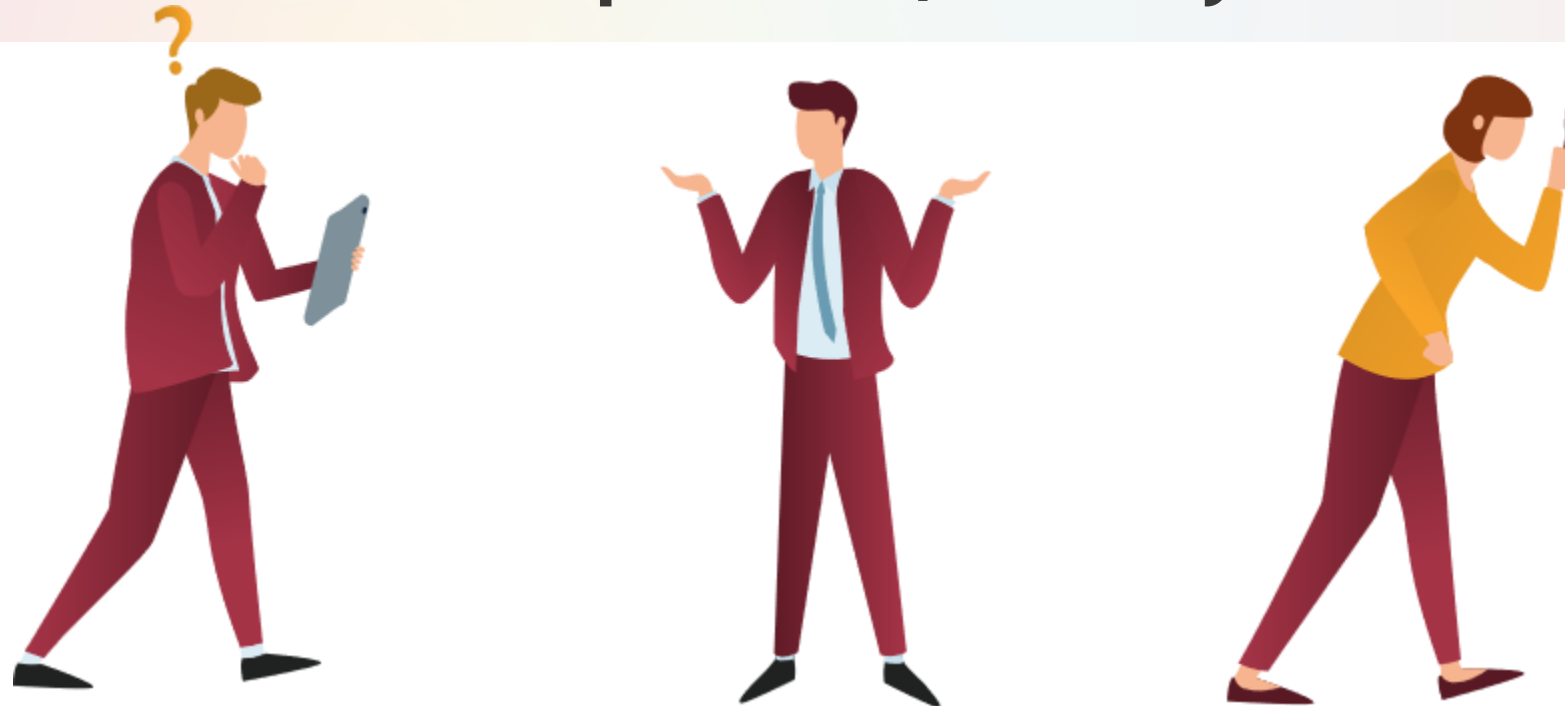
Discovering accurate and reliable simulation scenarios to evaluate improvement options

Automated Process Improvement

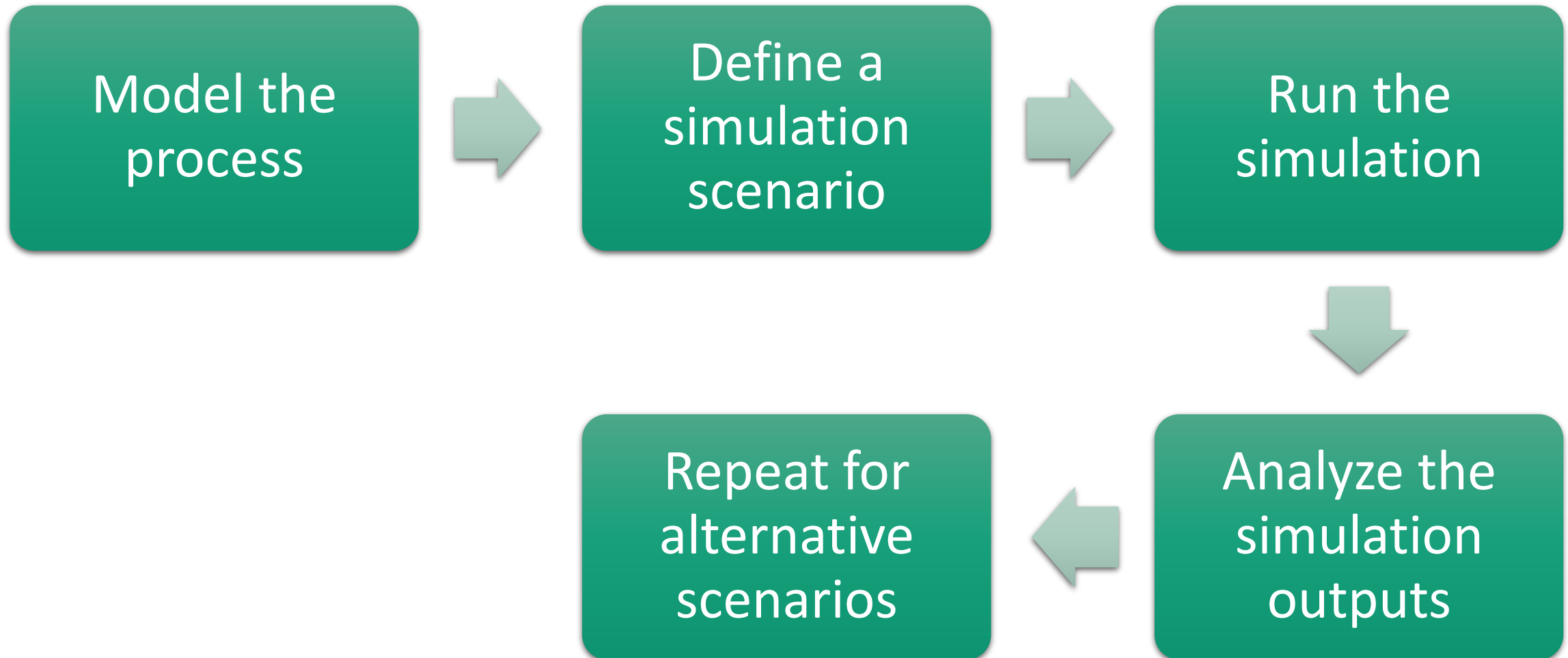
Automatically discovering optimal sets of improvement opportunities from data to optimize one or more performance indicators

Digital Process Twins

How to determine if a given intervention/change will improve a business process, and by how much?



The Traditional Answer: Business Process Simulation



Business Process Simulation: Assumptions

The process model is authoritative (always followed to the letter)

- No deviations
- No workarounds

The simulation parameters accurately reflect reality

- ...whereas in reality, they are often guesstimates

A resource only works on one task instance at a time / a task is performed by one resource

- No multi-tasking / no multi-resource tasks (teamwork)

Resources have robotic behavior (eager resources consume work items in FIFO mode)

- No batching
- No tiredness effects, no interruptions, no distractions beyond “stochastic” ones

Undifferentiated resources

- Every resource in a pool has the same performance as others

No time-sharing outside the simulated process

- Resources fully dedicated to one process

End Result

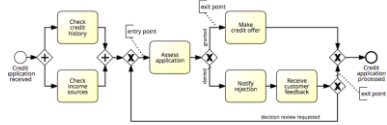
Business process simulations based on incomplete models, guesstimates, and simplifying assumptions are not faithful
→ adoption of business process simulation is disappointing

Data-Driven Construction of Digital Process Twins

Enterprise System



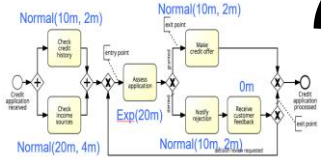
Process Constraints or Process Model



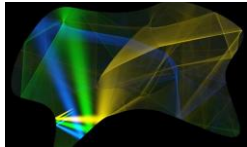
Process Change Specification



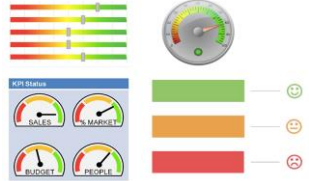
Simulation Model Discoverer



Simulation Model

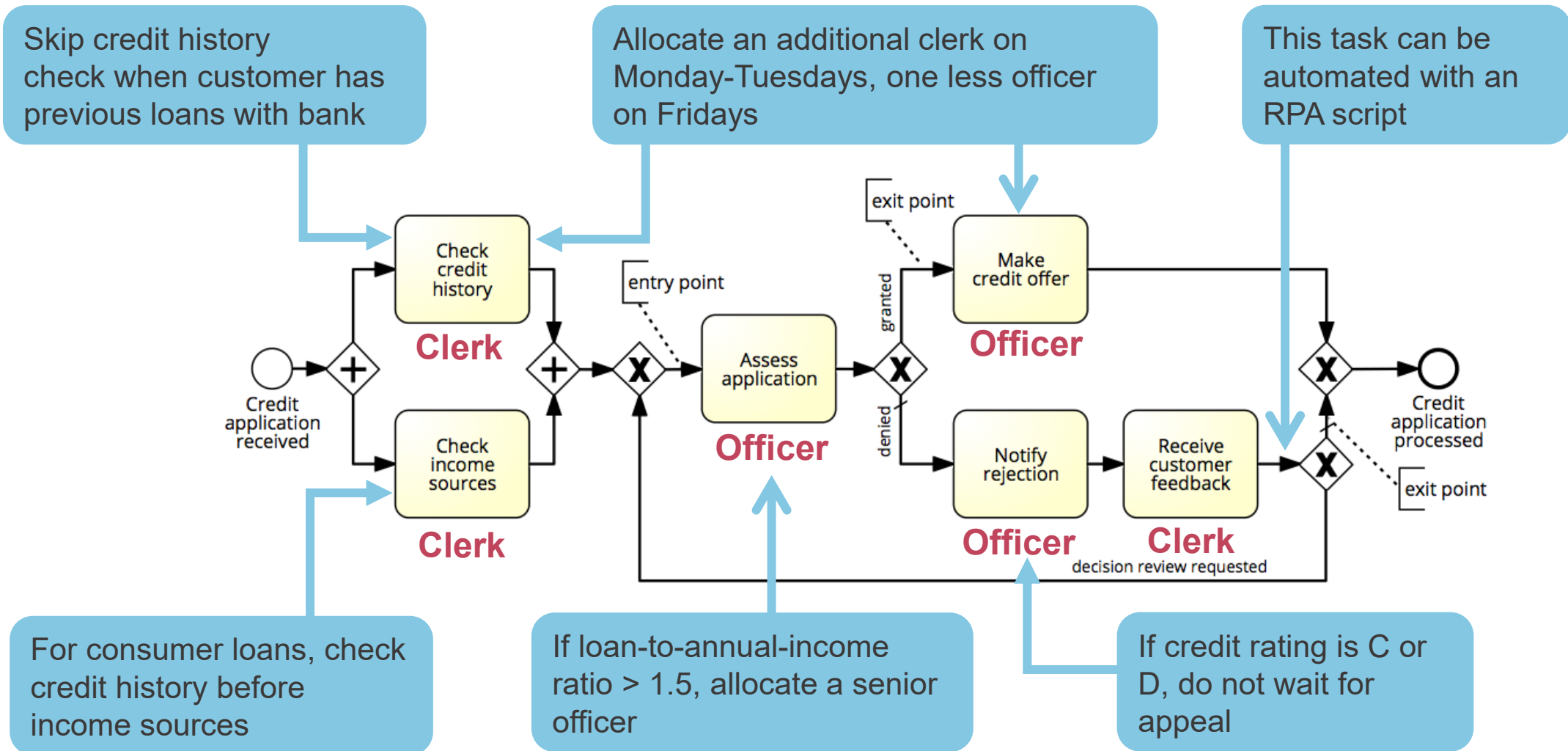


Simulation Engine



Predicted Performance

What's Next? → Automated Process Improvement



Process Mining is Everywhere!

Case distribution per Country

