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Advanced Process Mining

Prof. Dr. Agnes Koschmider

Lecture 6: Predictive Process Monitoring

Lecture Overview

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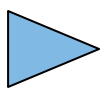

0	Organization and Introduction
I	Process Discovery
II	Process Conformance
III	Predictive Process Monitoring
IV	Event Log Preparation
V	Practical Tasks

Business Process Monitoring

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Definition of Business Process Monitoring

- Business Process Monitoring is the process-oriented monitoring of the most important or critical business processes of a company
- It includes the observation of all technical and business application-specific functions that are required for a smooth and reliable flow of the business processes

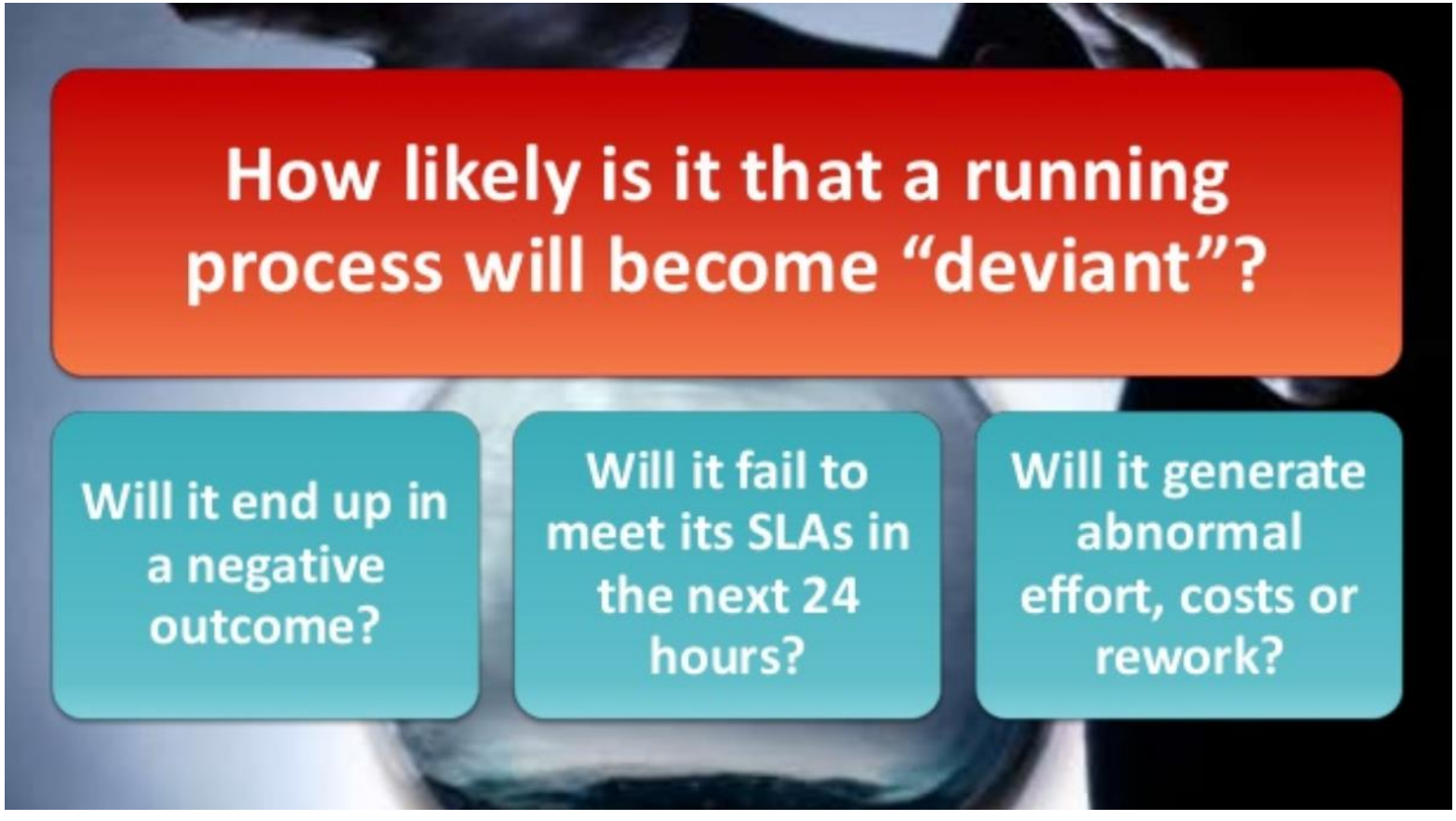
Goals of Business Process Monitoring

- To detect critical situations as early as possible
- To enable the customer's solution support organization to respond to and to solve problems as fast as possible

Monitoring types

- Proactive Monitoring: Activities are performed to prevent critical situations before they occur
- Reactive Monitoring: Once an error has occurred and detected, additional monitoring activities are required to analyse and solve the problem
- Automatic Monitoring: An automatic monitor triggers an alert immediately after an exceptional situation has occurred

Business Process Monitoring



Business Process Monitoring

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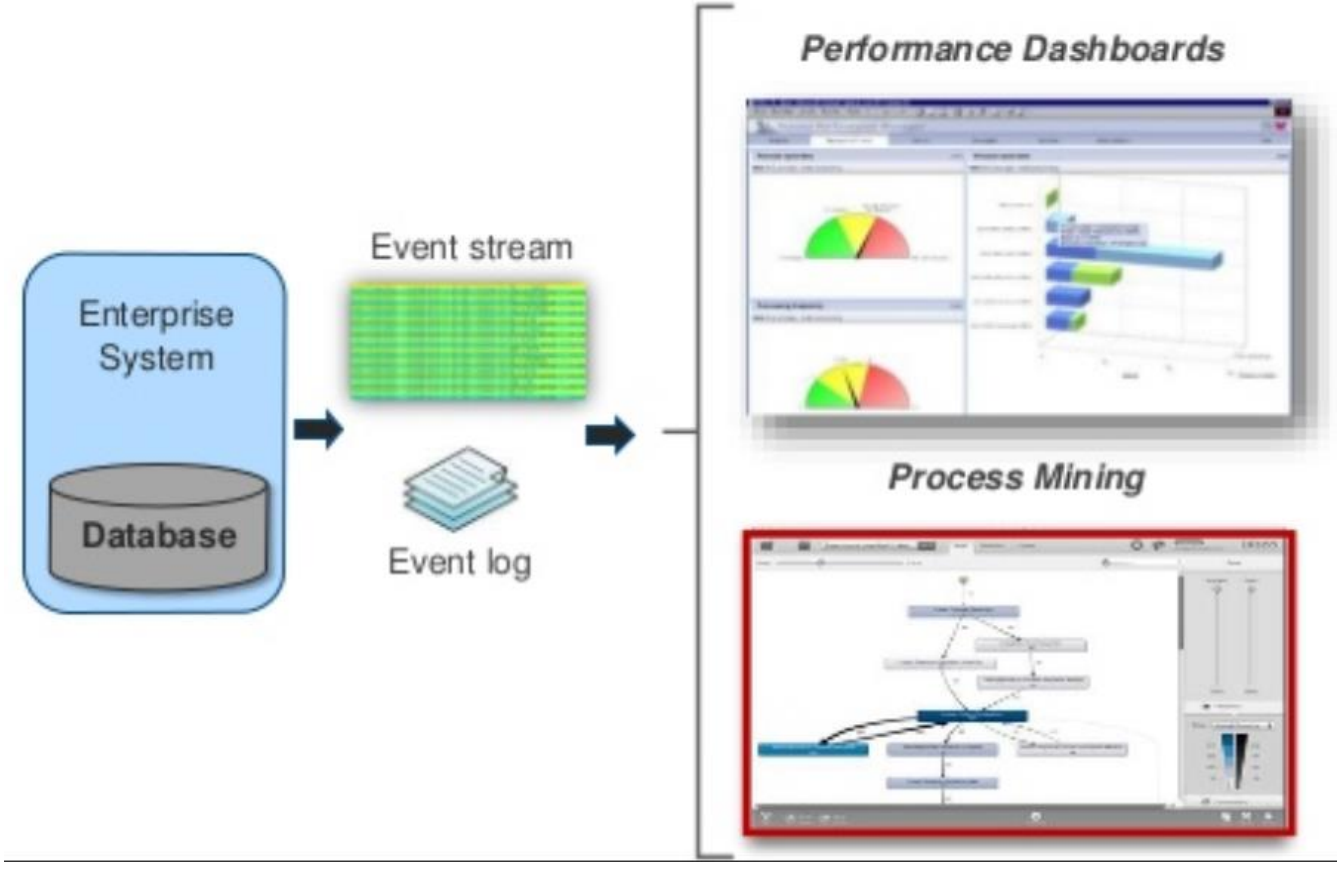

Predictive Process Monitoring

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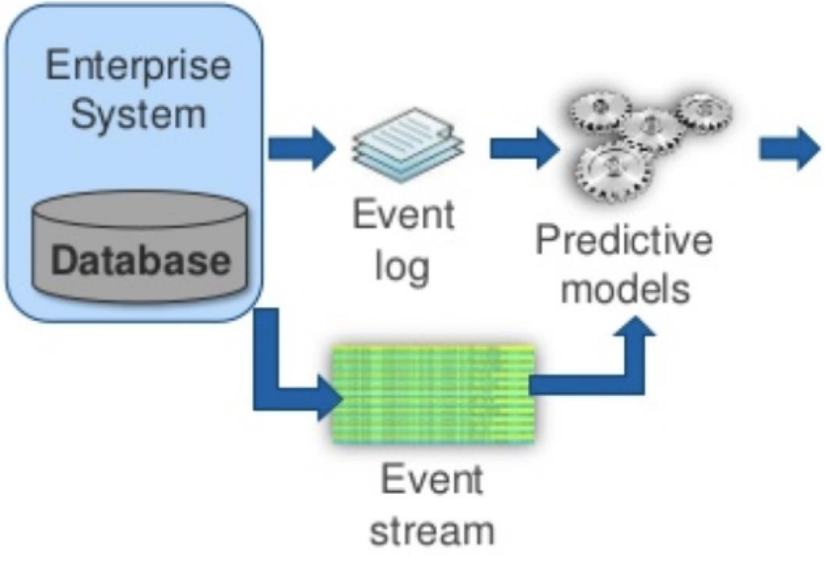
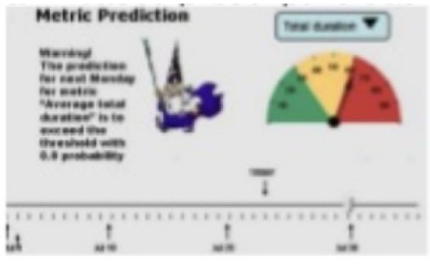


Aggregate predictive dashboards

Detailed predictive dashboard

Alarm -based prescriptive dashboard



Offline Process Mining

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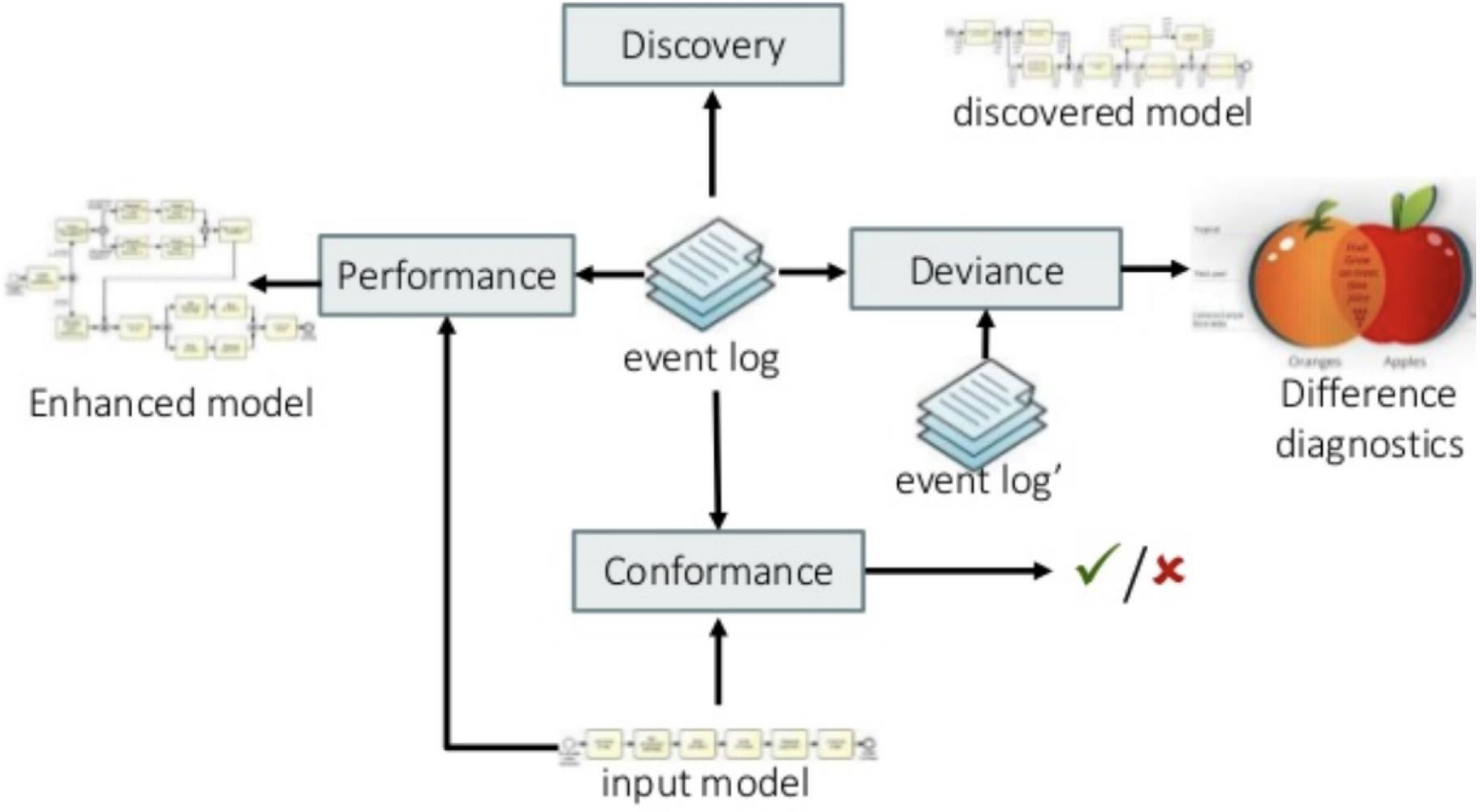

Deviation Mining via Sequence Classification

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- Apply discriminative sequence mining methods to extract features characteristic of one class
- Build classification models (e.g. decision trees)
- Extract difference diagnostics from classification model

Rank	Rule
1	{(*Open*, 2}:*anomalous*
2	{(*Closed*, 2), (*Postponed*, 0), (*Finished*, 0)}:*anomalous*
3	{(*Reopen*, 2)}:*anomalous*
4	{(*Closed*, 1), (*Rejected*, 1), (*Reopen*, 0)}:*anomalous*
5	{(*Reopen*, *Closed*, 1)}:*anomalous*

Deviance Mining and Predictive Monitoring

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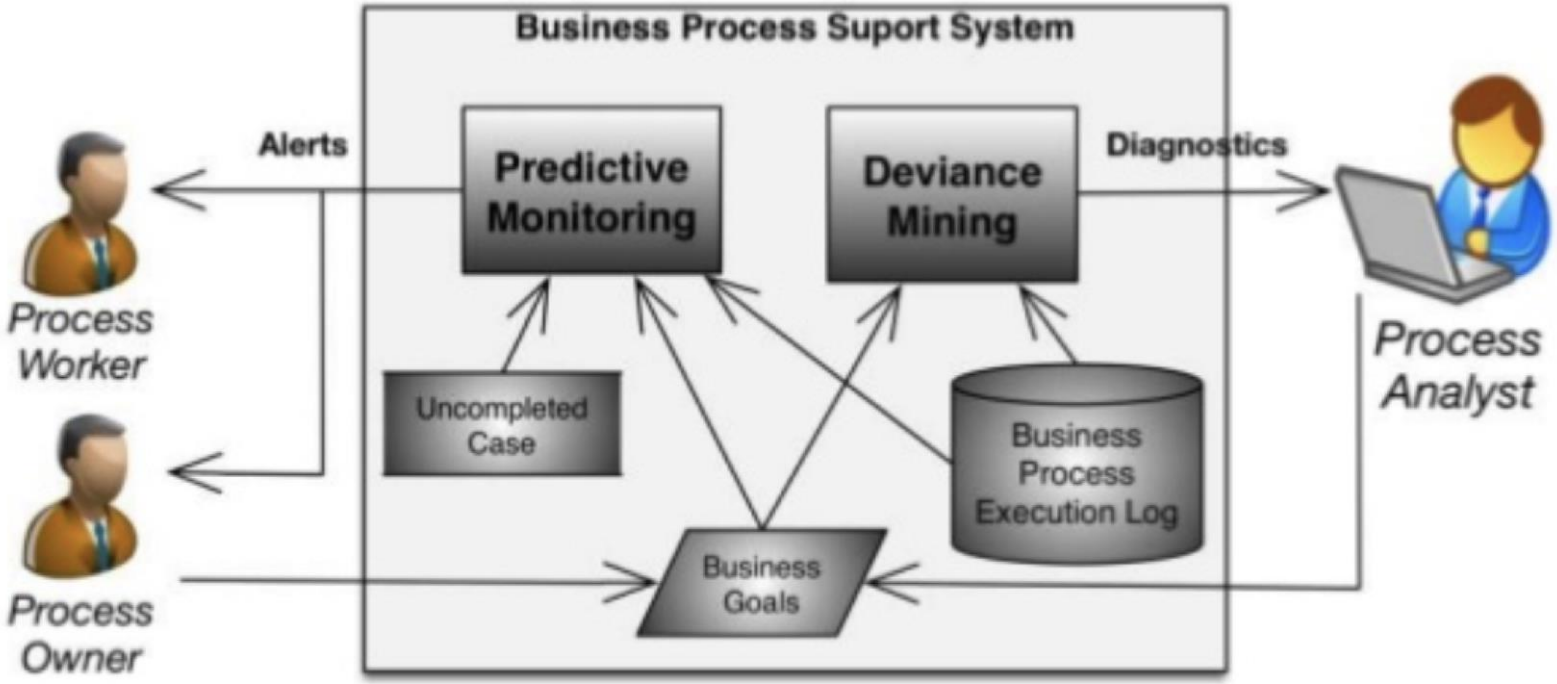
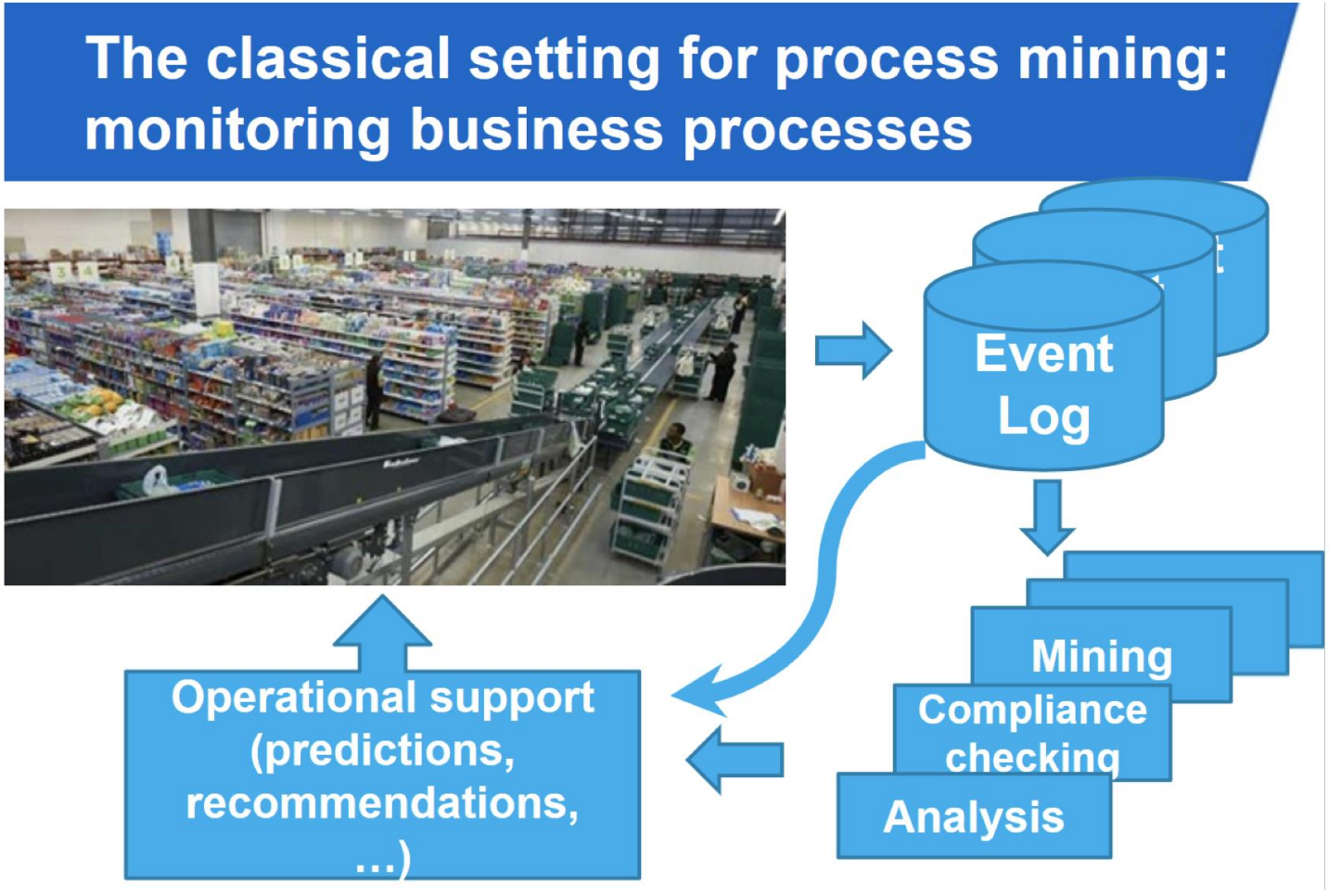


Classical Setting for Business Process Monitoring(1)



Classical Setting for Business Process Monitoring(2)

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We can tell at every moment:

- where each package is in the process,
- what is in each trolley,
- who is doing what

Classical Setting for Business Process Monitoring(3)

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We can tell at every moment:

- where each package is in the process,
- what is in each trolley,
- who is doing what

We can apply process mining to

- understand the process,
- check compliance,
- generate predictions,
- …

Data Analysis and Predictive Monitoring

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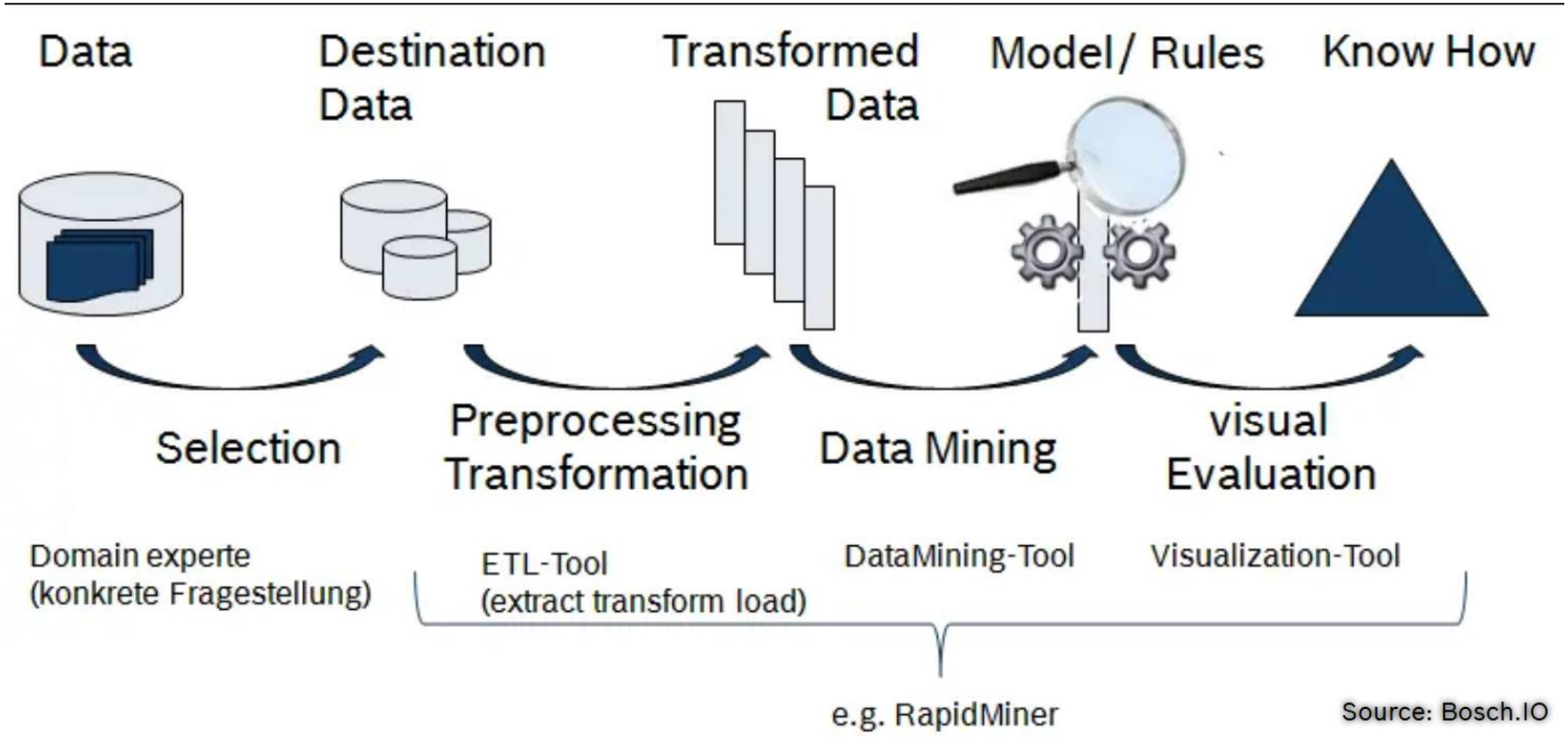

Quelle: https://blog.bosch-si.com/developer/large-scale-data-analysis-and-predictive-modeling-in-data-mining/

Predictive Monitoring Example: Debt Recovery Process (1)

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Predictive Monitoring Example: Debt Recovery Process (2)

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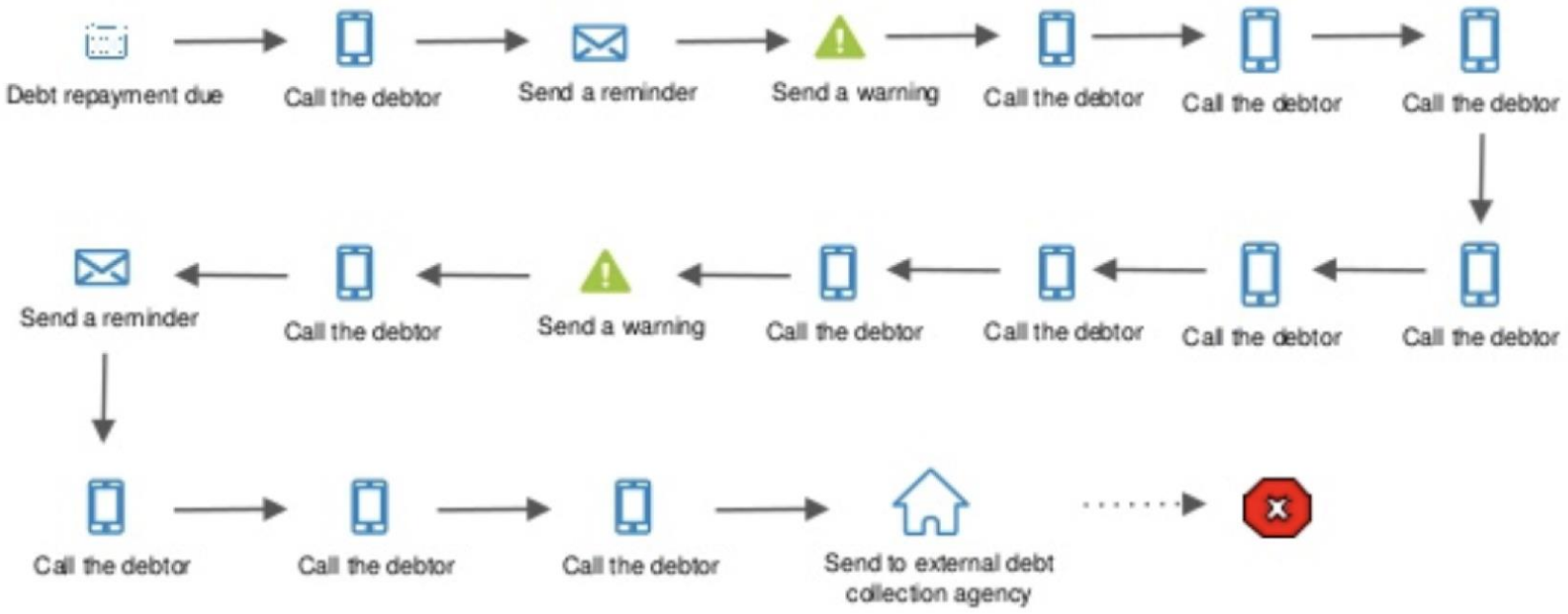

Time is important

- **Absolute time and its abstractions:**
  - **Between 9 pm and 6 am**
  - **On Sundays**
  - **…**
- **Relative time**
  - **Time from the last feeding**
  - **Time from falling asleep**
- **But also combinations of the two:**
  - **Time from the last feeding till 6am**

Predictive Business Process Monitoring

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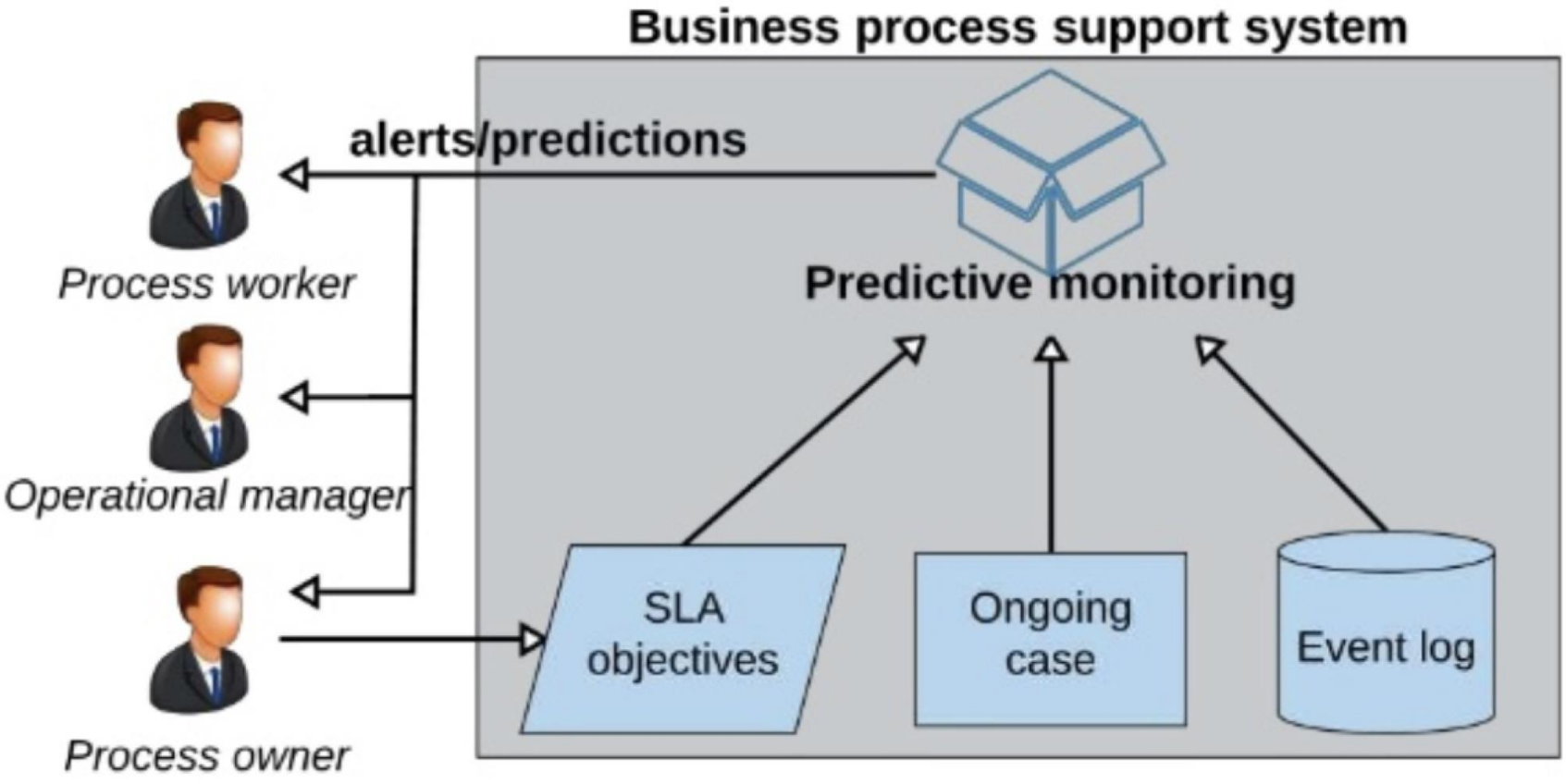

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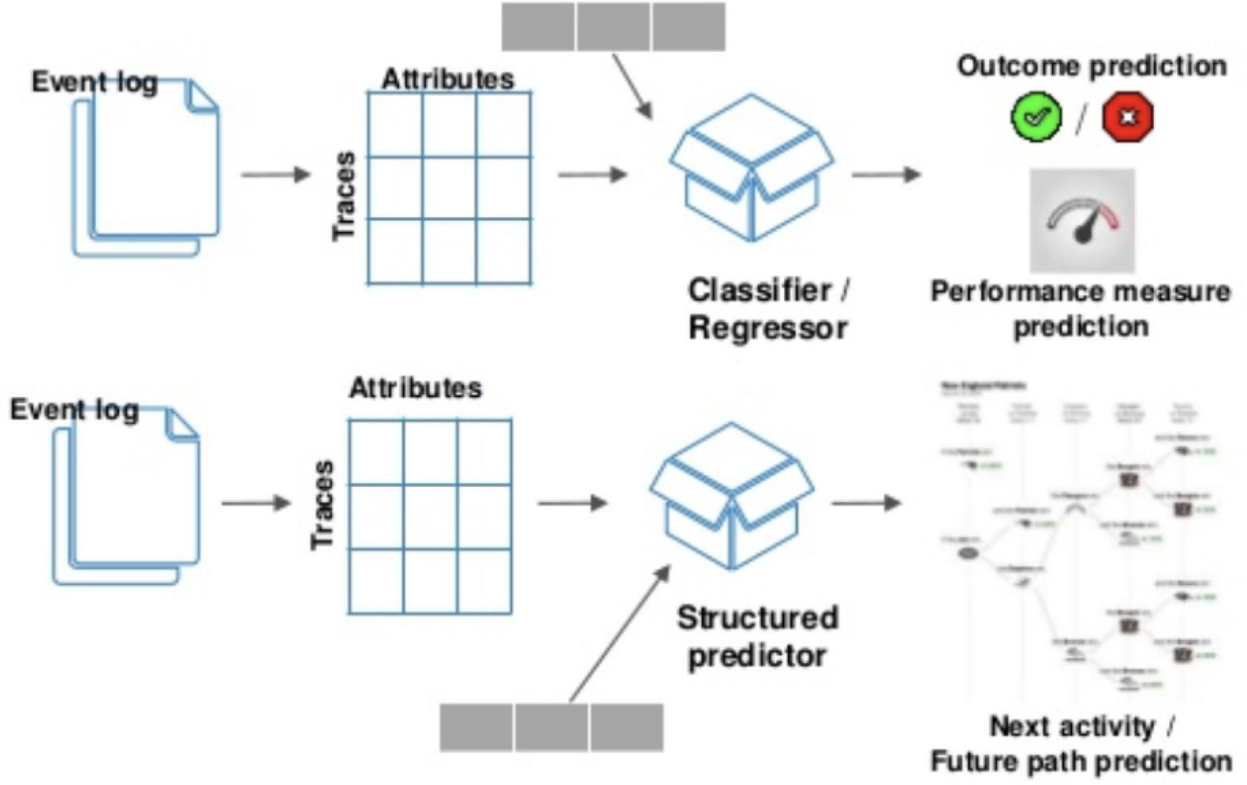
Predictive Process Monitoring: General Approach



Predictive Monitoring Example

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Case id	Event id	Properties				
		Timestamp	Activity	Resource	Cost	...
1	35654423	30-12-2010:11.02	register request	Pete	50	...
	35654424	31-12-2010:10.06	examine thoroughly	Sue	400	...
	35654425	05-01-2011:15.12	check ticket	Mike	100	...
	35654426	06-01-2011:11.18	decide	Sara	200	...
	35654427	07-01-2011:14.24	reject request	Pete	200	...
2	35654483	30-12-2010:11.32	register request	Mike	50	...
	35654485	30-12-2010:12.12	check ticket	Mike	100	...
	35654487	30-12-2010:14.16	examine casually	Pete	400	...
	35654488	05-01-2011:11.22	decide	Sara	200	...
	35654489	08-01-2011:12.05	pay compensation	Ellen	200	...
3	35654521	30-12-2010:14.32	register request	Pete	50	...
	35654522	30-12-2010:15.06	examine casually	Mike	400	...
	35654524	30-12-2010:16.34	check ticket	Ellen	100	...
	35654525	06-01-2011:09.18	decide	Sara	200	...
	35654526	06-01-2011:12.18	reinitiate request	Sara	200	...
	35654527	06-01-2011:13.06	examine thoroughly	Sean	400	...
	35654530	08-01-2011:11.43	check ticket	Pete	100	...
	35654531	09-01-2011:09.55	decide	Sara	200	...
	35654533	15-01-2011:10.45	pay compensation	Ellen	200	...

- What is the next activity for this case?
- When is this next activity going to take place?
- How long is this case still going to take until it is finished?
- What is the outcome of this case? Is the compensation going to be paid? Or rejected?

Current situation

Sequence encoding(1)

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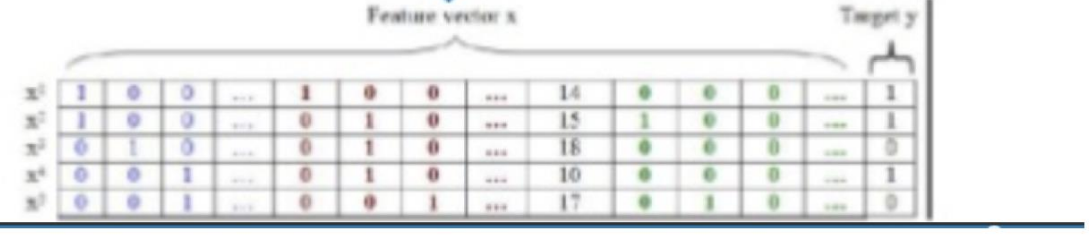
Case ID	Timestamp	Activity	Resource	Loan goal	Requested amt	Offered amt
C001	18-10-2016	Check completeness	Sue	Mortgage	100 000	-
C001	19-10-2016	Check credit history	Sue	Mortgage	100 000	-
C001	19-10-2016	Calculate risk score	Bob	Mortgage	100 000	-
C001	20-10-2016	Make offer	Mike	Mortgage	100 000	70 000
C001	25-10-2016	Make offer	Mike	Mortgage	100 000	80 000
C002	20-10-2016	Check completeness	Sue	Car	15 000	-
C002	20-10-2016	Check credit history	Sue	Car	15 000	-
C002	22-10-2016	Calculate risk score	Elsa	Car	15 000	-
C002	24-10-2016	Reject application	Elsa	Car	15 000	-
C003	02-11-2016	Check completeness	Maria	Mortgage	30 000	-
C003	04-11-2016	Ask for additional data	Maria	Mortgage	30 000	-
C003	10-11-2016	Check credit history	Maria	Mortgage	30 000	-
...	...	...	...	...	...	...



Sequence encoding(2)

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Case ID	Timestamp	Activity	Resource	Loan goal	Requested amt	Offered amt
C001	18-10-2016	Check completeness	Sue	Mortgage	100 000	-
C001	19-10-2016	Check credit history	Sue	Mortgage	100 000	-
C001	19-10-2016	Calculate risk score	Bob	Mortgage	100 000	-
C001	20-10-2016	Make offer	Mike	Mortgage	100 000	70 000
C001	25-10-2016	Make offer	Mike	Mortgage	100 000	80 000
C002	20-10-2016	Check completeness	Sue	Car	15 000	-
C002	20-10-2016	Check credit history	Sue	Car	15 000	-
C002	22-10-2016	Calculate risk score	Elsa	Car	15 000	-
C002	24-10-2016	Reject application	Elsa	Car	15 000	-
C003	02-11-2016	Check completeness	Maria	Mortgage	30 000	-
C003	04-11-2016	Ask for additional data	Maria	Mortgage	30 000	-
C003	10-11-2016	Check credit history	Maria	Mortgage	30 000	-
...	...	...	...	...	...	...

- Index-based encoding

id	loan goal	activity_1	...	activity_m	amount_1	...	amount_m	label
1	mortgage	check completeness	...	make offer	0	...	80 000	1
2	car	check completeness	...	calculate risk score	0	...	0	0

- Aggregation encoding

id	loan goal	count(check compl-ness)	...	count(make offer)	min(amt)	...	max(amt)	label
1	mortgage	1	...	1	0	...	80 000	1
2	car	1	...	0	0	...	0	0

- LSTM

id	event	loan goal	event	amount	label
1	1	mortgage	check completeness	0	1
	...	...	...	...	
	m	mortgage	make offer	80 000	
2	1	car	check completeness	0	0
	...	...	...	...	
	m	car	calculate risk score	0	

Predictive Monitoring with Unstructured Data

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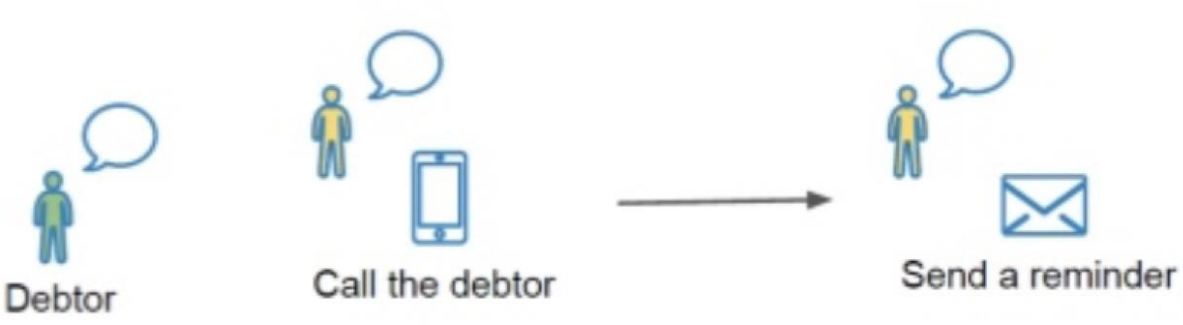

	Event1	Event2	Resource1	Resource2	Debtor	Summary1	Summary2
Trace1	Call the debtor	Send a reminder	Sue	Bob	Mark	?	?

Text Mining

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Text-Extended Index-Based Encoding

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	Event1	Event2	Resource1	Resource2	Debtor	t_{11}	...	t_{1n}	t_{21}	...	t_{2n}
Trace1	Call the debtor	Send a reminder	Sue	Bob	Mark	0.2	...	0.1	0.4	...	0.4

- Bag-of-N-grams
- Weighted bag-of-N-grams
- Latent Dirichlet Allocation (LDA)
- Paragraph Vector (PV)

LSTM-Based Predictive Process Monitoring

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