

Wat is er nieuw in de wereld van **process mining**?

SAI Webinar – 2022-05-11

dr. Gert Janssenswillen



studiecentrum voor automatische informatieverwerking vzw



About me

BIARU

Business Informatics
Applied Research Unit



UHASSELT

dr. Gert Janssenswillen

2014-2019

PhD candidate – Research group Business Informatics (BINF)
FWO PhD Fellow

*Unearthing the real process behind the event data:
The case for increased process realism*

Since 2016

Lean maintainer of bupaR

Since 2019

*BIARU – Applied Research Unit
Hasselt University*

Onderzoek

Process mining

*Process conformance & quality
Operational Excellence
Learning analytics*

Onderwijs

Explorative & Descriptive Data Analytics



Process Mining?



Business Process Intelligence

Business Process Analytics

Process Analytics

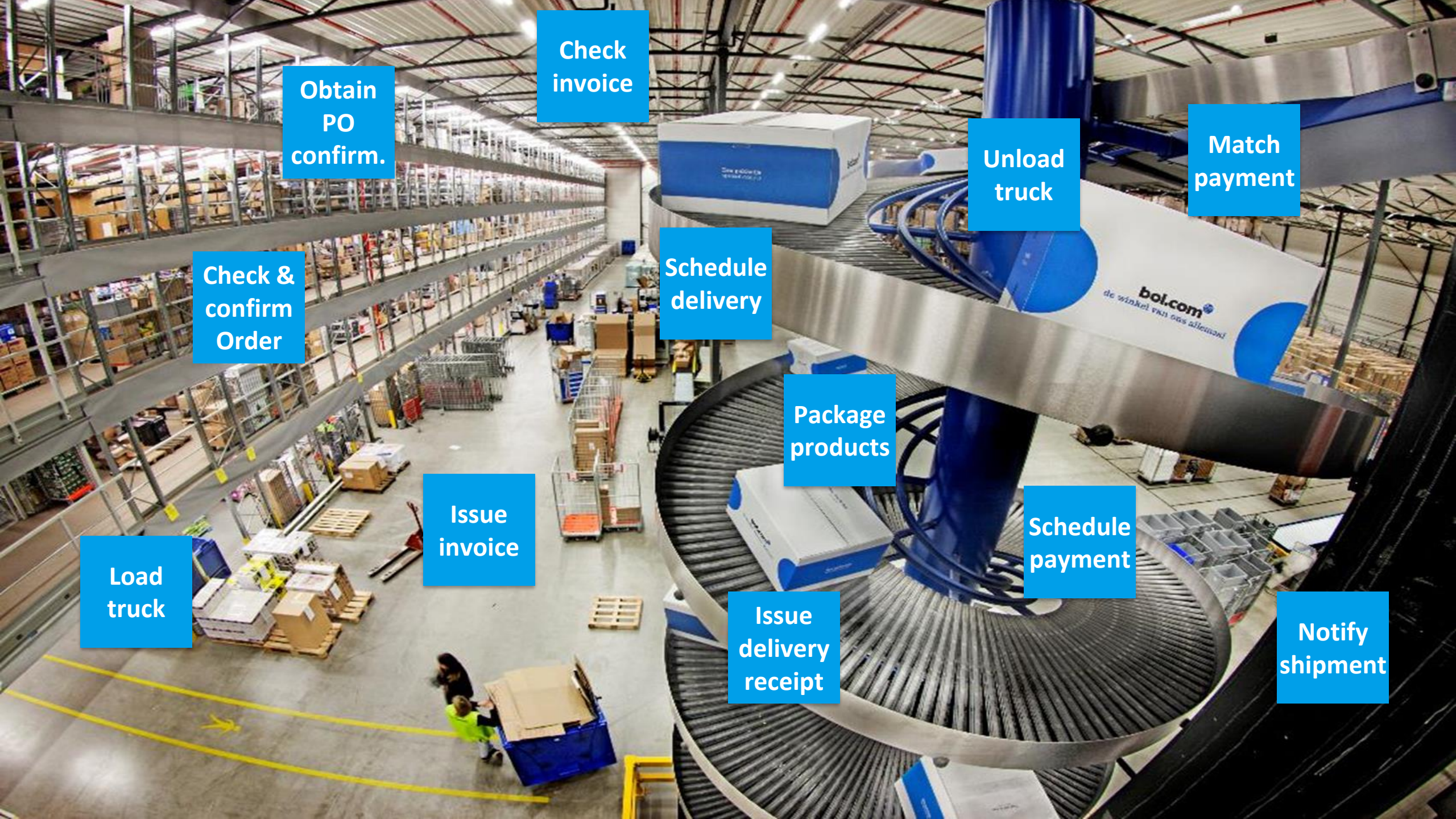
Process Mining?

< Process-oriented thinking >

Business Process Reengineering

Automated Business Process Discovery

Workflow Mining



Obtain
PO
confirm.

Check
invoice

Unload
truck

Match
payment

Check &
confirm
Order

Schedule
delivery

Package
products

Schedule
payment

Load
truck

Issue
invoice

Issue
delivery
receipt

Notify
shipment

Middelen & Partners

Financiën

Personeel

Technologie

Activa

Organisatie

Functie A

A

B

C

D

Functie B

E

F

G

H

Functie C

I

J

K

L

Klanten



Middelen & Partners

Financiën

Personeel

Technologie

Activa

Organisatie

Functie A

Functie B

Functie C

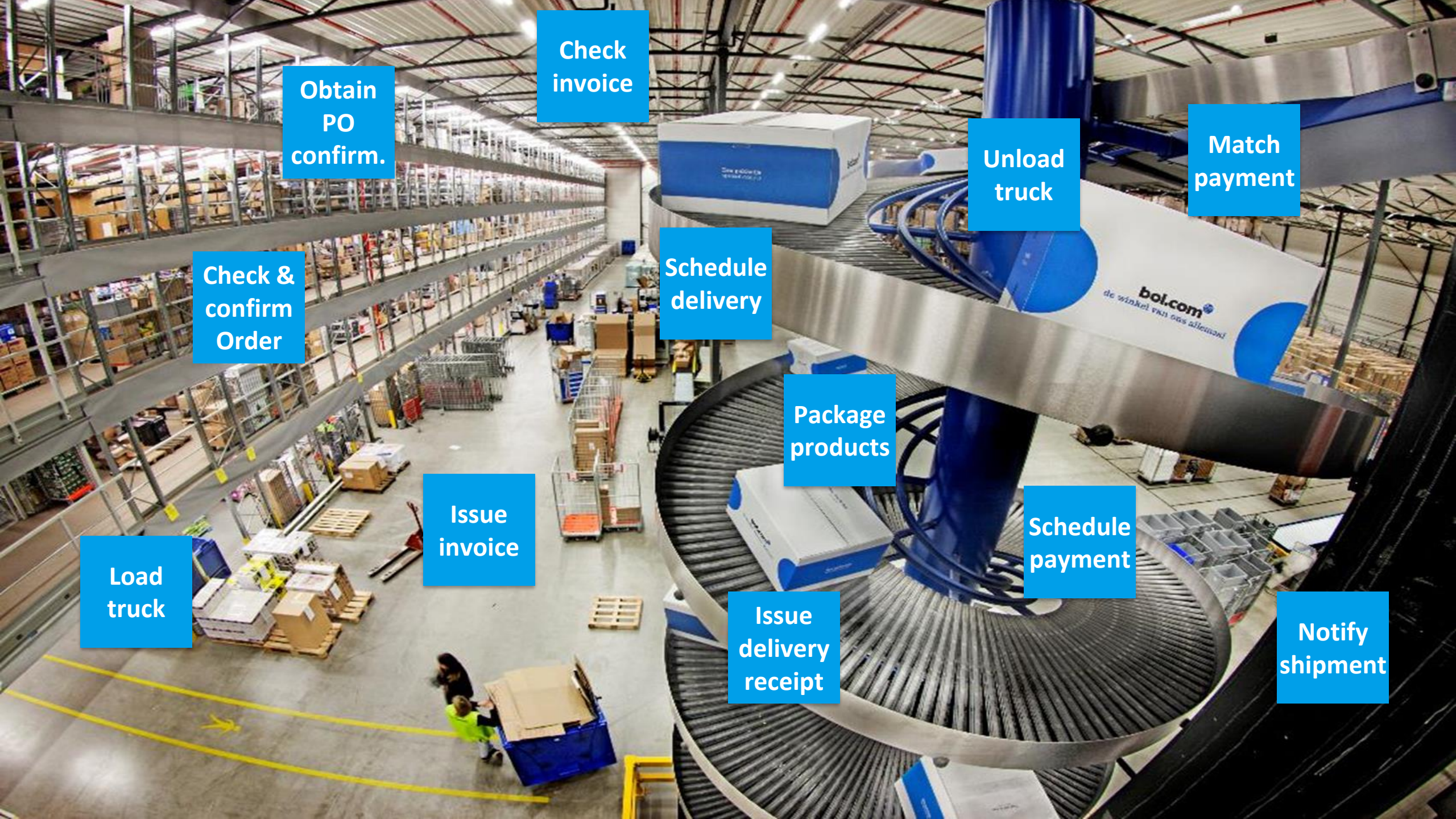
Business Process

Business Process

Business Process

Klanten





Obtain
PO
confirm.

Check
invoice

Unload
truck

Match
payment

Check &
confirm
Order

Schedule
delivery

Package
products

Schedule
payment

Load
truck

Issue
invoice

Issue
delivery
receipt

Notify
shipment

Bedrijfsproces

Een bedrijfsproces is een set van activiteiten die op een gecoördineerde wijze uitgevoerd worden met een specifiek bedrijfsdoel voor ogen

"A set of logically related tasks performed to achieve a defined business outcome."

Davenport (1990)

Voorbeelden

Order-to-Cash

Procure-to-Pay

Application-to-Approval

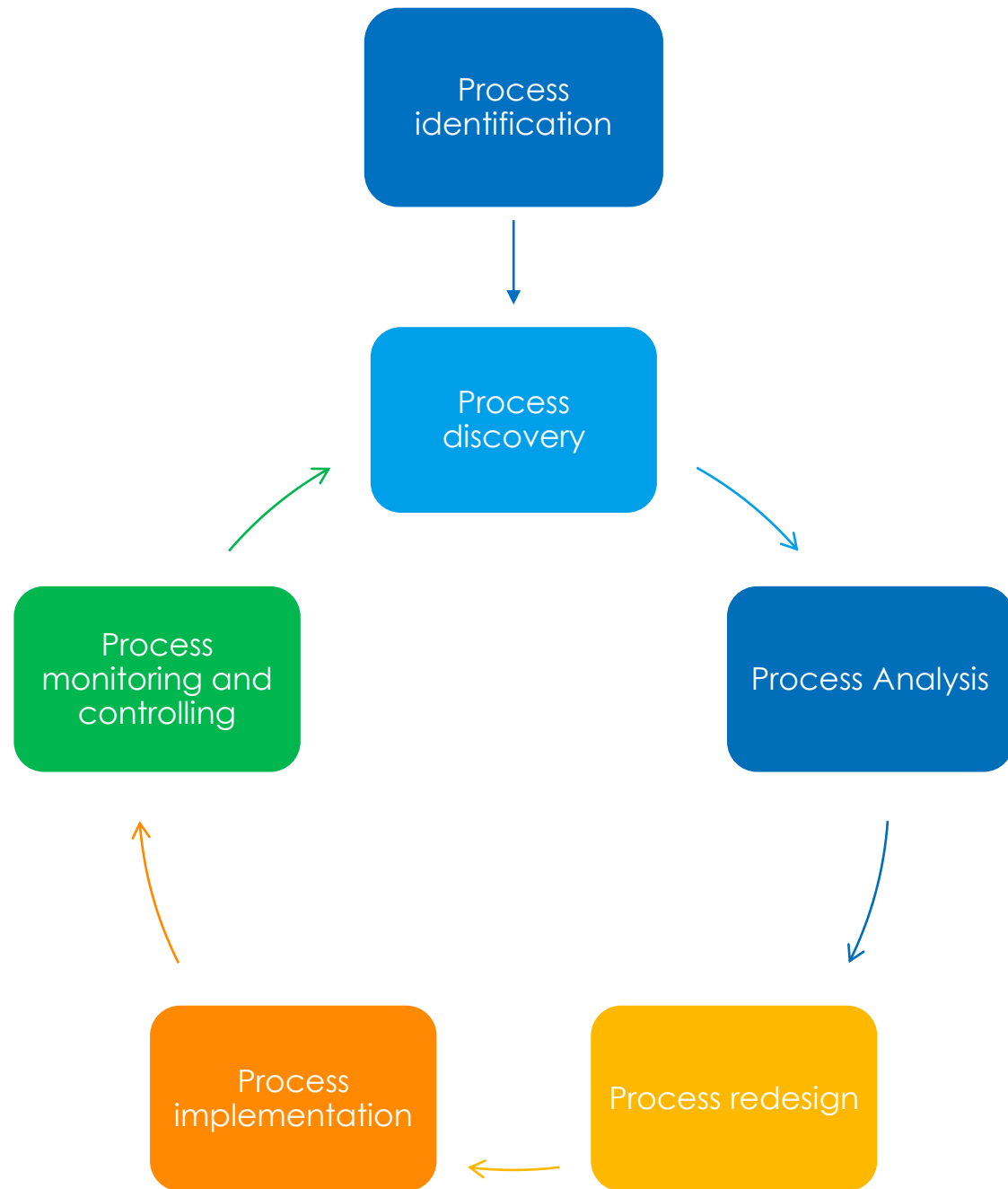
Complaint-to-Resolution

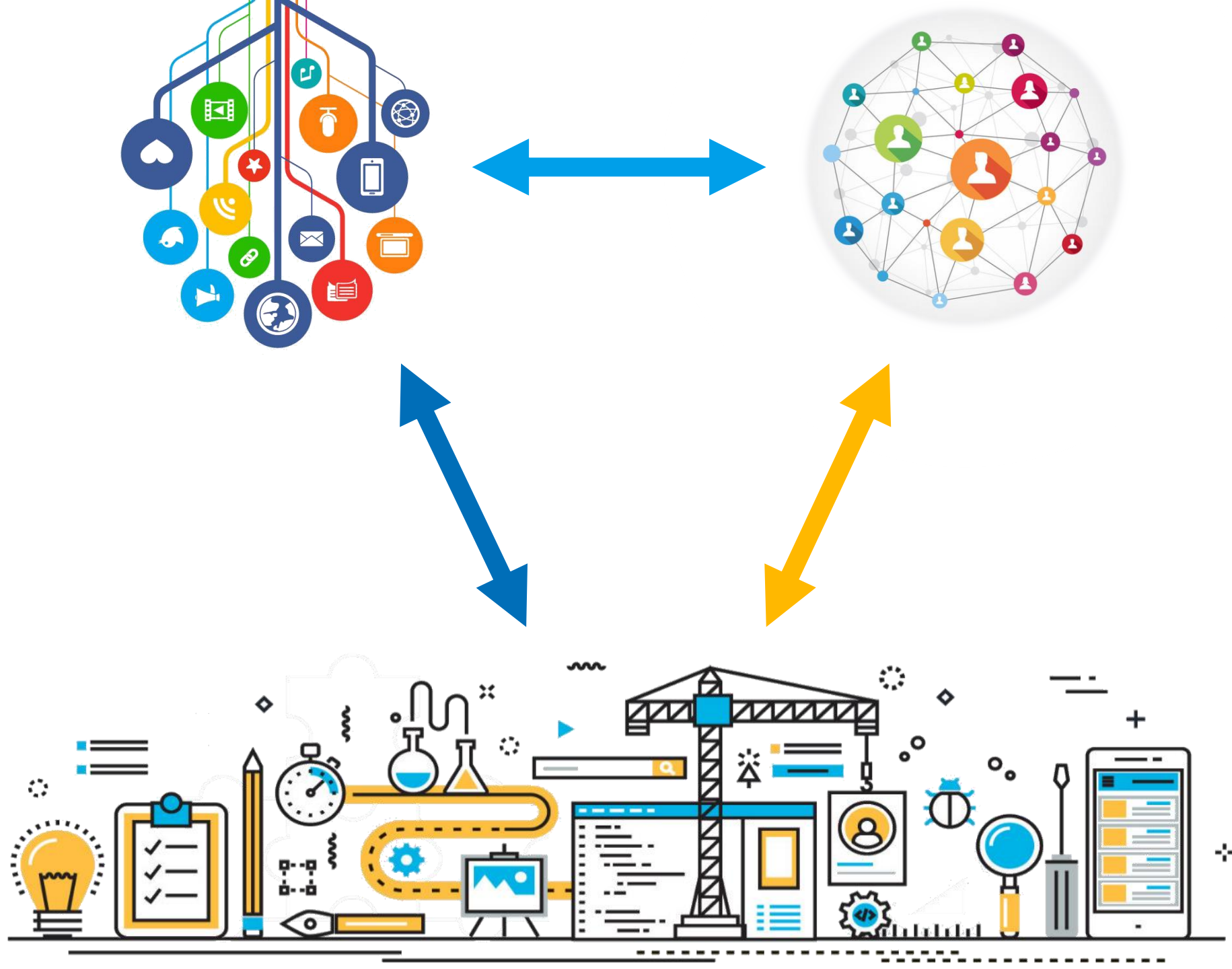
Fault-to-Resolution

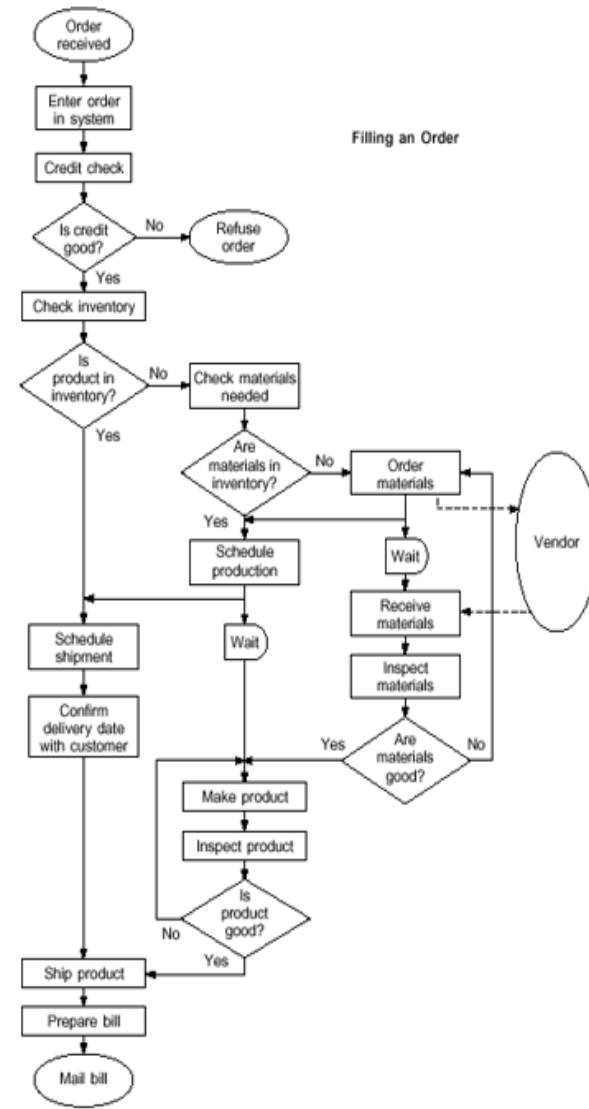
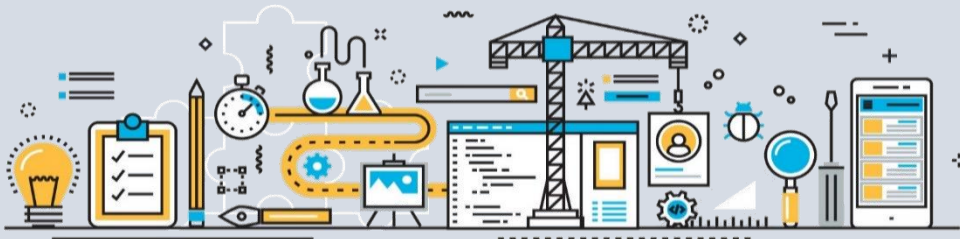
Processen onder controle?



BPM lifecycle







Verschil tussen ideale wereld en realiteit...

McDONALDS **BIG MAC**

ADVERTISEMENTS



ACTUAL BIG MAC
- ROTATED TO MOST ATTRACTIVE ANGLE



Reden 1

Uitzonderingen



Reden 2

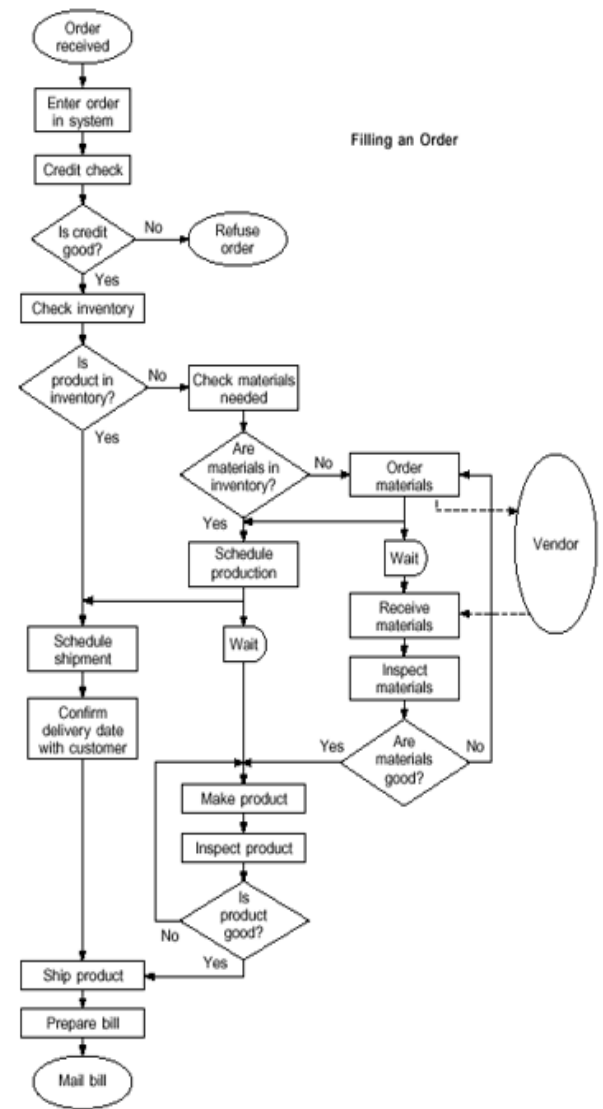
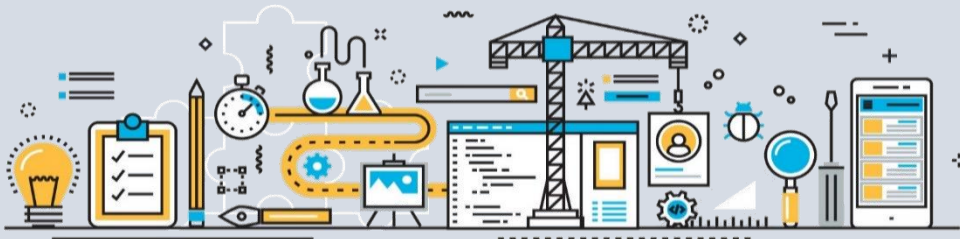
Processen veranderen



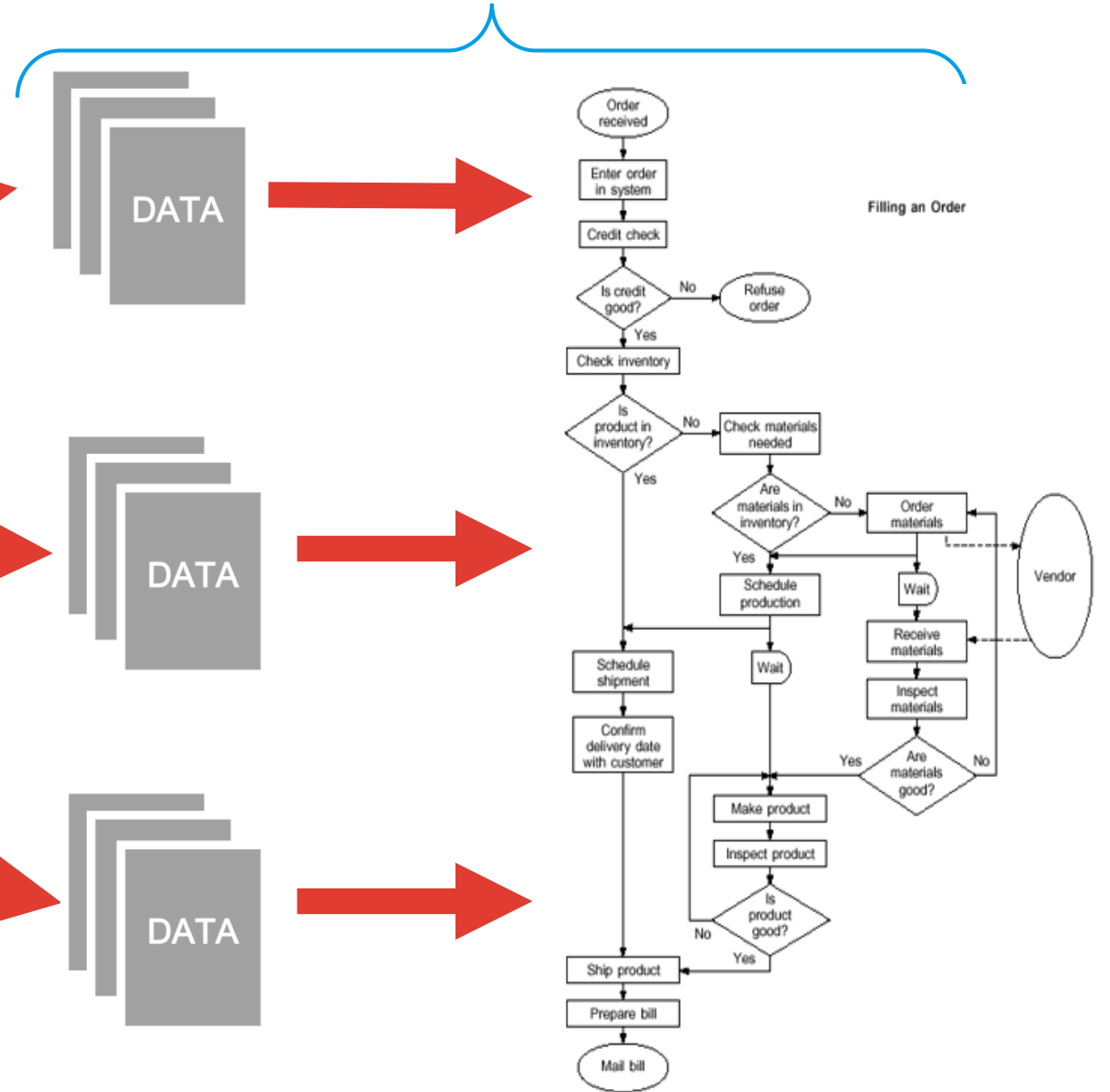
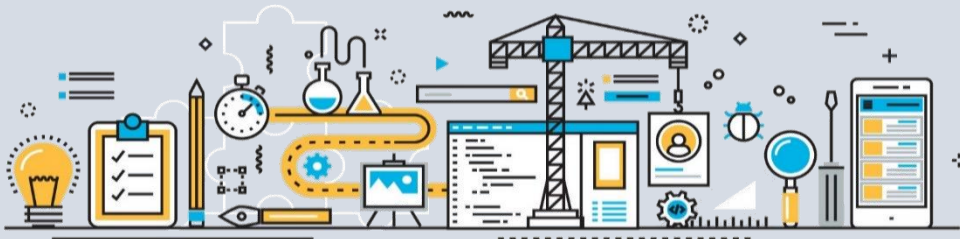


Reden 3

Ieder ziet slechts een deel



Process mining





modeleert

**Ontworpen
processmodel**



IT systems

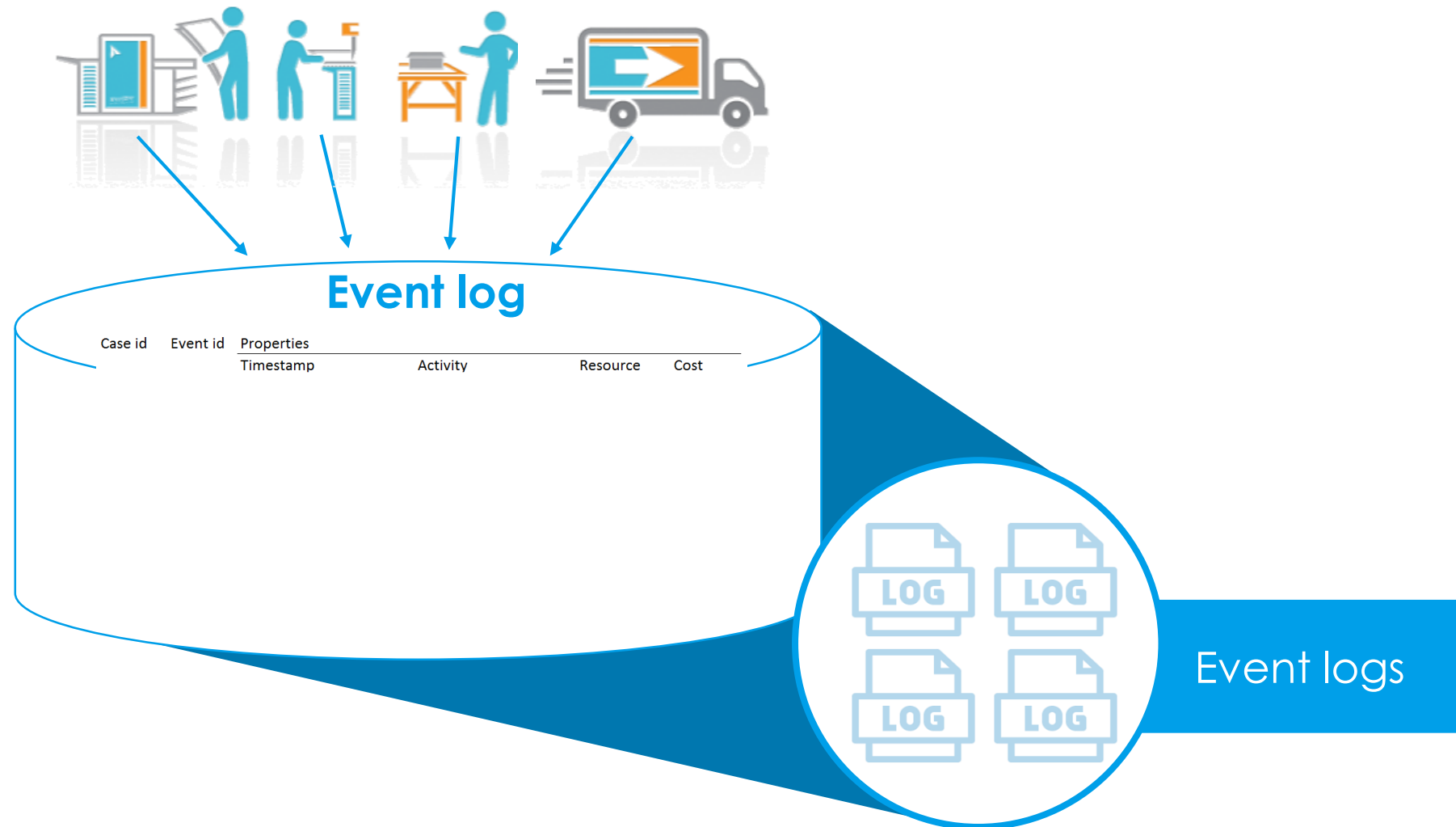


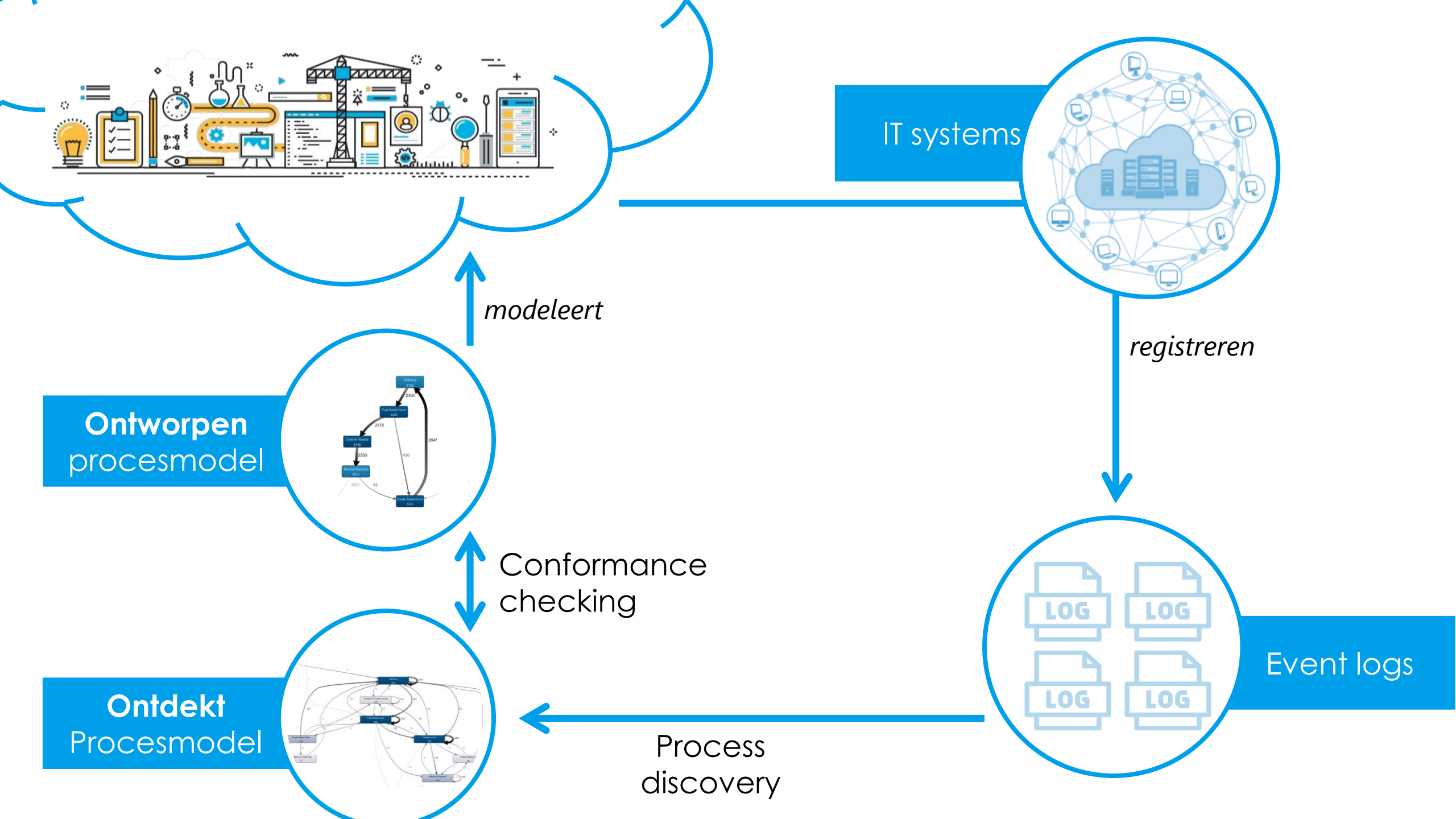
registreren



Event logs

Een logboek van
events – *acties* –
vaak in de
context van een
proces





Terminologie

Case Een proces instantie, e.g. order A101

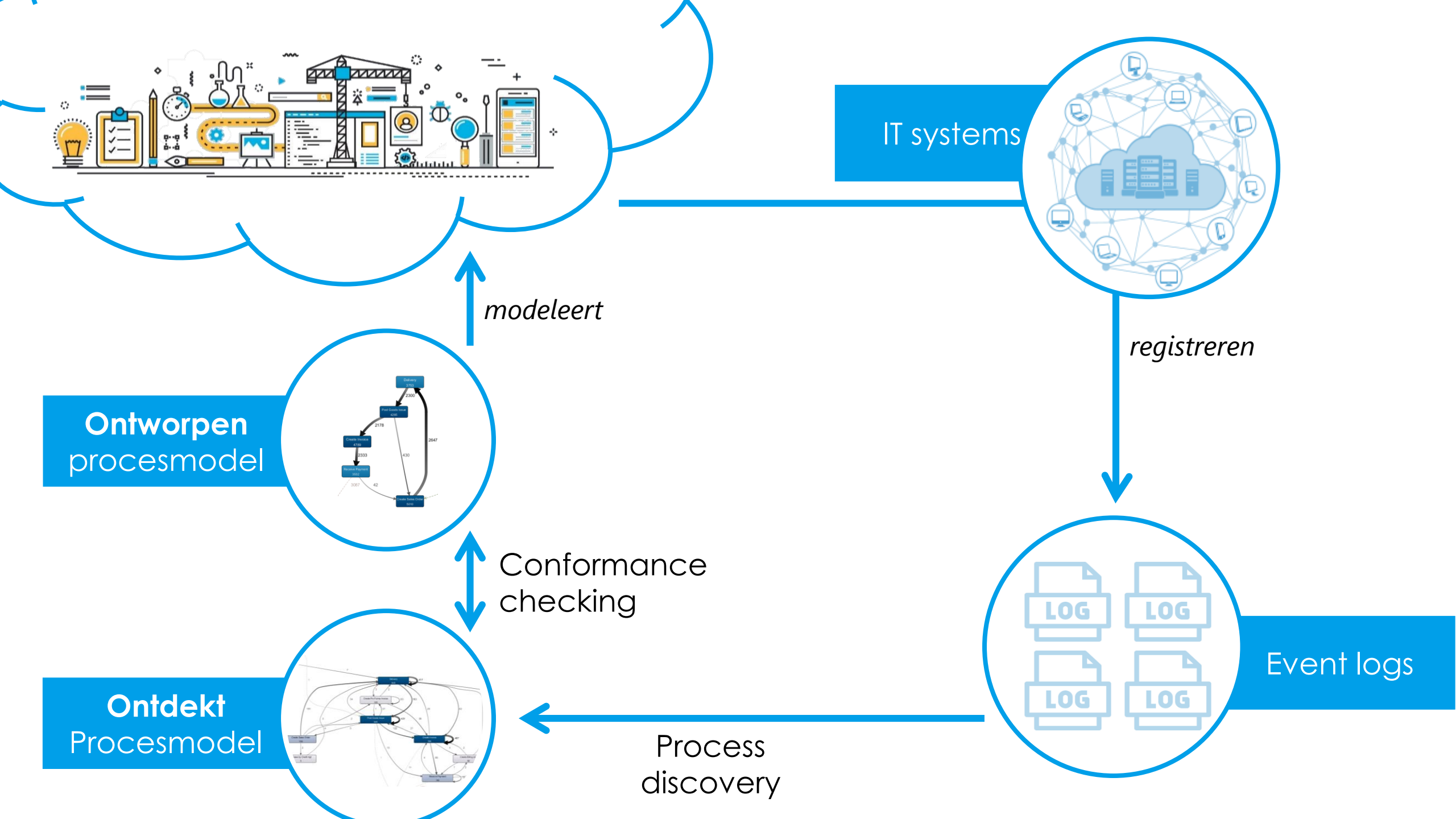
Activiteit Een actie, taak, e.g. delivery

Activiteit instantie Uitvoering van een taak, e.g. delivery 1001

Event Event binnen een uitvoering, e.g. depart delivery 1001

Timestamp Tijdstip van een event

Resource Uitvoerder van een event, e.g. Toon



Desire lines

Gemodelleerd gedrag



Werkelijk gedrag



Niet-problematisch

Nuttig inzicht

Werkelijk gedrag



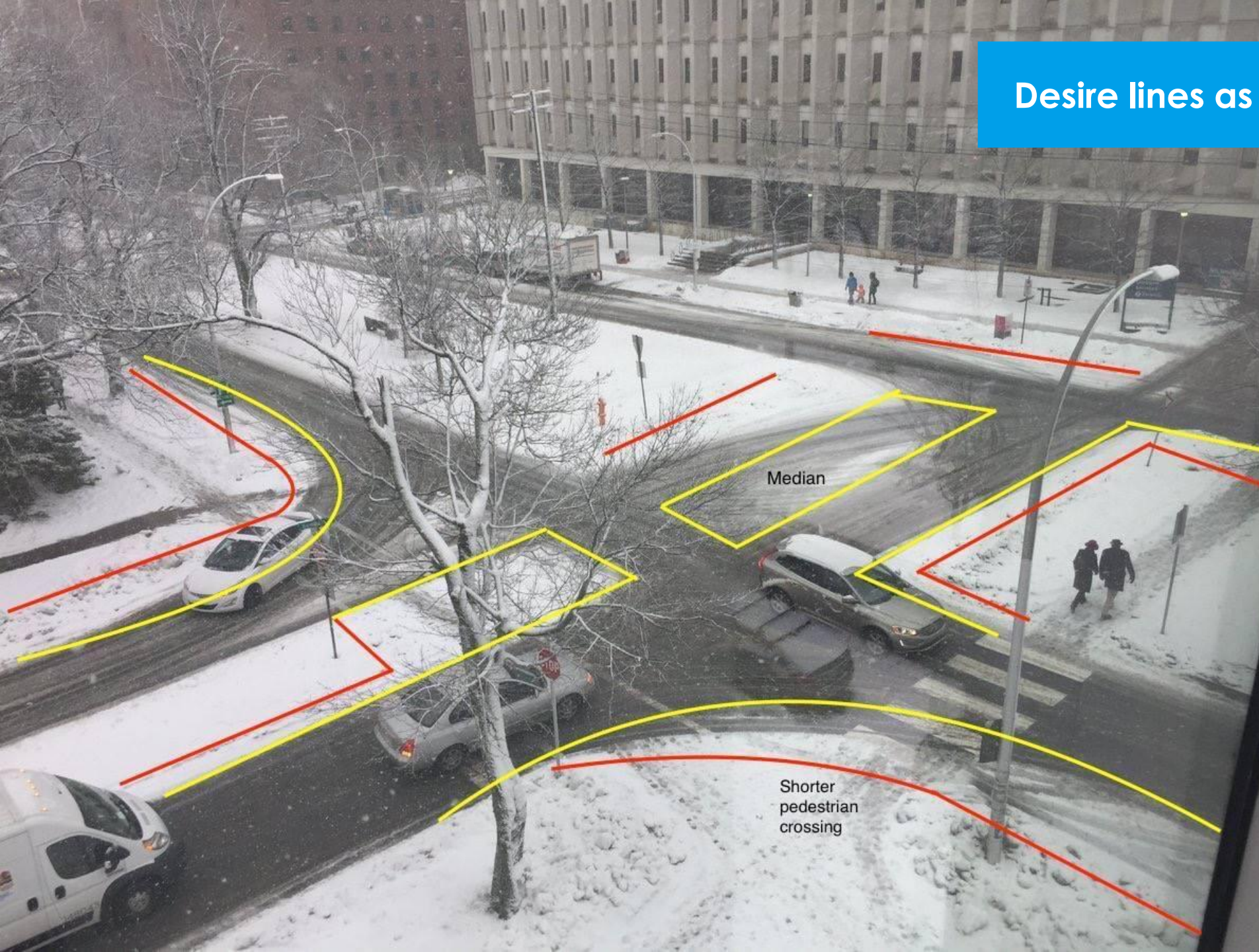
Problematisch

Controle nodig

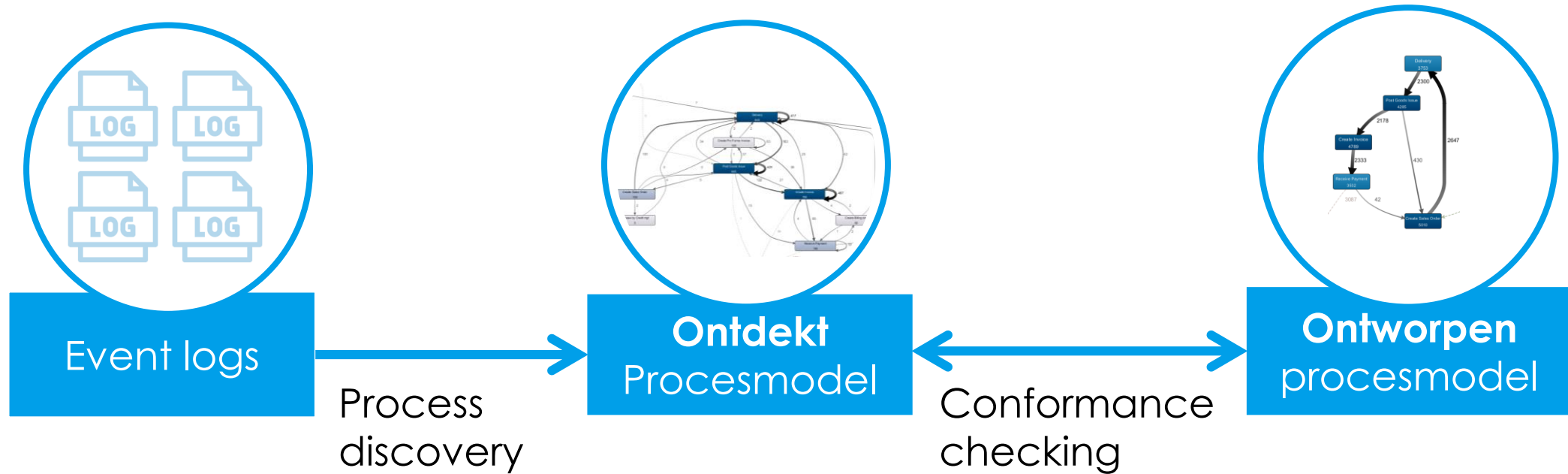
An aerial photograph of the Michigan State University campus during autumn. The image shows several large, multi-story brick buildings with curved and rectangular designs. These buildings are interspersed with green lawns, trees with vibrant orange and yellow foliage, and parking lots filled with cars. A prominent road with multiple lanes runs along the right side of the campus. The overall scene is a well-maintained university environment.

Michigan State University
desire lines as input for infrastructure

Desire lines as input for road design



Conceptueel



In praktijk

process mining

verloopt niet altijd sequentieel van aard
is niet altijd gericht op de control-flow
Is niet altijd gericht op het eind-tot-eind proces

Process mining

het **extraheren** van nuttige **inzichten**

over **processen**

op basis van **data**

met het oog op **verbeteringen** in performantie en risicobeheer

Confidence-
based
BPM



Evidence-
based
BPM

De waarde van process mining

Begrijp processen
zoals ze zijn

Niet volgens je
verbeelding

Staaf hypotheses
met bewijzen

Niet met intuïtie en
geloof

Kwantificeer de
impact van
redesign opties

Zowel voor als na
implementatie

Enkele voorbeelden





Operational Excellence project

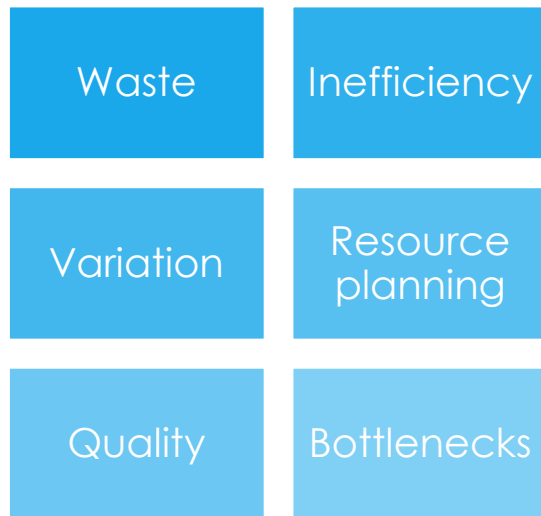
Netbeheerder nutsvoorzieningen

Hoe kan **process mining**
toegepast worden met
het oog op **operational
excellence**

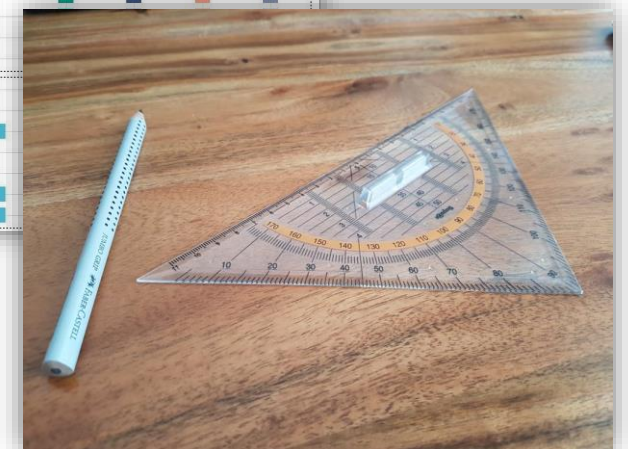
Operational Excellence project

Netbeheerder nutsvoorzieningen

Meten van **kwalitatieve concepten**

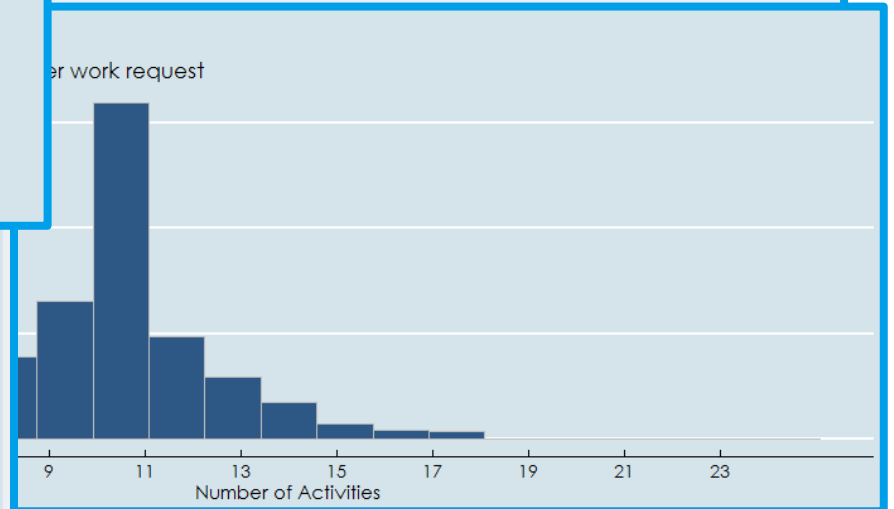
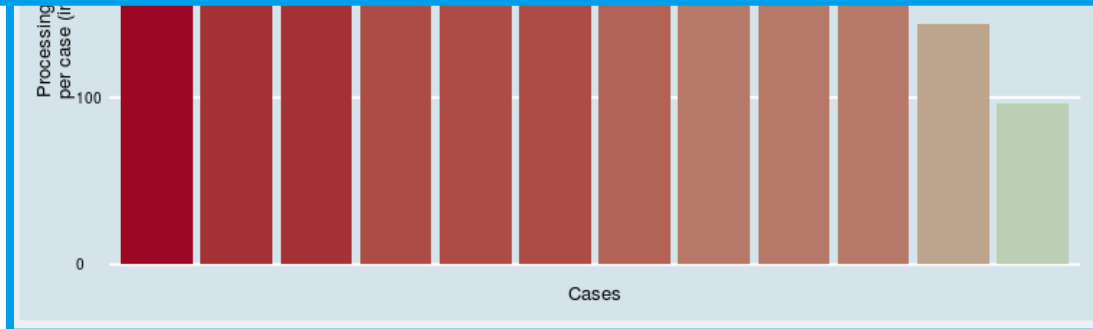
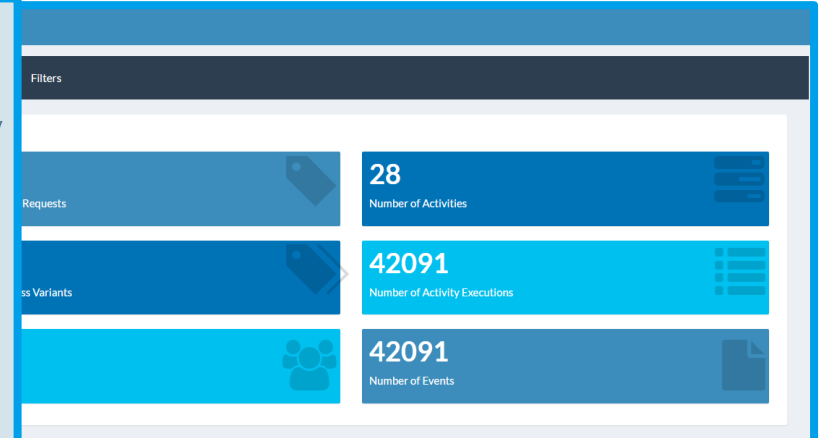
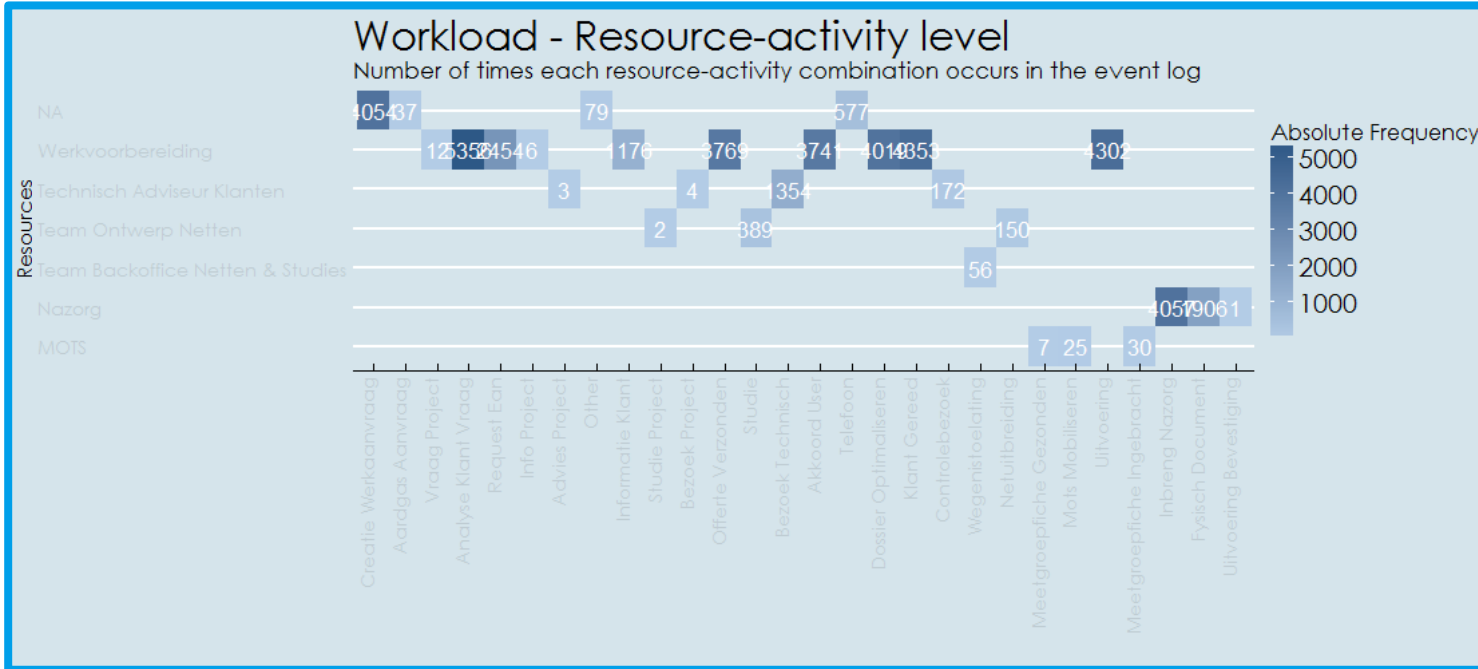


		Level of analysis					
		Log	Trace	Case	Activity	Resource	Resource-activity
Time	Idle Time	■	■	■		■	■
	Processing Time	■	■	■	■		■
	Throughput Time	■	■	■			
Organizational	Resource Frequency	■		■	■	■	■
	Resource Involvement					■	■
	Resource Specialisation	■		■		■	
Structuredness	Rework	■		■	■	■	■
		■		■	■	■	■
		■		■	■	■	■
	Number of Redo - Repetitions	■		■	■	■	■
		■		■	■	■	■
		■		■	■	■	■
	Number of Repeat - Repetitions	■		■	■	■	■
		■		■	■	■	■
		■		■	■	■	■
	Number of Repeat - Self-loops	■		■	■	■	■
Variance	Number of Traces	■					
	Activity Presence		■				
	Activity Frequency	■	■				
	End Activities	■					
	Start Activities	■					
	Trace Coverage	■	■				
	Trace Length	■	■				



Operational Excellence project

Netbeheerder nutsvoorzieningen



Capacity management

Infrabel

INFRABEL
Right On Track

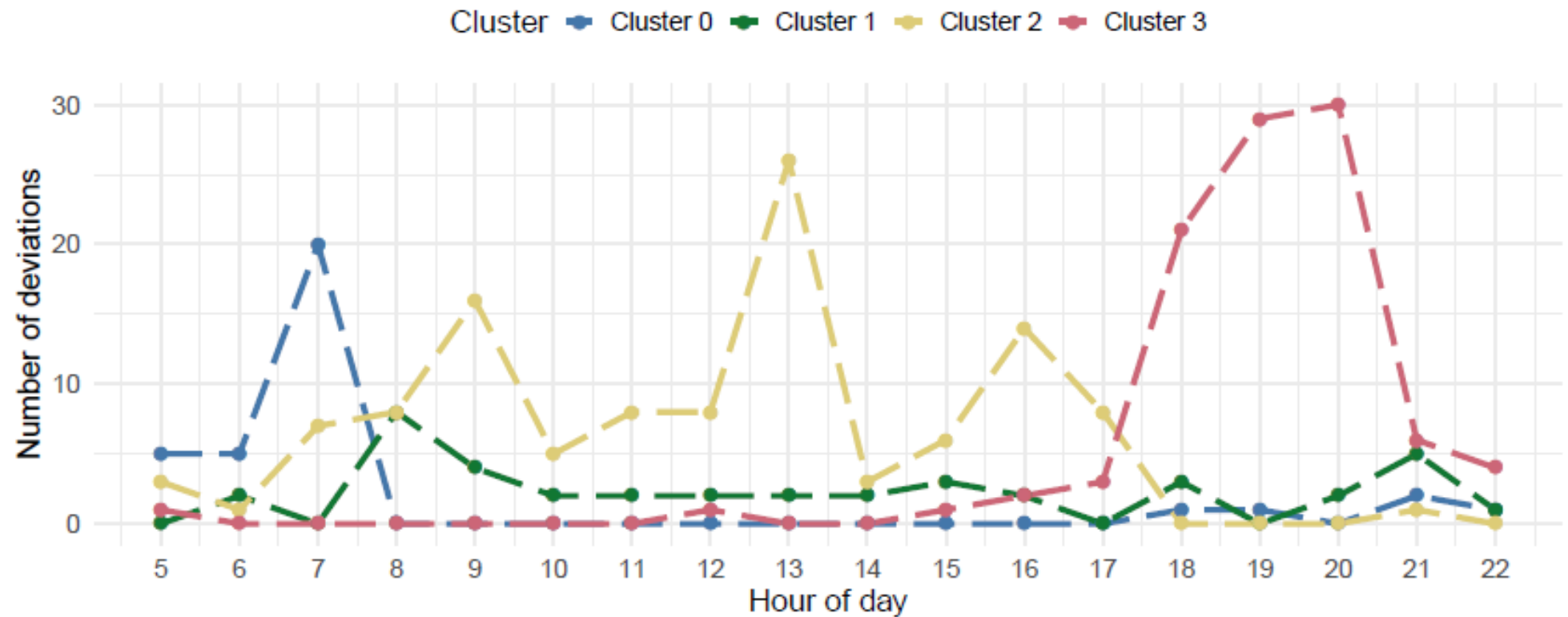
Wanneer wijken treinen af van hun toegewezen capaciteit?

Zijn er patronen in deze afwijken?

Hoe kan de dienstregeling geoptimaliseerd worden?

Capacity management

Infrabel



Learning Analytics

Studieloopbaan analyse Hoger Onderwijs



Is het gedrag van de student in overeenstemming met het voorgeschreven programma



Hoe nemen studenten beslissingen over hun traject?

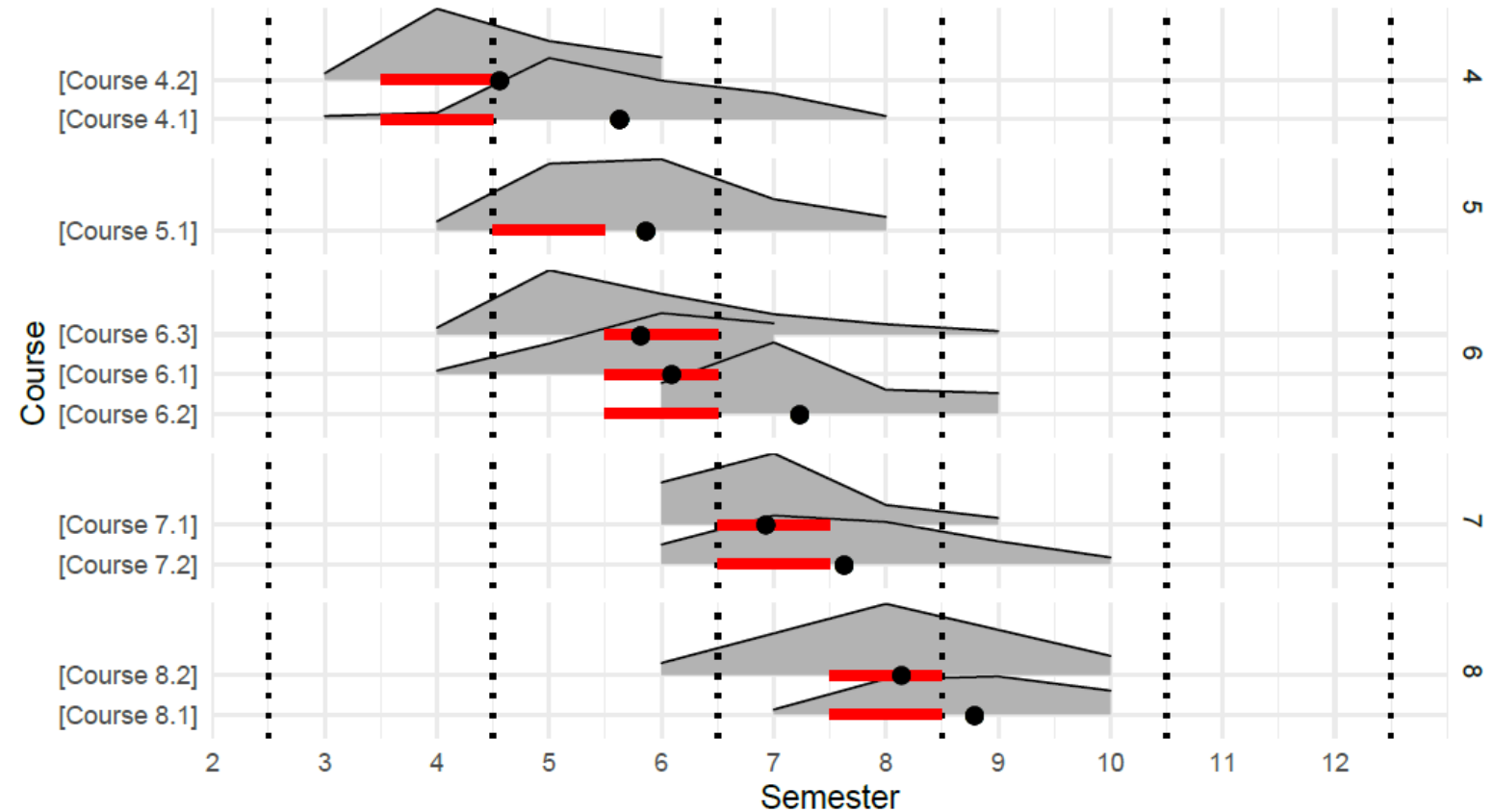


Wat is de impact van onvoldoendes?

Learning Analytics

Studieloopbaan analyse Hoger Onderwijs

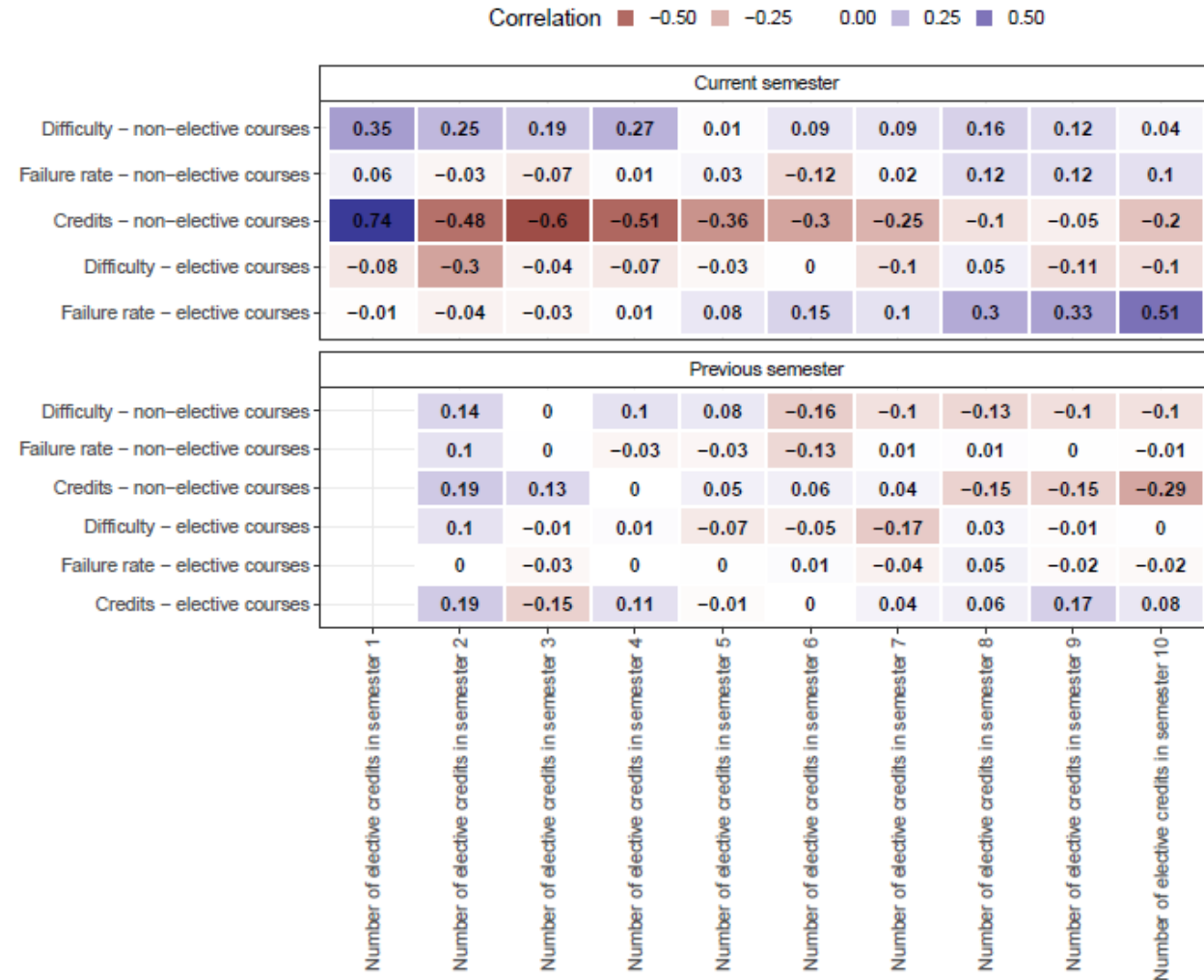
Is het gedrag van de student in overeenstemming met het voorgeschreven programma?



Learning Analytics

Top-ranked university Latin America

Hoe nemen studenten **beslissingen** met betrekking tot hun traject?



A slide titled 'Operational Excellence project' with a background image of high-voltage power lines at sunset. The text is in blue boxes.

Operational Excellence project
Netbeheerder nutsvoorzieningen

Hoe kan **process mining** toegepast worden met het oog op **operational excellence**

A slide titled 'Capacity management' with a background image of railway tracks curving into the distance. The text is in blue boxes.

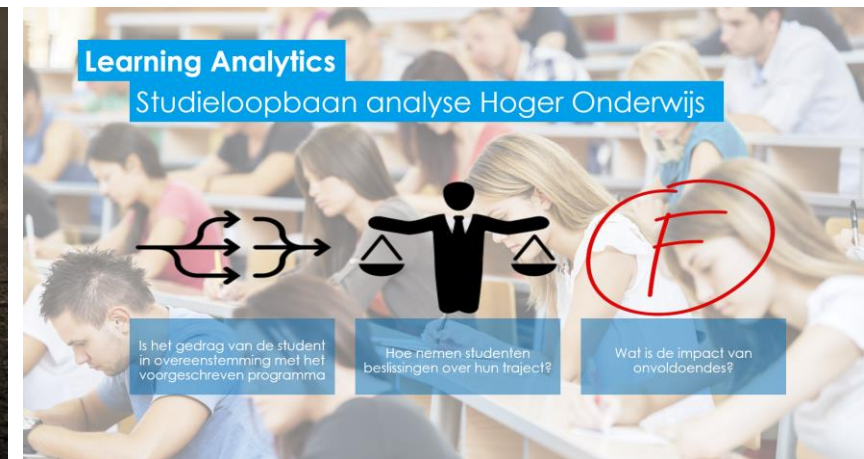
Capacity management
Infrabel

Wanneer wijken treinen af van hun toegewezen capaciteit?

Zijn er patronen in deze afwijken?

Hoe kan de dienstregeling geoptimaliseerd worden?

INFRABEL
Right On Track

A slide titled 'Learning Analytics' with a background image of students in a classroom. The text is in blue boxes, and there are icons for a flowchart, a person with scales, and a red 'F' grade.

Learning Analytics
Studieloopbaan analyse Hoger Onderwijs

Is het gedrag van de student in overeenstemming met het voorgeschreven programma

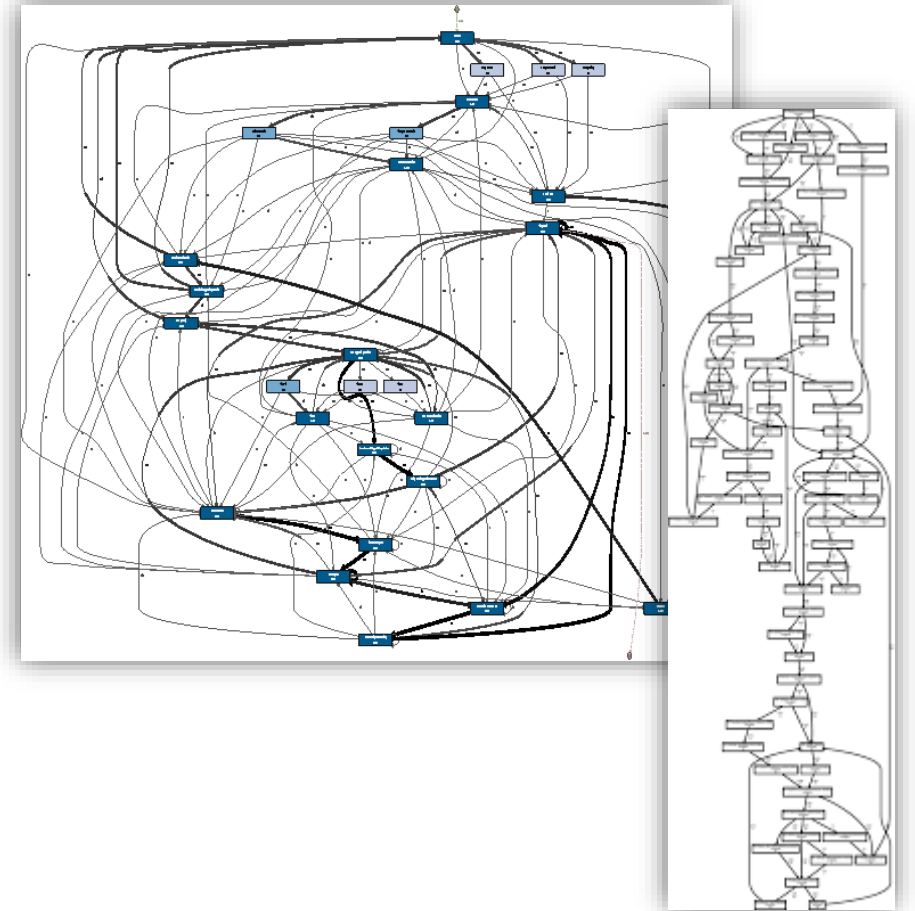
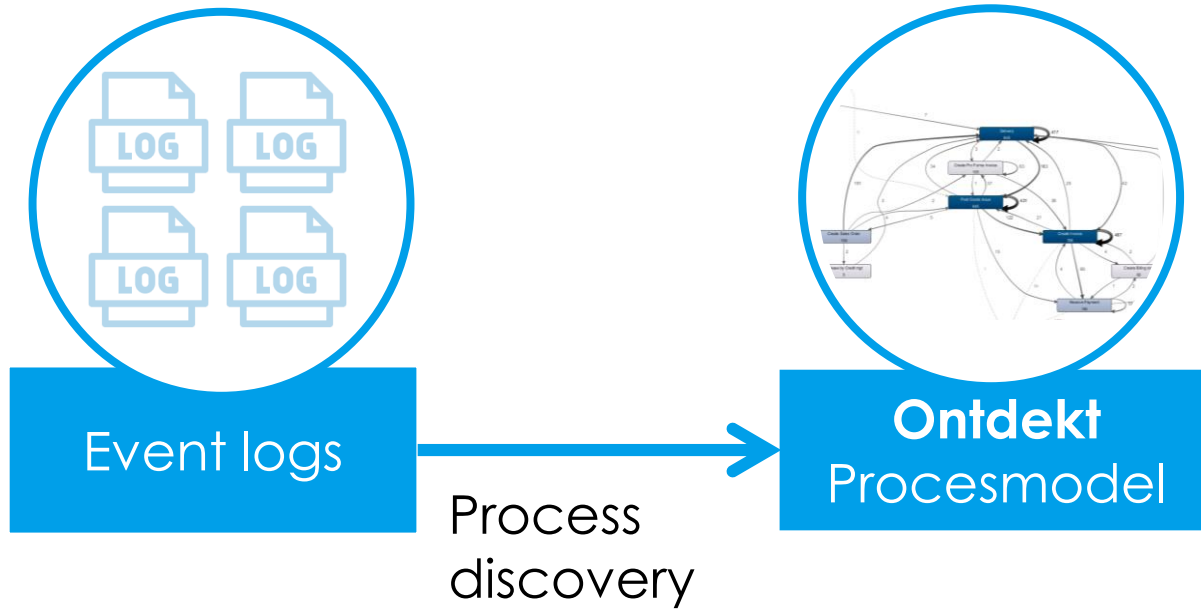
Hoe nemen studenten beslissingen over hun traject?

Wat is de impact van onvoldoendes?

Trends in process mining

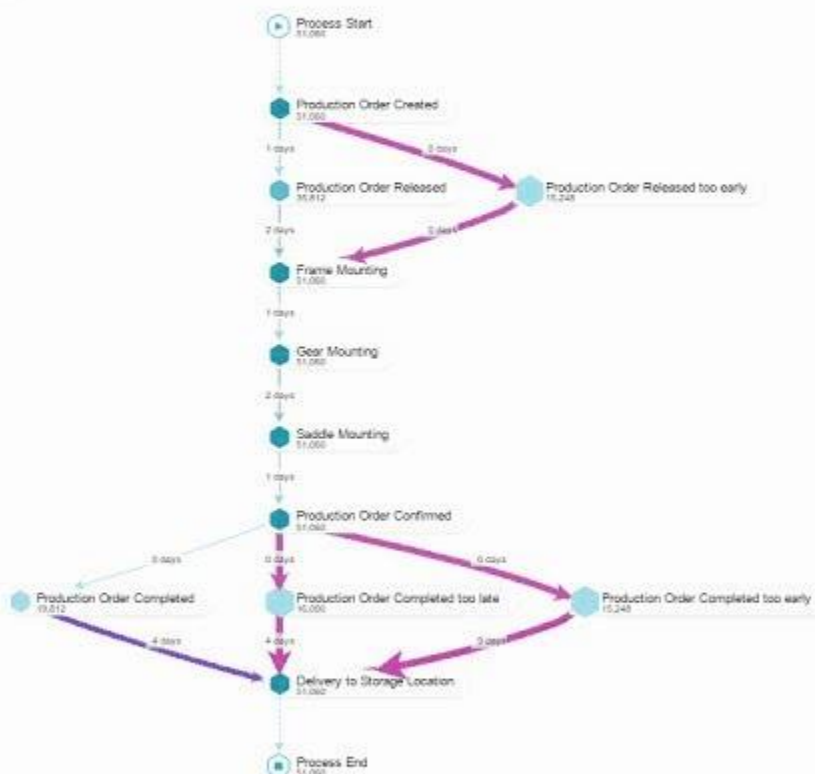


Ongoing challenges



Order Value: 280M €

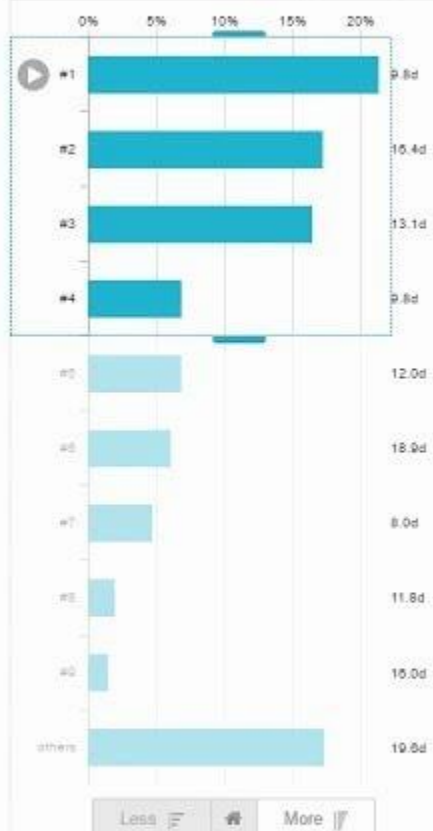
celonis



— Zoom +

Most common variant

Graph ▼



4

of 3,138 variants

62%

of cases covered

10/10



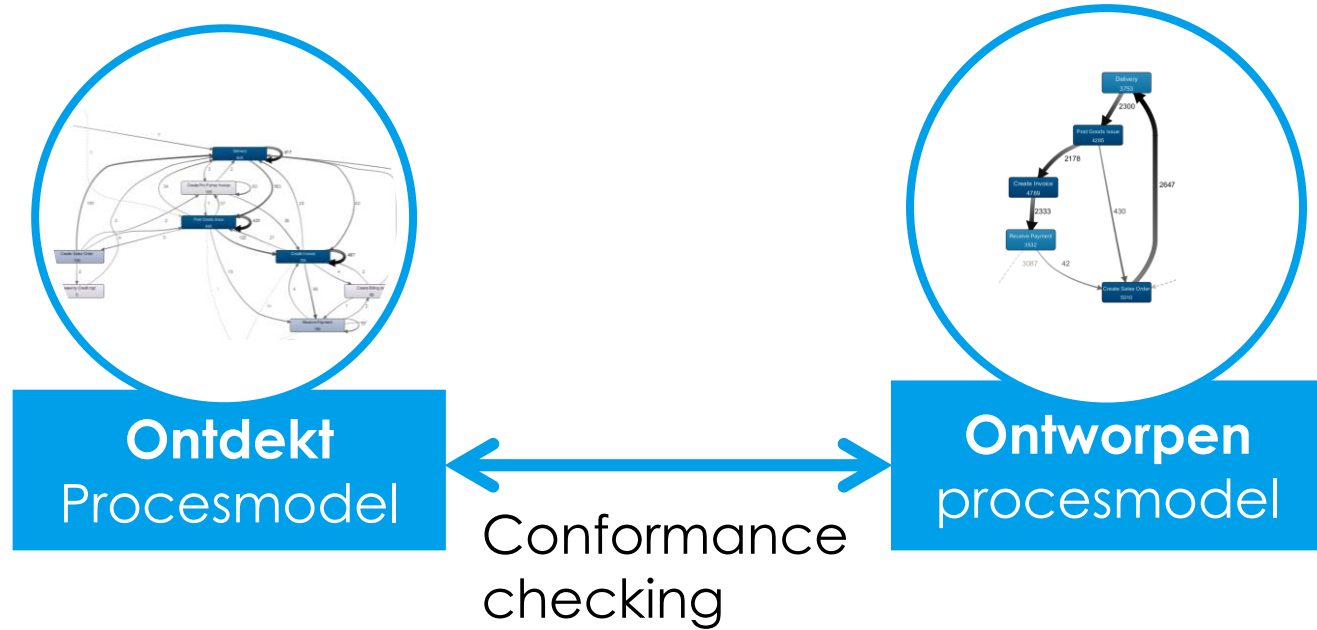
Company Codes



Orders by Plant

Plant	# Orders	Value
Stuttgart	16,708	50.3M €
Chicago	11,128	34.0M €
Toronto	7,780	23.5M €
Dortmund	7,460	22.4M €
Montreal	4,304	12.7M €
San Francisco	4,080	12.5M €
Detroit	3,392	10.3M €
Marseille	3,348	10.2M €
Munich	3,240	9.76M €
Yokohama	3,140	9.39M €
Barcelona	3,144	9.36M €
Madrid	3,048	9.30M €
Vancouver	2,948	9.16M €
Vienna	2,936	8.77M €
Tokyo	2,948	8.77M €
Seoul	2,972	8.74M €
Hong Kong	2,868	8.69M €

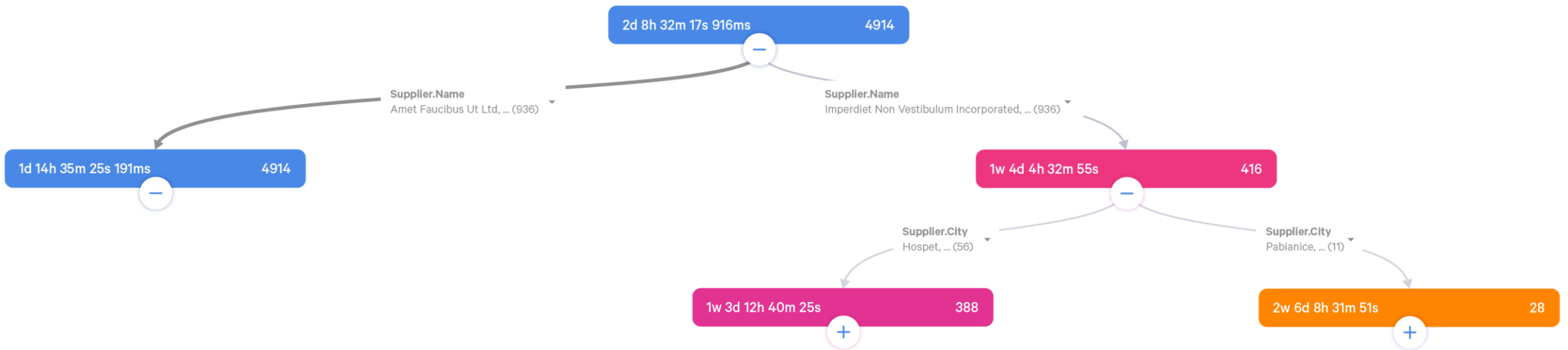
Ongoing challenges



- Multidimensioneel
- Descriptive vs actionable

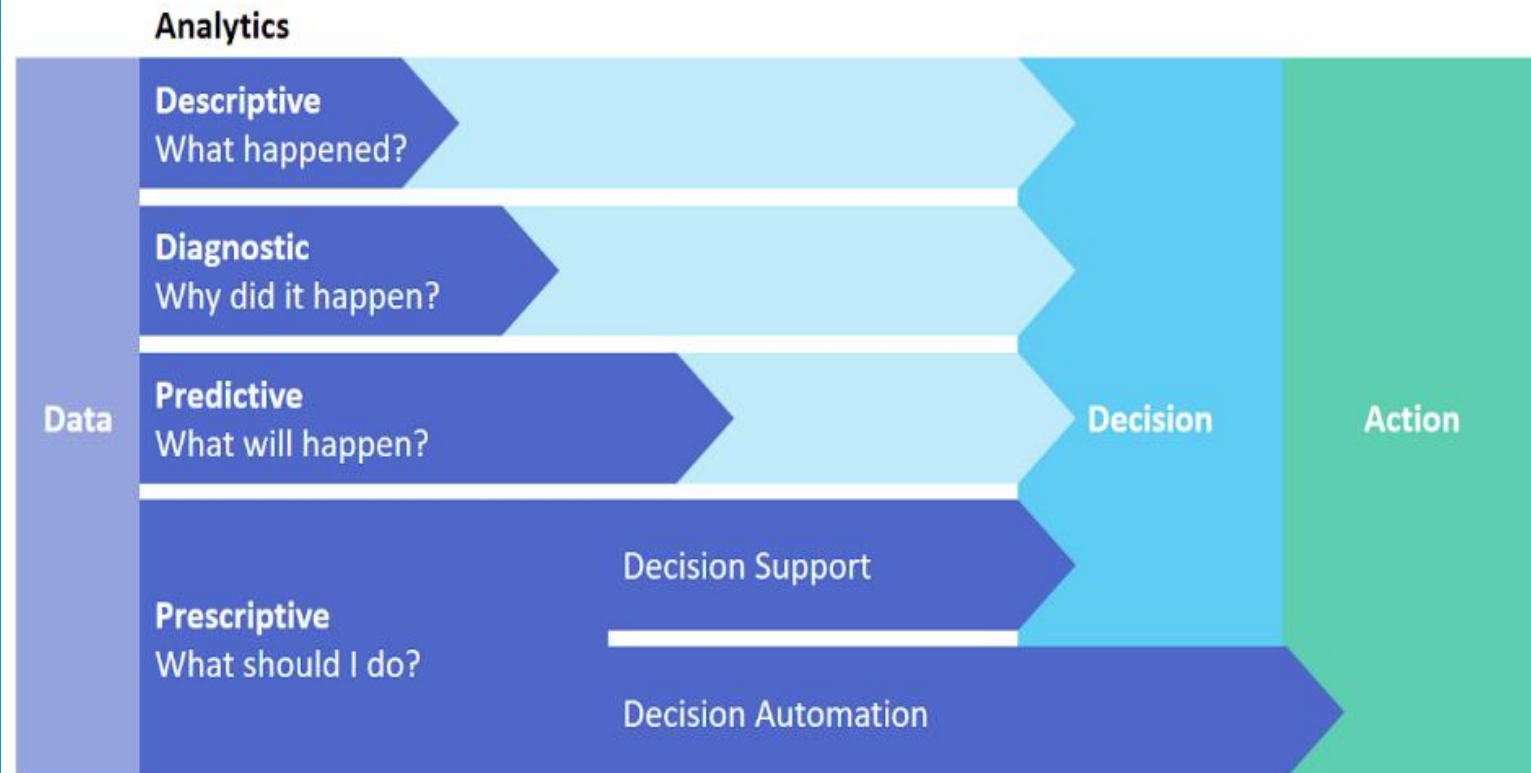
Trends in process mining

Focus on causality



Trends in process mining

Predictive & prescriptive process monitoring



Trends in process mining

Predictive & prescriptive process monitoring

Vele benaderingen

- NN
- LSTM
- CNN
- ...

Verschillende doeleinden

- Prescriptie van volgende stap
- Voorspellen/voorkomen van deviation
- Voorspellen van outcome
- Voorspellen van tijdsduur

Weinig kant-en-klare oplossingen

Trends in process mining IoT / Digital Twins



PROCESS MINING





Workplaces where automation and human workers operate in harmony,

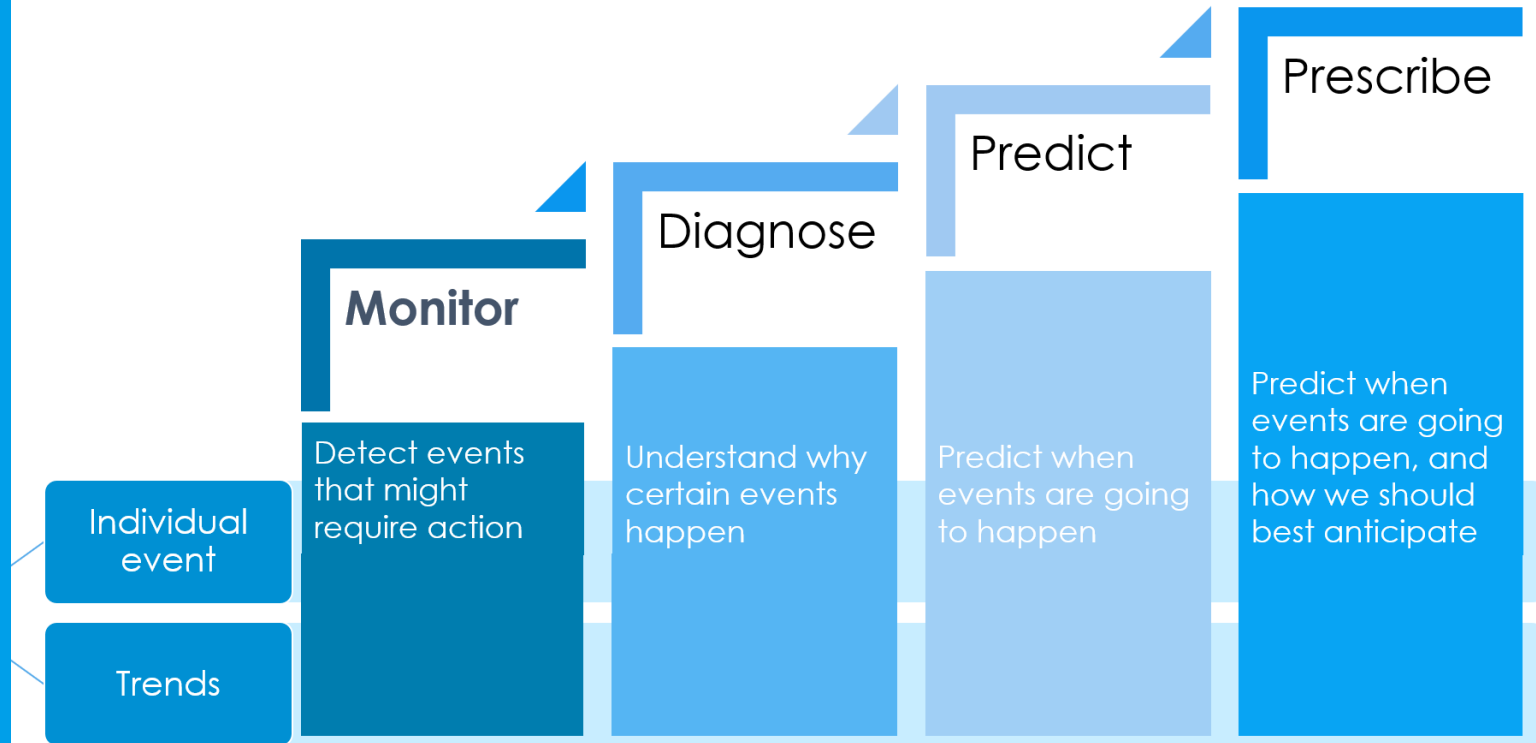
*"SII (Shopfloor Insight Intelligence) is a tool that can be used to **analyse manufacturing processes** as a basis for improvements. It is part of KIT (Knowledge in time), which can **assist industrial workers in completing complex tasks**."*

~Felix Mannhardt, researcher, Sintef

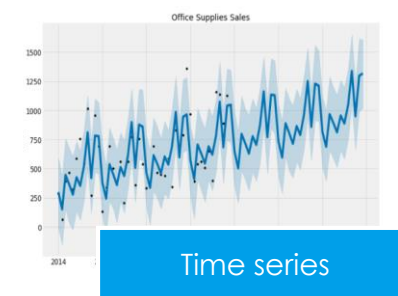
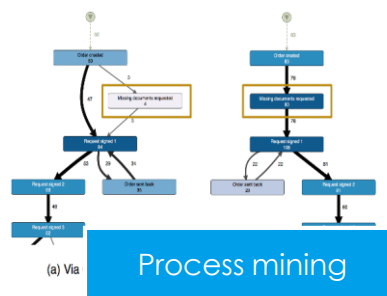
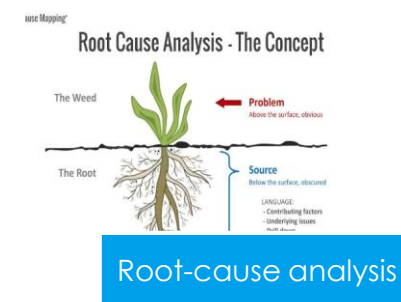
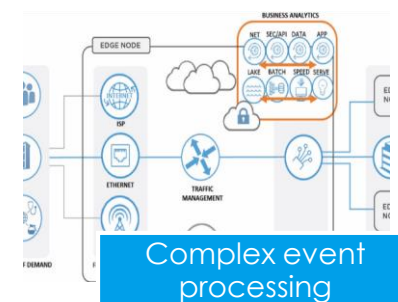
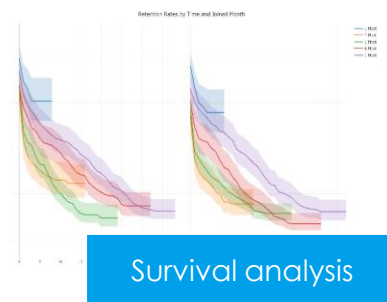


Trends in process mining

Behavioural Analytics / Event Analytics

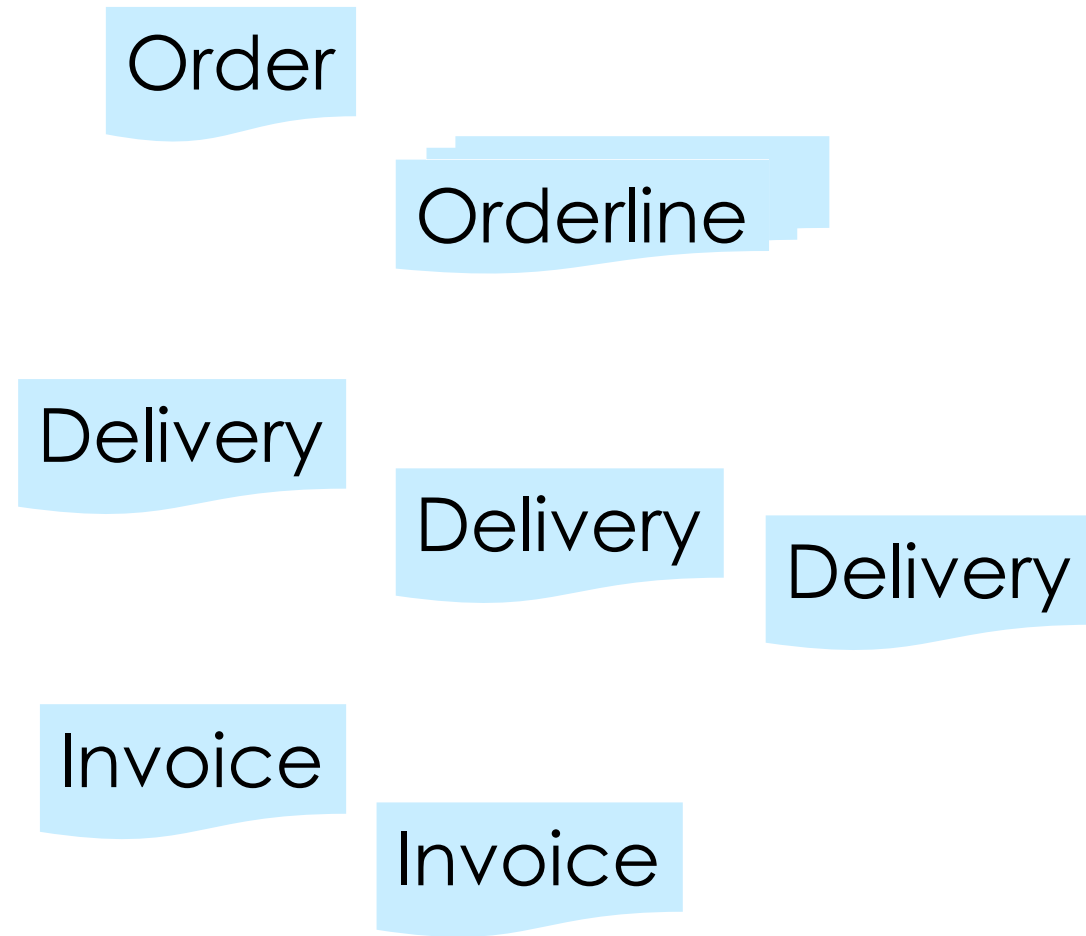


Behavioural Analytics / Event Analytics



Trends in process mining

Object-centric



What is our case? What do we want to analyse?

Trends in process mining

Multi-perspective



Richting een holistisch benadering

Toepassen





PM4PY



BUPAR

my *i*nvenio



paf
now



Apromore



celonis



SIGNAVIO

my **i**nvenio



Disco
by Fluxicon

paf
now

minit



PROCESSGOLD

LANA
LABS

celonis

BUPAR

PM4PY

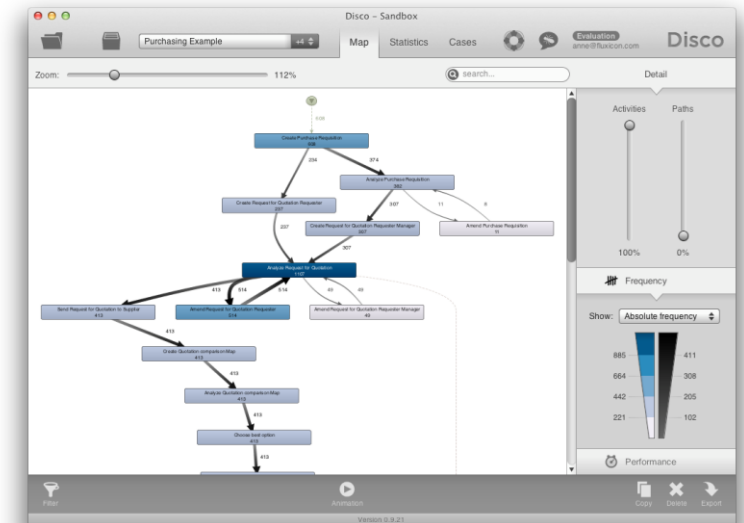
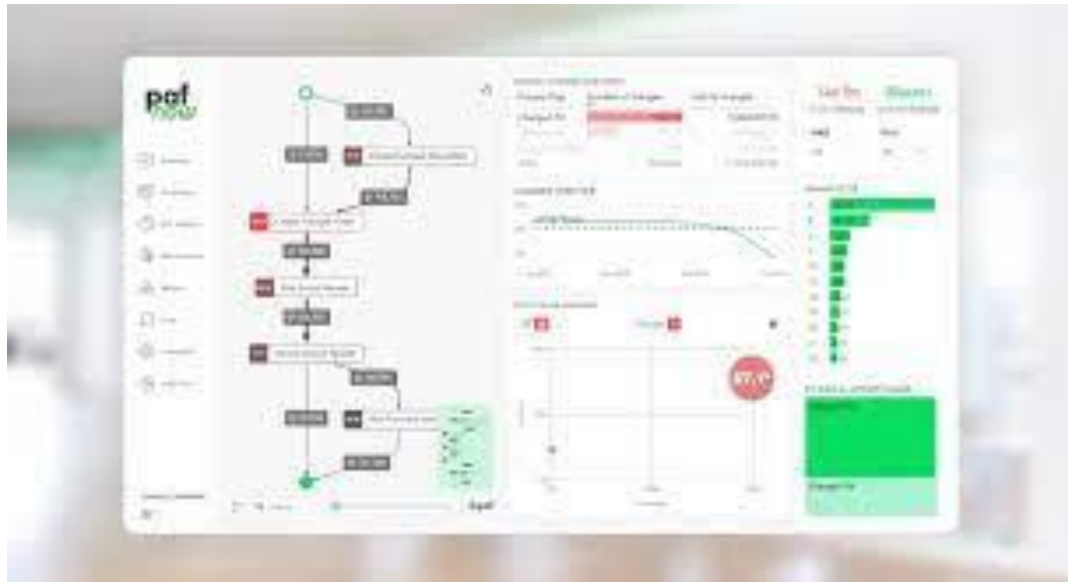
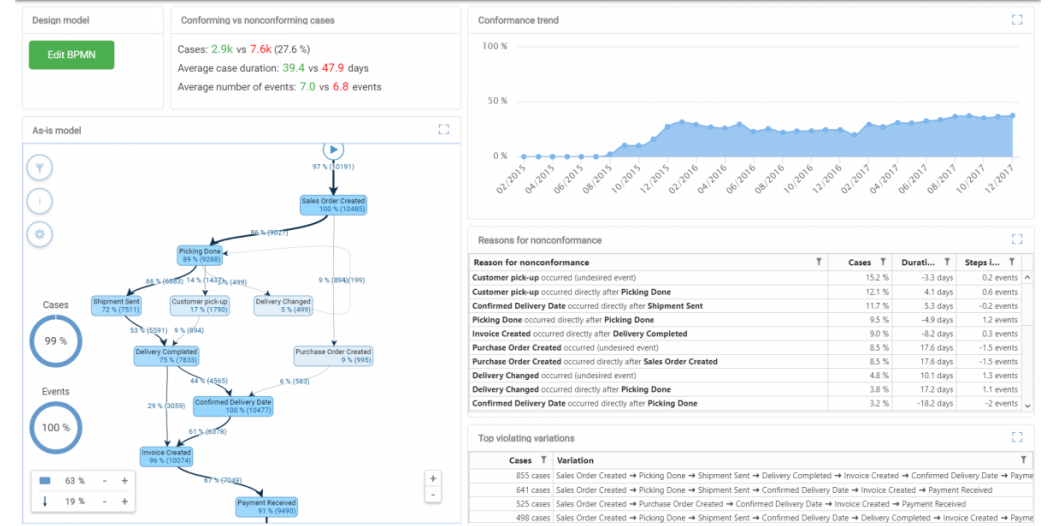
Apromore



celonis

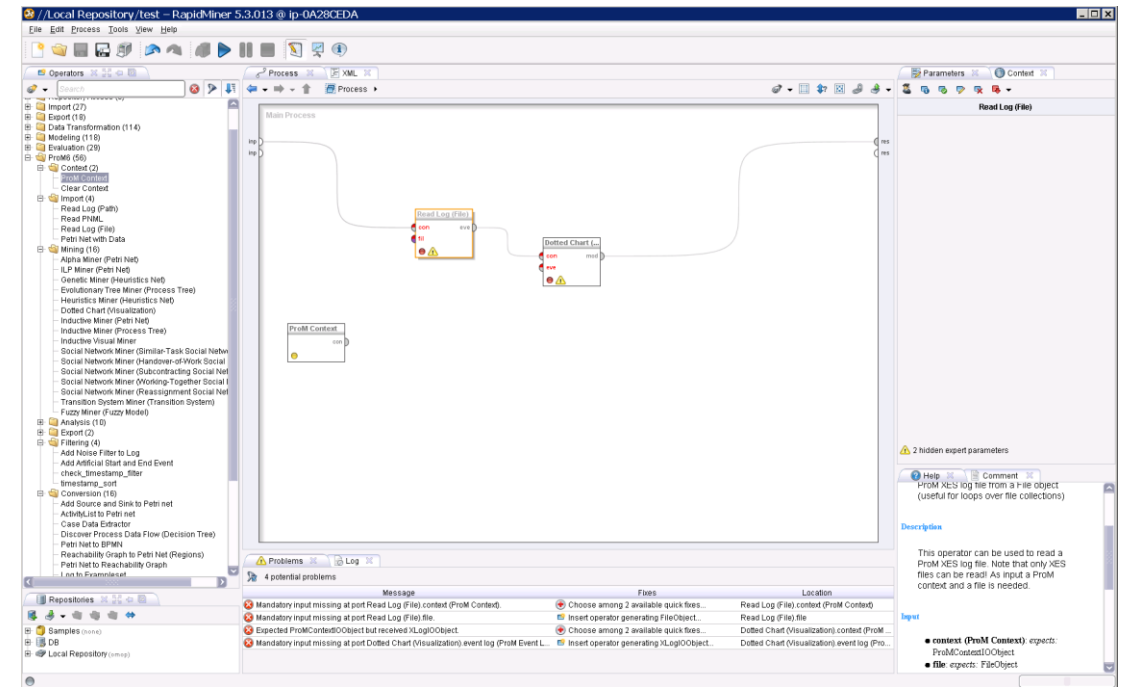
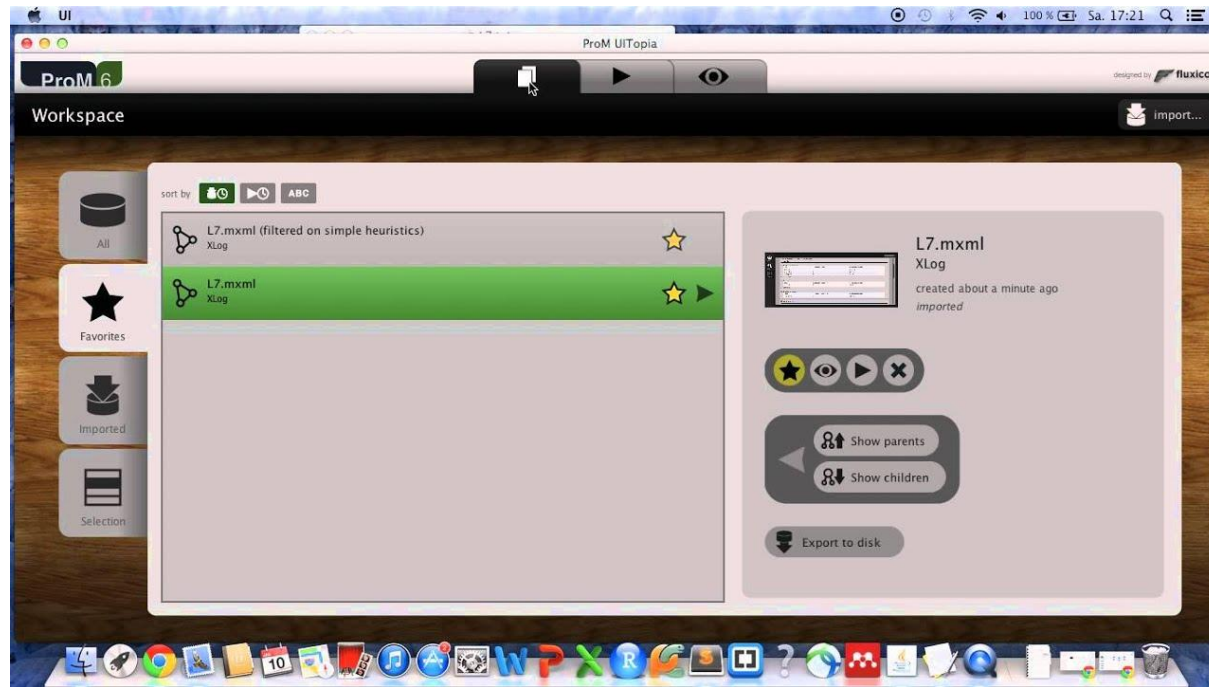


-QPR ProcessAnalyzer- Conformance View



paf
now

Disco
by Fluxicon



B U P A R

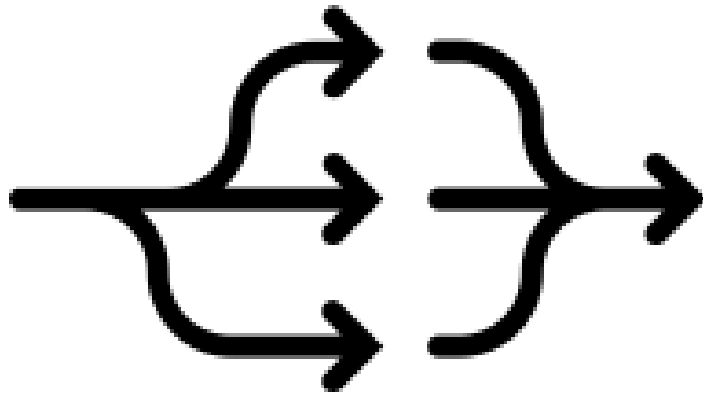
```
patients %>%  
  throughput_time("log") %>%  
  plot()
```



PM4PY

```
import pm4py  
log = pm4py.read_xes('<path-to-xes-log-file.xes>')  
process_model = pm4py.discover_bpmn_inductive(log)  
pm4py.view_bpmn(process_model)
```

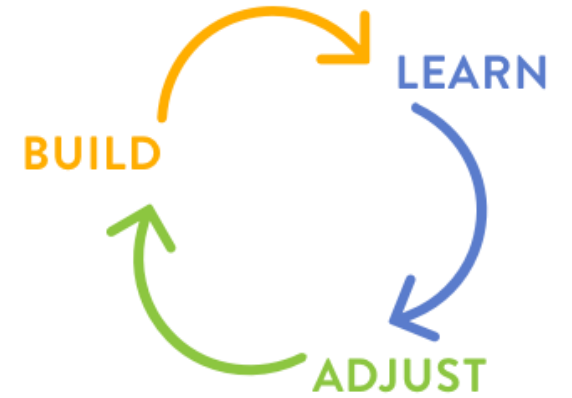




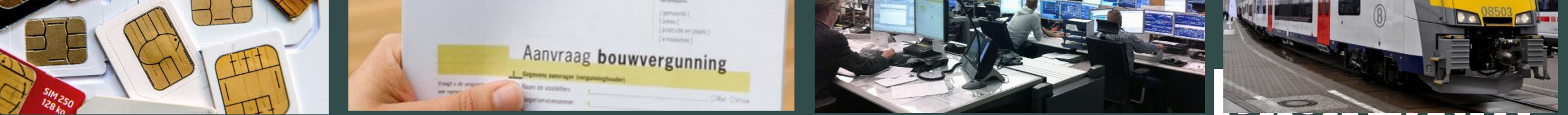
Flexibility



Connectivity

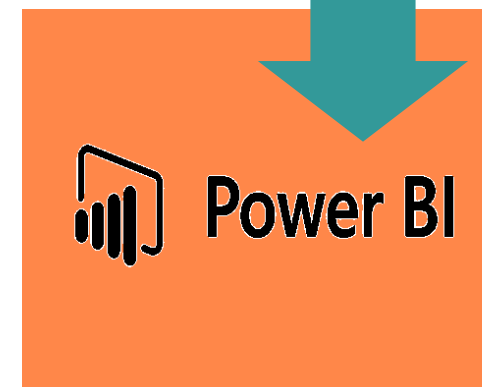
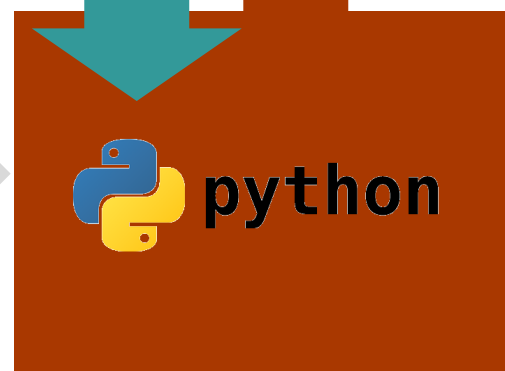
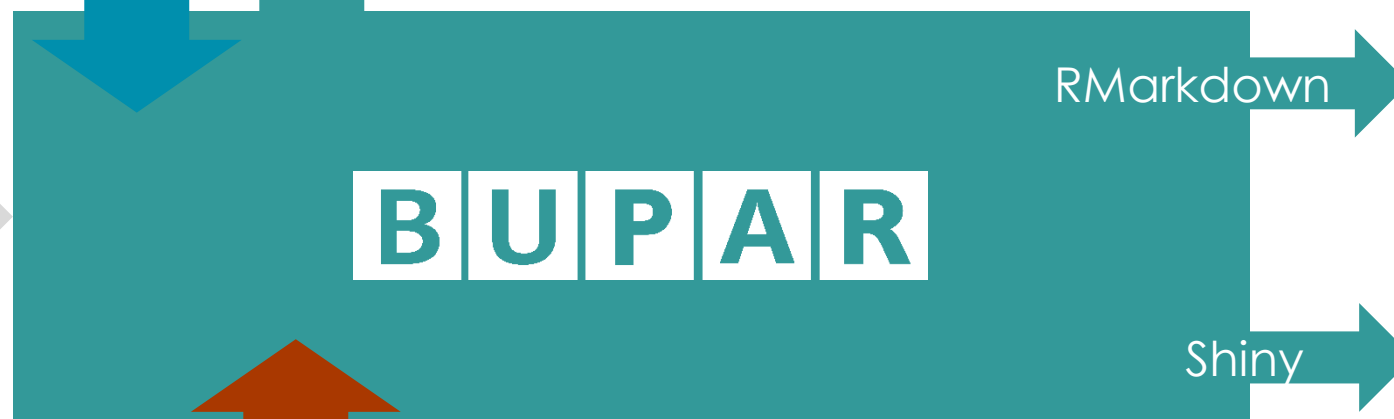


Reproducibility





Connectivity



RMarkdown

Shiny

Reproducible Reports

HTML



Dashboards



Reproducibility



SIGNAVIO

my **i**nvenio



Disco
by Fluxicon

paf
now



PROCESSGOLD



celonis

BUPAR

PM4PY

Apromore



Zelf aan de slag?

 DATA & AI

HANDS-ON MET PROCESS MINING

02-06-2022 12:30 – 19:00
WORKSHOP



studiecentrum voor automatische informatieverwerking vzw

SPREKER(S)

GERT JANSSENSWILLEN

Onderzoeker @UHasselt



TIJDSTIP

 02-06-2022 12:30 – 19:00

TAAL

 Nederlands

LOCATIE

 HOLIDAY INN EXPO GENT

Maaltekouter 3

9051 Gent (Sint-Denijs-Westrem)

België

Tel: +32 (0)9 220 24 24

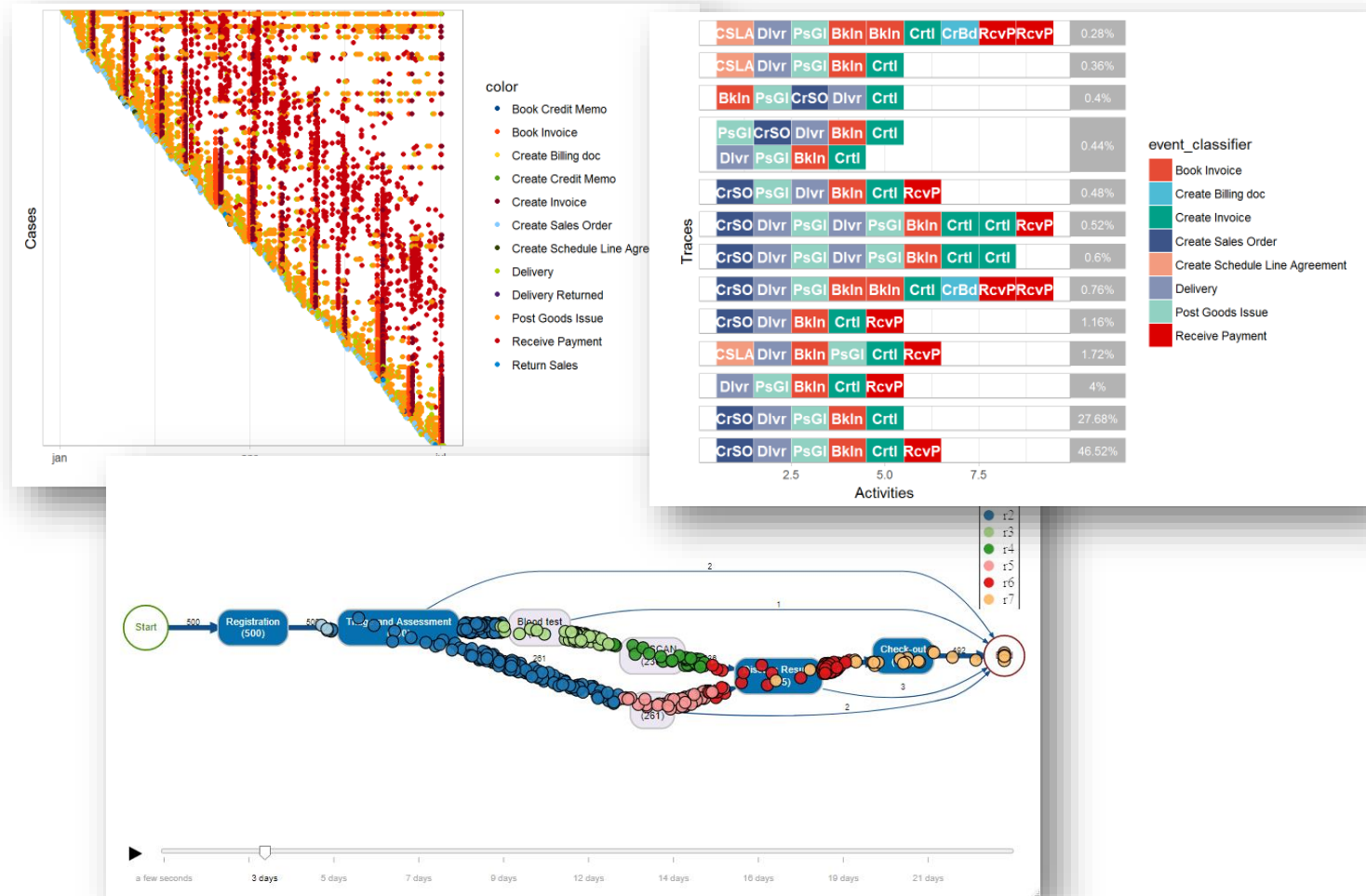
www.higentexpo.com



Business Process Analytics in R

State-of-the-art tool set for
process analysis in R

Developed by research group
Business Informatics Hasselt
University



Zelf aan de slag?

 DATA & AI

HANDS-ON MET PROCESS MINING

02-06-2022 12:30 – 19:00

WORKSHOP

SPREKER(S)

GERT JANSSENSWILLEN

Onderzoeker @UHasselt



TIJDSTIP

 02-06-2022 12:30 – 19:00

TAAL

 Nederlands

LOCATIE

 HOLIDAY INN EXPO GENT

Maaltekouter 3

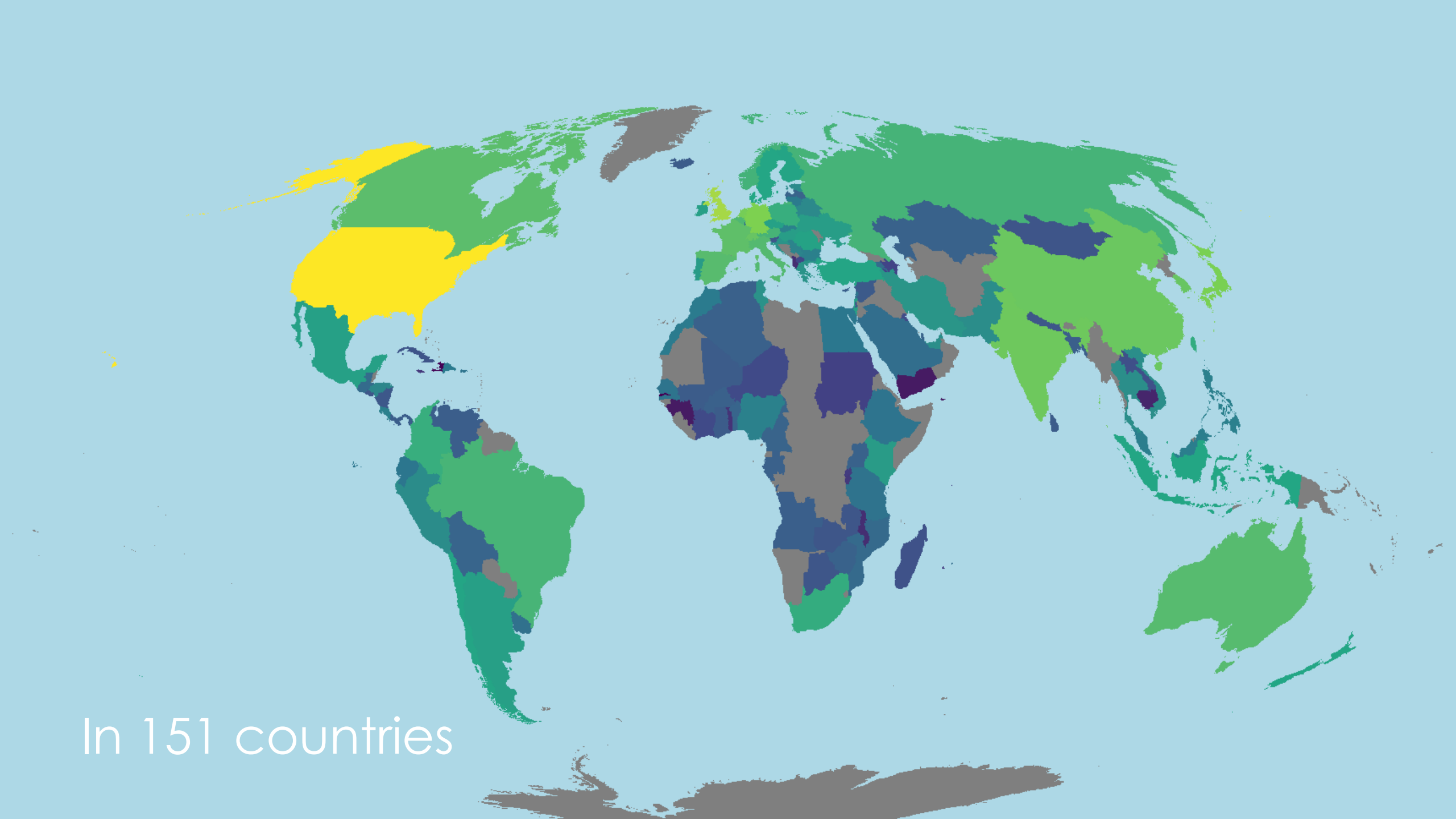
9051 Gent (Sint-Denijs-Westrem)

België

Tel: +32 (0)9 220 24 24

www.higentexpo.com





In 151 countries

BUPAR



Transformation of IT and operations



Visualizing patient pathways



Optimized outplacements of produced cars



Workplaces where automation and human workers operate in harmony,