TomTom for Business Process Management (TomTom4BPM)

CAiSE'09 Amsterdam

ProM

prof.dr.ir. Wil van der Aalst

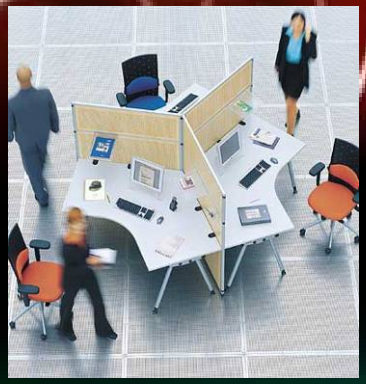
www.processmining.org

TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

Today's information systems are really crappy compared to a TomTom system!

- Good maps?
- Navigation by PowerPoints?
- Traffic information?
- Where is the next fuel station?
- Who is in charge?
- Seamless zoom?
- Customizable views?
- When will the destination be reached?



Process Mining

- Process discovery: "What is really happening?"
- Conformance checking: "Do we do what was agreed upon?"
- Performance analysis: "Where are the bottlenecks?"
- Process prediction: "Will this case be late?"
- Process improvement: "How to redesign this process?"
- Etc.

ProM

ter) (2)

Animation

2M104
J
1.000

2M008
J
0.390

2M004
J
0.367

2L441
J
0.458

2R000
J
0.436

2M227
J
0.415

Zoom

Concurrency filter

Edge filter

Node filter

Significance cutoff

- **Process discovery: "What is the real curriculum?"**
- **Conformance checking: "Do students meet the prerequisites?"**
- **Performance analysis: "Where are the bottlenecks?"**
- **Process prediction: "Will a student complete his studies (in time)?"**
- **Process improvement: "How to redesign the curriculum?"**

21:41:20 [M] Measured fuzzy conformance is 0.49239378538041256

Process Mining

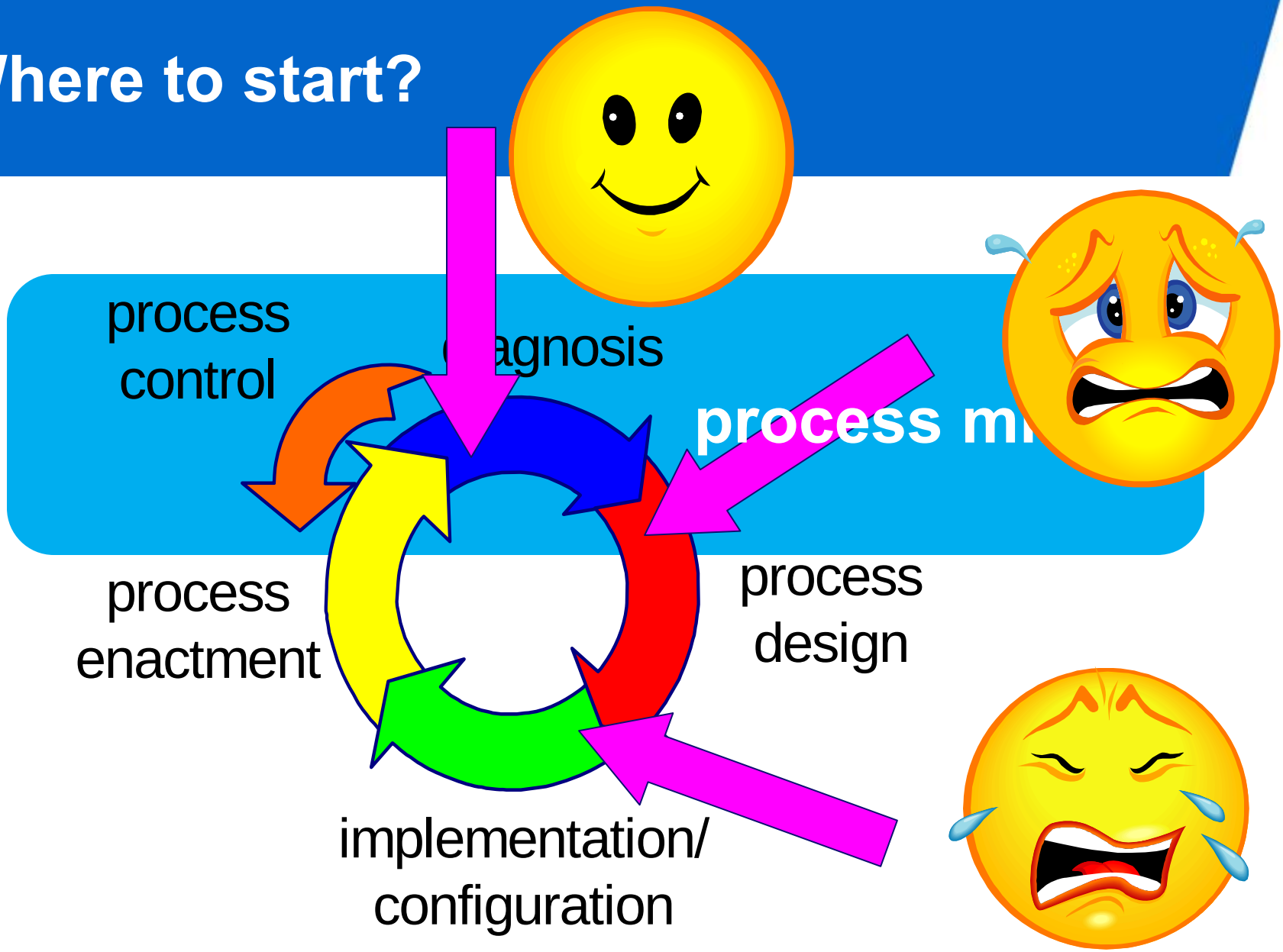
A step towards TomTom functionality for business processes

ProM

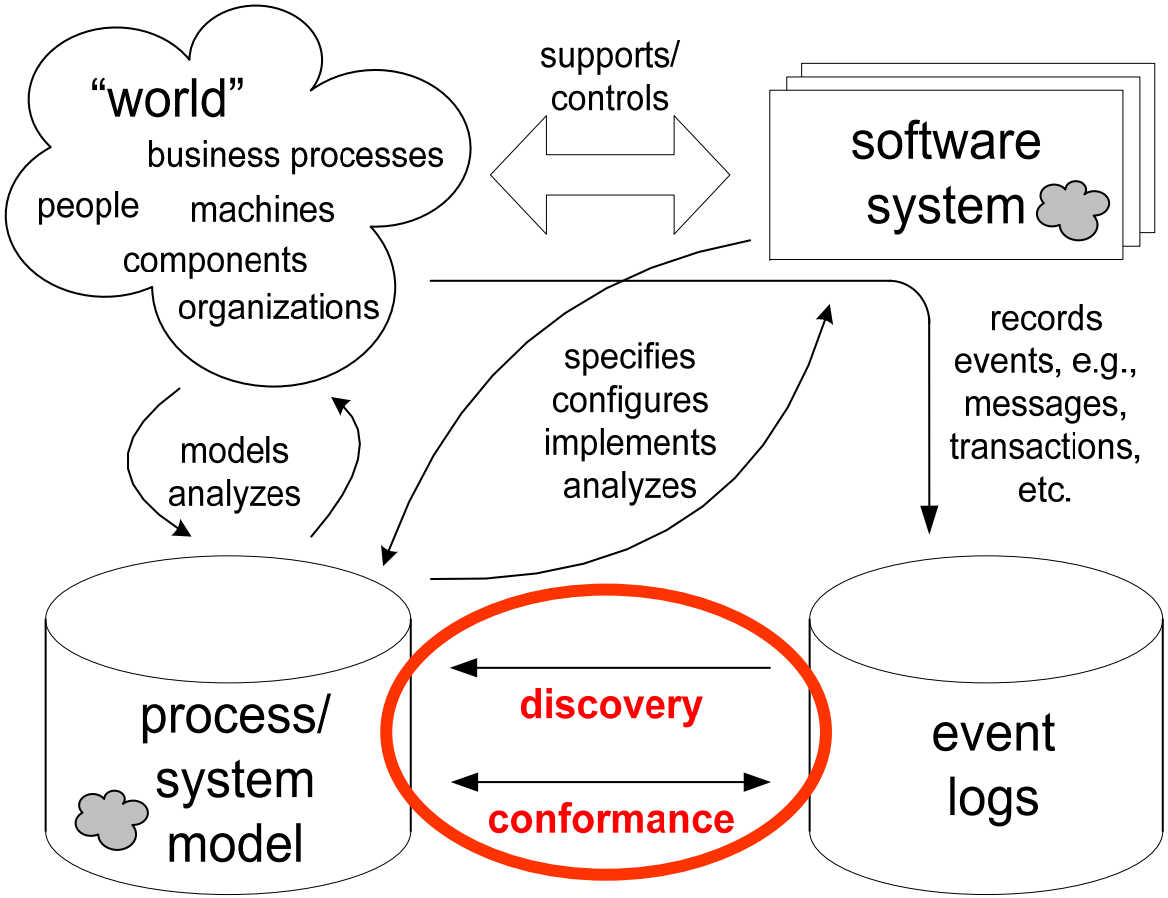
TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

Where to start?



Process mining: Linking events to models

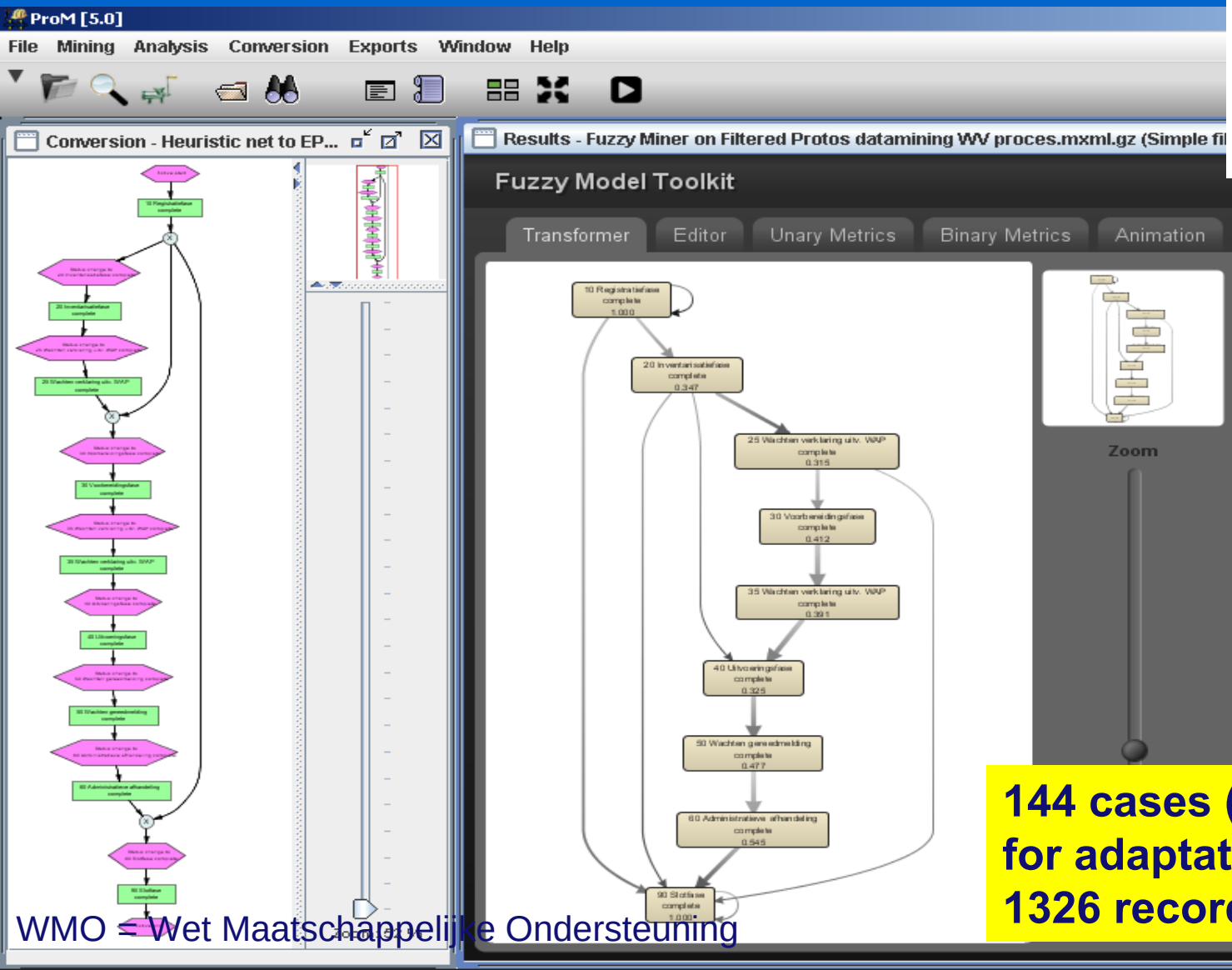


Process mining as a mirror ...

Where did we apply process mining?

- **Municipalities** (e.g., Alkmaar, Heusden, Harderwijk, etc.)
- **Government agencies** (e.g., Rijkswaterstaat, Centraal Justitieel Incasso Bureau, Justice department)
- **Insurance related agencies** (e.g., UWV)
- **Banks** (e.g., ING Bank)
- **Hospitals** (e.g., AMC hospital, Catharina hospital)
- **Multinationals** (e.g., DSM, Deloitte)
- **High-tech system manufacturers and their customers** (e.g., Philips Healthcare, ASML, Thales)
- **Media companies** (e.g. Winkwaves)
- **...**

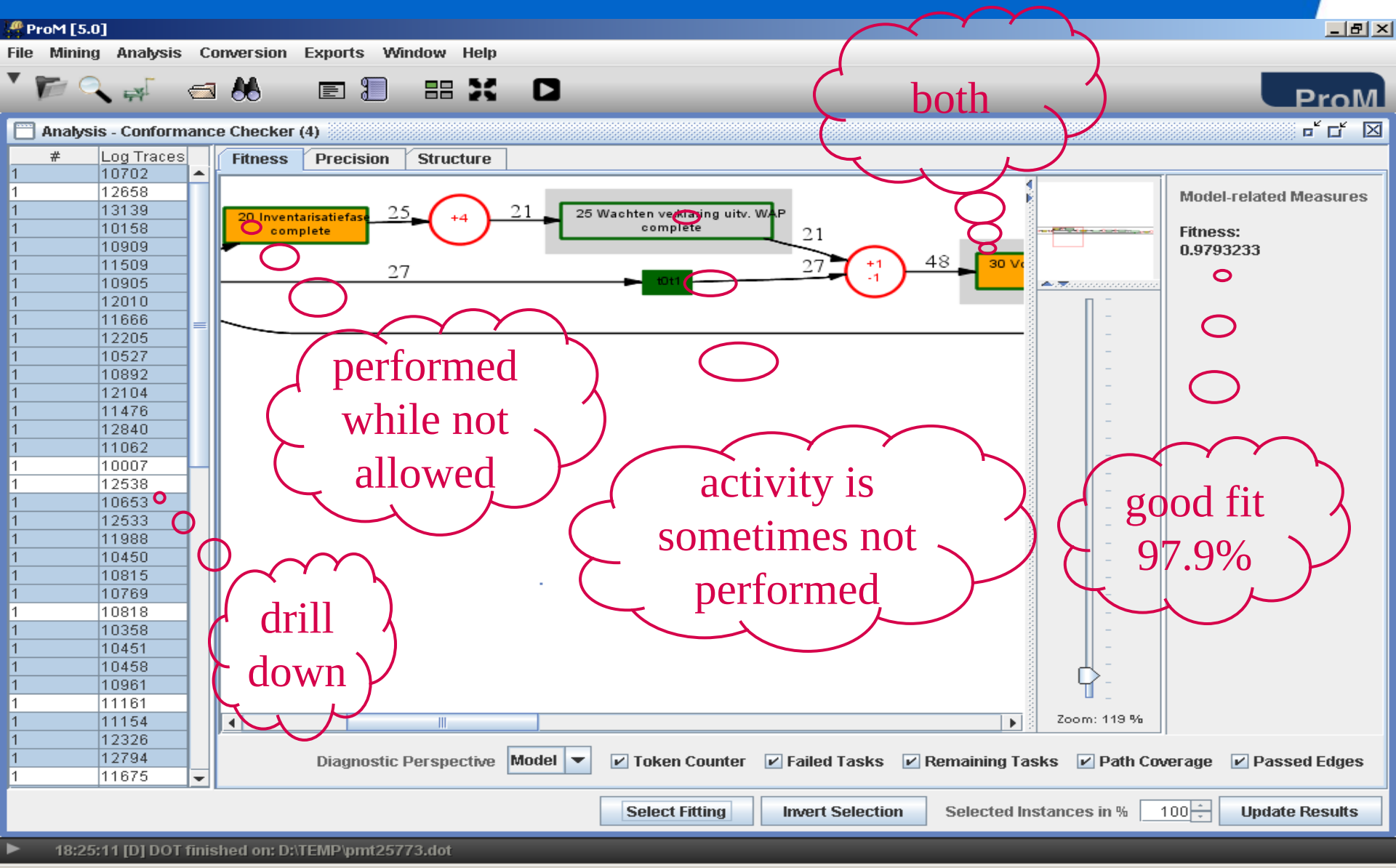
Example: WMO process of a Dutch Municipality



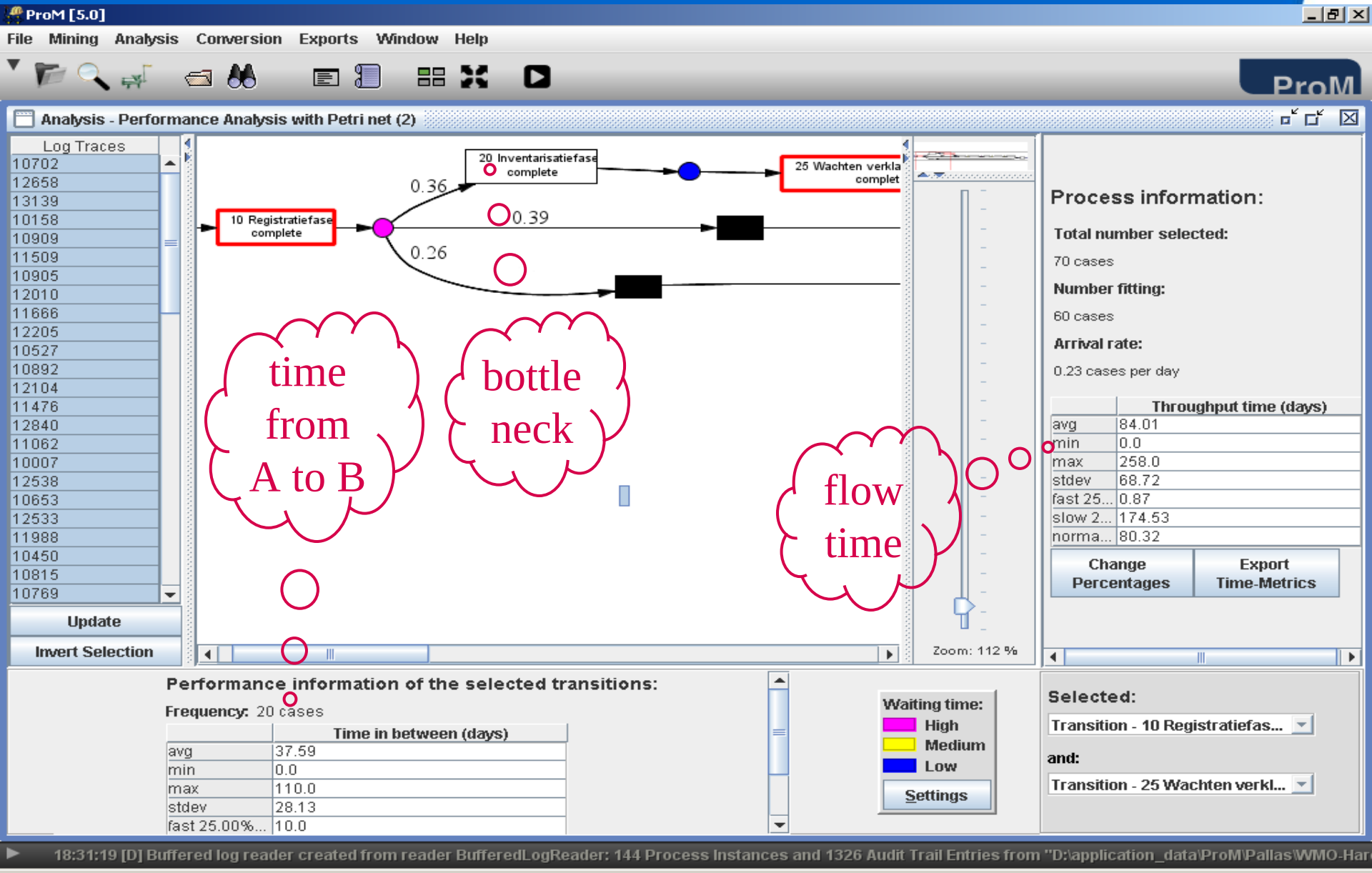
WMO = Wet Maatschappelijke Ondersteuning

144 cases (i.e., requests for adaptation of house)
1326 recorded events

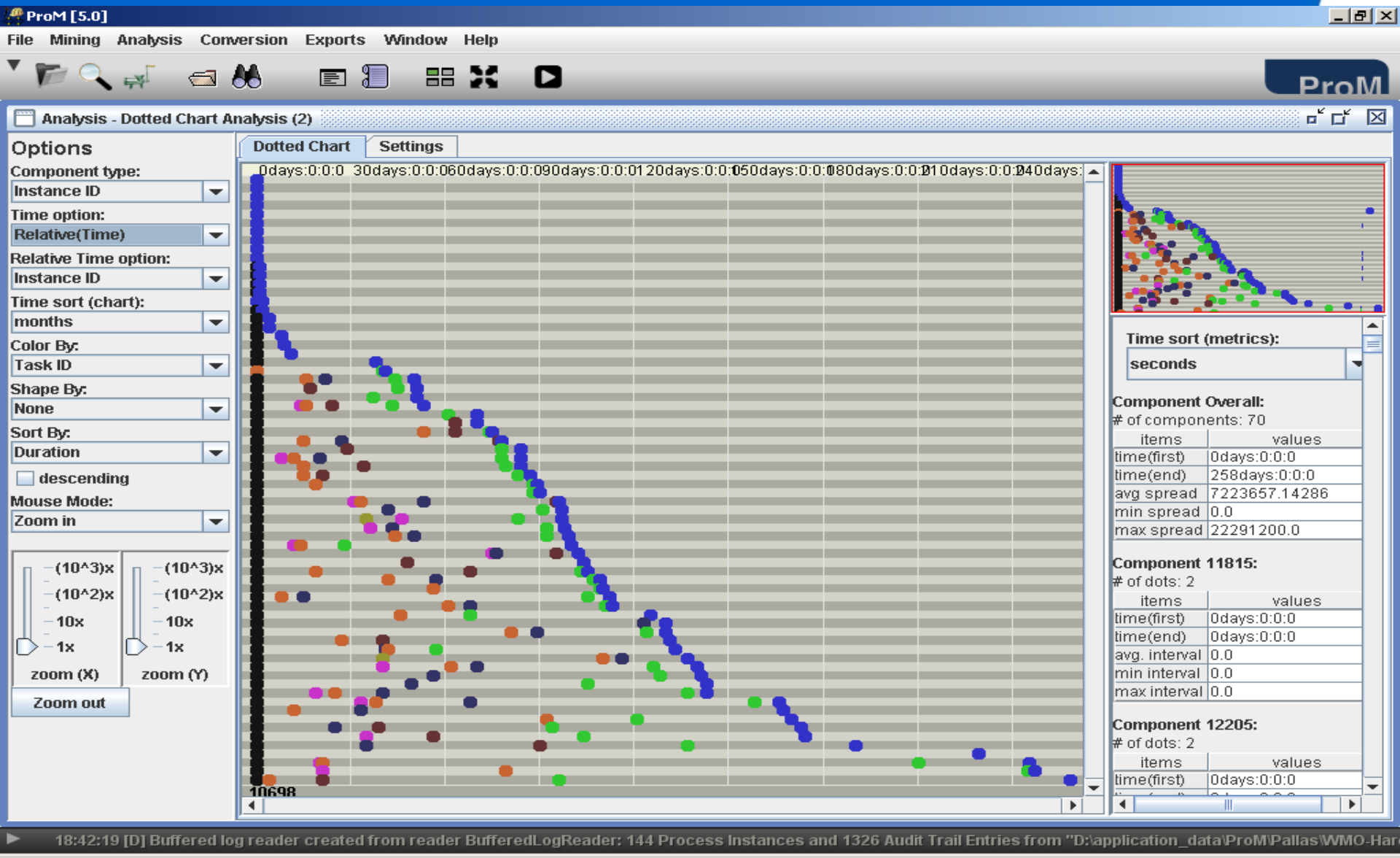
Conformance check of discovered model



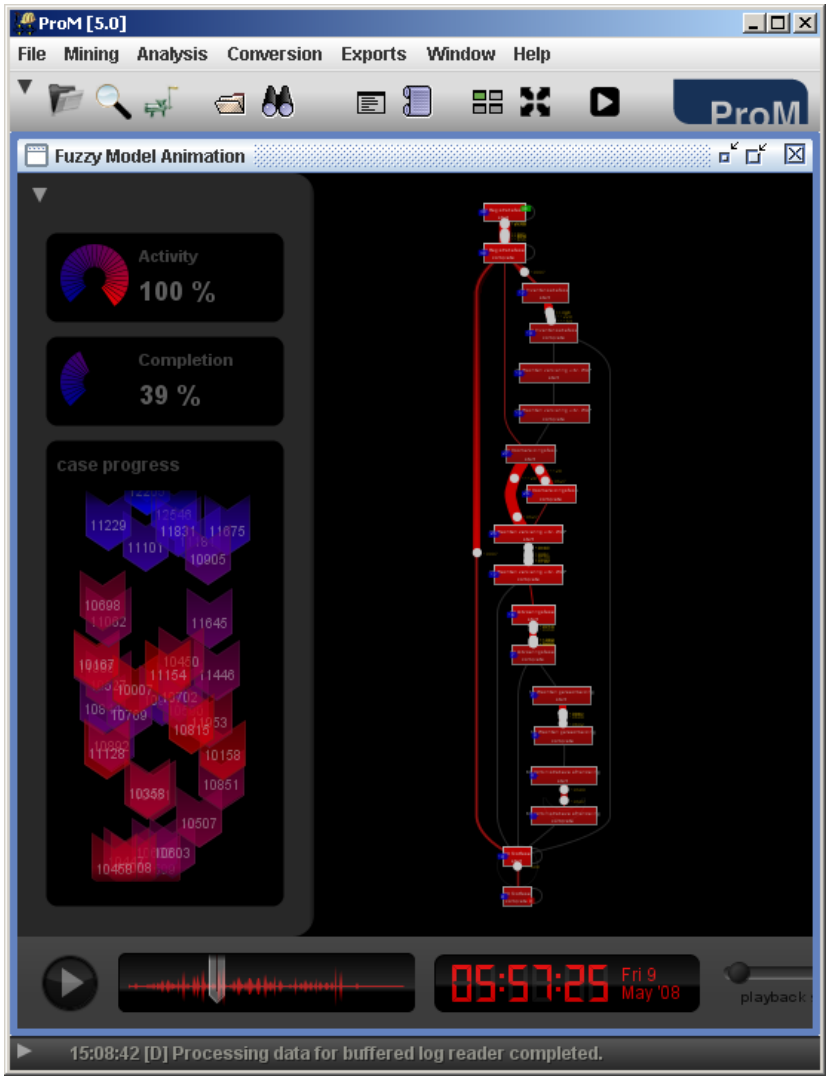
Performance analysis

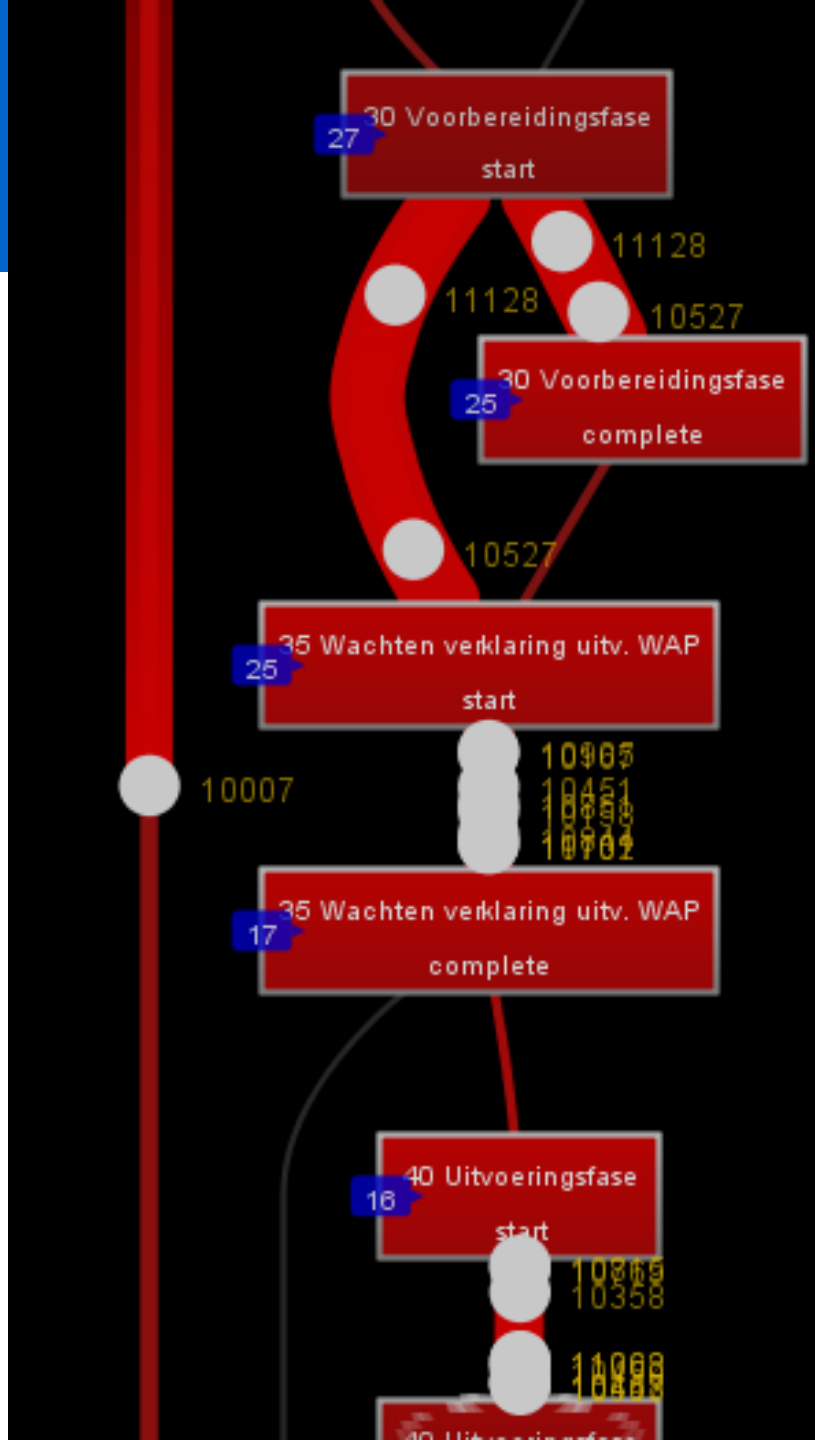


Events sorted by duration

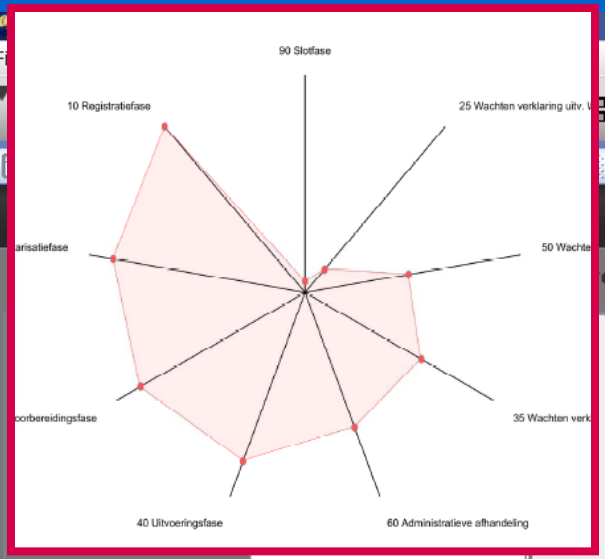


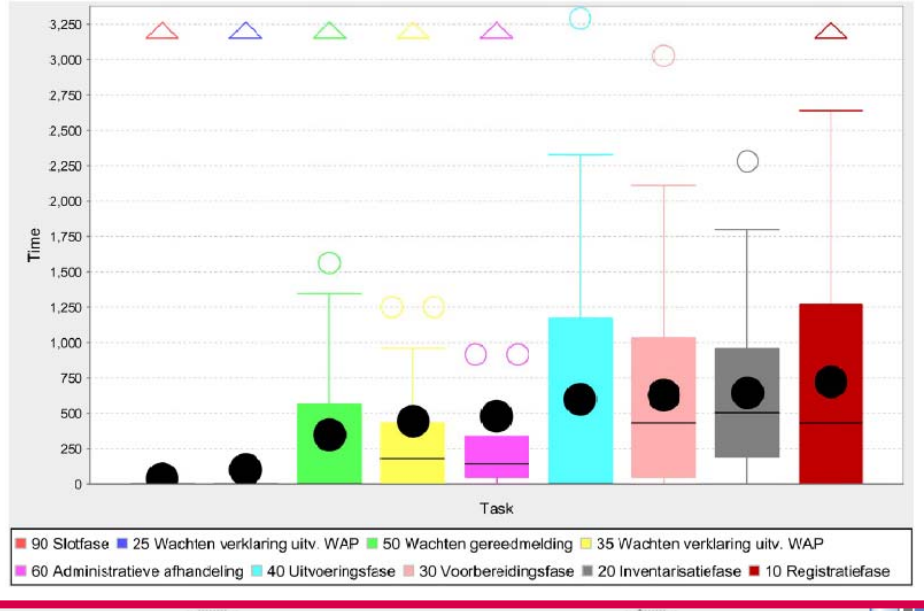
"Real" animation

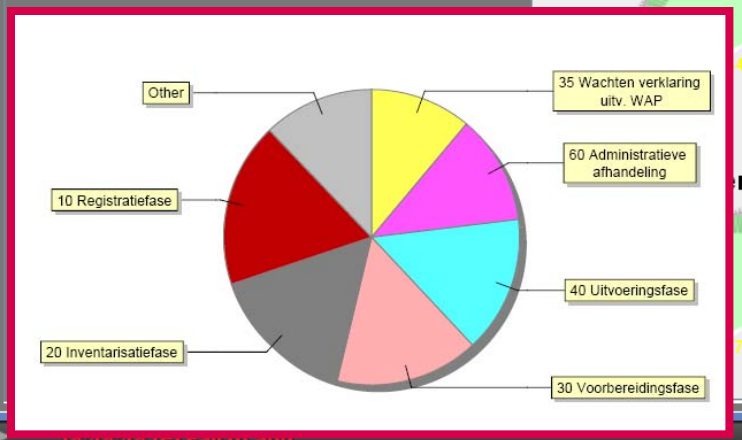




And of course ...







Help

processing (task)

Upper value (normal) 447.9239436619718

Upper value (warning) 585.0535211267606

Update

90 Slotfase

35 Wachten verklaring uitv. WAP

60 Administratieve afhandeling

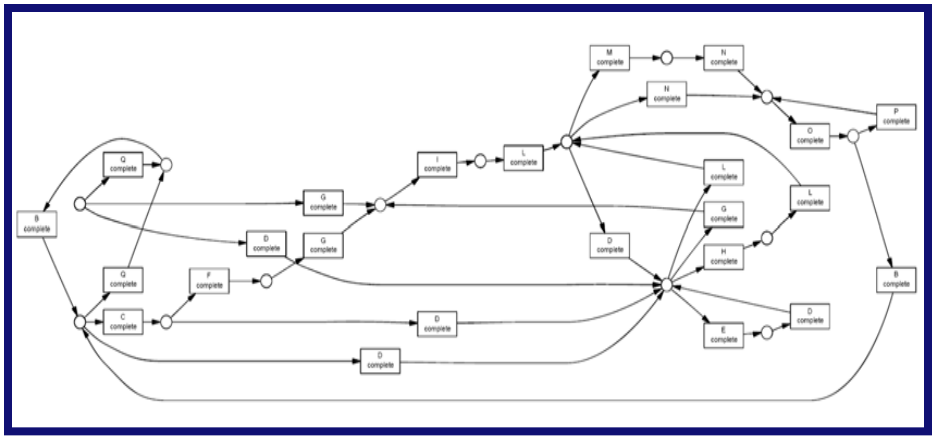
40 Uitvoeringsfase

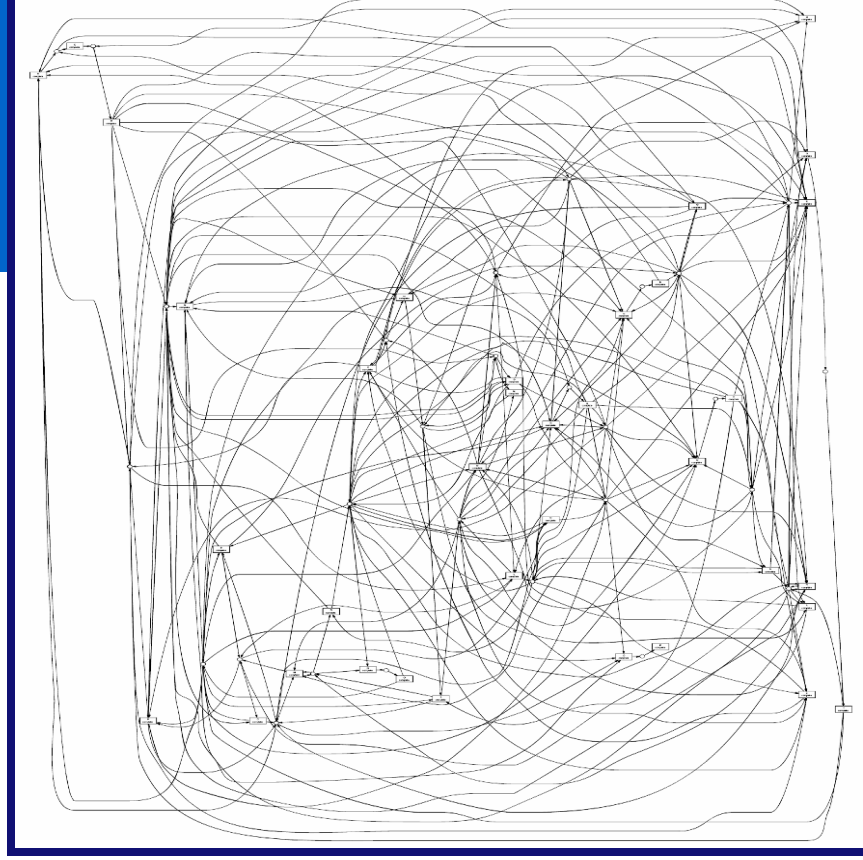
20 Inventarisatiefase

10 Registratiefase

Reality ≠ PowerPoint (or Visio)

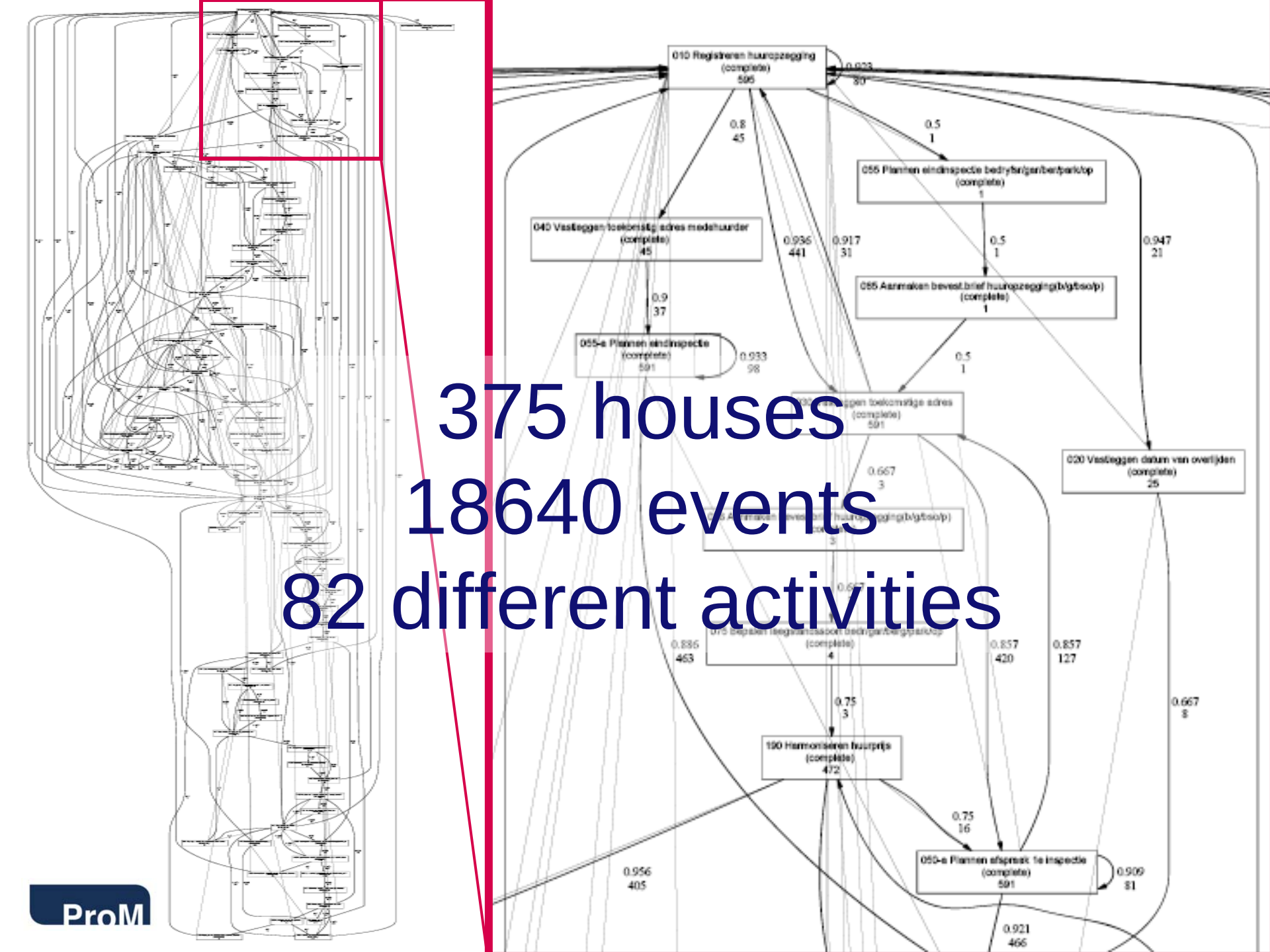
Process spectrum

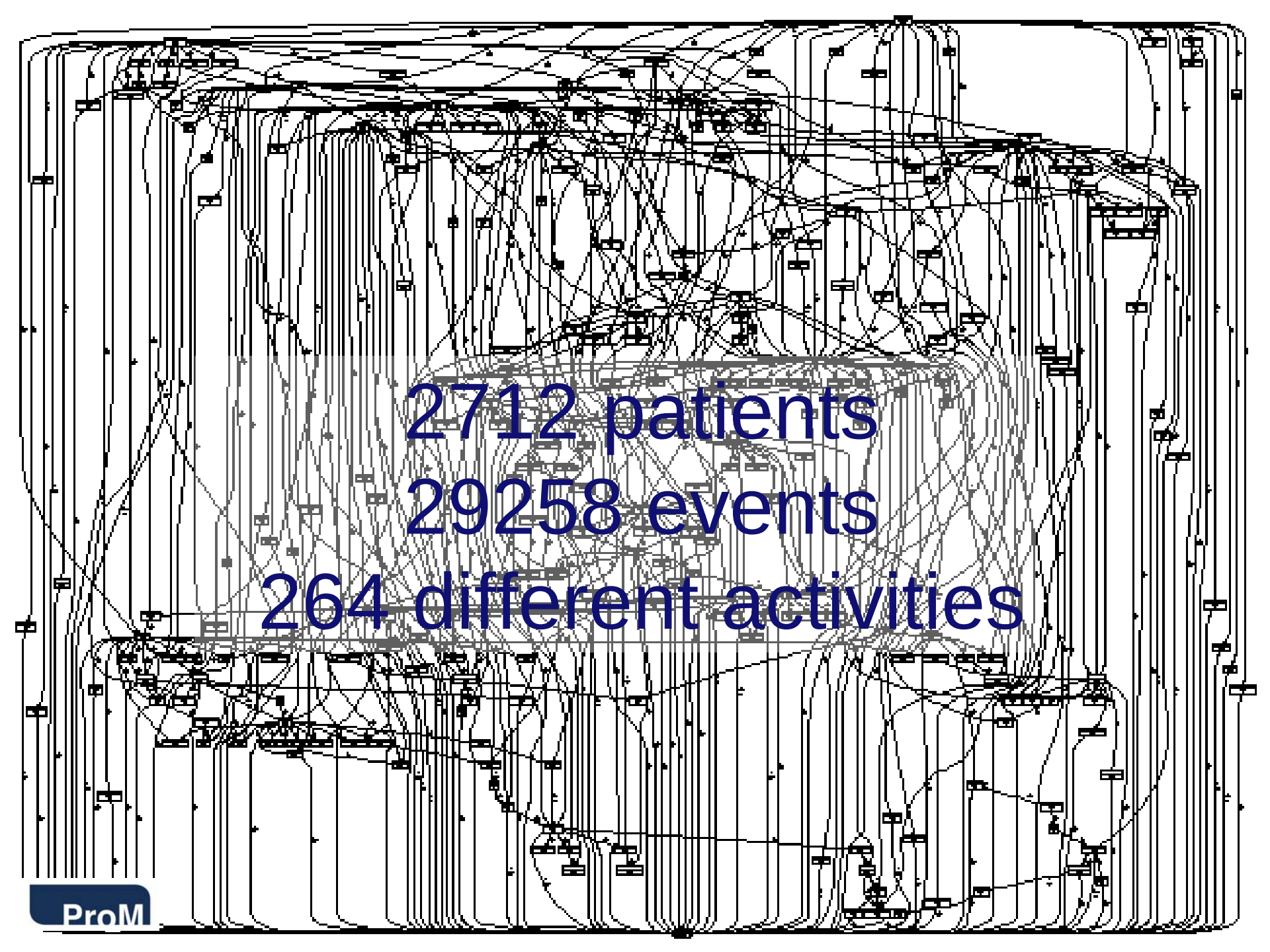


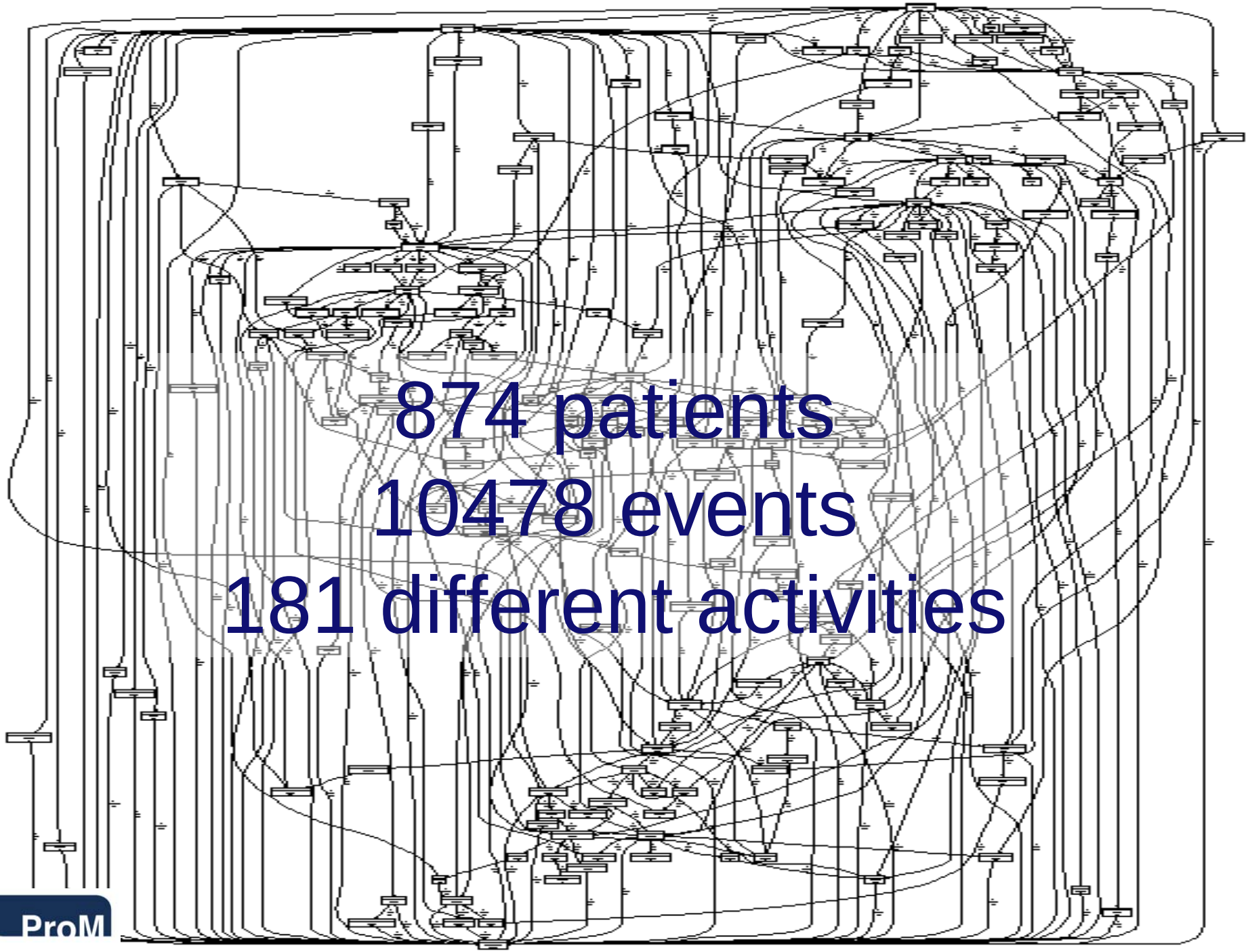


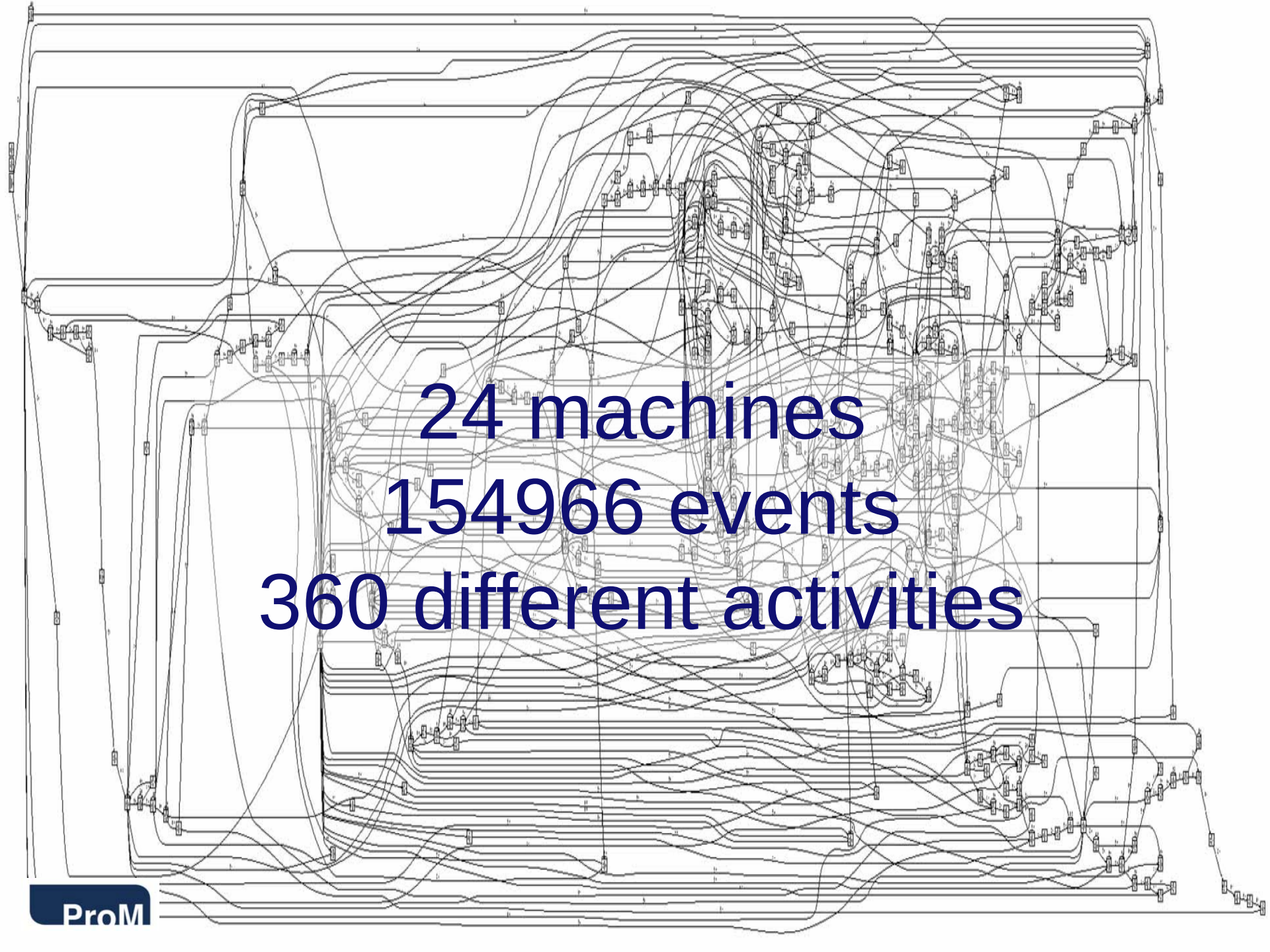
structured (Lasagna)

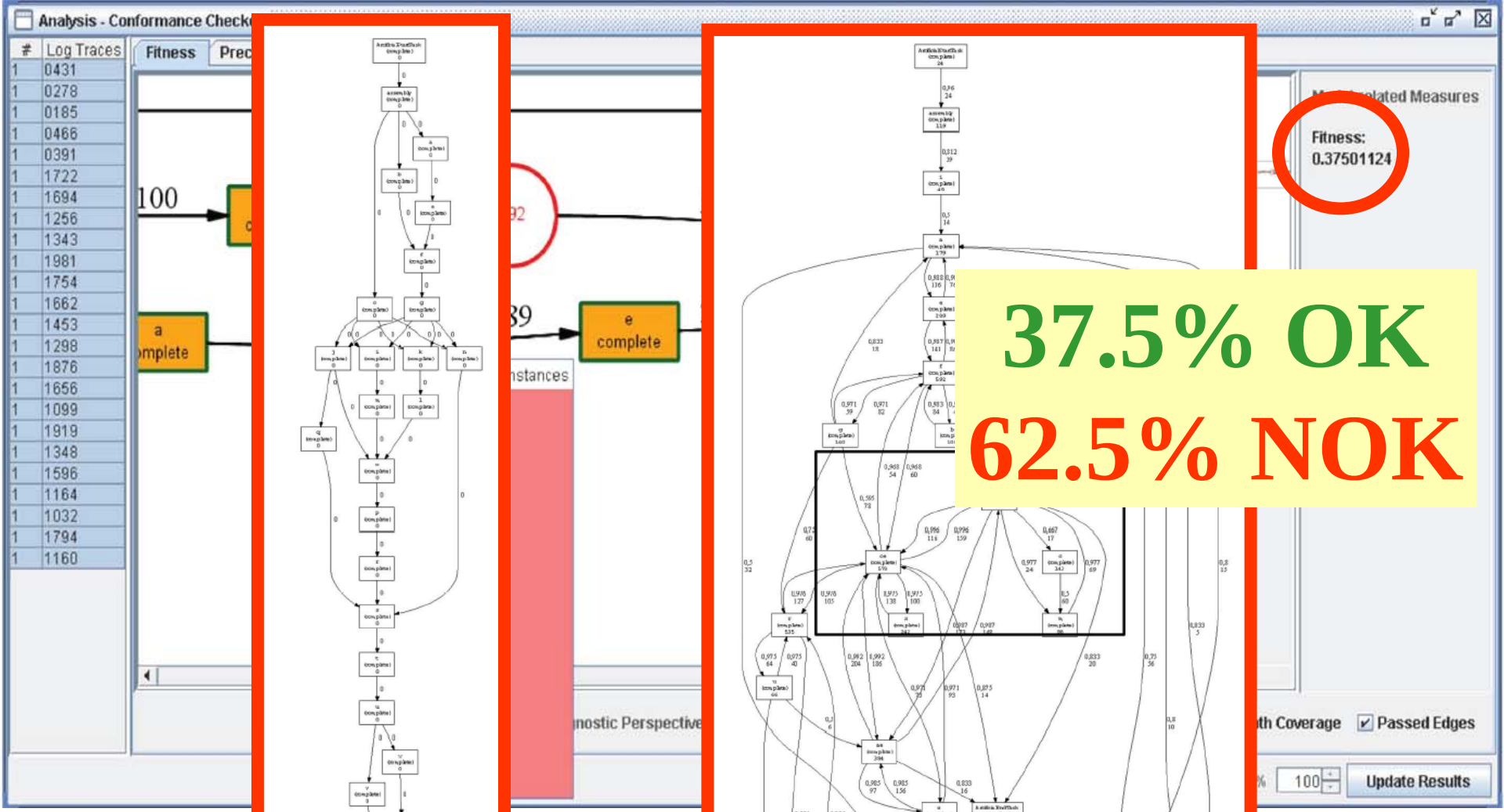
unstructured (Spaghetti)


010 Registreren huuropzegging
(complete)
595
040 Vastleggen toekomstig adres medehuurder
(complete)
45
055 Plannen eindinspectie bedrijfsr/gar/berk/park/op
(complete)
1
055 Aanmaken bevest.brief huuropzegging(b/g/tso/p)
(complete)
1
055-e Plannen eindinspectie
(complete)
591
020 Vastleggen datum van overlijden
(complete)
25
190 Harmoniseren huurprijs
(complete)
472
055-e Plannen afspraak 1e inspectie
(complete)
591
375 houses
18640 events
82 different activities
ProM


2712 patients
29258 events
264 different activities
ProM


874 patients
10478 events
181 different activities
ProM


24 machines
154966 events
360 different activities
ProM

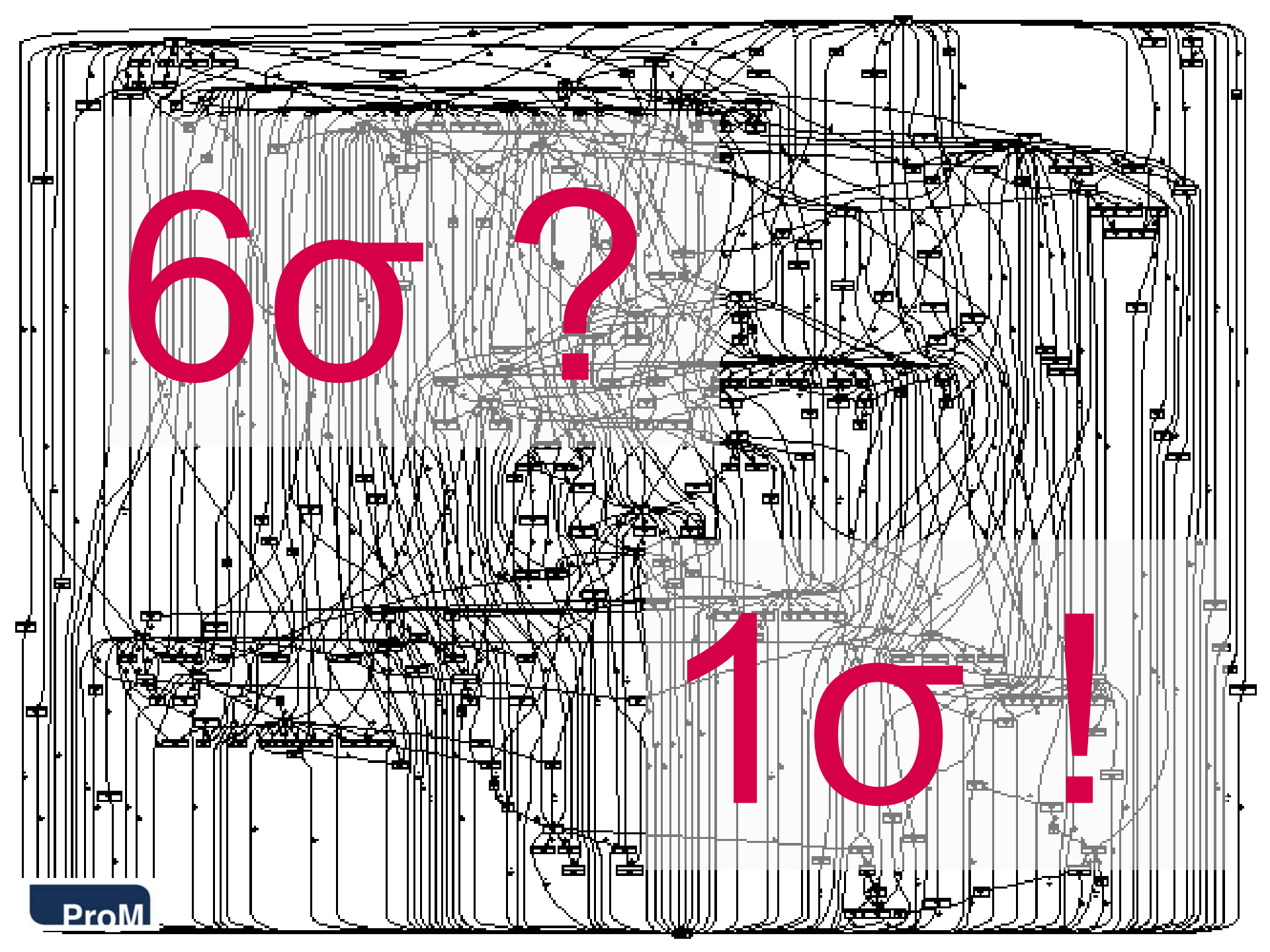


37.5% OK

62.5% NOK

design

reality


6σ?
1σ!
ProM

Process Mining: TomTom for Business Processes

TOMTOM

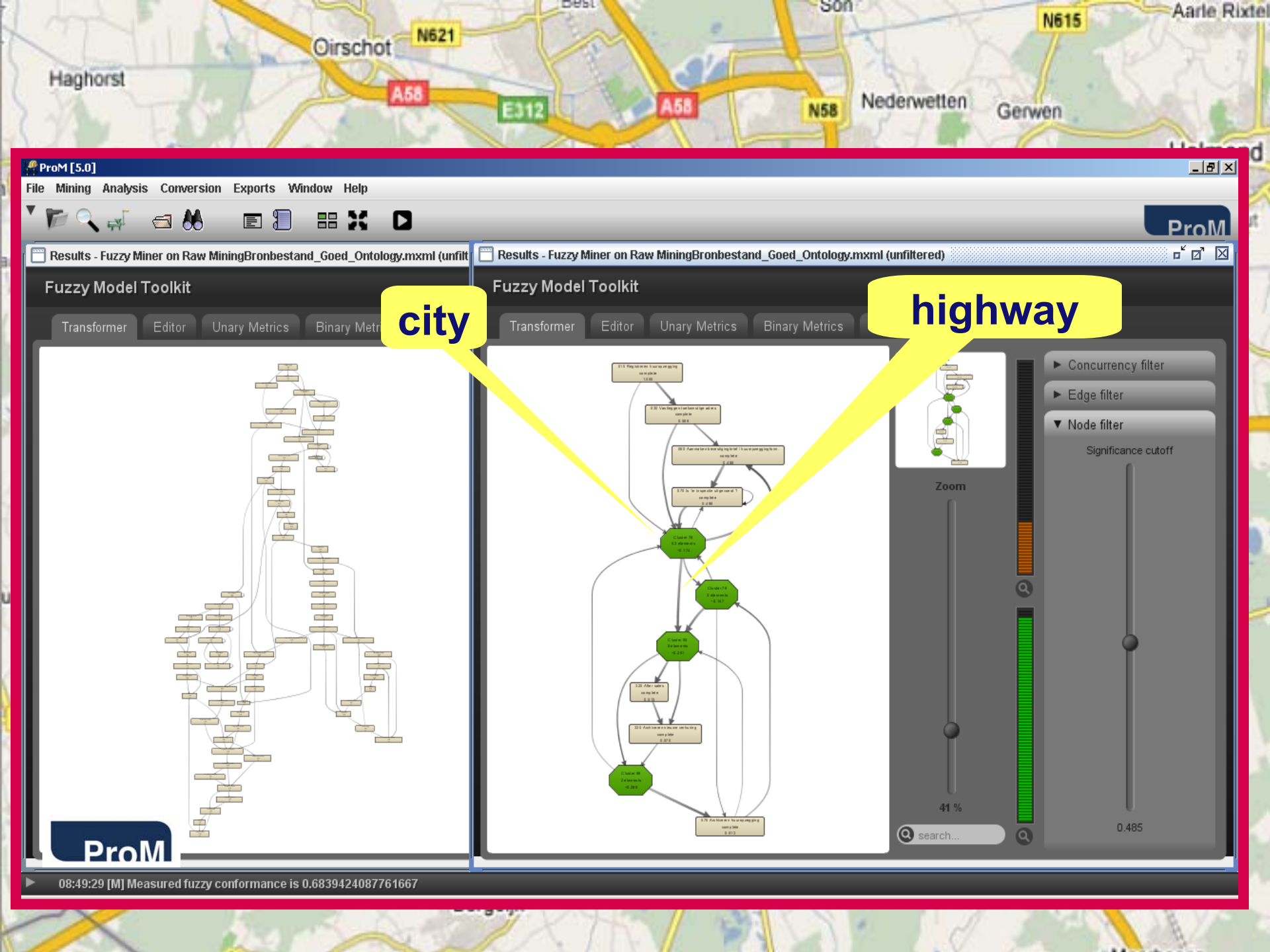
ProM

TU/e Technische Universiteit Eindhoven University of Technology

Where innovation starts

How can process mining help?

- Good maps?
- Navigation by PowerPoints?
- Traffic information?
- Where is the next fuel station?
- Who is in charge?
- Seamless zoom?
- Customizable views?
- When will the destination be reached?


Oirschot
N621
Haghorst
A58
E312
A58
N58
Nederwetten
Gerwen
N615
Aarle Rixtel
ProM [5.0]
File Mining Analysis Conversion Exports Window Help
Results - Fuzzy Miner on Raw MiningBronbestand_Goed_Ontology.mxml (unfilt
Fuzzy Model Toolkit
Transformer Editor Unary Metrics Binary Metr
city
Results - Fuzzy Miner on Raw MiningBronbestand_Goed_Ontology.mxml (unfiltered)
Fuzzy Model Toolkit
Transformer Editor Unary Metrics Binary Metrics
highway
Concurrency filter
Edge filter
Node filter
Significance cutoff
Zoom
41 %
search...
0.485
ProM
08:49:29 [M] Measured fuzzy conformance is 0.6839424087761667

ProM [5.0]

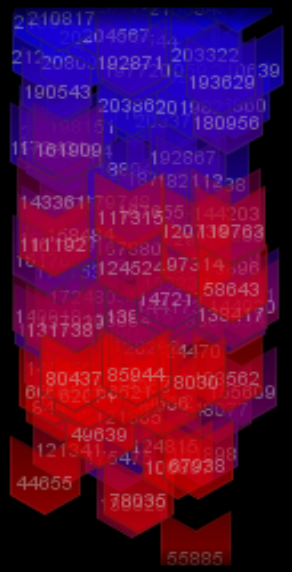
File Mining Analysis Conversion Exports Window Help

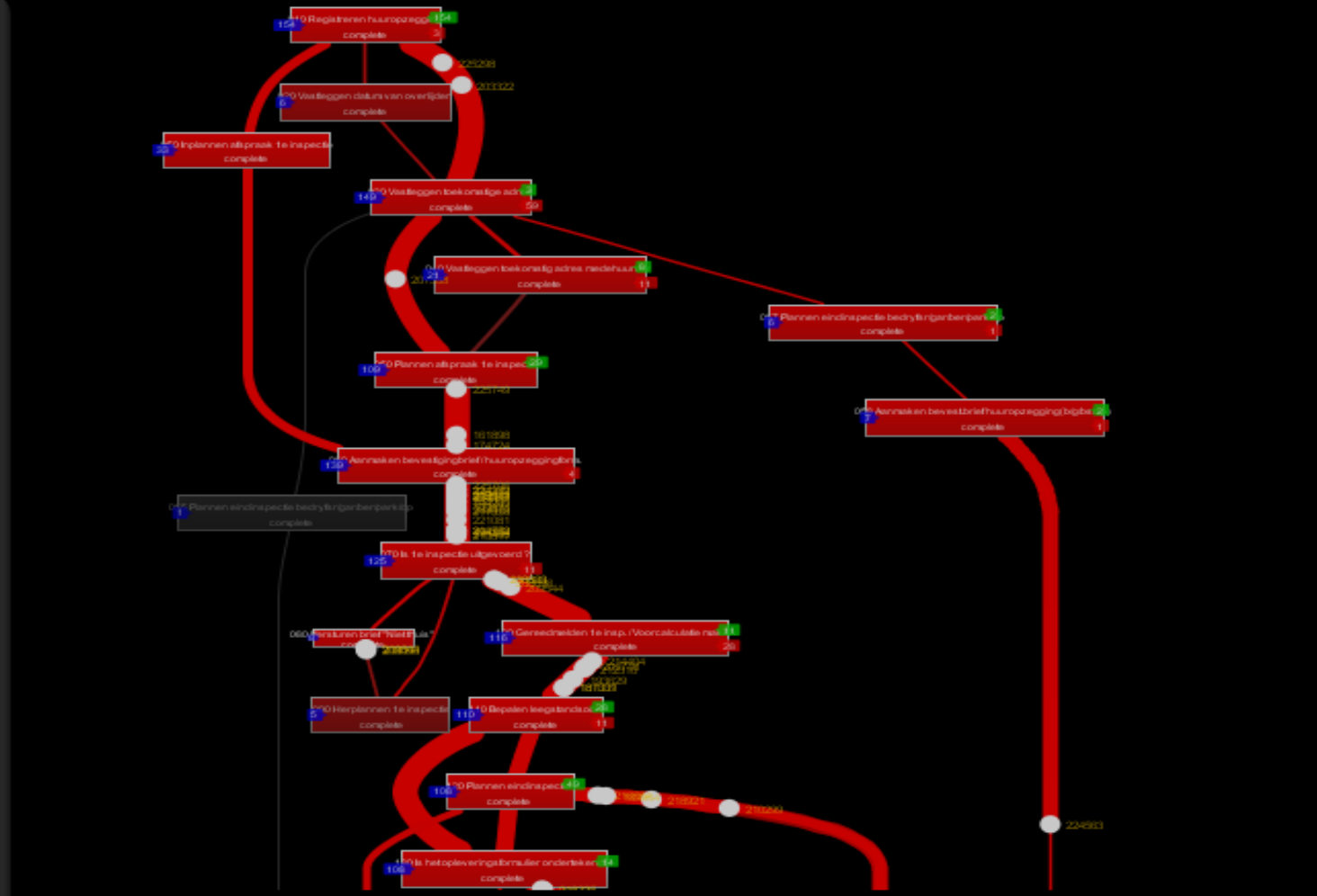
Fuzzy Model Animation (2)

Activity
100 %

Completion
43 %

case progress





10:36:05 Fri 9 Nov '07

playback speed

ProM

19:40:55 [D] Processing data for buffered log reader completed.

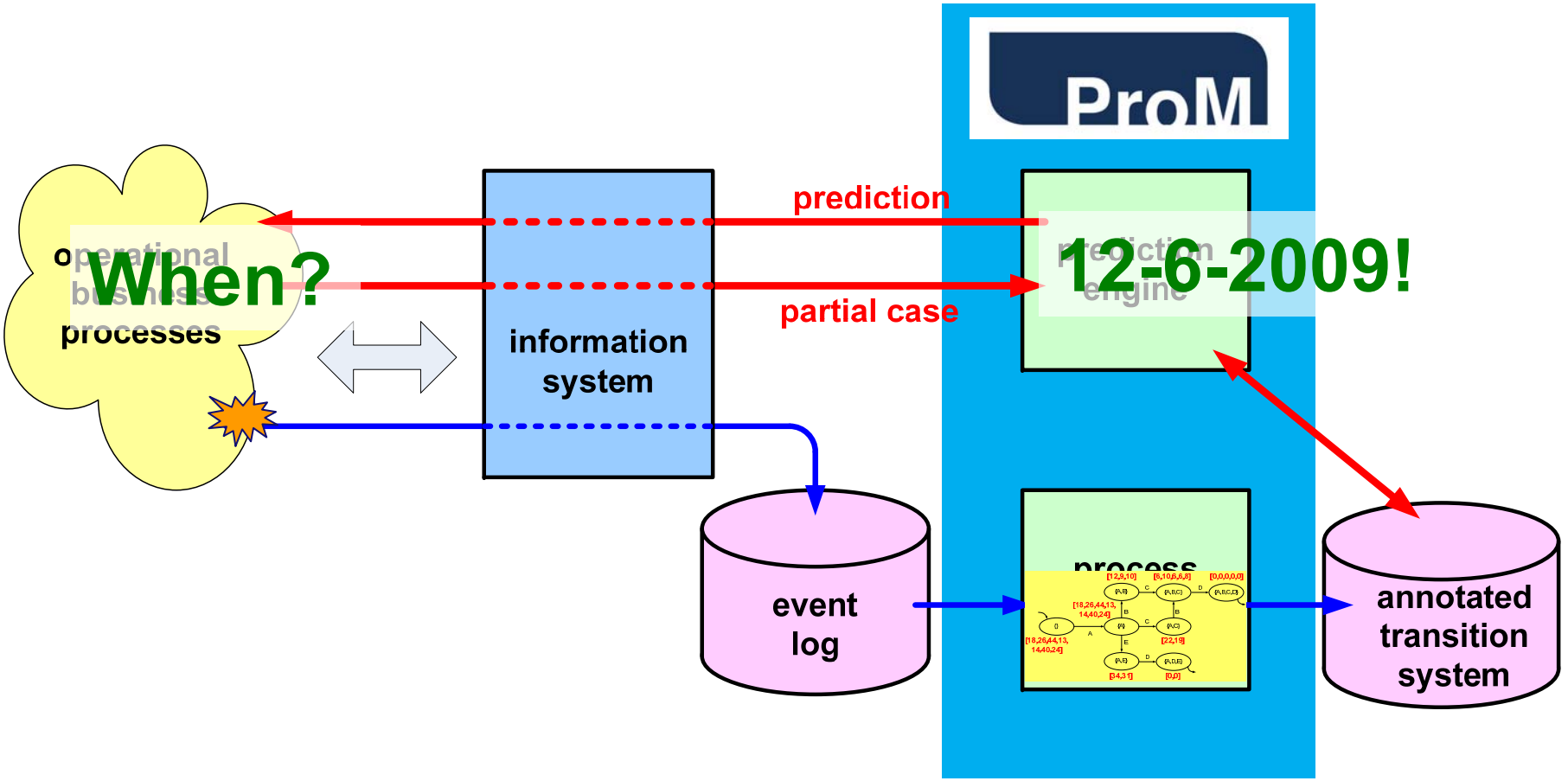
When will I be home?

Technische Universiteit
Eindhoven
University of Technology

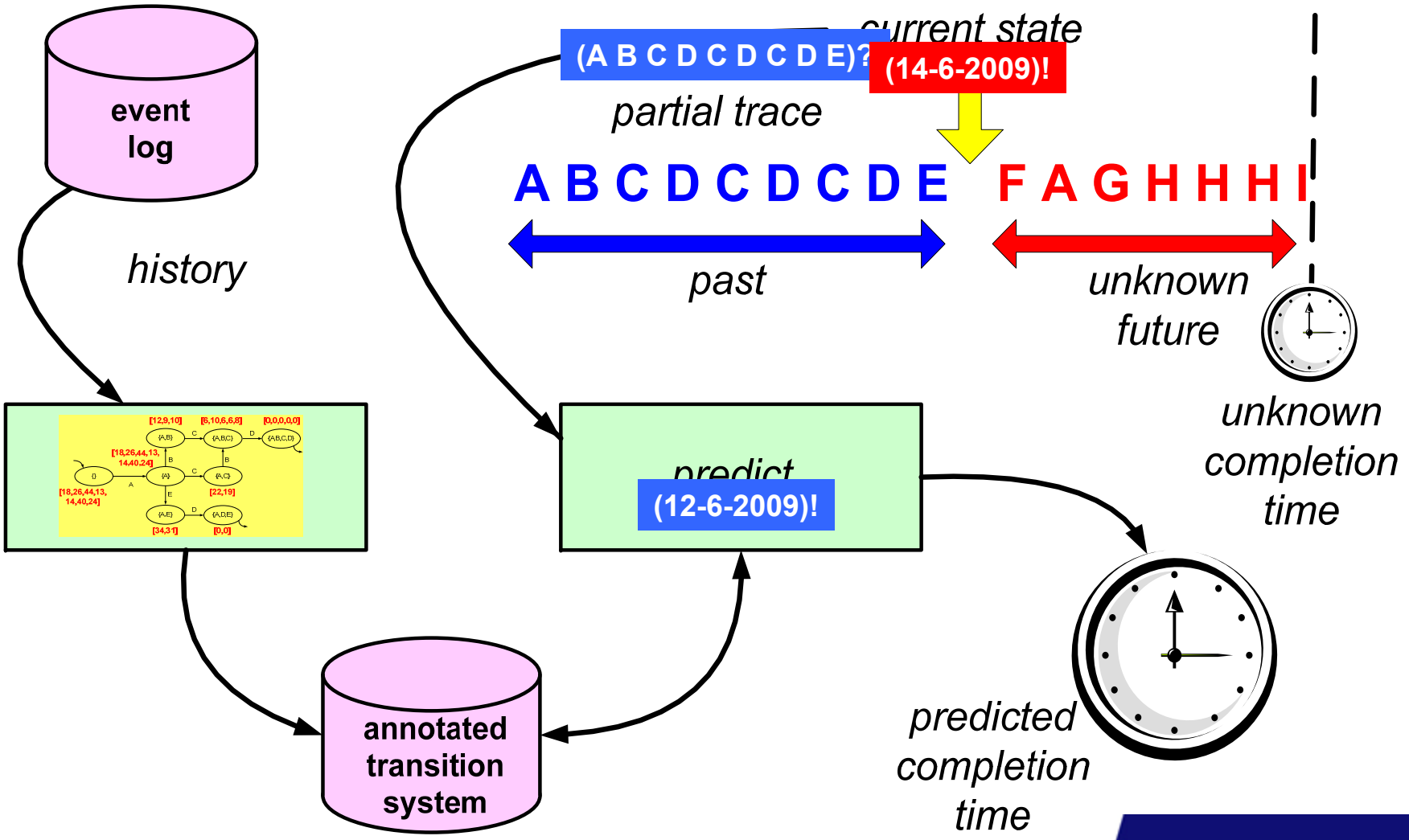
Where innovation starts


Amsterdam
600
meter
11:02
11:26
TOMTOM

Approach


ProM
When?
operational business processes
information system
prediction
partial case
prediction engine
12-6-2009!
event log
process
annotated transition system

Input: partial trace and historic information

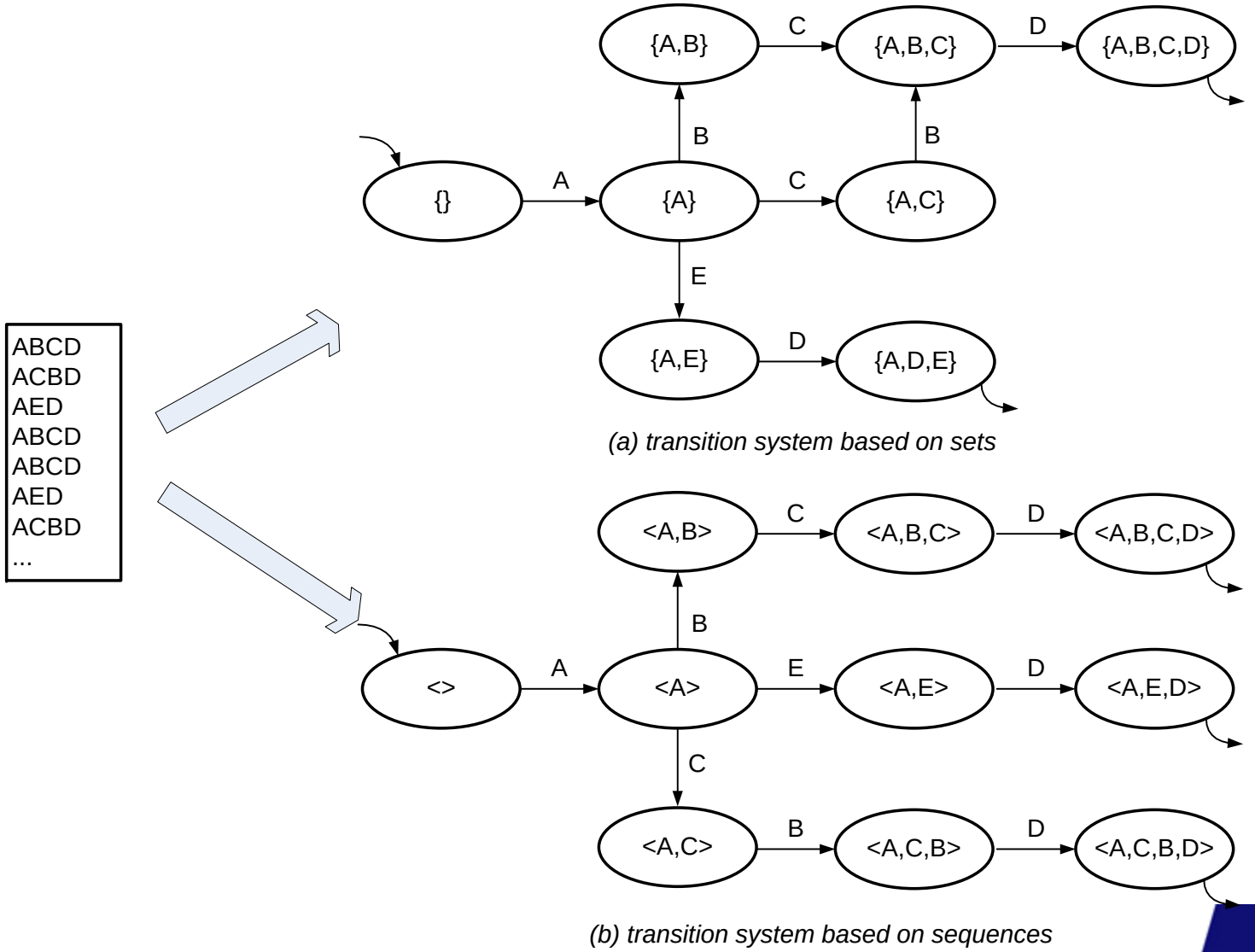


Input

event id	properties				
	timestamp	activity	resource	cost	...
35654423	30-12-2008:11.10	A	John	300	...
35654424	30-12-2008:15.21	B	John	400	...
35654425	30-12-2008:15.35	C	John	100	...
35654426	30-12-2008:15.55	D	John	400	...
35655526	29-12-2008:16.15	A	Ann	300	...
35655527	30-12-2008:16.05	C			
35655528	30-12-2008:16.25	B			
35655529	31-12-2008:10.55	D			
...	...	...			

1	$\langle A^{00}, B^{06}, C^{12}, D^{18} \rangle$
2	$\langle A^{10}, C^{14}, B^{26}, D^{36} \rangle$
3	$\langle A^{12}, E^{22}, D^{56} \rangle$
4	$\langle A^{15}, B^{19}, C^{22}, D^{28} \rangle$
5	$\langle A^{18}, B^{22}, C^{26}, D^{32} \rangle$
6	$\langle A^{19}, E^{28}, D^{59} \rangle$
7	$\langle A^{20}, C^{25}, B^{36}, D^{44} \rangle$

Building transition systems

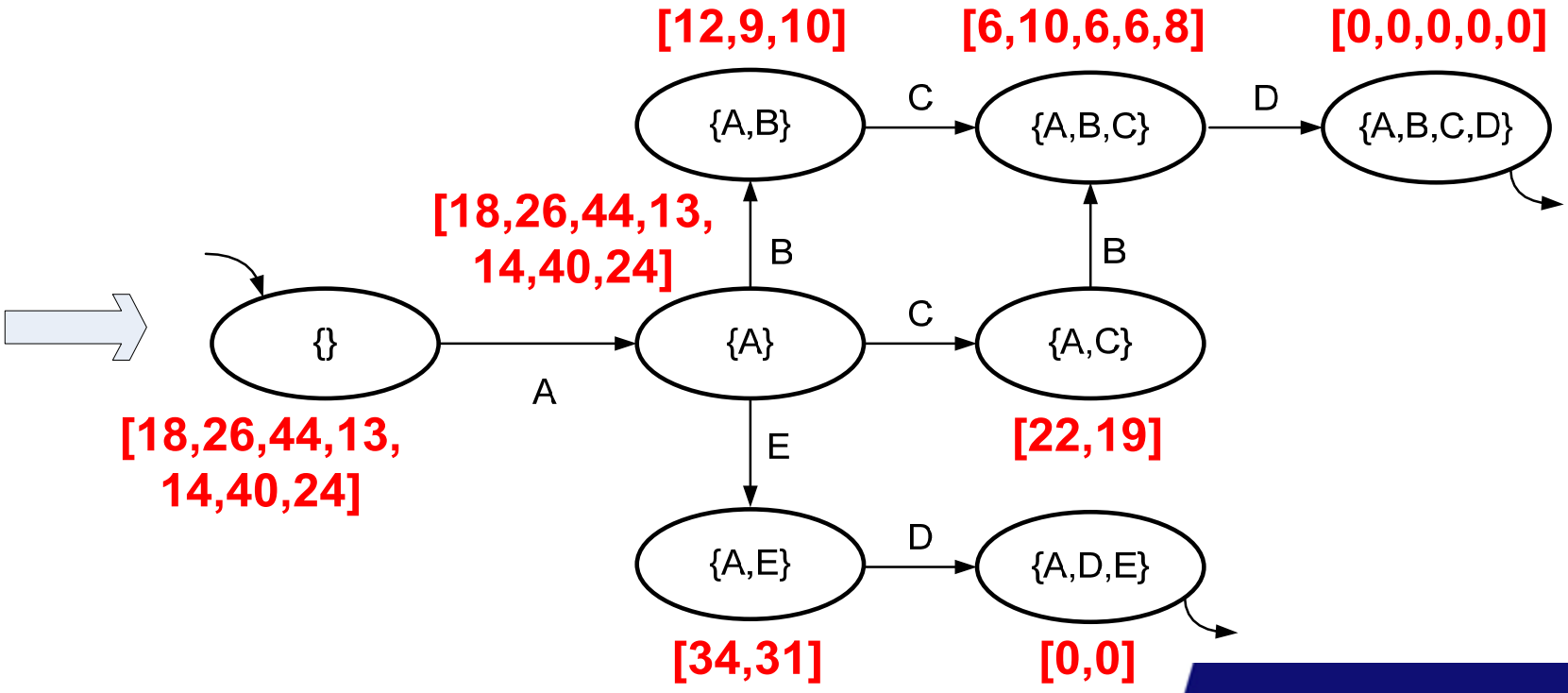


many abstractions are possible and supported by ProM's FSM miner

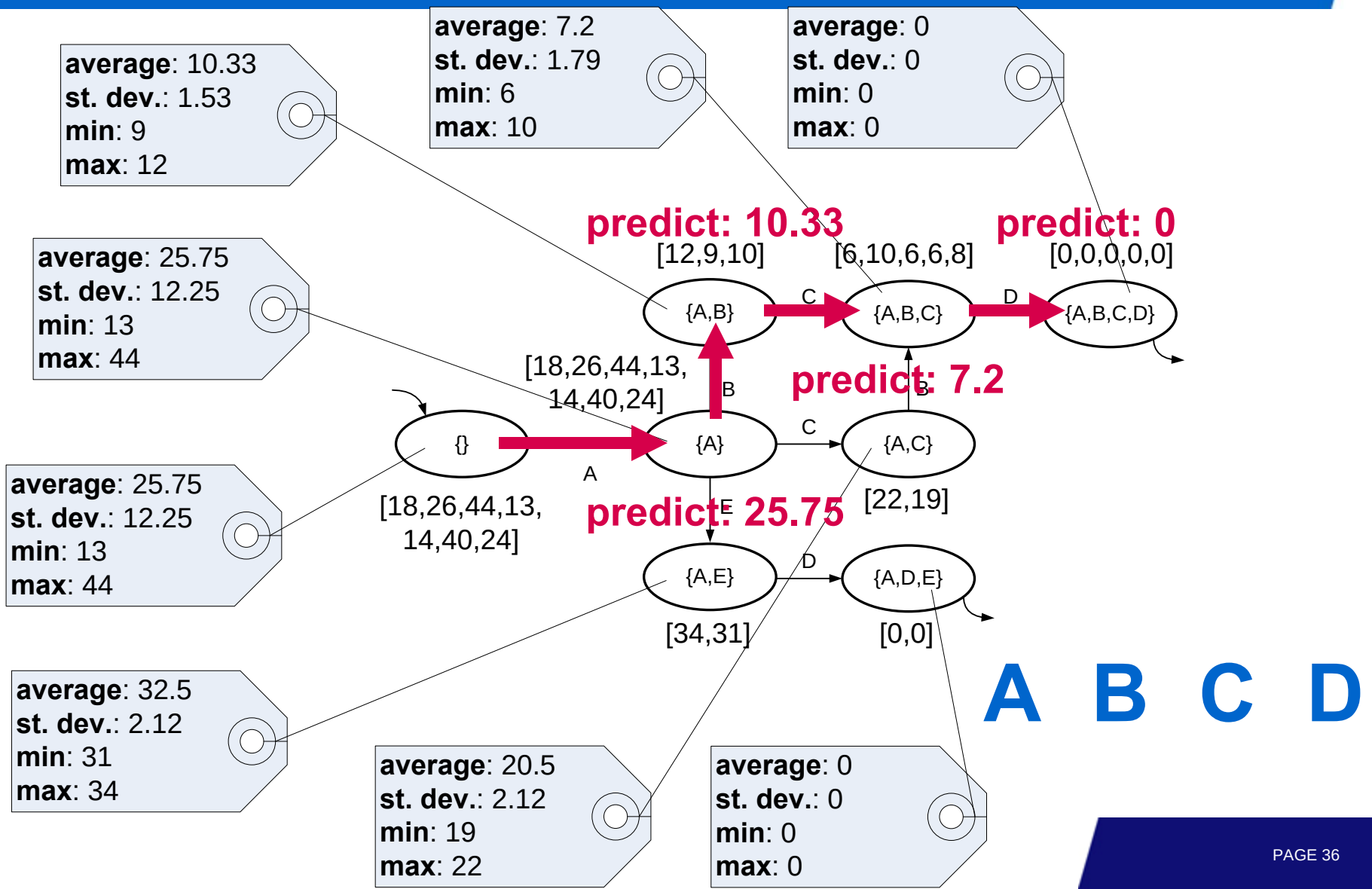
Annotated transition system based on remaining time

1	$\langle A^{00}, B^{06}, C^{12}, D^{18} \rangle$
2	$\langle A^{10}, C^{14}, B^{26}, D^{36} \rangle$
3	$\langle A^{12}, E^{22}, D^{56} \rangle$
4	$\langle A^{15}, B^{19}, C^{22}, D^{28} \rangle$
5	$\langle A^{18}, B^{22}, C^{26}, D^{32} \rangle$
6	$\langle A^{19}, E^{28}, D^{59} \rangle$
7	$\langle A^{20}, C^{25}, B^{36}, D^{44} \rangle$

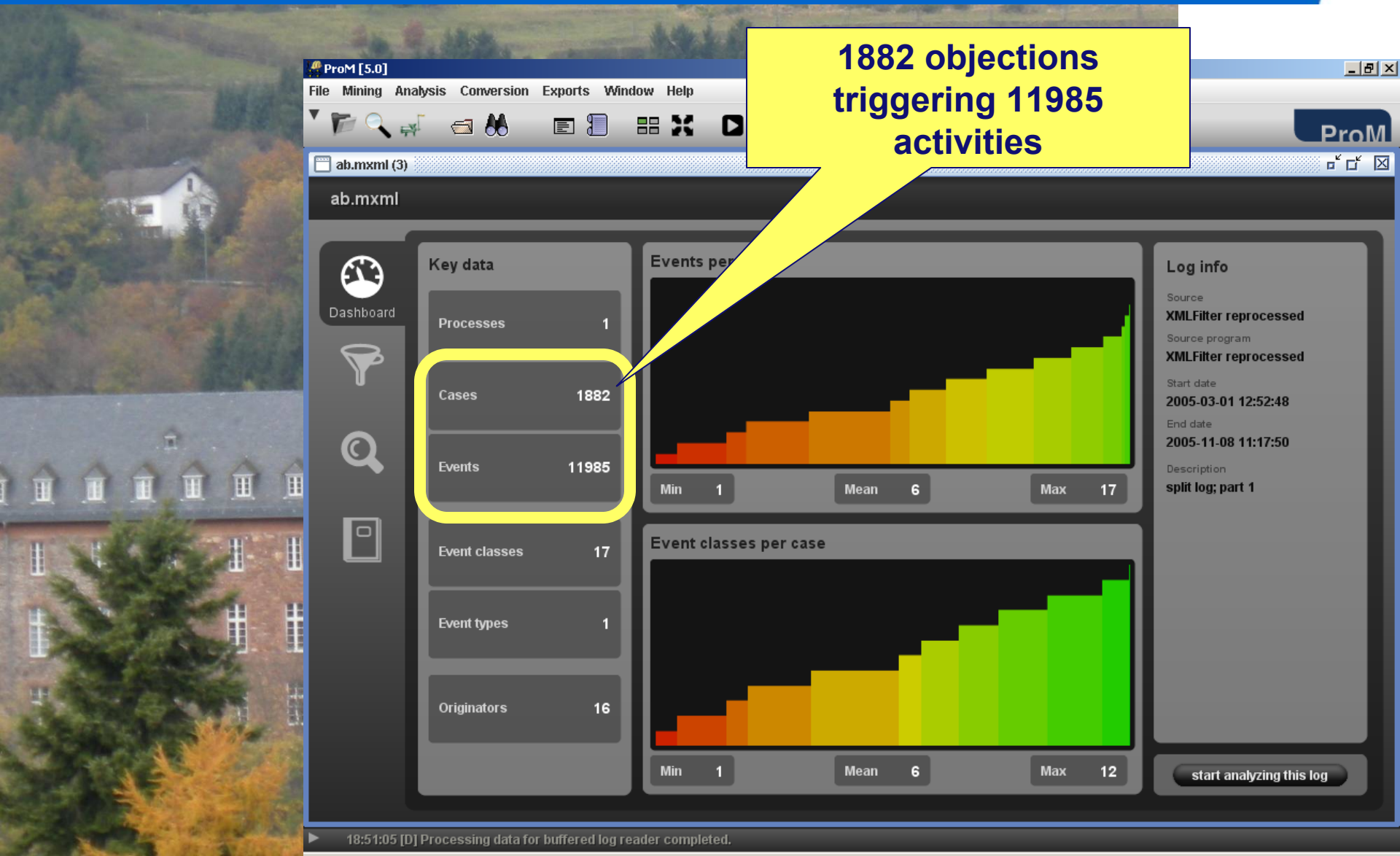
ABCD
ACBD
AED
ABCD
ABCD
AED
ACBD



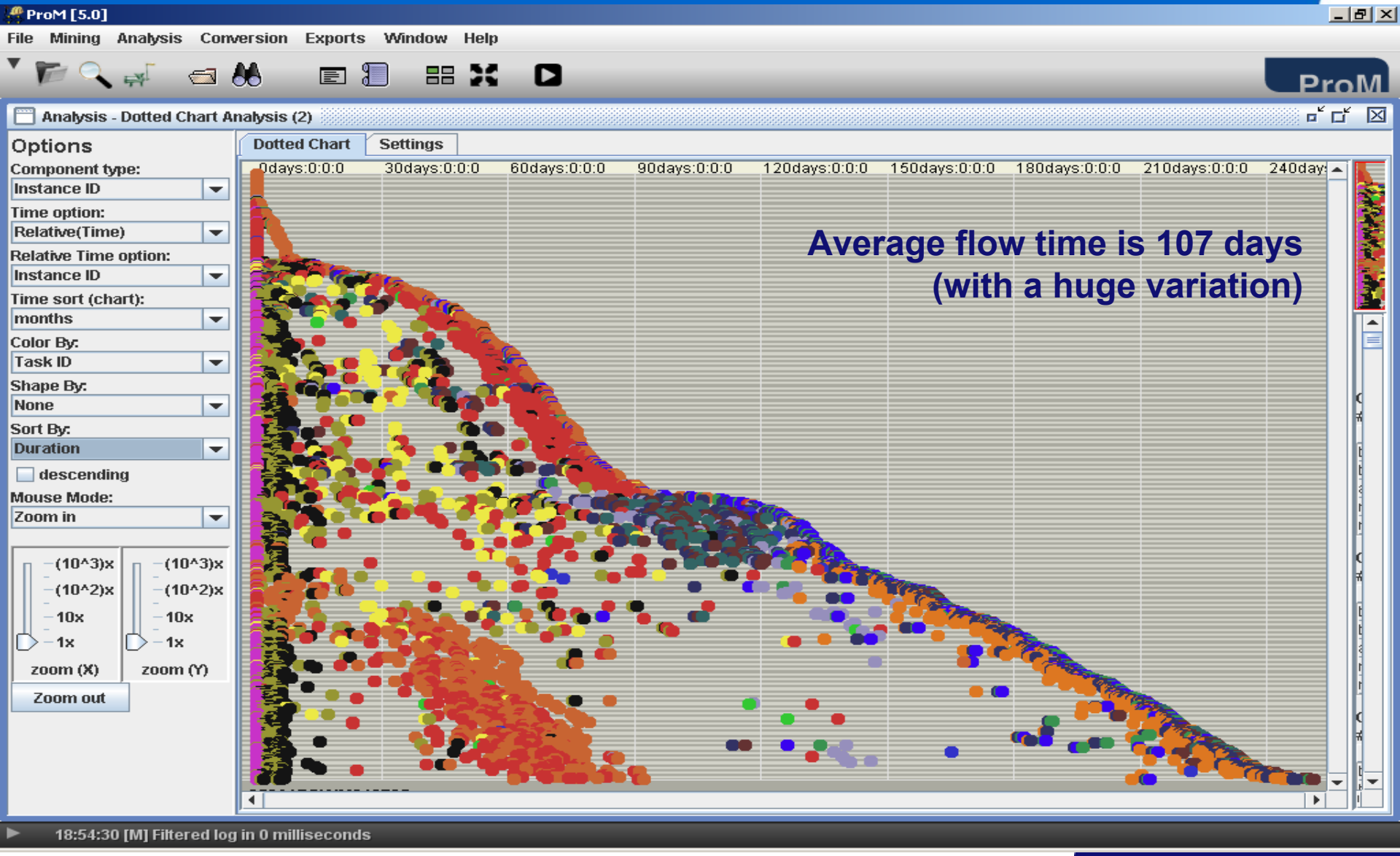
Predictive information

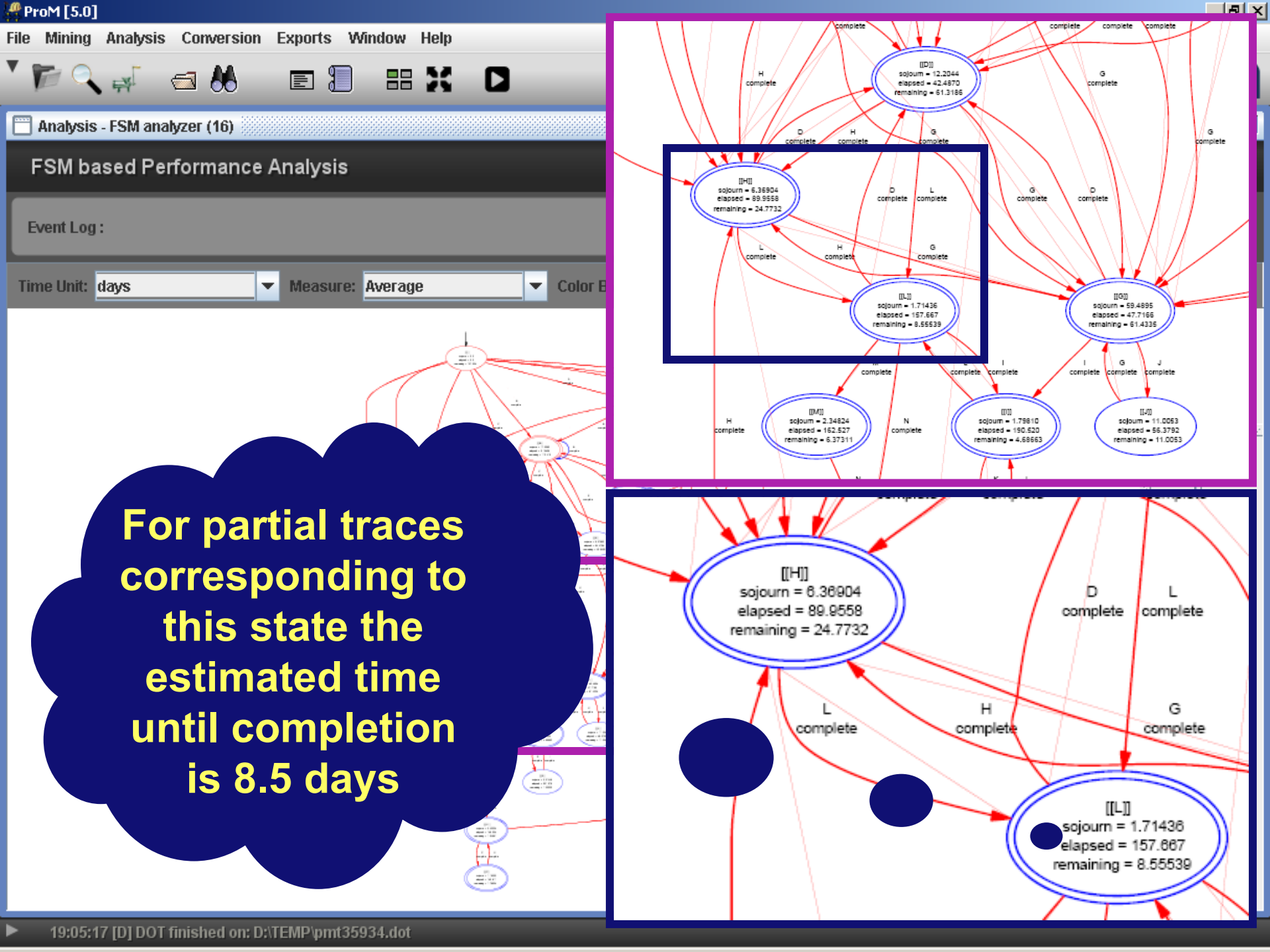


Example: WOZ process in Dutch Municipality



All 11985 events at a glance




ProM [5.0]
File Mining Analysis Conversion Exports Window Help
Analysis - FSM analyzer (16)
FSM based Performance Analysis
Event Log :
Time Unit: days
Measure: Average
[[H]]
sojourn = 6.36904
elapsed = 89.9558
remaining = 24.7732
[[L]]
sojourn = 1.71436
elapsed = 157.667
remaining = 8.55539
For partial traces corresponding to this state the estimated time until completion is 8.5 days
19:05:17 [D] DOT finished on: D:\TEMP\pmt35934.dot

Cross validation: training set and test set

Mean Average Error (MAE)

rooted MSE

MAPE

rts Window Help

ProM

graph view | text view

[[B]]	32.3442	70.6320	702.71.4	1488
[[C]]	64.8881	72.8452	406.781	896
[[D]]	63.1935	69.4784	51727.3	1240
[[G]]	72.8231	74.6510	24.3339	1546
[[I]]	3.25089	5.59291	103.264	629
[[L]]	9.82483	14.6016	406.304	922
[[M]]	8.89983	13.6616	1331.10	866
[[N]]	7.74203	12.2609	1478.89	799
[[O]]	3.17161	9.07740	1351.93	932
[[P]]	2.98513	8.61544	554.336	709
[[F]]	34.0397	44.4393	52294.3	16
[[H]]	16.2393	22.9282	447.301	326
[[E]]	46.4377	55.1125	1232.75	27
[[Q]]	36.6227	47.2489	133.769	238
[[J]]	2.67055	2.67055	25.7842	2
[[K]]	0.0	0.0	0.0	1
overall(mean)	31.3298	37.1198	11359.0	18
overall(aggregated				

pmt35935.dot

min 60 max 80 Update

H complete

G complete

D complete

L complete

G complete

H complete

G complete

[[L]]

MSE = 213.209

Frequency = 922

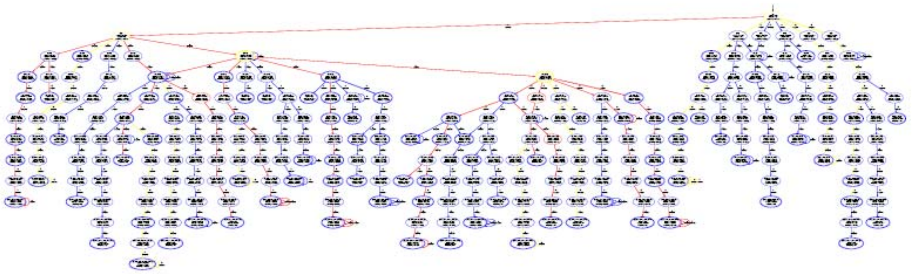
M complete

L complete

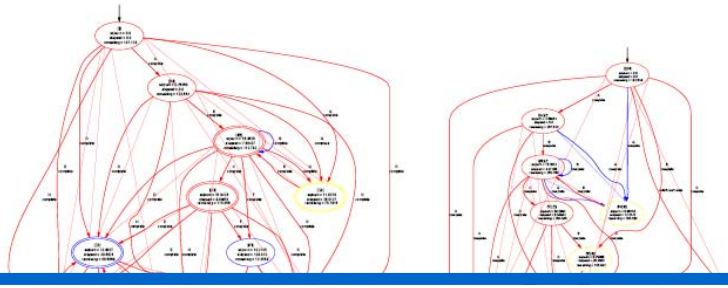
I complete

Zoom: 151 %

Some results



(a) Set abstraction based on all activities



Abstraction	MAE	RMSE	MAPE
Set abstraction based on all activities (cf. Figure 17(a))	41.648	47.513	1505.07
Set abstraction based on last activity (cf. Figure 17(b))	43.080	49.666	1818.49
Set abstraction based on last activity and additional information related to the occurrence of "I" (cf. Figure 17(c))	17.129	23.550	900.07
Complete abstraction (cf. Figure 17(d))	63.391	74.965	7169.55
Simple heuristic: half of average total flow time (53.57 days)	61.750	75.505	6188.04


Otto-Suhr-Allee
Hardenbergstraße
65
17.7
11:01
0:25
11:26
Marchstraße
TOMTOM

Conclusion

Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

Conclusion

- The abundance of event data enables a wide variety of process mining techniques ranging from process discovery to conformance checking.
- A reality check for people that are involved in process modeling.
- TomTom functionality is already possible today!
- Check out ProM with its 250+ plug-ins.
- Contribute: case studies, plug-ins, etc.

Thanks! cf. *www.processmining.org*

- Wil van der Aalst
- Peter van den Brand
- Boudewijn van Dongen
- Christian Günther
- Eric Verbeek
- Ana Karla Alves de Medeiros
- Anne Rozinat
- Minseok Song
- Ton Weijters
- Remco Dijkman
- Gianluigi Greco
- Antonella Guzzo
- Kristian Bisgaard Lassen
- Ronny Mans
- Jan Mendling
- Vladimir Rubin
- Nikola Trcka
- Irene Vanderfeesten
- Barbara Weber
- Lijie Wen
- Mercy Amiyo
- Carmen Bratosin
- Toon Calders
- Jorge Cardoso
- Ronald Crooy
- Florian Gottschalk
- Monique Jansen-Vullers
- Peter Khisa Wakholi
- Nicolas Knaak
- Sven Lambrechts
- Joyce Nakatumba
- Mariska Netjes
- Mykola Pechenizkiy
- Maja Pesic
- Hajo Reijers
- Stefanie Rinderle
- Domenico Saccà
- Helen Schonenberg
- Marc Voorhoeve
- Jianmin Wang
- Jan Martijn van der Werf
- Martin van Wingerden
- Jianhong Ye
- Huub de Beer
- Elena Casares
- Alina Chipaila
- Walid Gaaloul
- Martijn van Giessel
- Shaifali Gupta
- Thomas Hoffmann
- Peter Hornix
- René Kerstjens
- Ralf Kramer
- Wouter Kunst
- Laura Maruster
- Andriy Nikolov
- Adarsh Ramesh
- Jo Theunissen
- Kenny van Uden
- ...

Relevant WWW sites

http://www.senternovem.nl/innovatievouchers
MKB 2.500 – 7.500 euro

ProM

- http://www.processmining.org
- **http:// promimport.sourceforge.net**
- **http://prom.sourceforge.net**
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