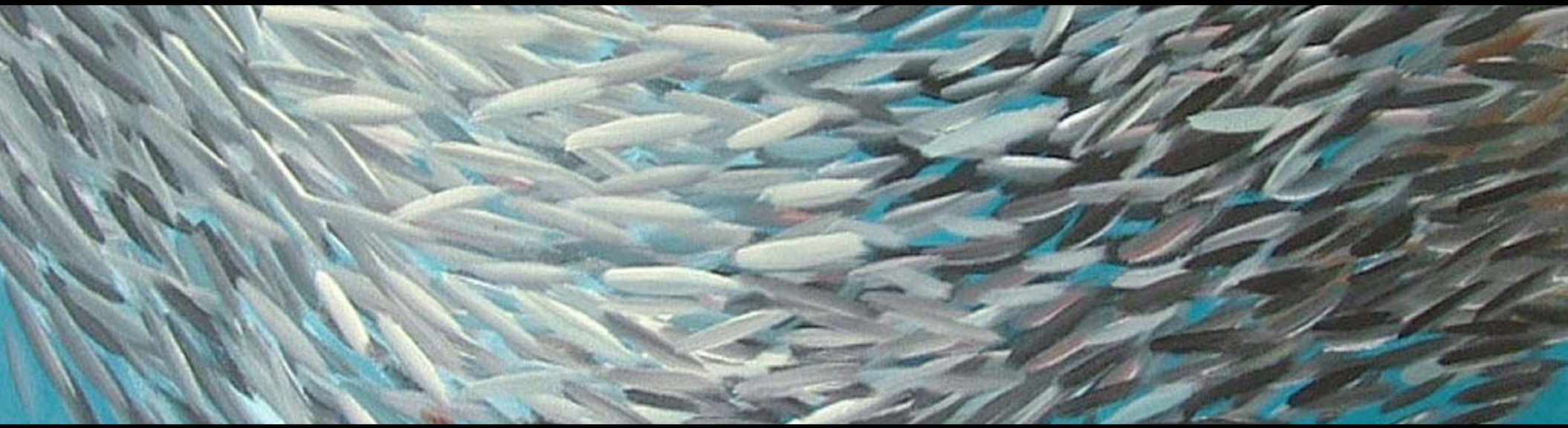
process mining



Prof.dr.ir. Wil van der Aalst

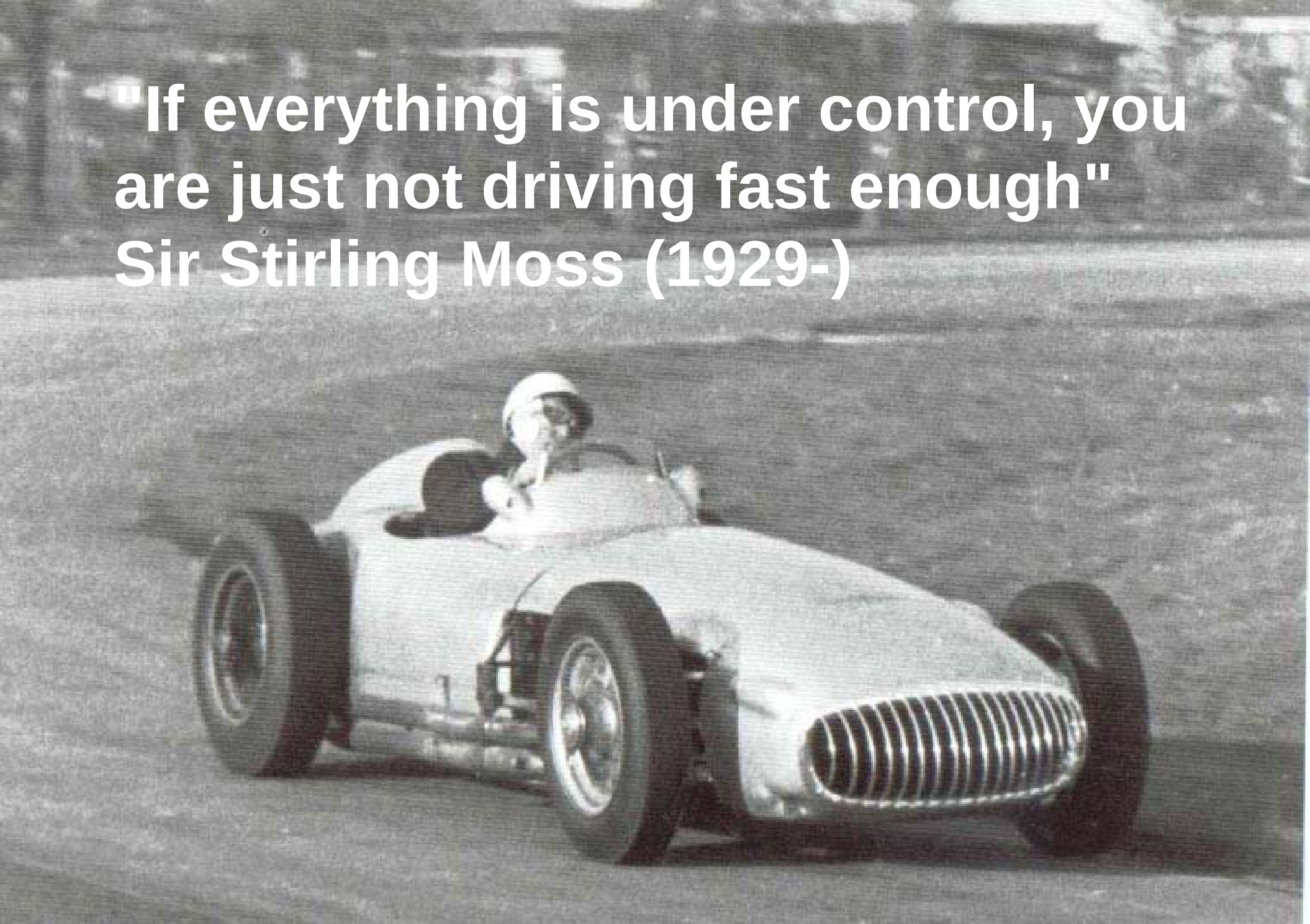
Eindhoven University of Technology,

P.O. Box 513, 5600 MB Eindhoven, The Netherlands

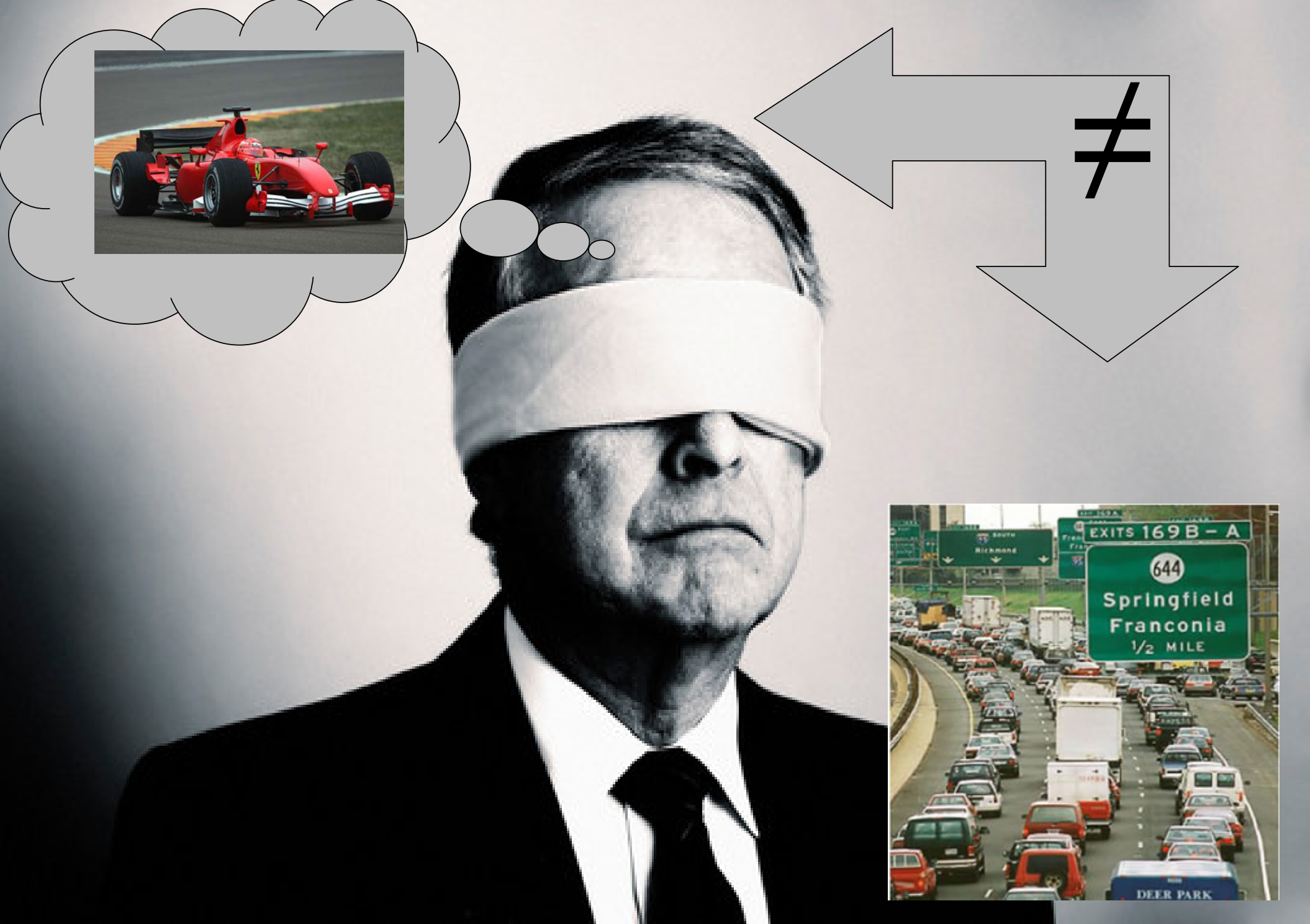
w.m.p.v.d.aalst@tue.nl

the organization, ...

... and its operational processes


"If everything is under control, you are just not driving fast enough"
Sir Stirling Moss (1929-)


but ...

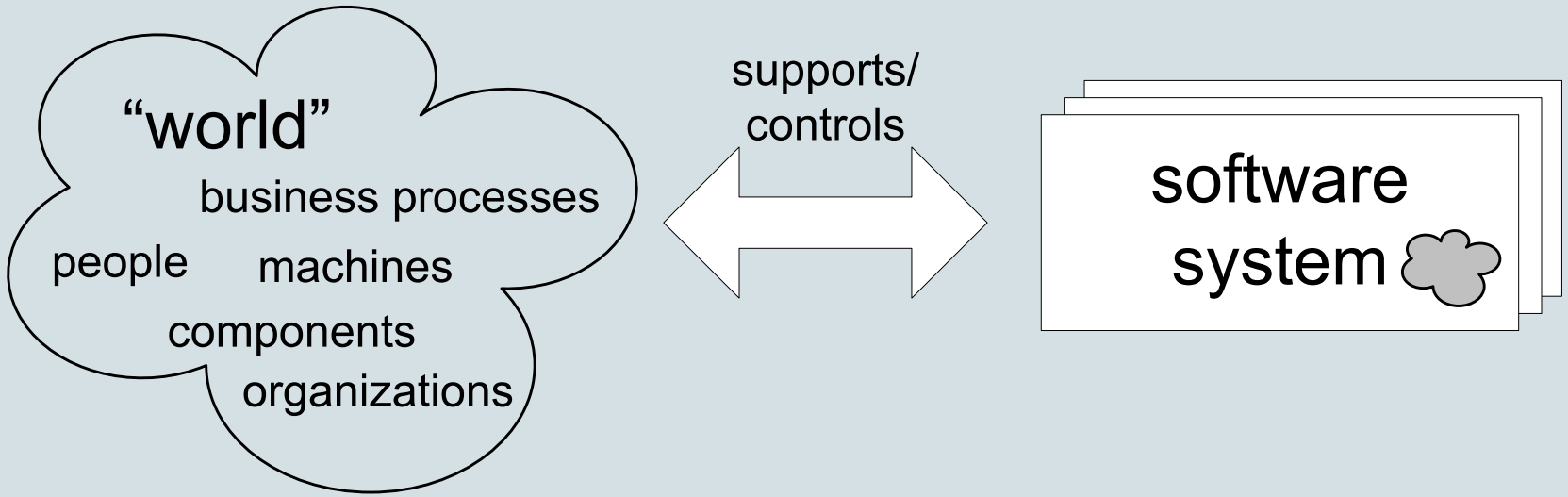

≠
EXITS 169B – A
644
Springfield
Franconia
½ MILE
DEER PARK

process mining

EIT
informatica onderwijs

ProM

Software systems are the mirror image of the “world”



TU/e technische universiteit e

Role of models

"world"

business process

people machines

components

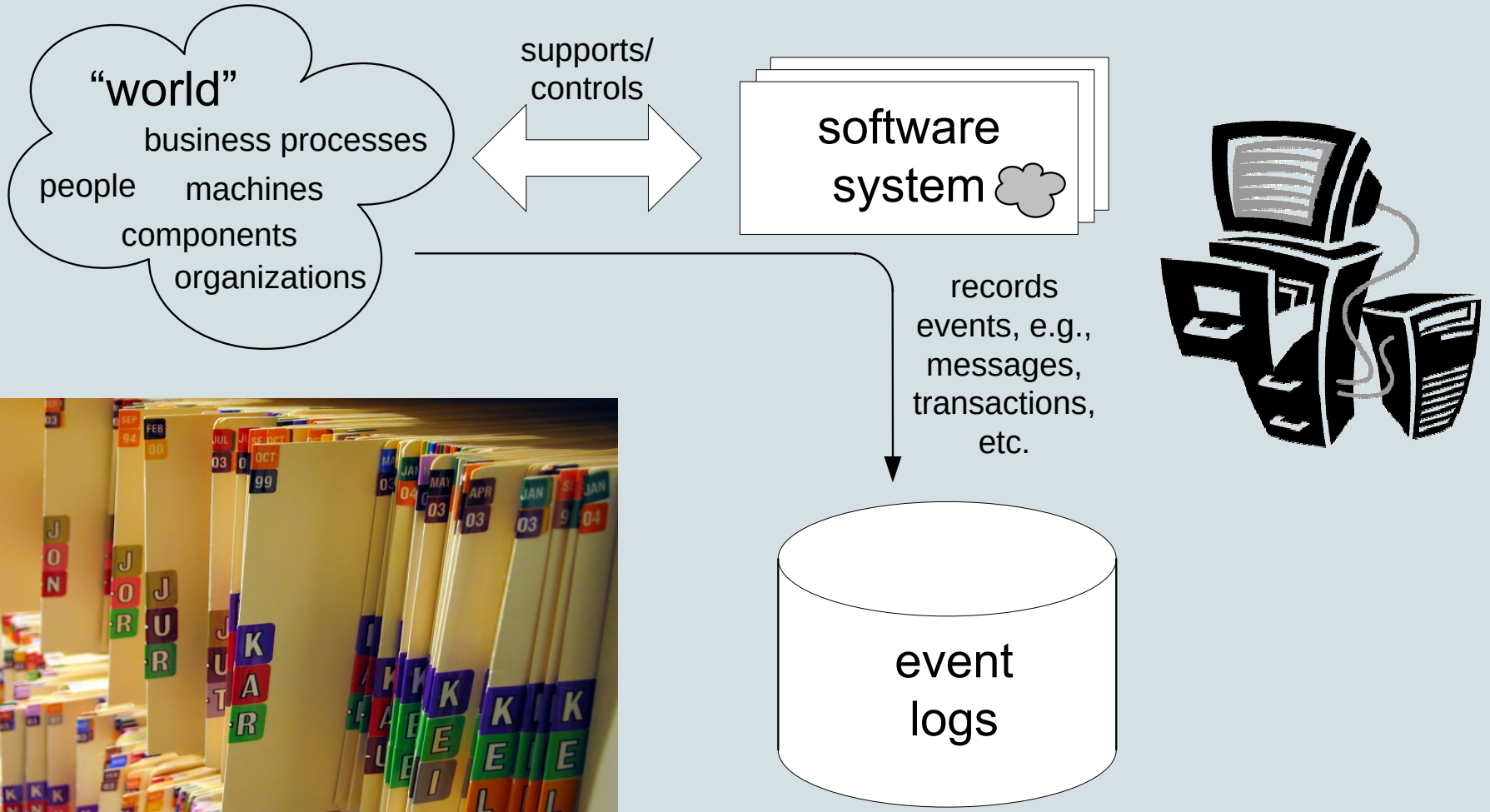
organizations

verification

real world

powerpoint reality

Event logs are a reflection of reality



Examples:

staffware. THE POWER OF PROCESS

IBM

Pallas Athena PROCESS MANAGEMENT

FileNet An IBM Company

océ

ORACLE

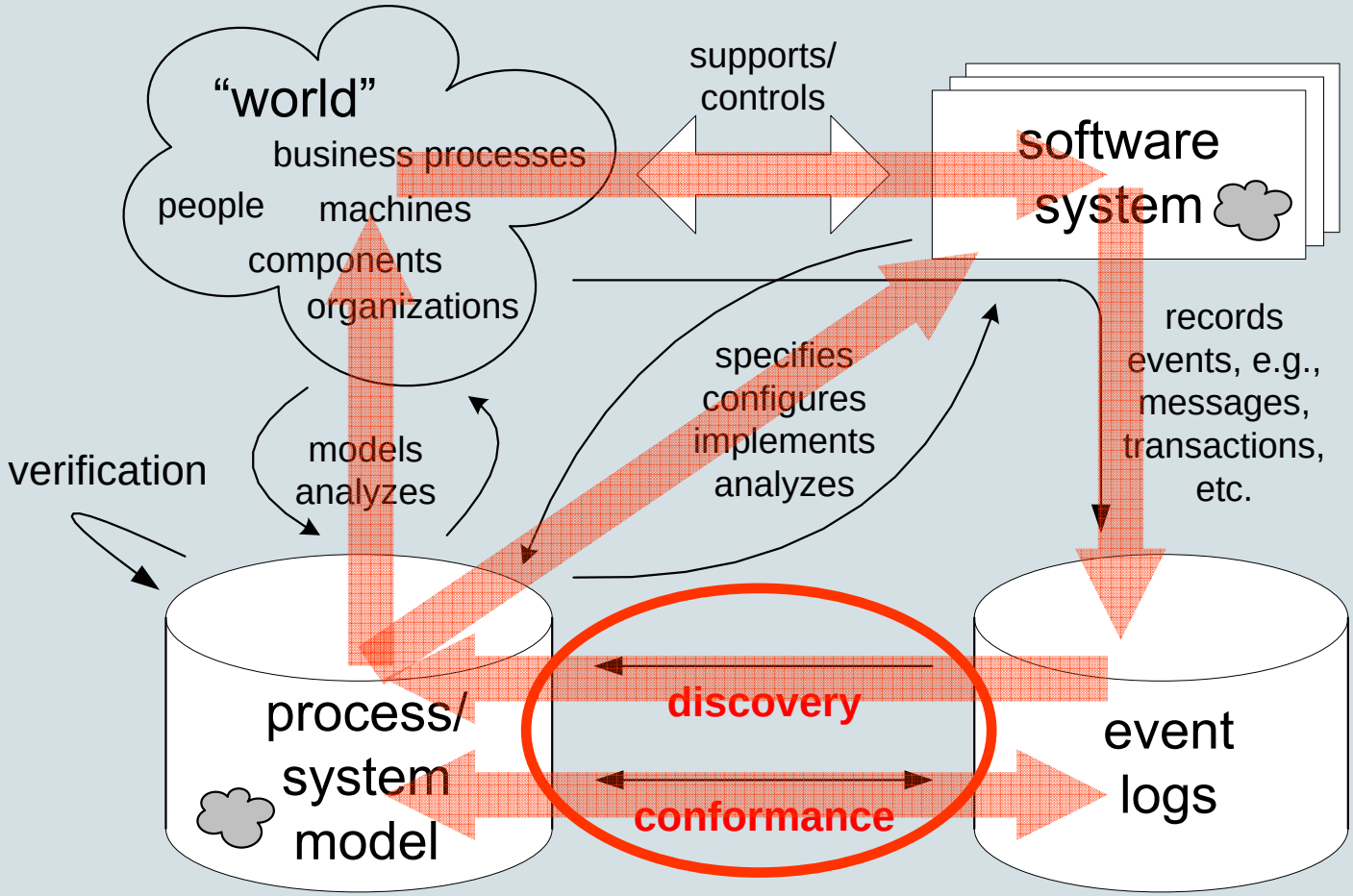
SAP

PHILIPS sense and simplicity

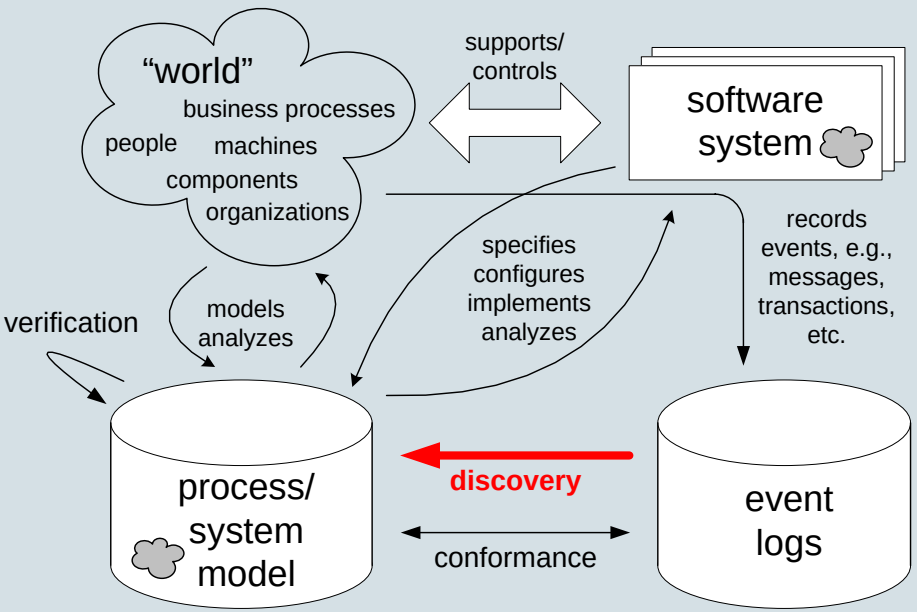
ASML

WebSphere. software

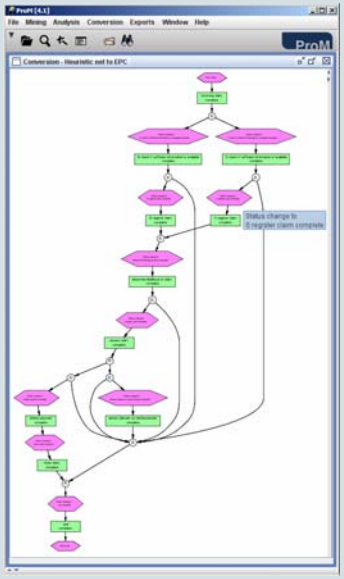
Process mining: Linking events to models

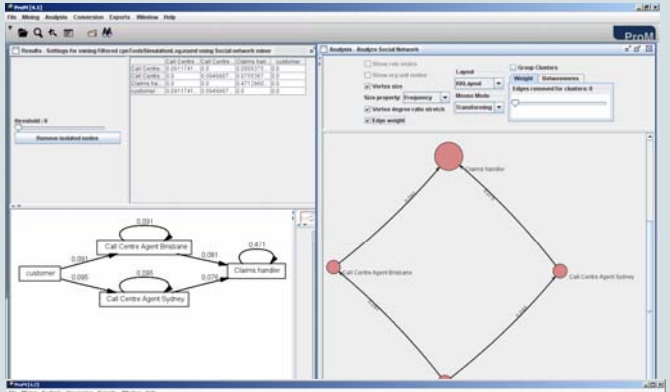


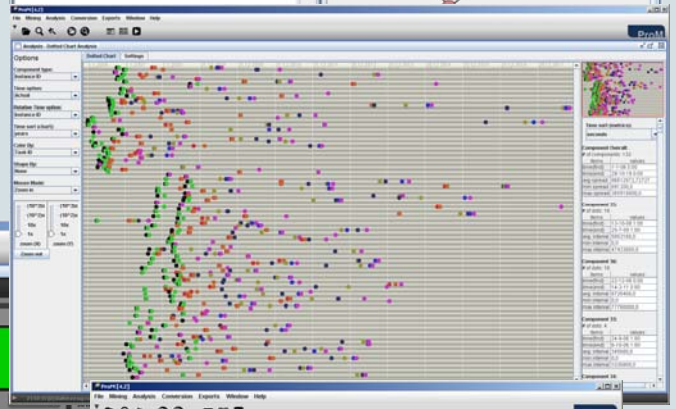
Discovery

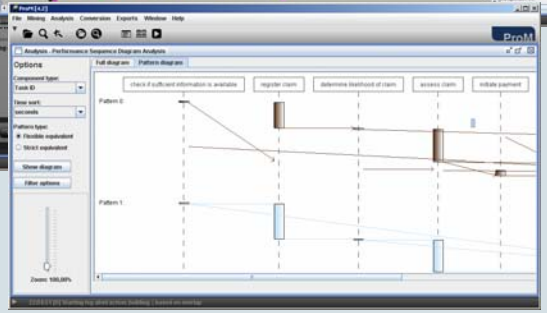

"world"
business processes
people
machines
components
organizations
supports/
controls
software
system
records
events, e.g.,
messages,
transactions,
etc.
specifies
configures
implements
analyzes
models
analyzes
verification
process/
system
model
discovery
conformance
event
logs

MXML Log
- instances: **3512**
- audit trail entries: **46138**

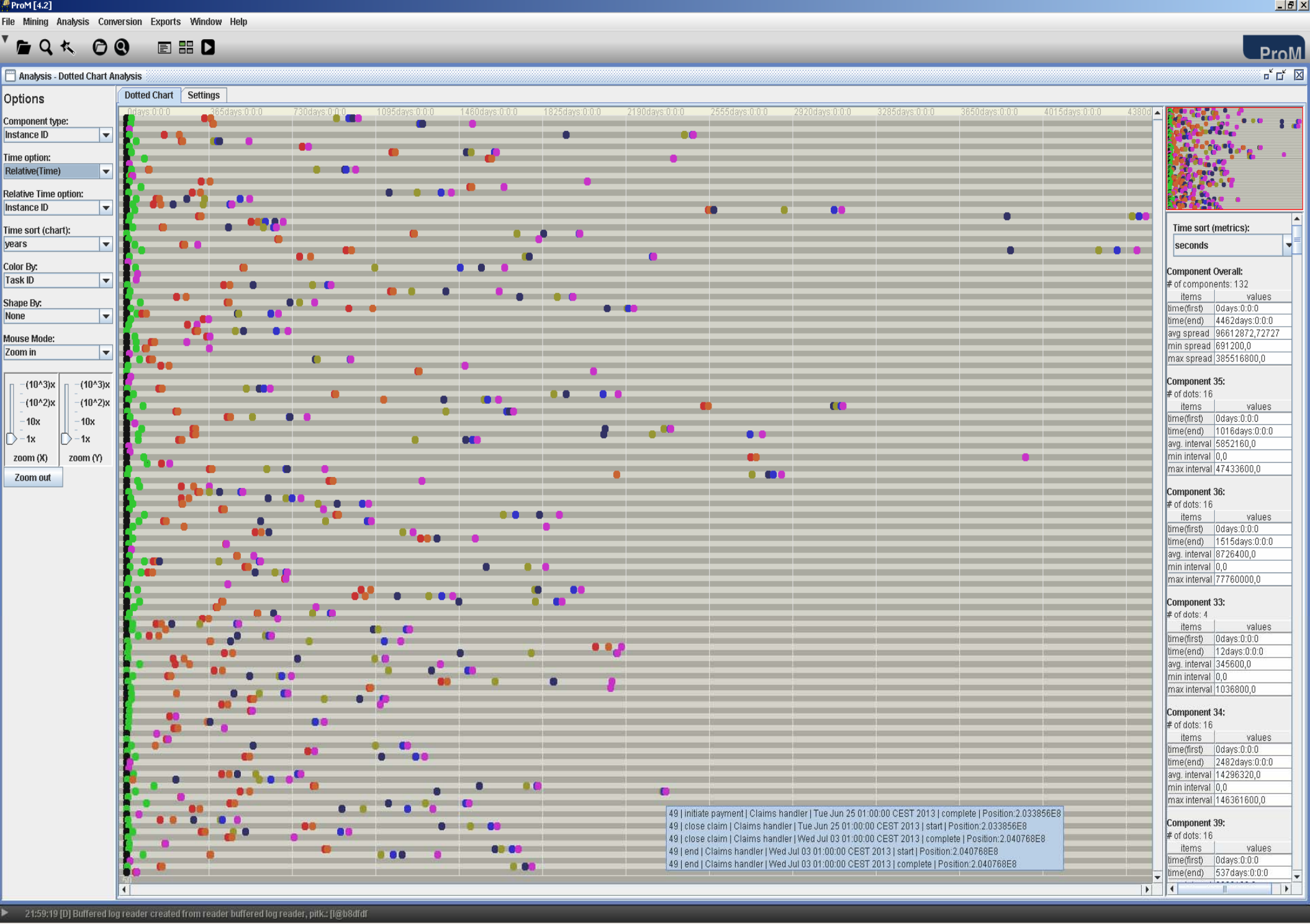








ProM supports +40 types of model discovery!


ProM [4.2]
File Mining Analysis Conversion Exports Window Help
Analysis - Dotted Chart Analysis
Options
Component type:
Instance ID
Time option:
Relative(Time)
Relative Time option:
Instance ID
Time sort (chart):
years
Color By:
Task ID
Shape By:
None
Mouse Mode:
Zoom in
(10^3)x
(10^2)x
10x
1x
zoom (X)
zoom (Y)
Zoom out
Dotted Chart
Settings
0days:0:0:0
365days:0:0:0
730days:0:0:0
1095days:0:0:0
1460days:0:0:0
1825days:0:0:0
2190days:0:0:0
2555days:0:0:0
2920days:0:0:0
3285days:0:0:0
3650days:0:0:0
4015days:0:0:0
4380d
49 | initiate payment | Claims handler | Tue Jun 25 01:00:00 CEST 2013 | complete | Position:2.033856E8
49 | close claim | Claims handler | Tue Jun 25 01:00:00 CEST 2013 | start | Position:2.033856E8
49 | close claim | Claims handler | Wed Jul 03 01:00:00 CEST 2013 | complete | Position:2.040768E8
49 | end | Claims handler | Wed Jul 03 01:00:00 CEST 2013 | start | Position:2.040768E8
49 | end | Claims handler | Wed Jul 03 01:00:00 CEST 2013 | complete | Position:2.040768E8
Time sort (metrics):
seconds
Component Overall:
# of components: 132
items values
time(first) 0days:0:0:0
time(end) 4462days:0:0:0
avg spread 96612872,72727
min spread 691200,0
max spread 385516800,0
Component 35:
# of dots: 16
items values
time(first) 0days:0:0:0
time(end) 1016days:0:0:0
avg. interval 5852160,0
min interval 0,0
max interval 47433600,0
Component 36:
# of dots: 16
items values
time(first) 0days:0:0:0
time(end) 1515days:0:0:0
avg. interval 8726400,0
min interval 0,0
max interval 77760000,0
Component 33:
# of dots: 4
items values
time(first) 0days:0:0:0
time(end) 12days:0:0:0
avg. interval 345600,0
min interval 0,0
max interval 1036800,0
Component 34:
# of dots: 16
items values
time(first) 0days:0:0:0
time(end) 2482days:0:0:0
avg. interval 14296320,0
min interval 0,0
max interval 146361600,0
Component 39:
# of dots: 16
items values
time(first) 0days:0:0:0
time(end) 537days:0:0:0
21:59:19 [D] Buffered log reader created from reader buffered log reader, pitk:: [I@b8dfdf

ProM [4.1]

File Mining Analysis Conversion Exports Window Help

Results - Settings for mining Filtered cpnToolsSimulationLog.mxml using Heuristics miner

incoming claim (complete) 3512

ProM [4.1]

File Mining Analysis Conversion Exports Window Help

Conversion - Heuristic net to Petri net

incoming claim complete

B check if sufficient information is available complete

S check if sufficient information is available complete

B register claim complete

S register claim complete

determine likelihood of claim complete

assess claim complete

ProM [4.1]

File Mining Analysis Conversion Exports Window Help

ProM

Conversion - Heuristic net to EPC

Status change to S register claim complete

ProM [4.1]

File Mining Analysis Conversion Exports Window Help

ProM

Conversion - Labeled WF net to YAWL model

incoming claim complete Task

[default]

true [1]

B check if sufficient information is available complete Task

S check if sufficient information is available complete Task

true [0]

[default]

B register claim complete Task

S register claim complete Task

determine likelihood of claim complete Task

true [0]

assess claim complete Task

true [0]

[default]

initiate payment complete Task

advise claimant on reimbursement complete Task

close claim complete Task

true [0]

[default]

end complete Task

[default]

true [0]

3512

ProM [4.1]

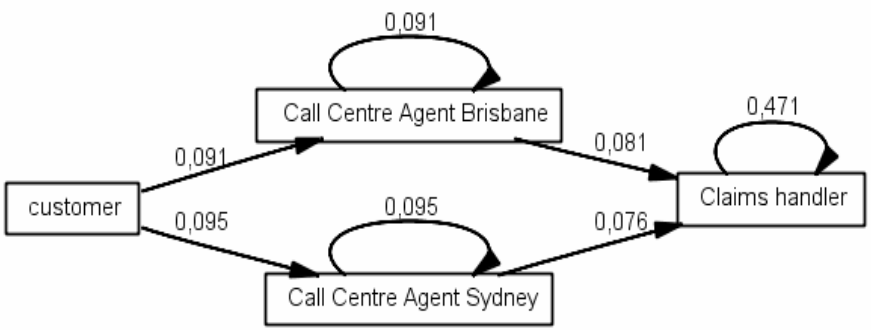
File Mining Analysis Conversion Exports Window Help

Results - Settings for mining Filtered cpnToolsSimulationLog.mxml using Social network miner

	Call Centre ...	Call Centre ...	Claims han...	customer
Call Centre...	0.0911741...	0.0	0.0808375...	0.0
Call Centre...	0.0	0.0949907...	0.0755367...	0.0
Claims ha...	0.0	0.0	0.4712960...	0.0
customer	0.0911741...	0.0949907...	0.0	0.0

threshold : 0

Remove isolated nodes



Zoom

Analysis - Analyze Social Network

Show role nodes
Show org unit nodes
Vertex size
Size property: Frequency
Vertex degree ratio stretch
Edge weight

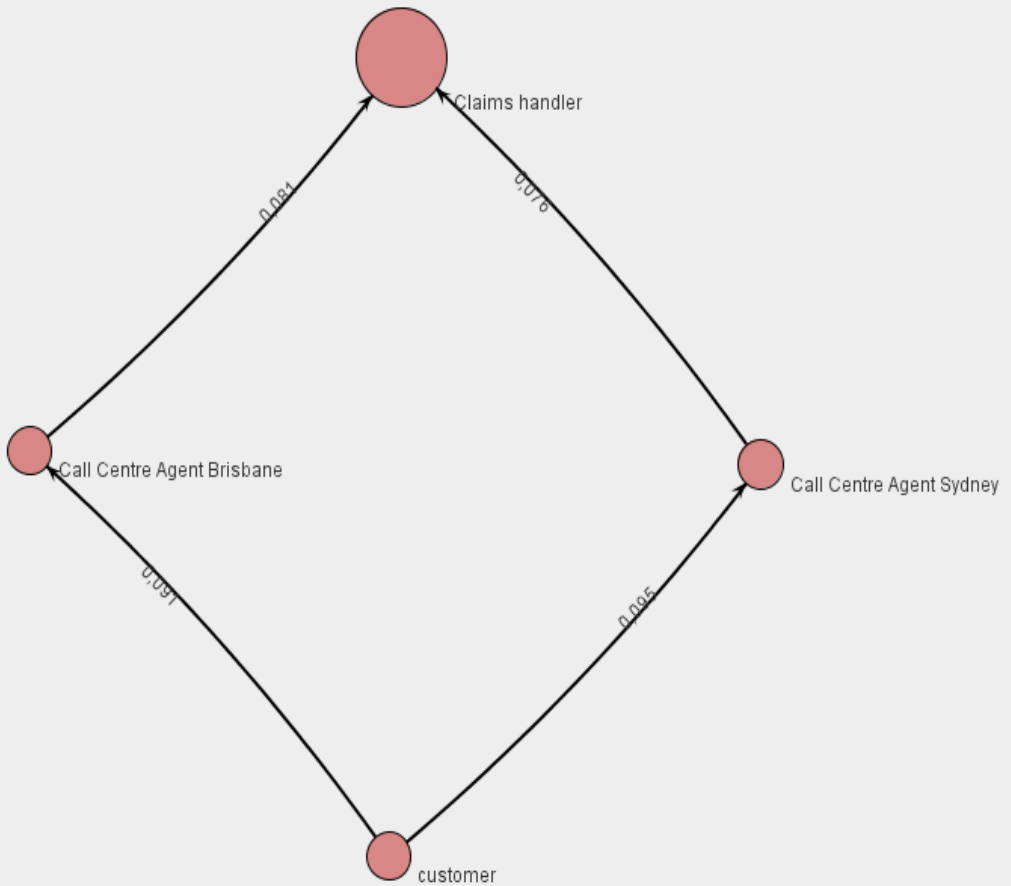
Layout: KKLayout

Mouse Mode: Transforming

Group Clusters

Weight | Betweenness

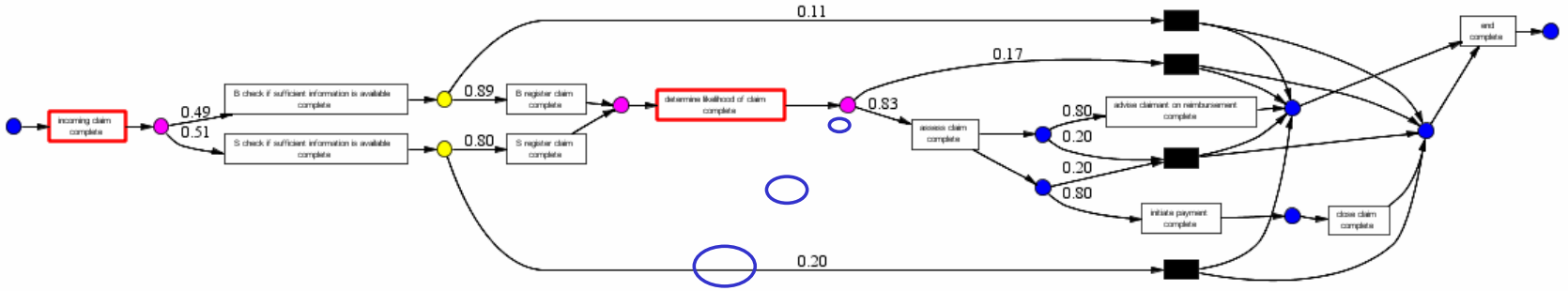
Edges removed for clusters: 0



ProM [4.1]

File Mining Analysis Conversion Exports Window Help

Analysis - Performance Analysis with Petri net



bottle-necks

throughput time

flow time from A to B

Process information:

Total number selected:

3512 cases

Number fitting:

3512 cases

Arrival rate:

0,12 cases per second

	Throughput time (seconds)
avg	11115,54
min	0,0
max	40704,0
stdev	8906,98
fast 25...	1379,19
slow 2...	23817,24
norma...	9632,87

Change Percentages | Export Time-Metrics

Performance information of the selected transitions:

Frequency: 2950 cases

	Time in between (seconds)
avg	12248,87
min	53,0
max	39706,0
stdev	8381,14

Waiting time:
High
Medium
Low
Settings

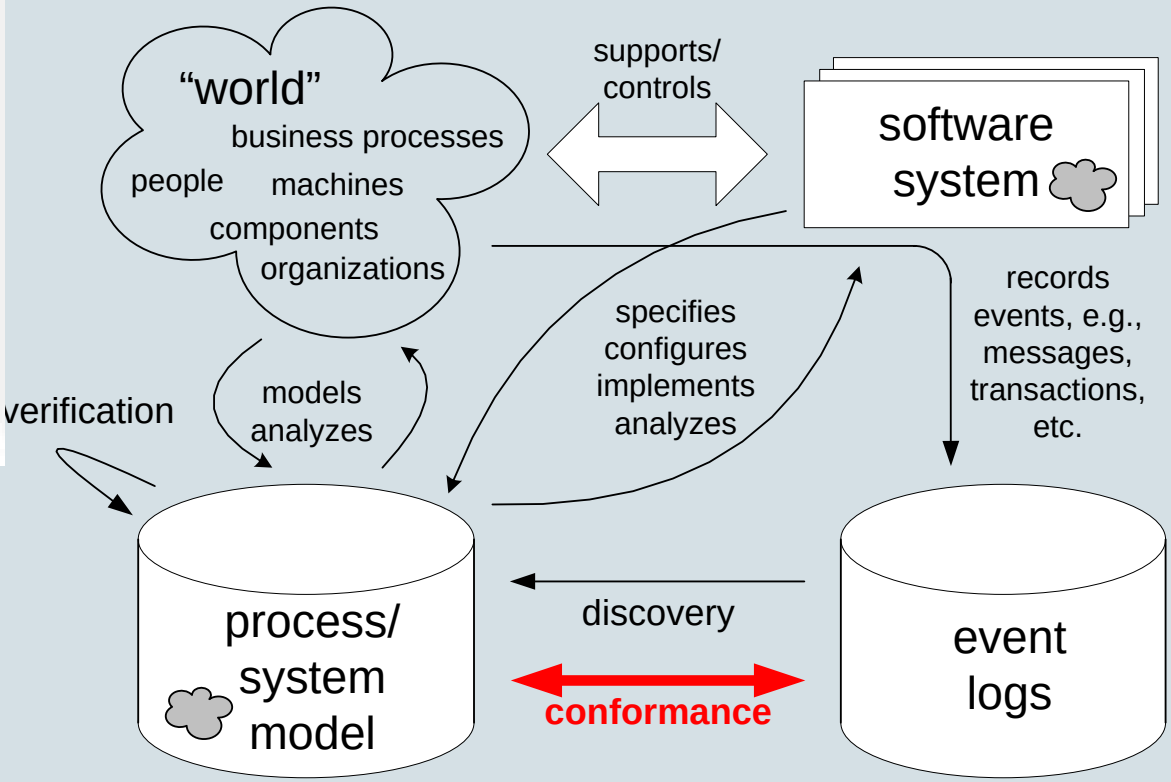
Selected:

Transition - incoming claim c...

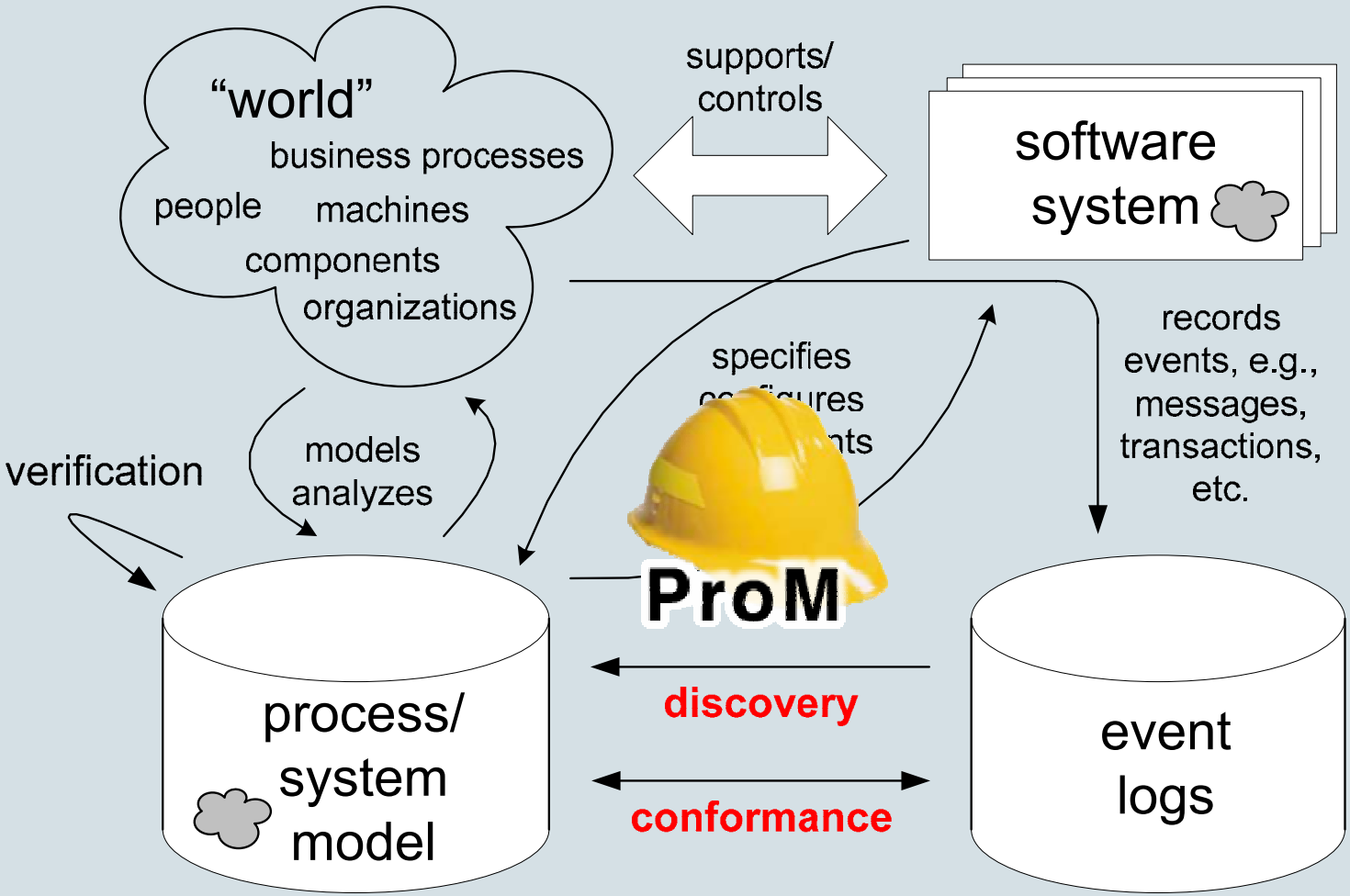
and:

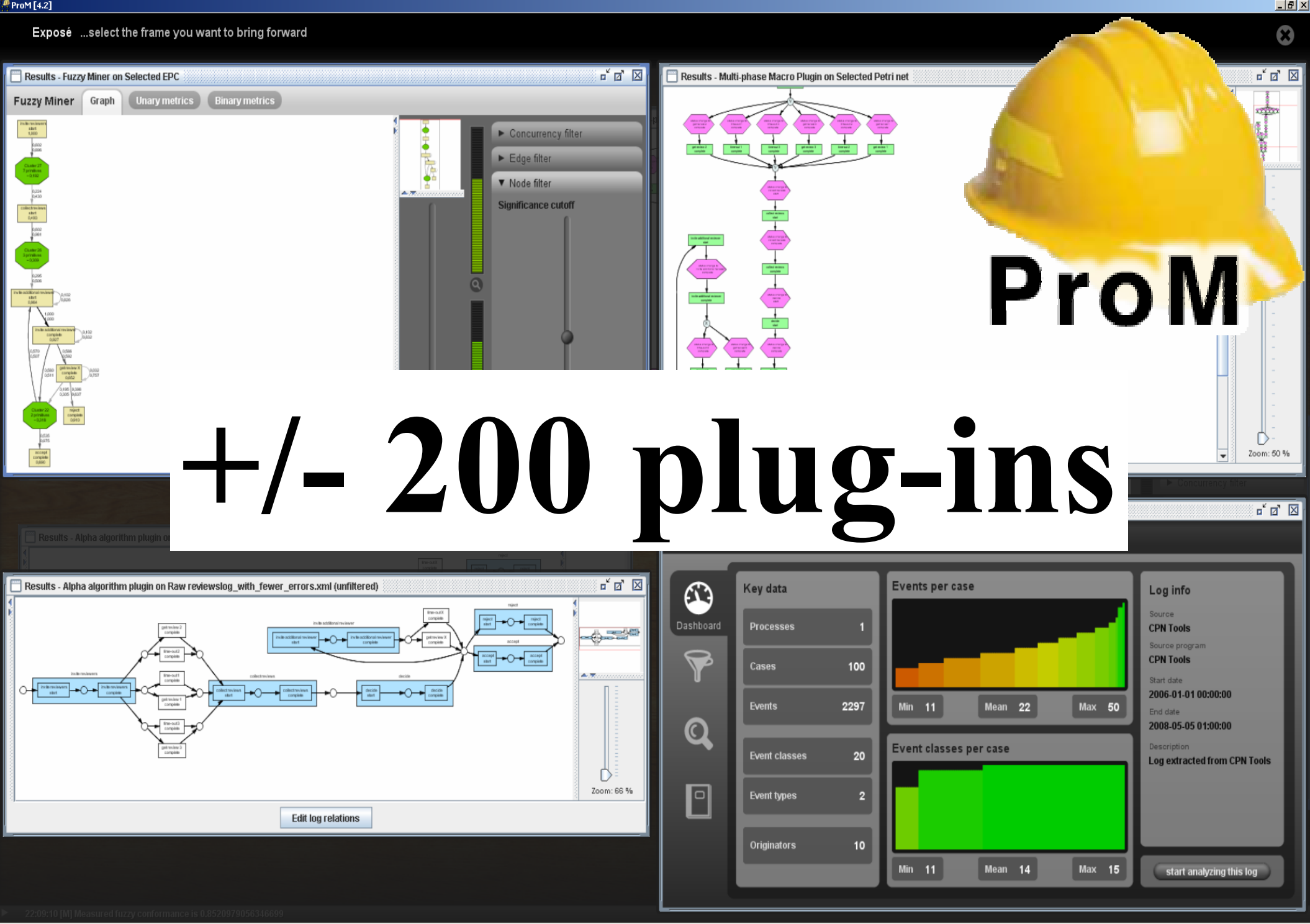
Transition - determine likeliho...

Conformance Checking



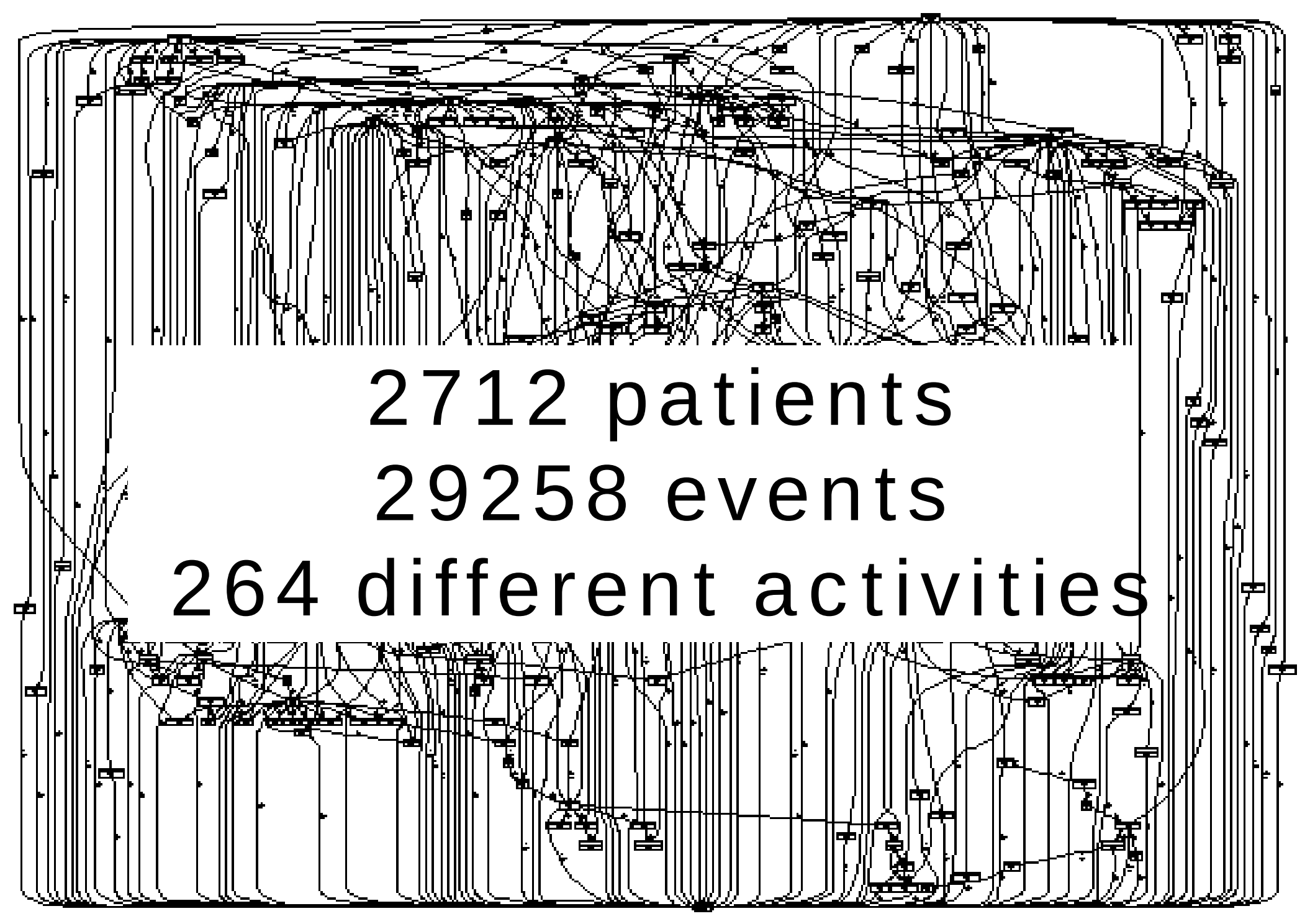
Goal of ProM: Complete support

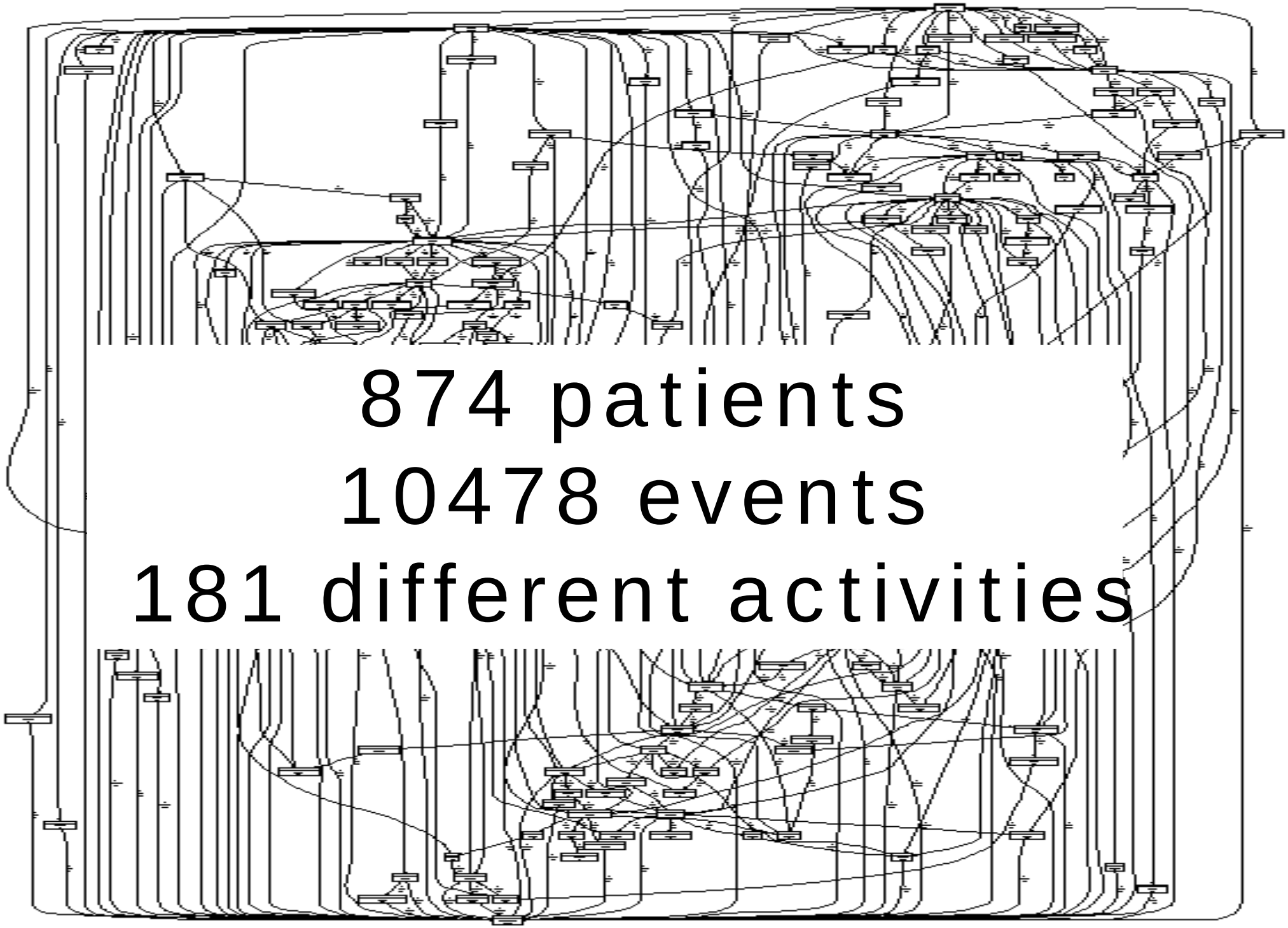


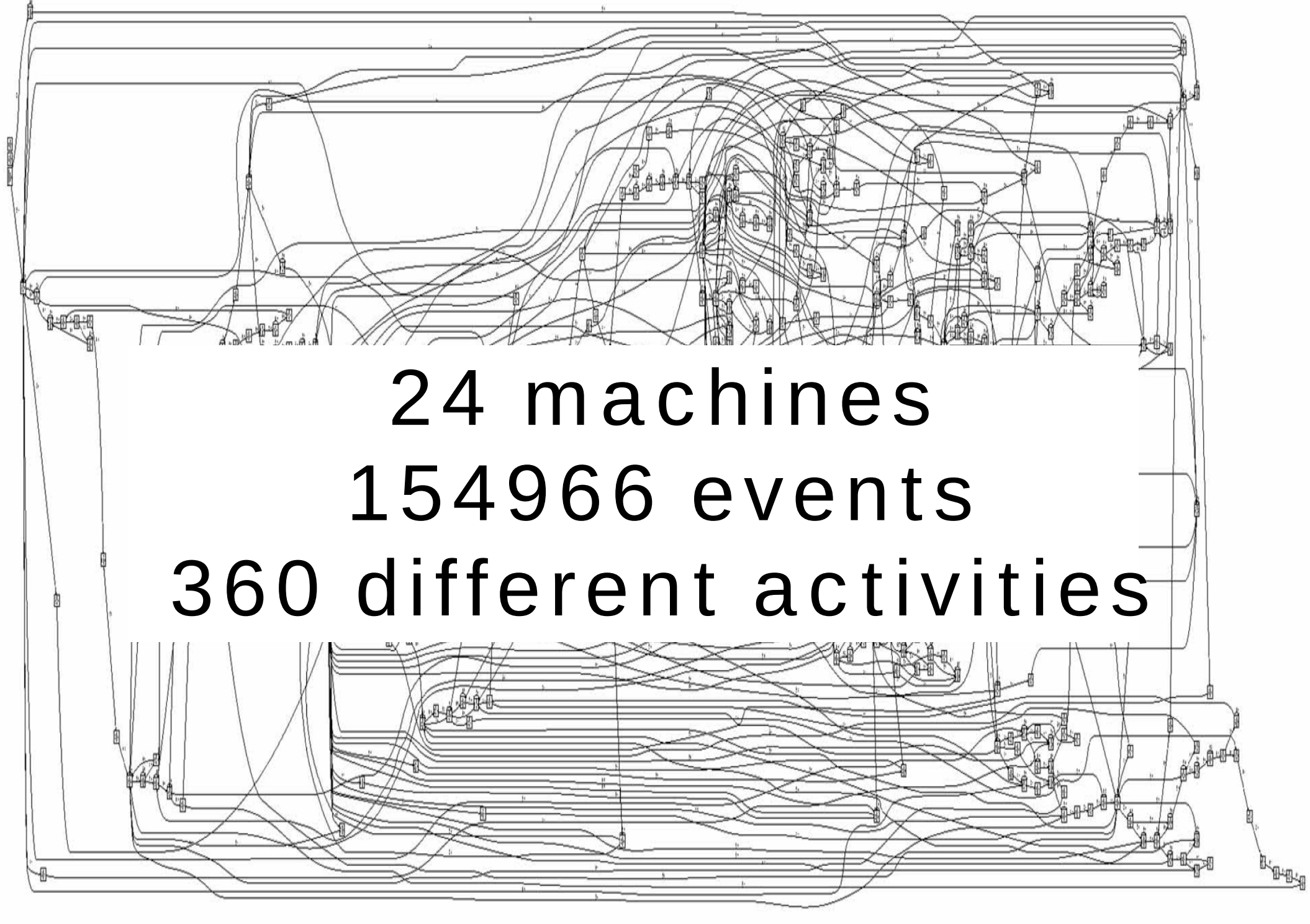

ProM [4.2]
Exposé ...select the frame you want to bring forward
Results - Fuzzy Miner on Selected EPC
Fuzzy Miner
Graph
Unary metrics
Binary metrics
Concurrency filter
Edge filter
Node filter
Significance cutoff
Results - Multi-phase Macro Plugin on Selected Petri net
ProM
Zoom: 50 %
+/- 200 plug-ins
Results - Alpha algorithm plugin on Raw reviewslog_with_fewer_errors.xml (unfiltered)
Zoom: 66 %
Edit log relations
Dashboard
Key data
Processes 1
Cases 100
Events 2297
Event classes 20
Event types 2
Originators 10
Events per case
Min 11
Mean 22
Max 50
Event classes per case
Min 11
Mean 14
Max 15
Log info
Source
CPN Tools
Source program
CPN Tools
Start date
2006-01-01 00:00:00
End date
2008-05-05 01:00:00
Description
Log extracted from CPN Tools
start analyzing this log

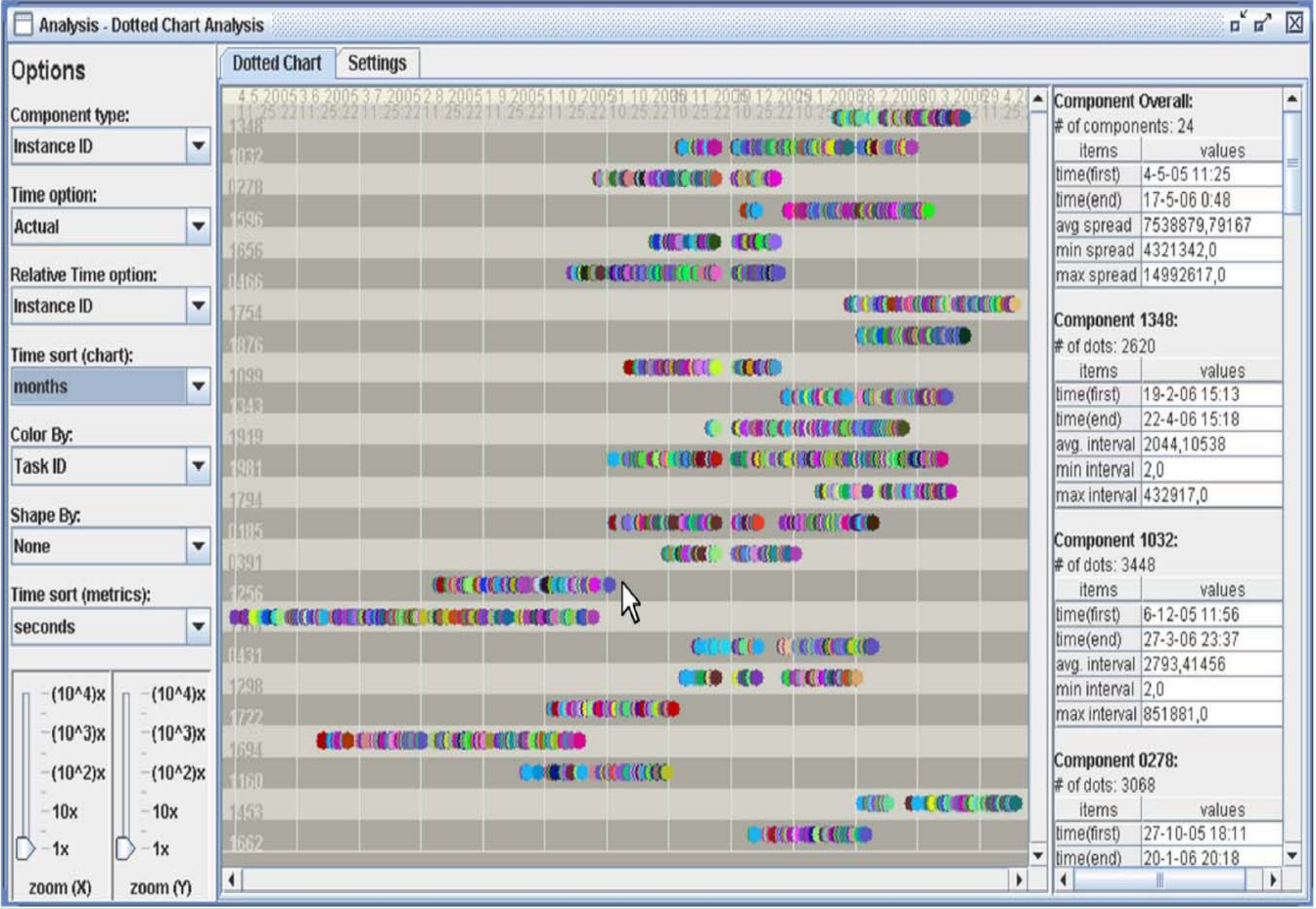
Lessons learned ...

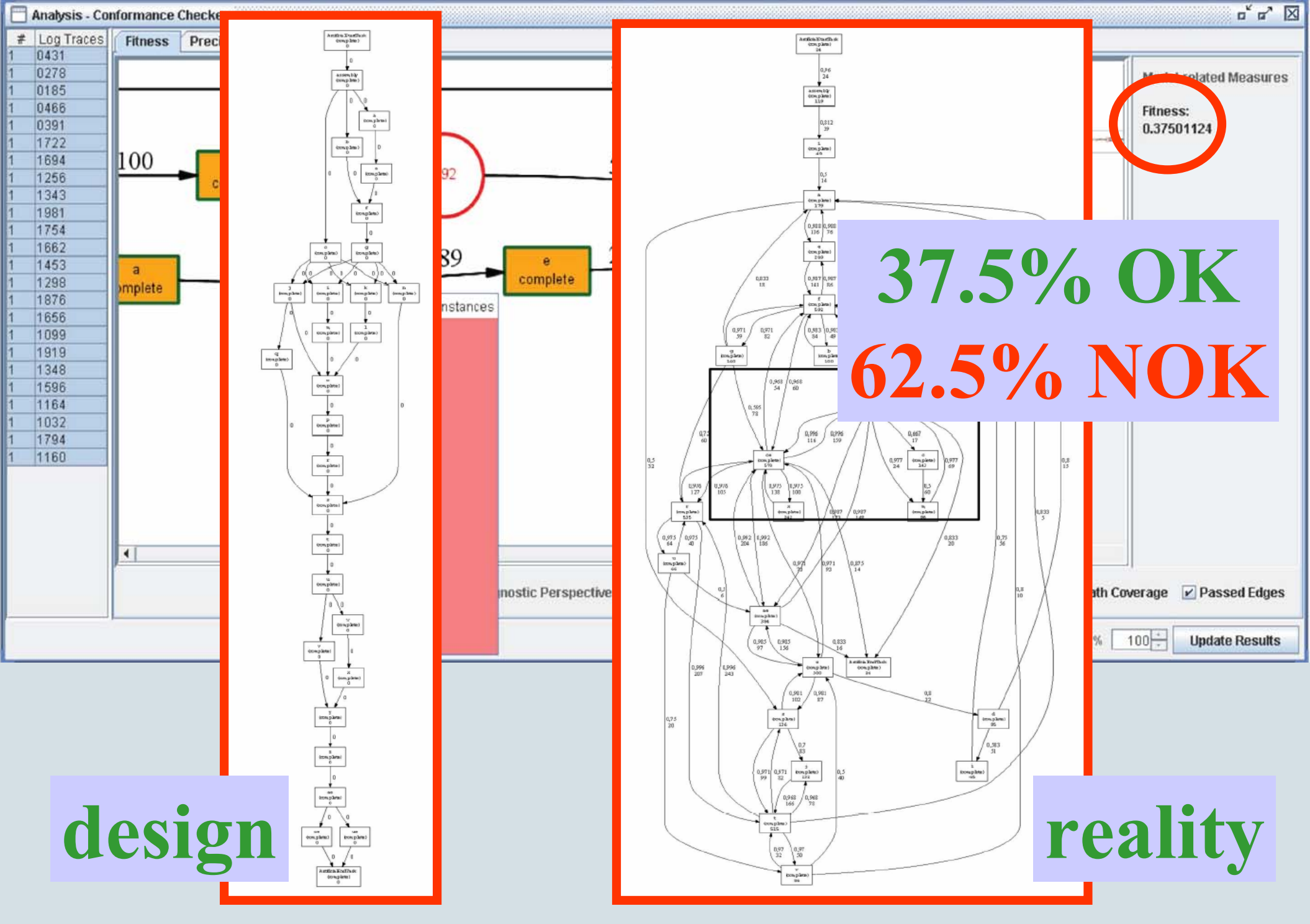
- Business Intelligence (BI) tools are NOT intelligent!
- Logs are everywhere!
- Process mining is possible and provides valuable insights.
- Process mining triggers process improvement.
- Most processes do not conform.
- Reality is much more complicated than people like to believe!


2712 patients
29258 events
264 different activities


874 patients
10478 events
181 different activities

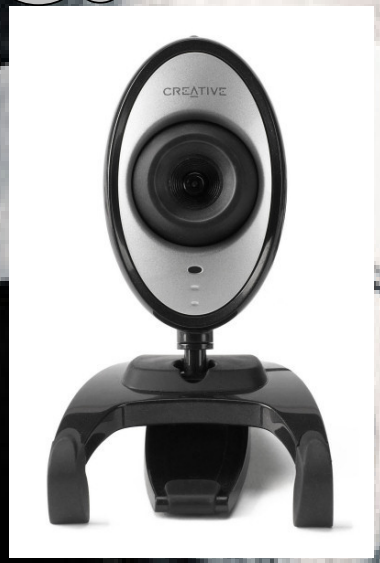

24 machines
154966 events
360 different activities

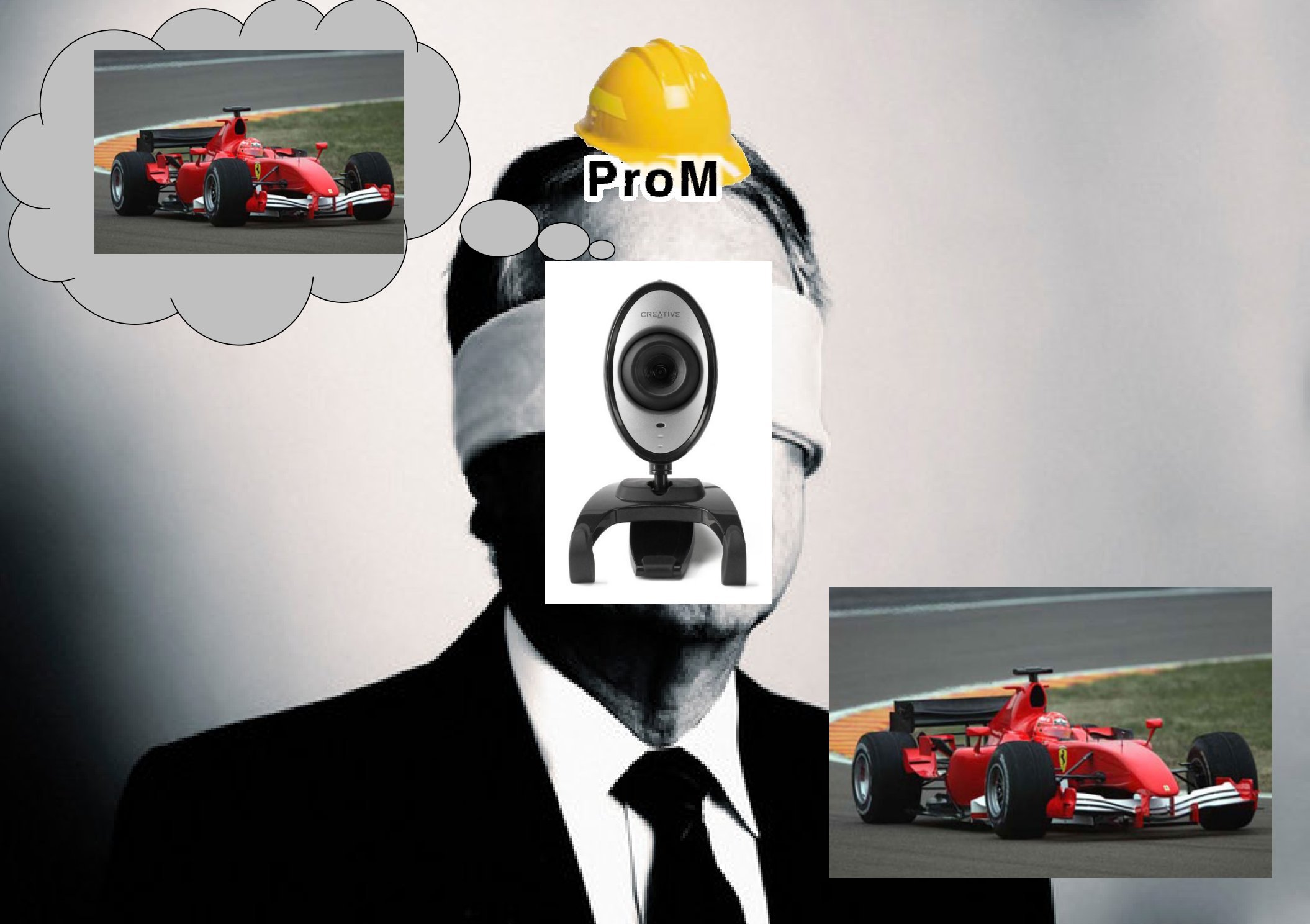

Analysis - Dotted Chart Analysis
Options
Component type:
Instance ID
Time option:
Actual
Relative Time option:
Instance ID
Time sort (chart):
months
Color By:
Task ID
Shape By:
None
Time sort (metrics):
seconds
(10^4)x
(10^3)x
(10^2)x
10x
1x
zoom (X)
zoom (Y)
Dotted Chart
Settings
Component Overall:
# of components: 24
items values
time(first) 4-5-05 11:25
time(end) 17-5-06 0:48
avg spread 7538879,79167
min spread 4321342,0
max spread 14992617,0
Component 1348:
# of dots: 2620
items values
time(first) 19-2-06 15:13
time(end) 22-4-06 15:18
avg. interval 2044,10538
min interval 2,0
max interval 432917,0
Component 1032:
# of dots: 3448
items values
time(first) 6-12-05 11:56
time(end) 27-3-06 23:37
avg. interval 2793,41456
min interval 2,0
max interval 851881,0
Component 0278:
# of dots: 3068
items values
time(first) 27-10-05 18:11
time(end) 20-1-06 20:18


Analysis - Conformance Checke
Log Traces
Fitness
Fitness:
0.37501124
Passed Edges
Update Results
37.5% OK
62.5% NOK
design
reality

"actionable information"

ProM




ProM
CREATIVE

technische universiteit eindhoven

LaQuSo Laboratory for Quality Software

For more information

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

Thanks EIT!