

MTAT.03.231 Business Process Management

Lecture 12: Business Process Monitoring & Mining

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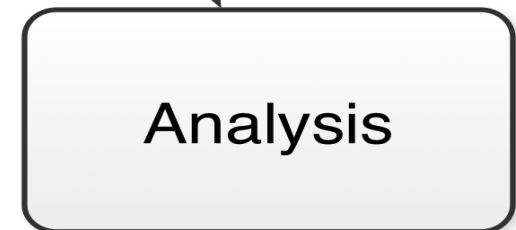
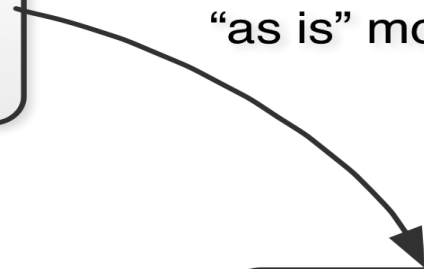
INSTITUTE OF COMPUTER SCIENCE



architecture



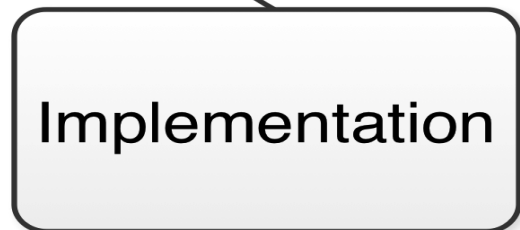
"as is" models



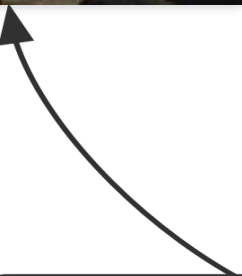
waste, issues,
risks, opportunities

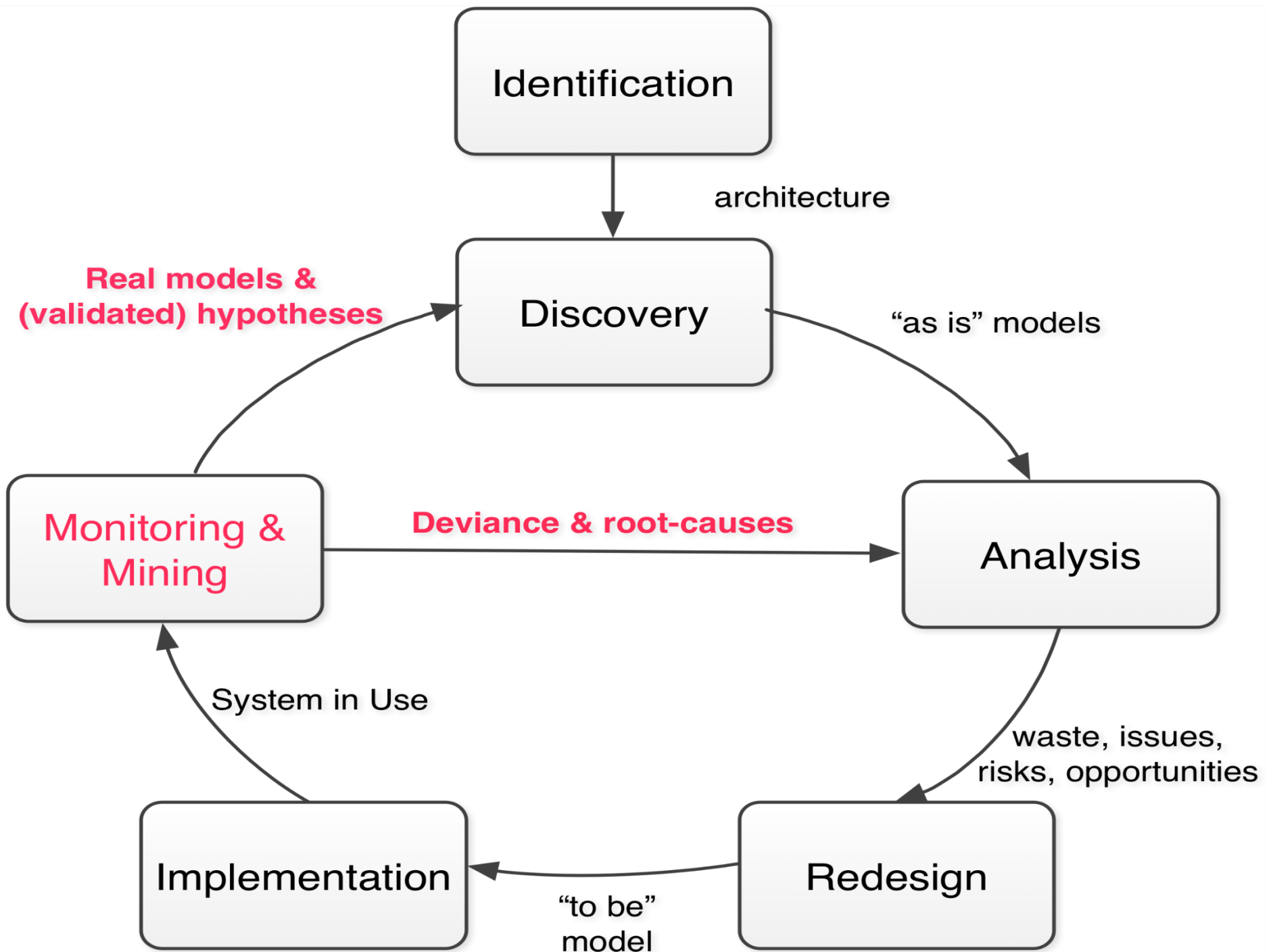


"to be" model



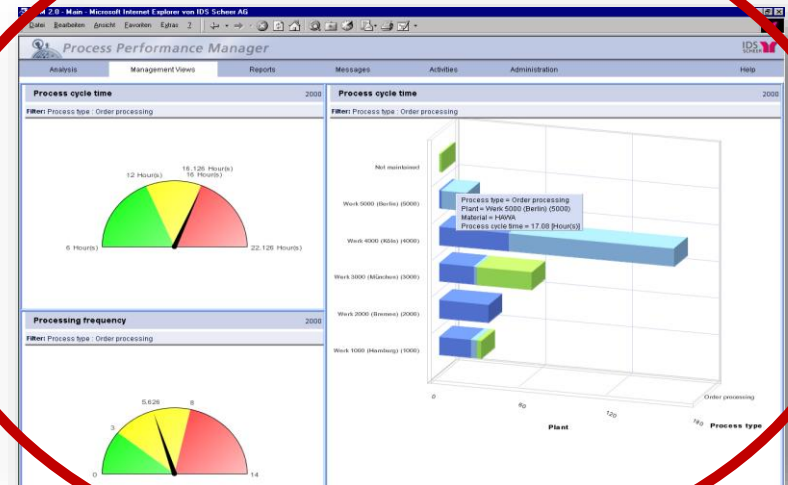
3 months later



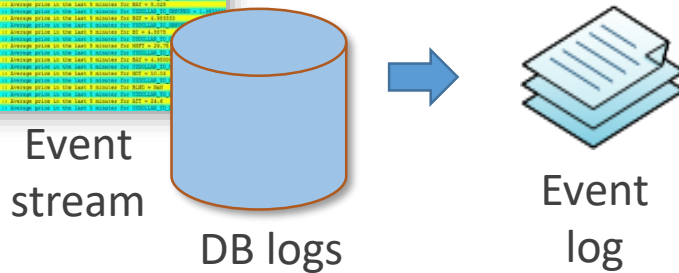
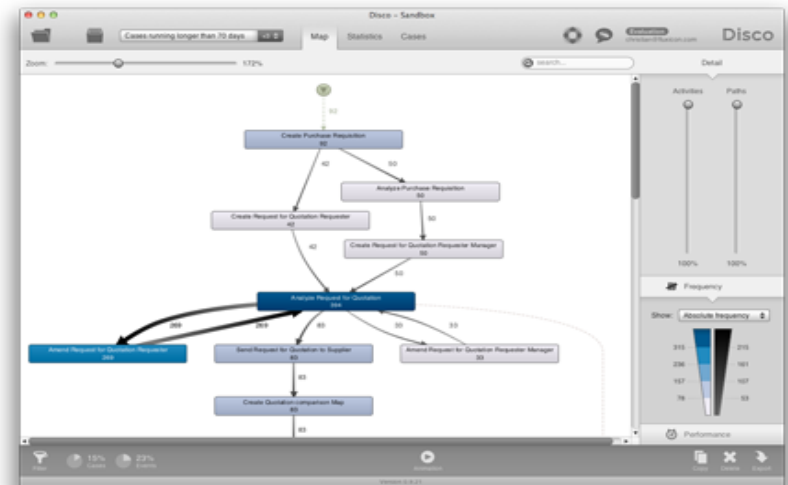


Business Process Monitoring

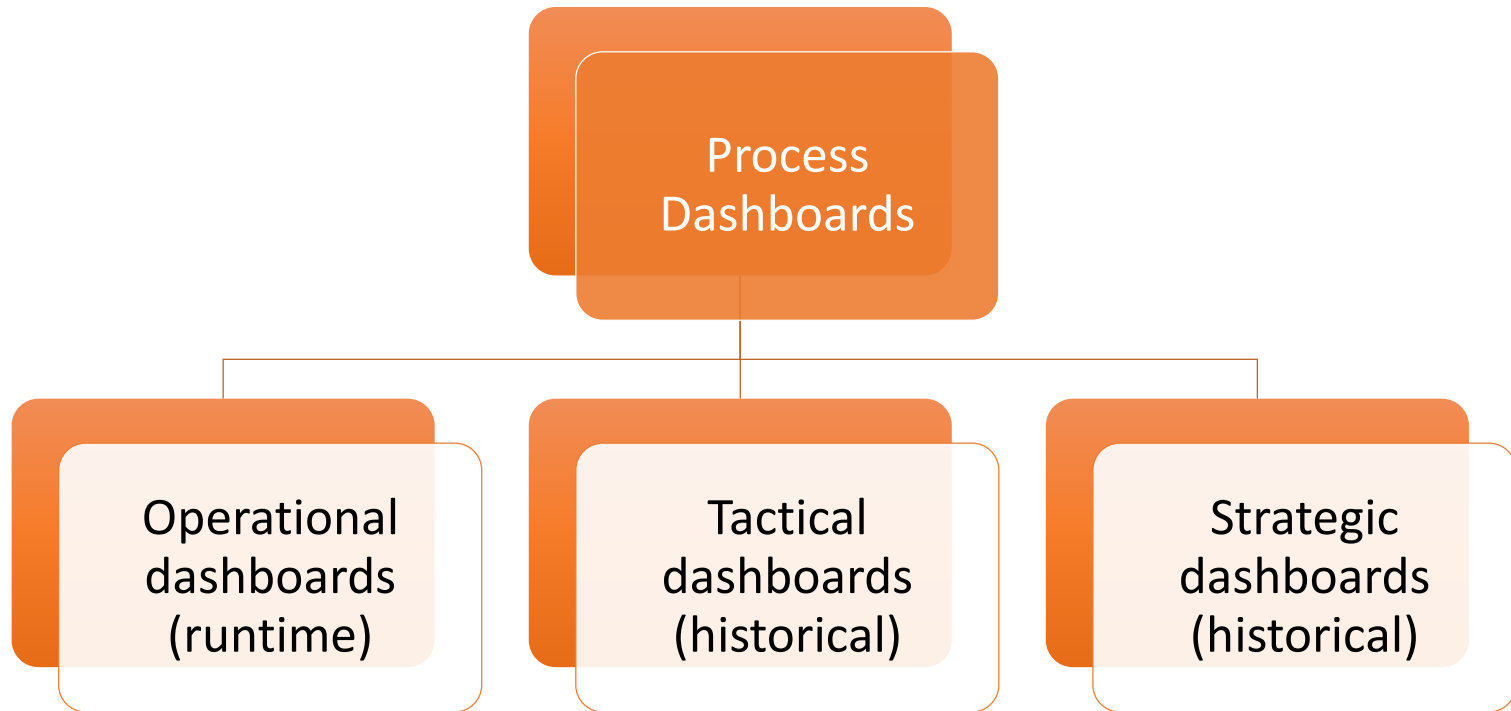
Dashboards & reports



Process mining



Types of process dashboards



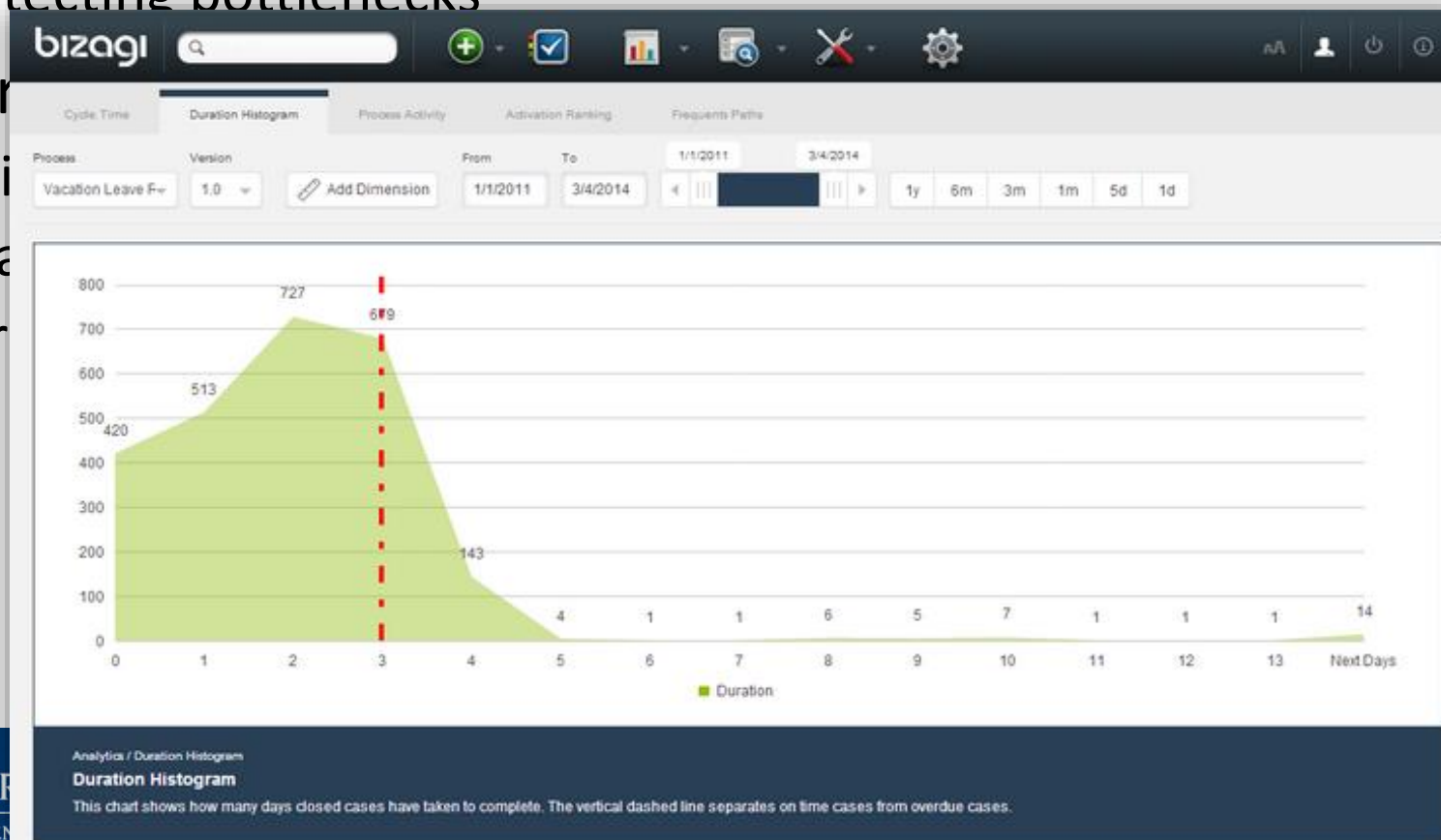
Operational process dashboards

- Aimed at process workers & operational managers
- Emphasis on monitoring (detect-and-respond), e.g.:
 - Work-in-progress
 - Problematic
 - Resource

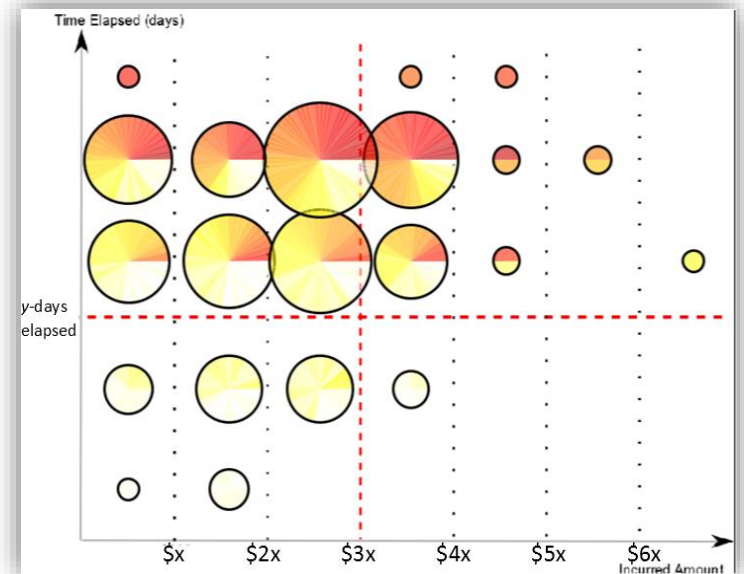
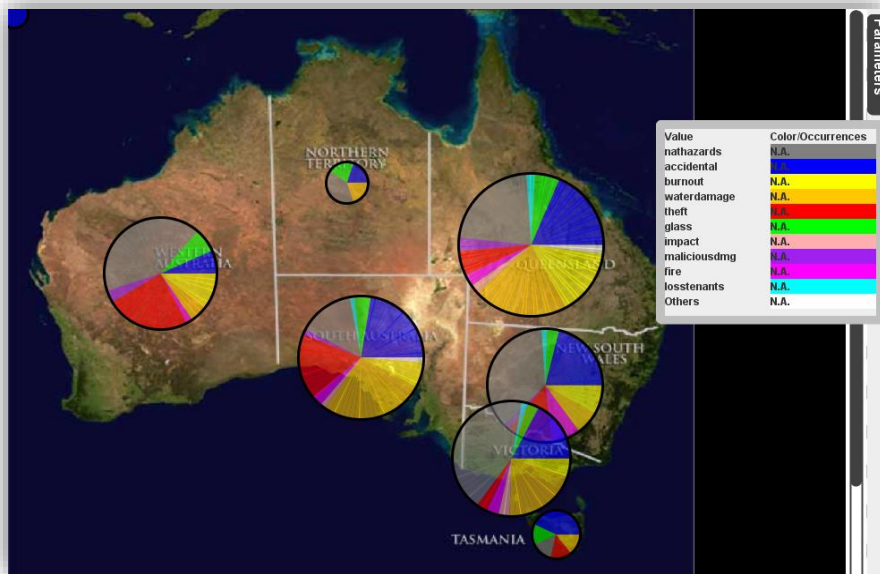


Tactical dashboards

- Aimed at process owners / managers
- Emphasis on analysis and management
 - E.g. detecting bottlenecks
- Typical process metrics
 - Cycle time
 - Error rate
 - Resource utilization



Tactical Performance Dashboard @ Australian Insurer



Strategic dashboards

- Aimed at executives & managers
- Emphasis on linking process performance to strategic objectives



Strategic Performance Dashboard @ Australian Utilities Provider

Process Key Performance	Manage Unplanned Outages	Manage Emergencies & Disasters	Manage Work Programming & Resourcing	Manage Procurement
Customer Satisfaction	0.5	0.55	-	0.2
Customer Complaint	0.6	-	-	0.5
Customer Feedback	0.4	-	-	0.8
Connection Less Than Agreed Time	0.3	0.6	0.7	-



Process: Manage Procurement

0.67

Process: Manage Emergencies & Disasters

0.58

Process: Manage Unplanned Outages

Overall Process Performance

0.54

1st Layer
Key Result
Area

Financial

0.5

People

0.4

Customer
Excellence

0.65

Operational
Excellence

0.5

Risk
Management

0.8

Health
& Safety

0.4

2nd Layer
Key Performance

Customer
Complaint

0.6

Customer
Satisfaction

0.7

3rd & 4th Layer
Process Performance
Measures

Customer
Rating (%)

0.7

Customer
Loyalty Index

0.6

Average Time
Spent on Plan

0.8

Satisfied
Customer Index

0.4

Market
Share (%)

0.8

Exercise

Sketch operational and tactical process monitoring dashboards for CVS Pharmacy's prescription fulfillment process (See Chapter 1, Exercise 1.6).

Consider the viewpoints of each stakeholder in the process.

- Customer
- Pharmacist
- Technician
- Process owner (overseeing 500+ pharmacies distributed geographically)



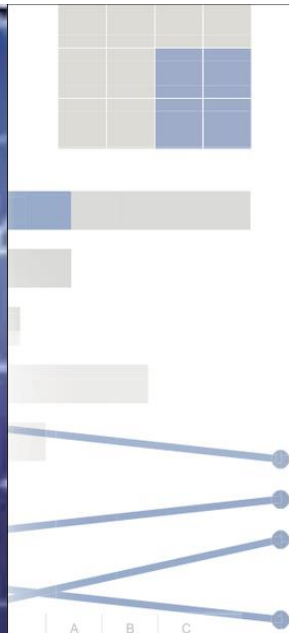


PERFORMANCE DASHBOARDS

MEASURING, MONITORING, AND MANAGING YOUR BUSINESS

SECOND EDITION

WAYNE ECKERSON



	A	B	C
1	15%	22%	42%
2	40%	36%	20%
3	35%	17%	34%
4	30%	29%	26%
5	55%	30%	58%
6	11%	25%	49%



	A	B	C
Category 1	15%	22%	42%
Category 2	40%	36%	20%
Category 3	35%	17%	34%
Category 4	30%	29%	26%
Category 5	55%	30%	58%
Category 6	11%	25%	49%

cole nussbaumer knaflic

storytelling with data

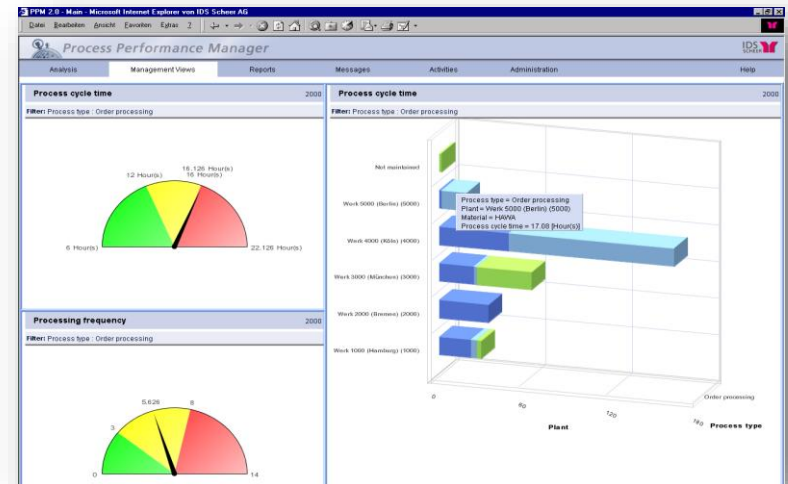
a data visualization guide for business professionals

WILEY

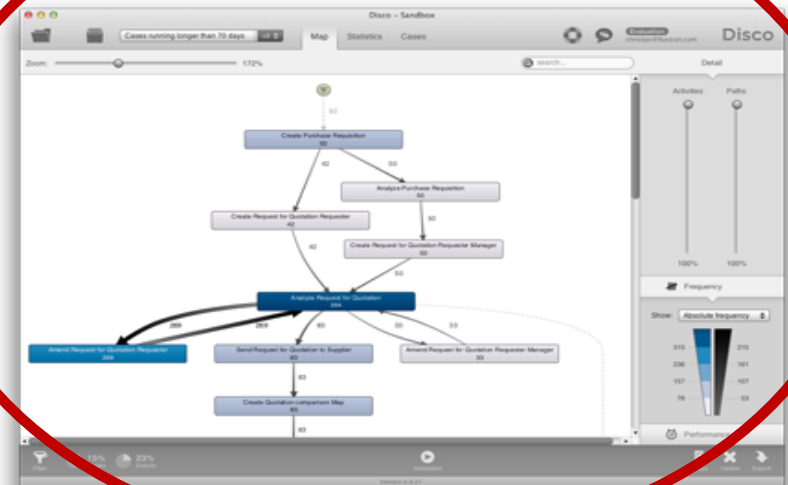
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Business Process Monitoring

Dashboards & reports



Process mining

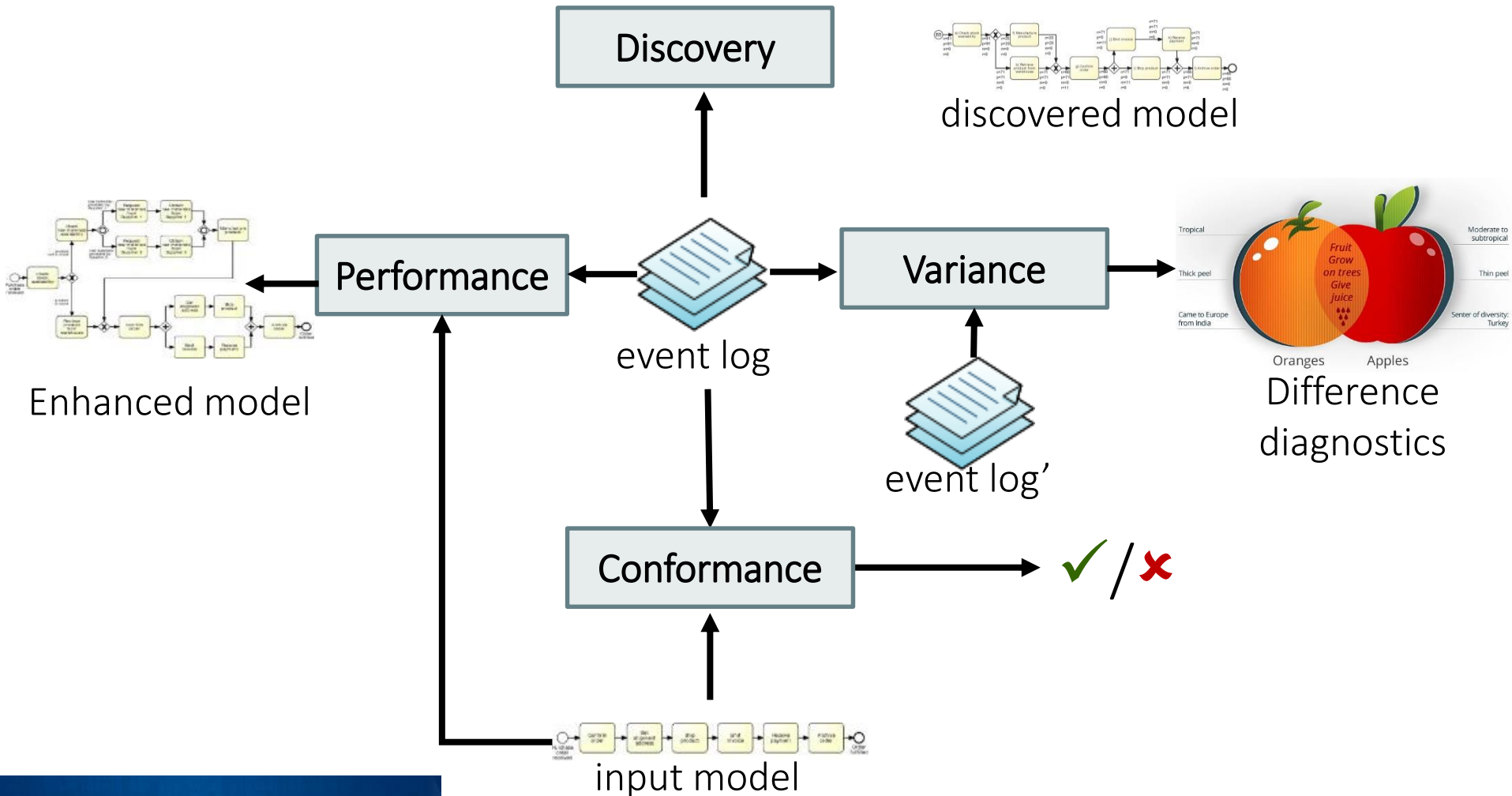


Event
stream

DB logs

Event
log

Process Mining



Event logs structure: minimum

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	...

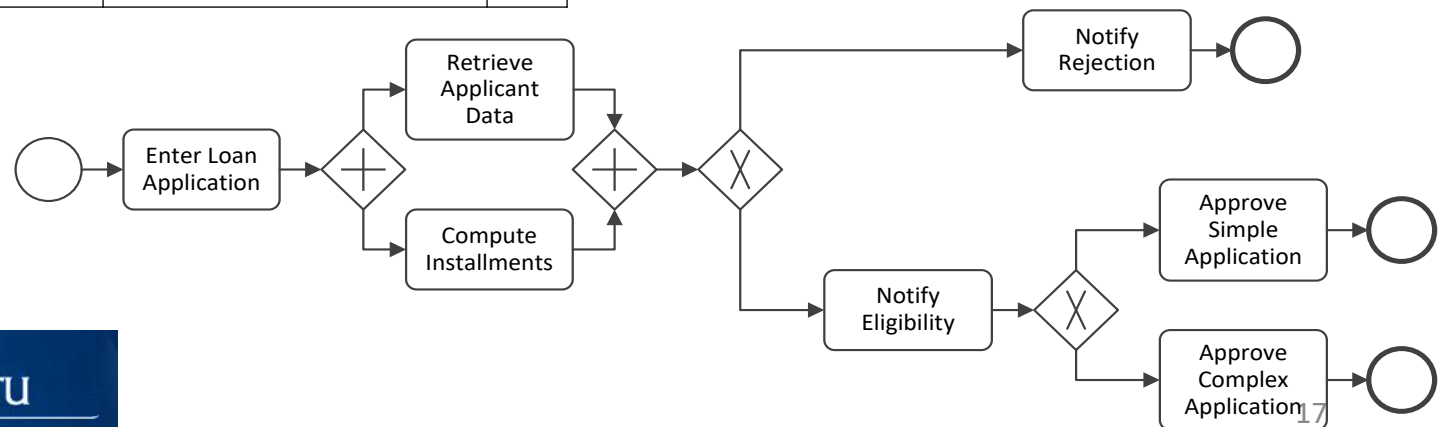
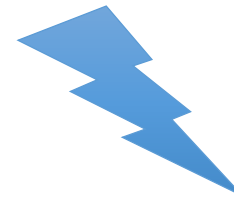
Concrete formats:

- Comma-Separated Values (CSV)
- XES (XML format)



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 Installements	2007-11-09 T 11:24:35	-
...



Process Mining Tools

Open-source

- **Apromore**
- ProM
- bupaR

Lightweight

- **Disco**

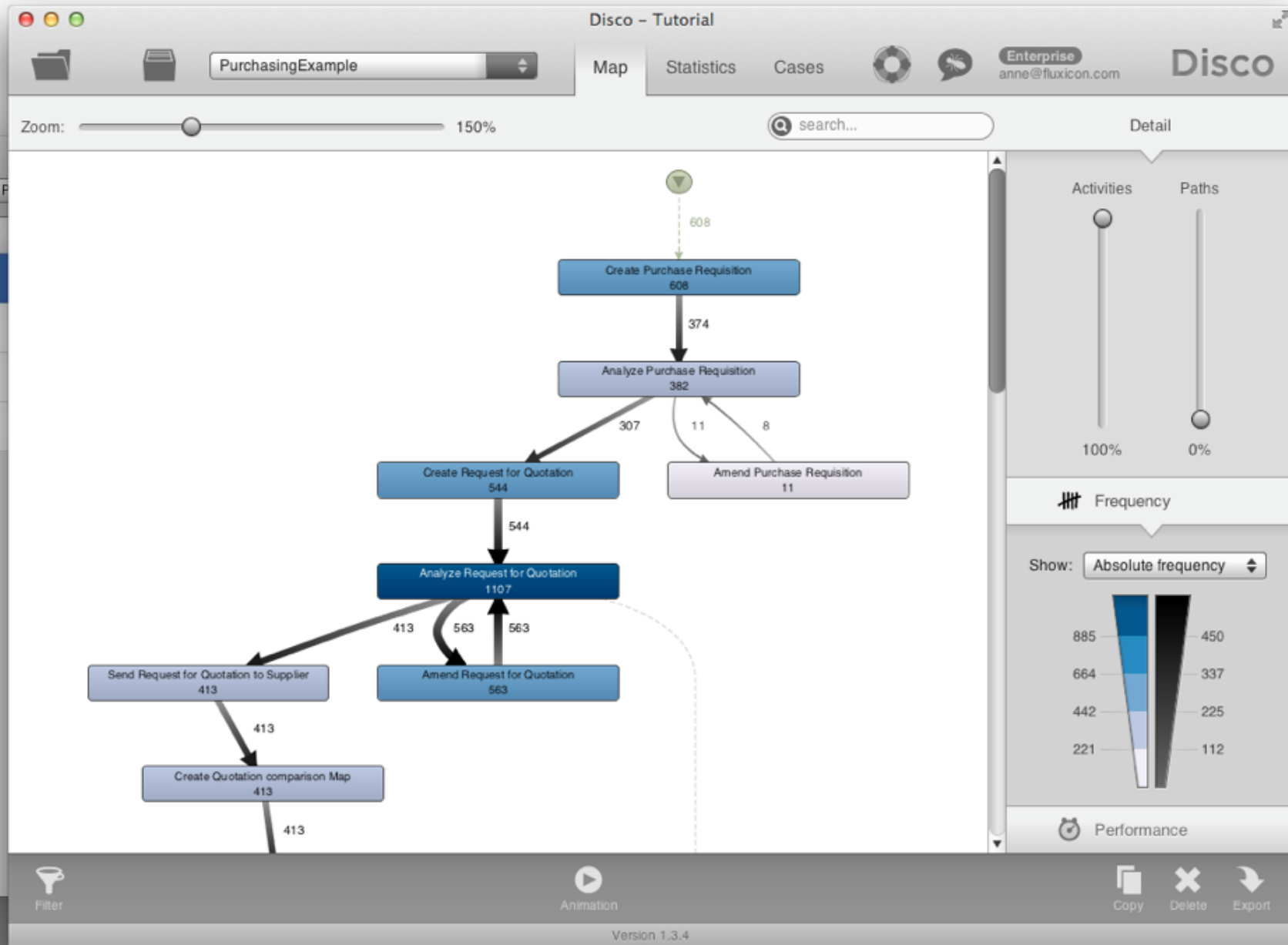
Mid-range

- Minit
- myInvenio
- ProcessGold
- QPR Process Analyzer
- Signavio Process Intelligence
- StereoLOGIC Discovery Analyst

Heavyweight

- ARIS Process Performance Manager
- Celonis Process Mining
- Perceptive Process Mining (Lexmark)
- Interstage Process Discovery (Fujitsu)

Fluxicon Disco



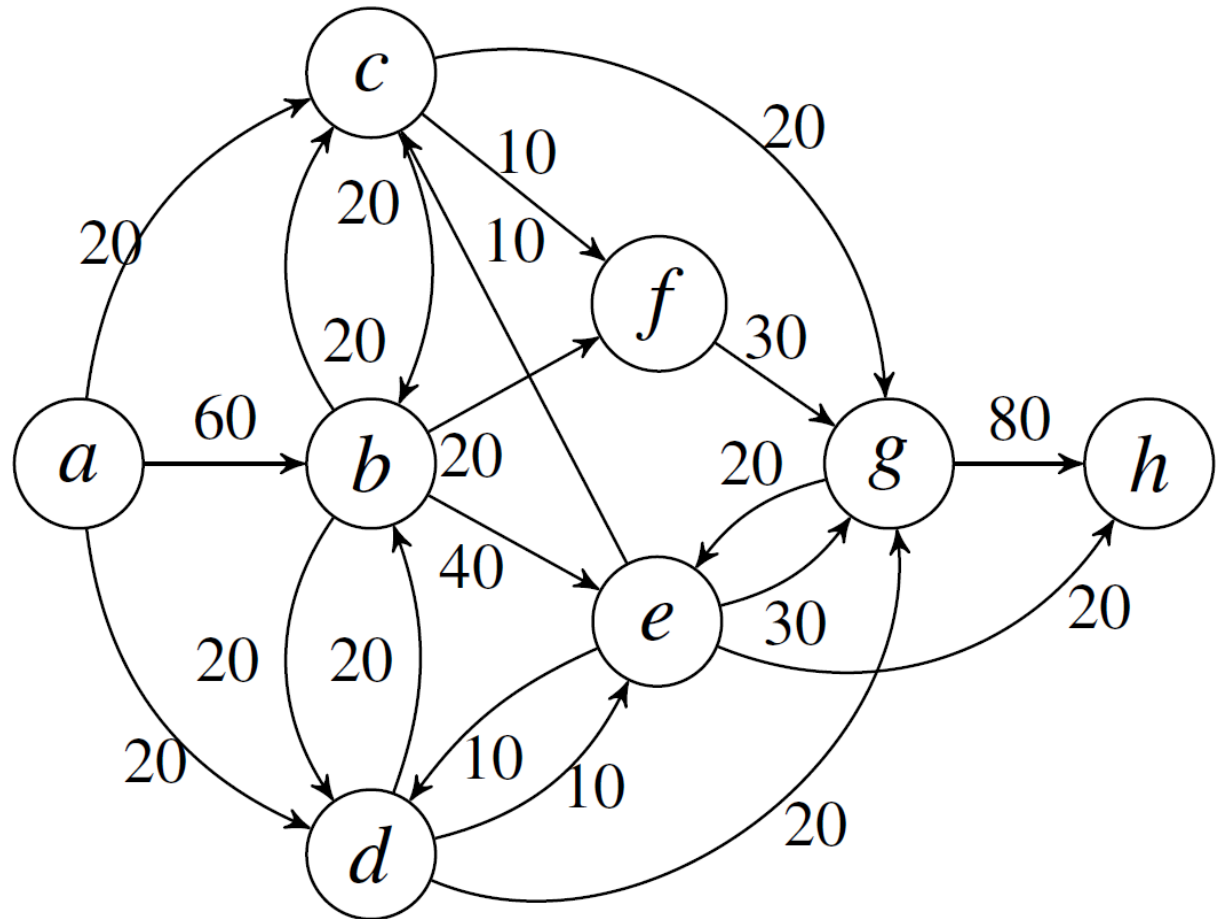
Process Maps

- A process map of an event log is a graph where:
 - Each activity is represented by one node
 - An arc from activity A to activity B means that B is directly followed by A in at least one trace in the log
- Arcs in a process map can be annotated with:
 - Absolute frequency: how many times B directly follows A?
 - Relative frequency: in what percentage of times when A is executed, it is directly followed by B?
 - Time: What is the average time between the occurrence of A and the occurrence of B?

Process Maps – Example

Event log:

10: a,b,c,g,e,h
10: a,b,c,f,g,h
10: a,b,d,g,e,h
10: a,b,d,e,g,h
10: a,b,e,c,g,h
10: a,b,e,d,g,h
10: a,c,b,e,g,h
10: a,c,b,f,g,h
10: a,d,b,e,g,h
10: a,d,b,f,g,h



Process Maps – Exercise

Case				Case			
ID	Task Name	Originator	Timestamp	ID	Task Name	Originator	Timestamp
1	File Fine	Anne	20-07-2004 14:00:00	3	Reminder	John	21-08-2004 10:00:00
2	File Fine	Anne	20-07-2004 15:00:00	2	Process Payment	system	22-08-2004 09:05:00
1	Send Bill	system	20-07-2004 15:05:00	2	Close case	system	22-08-2004 09:06:00
2	Send Bill	system	20-07-2004 15:07:00	4	Reminder	John	22-08-2004 15:10:00
3	File Fine	Anne	21-07-2004 10:00:00	4	Reminder	Mary	22-08-2004 17:10:00
3	Send Bill	system	21-07-2004 14:00:00	4	Process Payment	system	29-08-2004 14:01:00
4	File Fine	Anne	22-07-2004 11:00:00	4	Close Case	system	29-08-2004 17:30:00
4	Send Bill	system	22-07-2004 11:10:00	3	Reminder	John	21-09-2004 10:00:00
Process				3	Reminder	John	21-10-2004 10:00:00
1	Payment	system	24-07-2004 15:05:00	3	Process Payment	system	25-10-2004 14:00:00
1	Close Case	system	24-07-2004 15:06:00	3	Close Case	system	25-10-2004 14:01:00
2	Reminder	Mary	20-08-2004 10:00:00				

Process Maps in Disco

- Disco (and other commercial process mining tools) use process maps as the main visualization technique for event logs
- These tools also provide three types of operations:
 1. **Abstract** the process map:
 - Show only most frequent activities
 - Show only most frequent arcs
 2. **Filter** the traces in the event log...

Types of filters

- Event filters
 - Retain only events that fulfil a given condition (e.g. all events of type “Create purchase order”)
- Performance filter
 - Retain traces that have a duration above or below a given value
- Event pair filter (a.k.a. “follower” filter)
 - Retain traces where there is a pair of events that fulfil a given condition (e.g. “Create invoice” followed by “Create purchase order”)
- Endpoint filter
 - Retain traces that start with or finish with an event that fulfils a given condition

Process Maps in Disco

- Disco (and other commercial process mining tools) use process maps as the main visualization technique for event logs
- These tools also provide three types of operations:
 1. **Abstract** the process map:
 - Show only most frequent activities
 - Show only most frequent arcs
 2. **Filter** the traces in the event log
 3. Enhance the process map

Process Map Enhancement

- Nodes and arcs in a process map can be color-coded or thickness-coded to capture:
 - Frequency: How often a given task or a given directly-follows relation occurs?
 - Time performance: processing times, waiting times, cycles times of tasks
 - More advanced tools support enhancement by other attributes, e.g. cost, revenue, etc. if the data is available.

Disco tutorial

Exercise

Using Disco, answer the following questions on the PurchasingExample log:

- How many cases had to settle a dispute with the purchasing agent?
- Is there a difference in cycle time for the cases that had to settle a dispute with the purchasing agent, compared to the ones that did not? Make sure you only compare cases that actually reach the endpoint 'Pay invoice'
- Are there any cases where the invoice is released and authorized by the same resource? And if so, who is doing this most often?

Process Maps - Limitations

- Process maps over-generalize: some paths of a process map might not exist and might not make sense
 - Example: Draw the process map of [abc, adc, afce, afec] and check which traces it can recognize, for which there is no support in the event log.
- Process maps make it difficult to distinguish conditional branching, parallelism, and loops.
 - See previous example... or a simpler one: [abcd, acbd]
- Solution: automated BPMN process discovery
 - More on this next week...

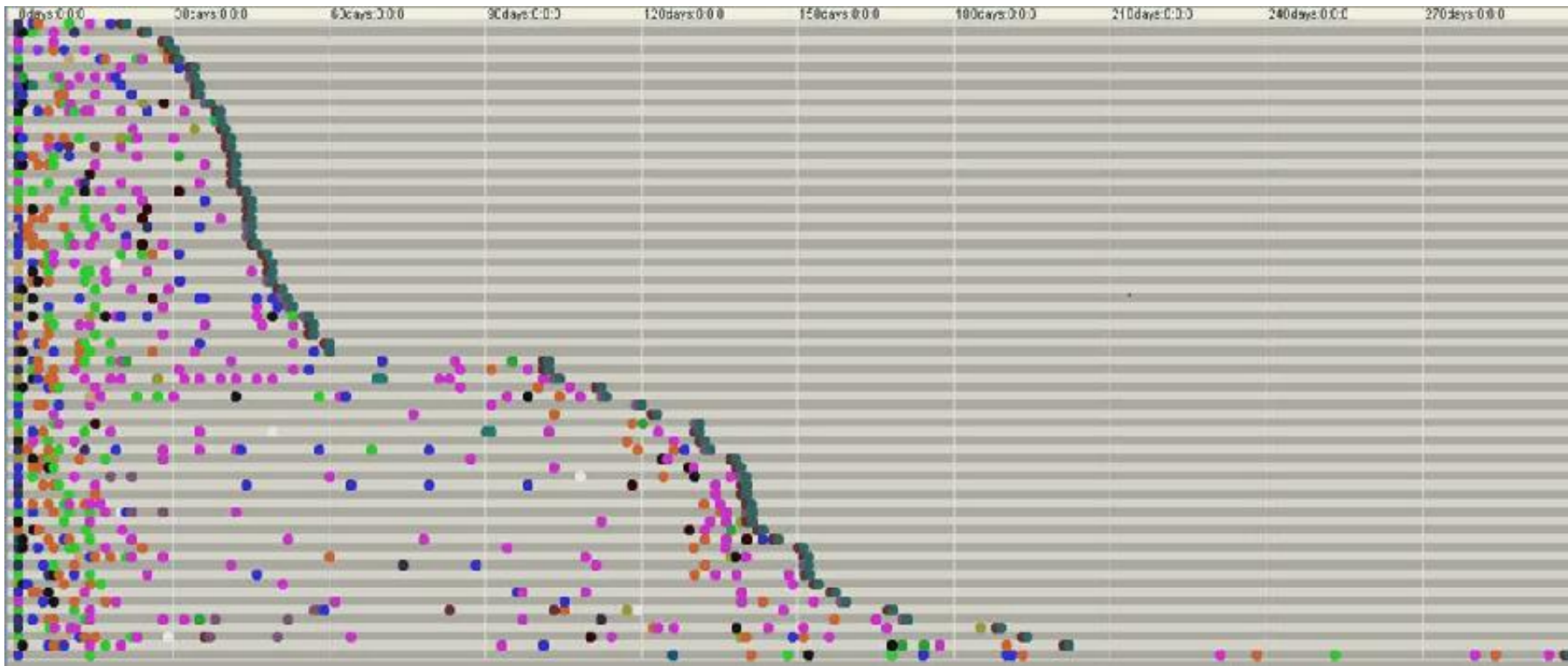
Example

- Let us consider the following event log of a telephone repair process?
 - <http://tinyurl.com/repairLogs>
- Open up this log and check if you can understand how this process is performed based on the process map only...

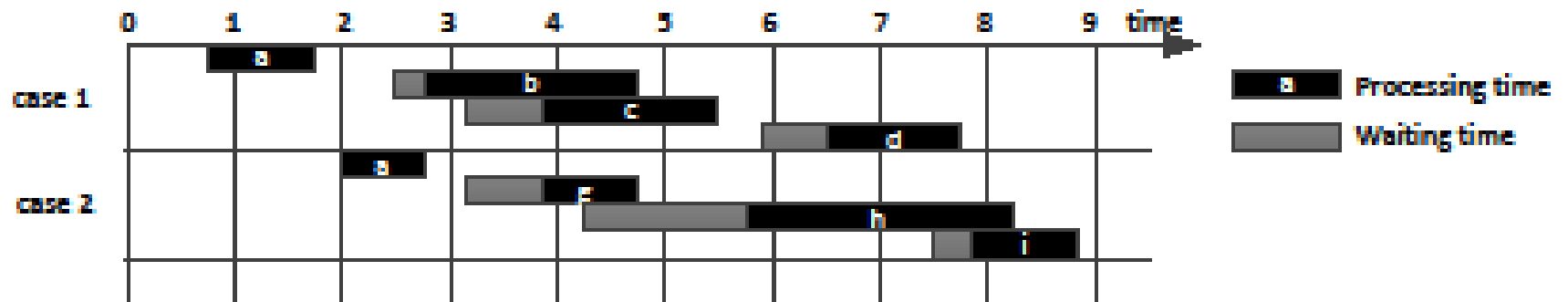
Process Performance Mining

- Dotted charts
 - One line per trace, each line contains points, one point per event
 - Each event type is mapped to a colour
 - Position of the point denotes its occurrence time (in a relative scale)
 - Birds-eye view of the timing of different events (e.g. activity end times), but does not allow one to see the “processing” times of activities
- Timeline diagrams
 - One line per trace, each line contains segments capturing the start and end of tasks
 - Captures process time (unlike dotted charts)
 - Not scalable for large event logs – good to show “representative” traces
- Performance-enhanced process maps
 - Process maps where nodes are colour-coded w.r.t a performance measure. Nodes may represent activities (default option)
 - But they may represent resources and then arcs denote hands-offs between resources

Dotted chart



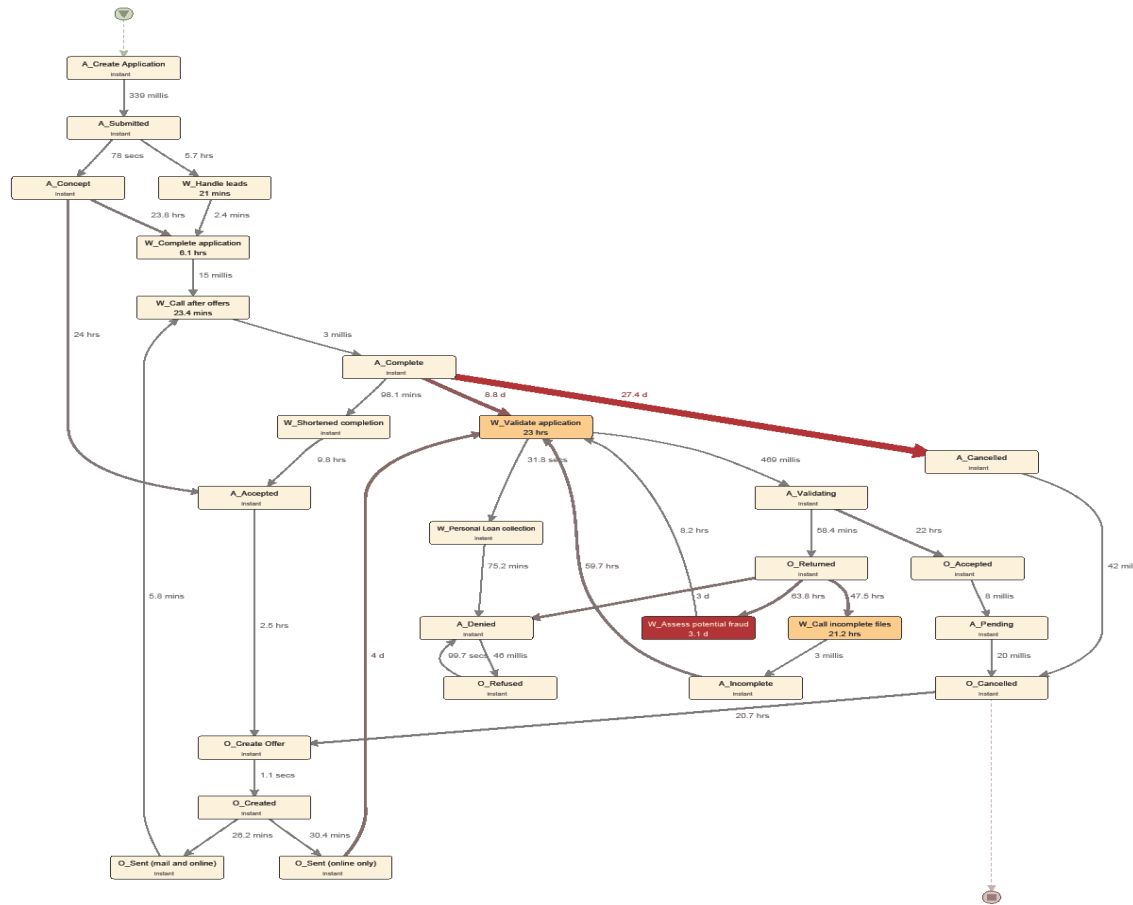
Timeline diagram



See: <http://timelines.nirdizati.org>

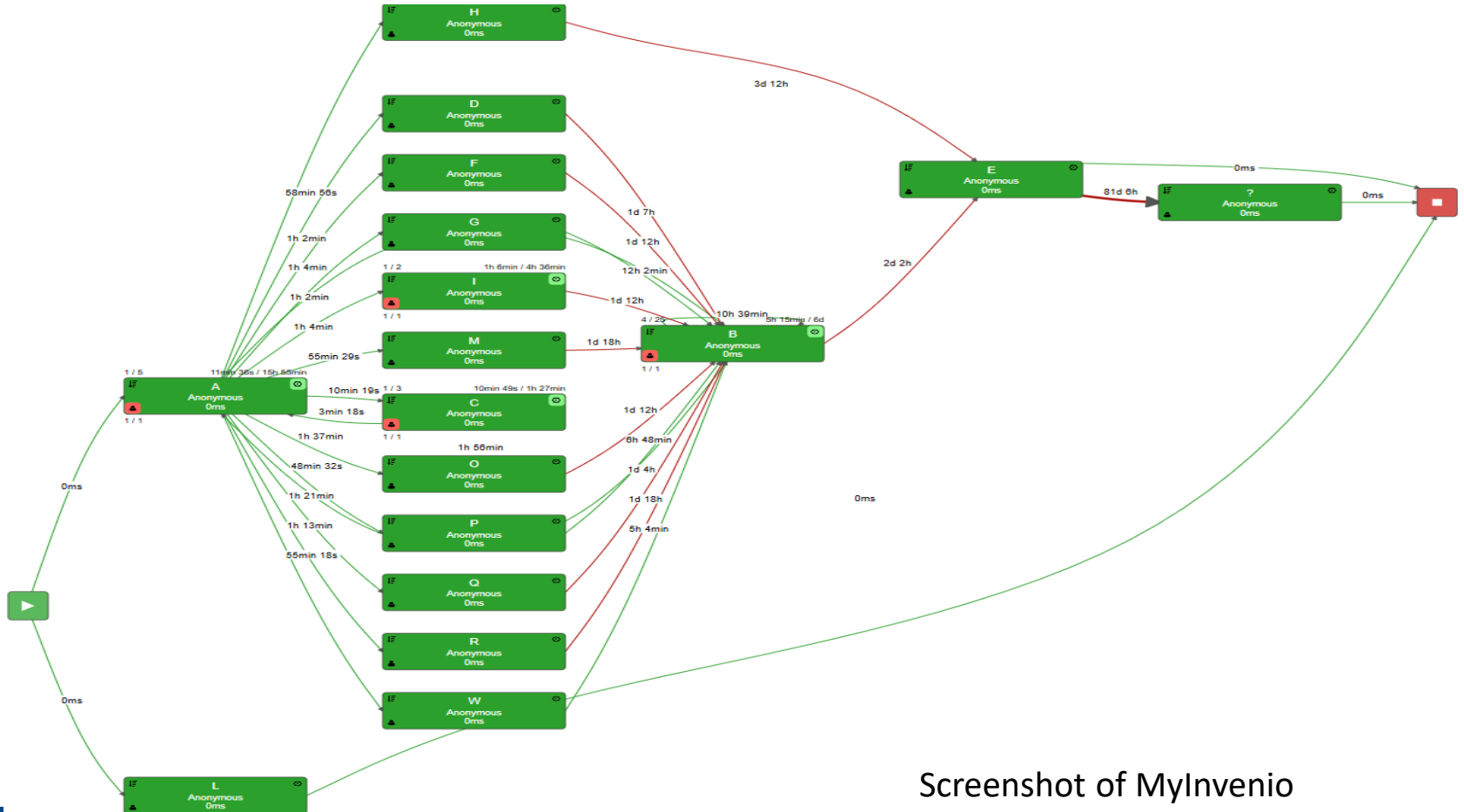
Performance-enhanced process map

Nodes are activities (default)



Screenshot of Disco

Performance-enhanced process map
Nodes are tasks (handoff graph)



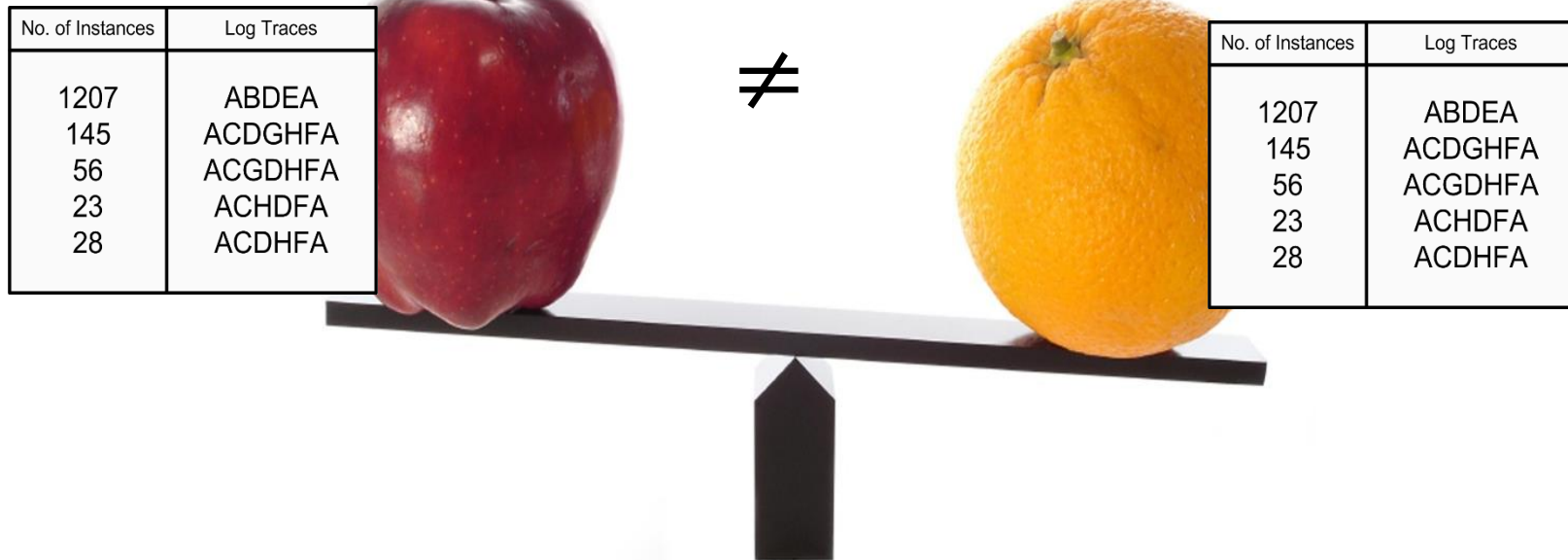
Screenshot of MyInvenio

Exercise

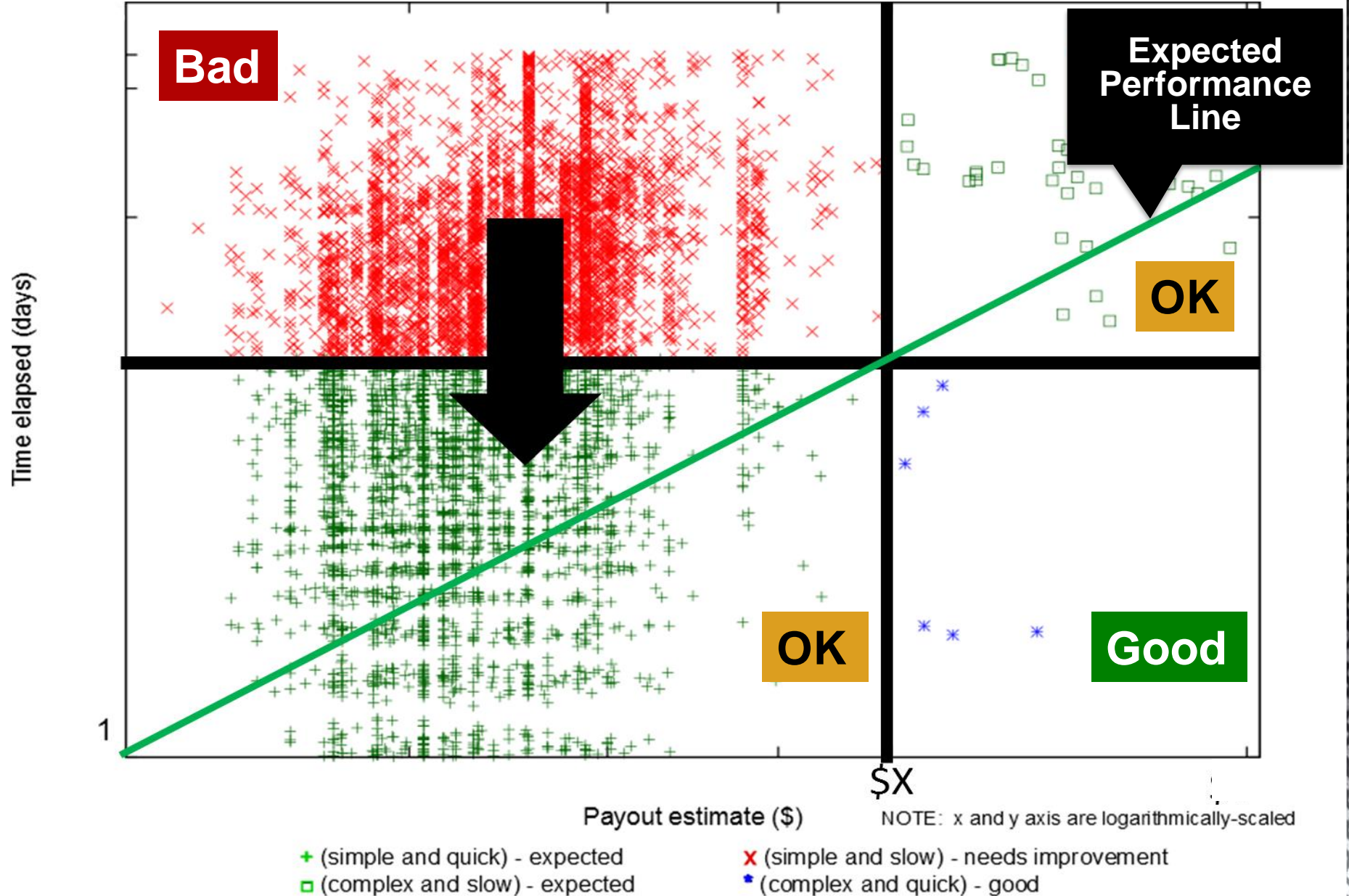
- Consider the following event log of a telephone repair process: <http://tinyurl.com/repairLogs>
 - What are the bottlenecks in this process?
 - Which task has the longest waiting time and which one has the longest processing time?

Variants Analysis

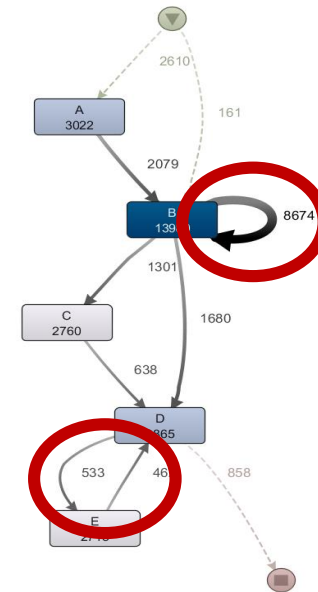
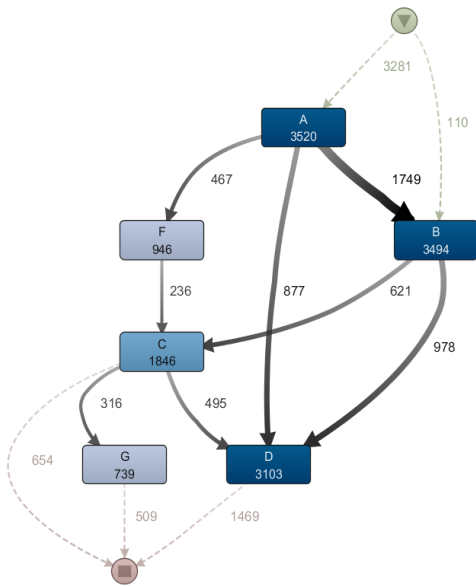
Given two logs, find the *differences* and *root causes* for variation or deviance between the two logs



Case Study: Variants Analysis at Suncorp



Variants Analysis via Process Map Comparison



Simple claims and quick

Simple claims and slow

Variants analysis - Exercise

We consider a process for handling health insurance claims, for which we have extracted two event logs, namely L1 and L2. Log L1 contains all the cases executed in 2011, while L2 contains all cases executed in 2012. The logs are available in the book's companion website or directly at: <http://tinyurl.com/InsuranceLogs>

Based on these logs, answer the following questions using a process mining tool:

1. What is the cycle time of each log?
2. Where are the bottlenecks (highest waiting times) in each of the two logs and how do these bottlenecks differ?
3. Describe the differences between the frequency of tasks and the order in which tasks are executed in 2011 (L1) versus 2012 (L2).
Hint: If you are using process maps, you should consider using the abstraction slider in your tool to hide some of the most infrequent arcs so as to make the maps more readable

Recap

- Process monitoring is about analysing events produced during the execution of a process to understand the performance and conformance of the process.
- Two major types of approaches to monitoring are:
 - Performance dashboards
 - Process mining
- Process mining is centered around diagrammatic representations of a process
 - Process maps or BPMN process models
- Process mining tools such as Disco allow us to apply abstraction, filtering, and enhancement to process maps and event logs.



Fundamentals of Business Process Management

Marlon Dumas
Marcello La Rosa
Jan Mendling
Hajo A. Reijers

 Springer

Wil M. P. van der Aalst

Process Mining

Discovery, Conformance and
Enhancement of Business Processes

 Springer