Business Process Management (BPM)

Process Monitoring and Mining

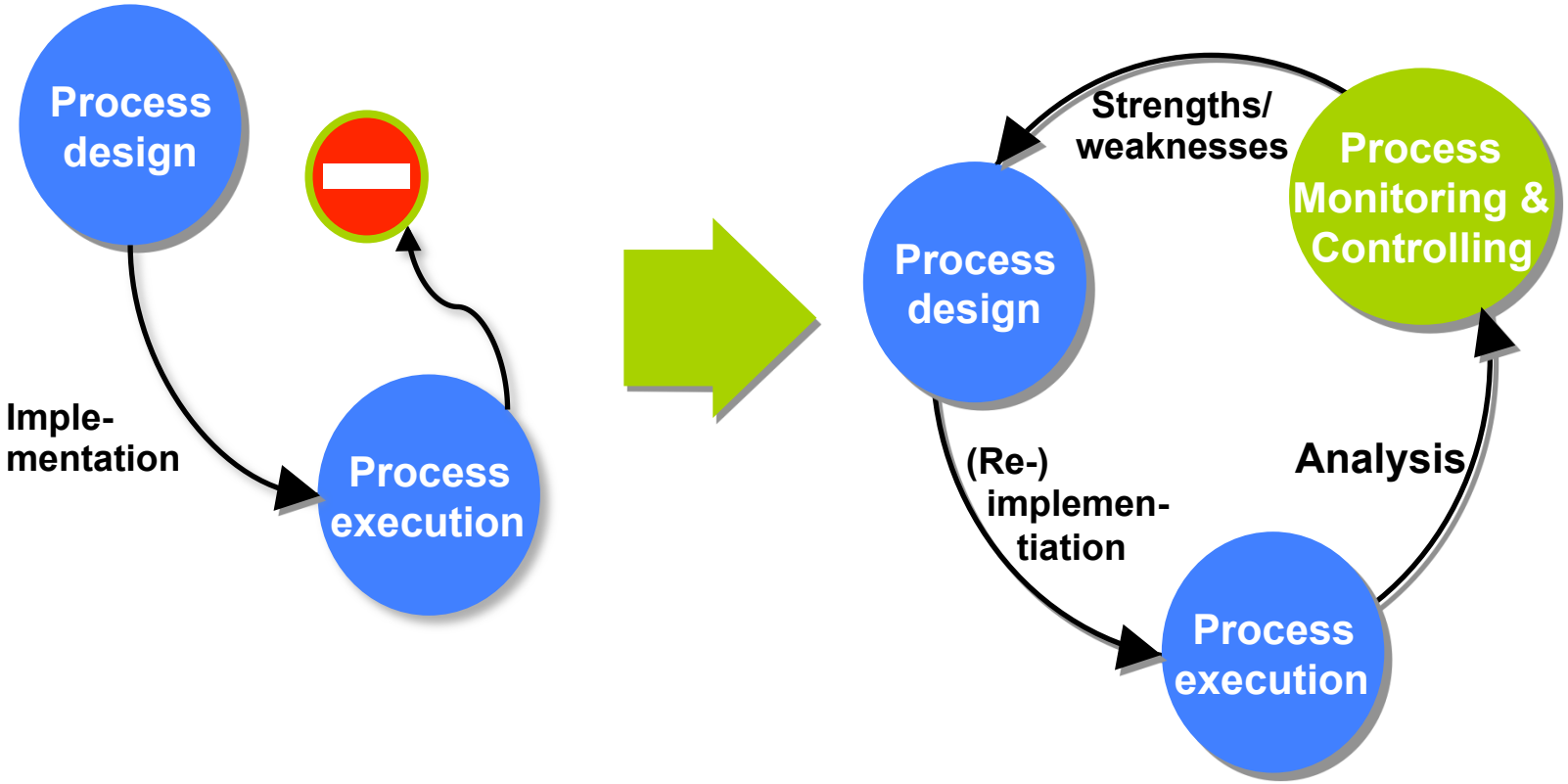
Fabrizio Maggi

(based on lecture material by Marlon Dumas, Wil van der Aalst and Ana Karla Alves de Medeiros http://www.processmining.org)

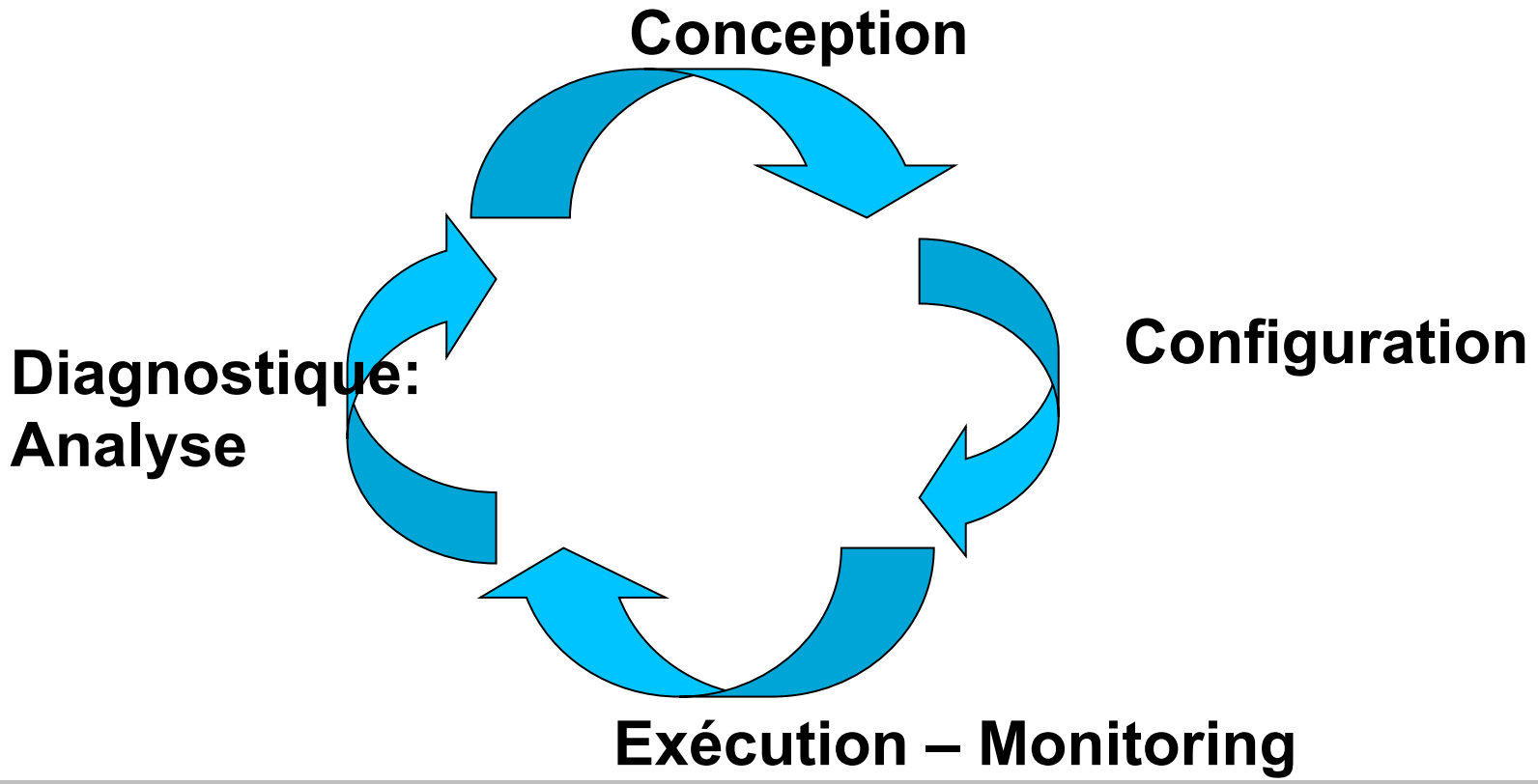
Business Process Lifecycle Management

- Process identification
- Process modelling (as-is)
- Process analysis
- Process improvement (to-be)
- Process implementation
- Process execution
- Process monitoring

Process Monitoring and Controlling



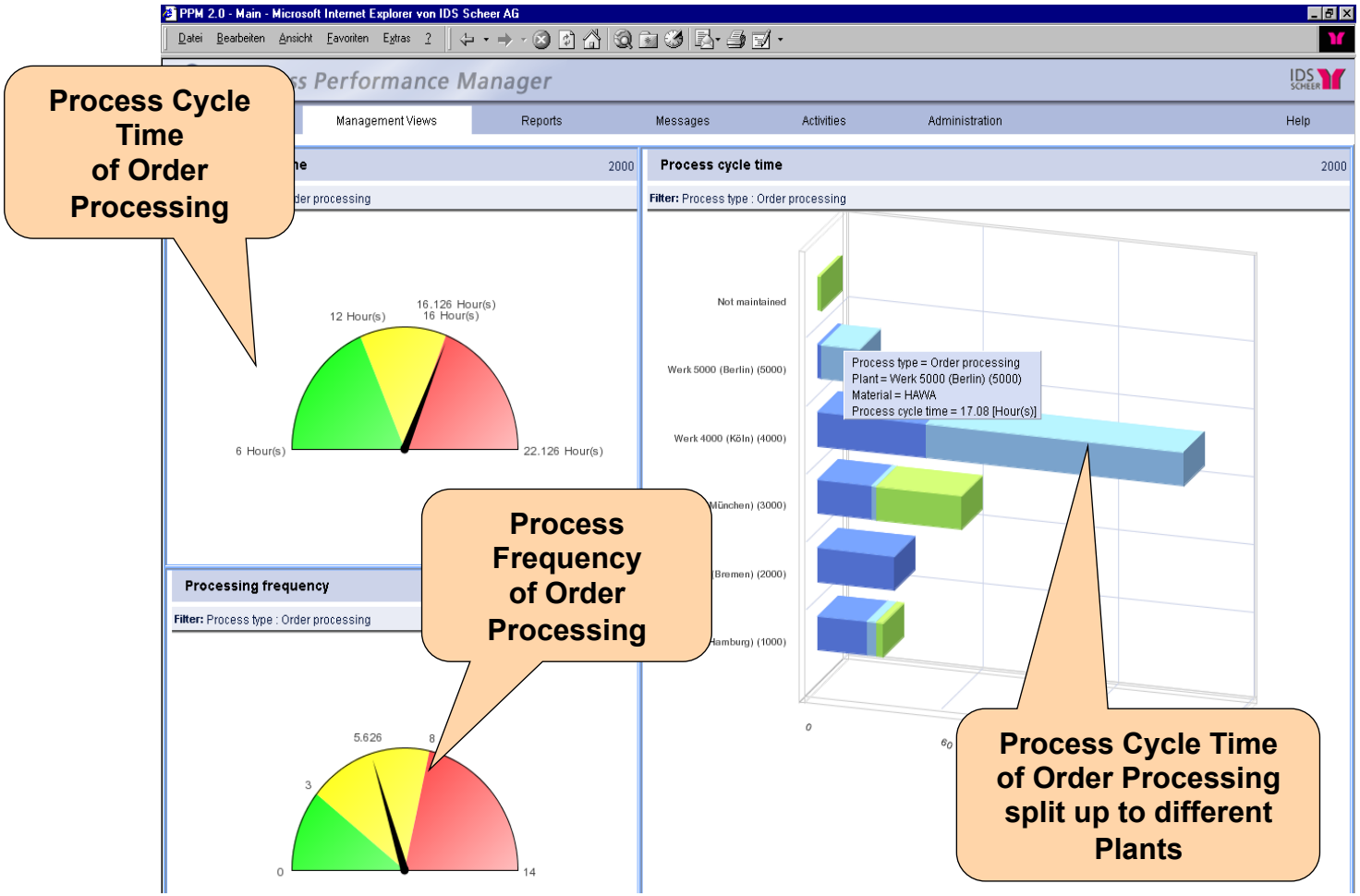
Cycle de vie d'un processus (2) : le cercle vertueux



Types of Process Monitoring

- *Runtime* Monitoring (Business Activity Monitoring)
  - Viewing the load of the process
  - Identifying problematic cases
  - Identifying late cases (risk of missing deadlines), etc.
- *Post-mortem Monitoring (aka Business Process Analytics)*
  - Performance KPIs: cycle times, resource utilization, error rates, …
  - Identification of bottlenecks
- See for example:
  - BizAgi BAM: http://wiki.bizagi.com/en/index.php?title=Analysis_Reports_BAM
  - Analytics: http://wiki.bizagi.com/en/index.php?title=Analysis_Reports_Analytics

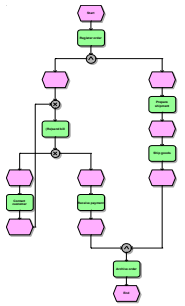
Process Monitoring: Dashboards



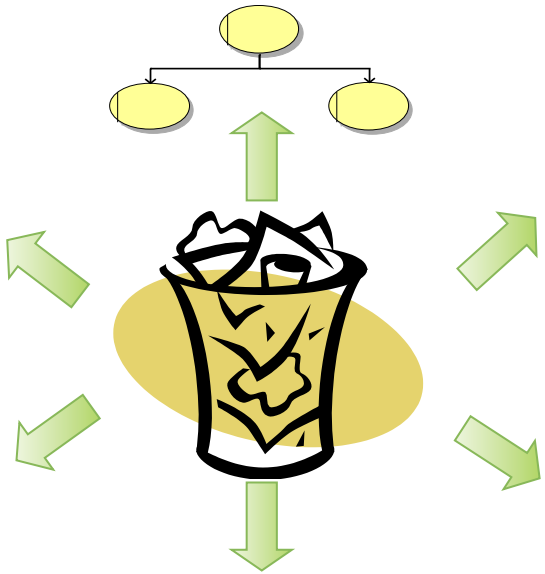
IDS (2003)

Beyond Monitoring – Process Mining

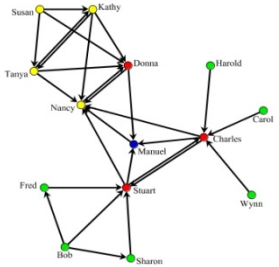
2) process model



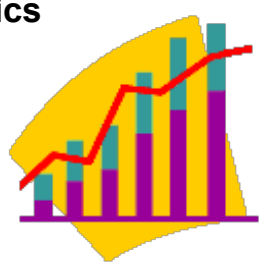
3) organizational model



4) social network



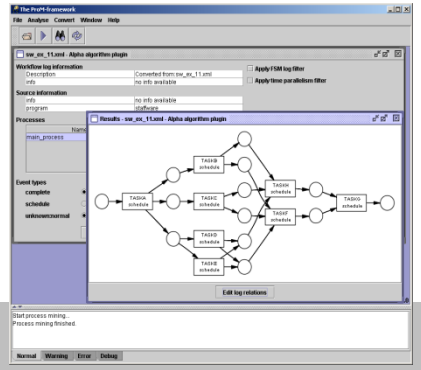
1) basic performance metrics



5) performance characteristics

6) auditing/security

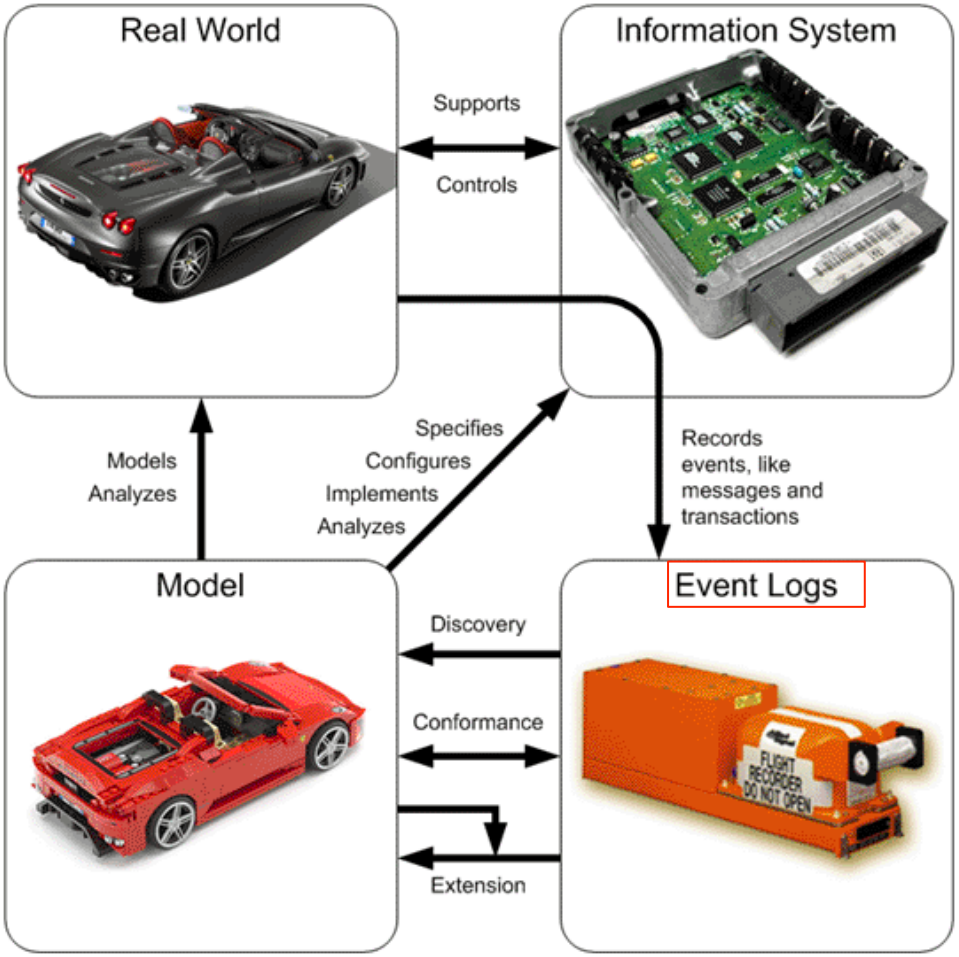
If …then …



Process Mining Tools

- ARIS Process Performance Manager
- Percetive Reflect
- Fujitsu Interstage (BPM Analytics)
- ProM

Starting point: Event Logs



<B A E F E>

<A A D F C D E>

<A B D F E>

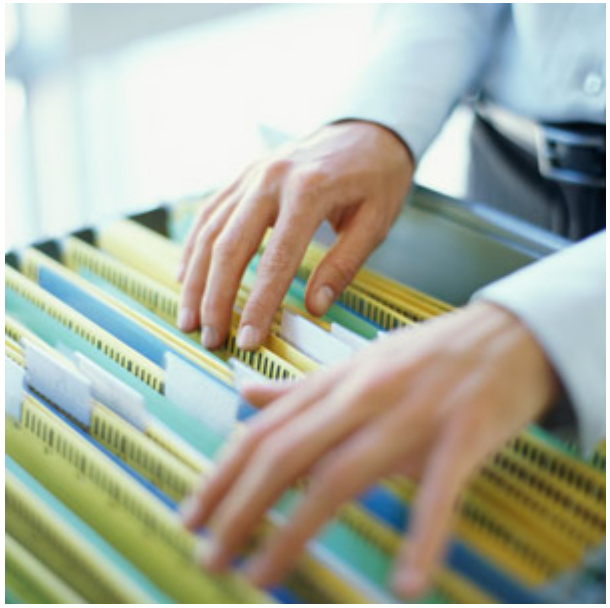
<D D A D F C D E>

<F A D E>

Starting point: Event Logs

Case ID	Task Name	Originator	Timestamp	Case 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
1	Process Payment	system	24-07-2004 15:05:00	3	Reminder	John	21-10-2004 10:00:00
1	Close Case	system	24-07-2004 15:06:00	3	Process Payment	system	25-10-2004 14:00:00
2	Reminder	Mary	20-08-2004 10:00:00	3	Close Case	system	25-10-2004 14:01:00

Starting point: Event Logs

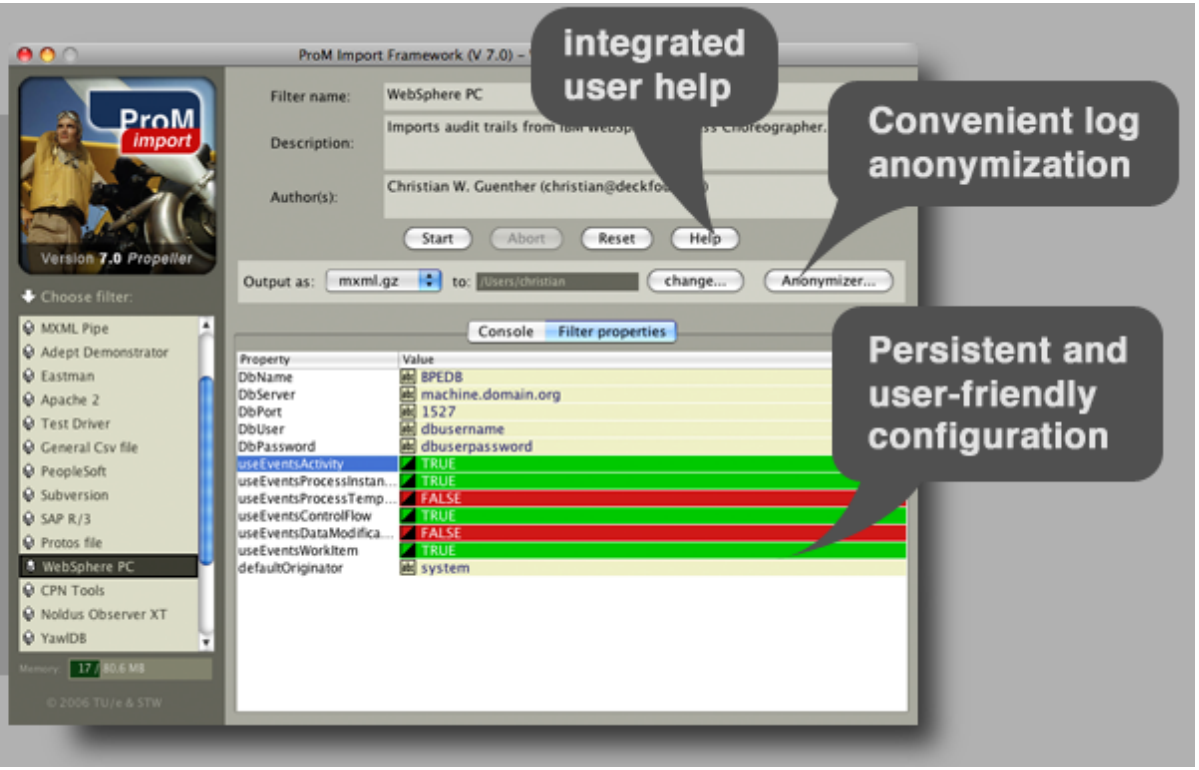


unified event log (MXML or XES format)

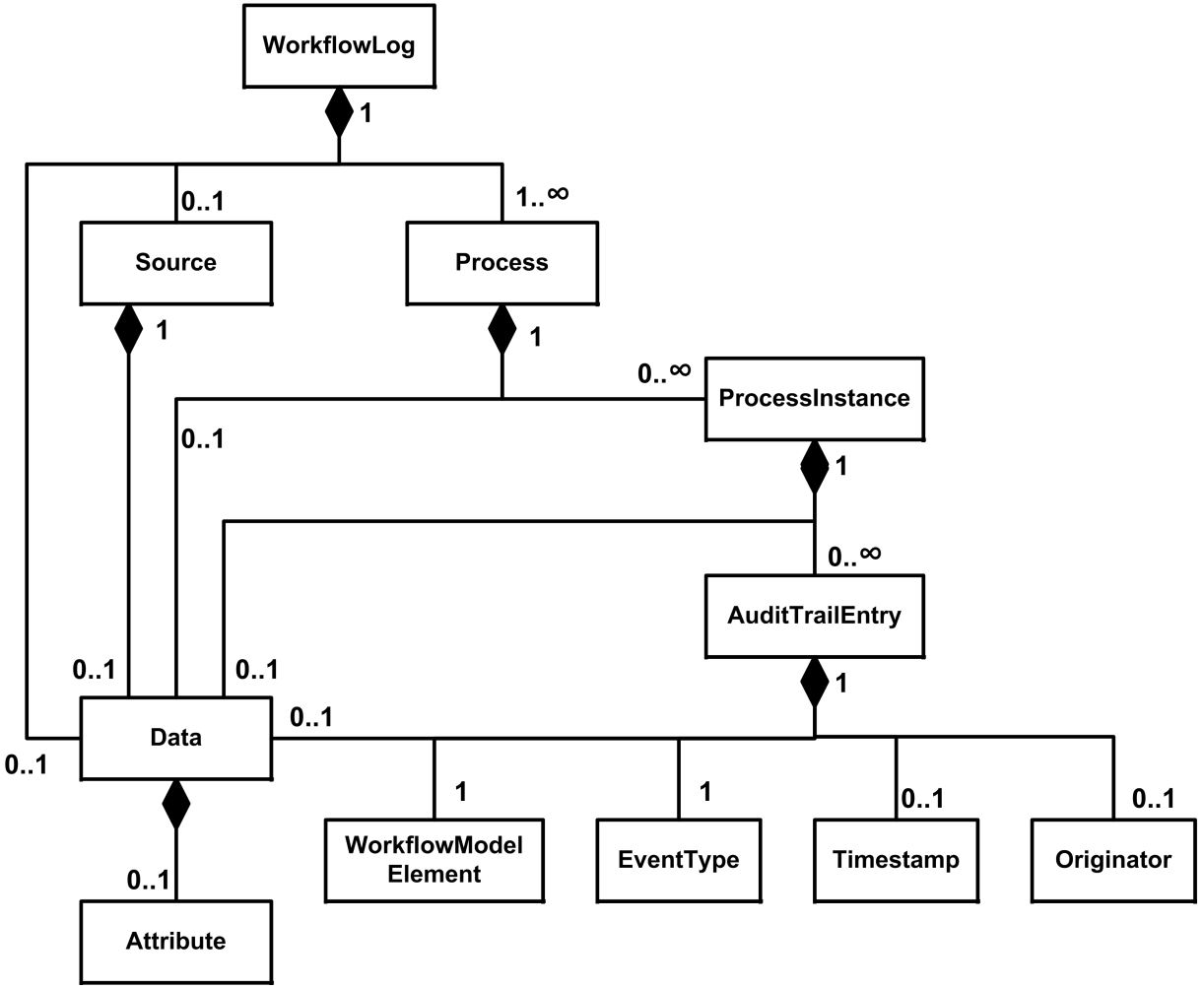
event logs, audit trails, databases, message logs, etc.

ProMimport

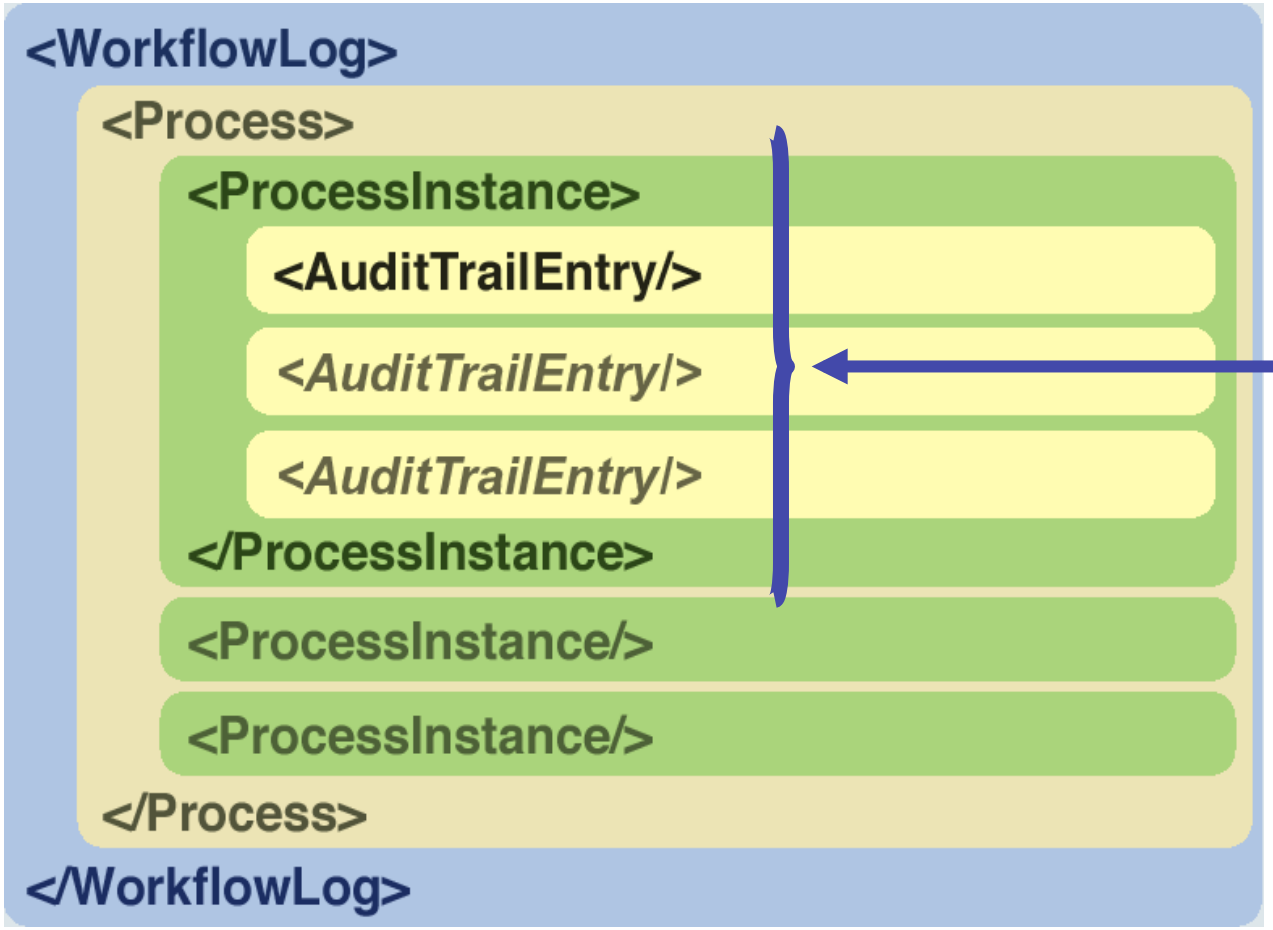
...choose from **more than 20 import filter plug-ins for all kinds of log-producing systems, like:**
WebSphere, FLOWer, Staffware, PeopleSoft, Eastman, Subversion, CVS, Apache, Aris PPM, CPN Tools,...
...and many more!



Event Log: MXML format

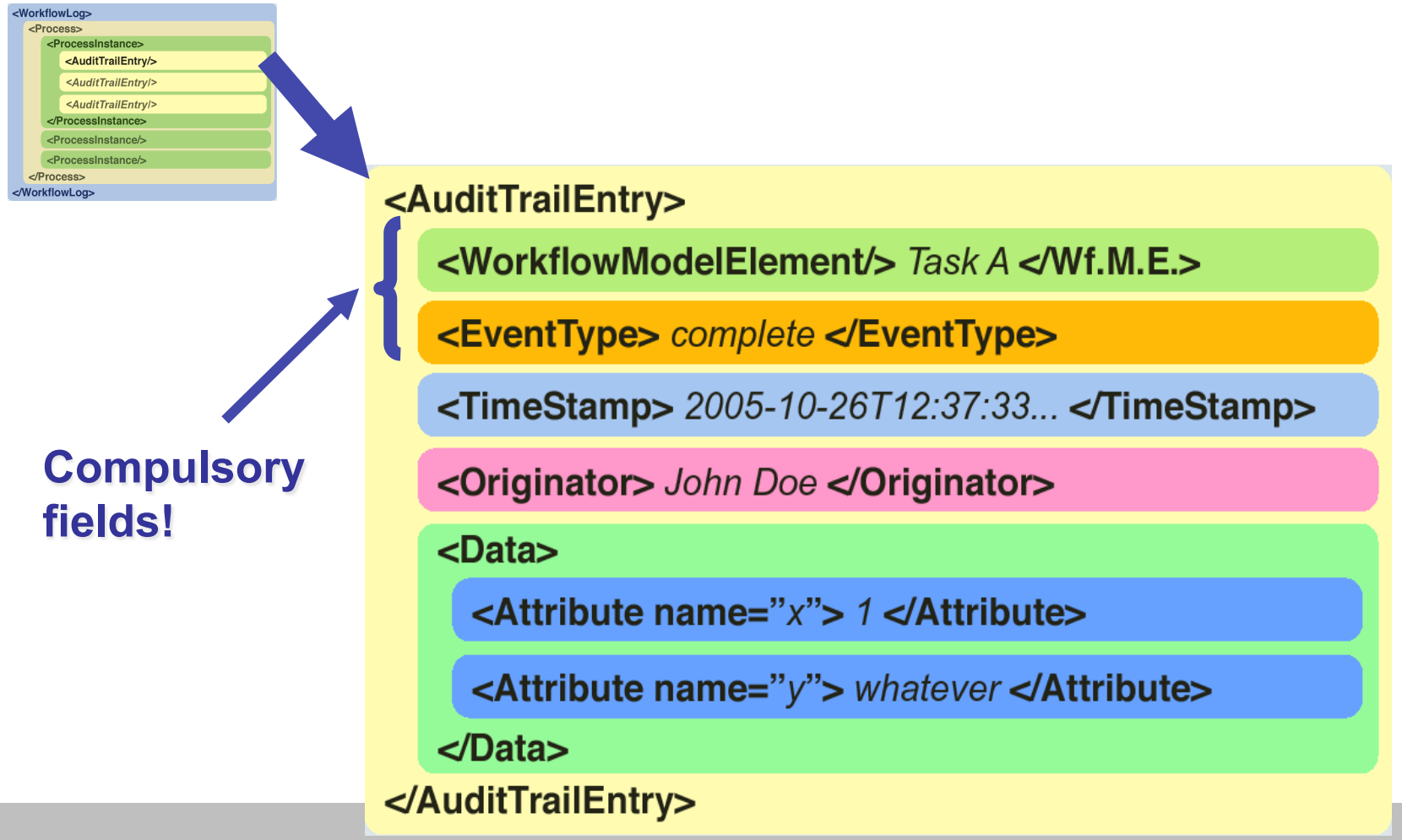


Event Log: MXML format



The notion of which tasks belong to a same instance is crucial for applying process mining techniques!

Event Log: MXML format



Event Log: MXML format

```
<WorkflowLog xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="http://is.tm.tue.nl/research/processmining/WorkflowLog.xsd"
    <Data>
        <Attribute name="app.name">MXMLib</Attribute>
        <Attribute name="app.version">1.9</Attribute>
        <Attribute name="java.vendor">Sun Microsystems Inc.</Attribute>
        <Attribute name="java.version">1.6.0_30</Attribute>
    </Data>
    <Source program="XES MXML serialization"/>
    <Process id="Compliant tracesAnonymous log imported from Isala.xez" description="process with id Compliant tracesAnonymous log imported from Isala.xez">
        <Data>
            <Attribute name="concept:name">Compliant tracesAnonymous log imported from Isala.xez</Attribute>
            <Attribute name="creator">Fluxicon Nitro</Attribute>
            <Attribute name="library">Fluxicon Octane</Attribute>
            <Attribute name="lifecycle:model">standard</Attribute>
        </Data>
        <ProcessInstance id="3340952" description="instance with id 3340952">
            <Data>
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                <Attribute name="creator">Fluxicon Nitro</Attribute>
            </Data>
            <AuditTrailEntry>
                <Data>
                    <Attribute name="Aantal">1</Attribute>
                    <Attribute name="ActiviteitCode">39859</Attribute>
                    <Attribute name="ActiviteitOmschrijving">Cysto-Urethroscopie</Attribute>
                    <Attribute name="AfdelingCode">W857</Attribute>
                    <Attribute name="Bronsysteem">IVA</Attribute>
                    <Attribute name="DBC_DatasetCS">0306|__11.__02.__30._323</Attribute>
                    <Attribute name="DBC_DatasetCSOmschrijving">Reguliere zorg.Haematurie.Blaastumor.endolum. endoscop. oper. kl.</Attribute>
                </Data>
                <WorkflowModelElement>Cysto-urethroscopy</WorkflowModelElement>
                <EventType>complete</EventType>
                <Timestamp>2010-06-01T08:30:00.000+02:00</Timestamp>
                <Originator>526521</Originator>
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```
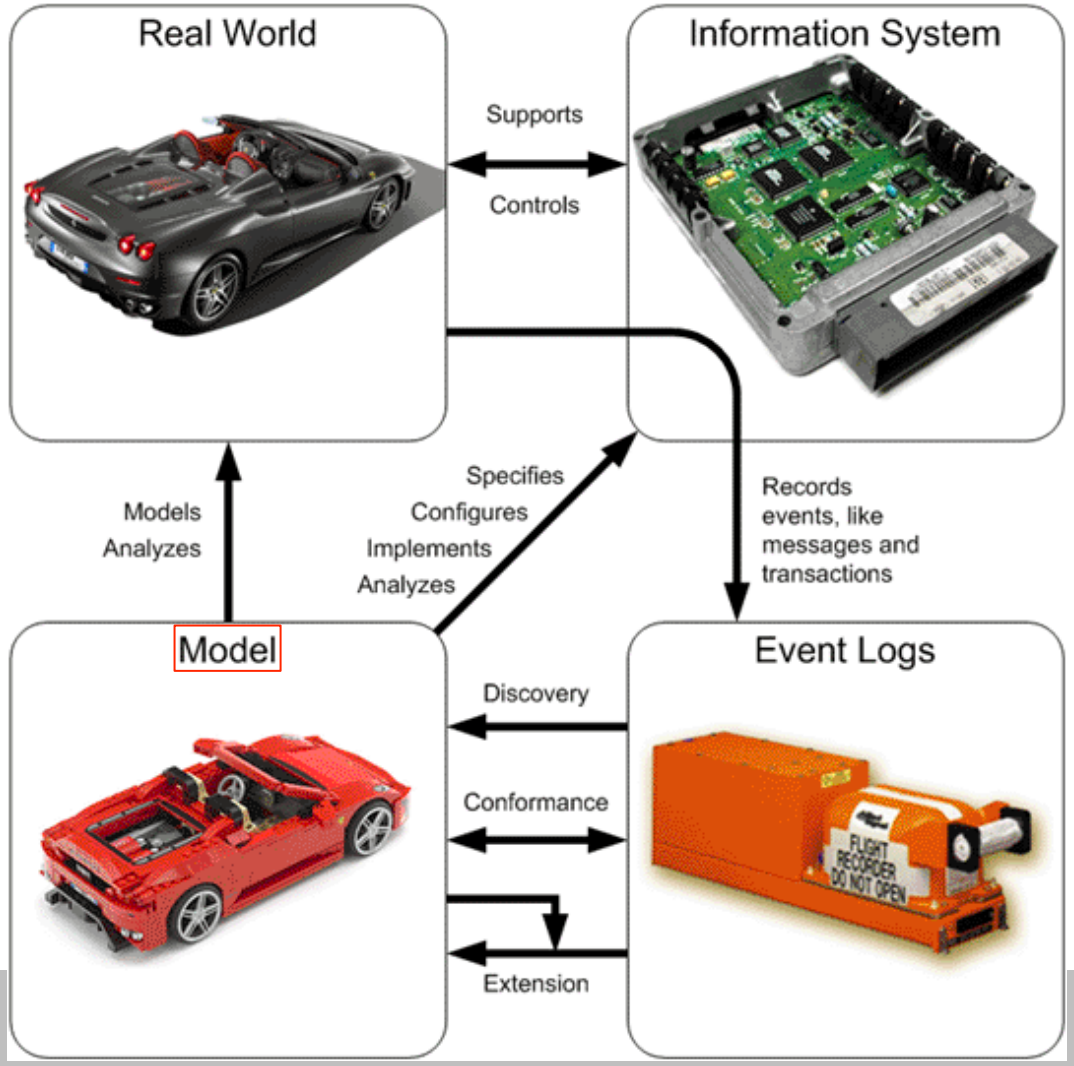
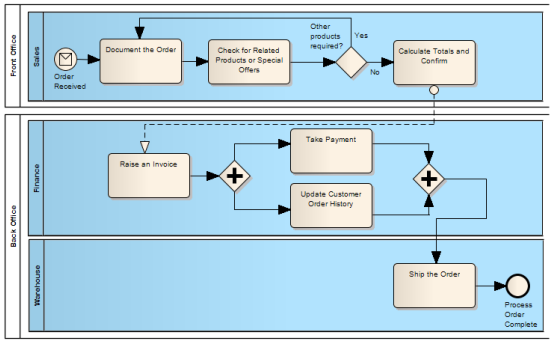
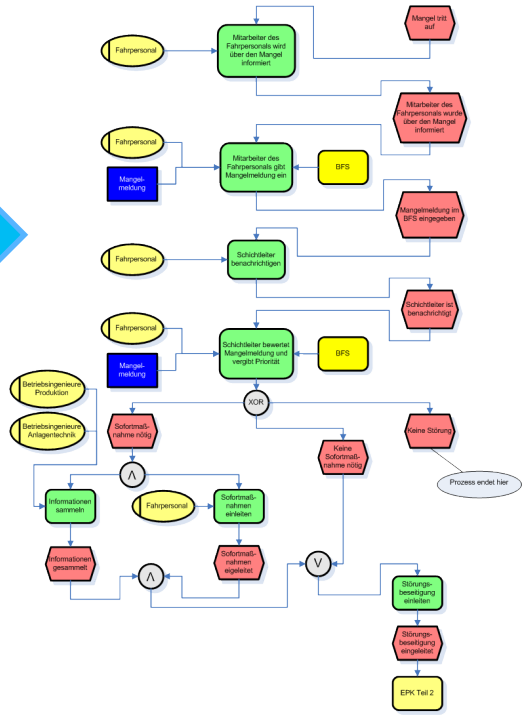
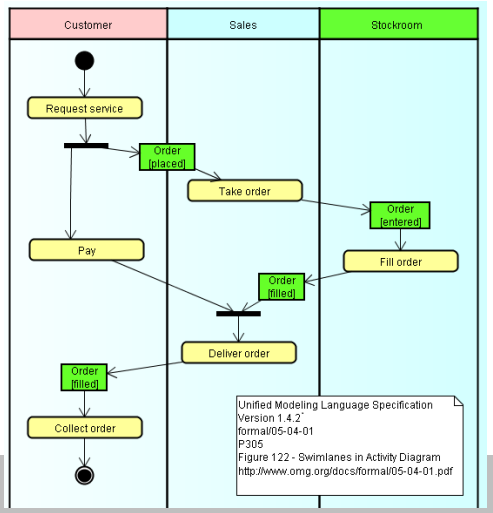

Process Mining

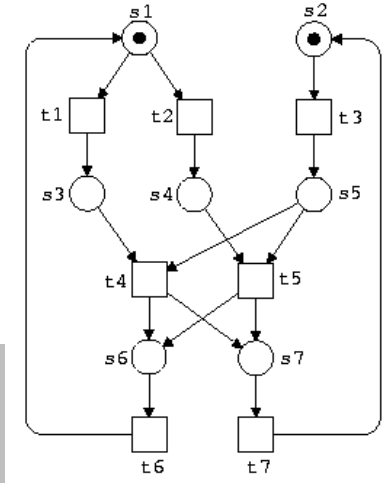


Process Models

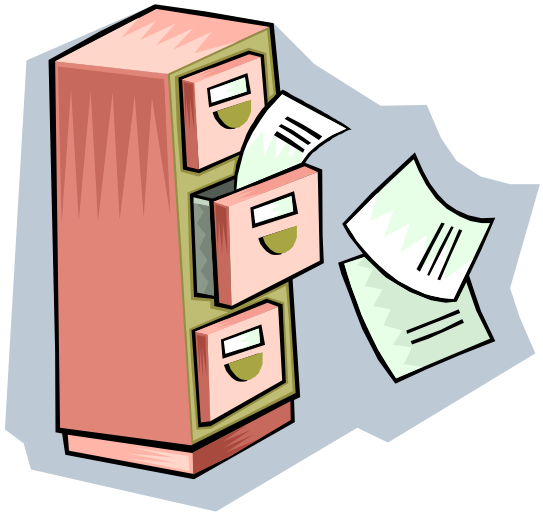


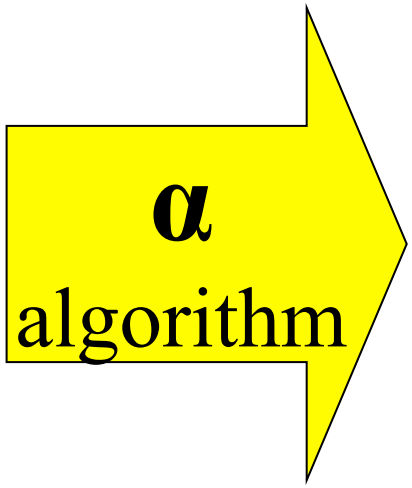


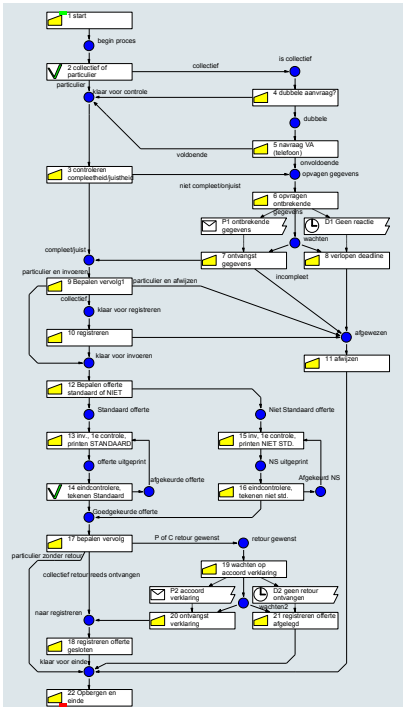




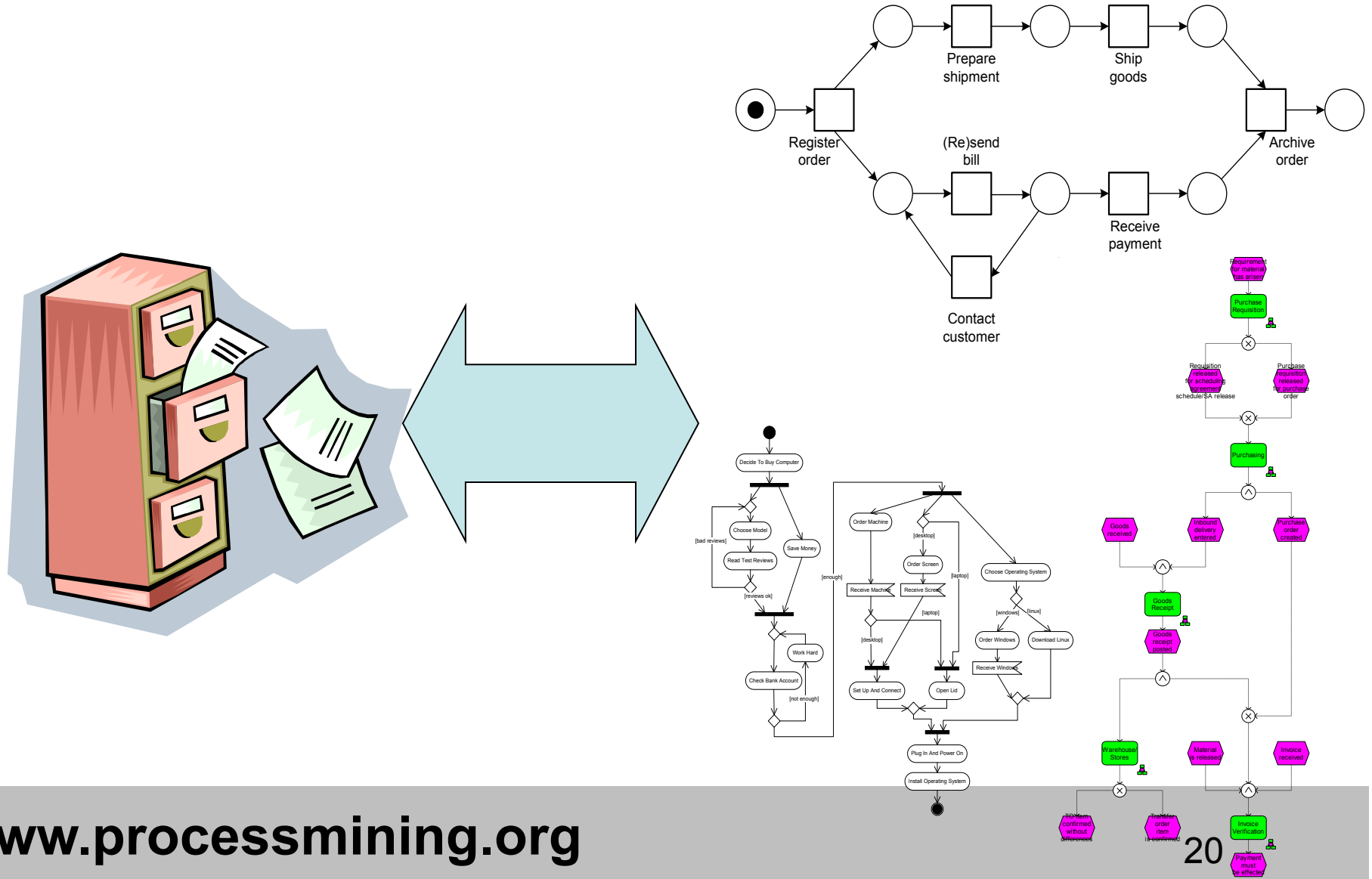
Process discovery



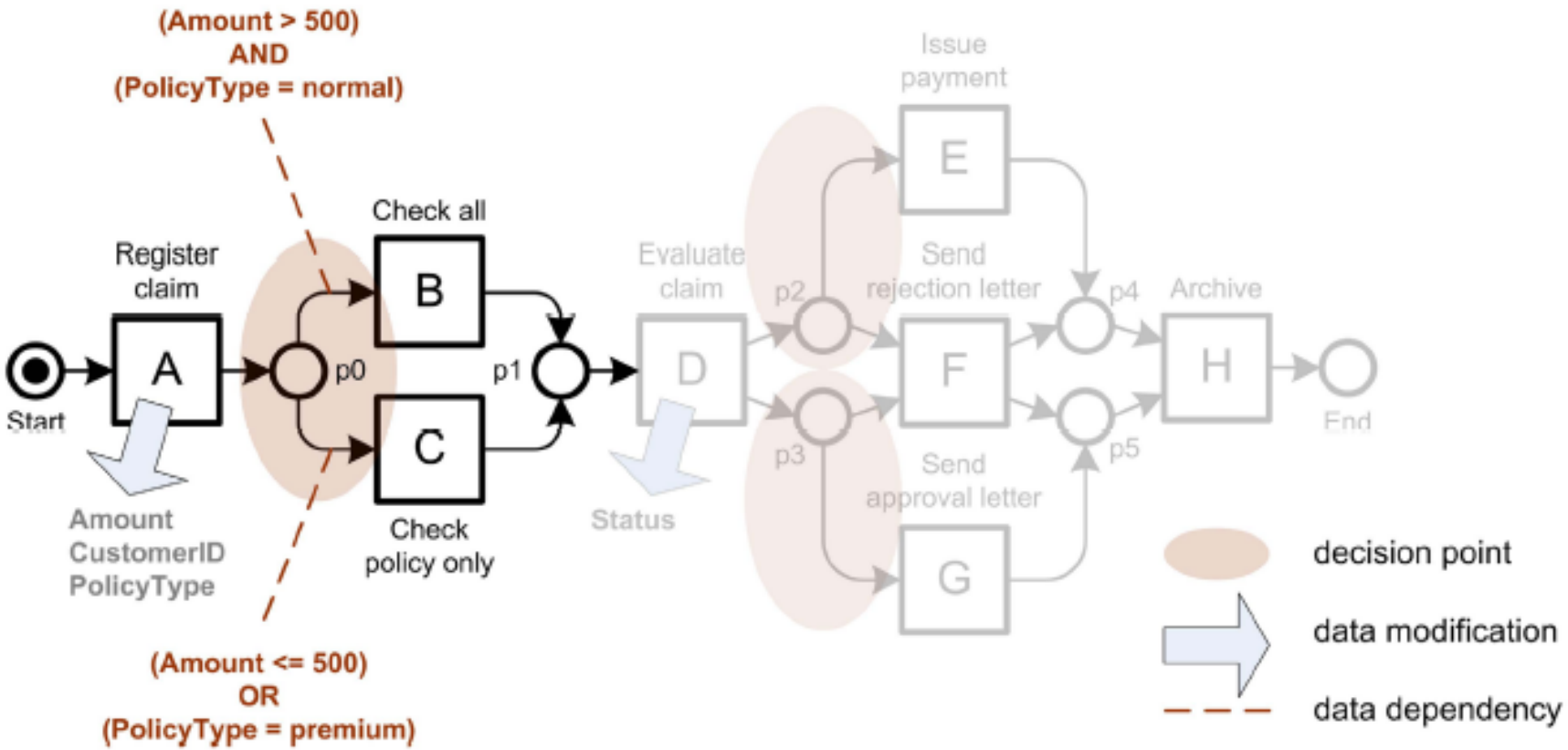




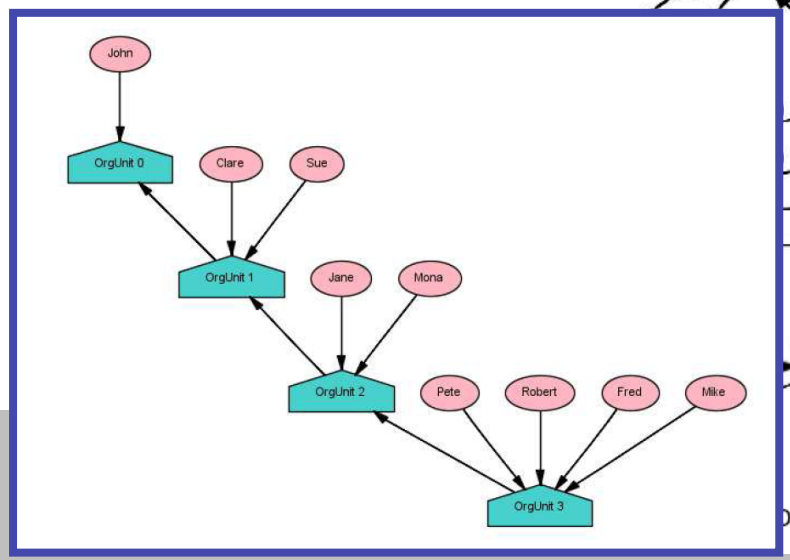
Conformance Checking

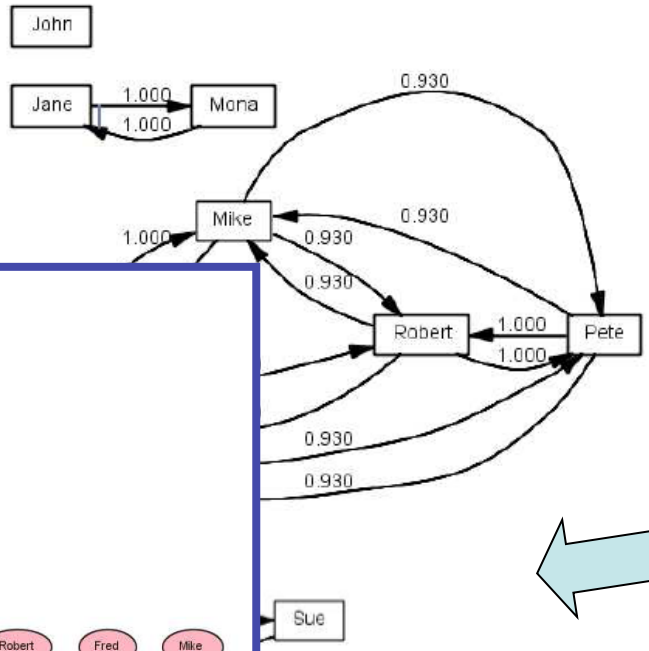


Advanced Features: Decision mining

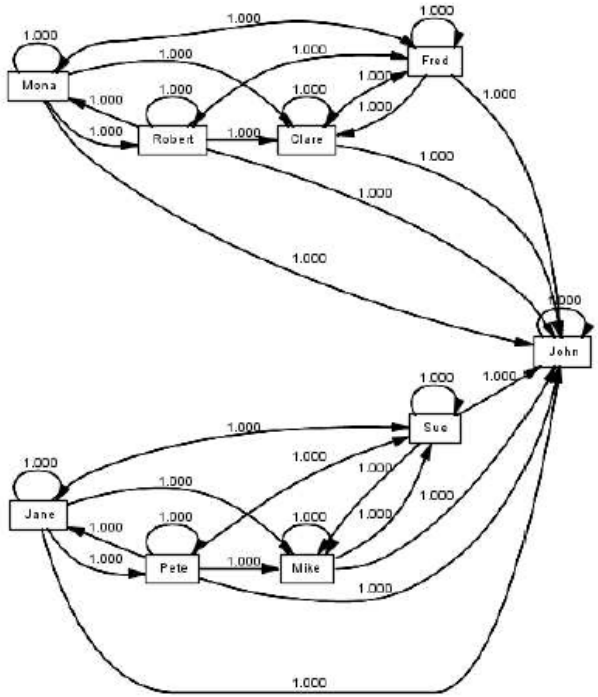


Advanced Features: Social network mining



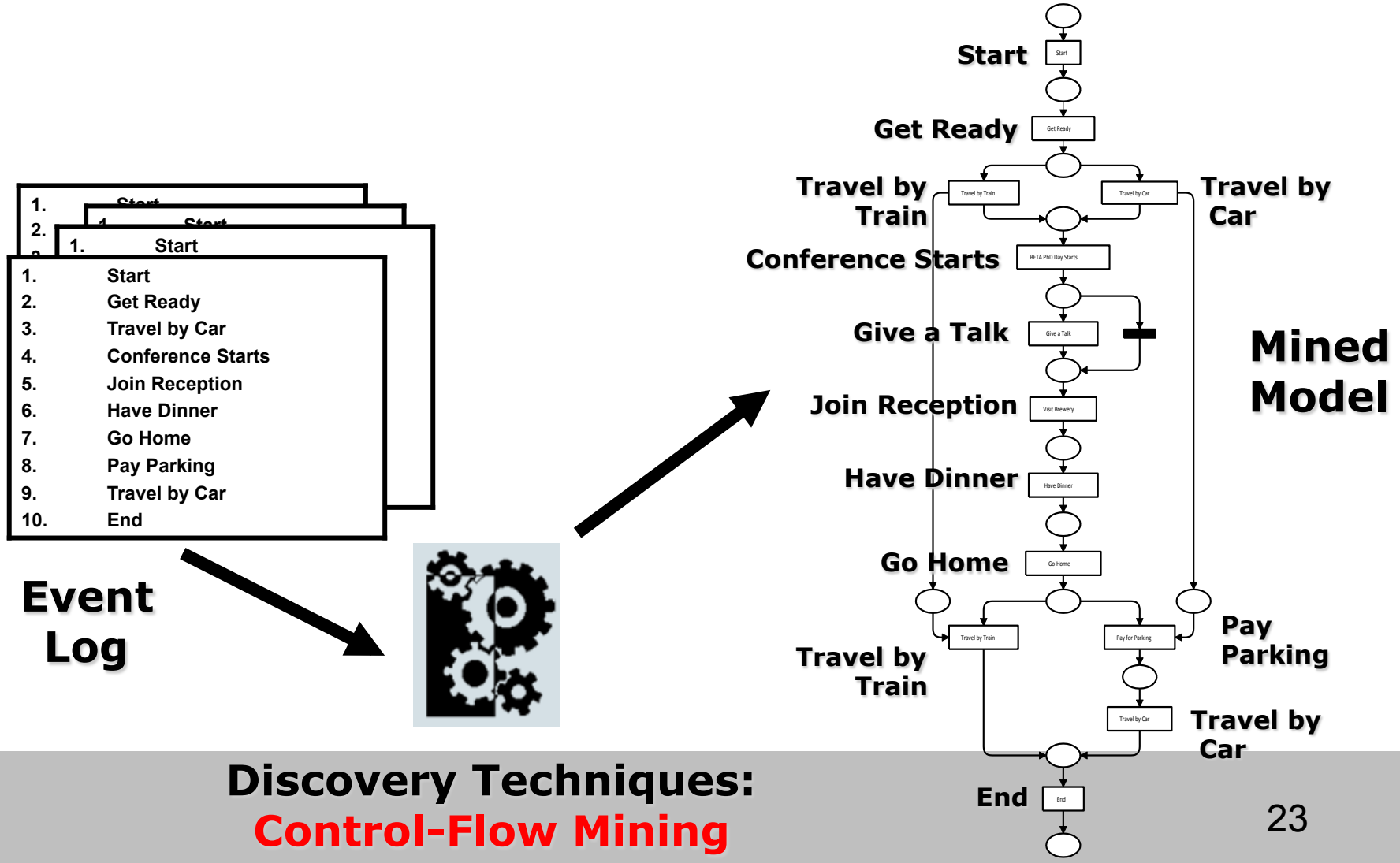


ping similar task



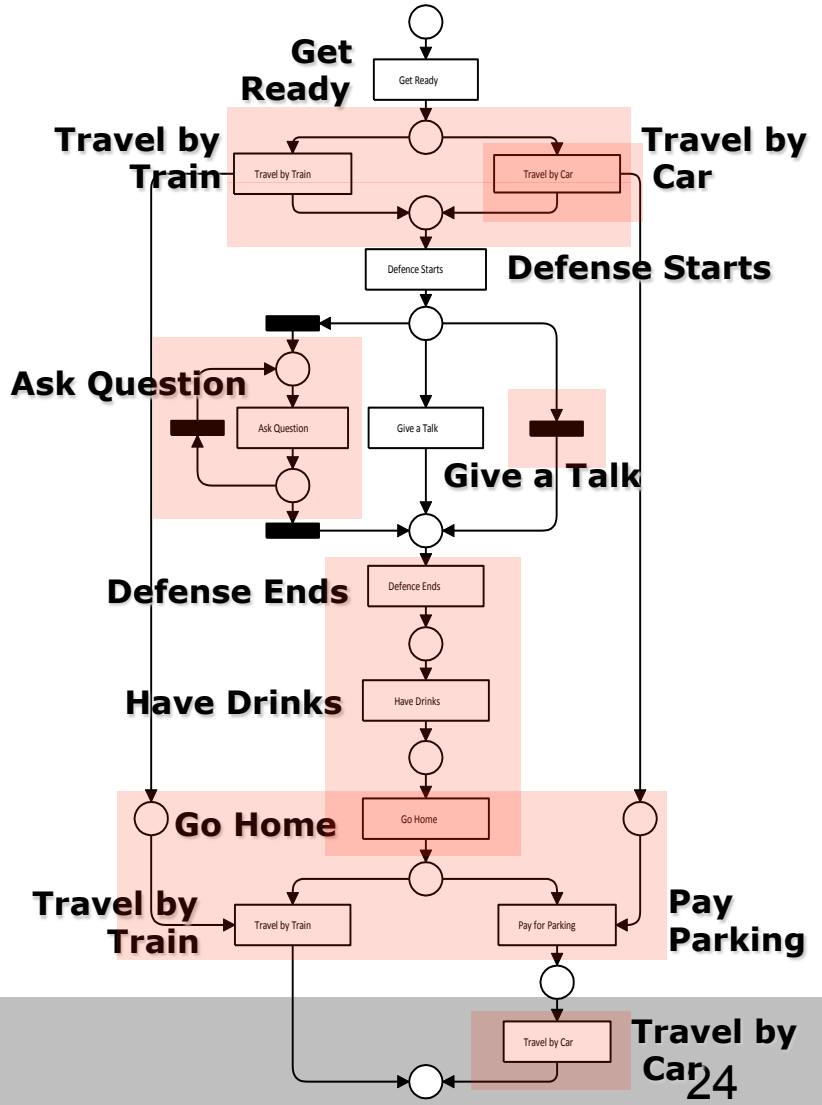
(b) working together

Control-Flow Mining

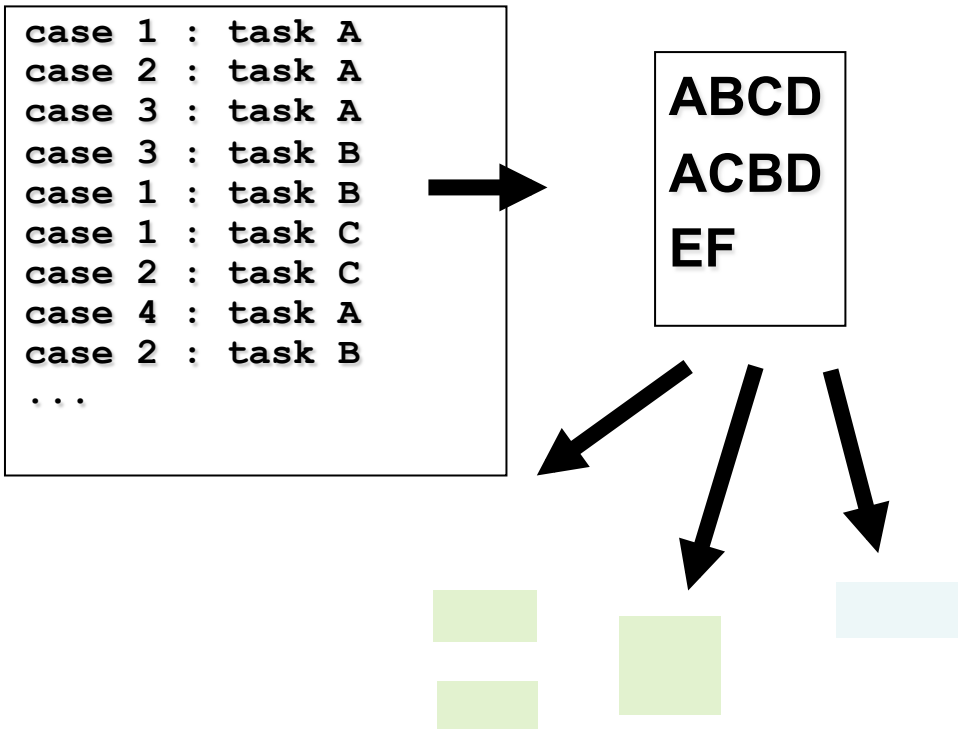


Mining Common Constructs

- Sequence
- Splits
- Joins
- Loops
- Non-Free Choice
- Invisible Tasks
- Duplicate Tasks

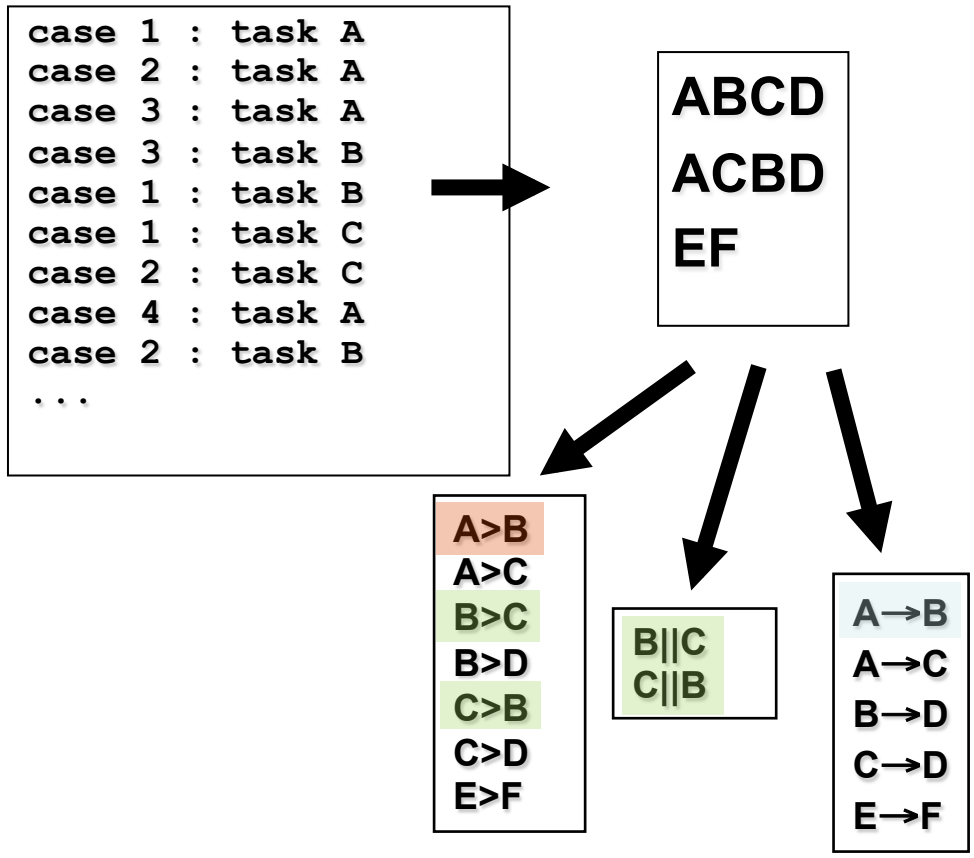


α-algorithm
Basic Idea: Ordering relations



α-algorithm
Basic Idea: Ordering relations

- **Direct succession:** x>y iff for some case x is directly followed by y.
- **Causality:** x→y iff x>y and not y>x.
- **Parallel:** x||y iff x>y and y>x
- **Unrelated:** x#y iff not x>y and not y>x.



Basic Idea: Example

$$L_1 = [\langle a, b, c, d\rangle^3, \langle a, c, b, d\rangle^2, \langle a, e, d\rangle]$$

Basic Idea: Example

$$L_1 = [\langle a, b, c, d\rangle^3, \langle a, c, b, d\rangle^2, \langle a, e, d\rangle]$$

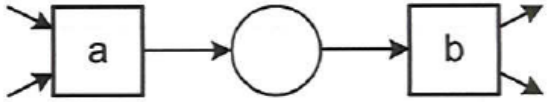
$$>_{L_1} = \{(a,b), (a,c), (a,e), (b,c), (c,b), (b,d), (c,d), (e,d)\}$$

$$\rightarrow_{L_1} = \{(a,b), (a,c), (a,e), (b,d), (c,d), (e,d)\}$$

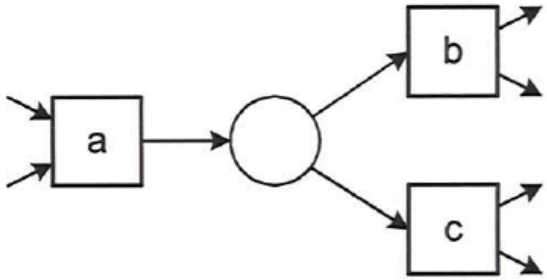
$$\#_{L_1} = \{(a,a), (a,d), (b,b), (b,e), (c,c), (c,e), (d,a), (d,d), (e,b), (e,c), (e,e)\}$$

$$\|_{L_1} = \{(b,c), (c,b)\}$$

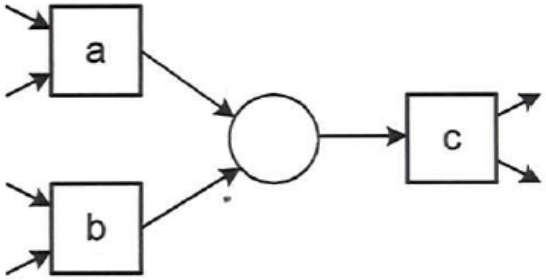
Basic Idea: Patterns



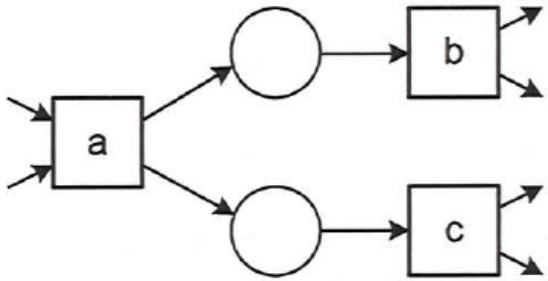
(a) sequence pattern: a→b



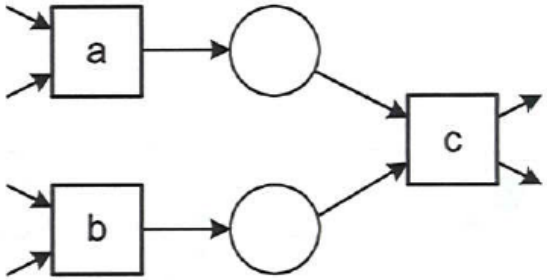
(b) XOR-split pattern:
a→b, a→c, and b#c



(c) XOR-join pattern:
a→c, b→c, and a#b



(d) AND-split pattern:
a→b, a→c, and b||c



(e) AND-join pattern:
a→c, b→c, and a||b