Process Mining

COMP9313: Big Data Management

What's process mining?

Wikipedia:

"Process mining is a family of techniques in the field of process management that support the analysis of business processes based on event logs. During process mining, specialized data mining algorithms are applied to event log data in order to identify trends, patterns and details contained in event logs recorded by an information system"

processmining.org

"Process mining techniques allow for extracting information from event logs. For example, the audit trails of a workflow management system or the transaction logs of an enterprise resource planning system can be used to discover models describing processes, organizations, and products."

(*) http://www.processmining.org

image: experienceswithlanguage.wordpress.com

What's process mining?

Process mining is about discovering what people really do in practice.

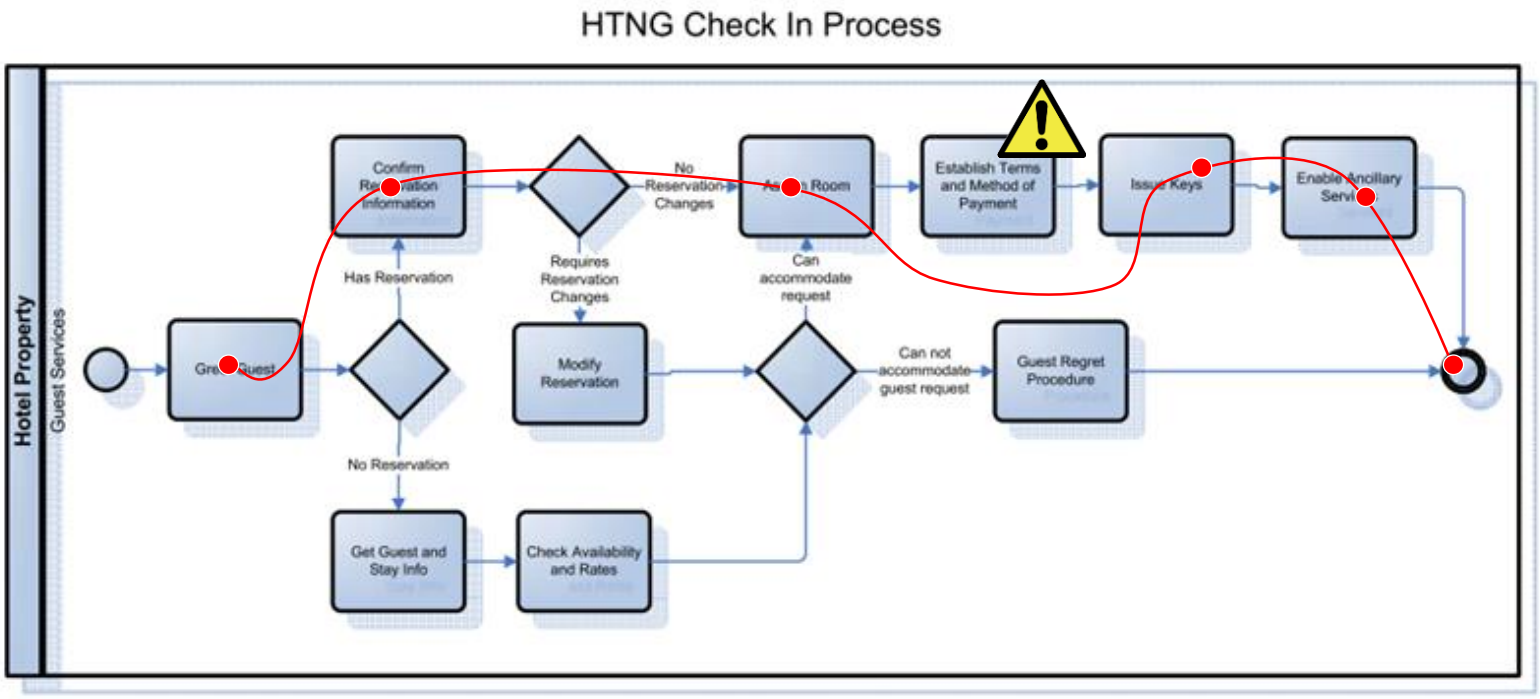
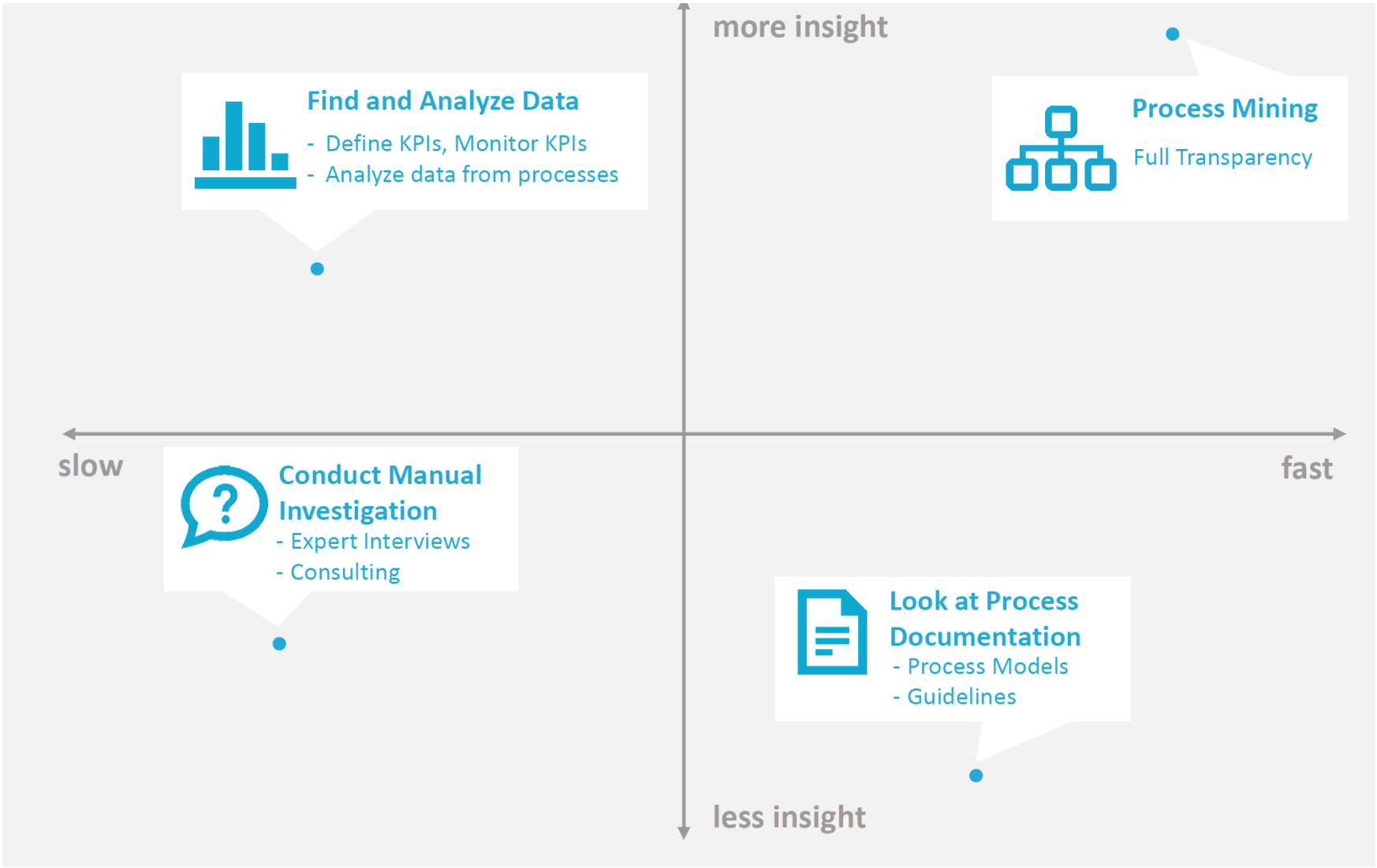
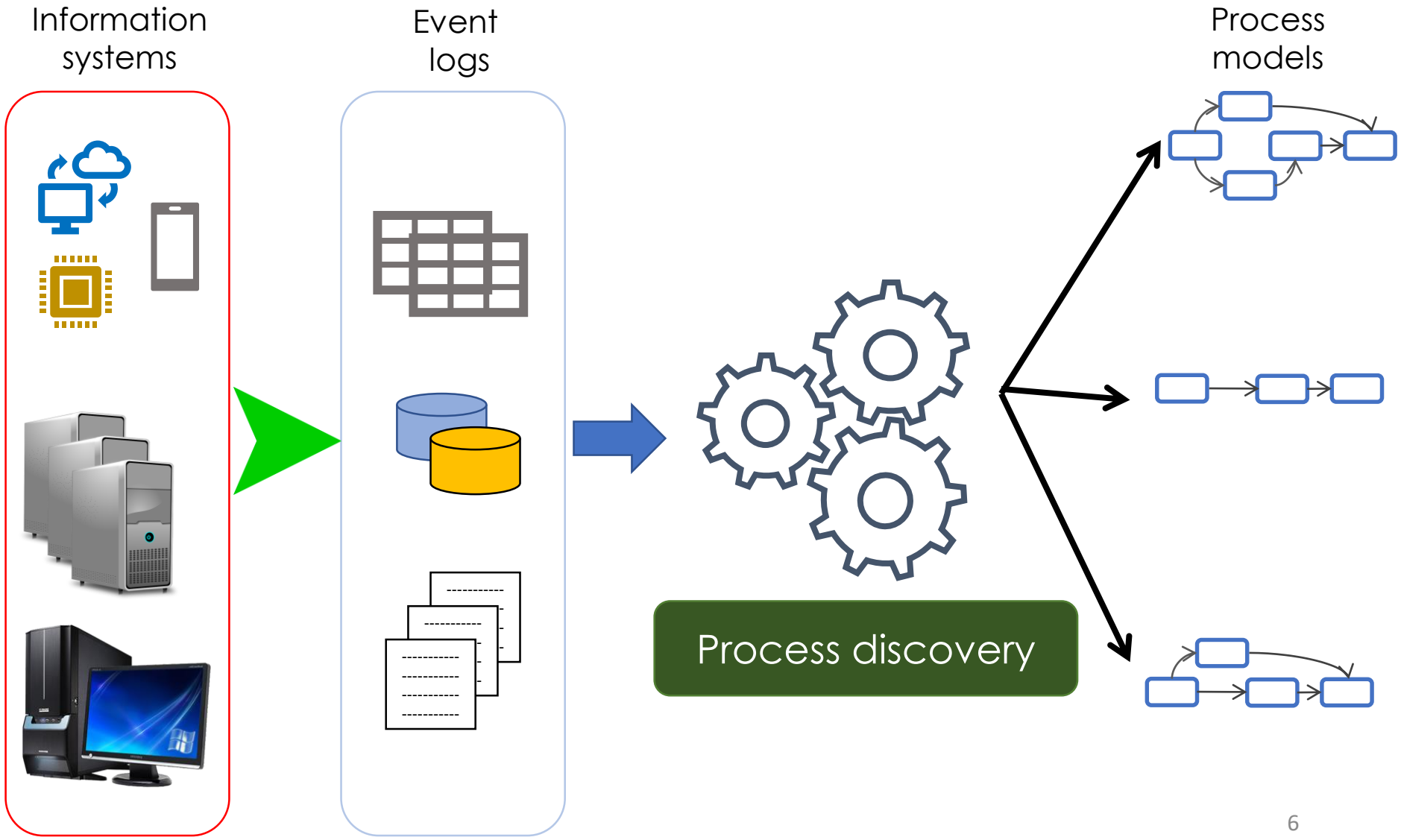


image: wiki.htng.org

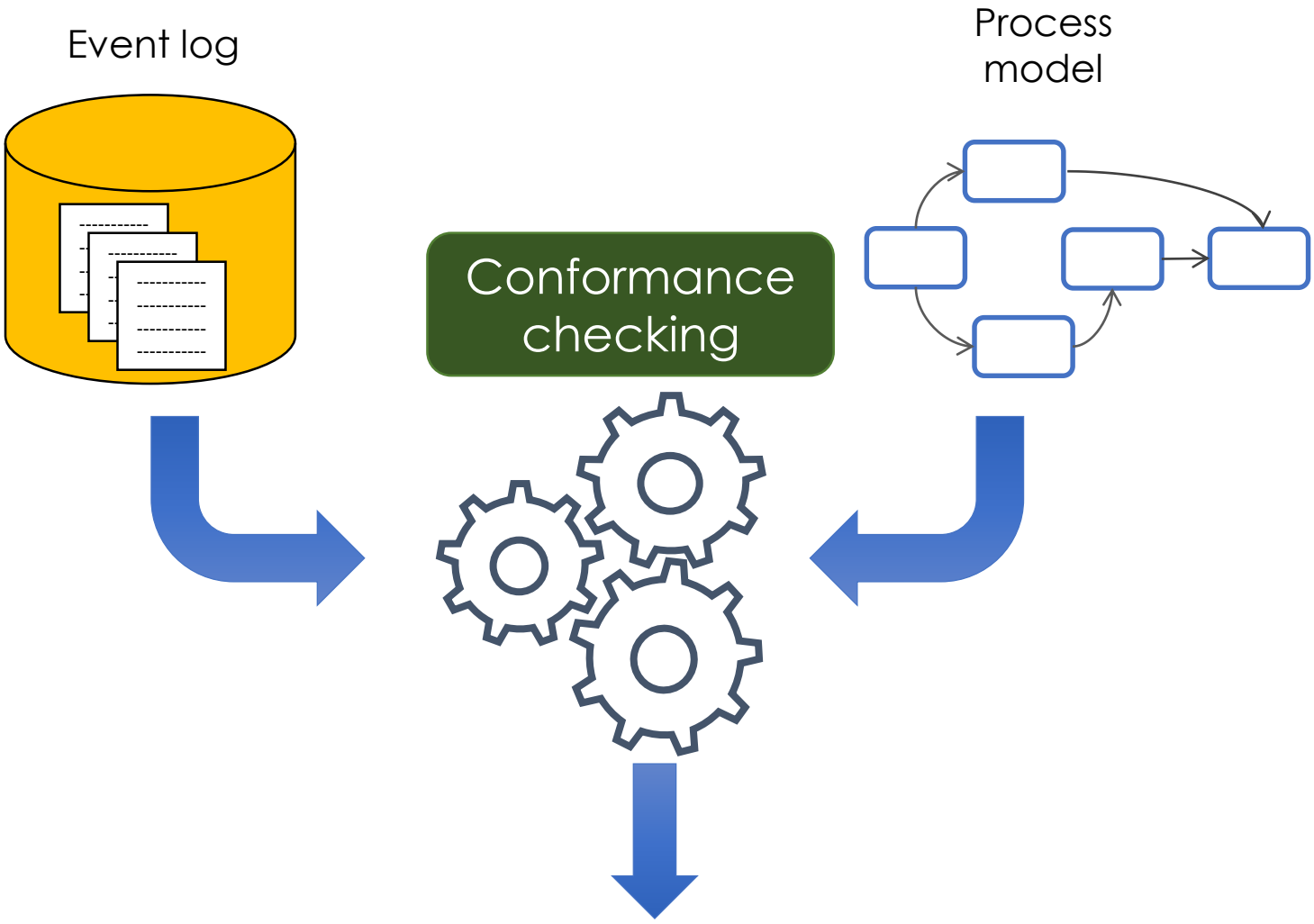
How to Get insights to business processes



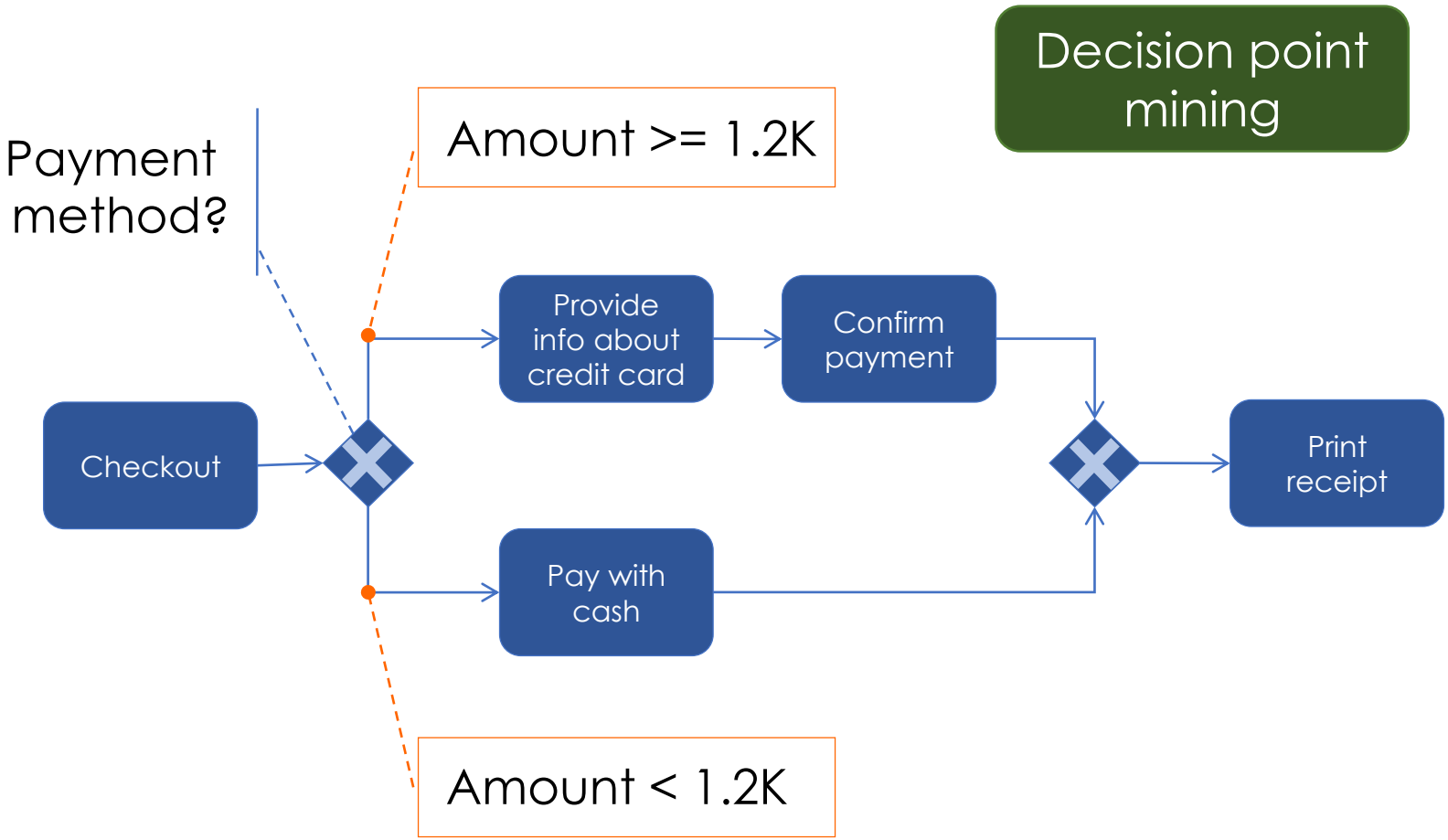
What can I do with process mining?



What can I do with process mining?



What can I do with process mining?



Data mining vs. Process mining

Data mining

- association rules
- graphs
- sequences (of items)
- clusters

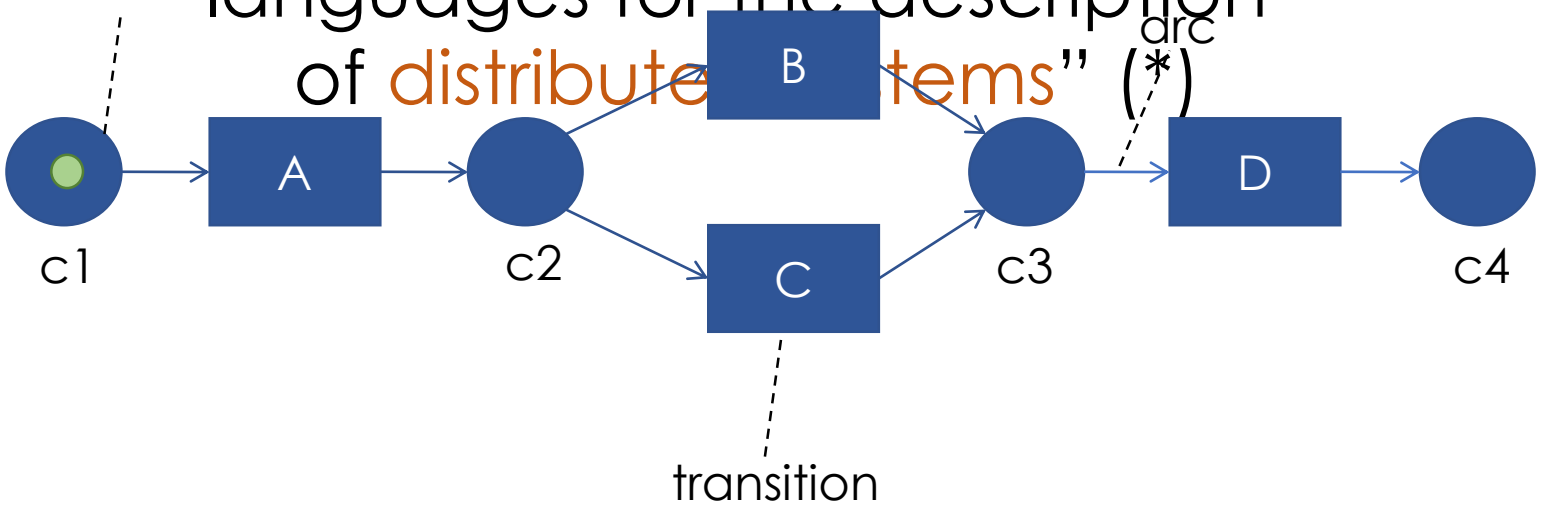
Process mining

- process models
- control flows
- decision points
- process execution data

Petri nets for business process modeling

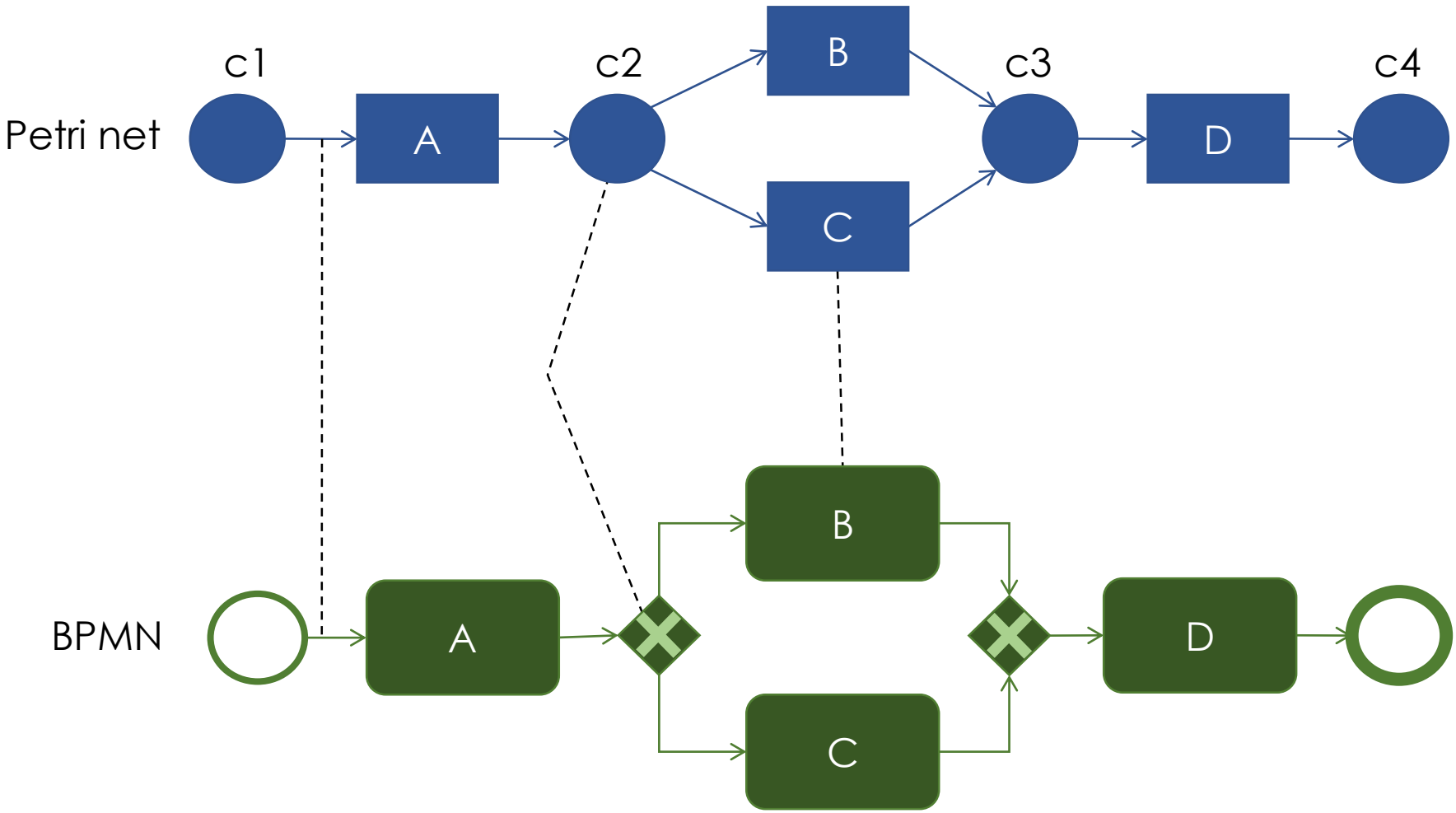
What's a Petri net?

"A Petri net, also known as a place/transition (PT) net, is one of several mathematical modeling languages for the description of distributed systems" (*)



(*) https://en.wikipedia.org/wiki/Petri_net

Relation to BPMN

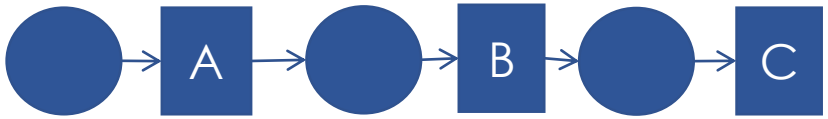


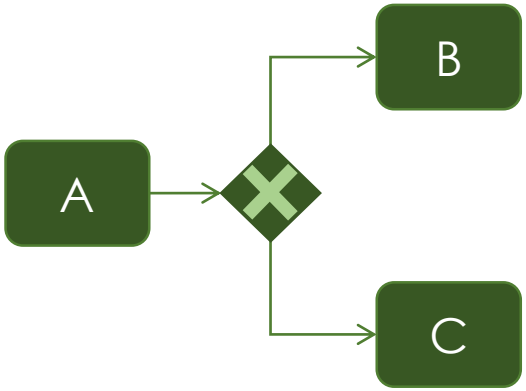
Relation to BPMN

BPMN

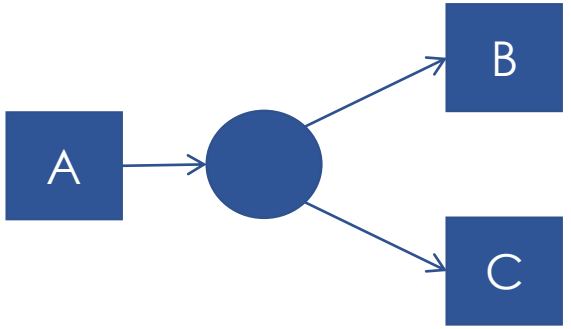
Petri Net

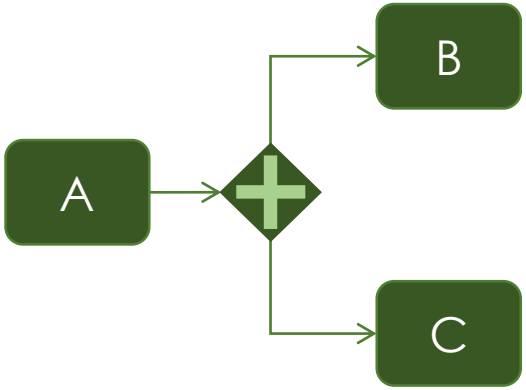
sequential routing



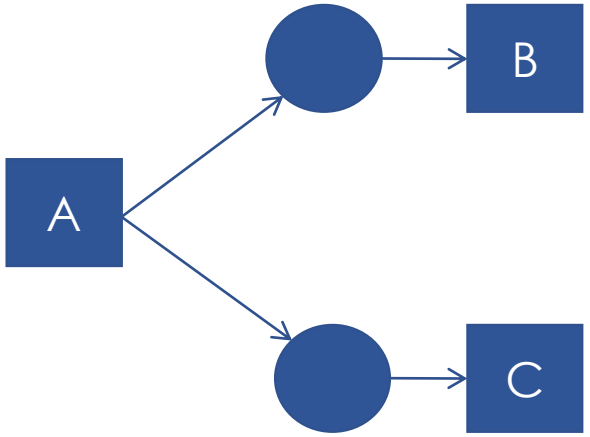


conditional routing



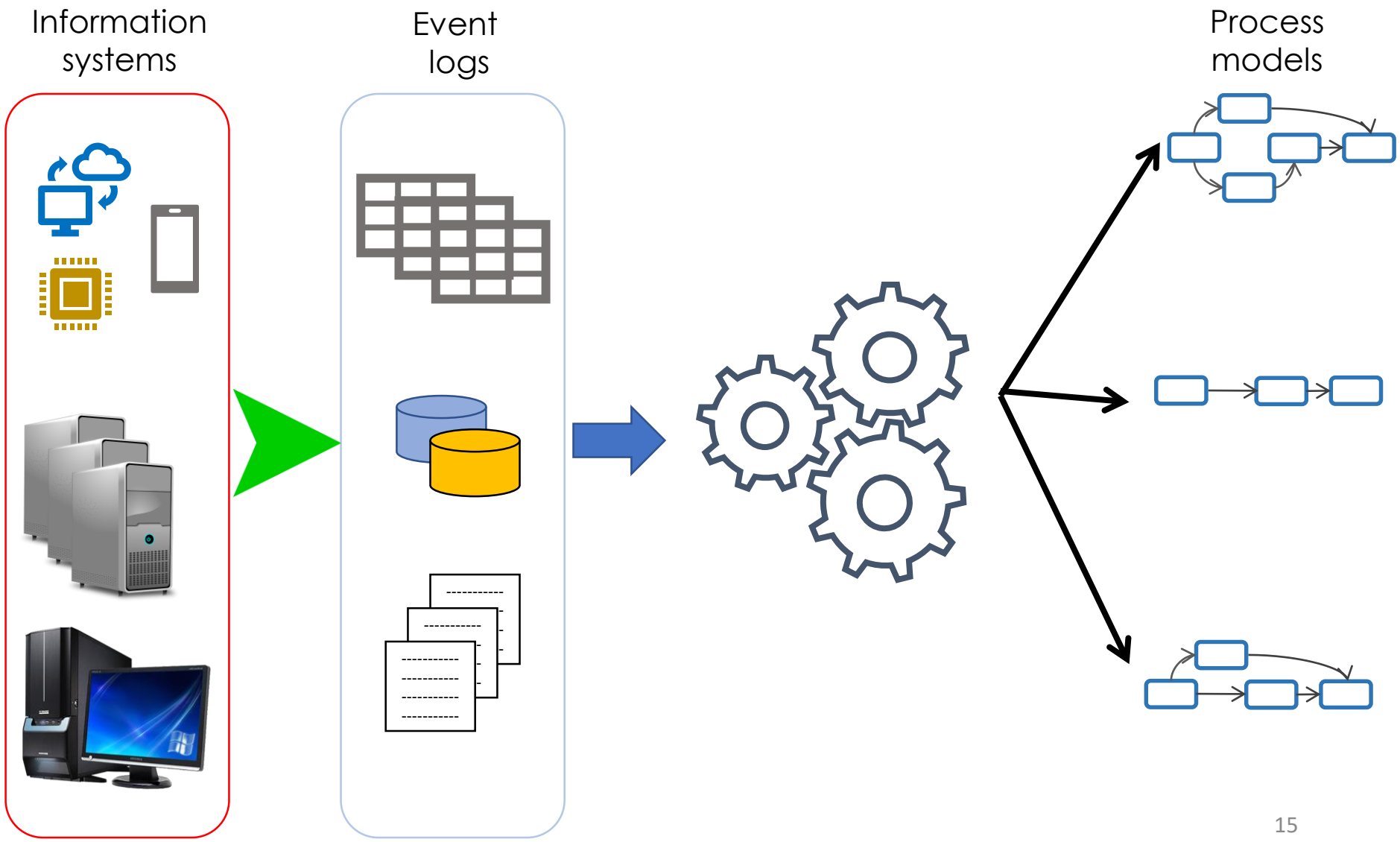


parallel routing

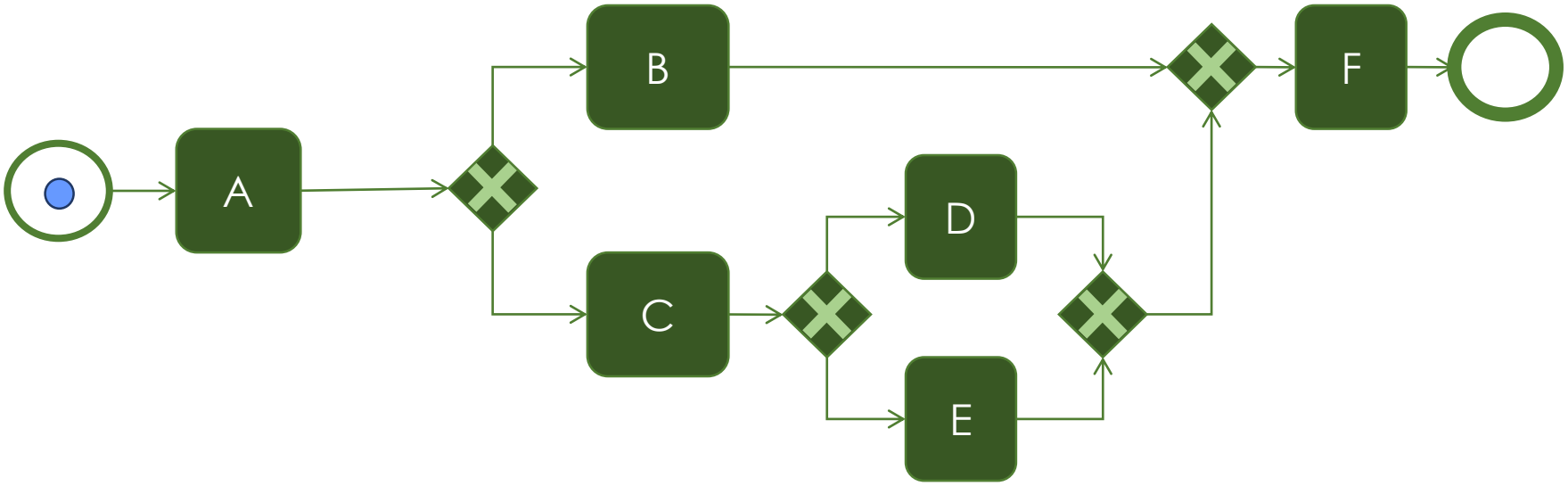


Process Discovery

recall...



Event logs



Case ID	Activity	Timestamp
1	A	2019-03-25 11:15:01
1	C	2019-03-25 11:15:05
1	D	2019-03-25 11:15:10
1	F	2019-03-25 11:15:18

Event logs

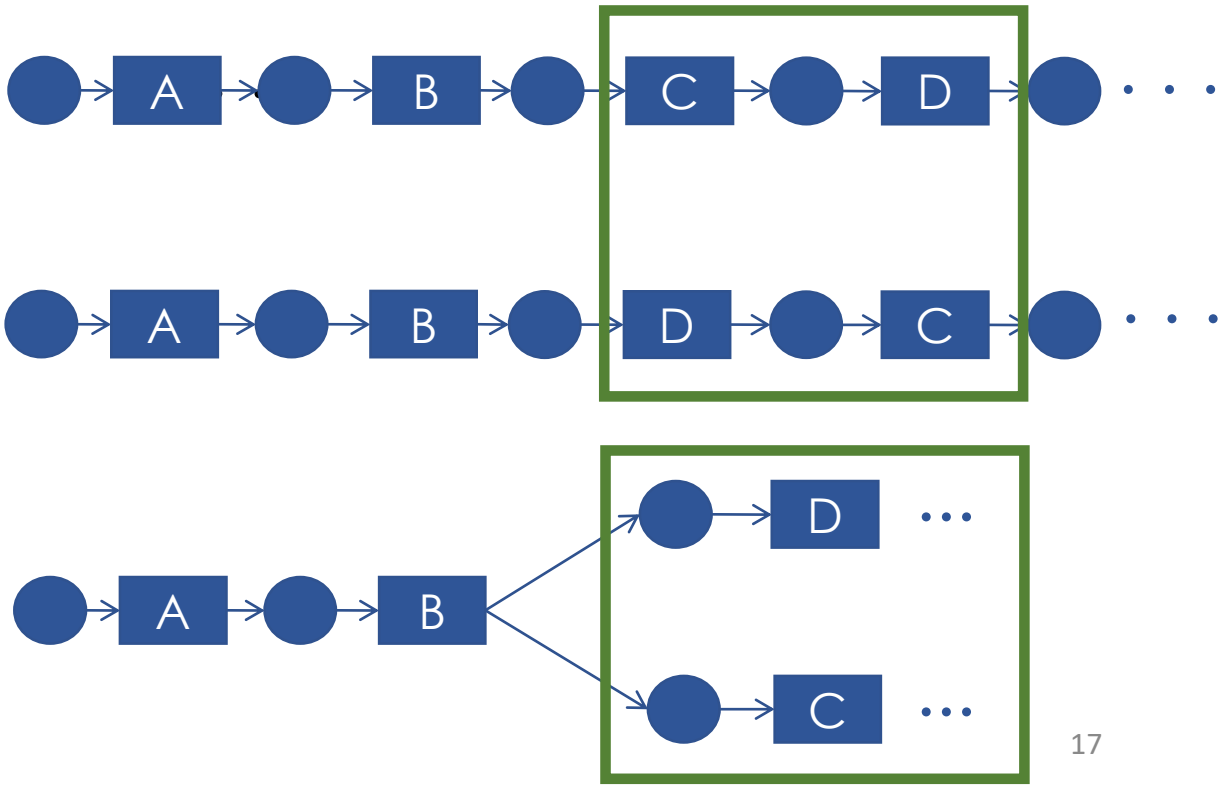
InstanceID	Activity	Timestamp
107	J	2015-02-13 21:22
111	C	2015-02-23 15:29
114	H	2015-02-14 15:17
117	D	2015-02-20 18:30
118	E	2015-02-24 22:28
145	D	2015-02-11 16:14
159	G	2015-02-12 17:20
163	H	2015-02-21 17:11
166	B	2015-02-21 20:14
170	F	2015-02-18 18:27
173	D	2015-02-13 23:57
188	F	2015-02-22 13:32
190	G	2015-02-26 16:47
194	D	2015-02-18 16:48
205	E	2015-02-25 16:36
216	J	2015-02-14 12:59
223	G	2015-02-27 21:52
243	H	2015-02-25 24:25
246	C	2015-02-28 21:12
249	G	2015-02-20 18:22
267	J	2015-02-12 16:14
268	F	2015-02-16 15:20
275	H	2015-02-25 23:11
289	G	2015-02-16 17:48
294	A	2015-02-24 16:37
299	B	2015-02-25 21:12
302	J	2015-02-19 20:35
308	D	2015-02-15 18:31
329	H	2015-02-20 17:59
329	C	2015-02-23 24:23
340	J	2015-02-21 15:16
341	D	2015-02-12 21:23

Traces:

case 1: A B C D E F

case 2: A B D C F I

case 3: A D E F G H J



α - Algorithm

1. Read a log
2. Get the set of tasks
3. **Infer the ordering relations**
4. Build the net based on inferred relations
5. Output the net

Example:α - Algorithm

Event log

```
instance 1 : task A
instance 2 : task A
instance 3 : task A
instance 3 : task B
instance 1 : task B
instance 1 : task C
instance 2 : task C
instance 4 : task A
instance 2 : task B
instance 2 : task D
instance 5 : task E
instance 4 : task C
instance 1 : task D
instance 3 : task C
instance 3 : task D
instance 4 : task B
instance 5 : task F
instance 4 : task D
```

- 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
- Choice: x#y iff not x>y and not y>x

```
trace1: A B C D
trace2: A C B D
trace3: A B C D
trace4: A C B D
trace5: E F
```

```
A>B
A>C
B>C
B>D
C>B
C>D
E>F
```

```
A→B
A→C
B→D
C→D
E→F
```

```
B||C
```

```
A#E
B#E
C#E
D#E
A#F
B#F
C#F
D#F
...
```

Reference: Workflow mining: A survey of issues and approaches (van der Aalst et al.)

Example:α - Algorithm

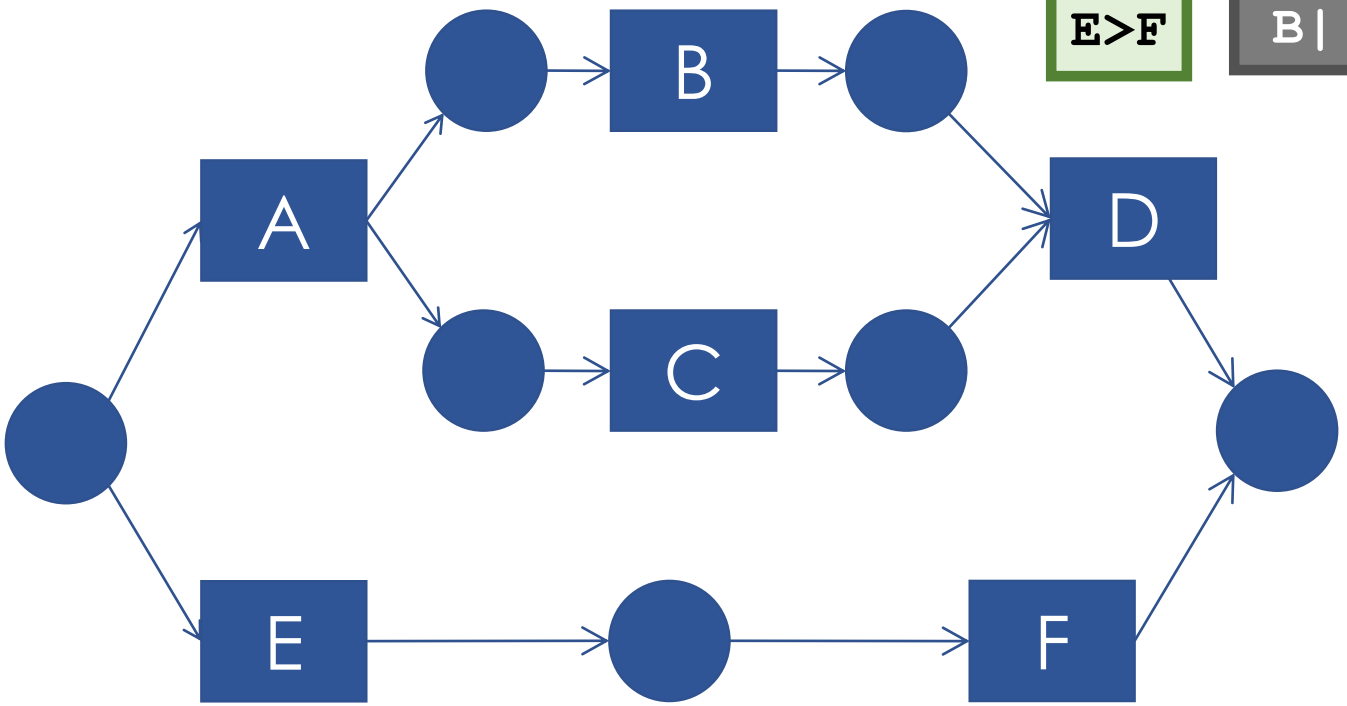
Trace1: A B C D
Trace2: A C B D
Trace3: A B C D
Trace4: A C B D
Trace5: E F

A>B
A>C
B>C
B>D
C>B
C>D
E>F

A→B
A→C
B→D
C→D
E→F

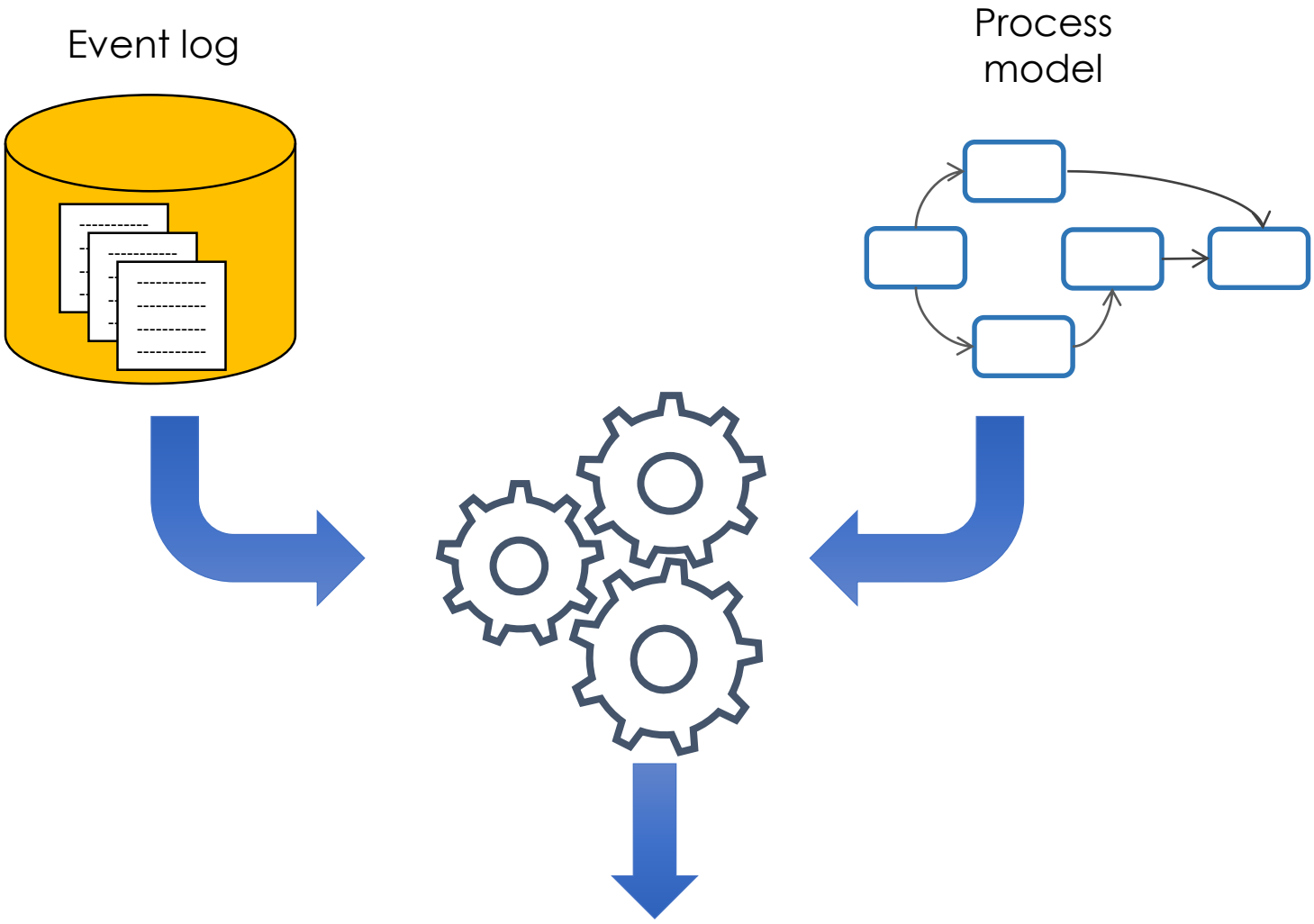
B||C

A#E
B#E
C#E
D#E
A#F
B#F
C#F
D#F



Conformance Checking

recall…

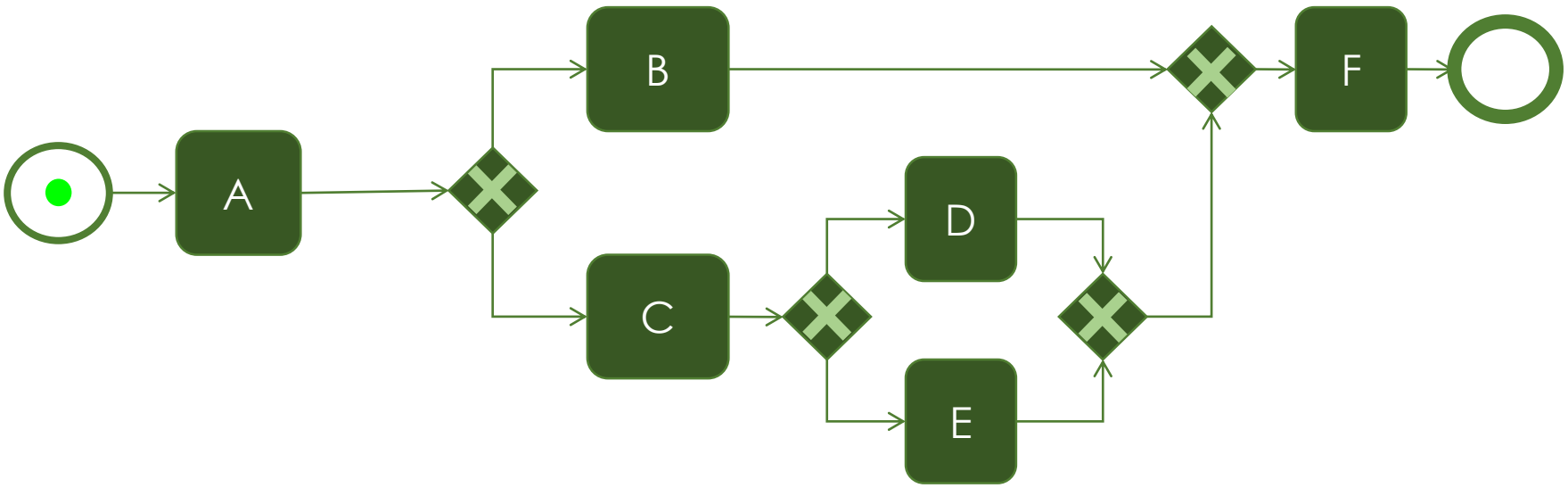

Event log
Process model
Conformant / Non conformant
to what extent?

Main idea of conformance checking

trace 1: A C D F

trace 2: A D F

Trace 3: A B D F



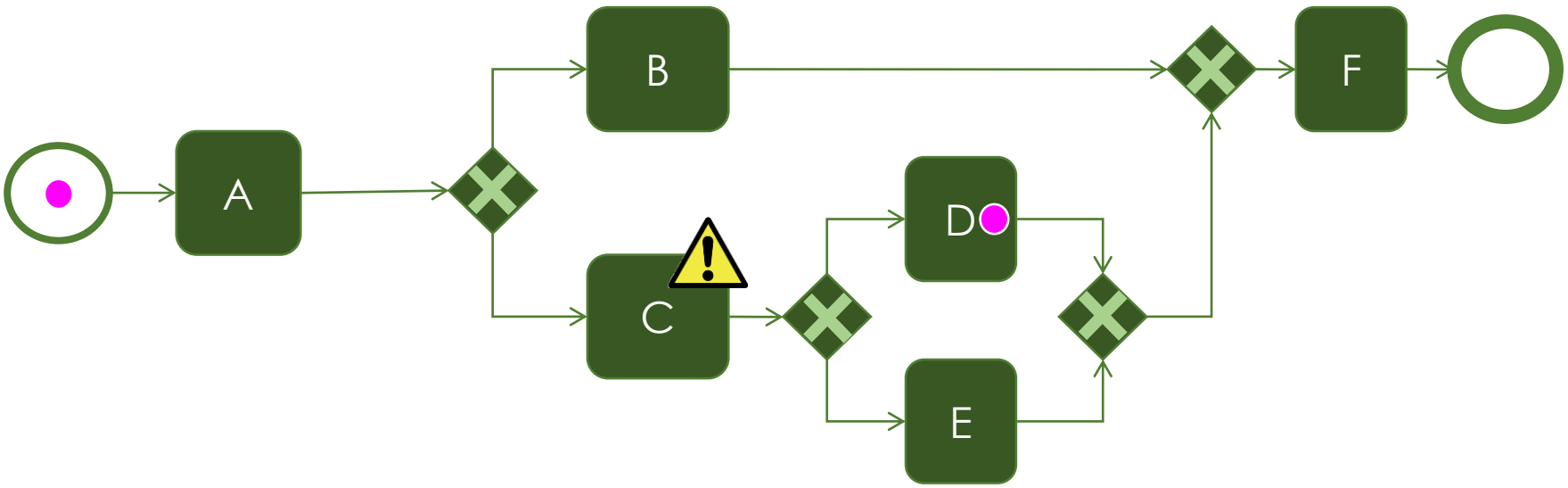
Reference: Conformance checking of processes based on monitoring real behavior (Ronizat et al., 2008)

Main idea of conformance checking

trace 1: A C D F

trace 2: A D F

Trace 3: A B D F

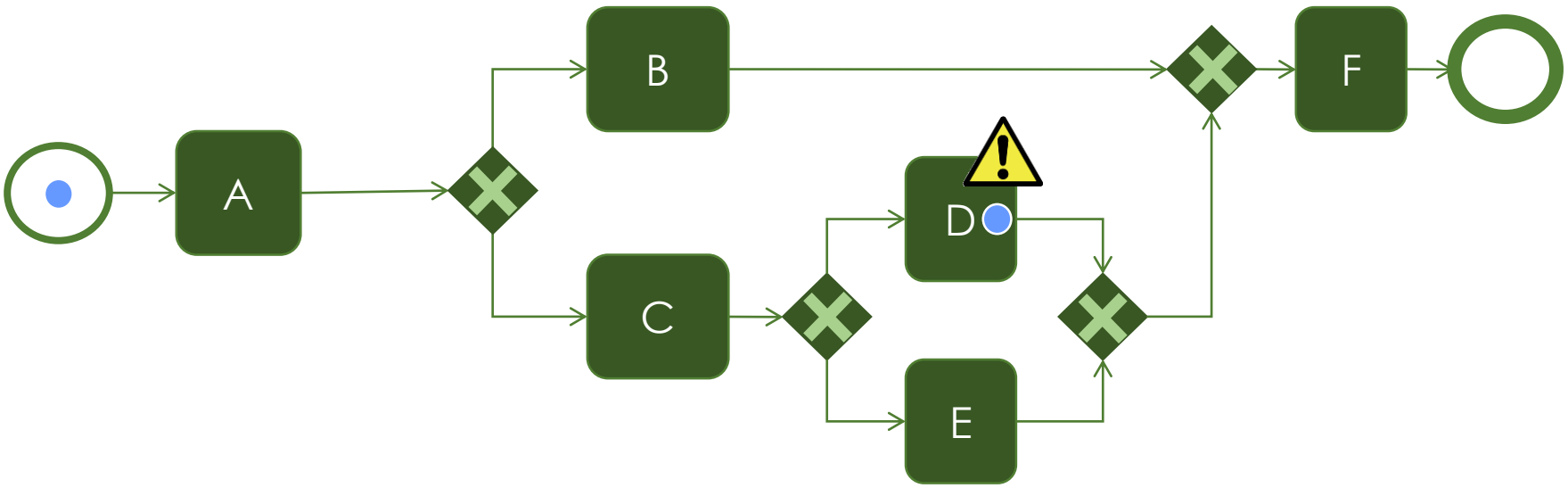


Main idea of conformance checking

trace 1: A C D F

trace 2: A D F

Trace 3: A B D F



Metrics for conformance checking

Fitness

How well is model able to replay the log?

Behavioral appropriateness (precision)

How much extra-behavior is allowed by the model?

Structural appropriateness

How many "unnecessary" redundant and invisible tasks are there in the model?

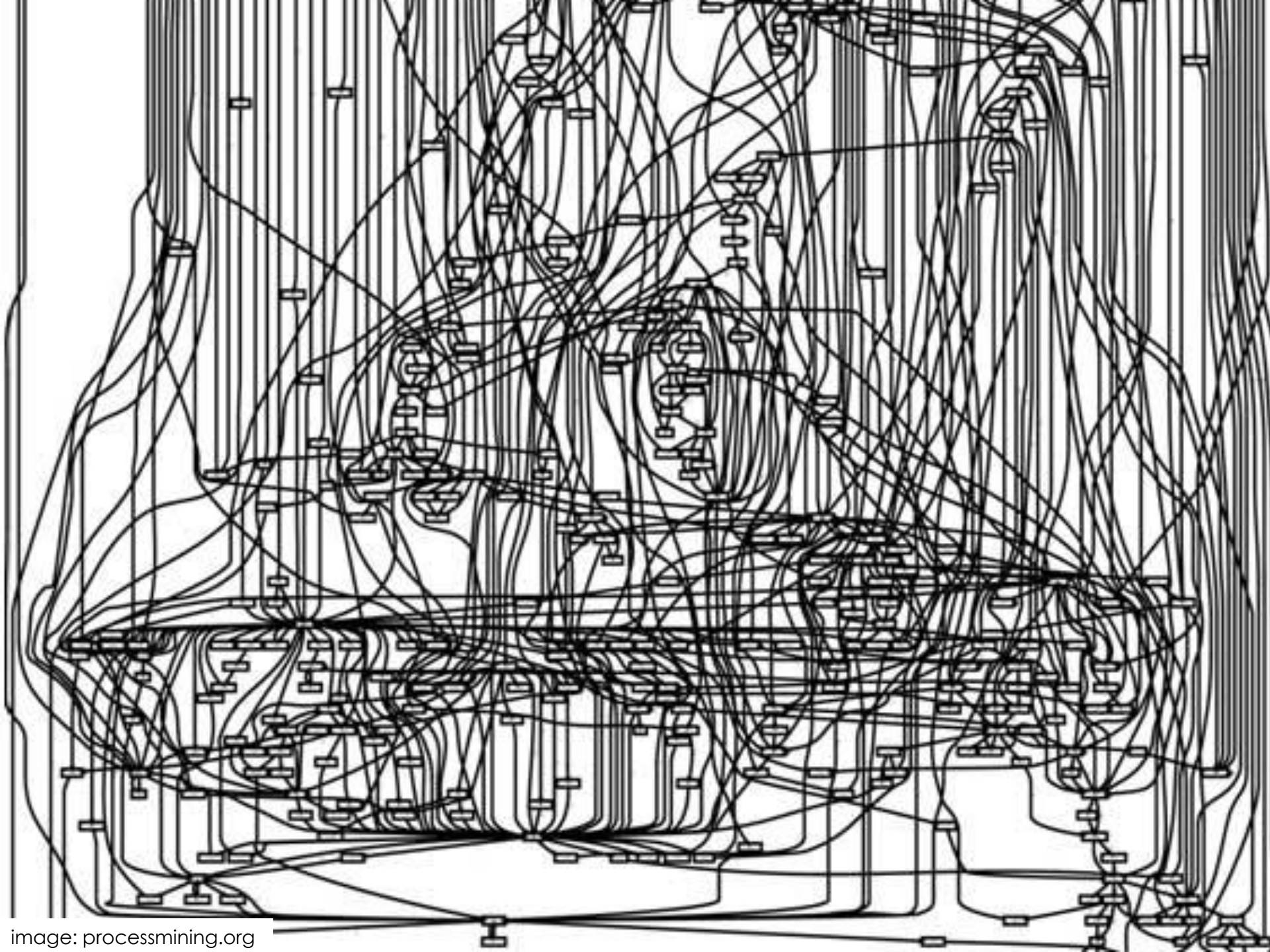


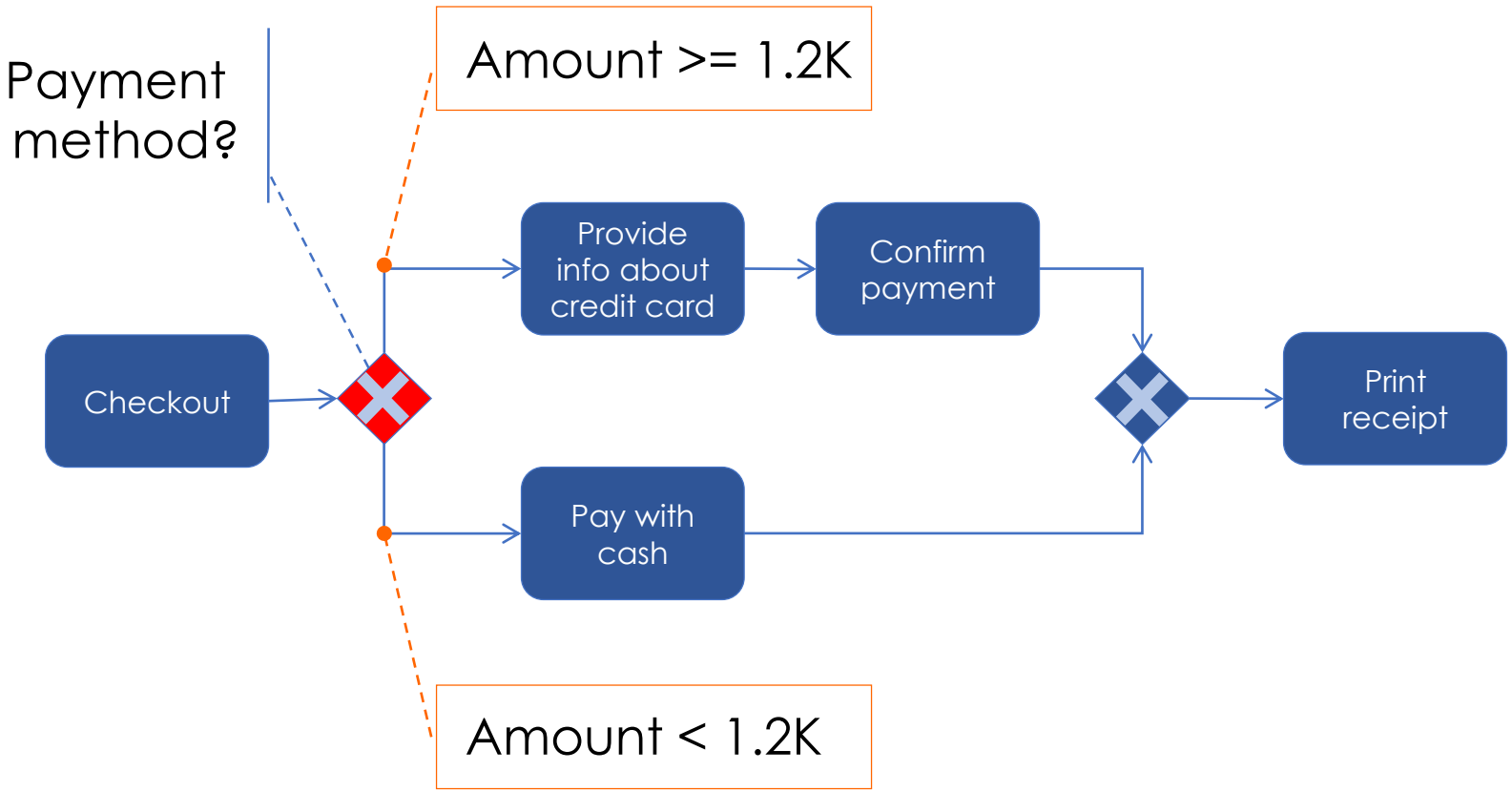
image: processmining.org

conformant? not conformant? so what?

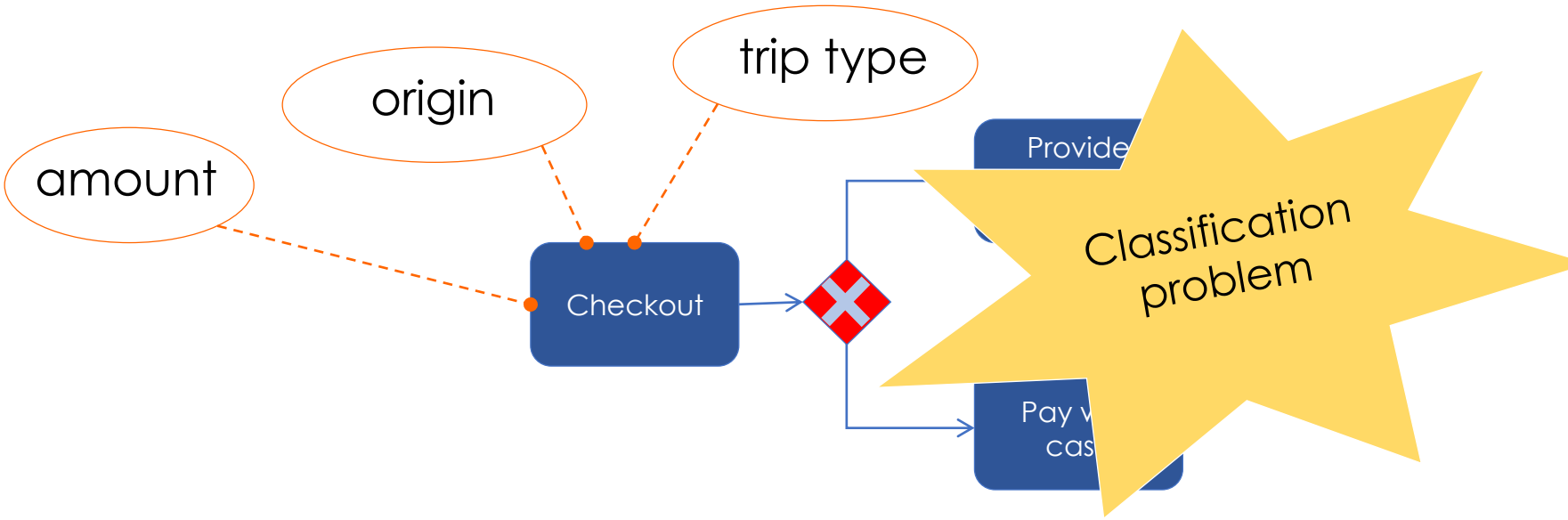
image: experienceswithlanguage.wordpress.com

Decision Point Mining

recall...


Payment method?
Amount >= 1.2K
Provide info about credit card
Confirm payment
Checkout
Print receipt
Pay with cash
Amount < 1.2K

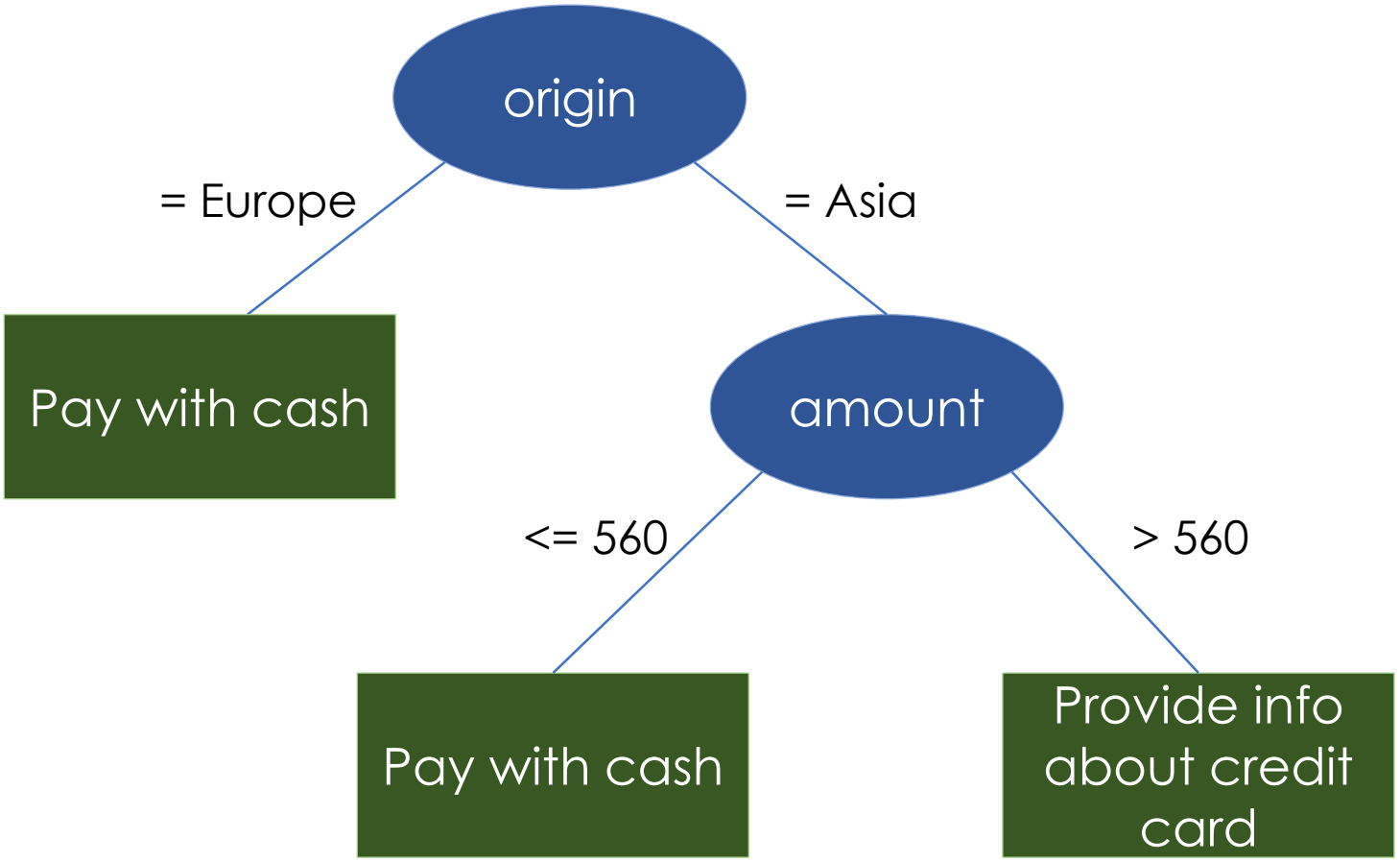
How does it work?



Case ID	amount	origin	trip type	branch
1	243	Europe	Leisure	Pay with cash
2	325	Europe	Business	Pay with cash
3	1021	Asia	Business	Provide info about credit card
4	560	Asia	Leisure	Pay with cash

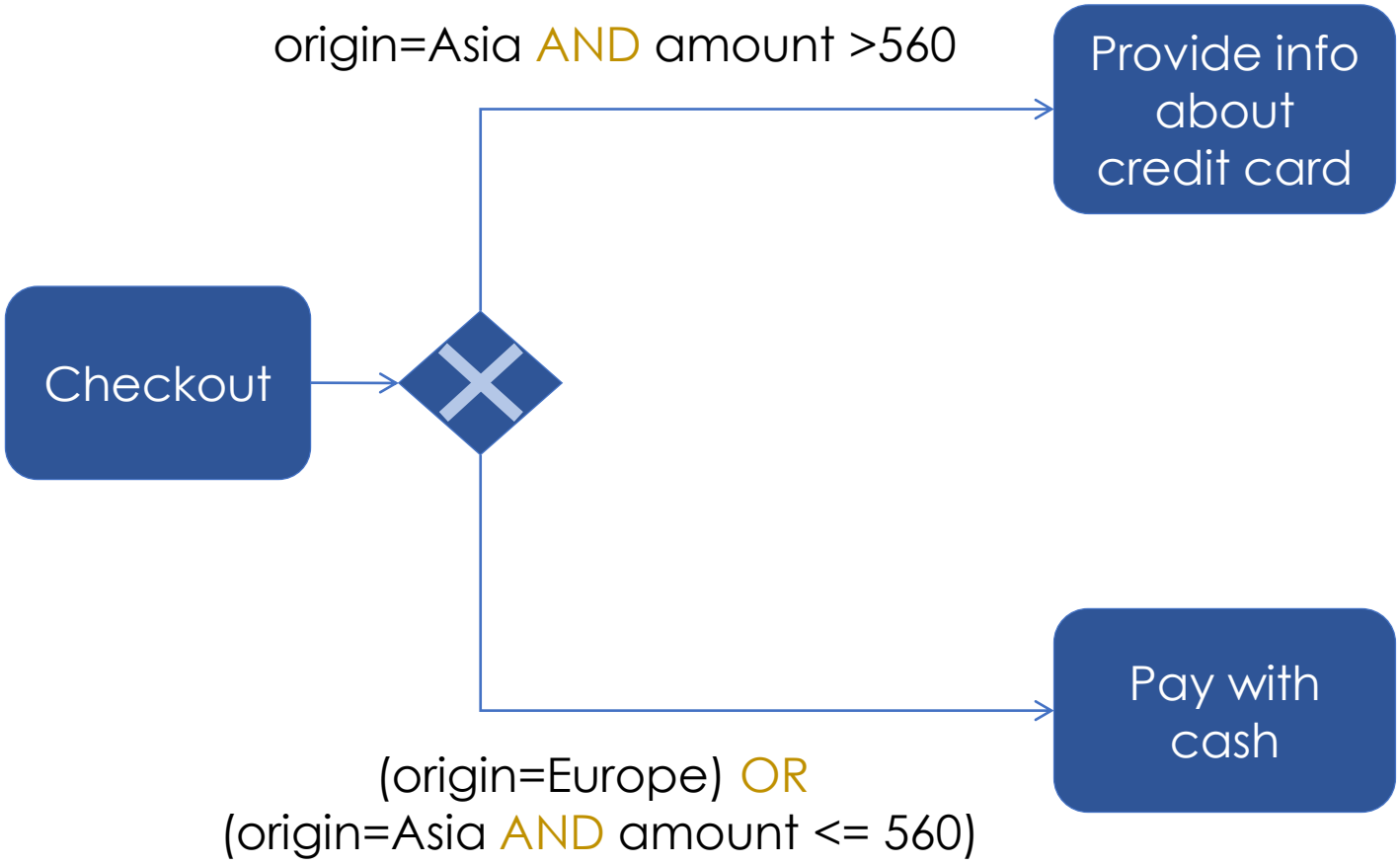
Reference: Decision mining in business process (Rozinat & van der Aalst, 2006)

Decision point mining with decision trees



Reference: Machine Learning (T. Mitchell, 1997)

Decision point mining with decision trees



Useful Tools

- ProM (opensource)
- Apromore (opensource)
- Celonis (Commercial but free for Education)

Questions?