# Resolving Inconsistencies and Redundancies in Declarative Process Models

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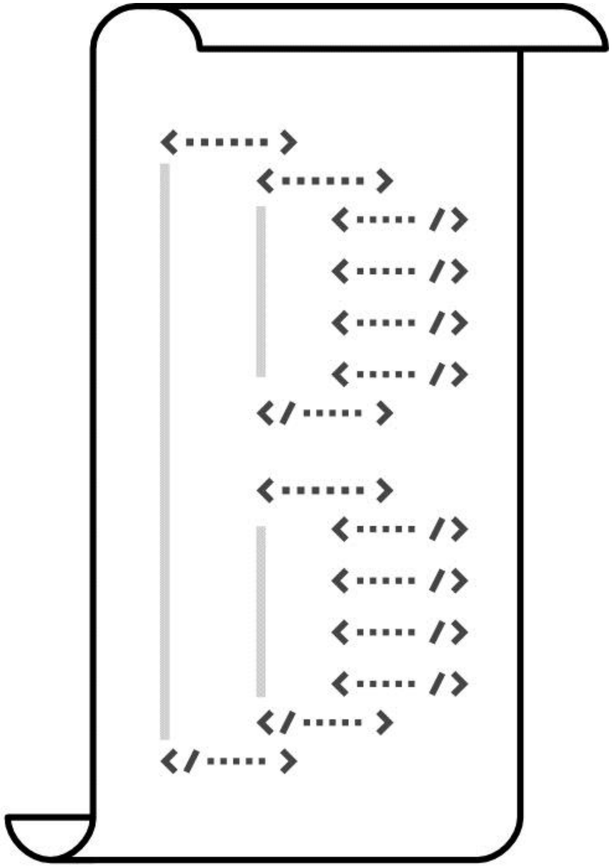
# Foreword

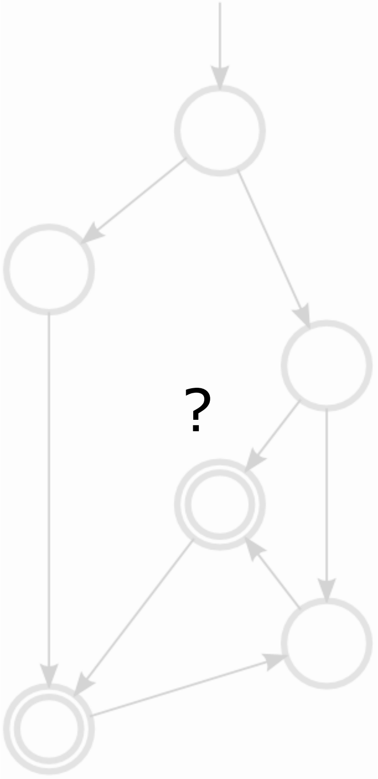
(Declarative) process discovery

Declarative constraints as automata

# Process discovery

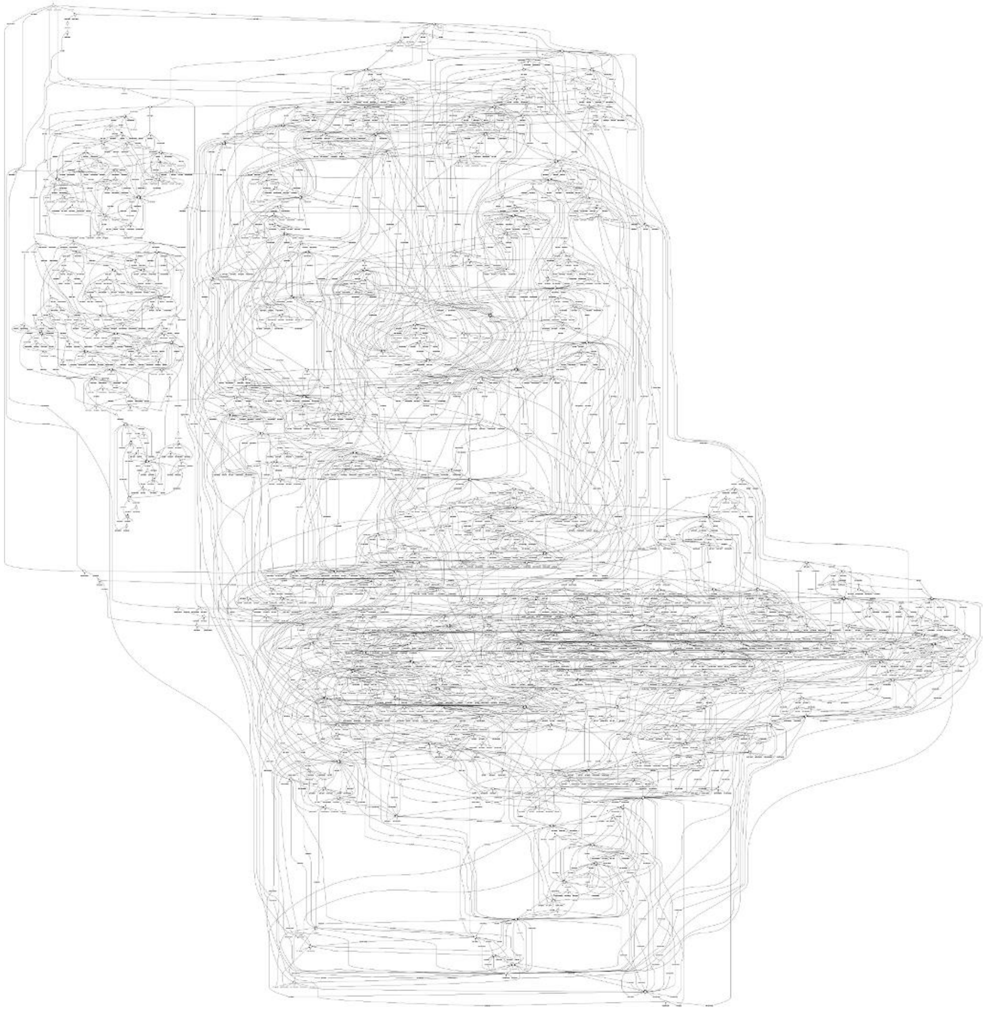


Event log

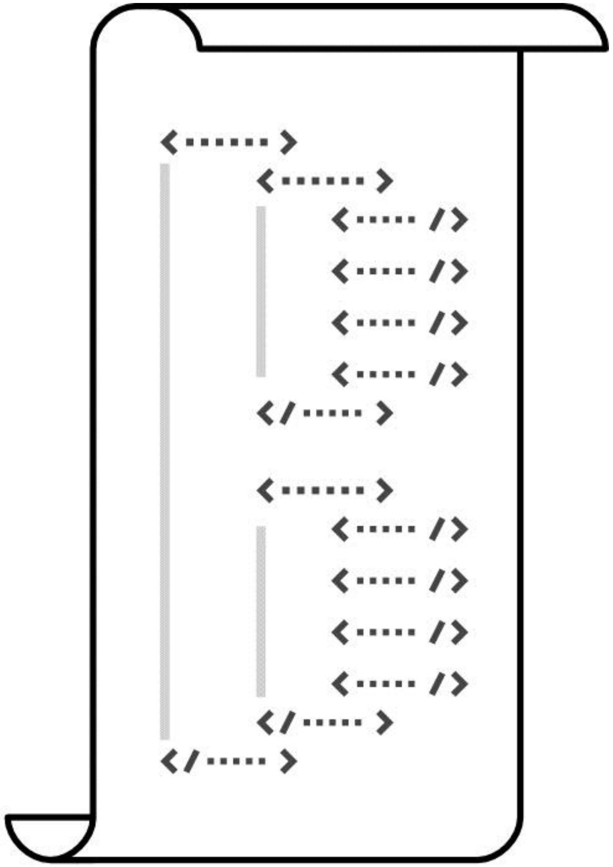


Process model

# Mining flexible processes



# Declarative process discovery



?

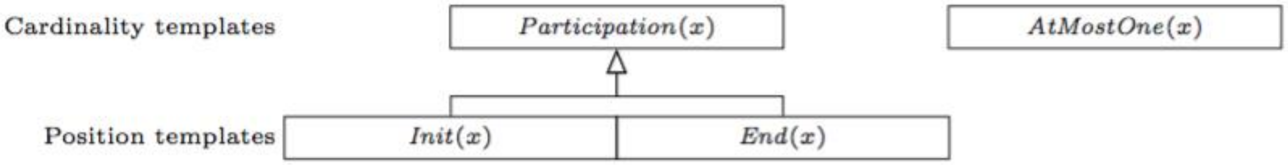
Objective: understanding the **constraints** that best **define the allowed behaviour** of the process behind the event log

# Declarative modelling of processes

- Usage of constraints
  - “Open model”
- Declare
  - state-of-the-art language

- Init(c)
  - c *is always* *<u>the first</u>* *executed activity*
- End(d)
  - d *is always* *<u>the last</u>* *executed activity*
- RespondedExistence(a,b)
  - *If* a *is executed,* b *has to be executed*
- Response(a,b)
  - *If* a *is executed,* b *has to be executed* *<u>afterwards</u>*
- ChainResponse(a,b)
  - *If* a *is executed,* b *has to be executed* *<u>immediately afterwards</u>*
- Precedence(a,b)
  - *If* b *is executed,* a *must have been executed* *<u>beforehand</u>*
- ChainPrecedence(a,b)
  - *If* b *is executed,* a *has to be executed* *<u>immediately beforehand</u>*
- NotChainSuccession(a,b)
  - *If* a *is executed,* b *<u>cannot</u>* *be executed* *<u>immediately afterwards</u>*

# Subsumption hierarchy of relation Declare templates



Cardinality templates

*Participation*(*x*)

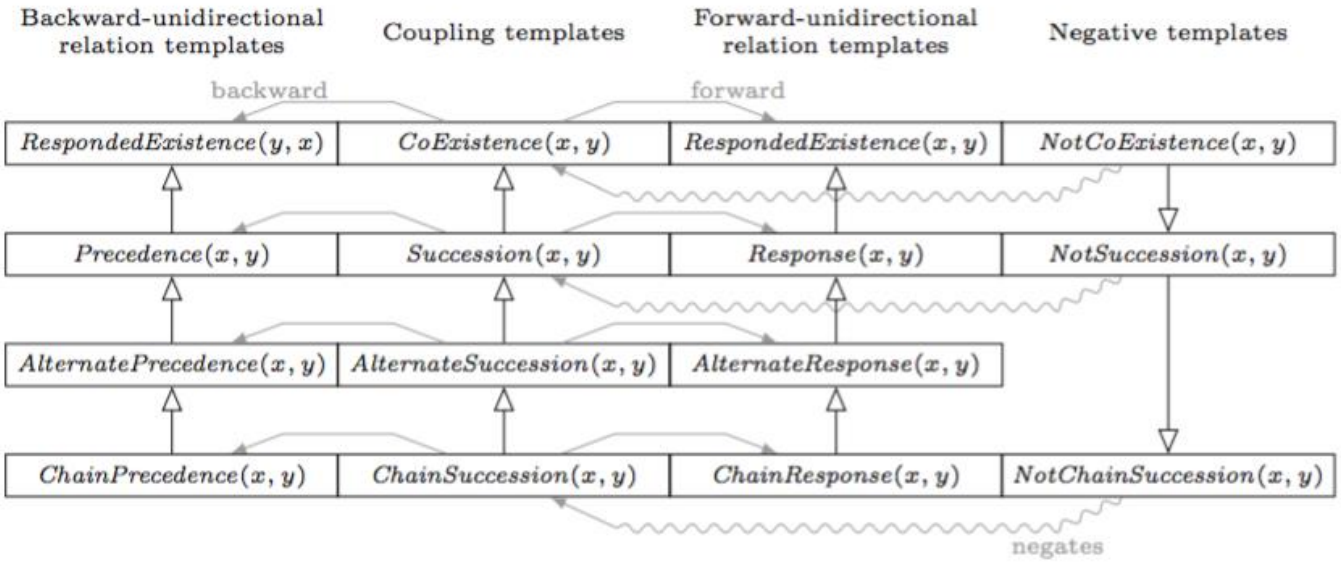
*AtMostOne*(*x*)

Position templates

*Init*(*x*)

*End*(*x*)

(a) Existence templates



Backward-unidirectional relation templates

Coupling templates

Forward-unidirectional relation templates

Negative templates

backward

forward

*RespondedExistence*(*y*, *x*)

*CoExistence*(*x*, *y*)

*RespondedExistence*(*x*, *y*)

*NotCoExistence*(*x*, *y*)

*Precedence*(*x*, *y*)

*Succession*(*x*, *y*)

*Response*(*x*, *y*)

*NotSuccession*(*x*, *y*)

*AlternatePrecedence*(*x*, *y*)

*AlternateSuccession*(*x*, *y*)

*AlternateResponse*(*x*, *y*)

*ChainPrecedence*(*x*, *y*)

*ChainSuccession*(*x*, *y*)

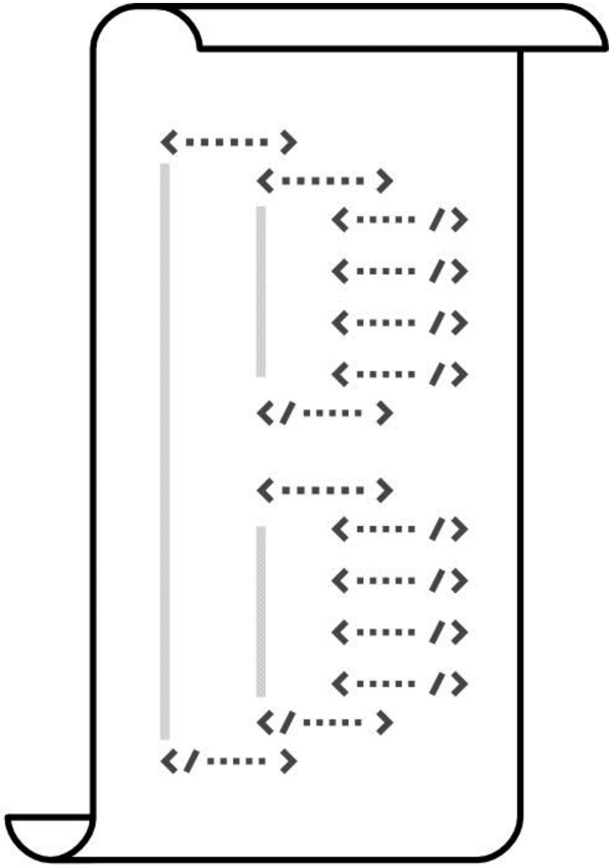
*ChainResponse*(*x*, *y*)

*NotChainSuccession*(*x*, *y*)

negates

(b) Relation templates

# Mining declarative processes: ingredients



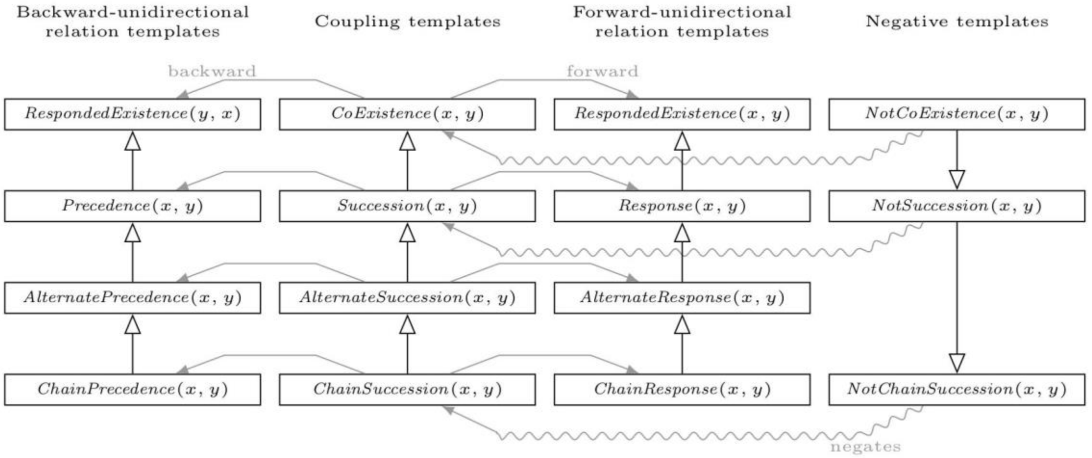
Event log

“Submit draft”,
“Write deliverable”,
“Organise agenda”,
…

Activities

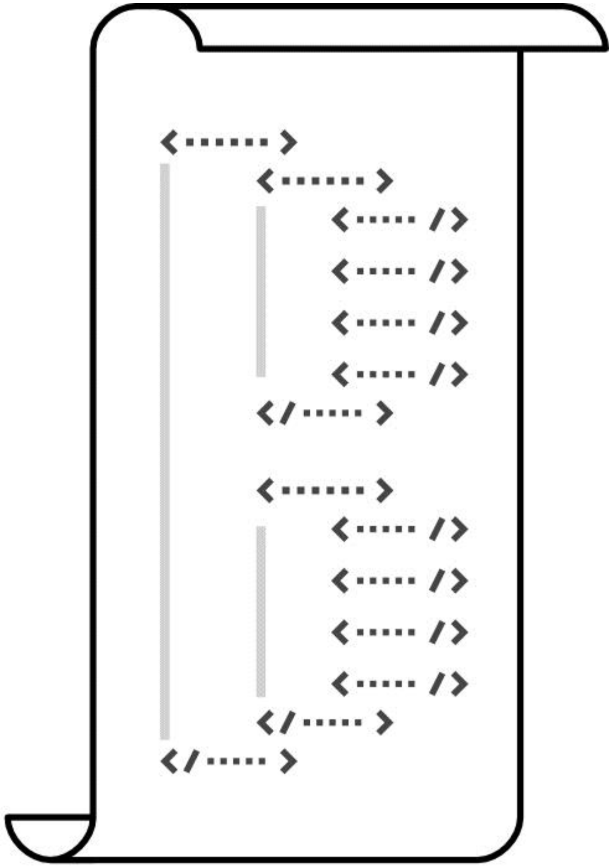
a,
b,
c,
…

Process alphabet



Declarative constraint templates

# Mining declarative processes



RespondedExistence(a,b) ?

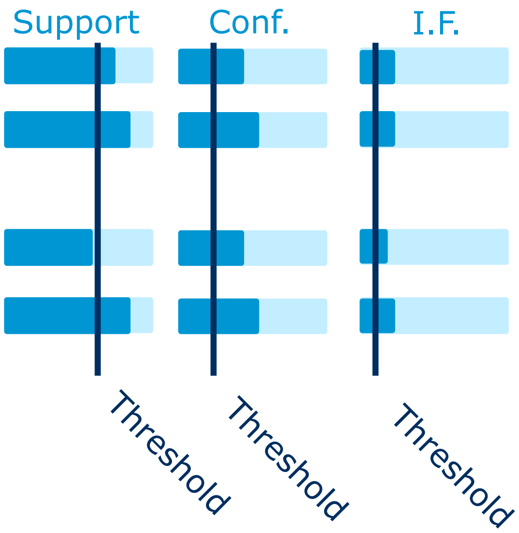
RespondedExistence(a,c) ?

…

Response(a,b) ?

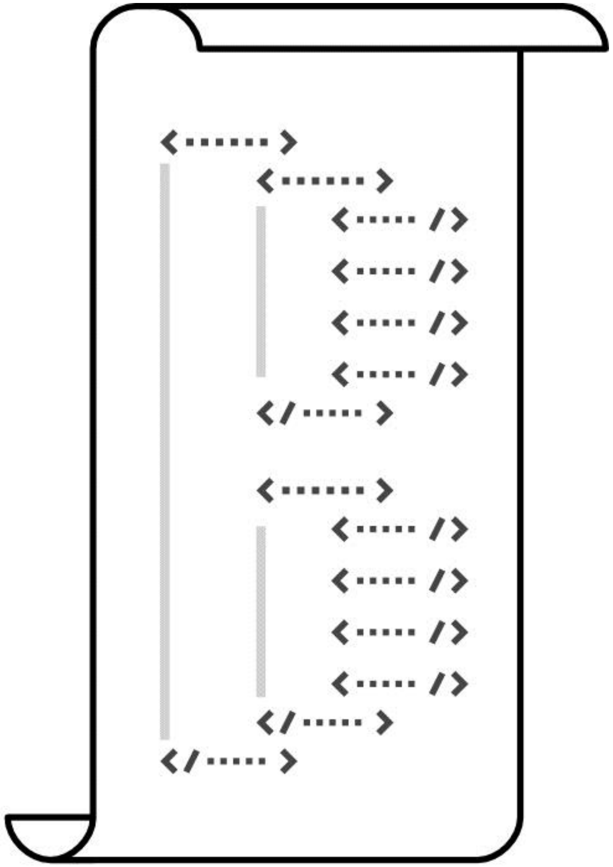
Response(a,c) ?

…



- Support:
  fraction of cases fulfilling the constraint
- Confidence:
  support scaled by fraction of traces in which the activation occurs
- Interest factor:
  confidence scaled by fraction of traces in which the target occurs

# Mining declarative processes



RespondedExistence(a,b) ?

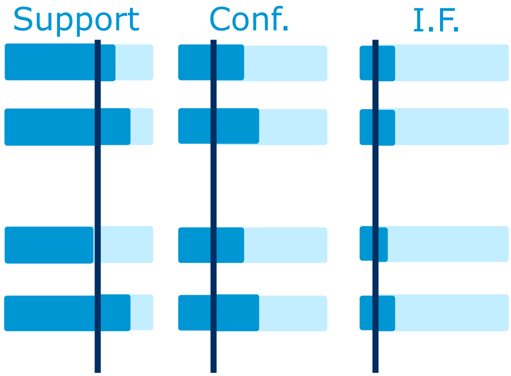
RespondedExistence(a,c) ?

…

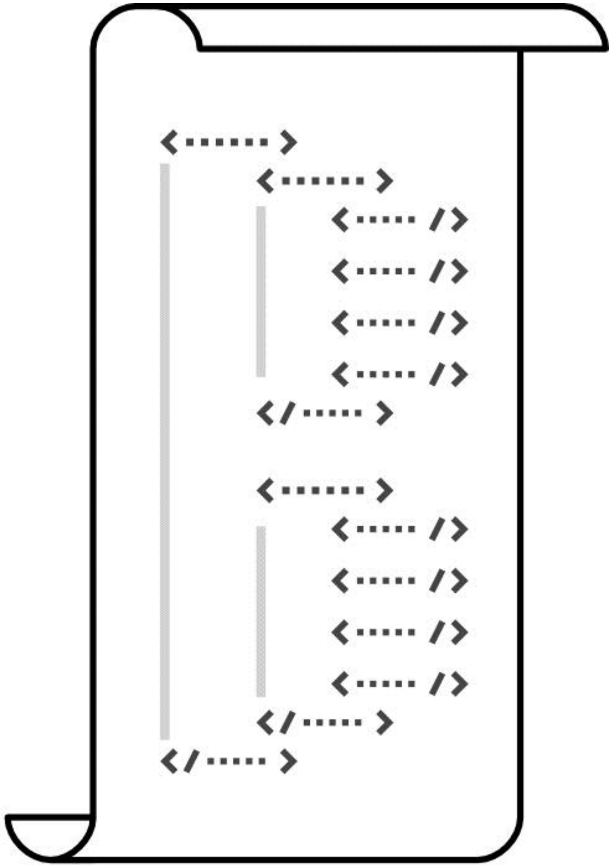
Response(a,b) ?

Response(a,c) ?

…



# Mining declarative processes



RespondedExistence(a,b) ☑

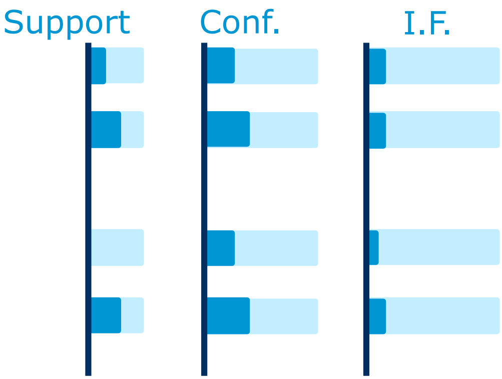
RespondedExistence(a,c) ?

…

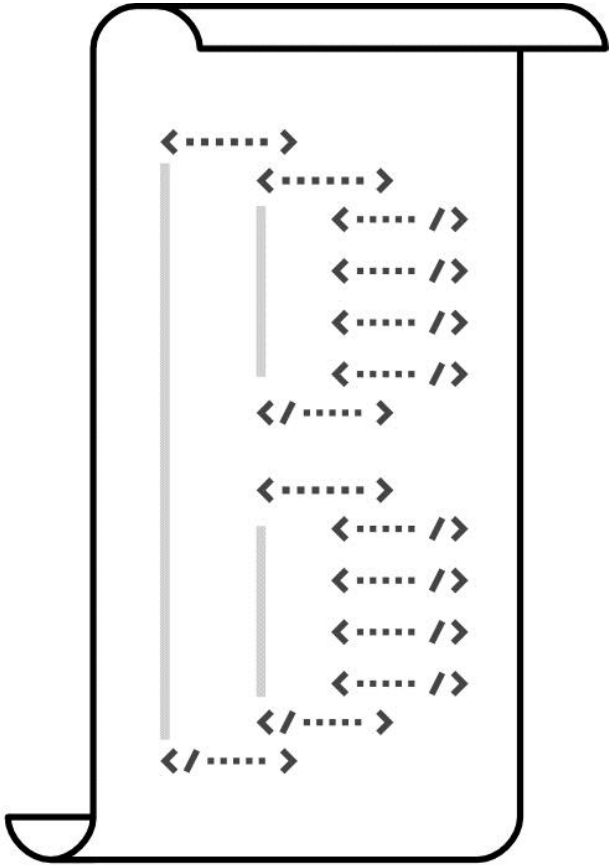
Response(a,b) ?

Response(a,c) ☑

…



# Mining declarative processes



RespondedExistence(a,b) ☑

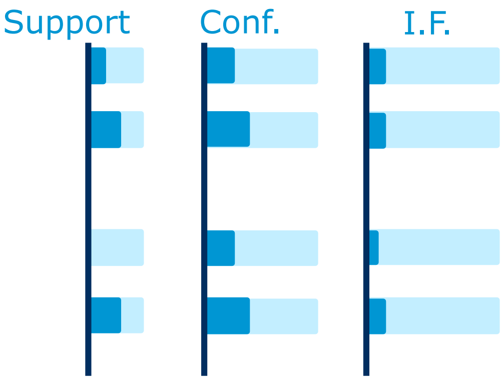
RespondedExistence(a,c) ?

…

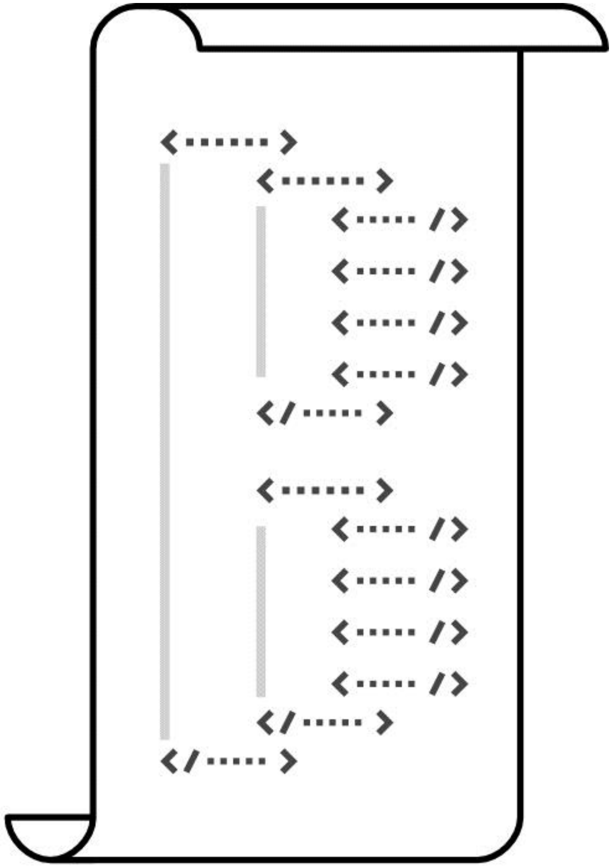
~~Response(a,b)~~ ☒

Response(a,c) ☑

…



# Mining declarative processes



RespondedExistence(a,b) ☑

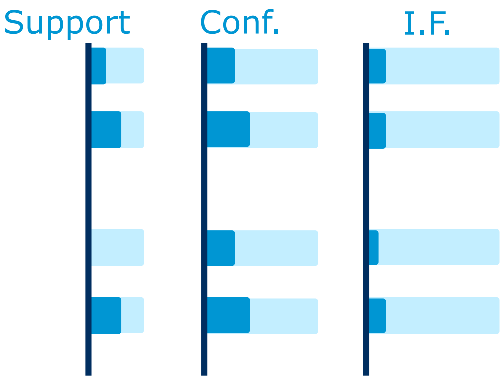
RespondedExistence(a,c) ?

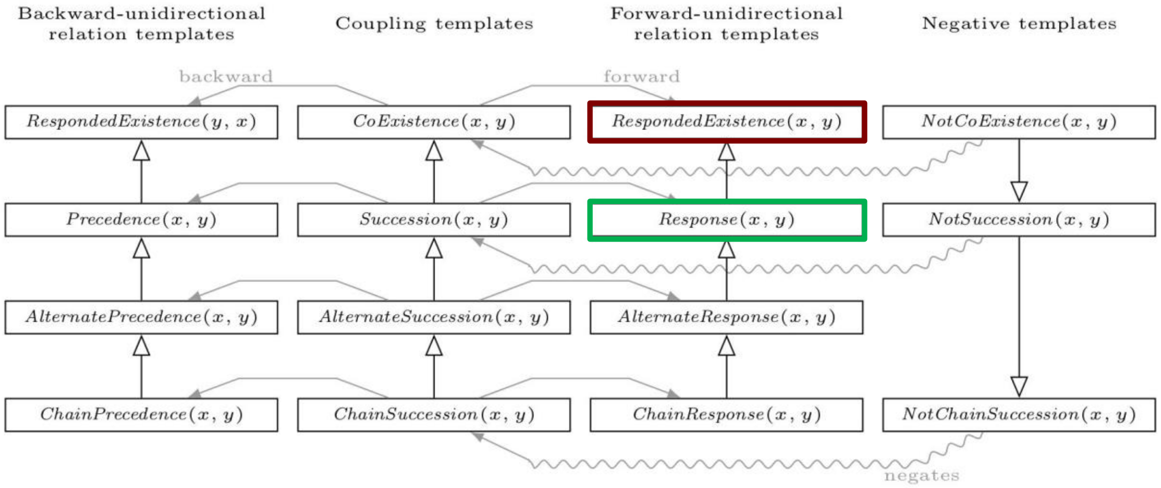
…

~~Response(a,b)~~ ☒

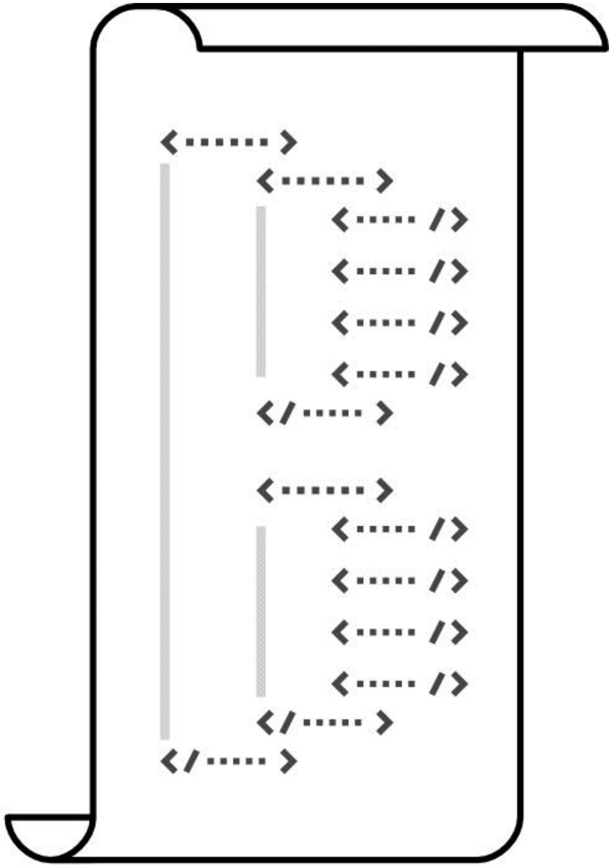
Response(a,c) ☑

…





# Mining declarative processes



RespondedExistence(a,b) ☑

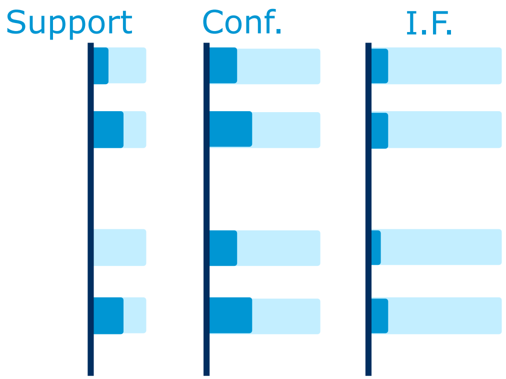
~~RespondedExistence(a,c)~~ ☒

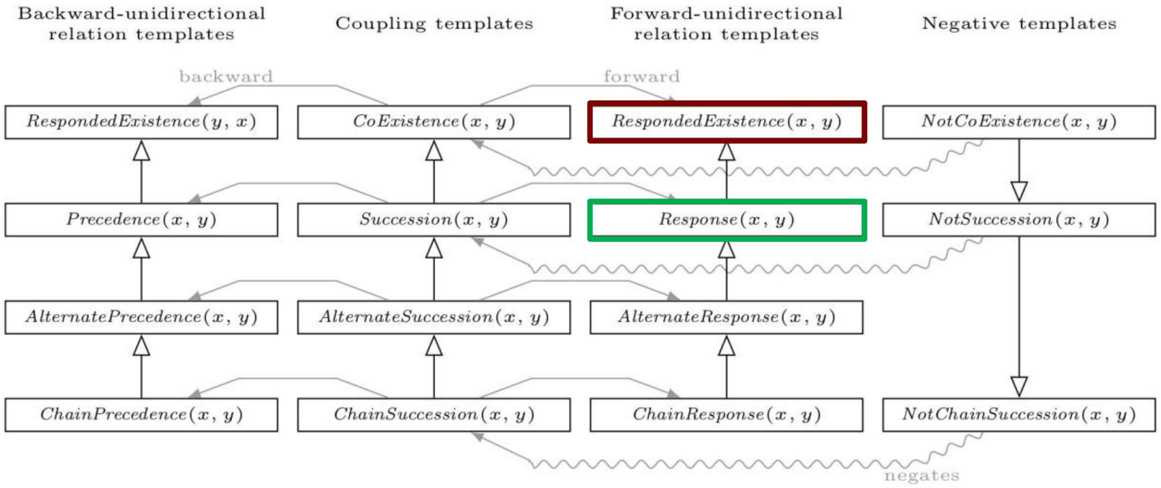
…

~~Response(a,b)~~ ☒

Response(a,c) ☑

…





# Mining declarative processes

RespondedExistence(a,b)

RespondedExistence(a,c) ☒

*and*

Response(a,b) ☒

Response(a,c)

*and*

…

# From constraints-based model to FSA

RespondedExistence(a,b)

RespondedExistence(a,c) ☒

*and*

Response(a,b) ☒

Response(a,c)

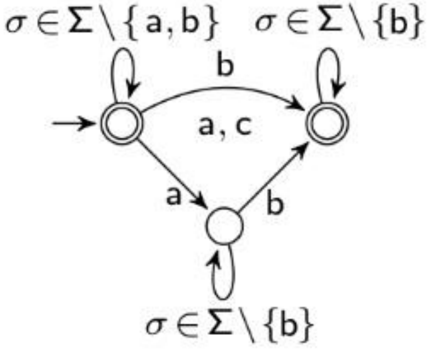
*and*

...

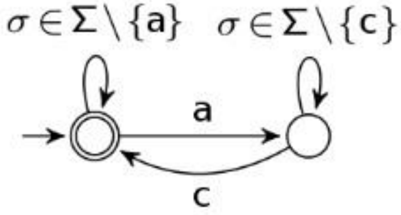
Regular Expression

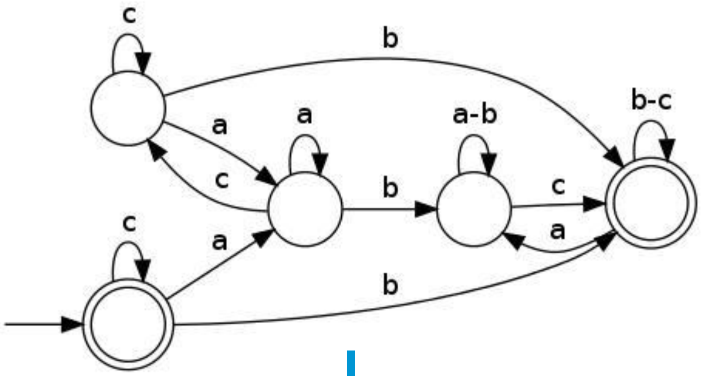
```
[^a]*((a.*b.*)|(b.*a.*))*[^a]*
```

```
[^a]*(a.*c)*[^a]*
```



×





Deterministic Finite State Automaton

# To be kept in mind

RespondedExistence(a,b)

RespondedExistence(a,c) ☒

*and*

Response(a,b) ☒

Response(a,c)

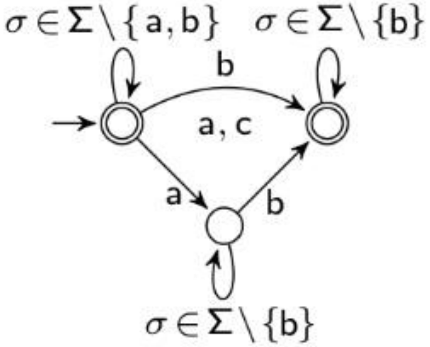
*and*

...

Regular Expression

`[^a]*((a.*b.*)|(b.*a.*))*[^a]*`

`[^a]*(a.*c)*[^a]*`



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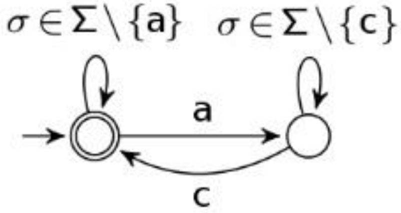
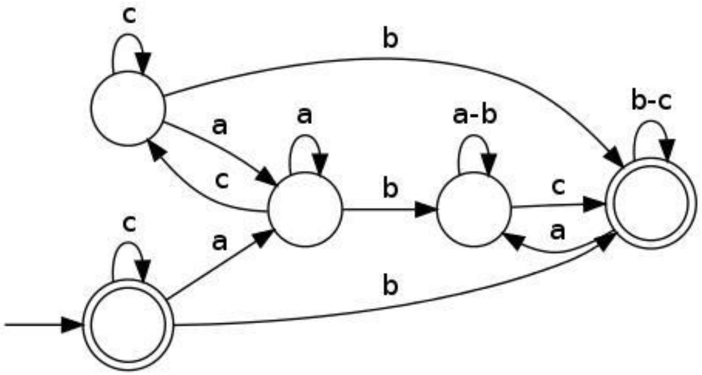


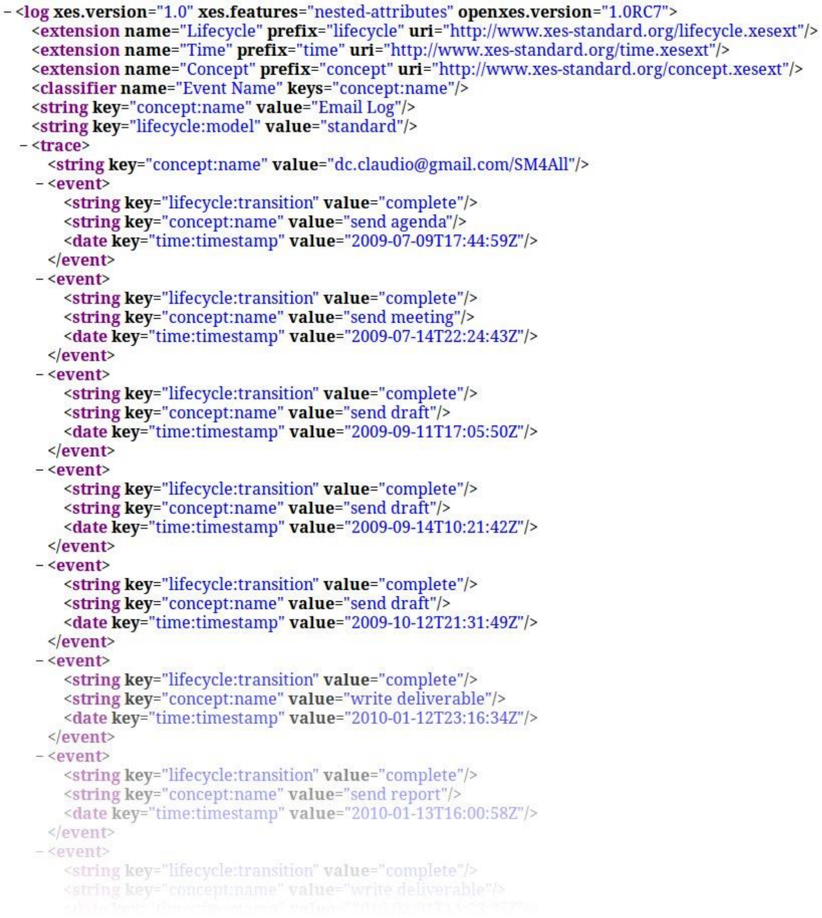


Deterministic Finite State Automaton

# So far, so good

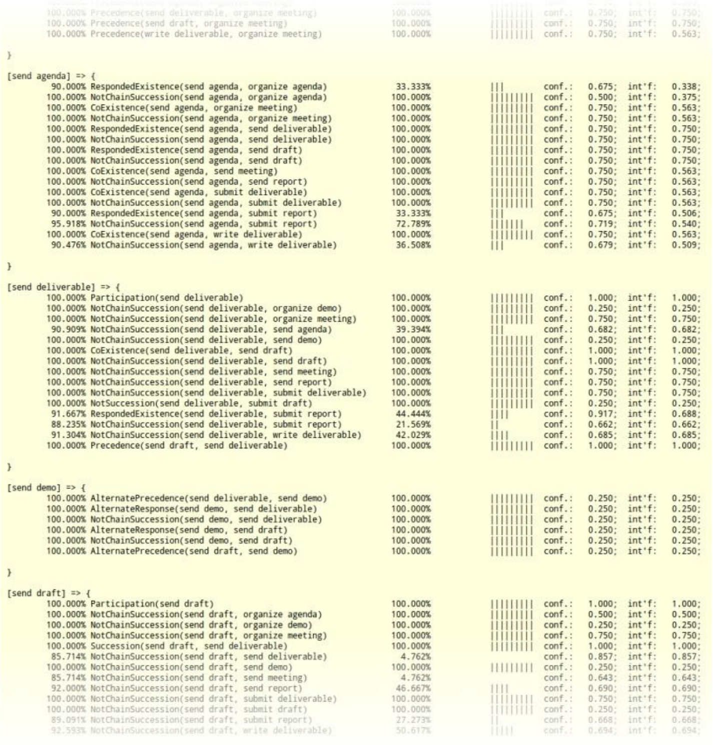
What is the problem?

# While mining a real-life log…



```
- <log xes.version="1.0" xes.features="nested-attributes" openxes.version="1.0RC7">
    <extension name="Lifecycle" prefix="lifecycle" uri="http://www.xes-standard.org/lifecycle.xesext"/>
    <extension name="Time" prefix="time" uri="http://www.xes-standard.org/time.xesext"/>
    <extension name="Concept" prefix="concept" uri="http://www.xes-standard.org/concept.xesext"/>
    <classifier name="Event Name" keys="concept:name"/>
    <string key="concept:name" value="Email Log"/>
    <string key="lifecycle:model" value="standard"/>
  - <trace>
      <string key="concept:name" value="dc.claudio@gmail.com/SM4All"/>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="send agenda"/>
        <date key="time:timestamp" value="2009-07-09T17:44:59Z"/>
      </event>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="send meeting"/>
        <date key="time:timestamp" value="2009-07-14T22:24:43Z"/>
      </event>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="send draft"/>
        <date key="time:timestamp" value="2009-09-11T17:05:50Z"/>
      </event>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="send draft"/>
        <date key="time:timestamp" value="2009-09-14T10:21:42Z"/>
      </event>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="send draft"/>
        <date key="time:timestamp" value="2009-10-12T21:31:49Z"/>
      </event>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="write deliverable"/>
        <date key="time:timestamp" value="2010-01-12T23:16:34Z"/>
      </event>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="send report"/>
        <date key="time:timestamp" value="2010-01-13T16:00:58Z"/>
      </event>
    - <event>
        <string key="lifecycle:transition" value="complete"/>
        <string key="concept:name" value="write deliverable"/>
        [illegible]
```

- Support threshold: 0.85
- Confidence threshold: 0.25
- Interest factor threshold: 0.25



```
        100.000% Precedence(send deliverable, organize meeting)          100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(send draft, organize meeting)                100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(write deliverable, organize meeting)         100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;

}

[send agenda] => {
         90.000% RespondedExistence(send agenda, organize agenda)         33.333%      |||        conf.:  0.675;  int'f:  0.338;
        100.000% NotChainSuccession(send agenda, organize agenda)        100.000%      |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send agenda, organize meeting)              100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, organize meeting)       100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send agenda, send deliverable)       100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send deliverable)       100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send agenda, send draft)             100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send draft)             100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(send agenda, send meeting)                  100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, send report)            100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send agenda, submit deliverable)            100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, submit deliverable)     100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;
         90.000% RespondedExistence(send agenda, submit report)           33.333%      |||        conf.:  0.675;  int'f:  0.506;
         95.918% NotChainSuccession(send agenda, submit report)           72.789%      |||||||    conf.:  0.719;  int'f:  0.540;
        100.000% CoExistence(send agenda, write deliverable)             100.000%      |||||||||  conf.:  0.750;  int'f:  0.563;
         90.476% NotChainSuccession(send agenda, write deliverable)       36.508%      |||        conf.:  0.679;  int'f:  0.509;

}

[send deliverable] => {
        100.000% Participation(send deliverable)                         100.000%      |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, organize demo)     100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send deliverable, organize meeting)  100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
         90.909% NotChainSuccession(send deliverable, send agenda)        39.394%      |||        conf.:  0.682;  int'f:  0.682;
        100.000% NotChainSuccession(send deliverable, send demo)         100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% CoExistence(send deliverable, send draft)               100.000%      |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send draft)        100.000%      |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send meeting)      100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, send report)       100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, submit deliverable) 100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotSuccession(send deliverable, submit draft)           100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
         91.667% RespondedExistence(send deliverable, submit report)      44.444%      ||||       conf.:  0.917;  int'f:  0.688;
         88.235% NotChainSuccession(send deliverable, submit report)      21.569%      ||         conf.:  0.662;  int'f:  0.662;
         91.304% NotChainSuccession(send deliverable, write deliverable)  42.029%      ||||       conf.:  0.685;  int'f:  0.685;
        100.000% Precedence(send draft, send deliverable)                100.000%      |||||||||  conf.:  1.000;  int'f:  1.000;

}

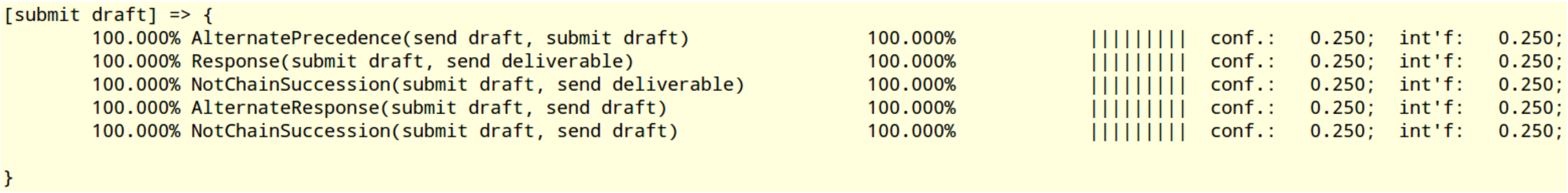
[send demo] => {
        100.000% AlternatePrecedence(send deliverable, send demo)        100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send deliverable)          100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send deliverable)         100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send draft)                100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send draft)               100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, send demo)              100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;

}

[send draft] => {
        100.000% Participation(send draft)                               100.000%      |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send draft, organize agenda)         100.000%      |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(send draft, organize demo)           100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send draft, organize meeting)        100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Succession(send draft, send deliverable)                100.000%      |||||||||  conf.:  1.000;  int'f:  1.000;
         85.714% NotChainSuccession(send draft, send deliverable)          4.762%                 conf.:  0.857;  int'f:  0.857;
        100.000% NotChainSuccession(send draft, send demo)               100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
         85.714% NotChainSuccession(send draft, send meeting)              4.762%                 conf.:  0.643;  int'f:  0.643;
         92.000% NotChainSuccession(send draft, send report)              46.667%      ||||       conf.:  0.690;  int'f:  0.690;
        100.000% NotChainSuccession(send draft, submit deliverable)      100.000%      |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send draft, submit draft)            100.000%      |||||||||  conf.:  0.250;  int'f:  0.250;
         89.091% NotChainSuccession(send draft, submit report)            27.273%      ||         conf.:  0.668;  int'f:  0.668;
         92.593% NotChainSuccession(send draft, write deliverable)        50.617%      |||||      conf.:  0.694;  int'f:  0.694;

}
```

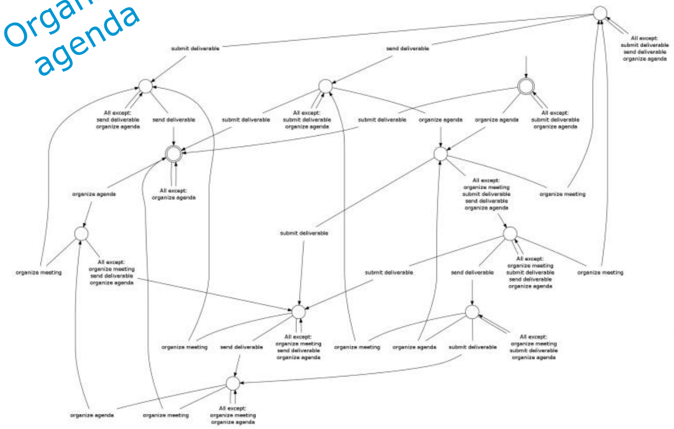
# While mining a real-life log…



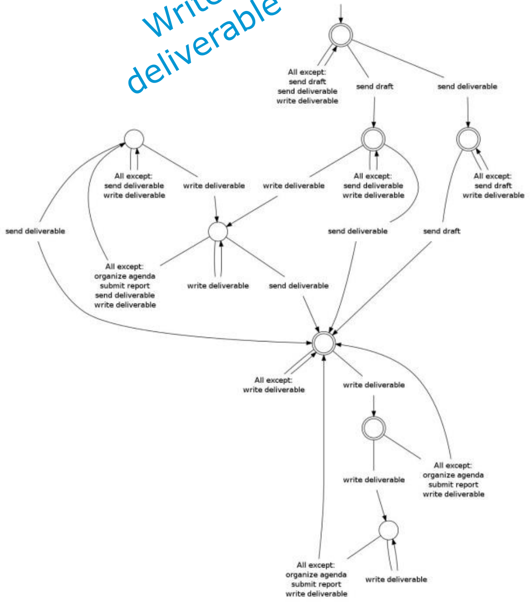
```
[submit draft] => {
        100.000% AlternatePrecedence(send draft, submit draft)           100.000%          |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% Response(submit draft, send deliverable)                100.000%          |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% NotChainSuccession(submit draft, send deliverable)      100.000%          |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% AlternateResponse(submit draft, send draft)             100.000%          |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% NotChainSuccession(submit draft, send draft)            100.000%          |||||||||  conf.:   0.250;  int'f:   0.250;

}
```

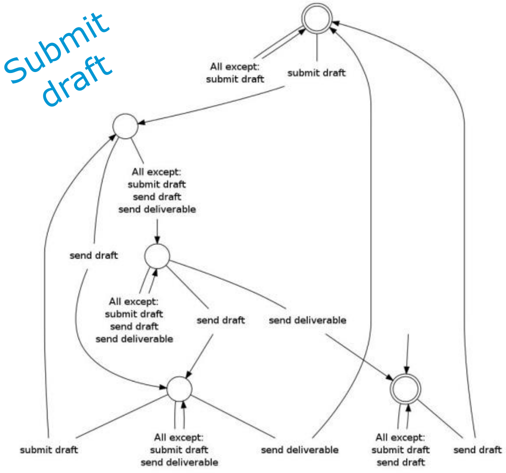
Organise agenda



Write deliverable



Submit draft

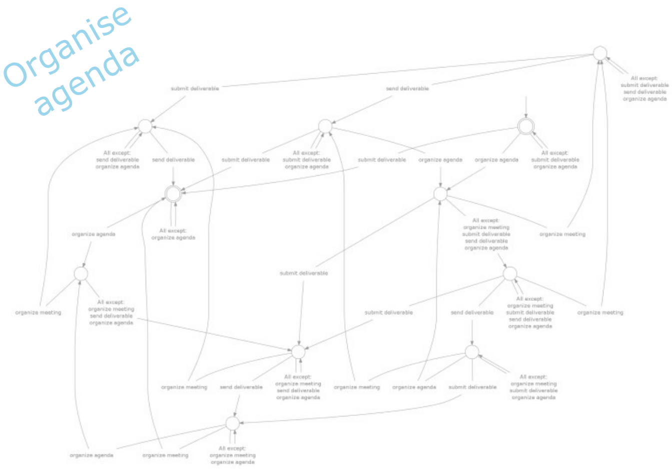


# Time to challenge the X

WIRTSCHAFTS UNIVERSITÄT WIEN VIENNA UNIVERSITY OF ECONOMICS AND BUSINESS

```
[submit draft] => {
        100.000% AlternatePrecedence(send draft, submit draft)            100.000%            |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% Response(submit draft, send deliverable)                 100.000%            |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% NotChainSuccession(submit draft, send deliverable)       100.000%            |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% AlternateResponse(submit draft, send draft)              100.000%            |||||||||  conf.:   0.250;  int'f:   0.250;
        100.000% NotChainSuccession(submit draft, send draft)             100.000%            |||||||||  conf.:   0.250;  int'f:   0.250;

}
```


Organise agenda
submit deliverable
send deliverable
All except: submit deliverable send deliverable organize agenda
All except: send deliverable organize agenda
send deliverable
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All except: submit deliverable organize agenda
submit deliverable
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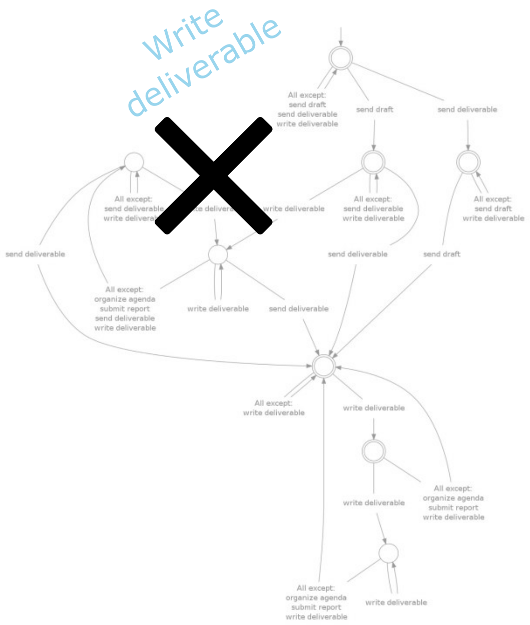
Write deliverable
All except: send draft send deliverable write deliverable
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All except: send deliverable write deliverable
All except: send draft write deliverable
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All except: organize agenda submit report send deliverable write deliverable
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All except: write deliverable
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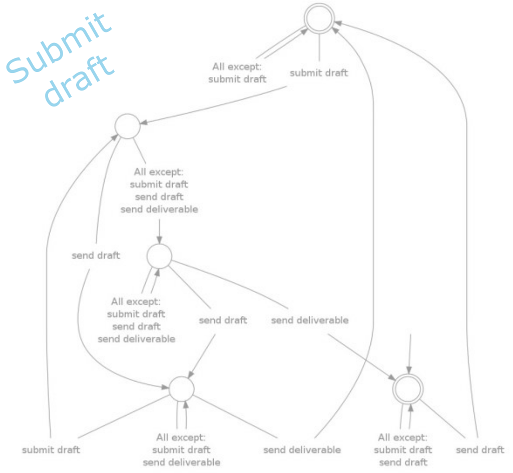
All except: organize agenda submit report write deliverable
write deliverable
All except: organize agenda submit report write deliverable
write deliverable


Submit draft
All except: submit draft
submit draft
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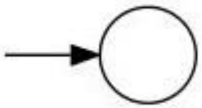
send draft
All except: submit draft send draft send deliverable
send draft
send deliverable
submit draft
All except: submit draft send deliverable
send deliverable
All except: submit draft send draft
send draft

EFMD EQUIS

# Time to challenge the X

Loading…

# The result



# The problems
# 1) inconsistency

- When support threshold is lower than 100%,
  constraints can be valid through most of the log, though being in conflict
- Example: an event log consists of two traces:
  1. <a, b, a, b, a, b, c>
  2. <a, b, a, b, a, c>
- Support threshold: 0.7
  - a is always the first
    ⇒ Init(a)
  - c is always the last
    ⇒ End(c)
  - In 6 cases over 8 (75%), a and c do not directly follow each other
    ⇒ NotChainSuccession(a,c)
  - In 5 cases over 7 (71.143%), b and c do not directly follow each other
    ⇒ NotChainSuccession(b,c)

# The problems
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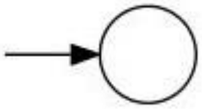


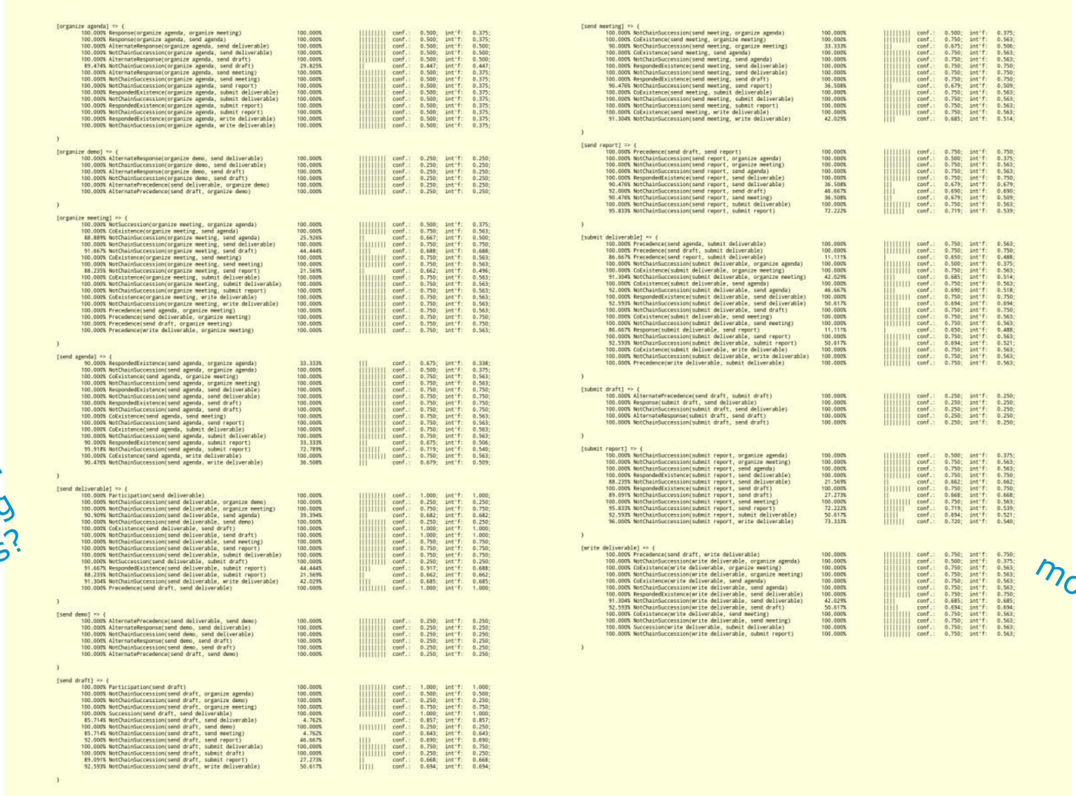
- Question: what can be done right before c?
  ⇒ inconsistency!

# The problems
# 1) inconsistency

- When support threshold is lower than 100%,
  constraints can be valid through most of the log, though being in conflict
- How to trust a discovery algorithm that can return inconsistent models?

Which constraints conflict?

From where should we start?



```
[organize agenda] => {
        100.000% Response(organize agenda, organize meeting)                      100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% Response(organize agenda, send agenda)                           100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% AlternateResponse(organize agenda, send deliverable)             100.000%    |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(organize agenda, send deliverable)            100.000%    |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% AlternateResponse(organize agenda, send draft)                   100.000%    |||||||||  conf.:  0.500;  int'f:  0.500;
         89.474% NotChainSuccession(organize agenda, send draft)                   29.825%    ||         conf.:  0.447;  int'f:  0.447;
        100.000% AlternateResponse(organize agenda, send meeting)                 100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, send meeting)                100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, send report)                 100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, submit deliverable)          100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, submit deliverable)          100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, submit report)               100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, submit report)               100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, write deliverable)           100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, write deliverable)           100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;

}

[organize demo] => {
        100.000% AlternateResponse(organize demo, send deliverable)               100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(organize demo, send deliverable)              100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(organize demo, send draft)                     100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(organize demo, send draft)                    100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send deliverable, organize demo)             100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, organize demo)                   100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;

}

[organize meeting] => {
        100.000% NotSuccession(organize meeting, organize agenda)                 100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(organize meeting, send agenda)                       100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         88.889% NotChainSuccession(organize meeting, send agenda)                 25.926%    ||         conf.:  0.667;  int'f:  0.500;
        100.000% NotChainSuccession(organize meeting, send deliverable)           100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         91.667% NotChainSuccession(organize meeting, send draft)                  44.444%    ||||       conf.:  0.688;  int'f:  0.688;
        100.000% CoExistence(organize meeting, send meeting)                      100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, send meeting)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         88.235% NotChainSuccession(organize meeting, send report)                 21.569%    ||         conf.:  0.662;  int'f:  0.496;
        100.000% CoExistence(organize meeting, submit deliverable)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit deliverable)         100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit report)              100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(organize meeting, write deliverable)                 100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, write deliverable)          100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send agenda, organize meeting)                        100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send deliverable, organize meeting)                   100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(send draft, organize meeting)                         100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(write deliverable, organize meeting)                  100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;

}

[send agenda] => {
         90.000% RespondedExistence(send agenda, organize agenda)                  33.333%    |||        conf.:  0.675;  int'f:  0.338;
        100.000% NotChainSuccession(send agenda, organize agenda)                 100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send agenda, organize meeting)                       100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, organize meeting)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send agenda, send deliverable)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send deliverable)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send agenda, send draft)                      100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send draft)                      100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(send agenda, send meeting)                           100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, send report)                     100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send agenda, submit deliverable)                     100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, submit deliverable)              100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         90.000% RespondedExistence(send agenda, submit report)                    33.333%    |||        conf.:  0.675;  int'f:  0.506;
         95.918% NotChainSuccession(send agenda, submit report)                    72.789%    |||||||    conf.:  0.719;  int'f:  0.540;
        100.000% CoExistence(send agenda, write deliverable)                      100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         90.476% NotChainSuccession(send agenda, write deliverable)                36.508%    |||        conf.:  0.679;  int'f:  0.509;

}

[send deliverable] => {
        100.000% Participation(send deliverable)                                  100.000%    |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, organize demo)              100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send deliverable, organize meeting)           100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         90.909% NotChainSuccession(send deliverable, send agenda)                 39.394%    |||        conf.:  0.682;  int'f:  0.682;
        100.000% NotChainSuccession(send deliverable, send demo)                  100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% CoExistence(send deliverable, send draft)                        100.000%    |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send draft)                 100.000%    |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send meeting)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, send report)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, submit deliverable)         100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotSuccession(send deliverable, submit draft)                    100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
         91.667% RespondedExistence(send deliverable, submit report)               44.444%    ||||       conf.:  0.917;  int'f:  0.688;
         88.235% NotChainSuccession(send deliverable, submit report)               21.569%    ||         conf.:  0.662;  int'f:  0.662;
         91.304% NotChainSuccession(send deliverable, write deliverable)           42.029%    ||||       conf.:  0.685;  int'f:  0.685;
        100.000% Precedence(send draft, send deliverable)                         100.000%    |||||||||  conf.:  1.000;  int'f:  1.000;

}

[send demo] => {
        100.000% AlternatePrecedence(send deliverable, send demo)                 100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send deliverable)                   100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send deliverable)                  100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send draft)                         100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send draft)                        100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, send demo)                       100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;

}

[send draft] => {
        100.000% Participation(send draft)                                        100.000%    |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send draft, organize agenda)                  100.000%    |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(send draft, organize demo)                    100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send draft, organize meeting)                 100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Succession(send draft, send deliverable)                         100.000%    |||||||||  conf.:  1.000;  int'f:  1.000;
         85.714% NotChainSuccession(send draft, send deliverable)                   4.762%               conf.:  0.857;  int'f:  0.857;
        100.000% NotChainSuccession(send draft, send demo)                        100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
         85.714% NotChainSuccession(send draft, send meeting)                       4.762%               conf.:  0.643;  int'f:  0.643;
         92.000% NotChainSuccession(send draft, send report)                       46.667%    ||||       conf.:  0.690;  int'f:  0.690;
        100.000% NotChainSuccession(send draft, submit deliverable)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send draft, submit draft)                     100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
         89.091% NotChainSuccession(send draft, submit report)                     27.273%    ||         conf.:  0.668;  int'f:  0.668;
         92.593% NotChainSuccession(send draft, write deliverable)                 50.617%    |||||      conf.:  0.694;  int'f:  0.694;

}

[send meeting] => {
        100.000% NotChainSuccession(send meeting, organize agenda)                100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send meeting, organize meeting)                      100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         90.000% NotChainSuccession(send meeting, organize meeting)                33.333%    |||        conf.:  0.675;  int'f:  0.506;
        100.000% CoExistence(send meeting, send agenda)                           100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, send agenda)                    100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send meeting, send deliverable)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send meeting, send deliverable)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send meeting, send draft)                     100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send meeting, send report)                     36.508%    |||        conf.:  0.679;  int'f:  0.509;
        100.000% CoExistence(send meeting, submit deliverable)                    100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit deliverable)             100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit report)                  100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send meeting, write deliverable)                     100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         91.304% NotChainSuccession(send meeting, write deliverable)               42.029%    ||||       conf.:  0.685;  int'f:  0.514;

}

[send report] => {
        100.000% Precedence(send draft, send report)                              100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send report, organize agenda)                 100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(send report, organize meeting)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send report, send agenda)                     100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send report, send deliverable)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send report, send deliverable)                 36.508%    |||        conf.:  0.679;  int'f:  0.679;
         92.000% NotChainSuccession(send report, send draft)                       46.667%    ||||       conf.:  0.690;  int'f:  0.690;
         90.476% NotChainSuccession(send report, send meeting)                     36.508%    |||        conf.:  0.679;  int'f:  0.509;
        100.000% NotChainSuccession(send report, submit deliverable)              100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         95.833% NotChainSuccession(send report, submit report)                    72.222%    |||||||    conf.:  0.719;  int'f:  0.539;

}

[submit deliverable] => {
        100.000% Precedence(send agenda, submit deliverable)                      100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send draft, submit deliverable)                       100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         86.667% Precedence(send report, submit deliverable)                       11.111%    |          conf.:  0.650;  int'f:  0.488;
        100.000% NotChainSuccession(submit deliverable, organize agenda)          100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(submit deliverable, organize meeting)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         91.304% NotChainSuccession(submit deliverable, organize meeting)          42.029%    ||||       conf.:  0.685;  int'f:  0.514;
        100.000% CoExistence(submit deliverable, send agenda)                     100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         92.000% NotChainSuccession(submit deliverable, send agenda)               46.667%    ||||       conf.:  0.690;  int'f:  0.518;
        100.000% RespondedExistence(submit deliverable, send deliverable)         100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         92.593% NotChainSuccession(submit deliverable, send deliverable)          50.617%    |||||      conf.:  0.694;  int'f:  0.694;
        100.000% NotChainSuccession(submit deliverable, send draft)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(submit deliverable, send meeting)                    100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit deliverable, send meeting)             100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         86.667% Response(submit deliverable, send report)                         11.111%    |          conf.:  0.650;  int'f:  0.488;
        100.000% NotChainSuccession(submit deliverable, send report)              100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         92.593% NotChainSuccession(submit deliverable, submit report)             50.617%    |||||      conf.:  0.694;  int'f:  0.521;
        100.000% CoExistence(submit deliverable, write deliverable)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit deliverable, write deliverable)        100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(write deliverable, submit deliverable)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;

}

[submit draft] => {
        100.000% AlternatePrecedence(send draft, submit draft)                    100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% Response(submit draft, send deliverable)                         100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(submit draft, send deliverable)               100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(submit draft, send draft)                      100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(submit draft, send draft)                     100.000%    |||||||||  conf.:  0.250;  int'f:  0.250;

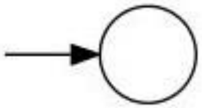
}

[submit report] => {
        100.000% NotChainSuccession(submit report, organize agenda)               100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(submit report, organize meeting)              100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit report, send agenda)                   100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(submit report, send deliverable)              100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         88.235% NotChainSuccession(submit report, send deliverable)               21.569%    ||         conf.:  0.662;  int'f:  0.662;
        100.000% RespondedExistence(submit report, send draft)                    100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         89.091% NotChainSuccession(submit report, send draft)                     27.273%    ||         conf.:  0.668;  int'f:  0.668;
        100.000% NotChainSuccession(submit report, send meeting)                  100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
         95.833% NotChainSuccession(submit report, send report)                    72.222%    |||||||    conf.:  0.719;  int'f:  0.539;
         92.593% NotChainSuccession(submit report, submit deliverable)             50.617%    |||||      conf.:  0.694;  int'f:  0.521;
         96.000% NotChainSuccession(submit report, write deliverable)              73.333%    |||||||    conf.:  0.720;  int'f:  0.540;

}

[write deliverable] => {
        100.000% Precedence(send draft, write deliverable)                        100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(write deliverable, organize agenda)           100.000%    |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(write deliverable, organize meeting)                 100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, organize meeting)          100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(write deliverable, send agenda)                      100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, send agenda)               100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(write deliverable, send deliverable)          100.000%    |||||||||  conf.:  0.750;  int'f:  0.750;
         91.304% NotChainSuccession(write deliverable, send deliverable)           42.029%    ||||       conf.:  0.685;  int'f:  0.685;
         92.593% NotChainSuccession(write deliverable, send draft)                 50.617%    |||||      conf.:  0.694;  int'f:  0.694;
        100.000% CoExistence(write deliverable, send meeting)                     100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, send meeting)              100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Succession(write deliverable, submit deliverable)                100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, submit report)             100.000%    |||||||||  conf.:  0.750;  int'f:  0.563;

}
```



How can we be sure we found all conflicting constraints?

Can we avoid to check the same sets of constraints more than once?

# The problems
# 2) redundancy

- Many constraints may be fulfilled 100% of times yet not add a bit of information to other already discovered ones
- Example: an event log consists of two traces:
  1. <a, b, a, b, a, b, c>
  2. <a, b, a, b, a, c>

- a *is always the first*
  ⇒ Init(a)
- c *is always the last*
  ⇒ End(c)
- *Before* c, a *precedes*
  ⇒ Precedence(a,c)
- *Before* b, a *precedes*
  ⇒ Precedence(a,b)
- *After* a, c *eventually follows*
  ⇒ Response(a,c)
- *After* b, c *eventually follows*
  ⇒ Response(b,c)

# The problems
# 2) redundancy

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- Example: an event log consists of two traces:
  1. <a, b, a, b, a, b, c>
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  ⇒ Response(a,c)
- *After* b, c *eventually follows*
  ⇒ Response(b,c)

*Of course! a is always the first*

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  - *a is always the first*
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    ⇒ End(c)
  - *Before* c, a *precedes*
    ⇒ Precedence(a,c)
  - *Before* b, a *precedes*
    ⇒ Precedence(a,b)
  - *After* a, c *eventually follows*
    ⇒ Response(a,c)
  - *After* b, c *eventually follows*
    ⇒ Response(b,c)

*Of course! a is always the first*

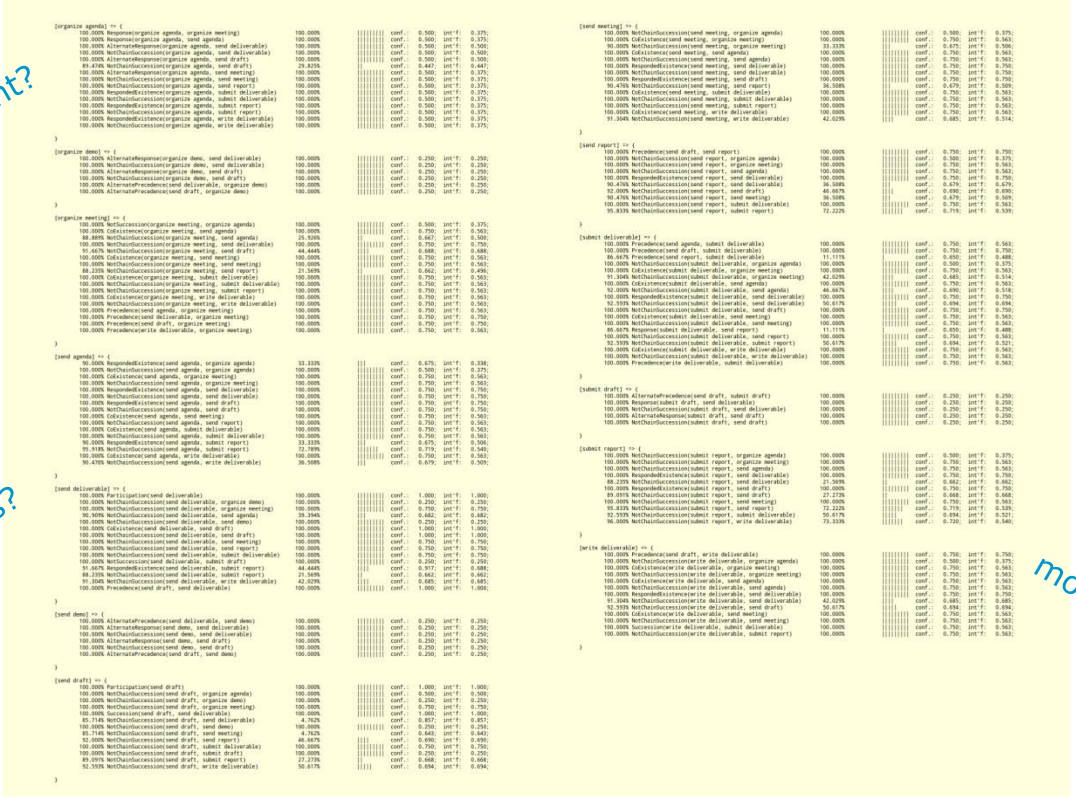
*Of course! c is always the last*

- Question: can't we avoid stating the obvious?
  ⇒ redundancy!

# The problems
# 2) redundancy

- Many constraints may be fulfilled 100% of times yet not add a bit of information to other already discovered ones
- How to reduce the number of unnecessary returned constraints?

Which constraints are redundant?



```
[organize agenda] => {
        100.000% Response(organize agenda, organize meeting)                 100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% Response(organize agenda, send agenda)                      100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% AlternateResponse(organize agenda, send deliverable)        100.000%     |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(organize agenda, send deliverable)       100.000%     |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% AlternateResponse(organize agenda, send draft)              100.000%     |||||||||  conf.:  0.500;  int'f:  0.500;
         89.474% NotChainSuccession(organize agenda, send draft)              29.825%     ||         conf.:  0.447;  int'f:  0.447;
        100.000% AlternateResponse(organize agenda, send meeting)            100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, send meeting)           100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, send report)            100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, submit deliverable)     100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, submit deliverable)     100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, submit report)          100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, submit report)          100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, write deliverable)      100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, write deliverable)      100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;

}

[organize demo] => {
        100.000% AlternateResponse(organize demo, send deliverable)          100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(organize demo, send deliverable)         100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(organize demo, send draft)                100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(organize demo, send draft)               100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send deliverable, organize demo)        100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, organize demo)              100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;

}

[organize meeting] => {
        100.000% NotSuccession(organize meeting, organize agenda)            100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(organize meeting, send agenda)                  100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         88.889% NotChainSuccession(organize meeting, send agenda)            25.926%     ||         conf.:  0.667;  int'f:  0.500;
        100.000% NotChainSuccession(organize meeting, send deliverable)      100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
         91.667% NotChainSuccession(organize meeting, send draft)             44.444%     ||||       conf.:  0.688;  int'f:  0.688;
        100.000% CoExistence(organize meeting, send meeting)                 100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, send meeting)          100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         88.235% NotChainSuccession(organize meeting, send report)            21.569%     ||         conf.:  0.662;  int'f:  0.496;
        100.000% CoExistence(organize meeting, submit deliverable)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit deliverable)    100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit report)         100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(organize meeting, write deliverable)            100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, write deliverable)     100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send agenda, organize meeting)                   100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send deliverable, organize meeting)              100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(send draft, organize meeting)                    100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(write deliverable, organize meeting)             100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;

}

[send agenda] => {
         90.000% RespondedExistence(send agenda, organize agenda)             33.333%     |||        conf.:  0.675;  int'f:  0.338;
        100.000% NotChainSuccession(send agenda, organize agenda)            100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send agenda, organize meeting)                  100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, organize meeting)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send agenda, send deliverable)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send deliverable)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send agenda, send draft)                 100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send draft)                 100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(send agenda, send meeting)                      100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, send report)                100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send agenda, submit deliverable)                100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, submit deliverable)         100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         90.000% RespondedExistence(send agenda, submit report)               33.333%     |||        conf.:  0.675;  int'f:  0.506;
         95.918% NotChainSuccession(send agenda, submit report)               72.789%     |||||||    conf.:  0.719;  int'f:  0.540;
        100.000% CoExistence(send agenda, write deliverable)                 100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         90.476% NotChainSuccession(send agenda, write deliverable)           36.508%     |||        conf.:  0.679;  int'f:  0.509;

}

[send deliverable] => {
        100.000% Participation(send deliverable)                             100.000%     |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, organize demo)         100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send deliverable, organize meeting)      100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
         90.909% NotChainSuccession(send deliverable, send agenda)            39.394%     |||        conf.:  0.682;  int'f:  0.682;
        100.000% NotChainSuccession(send deliverable, send demo)             100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% CoExistence(send deliverable, send draft)                   100.000%     |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send draft)            100.000%     |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send meeting)          100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, send report)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, submit deliverable)    100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotSuccession(send deliverable, submit draft)               100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
         91.667% RespondedExistence(send deliverable, submit report)          44.444%     ||||       conf.:  0.917;  int'f:  0.688;
         88.235% NotChainSuccession(send deliverable, submit report)          21.569%     ||         conf.:  0.662;  int'f:  0.662;
         91.304% NotChainSuccession(send deliverable, write deliverable)      42.029%     ||||       conf.:  0.685;  int'f:  0.685;
        100.000% Precedence(send draft, send deliverable)                    100.000%     |||||||||  conf.:  1.000;  int'f:  1.000;

}

[send demo] => {
        100.000% AlternatePrecedence(send deliverable, send demo)            100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send deliverable)              100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send deliverable)             100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send draft)                    100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send draft)                   100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, send demo)                  100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;

}

[send draft] => {
        100.000% Participation(send draft)                                   100.000%     |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send draft, organize agenda)             100.000%     |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(send draft, organize demo)               100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send draft, organize meeting)            100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Succession(send draft, send deliverable)                    100.000%     |||||||||  conf.:  1.000;  int'f:  1.000;
         85.714% NotChainSuccession(send draft, send deliverable)              4.762%                conf.:  0.857;  int'f:  0.857;
        100.000% NotChainSuccession(send draft, send demo)                   100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
         85.714% NotChainSuccession(send draft, send meeting)                  4.762%                conf.:  0.643;  int'f:  0.643;
         92.000% NotChainSuccession(send draft, send report)                  46.667%     ||||       conf.:  0.690;  int'f:  0.690;
        100.000% NotChainSuccession(send draft, submit deliverable)          100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send draft, submit draft)                100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
         89.091% NotChainSuccession(send draft, submit report)                27.273%     ||         conf.:  0.668;  int'f:  0.668;
         92.593% NotChainSuccession(send draft, write deliverable)            50.617%     |||||      conf.:  0.694;  int'f:  0.694;

}

[send meeting] => {
        100.000% NotChainSuccession(send meeting, organize agenda)           100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send meeting, organize meeting)                 100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         90.000% NotChainSuccession(send meeting, organize meeting)           33.333%     |||        conf.:  0.675;  int'f:  0.506;
        100.000% CoExistence(send meeting, send agenda)                      100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, send agenda)               100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send meeting, send deliverable)          100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send meeting, send deliverable)          100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send meeting, send draft)                100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send meeting, send report)                36.508%     |||        conf.:  0.679;  int'f:  0.509;
        100.000% CoExistence(send meeting, submit deliverable)               100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit deliverable)        100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit report)             100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send meeting, write deliverable)                100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         91.304% NotChainSuccession(send meeting, write deliverable)          42.029%     ||||       conf.:  0.685;  int'f:  0.514;

}

[send report] => {
        100.000% Precedence(send draft, send report)                         100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send report, organize agenda)            100.000%     |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(send report, organize meeting)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send report, send agenda)                100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send report, send deliverable)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send report, send deliverable)            36.508%     |||        conf.:  0.679;  int'f:  0.679;
         92.000% NotChainSuccession(send report, send draft)                  46.667%     ||||       conf.:  0.690;  int'f:  0.690;
         90.476% NotChainSuccession(send report, send meeting)                36.508%     |||        conf.:  0.679;  int'f:  0.509;
        100.000% NotChainSuccession(send report, submit deliverable)         100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         95.833% NotChainSuccession(send report, submit report)               72.222%     |||||||    conf.:  0.719;  int'f:  0.539;

}

[submit deliverable] => {
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        100.000% Precedence(send draft, submit deliverable)                  100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
         86.667% Precedence(send report, submit deliverable)                  11.111%     |          conf.:  0.650;  int'f:  0.488;
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         91.304% NotChainSuccession(submit deliverable, organize meeting)     42.029%     ||||       conf.:  0.685;  int'f:  0.514;
        100.000% CoExistence(submit deliverable, send agenda)                100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
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         92.593% NotChainSuccession(submit deliverable, send deliverable)     50.617%     |||||      conf.:  0.694;  int'f:  0.694;
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        100.000% NotChainSuccession(submit deliverable, send meeting)        100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
         86.667% Response(submit deliverable, send report)                    11.111%     |          conf.:  0.650;  int'f:  0.488;
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         92.593% NotChainSuccession(submit deliverable, submit report)        50.617%     |||||      conf.:  0.694;  int'f:  0.521;
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        100.000% NotChainSuccession(submit deliverable, write deliverable)   100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
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}

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        100.000% AlternateResponse(submit draft, send draft)                 100.000%     |||||||||  conf.:  0.250;  int'f:  0.250;
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}

[submit report] => {
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         95.833% NotChainSuccession(submit report, send report)               72.222%     |||||||    conf.:  0.719;  int'f:  0.539;
         92.593% NotChainSuccession(submit report, submit deliverable)        50.617%     |||||      conf.:  0.694;  int'f:  0.521;
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}

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        100.000% CoExistence(write deliverable, organize meeting)            100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, organize meeting)     100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(write deliverable, send agenda)                 100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, send agenda)          100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(write deliverable, send deliverable)     100.000%     |||||||||  conf.:  0.750;  int'f:  0.750;
         91.304% NotChainSuccession(write deliverable, send deliverable)      42.029%     ||||       conf.:  0.685;  int'f:  0.685;
         92.593% NotChainSuccession(write deliverable, send draft)            50.617%     |||||      conf.:  0.694;  int'f:  0.694;
        100.000% CoExistence(write deliverable, send meeting)                100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
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        100.000% Succession(write deliverable, submit deliverable)           100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, submit report)        100.000%     |||||||||  conf.:  0.750;  int'f:  0.563;

}
```

From where should we start?

How to find redundancies?

Can we avoid to check the same sets of constraints more than once?

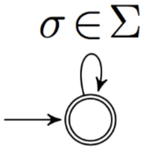
# The solution

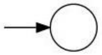
Automata-product *monoid*

*Algebraic structure with composition operator* (□) *holding the properties of*

- commutativity
- associativity

*and bearing*

- identity element 

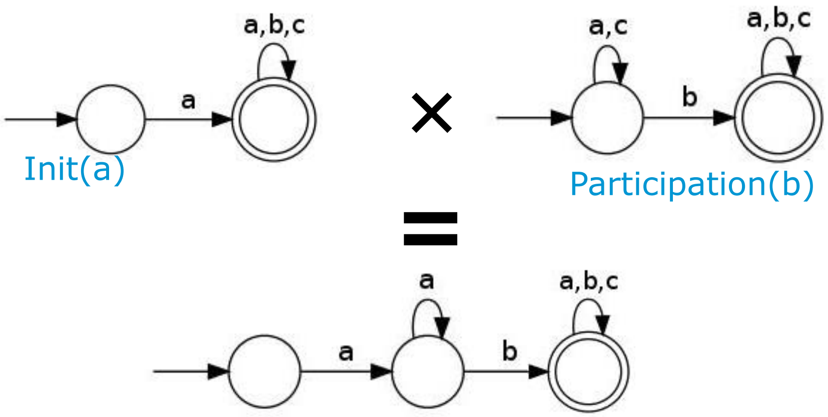
- and absorbing element 

# The solution

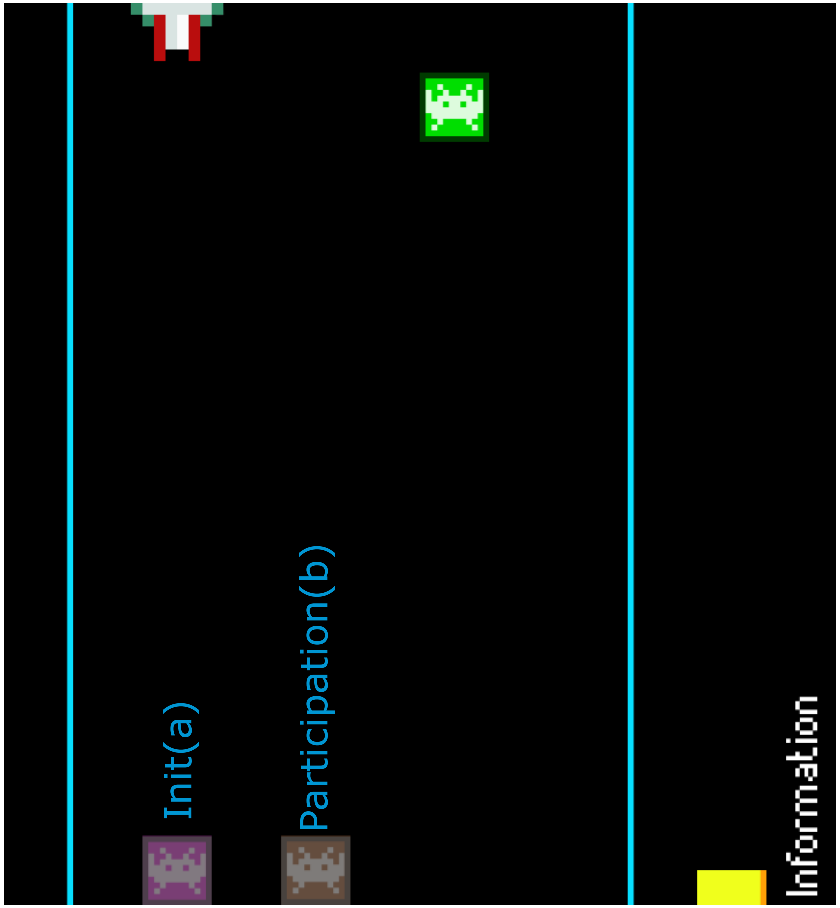
Automata-product *monoid*

# Rules of the game

- Intersect the **product automaton** with the newly visited constraints, one at a time



Product automaton



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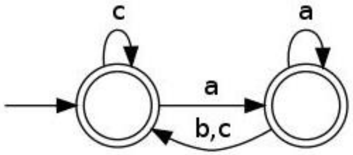
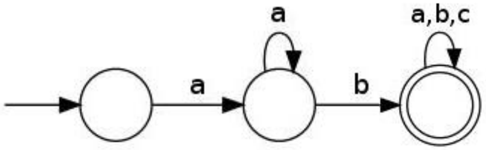
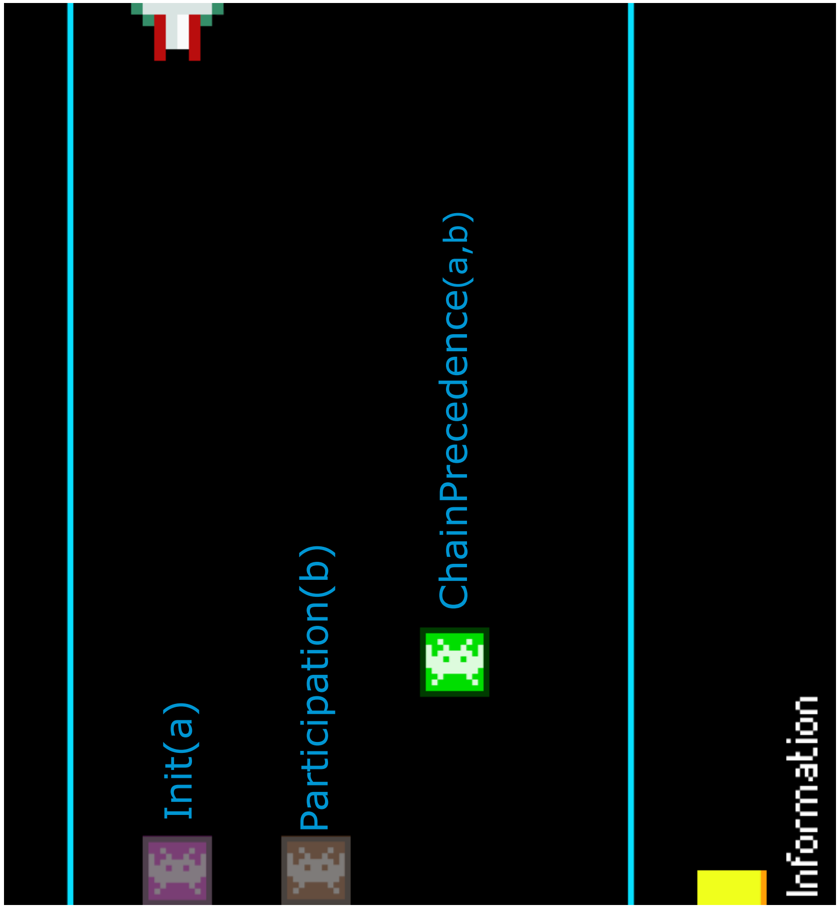


ChainPrecedence(a,b)

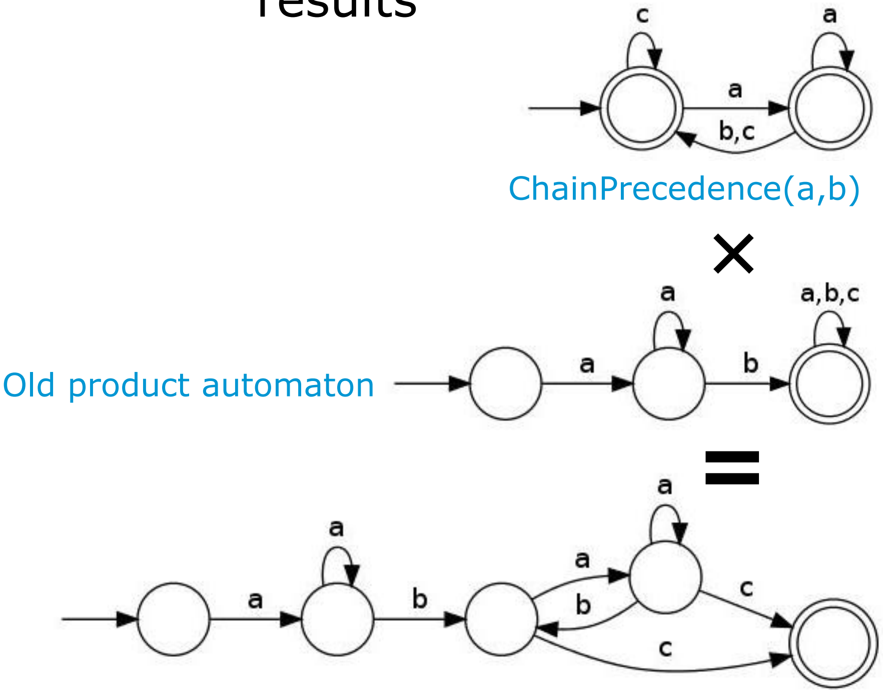


Product automaton



# Exploiting formal properties

- We take advantage of
  1. associativity
     - allows for "storage" of results



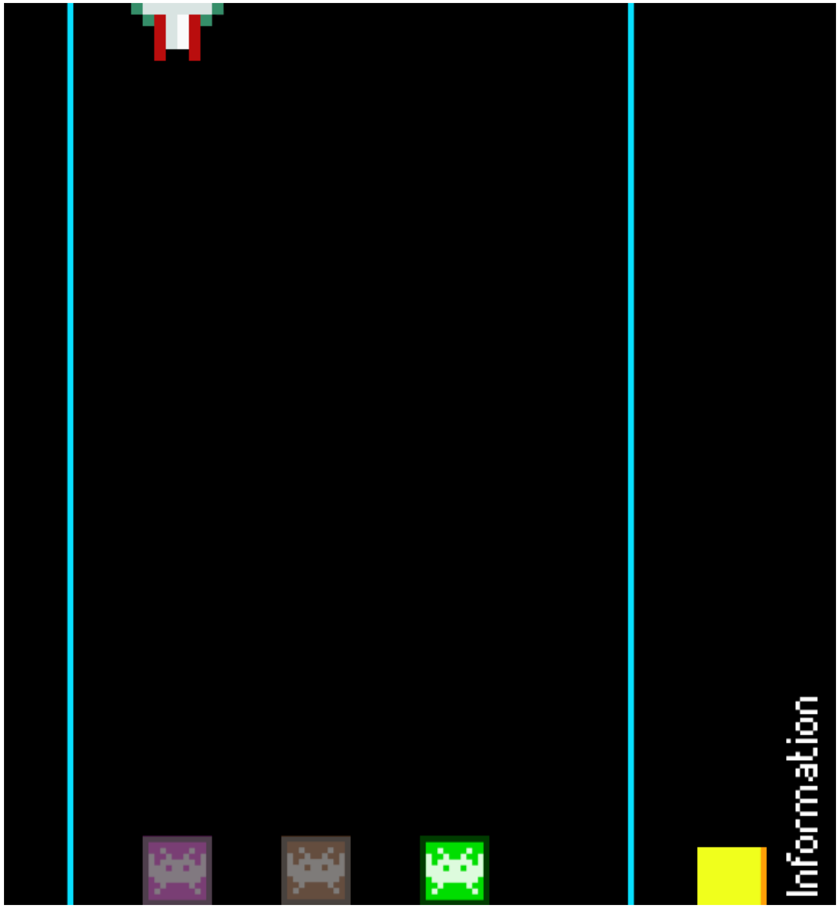
ChainPrecedence(a,b)

×

Old product automaton

=

Product automaton



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- We take advantage of
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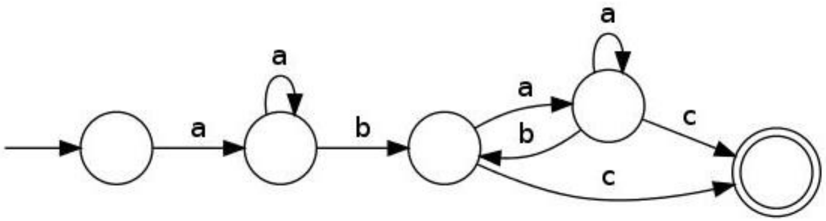
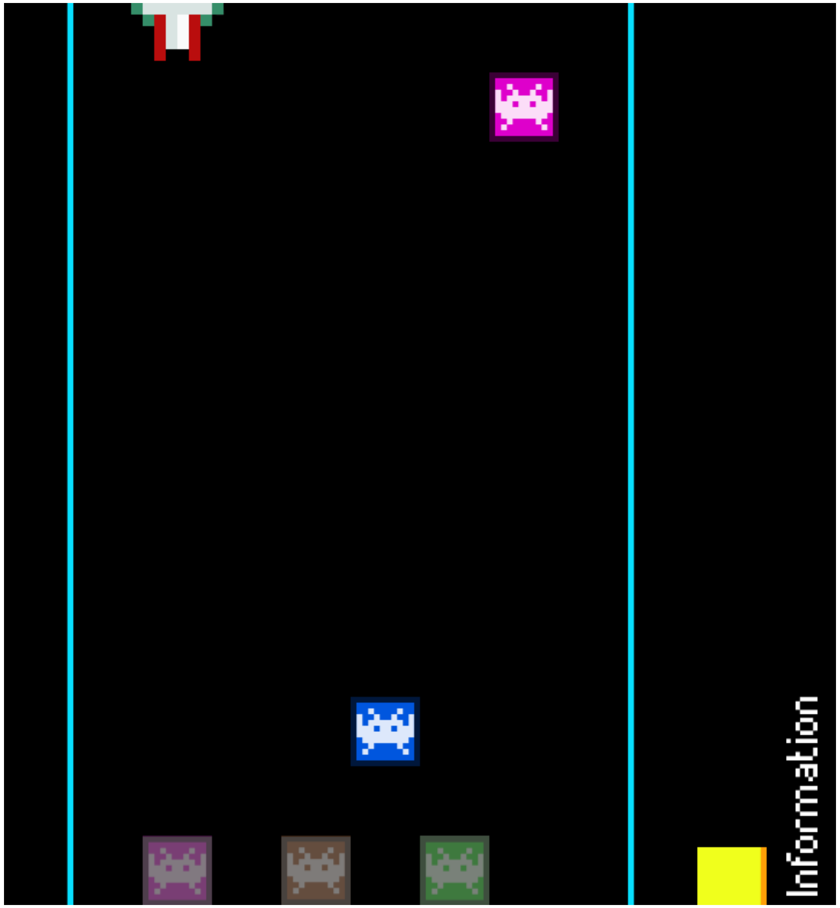
     - allows for priority sorting of constraints



Product automaton



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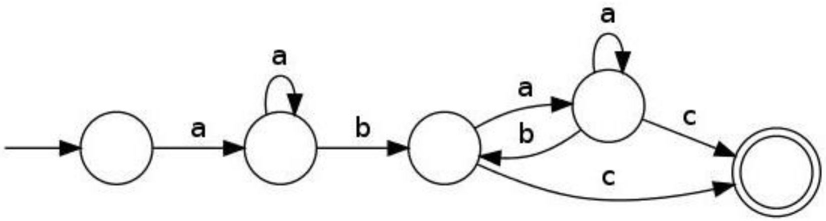
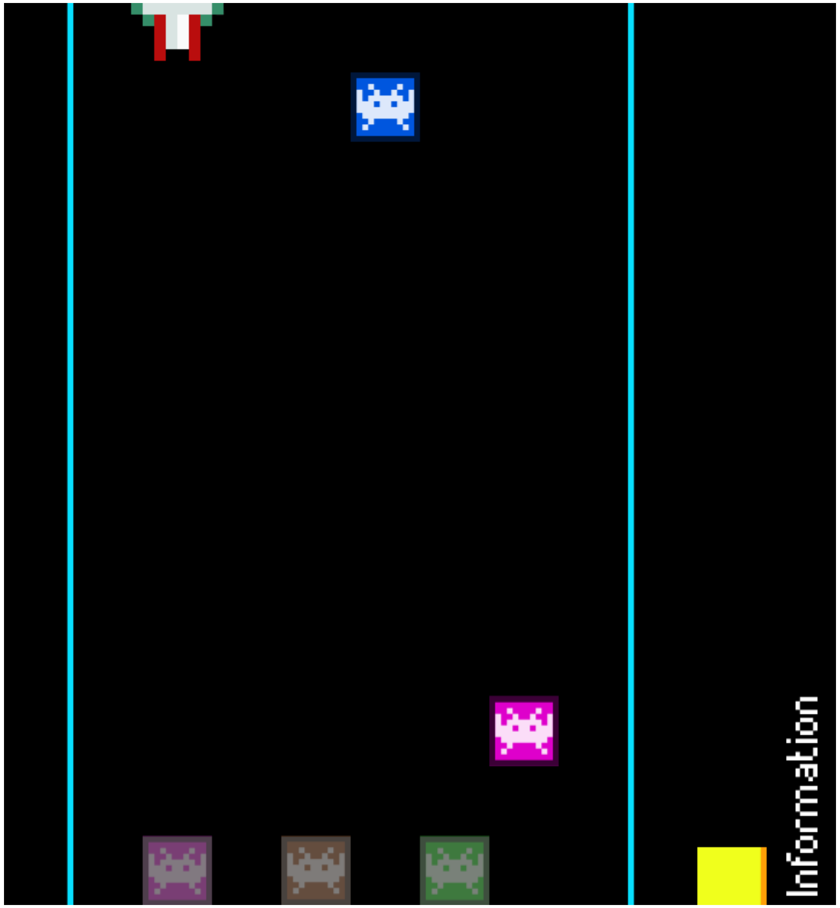
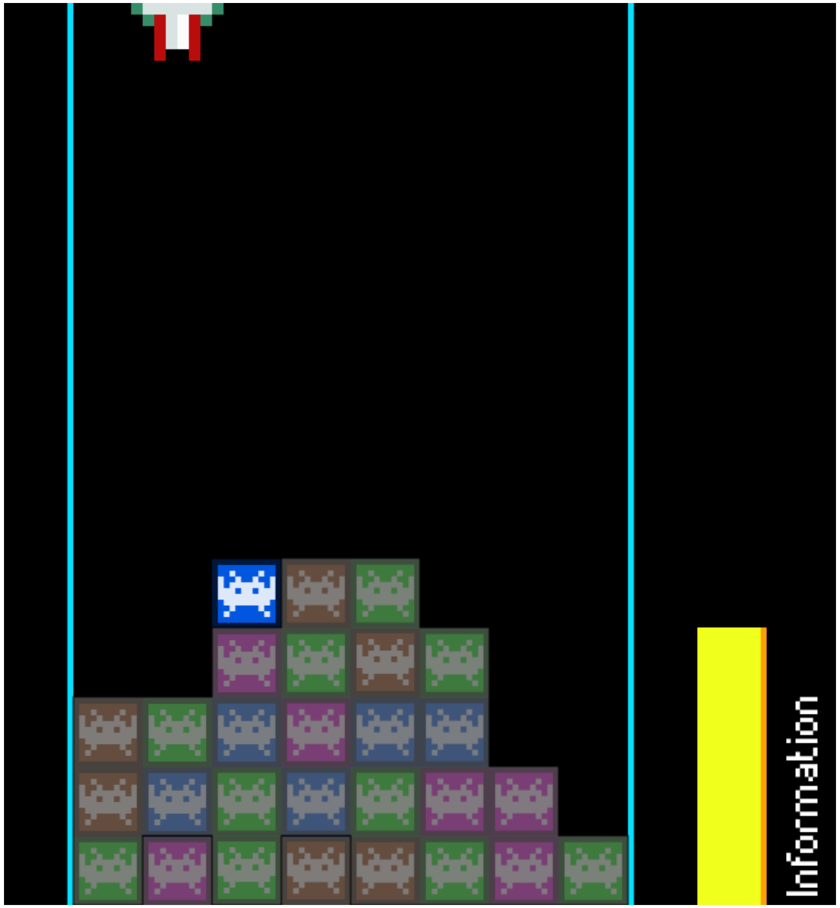


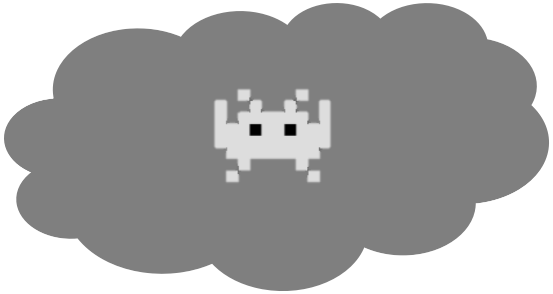


Product automaton

# Playing the game

- Newly visited constraints add information to the knowledge on the process model if they reduce the number of possible traces (accepted strings)





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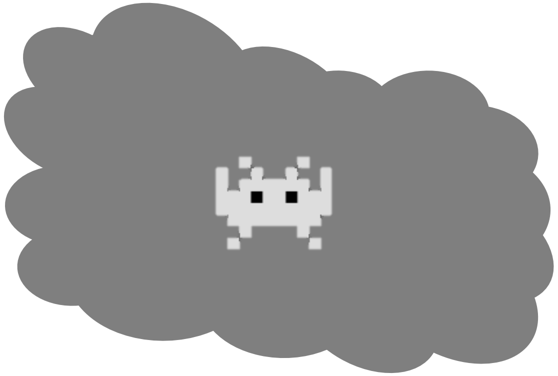
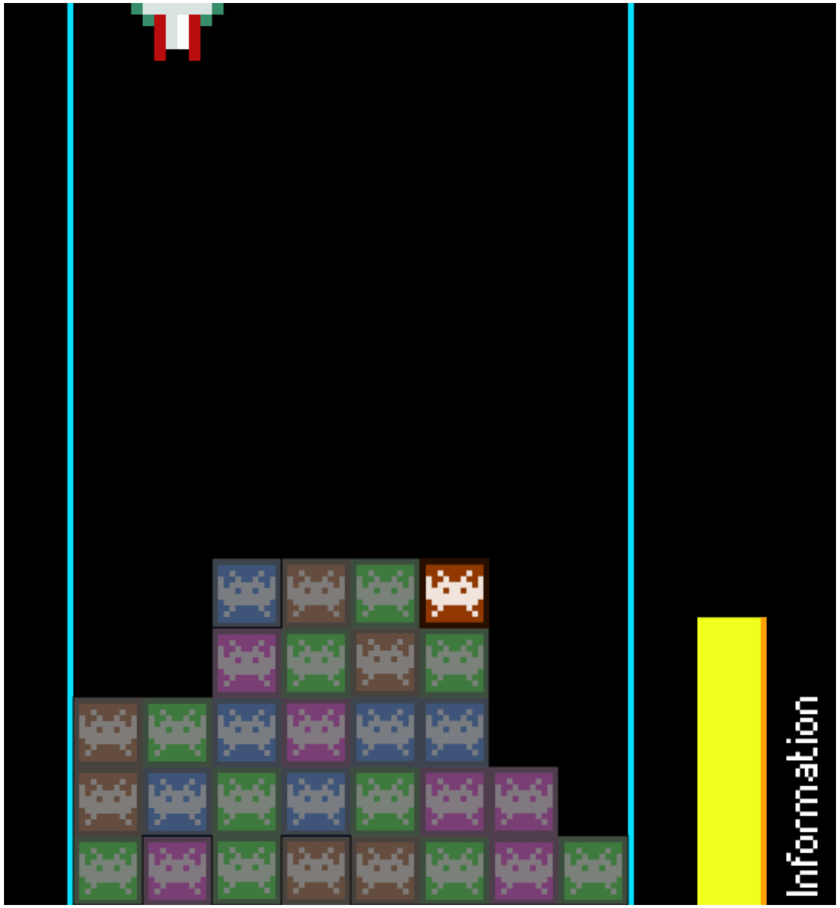


Product automaton



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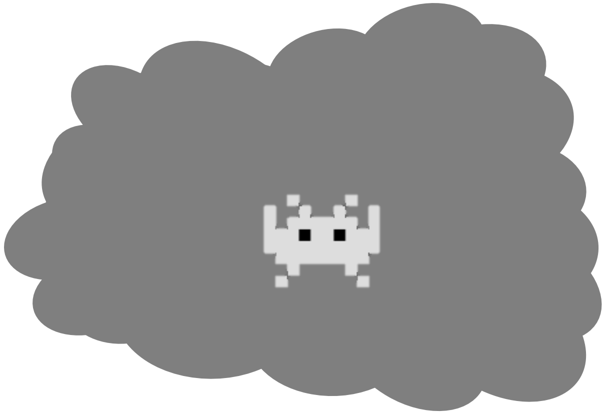
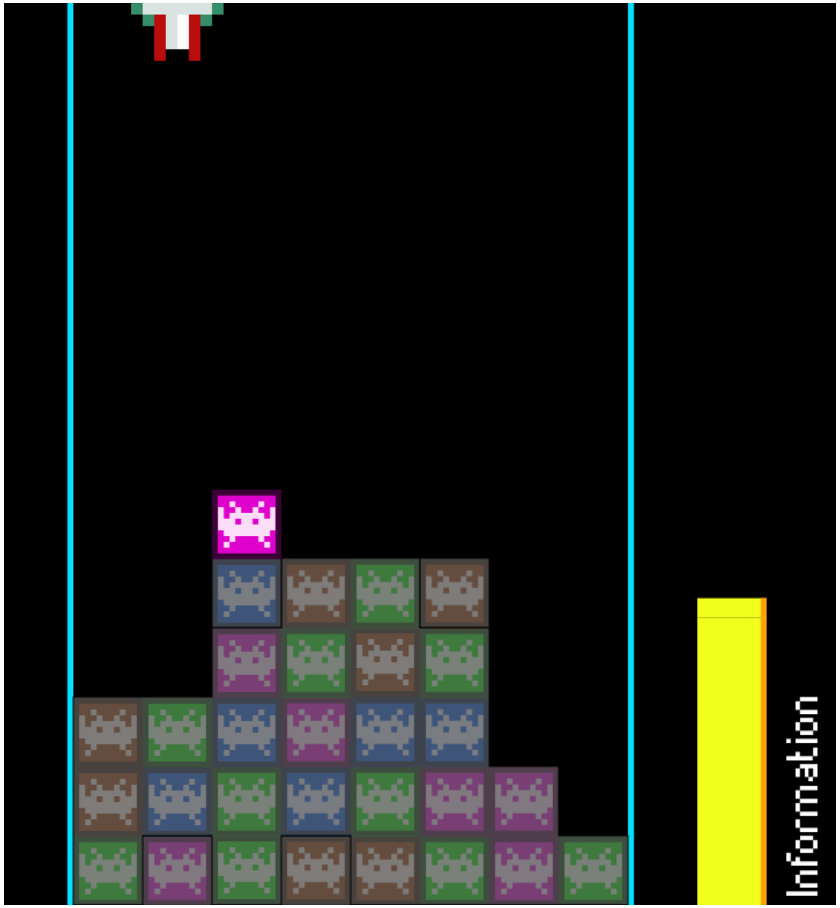
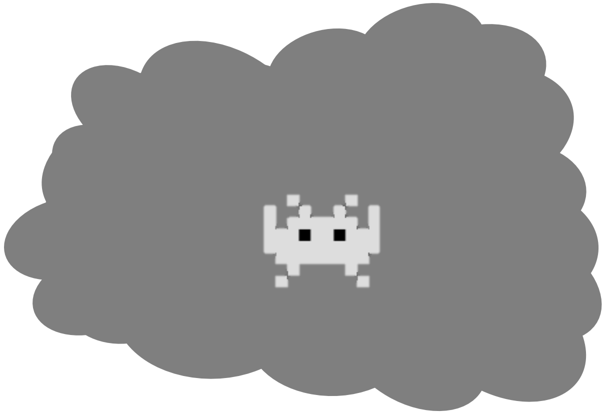


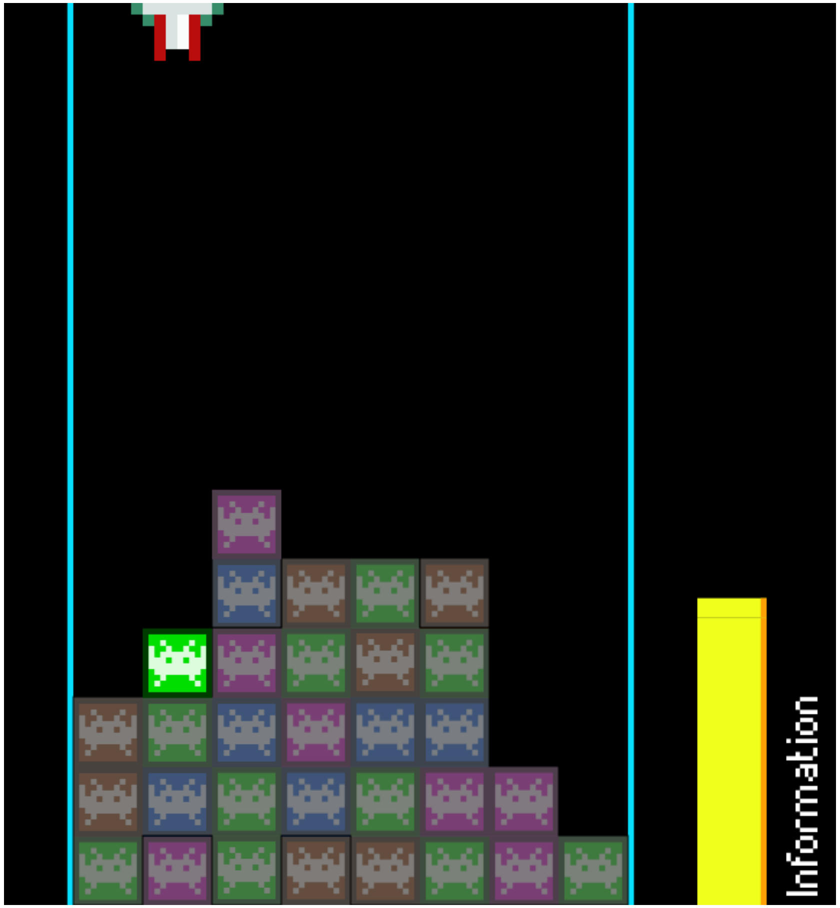


Product automaton

# Inconsistency!

- Newly visited constraints add information to the knowledge on the process model if they reduce the number of possible traces (accepted strings)
- Conflict:





Product automaton

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- Newly visited constraints add information to the knowledge on the process model if they reduce the number of possible traces (accepted strings)
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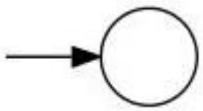
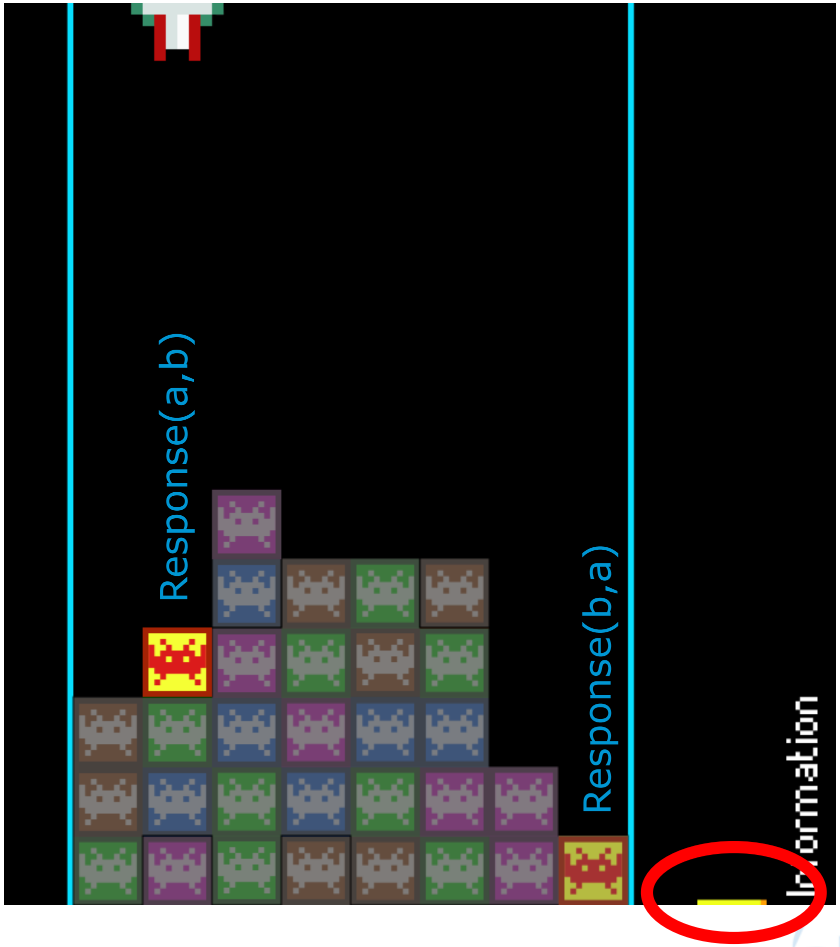


(**empty language**)



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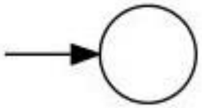
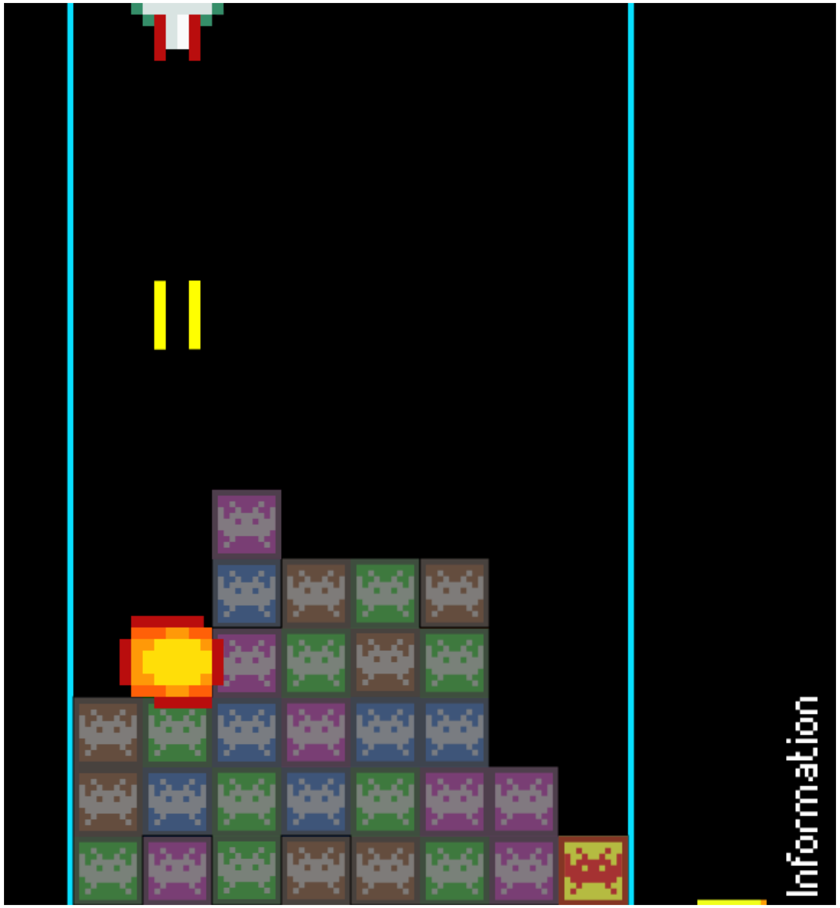


(**empty language**)

# Inconsistency!

- Newly visited constraints add information to the knowledge on the process model if they reduce the number of possible traces (accepted strings)
- **Conflict**:
  - Remove the constraint, in case



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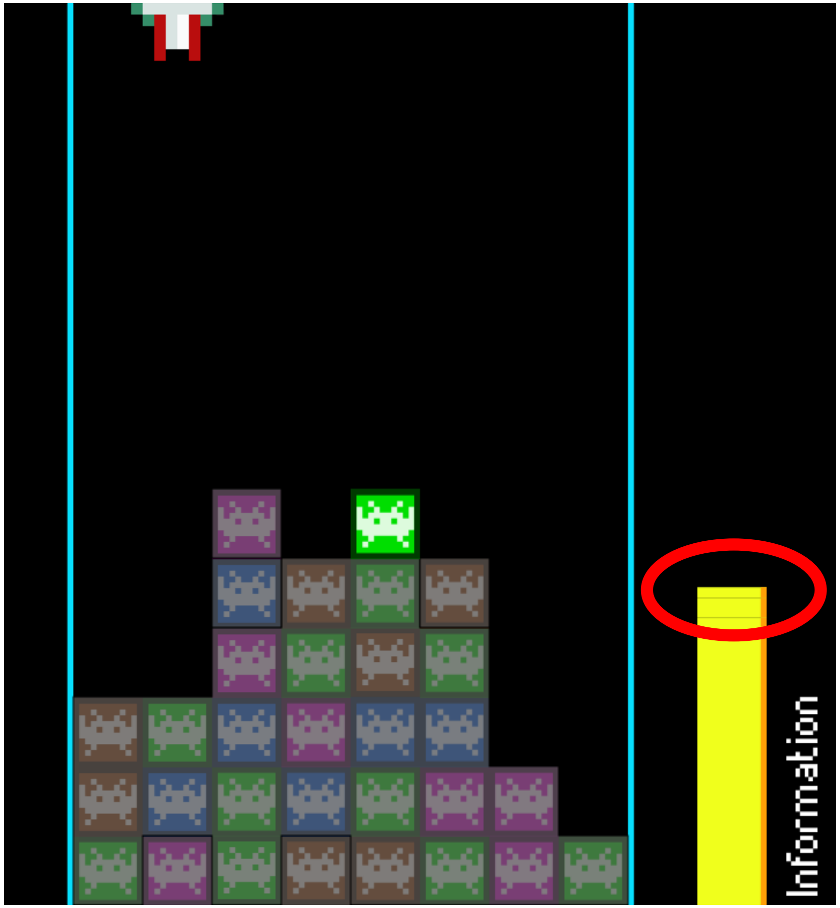
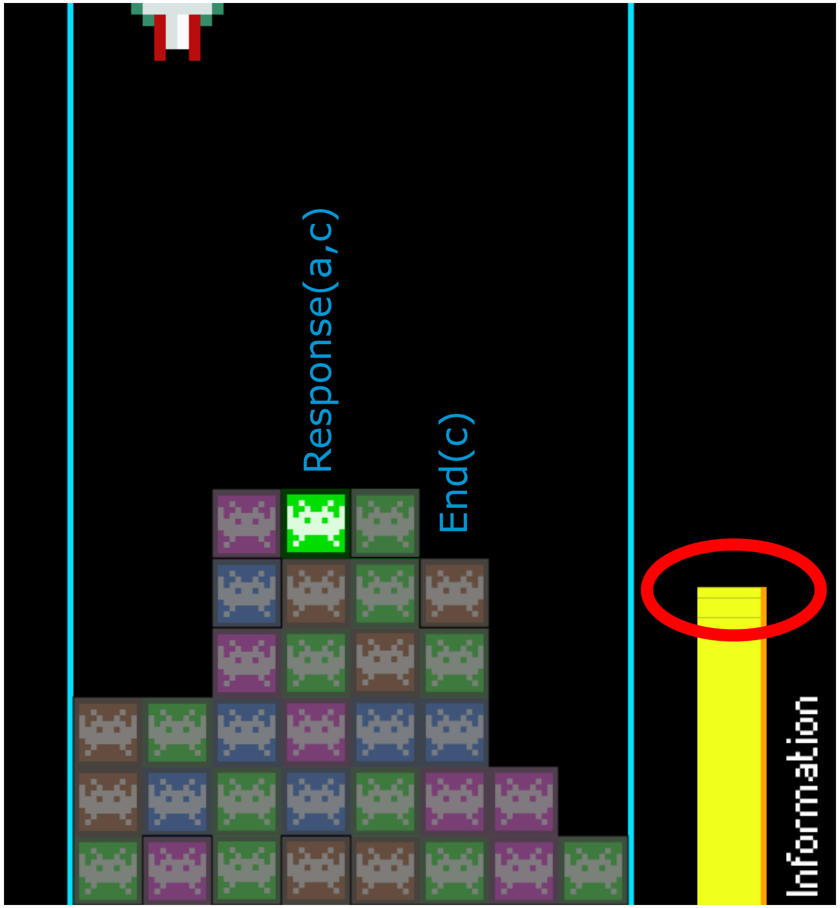
- Newly visited constraints add information to the knowledge on the process model if they reduce the number of possible traces (accepted strings)
- **Redundancy**:



# Redundancy!

- Newly visited constraints add information to the knowledge on the process model if they reduce the number of possible traces (accepted strings)
- **Redundancy**:
  - The new product automaton accepts the same strings as before (**language inclusion**)



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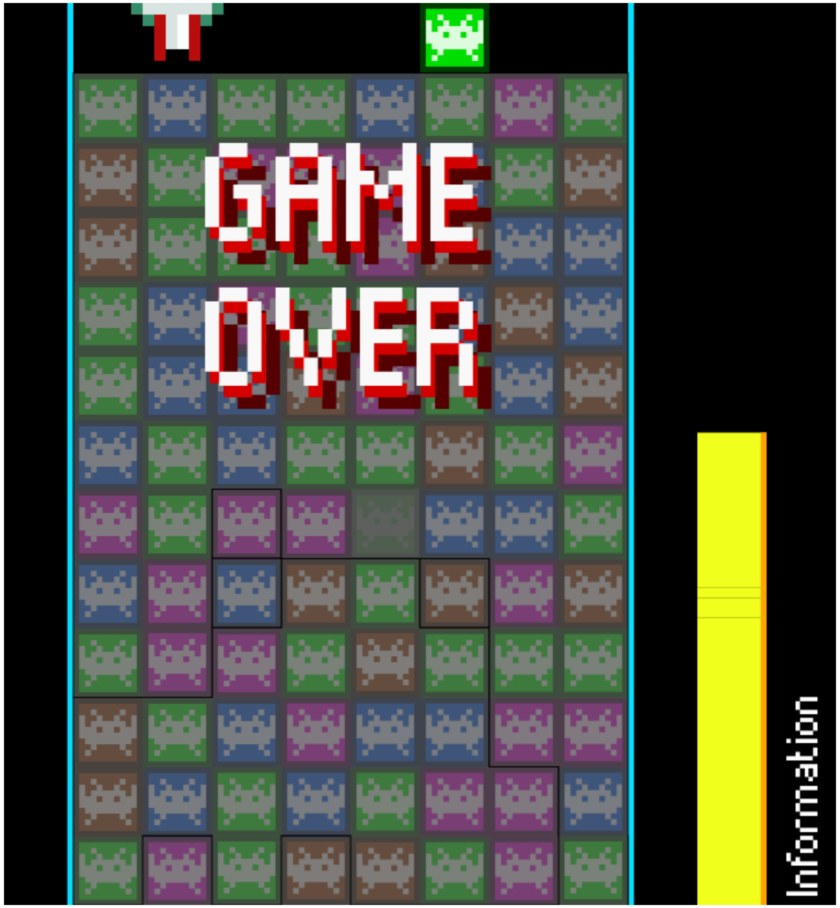

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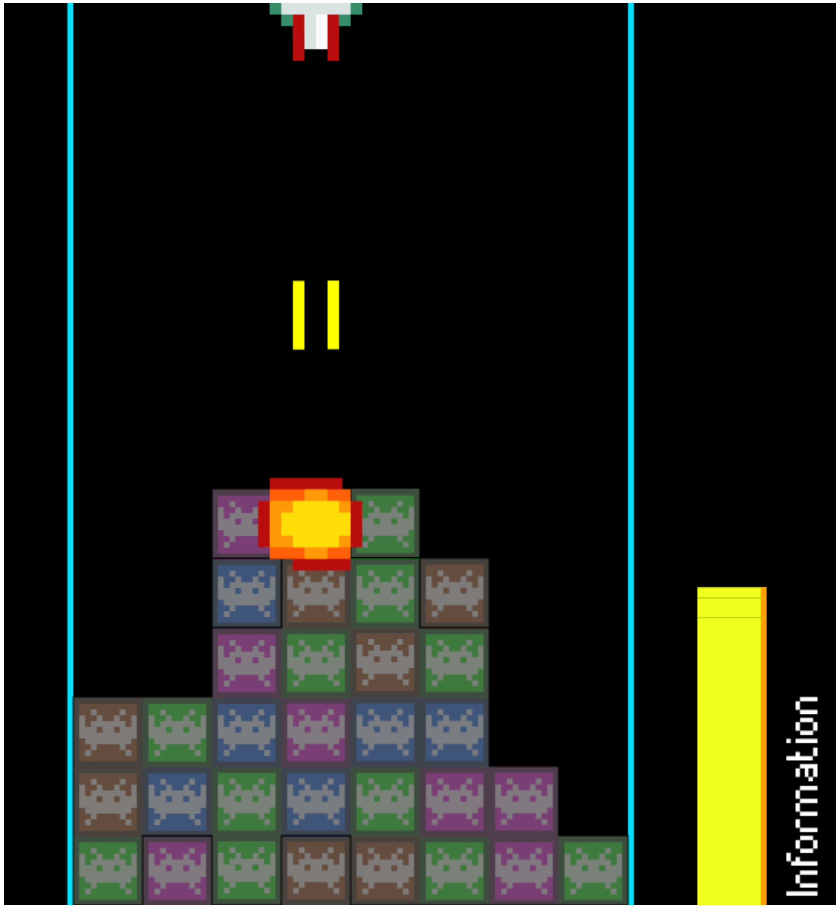
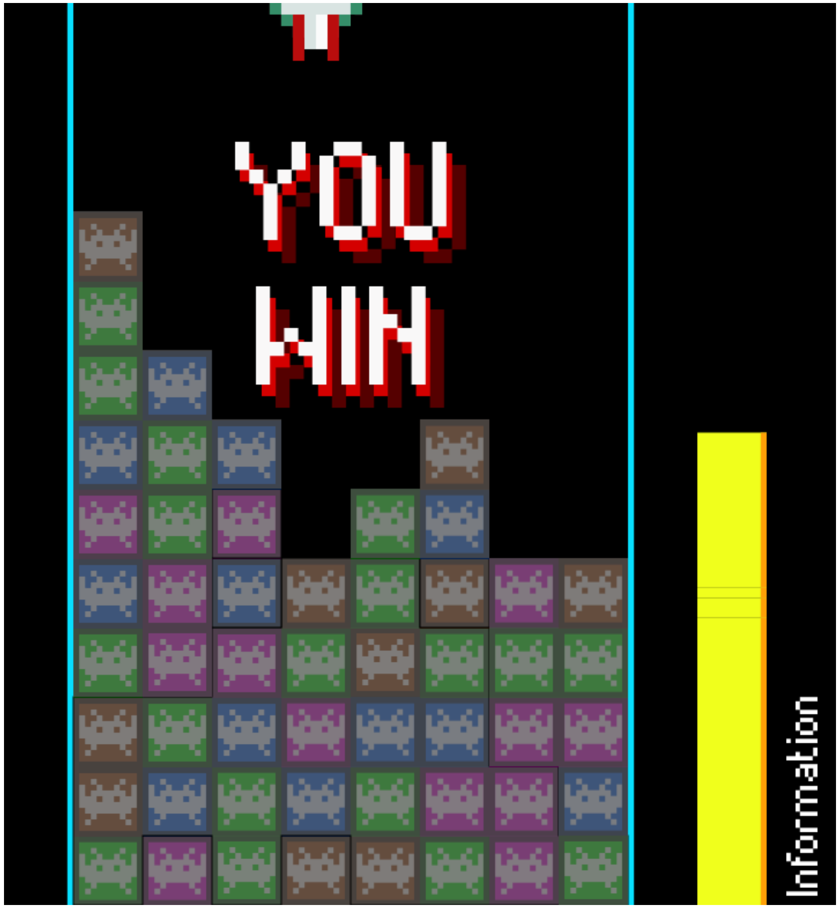


# Objectives

- Remove inconsistencies
- Minimise redundancies
- Analyse each constraint once



# The solution: Inconsistency detection

- Rationale:
  1. How to **find** inconsistencies among constraints?
     - Use the automaton-based model for constraints
     - Does the cross-product automaton recognise the **empty language**?
  2. How to **search** the inconsistencies?
     - Exploit:
       a) The product operation between automata
       b) The sorting of Declare templates
- Guideline:
  - Preserve the most meaningful constraints
    - The sorting prioritises constraints

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- Guideline:
  - Preserve the most meaningful constraints
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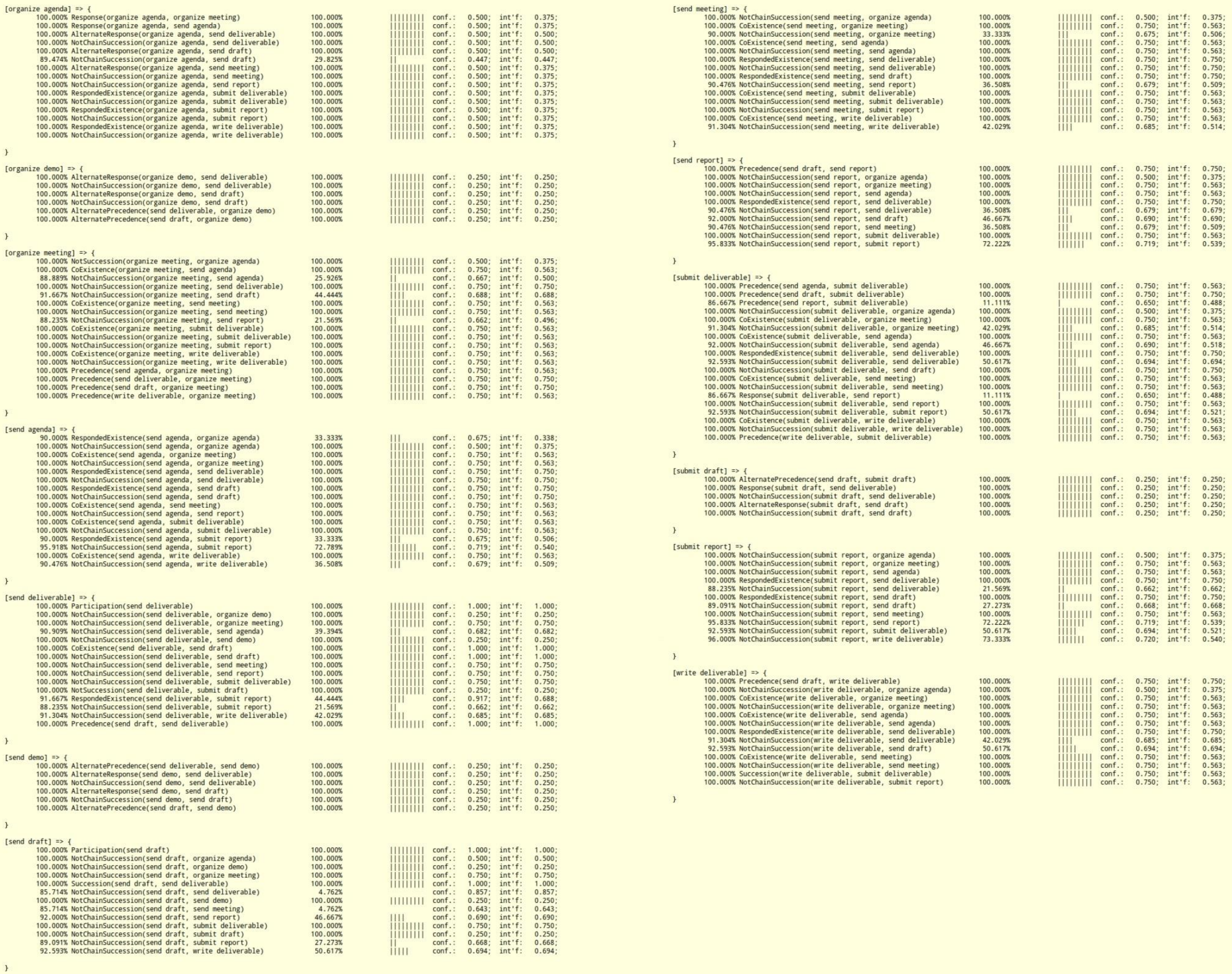
# Conclusion

Which were the conflicting constraints in the log?

How does the redundancy removal perform?

What is more in the paper?

Limitations and future work



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        100.000% AlternateResponse(organize agenda, send draft)                100.000%       |||||||||  conf.:  0.500;  int'f:  0.500;
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}

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        100.000% AlternateResponse(organize demo, send draft)                  100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(organize demo, send draft)                 100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send deliverable, organize demo)          100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, organize demo)                100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;

}

[organize meeting] => {
        100.000% NotSuccession(organize meeting, organize agenda)              100.000%       |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(organize meeting, send agenda)                    100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         88.889% NotChainSuccession(organize meeting, send agenda)              25.926%       ||         conf.:  0.667;  int'f:  0.500;
        100.000% NotChainSuccession(organize meeting, send deliverable)        100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         91.667% NotChainSuccession(organize meeting, send draft)               44.444%       ||||       conf.:  0.688;  int'f:  0.688;
        100.000% CoExistence(organize meeting, send meeting)                   100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, send meeting)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         88.235% NotChainSuccession(organize meeting, send report)              21.569%       ||         conf.:  0.662;  int'f:  0.496;
        100.000% CoExistence(organize meeting, submit deliverable)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit deliverable)      100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit report)           100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(organize meeting, write deliverable)              100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, write deliverable)       100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send agenda, organize meeting)                     100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send deliverable, organize meeting)                100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(send draft, organize meeting)                      100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(write deliverable, organize meeting)               100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;

}

[send agenda] => {
         90.000% RespondedExistence(send agenda, organize agenda)               33.333%       |||        conf.:  0.675;  int'f:  0.338;
        100.000% NotChainSuccession(send agenda, organize agenda)              100.000%       |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send agenda, organize meeting)                    100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, organize meeting)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send agenda, send deliverable)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send deliverable)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send agenda, send draft)                   100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send draft)                   100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(send agenda, send meeting)                        100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, send report)                  100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send agenda, submit deliverable)                  100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, submit deliverable)           100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         90.000% RespondedExistence(send agenda, submit report)                 33.333%       |||        conf.:  0.675;  int'f:  0.506;
         95.918% NotChainSuccession(send agenda, submit report)                 72.789%       |||||||    conf.:  0.719;  int'f:  0.540;
        100.000% CoExistence(send agenda, write deliverable)                   100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         90.476% NotChainSuccession(send agenda, write deliverable)             36.508%       |||        conf.:  0.679;  int'f:  0.509;

}

[send deliverable] => {
        100.000% Participation(send deliverable)                               100.000%       |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, organize demo)           100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send deliverable, organize meeting)        100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         90.909% NotChainSuccession(send deliverable, send agenda)              39.394%       |||        conf.:  0.682;  int'f:  0.682;
        100.000% NotChainSuccession(send deliverable, send demo)               100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% CoExistence(send deliverable, send draft)                     100.000%       |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send draft)              100.000%       |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send meeting)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, send report)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, submit deliverable)      100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotSuccession(send deliverable, submit draft)                 100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
         91.667% RespondedExistence(send deliverable, submit report)            44.444%       ||||       conf.:  0.917;  int'f:  0.688;
         88.235% NotChainSuccession(send deliverable, submit report)            21.569%       ||         conf.:  0.662;  int'f:  0.662;
         91.304% NotChainSuccession(send deliverable, write deliverable)        42.029%       ||||       conf.:  0.685;  int'f:  0.685;
        100.000% Precedence(send draft, send deliverable)                      100.000%       |||||||||  conf.:  1.000;  int'f:  1.000;

}

[send demo] => {
        100.000% AlternatePrecedence(send deliverable, send demo)              100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send deliverable)                100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send deliverable)               100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send draft)                      100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send draft)                     100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, send demo)                    100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;

}

[send draft] => {
        100.000% Participation(send draft)                                     100.000%       |||||||||  conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send draft, organize agenda)               100.000%       |||||||||  conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(send draft, organize demo)                 100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send draft, organize meeting)              100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% Succession(send draft, send deliverable)                      100.000%       |||||||||  conf.:  1.000;  int'f:  1.000;
         85.714% NotChainSuccession(send draft, send deliverable)                4.762%                  conf.:  0.857;  int'f:  0.857;
        100.000% NotChainSuccession(send draft, send demo)                     100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
         85.714% NotChainSuccession(send draft, send meeting)                    4.762%                  conf.:  0.643;  int'f:  0.643;
         92.000% NotChainSuccession(send draft, send report)                    46.667%       ||||       conf.:  0.690;  int'f:  0.690;
        100.000% NotChainSuccession(send draft, submit deliverable)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send draft, submit draft)                  100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
         89.091% NotChainSuccession(send draft, submit report)                  27.273%       ||         conf.:  0.668;  int'f:  0.668;
         92.593% NotChainSuccession(send draft, write deliverable)              50.617%       |||||      conf.:  0.694;  int'f:  0.694;

}

[send meeting] => {
        100.000% NotChainSuccession(send meeting, organize agenda)             100.000%       |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send meeting, organize meeting)                   100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         90.000% NotChainSuccession(send meeting, organize meeting)             33.333%       |||        conf.:  0.675;  int'f:  0.506;
        100.000% CoExistence(send meeting, send agenda)                        100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, send agenda)                 100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send meeting, send deliverable)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send meeting, send deliverable)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send meeting, send draft)                  100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send meeting, send report)                  36.508%       |||        conf.:  0.679;  int'f:  0.509;
        100.000% CoExistence(send meeting, submit deliverable)                 100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit deliverable)          100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit report)               100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send meeting, write deliverable)                  100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         91.304% NotChainSuccession(send meeting, write deliverable)            42.029%       ||||       conf.:  0.685;  int'f:  0.514;

}

[send report] => {
        100.000% Precedence(send draft, send report)                           100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send report, organize agenda)              100.000%       |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(send report, organize meeting)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send report, send agenda)                  100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send report, send deliverable)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send report, send deliverable)              36.508%       |||        conf.:  0.679;  int'f:  0.679;
         92.000% NotChainSuccession(send report, send draft)                    46.667%       ||||       conf.:  0.690;  int'f:  0.690;
         90.476% NotChainSuccession(send report, send meeting)                  36.508%       |||        conf.:  0.679;  int'f:  0.509;
        100.000% NotChainSuccession(send report, submit deliverable)           100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         95.833% NotChainSuccession(send report, submit report)                 72.222%       |||||||    conf.:  0.719;  int'f:  0.539;

}

[submit deliverable] => {
        100.000% Precedence(send agenda, submit deliverable)                   100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send draft, submit deliverable)                    100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         86.667% Precedence(send report, submit deliverable)                    11.111%       |          conf.:  0.650;  int'f:  0.488;
        100.000% NotChainSuccession(submit deliverable, organize agenda)       100.000%       |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(submit deliverable, organize meeting)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         91.304% NotChainSuccession(submit deliverable, organize meeting)       42.029%       ||||       conf.:  0.685;  int'f:  0.514;
        100.000% CoExistence(submit deliverable, send agenda)                  100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         92.000% NotChainSuccession(submit deliverable, send agenda)            46.667%       ||||       conf.:  0.690;  int'f:  0.518;
        100.000% RespondedExistence(submit deliverable, send deliverable)      100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         92.593% NotChainSuccession(submit deliverable, send deliverable)       50.617%       |||||      conf.:  0.694;  int'f:  0.694;
        100.000% NotChainSuccession(submit deliverable, send draft)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(submit deliverable, send meeting)                 100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit deliverable, send meeting)          100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         86.667% Response(submit deliverable, send report)                      11.111%       |          conf.:  0.650;  int'f:  0.488;
        100.000% NotChainSuccession(submit deliverable, send report)           100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         92.593% NotChainSuccession(submit deliverable, submit report)          50.617%       |||||      conf.:  0.694;  int'f:  0.521;
        100.000% CoExistence(submit deliverable, write deliverable)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit deliverable, write deliverable)     100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(write deliverable, submit deliverable)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;

}

[submit draft] => {
        100.000% AlternatePrecedence(send draft, submit draft)                 100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% Response(submit draft, send deliverable)                      100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(submit draft, send deliverable)            100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(submit draft, send draft)                   100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(submit draft, send draft)                  100.000%       |||||||||  conf.:  0.250;  int'f:  0.250;

}

[submit report] => {
        100.000% NotChainSuccession(submit report, organize agenda)            100.000%       |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(submit report, organize meeting)           100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit report, send agenda)                100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(submit report, send deliverable)           100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         88.235% NotChainSuccession(submit report, send deliverable)            21.569%       ||         conf.:  0.662;  int'f:  0.662;
        100.000% RespondedExistence(submit report, send draft)                 100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         89.091% NotChainSuccession(submit report, send draft)                  27.273%       ||         conf.:  0.668;  int'f:  0.668;
        100.000% NotChainSuccession(submit report, send meeting)               100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
         95.833% NotChainSuccession(submit report, send report)                 72.222%       |||||||    conf.:  0.719;  int'f:  0.539;
         92.593% NotChainSuccession(submit report, submit deliverable)          50.617%       |||||      conf.:  0.694;  int'f:  0.521;
         96.000% NotChainSuccession(submit report, write deliverable)           73.333%       |||||||    conf.:  0.720;  int'f:  0.540;

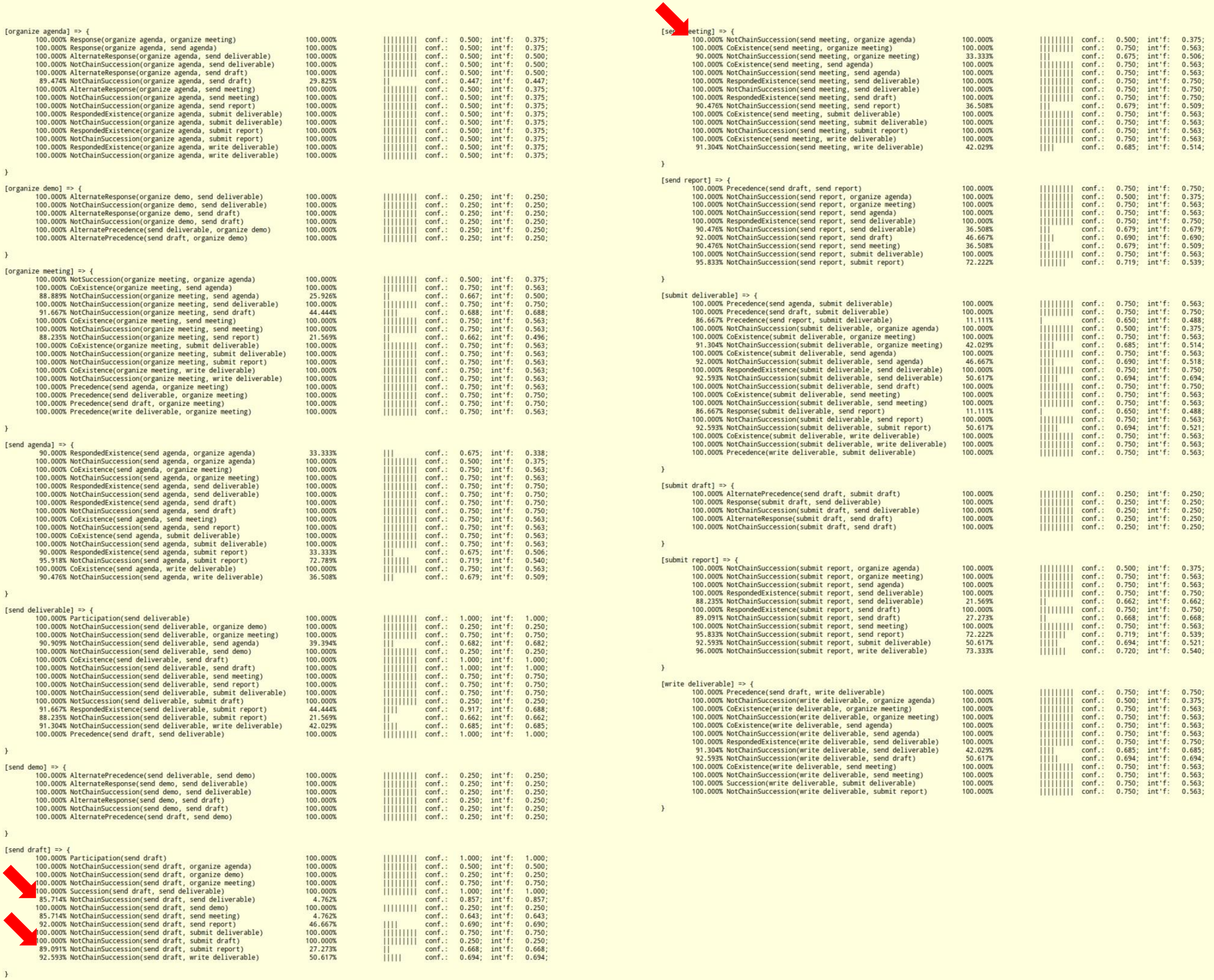
}

[write deliverable] => {
        100.000% Precedence(send draft, write deliverable)                     100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(write deliverable, organize agenda)        100.000%       |||||||||  conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(write deliverable, organize meeting)              100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, organize meeting)       100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(write deliverable, send agenda)                   100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, send agenda)            100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(write deliverable, send deliverable)       100.000%       |||||||||  conf.:  0.750;  int'f:  0.750;
         91.304% NotChainSuccession(write deliverable, send deliverable)        42.029%       ||||       conf.:  0.685;  int'f:  0.685;
         92.593% NotChainSuccession(write deliverable, send draft)              50.617%       |||||      conf.:  0.694;  int'f:  0.694;
        100.000% CoExistence(write deliverable, send meeting)                  100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, send meeting)           100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% Succession(write deliverable, submit deliverable)             100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, submit report)          100.000%       |||||||||  conf.:  0.750;  int'f:  0.563;

}
```

# Which were the conflicting constraints in the log?

1. NotSuccession(send meeting, organize agenda)
2. NotChainSuccession(send draft, send deliverable)
3. Succession(send draft, submit report)



```
[organize agenda] => {
        100.000% Response(organize agenda, organize meeting)                100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% Response(organize agenda, send agenda)                     100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% AlternateResponse(organize agenda, send deliverable)       100.000%        ||||||||| conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(organize agenda, send deliverable)      100.000%        ||||||||| conf.:  0.500;  int'f:  0.500;
        100.000% AlternateResponse(organize agenda, send draft)             100.000%        ||||||||| conf.:  0.500;  int'f:  0.500;
         89.474% NotChainSuccession(organize agenda, send draft)             29.825%        ||        conf.:  0.447;  int'f:  0.447;
        100.000% AlternateResponse(organize agenda, send meeting)           100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, send meeting)          100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, send report)           100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, submit deliverable)    100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, submit deliverable)    100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, submit report)         100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, submit report)         100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% RespondedExistence(organize agenda, write deliverable)     100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(organize agenda, write deliverable)     100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;

}

[organize demo] => {
        100.000% AlternateResponse(organize demo, send deliverable)         100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(organize demo, send deliverable)        100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(organize demo, send draft)               100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(organize demo, send draft)              100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send deliverable, organize demo)       100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, organize demo)             100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;

}

[organize meeting] => {
        100.000% NotSuccession(organize meeting, organize agenda)           100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(organize meeting, send agenda)                 100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         88.889% NotChainSuccession(organize meeting, send agenda)           25.926%        ||        conf.:  0.667;  int'f:  0.500;
        100.000% NotChainSuccession(organize meeting, send deliverable)     100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         91.667% NotChainSuccession(organize meeting, send draft)            44.444%        ||||      conf.:  0.688;  int'f:  0.688;
        100.000% CoExistence(organize meeting, send meeting)                100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, send meeting)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         88.235% NotChainSuccession(organize meeting, send report)           21.569%        ||        conf.:  0.662;  int'f:  0.496;
        100.000% CoExistence(organize meeting, submit deliverable)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit deliverable)   100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, submit report)        100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(organize meeting, write deliverable)           100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(organize meeting, write deliverable)    100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send agenda, organize meeting)                  100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send deliverable, organize meeting)             100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(send draft, organize meeting)                   100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% Precedence(write deliverable, organize meeting)            100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;

}

[send agenda] => {
         90.000% RespondedExistence(send agenda, organize agenda)            33.333%        |||       conf.:  0.675;  int'f:  0.338;
        100.000% NotChainSuccession(send agenda, organize agenda)           100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send agenda, organize meeting)                 100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, organize meeting)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send agenda, send deliverable)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send deliverable)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send agenda, send draft)                100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send agenda, send draft)                100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(send agenda, send meeting)                     100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, send report)               100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send agenda, submit deliverable)               100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send agenda, submit deliverable)        100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         90.000% RespondedExistence(send agenda, submit report)              33.333%        |||       conf.:  0.675;  int'f:  0.506;
         95.918% NotChainSuccession(send agenda, submit report)              72.789%        |||||||   conf.:  0.719;  int'f:  0.540;
        100.000% CoExistence(send agenda, write deliverable)                100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         90.476% NotChainSuccession(send agenda, write deliverable)          36.508%        |||       conf.:  0.679;  int'f:  0.509;

}

[send deliverable] => {
        100.000% Participation(send deliverable)                            100.000%        ||||||||| conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, organize demo)        100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send deliverable, organize meeting)     100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         90.909% NotChainSuccession(send deliverable, send agenda)           39.394%        |||       conf.:  0.682;  int'f:  0.682;
        100.000% NotChainSuccession(send deliverable, send demo)            100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% CoExistence(send deliverable, send draft)                  100.000%        ||||||||| conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send draft)           100.000%        ||||||||| conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send deliverable, send meeting)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, send report)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send deliverable, submit deliverable)   100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotSuccession(send deliverable, submit draft)              100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
         91.667% RespondedExistence(send deliverable, submit report)         44.444%        ||||      conf.:  0.917;  int'f:  0.688;
         88.235% NotChainSuccession(send deliverable, submit report)         21.569%        ||        conf.:  0.662;  int'f:  0.662;
         91.304% NotChainSuccession(send deliverable, write deliverable)     42.029%        ||||      conf.:  0.685;  int'f:  0.685;
        100.000% Precedence(send draft, send deliverable)                   100.000%        ||||||||| conf.:  1.000;  int'f:  1.000;

}

[send demo] => {
        100.000% AlternatePrecedence(send deliverable, send demo)           100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send deliverable)             100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send deliverable)            100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(send demo, send draft)                   100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send demo, send draft)                  100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% AlternatePrecedence(send draft, send demo)                 100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;

}

[send draft] => {
        100.000% Participation(send draft)                                  100.000%        ||||||||| conf.:  1.000;  int'f:  1.000;
        100.000% NotChainSuccession(send draft, organize agenda)            100.000%        ||||||||| conf.:  0.500;  int'f:  0.500;
        100.000% NotChainSuccession(send draft, organize demo)              100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(send draft, organize meeting)           100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% Succession(send draft, send deliverable)                   100.000%        ||||||||| conf.:  1.000;  int'f:  1.000;
         85.714% NotChainSuccession(send draft, send deliverable)             4.762%                  conf.:  0.857;  int'f:  0.857;
        100.000% NotChainSuccession(send draft, send demo)                  100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
         85.714% NotChainSuccession(send draft, send meeting)                 4.762%                  conf.:  0.643;  int'f:  0.643;
         92.000% NotChainSuccession(send draft, send report)                 46.667%        ||||      conf.:  0.690;  int'f:  0.690;
        100.000% NotChainSuccession(send draft, submit deliverable)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send draft, submit draft)               100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
         89.091% NotChainSuccession(send draft, submit report)               27.273%        ||        conf.:  0.668;  int'f:  0.668;
         92.593% NotChainSuccession(send draft, write deliverable)           50.617%        |||||     conf.:  0.694;  int'f:  0.694;

}

[se  eeting] => {
        100.000% NotChainSuccession(send meeting, organize agenda)          100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(send meeting, organize meeting)                100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         90.000% NotChainSuccession(send meeting, organize meeting)          33.333%        |||       conf.:  0.675;  int'f:  0.506;
        100.000% CoExistence(send meeting, send agenda)                     100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, send agenda)              100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send meeting, send deliverable)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send meeting, send deliverable)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% RespondedExistence(send meeting, send draft)               100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send meeting, send report)               36.508%        |||       conf.:  0.679;  int'f:  0.509;
        100.000% CoExistence(send meeting, submit deliverable)              100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit deliverable)       100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send meeting, submit report)            100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(send meeting, write deliverable)               100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         91.304% NotChainSuccession(send meeting, write deliverable)         42.029%        ||||      conf.:  0.685;  int'f:  0.514;

}

[send report] => {
        100.000% Precedence(send draft, send report)                        100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(send report, organize agenda)           100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(send report, organize meeting)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(send report, send agenda)               100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(send report, send deliverable)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         90.476% NotChainSuccession(send report, send deliverable)           36.508%        |||       conf.:  0.679;  int'f:  0.679;
         92.000% NotChainSuccession(send report, send draft)                 46.667%        ||||      conf.:  0.690;  int'f:  0.690;
         90.476% NotChainSuccession(send report, send meeting)               36.508%        |||       conf.:  0.679;  int'f:  0.509;
        100.000% NotChainSuccession(send report, submit deliverable)        100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         95.833% NotChainSuccession(send report, submit report)              72.222%        |||||||   conf.:  0.719;  int'f:  0.539;

}

[submit deliverable] => {
        100.000% Precedence(send agenda, submit deliverable)                100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(send draft, submit deliverable)                 100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         86.667% Precedence(send report, submit deliverable)                 11.111%        |         conf.:  0.650;  int'f:  0.488;
        100.000% NotChainSuccession(submit deliverable, organize agenda)    100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(submit deliverable, organize meeting)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         91.304% NotChainSuccession(submit deliverable, organize meeting)    42.029%        ||||      conf.:  0.685;  int'f:  0.514;
        100.000% CoExistence(submit deliverable, send agenda)               100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         92.000% NotChainSuccession(submit deliverable, send agenda)         46.667%        ||||      conf.:  0.690;  int'f:  0.518;
        100.000% RespondedExistence(submit deliverable, send deliverable)   100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         92.593% NotChainSuccession(submit deliverable, send deliverable)    50.617%        |||||     conf.:  0.694;  int'f:  0.694;
        100.000% NotChainSuccession(submit deliverable, send draft)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% CoExistence(submit deliverable, send meeting)              100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit deliverable, send meeting)       100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         86.667% Response(submit deliverable, send report)                   11.111%        |         conf.:  0.650;  int'f:  0.488;
        100.000% NotChainSuccession(submit deliverable, send report)        100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         92.593% NotChainSuccession(submit deliverable, submit report)       50.617%        |||||     conf.:  0.694;  int'f:  0.521;
        100.000% CoExistence(submit deliverable, write deliverable)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit deliverable, write deliverable)  100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% Precedence(write deliverable, submit deliverable)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;

}

[submit draft] => {
        100.000% AlternatePrecedence(send draft, submit draft)              100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% Response(submit draft, send deliverable)                   100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(submit draft, send deliverable)         100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% AlternateResponse(submit draft, send draft)                100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;
        100.000% NotChainSuccession(submit draft, send draft)               100.000%        ||||||||| conf.:  0.250;  int'f:  0.250;

}

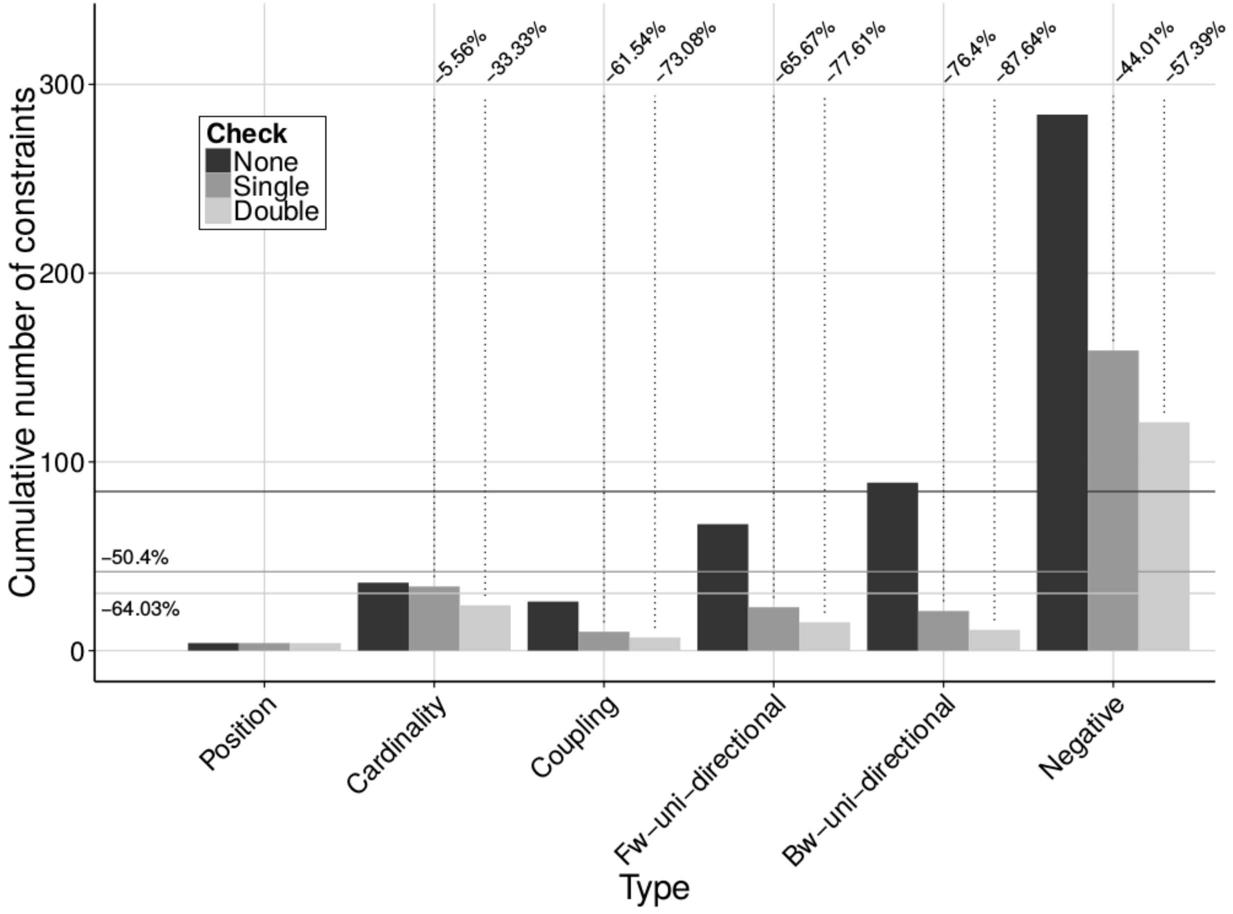
[submit report] => {
        100.000% NotChainSuccession(submit report, organize agenda)         100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% NotChainSuccession(submit report, organize meeting)        100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(submit report, send agenda)             100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(submit report, send deliverable)        100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         88.235% NotChainSuccession(submit report, send deliverable)         21.569%        ||        conf.:  0.662;  int'f:  0.662;
        100.000% RespondedExistence(submit report, send draft)              100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         89.091% NotChainSuccession(submit report, send draft)               27.273%        ||        conf.:  0.668;  int'f:  0.668;
        100.000% NotChainSuccession(submit report, send meeting)            100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
         95.833% NotChainSuccession(submit report, send report)              72.222%        |||||||   conf.:  0.719;  int'f:  0.539;
         92.593% NotChainSuccession(submit report, submit deliverable)       50.617%        |||||     conf.:  0.694;  int'f:  0.521;
         96.000% NotChainSuccession(submit report, write deliverable)        73.333%        |||||||   conf.:  0.720;  int'f:  0.540;

}

[write deliverable] => {
        100.000% Precedence(send draft, write deliverable)                  100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
        100.000% NotChainSuccession(write deliverable, organize agenda)     100.000%        ||||||||| conf.:  0.500;  int'f:  0.375;
        100.000% CoExistence(write deliverable, organize meeting)           100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, organize meeting)    100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% CoExistence(write deliverable, send agenda)                100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, send agenda)         100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% RespondedExistence(write deliverable, send deliverable)    100.000%        ||||||||| conf.:  0.750;  int'f:  0.750;
         91.304% NotChainSuccession(write deliverable, send deliverable)     42.029%        ||||      conf.:  0.685;  int'f:  0.685;
         92.593% NotChainSuccession(write deliverable, send draft)           50.617%        |||||     conf.:  0.694;  int'f:  0.694;
        100.000% CoExistence(write deliverable, send meeting)               100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, send meeting)        100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% Succession(write deliverable, submit deliverable)          100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;
        100.000% NotChainSuccession(write deliverable, submit report)       100.000%        ||||||||| conf.:  0.750;  int'f:  0.563;

}
```

# Redundancy reduction



# Conclusions, limitations and future work

We have presented an algorithm which automatically finds inconsistencies and redundancies in mined Declare models

- The checks are purely based on operations over automata (remember: **monoids**)
- http://github.com/cdc08x/minerful

More in the paper:

- The order in which the constraints are checked deeply affects the returned result
  - Comparative studies prove different sorting strategies to affect
    - computation time
    - fitness of the returned model
    - size

Limitations:

- Performances are heavily affected by the interplay of constraints

Future work:

- Users/analysts involvement
- http://www.promtools.org/prom6/nightly

# Resolving Inconsistencies and Redundancies in Declarative Process Models

Claudio Di Ciccio, Fabrizio Maria Maggi, Marco Montali and Jan Mendling

*8th International Workshop on Enterprise Modeling and Information Systems Architectures (EMISA 2017)*
*Essen, Germany*

claudio.di.ciccio@wu.ac.at

Di Ciccio, C., Maggi, F. M., Montali, M., Mendling, J. (2017). Resolving inconsistencies and redundancies in declarative process models. *Information Systems, 64*, 425–446. https://doi.org/10.1016/j.is.2016.09.005

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**Extra slides deck**

# Computational time complexity

Number of constraints

Automata product / language check

$$O\Bigg(\underbrace{n\cdot\log n}_{\text{sorting}} + \underbrace{n\cdot \circlearrowright^{\mathrm{T}}_{\mathscr{A}}}_{\text{conflict and redundancy (single) check}} + \underbrace{n^{2}\cdot \circlearrowright^{\mathrm{T}}_{\mathscr{A}}}_{\text{redundancy double-check}}\Bigg)$$