Constructing BPMN-models from Causal nets

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Process mining – what is it?

Some activity

Event log

Discovery
Conformance
Enhancement

Process Model
Process mining – 3 main problems

- Discovery – how can we obtain the process model?
- Conformance – how good is our model?
- Enhancement – how we can improve our model?
Variety of models

Transition System

YAWL

Petri Net

Causal Net

BPMN
ProM

- Process-aware software system
- Plugin-based
- Supports a lot of models and operations
- Some plugins use Causal Nets as a result of the discovery
Causal Nets
What is the point?

Valid sequences:
(a, b, e), (a, d, b, e), (a, b, d, c, e)

Invalid sequences:
(a, b, c, e), (a, d, e)
Why should we use yet another model?

• High control flow expressivity
• Internally consistent: pay no attention to invalid sequences $\Rightarrow$ no deadlocks, livelocks...
• Models AND, OR, XOR without additional elements
Formal definition

- Causal Net $C = (A, a_i, a_o, D, I, O)$, where:
  - $A$ – finite set of activities
  - $a_i$ – start activity
  - $a_o$ – end activity
  - $D \subseteq A \times A$ – dependency relation
  - $AS = \{X \subseteq P(A) | X = \{\emptyset\} \lor \emptyset \notin X\}$
  - $I \in A \rightarrow AS$ – set of possible input bindings
  - $O \in A \rightarrow AS$ – set of possible output bindings
  - Start activity has no input bindings
  - End activity has no output bindings
  - All activities in graph $(A, D)$ are on the way from $a_i$ to $a_o$
Why conversion is needed?

- Causal nets provide declarative semantics
- Presentation is low-level
- Presentation may be not so obvious
BPMN

- Higher-level language
- Allows to quickly understand process logic
- De facto standard
- Continuously supported and improving
Constraints of conversion

• BPMN is a *free-choice* net, while C-net is more expressive in terms of control flow
• This fact is the reason of Causal net splitting necessity
• The conflict of declarative semantics and local-rules semantics
• Successful conversion criteria: C-net valid binding sequences $\iff$ BPMN valid firing sequences
Preparing C-net: splitting

• Every activity is split into set of activity copies and terminal activity
Splitting in action
Result of splitting
Conversion to BPMN

• This is not the result of modeling!!! Of course, model should be simplified
• Seeming complexity is the price for quite precise behavior from the C-net
What do we get?

• BPMN valid firing sequences correspond to valid binding sequences of Causal Net
• No additional valid sequences occurred
Applicability of conversion

• Plugin for ProM
• Enriches mathematical toolset – let’s discover new models, methods and approaches!
References

• W.M.P. van der Aalst. Process Mining: Discovery, Conformance and Enhancement of Business Processes


• W.M.P. van der Aalst, K.M. van Hee, A.H.M. ter Hofstede, N. Sidorova, H.M.W. Verbeek, M. Voorhoeve, and M.T. Wynn. Soundness of Workflow Nets: Classification, Decidability and Analysis

• [http://promtools.org](http://promtools.org) – ProM
Thank you!