

Algorithms for Computing Coverability Graphs for Hybrid Petri Nets

Petr Novosad and Milan Češka

Faculty of Information Technology
Brno University of Technology
Brno, Czech Republic

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Outline

- 1 Introduction
- 2 Hybrid Petri Nets
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Introduction.

- Petri nets.
- Reachability graphs.
- Coverability graphs.

Hybrid Petri Nets.

- Authors David and Alla.
- Fluidification of discrete Petri net.
- Continuous and hybrid marking.
- Enabled transitions and enabling degree.
- Continuous and hybrid macro-marking.

Coverability graphs for bounded hybrid Petri nets.

- $G_{hb} = (N, E)$
 - $N \subseteq (\mathbb{R}^+ \cup \{c_1, \dots, c_{|P_C|}\})^{|P_C|} \times \mathbb{N}^{|P_D|}$
 - $E \subseteq N \times T \times ((\mathbb{Q}^+ \setminus \{0\}) \cup \{c_1, \dots, c_{|P_C|}\}) \times N$

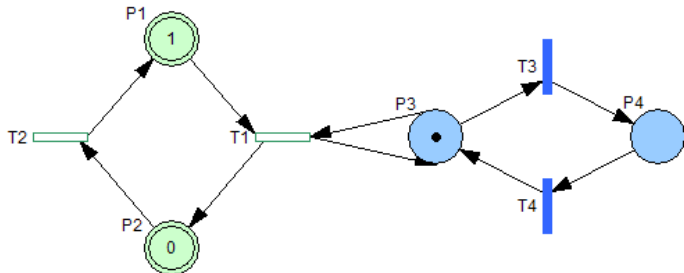
Algorithm 1

■ Method:

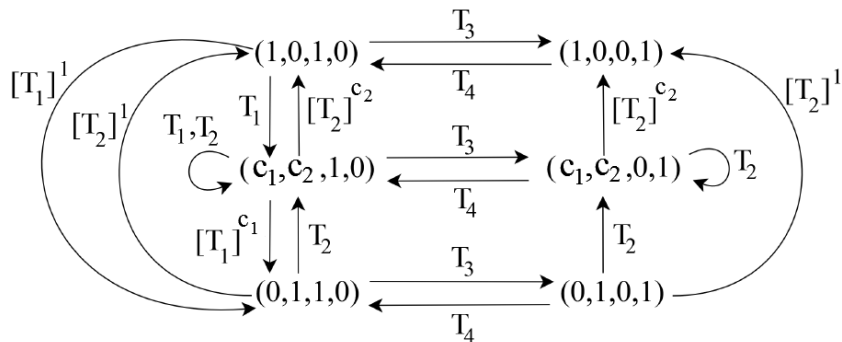
```

begin
  AddNewNode ( $M_0$ );
  while exists a node  $n \in N$  such that  $n$  is unprocessed do
    Flag the node  $n$  as processed;
     $F = \text{GetEnabledTransitions}(n)$ ;
    for each transition  $t \in F$  do
       $Q = \text{GetEnablingDegrees}(n, t)$ ;
      for each degree  $q \in Q$  do
         $m' = \text{FireTransition}(n, t, q)$ ;
        if a node with  $m'$  does not exist in  $N$  then
          AddNewNode ( $m'$ );
        end
         $n' = \text{GetNode}(m')$ ;
        if an edge  $(n, t, q, n')$  does not exist in  $E$  then
          AddNewEdge ( $n, t, q, n'$ );
        end
      end
    end
  end
end
end
end
end
  
```

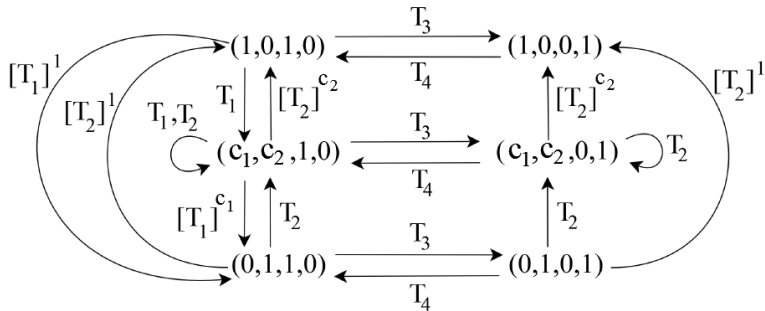
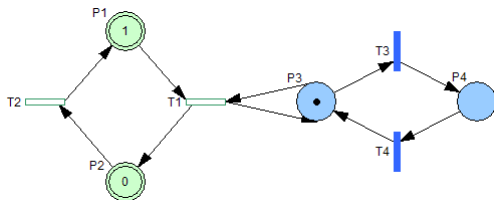
Coverability graph example.



Coverability graph example.



Coverability graph example.



Coverability graphs for unbounded hybrid Petri nets.

- $G_{hu} = (N, E)$
 - $N \subseteq (\mathbb{R}^+ \cup \{\omega\} \cup \{c_1, \dots, c_{|P_C|}\})^{|P_C|} \times (\mathbb{N} \cup \{\omega\})^{|P_D|}$
 - Macro-markings with ω symbol.

Algorithm 2

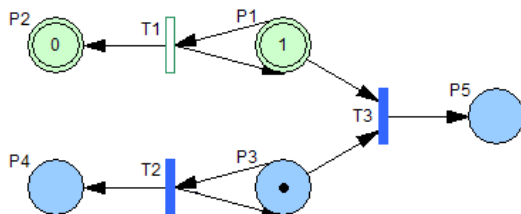
- Method:

- `FireTransition()`

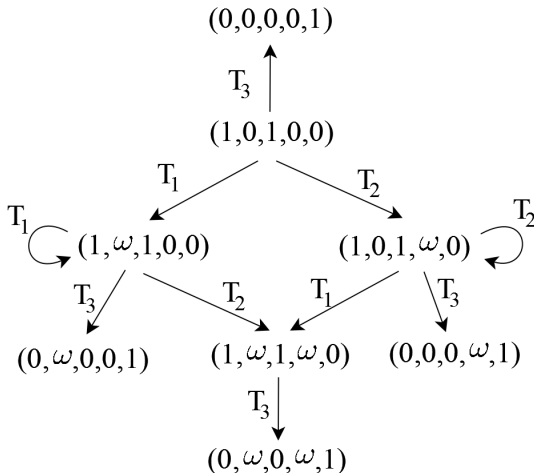
- Macro-markings with ω symbol.

- Propagation to succeeding macro-markings.

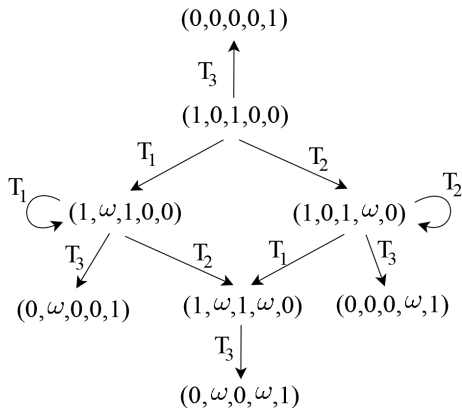
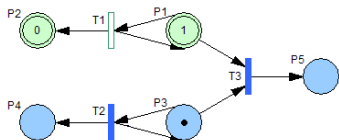
Coverability graph example.



Coverability graph example.



Coverability graph example.



Conclusion

- Summary:
 - Definitions of coverability graphs.
 - Algorithms for their computation.

- Future work:
 - Tool implementation.

Thank you for your attention.

Questions