Algorithms for Computing Coverability Graphs for Hybrid Petri Nets

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MEMICS 2008
Outline

1. Introduction
2. Hybrid Petri Nets
3. Coverability Graphs
4. Conclusion
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.

\[ G_{hb} = (N, E) \]

\[ N \subseteq (\mathbb{R}^+ \cup \{ c_1, \ldots, c_{|P_C|}\})^{|P_c|} \times \mathbb{N}^{|P_D|} \]

\[ E \subseteq N \times T \times ((\mathbb{Q}^+ \setminus \{0\}) \cup \{ c_1, \ldots, c_{|P_C|}\}) \times N \]
Algorithm 1

Method:

\begin{verbatim}
begin
  AddNewNode(M_0);
  while exists a node n \in N such that n is unprocessed do
    Flag the node n as processed;
    F = GetEnabledTransitions(n);
    for each transition t \in F do
      Q = GetEnablingDegrees(n, t);
      for each degree q \in Q do
        m' = FireTransition(n, t, q);
        if a node with m' does not exist in N then
          AddNewNode(m');
        end
      end
      n' = GetNode(m');
      if an edge \langle n, t, q, n' \rangle does not exist in E then
        AddNewEdge(n, t, q, n');
      end
    end
  end
end
\end{verbatim}
Coverability graph example.
Coverability graph example.
Coverability graph example.
Coverability graphs for unbounded hybrid Petri nets.

- $G_{hu} = (N, E)$
  - $N \subseteq (\mathbb{R}^+ \cup \{\omega\} \cup \{c_1, \ldots, c_{|P_c|}\})^{|P_c|} \times (\mathbb{N} \cup \{\omega\})^{|P_D|}$
  - Macro-markings with $\omega$ symbol.
Algorithm 2

Method:
- FireTransition()
  - Macro-markings with $\omega$ symbol.
  - Propagation to succeeding macro-markings.
Coverability graph example.
Coverability graph example.

- $(0,0,0,0,1)$
  - $T_3$ to $(1,0,1,0,0)$
- $(1,0,1,0,0)$
  - $T_1$ to $(1,1,1,0,0)$
  - $T_2$ to $(1,0,1,\omega,0)$
- $(1,1,1,0,0)$
  - $T_1$ to $(1,0,1,\omega,0)$
  - $T_3$ to $(0,\omega,0,0,1)$
- $(1,0,1,\omega,0)$
  - $T_2$ to $(1,0,1,\omega,0)$
  - $T_3$ to $(0,\omega,0,\omega,1)$
- $(0,\omega,0,0,1)$
  - $T_3$ to $(0,\omega,0,\omega,1)$
Coverability graph example.
Conclusion

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

Future work:
- Tool implementation.
Thank you for your attention.

Questions