Preliminary of Petri nets in the Paper

Symbolic State Estimation in Bounded Timed Labeled Petri Nets[1]

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A Petri net is a quadruple $N = (P, T, Pre, Post)$, where P is a set of m places, T is a set of n transitions, and $Pre : P \times T \to \mathbb{N}$ and $Post : P \times T \to \mathbb{N}$ are the pre- and post-incidence functions that specify the arcs pointing from places to transitions, and vice versa (the notation $\mathbb{N}$ represents the set of non-negative integers). Functions Pre and $Post$ can be tabulated and further represented by two $m \times n$ matrices indexed by P and T, respectively. We use $C = Post - Pre$ to represent the incidence matrix of a Petri net. A marking of a Petri net is defined as a mapping $M : P \to \mathbb{N}$ that assigns to each place of a Petri net a non-negative integer number of tokens, which is graphically represented by black dots. A marking M can be represented by a column vector with m elements. We use $M(p)$ to represent the number of tokens in place p at marking M, and for economy of space, denote a marking M as $M = \sum_{p \in P} M(p) \cdot p$. A Petri net system $\langle N, M_0 \rangle$ is a net structure N with an initial marking M_0.

A transition t is enabled at a marking M if $M \geq Pre(\cdot, t)$ and may fire yielding a marking $M' = M + C(\cdot, t)$ (briefly denoted as $M[t\rangle M'$). We write $M[\sigma\rangle$ to denote that a sequence of transitions $\sigma = t_{j1} \cdots t_{jk}$ is sequentially enabled at M, and $M[\sigma\rangle M'$ to denote that the firing of σ yields M'. A marking M' is reachable from marking M if there exists a sequence of transitions σ such that $M[\sigma\rangle M'$, and the set of all markings reachable from M_0 is denoted by $R(N, M_0)$. If there exists a non-negative integer $k \in \mathbb{N}$ such that for all places $p \in P$ and all reachable markings $M \in R(N, M_0)$, $M(p) \leq k$ holds, the net system $\langle N, M_0 \rangle$ is said to be bounded, or k-bounded. A Petri net is said to be acyclic if there are no oriented cycles.

[1]To cite this note, please refer to Y. F. Dong, N. Q. Wu, and Z. W. Li, "State Estimation in TLPN," Available: https://github.com/dongyifan199/Opacity-on-TLPN, Jul. 2022.