Glossary of properties for Petri nets

In this document we recall the meaning of all the properties that could be analyzed with our tool: PN-Suite. They could be classified into behavioural and structural properties.

Behavioural properties are those that depend on the initial marking.

- *strongly live*: A Petri net is strongly live when all of its transitions are strongly live. A transition is strongly live when for every reachable marking there exists a firing sequence after which this transition is enabled.
- *weakly live*: A Petri net is weakly live when all of its transitions are weakly live. A transition is weakly live if an infinite firing sequence exists that fires this transition infinitely often.
- *simply live*: A Petri net is simply live when all of its transitions are simply live. A transition is simply live when it can be fired at least once.
- *deadlock freedom*: A Petri net is deadlock-free if every reachable marking enables some transition.
- *persistent*: A Petri net is persistent if, for any two enabled transitions, the firing of one transition will not disable the other.
- *backwards persistent*: A LTS is persistent if for all reachable states s and enabled labels a, b ($a \neq b$), there is a state r so that both $s[ab\rangle r$ and $s[ba\rangle r$. A Petri net is persistent if its reachability graph is persistent.
- *bounded*: A Petri net is bounded if there is an upper limit for the number of tokens in each place.
- *k-bounded*: A Petri net is k-bounded if there is an upper limit no bigger than k for the number of tokens in each place. That is, in every reachable marking, every place contains at most k tokens.

- *safe*: A Petri net is safe if it is 1-bounded.
- *k-marking*: The initial marking of each place is a multiple of k.
- *reversible*: A Petri net is reversible if its reachability graph is reversible, that is, for each marking M in $R(M_0)$, M_0 is reachable from M. Thus, in a reversible net one can always get back to the initial marking.
- *binary conflict free*: A Petri net is binary conflict free (bicf) if in every reachable marking M and for any enabled pair of transitions ($M[t_1\rangle, M[t_2\rangle$ and $t_1 \neq t_2$), enough tokens for both transitions are present ($\forall p \in P\colon M(p) \geq F(p, t_1) + F(p, t_2)$).
- *behaviourally conflict free*: A Petri net is behaviourally conflict free (bcf) if in every reachable marking M and for any enabled pair of transitions ($M[t_1\rangle, M[t_2\rangle$ and $t_1 \neq t_2$), the presets of the transitions are disjoint (${}^\bullet t_1 \cap {}^\bullet t_2 = \emptyset$).

Structural properties are those that depend on the topological structure of the Petri net. They are independent of the initial marking in the sense that these properties hold for any initial marking or are concerned with the existence of certain firing sequences from some initial marking.

- *strongly connected*: A Petri net is strongly connected if, for each two elements x and y, there exists a directed path leading from x to y. A directed path of a net is a nonempty sequence $x_0 \ldots x_k$ of elements satisfying $x_i \in x_{i-1}^\bullet$ for each i $(1 < i < k)$. It leads from x_0 to x_k.
- *weakly connected*: A Petri net is weakly connected if, for each two elements x and y, there exists an undirected path leading from x to y. An undirected path of a net is a nonempty sequence $x_0 \ldots x_k$ of elements satisfying $x_i \in {}^\bullet x_{i-1} \cup x_{i-1}^\bullet$ for each i $(1 < i < k)$. It leads from x_0 to x_k.
- *isolated elements*: A Petri net contains isolated elements when at least one element's preset and postset is empty. An element x is isolated if ${}^\bullet x = x^\bullet = \emptyset$.
- *free choice*: A Petri net is free choice if $\forall t_1, t_2 \in T\colon {}^\bullet t_1 \cap {}^\bullet t_2 \neq \emptyset \Rightarrow {}^\bullet t_1 = {}^\bullet t_2$.
- *restricted free choice*: A Petri net is restricted free choice if $\forall t_1, t_2 \in T\colon {}^\bullet t_1 \cap {}^\bullet t_2 \neq \emptyset \Rightarrow |{}^\bullet t_1| = |{}^\bullet t_2| = 1$.

- *asymmetric choice*: A Petri net is asymmetric choice if $\forall p_1, p_2 \in P \colon p_1^\bullet \cap p_2^\bullet \neq \emptyset \Rightarrow p_1^\bullet \subseteq p_2^\bullet \vee p_1^\bullet \supseteq p_2^\bullet$.
- *siphons*: A siphon is a set of places so that every transition consuming tokens from one of these places also produces tokens in at least one place in the set. Thus, a siphon has a behavioral property that if it is token-free under some marking, then it remains token-free under each successor marking. A siphon is said to be minimal if it does not contain any other siphon.
- *traps*: A trap is a set of places so that every transition producing tokens on one of these places also consumes tokens from at least one place in the set. Thus, a trap has a behavioral property that if it is marked (i.e., it has at least one token) under some marking, then it remains marked under each successor marking. A trap is said to be minimal if it does not contain any other trap.
- *pure*: A Petri net is pure if there are no side conditions. A side condition is a loop between a place p and a transition t ($F(p,t) > 0$ and $F(t,p) > 0$). A Petri net is pure when every transition either consumes or produces tokens on a place, but not both.
- *nonpure only simple side conditions*: A Petri net is nonpure when there exists at least one self-loop. A side condition is simple, when both arcs of the self-loop have a weight of 1.
- *homogeneous*: A Petri net is homogeneous if all outgoing flows from a place have the same weight. That is: $\forall p \in P \colon \forall t_1, t_2 \in p^\bullet \colon F(p, t_1) = F(p, t_2)$.
- *plain*: A Petri net is plain if every flow has a weight of at most one.
- *conflict free*: A Petri net is conflict free if it is plain and every place either has at most one entry in its postset or its preset is contained in its postset. That is: $\forall p \in P \colon |p^\bullet| \leq 1 \vee p^\bullet \subset {}^\bullet p$.
- *output-nonbranching*: A Petri net is output-nonbranching if it is plain and every place's postset contains at most one entry. That is: $\forall p \in P \colon |p^\bullet| \leq 1$.
- *t-net*: A Petri net is a T-net if it is plain and the preset and postset of any place has at most one entry.
- *s-net*: A Petri net is a S-net if it is plain and the preset and postset of any transition has at most one entry.