

Simulations of the Minimax Basis Reachability Graph

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Abstract

In this note we report the simulation results of three benchmarks based on the minimax basis reachability graph (minimax-BRG). All tests are executed based on a laptop with Intel i7-5500U 2.40 GHz processor and 8 GB RAM.

1 Benchmark I

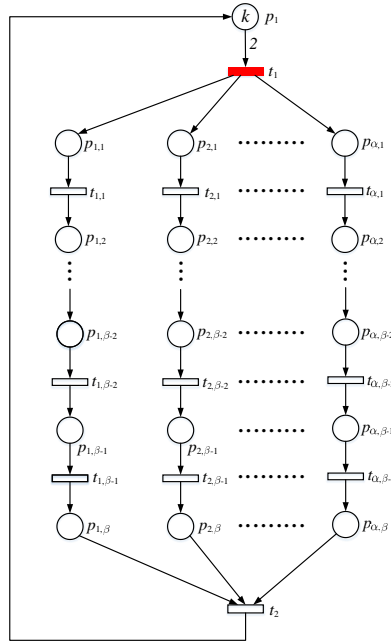


Fig. 1: Benchmark I

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As shown in Fig. 1, the first benchmark is a parameterized net system taken from [2] which represents a manufacturing system that contains a number of parallel production lines. However, some minor adjustments are made, i.e., the weight from p_1 to t_1 is increased to 2 and a series of transitions between places $p_{1,\beta-1}$ to $p_{\alpha,\beta-1}$ are removed. There are three parameters, i.e., k, α and β . With the change of the two parameters α and β , the scale of the system changes correspondingly. k indicates the initial resource quantity, while α and β represent the number of parallel lines and the length of each production line, respectively. Let $T_E = \{t_1\}$ (marked in red). For different values of k, α and β , the number of minimax basis markings $\mathcal{M}_{\mathcal{B}_M}$ and all reachable markings $M \in R(N, M_0)$, as well as their computing times are listed in Table 1. Through all the testings, it can be concluded that the computation efficiency of obtaining the minimax-BRG is outperformed that of the reachability graph (RG).

Table 1: Analysis of the RG and minimax-BRG for the net in Fig. 1 with $T_E = \{t_1\}$.

Run	k	α	β	$ R(N, M_0) $	Time (s)	$ \mathcal{M}_{\mathcal{B}_M} $	Time (s)	$ \mathcal{M}_{\mathcal{B}_M} / R(N, M_0) $	Time ratio
1	5	4	3	2921	21	7	0.03	0.2%	0.1%
2	6	4	3	14299	532	10	0.3	< 0.1%	< 0.1%
3	7	4	3	-	o.t.	13	0.9	-	-
4	8	4	3	-	o.t.	17	16	-	-
5	9	4	3	-	o.t.	21	48	-	-
6	10	4	3	-	o.t.	26	515	-	-
7	11	4	3	-	o.t.	31	1400	-	-
8	5	4	4	21029	1168	7	0.15	<0.1%	<0.1%
9	6	4	4	-	o.t.	10	14	-	-
10	7	4	4	-	o.t.	13	42	-	-
11	8	4	4	-	o.t.	17	4476	-	-

* The computing time is denoted by *overtime* (o.t.) if the program does not terminate within 36,000 seconds (10 hours).

2 Benchmark II

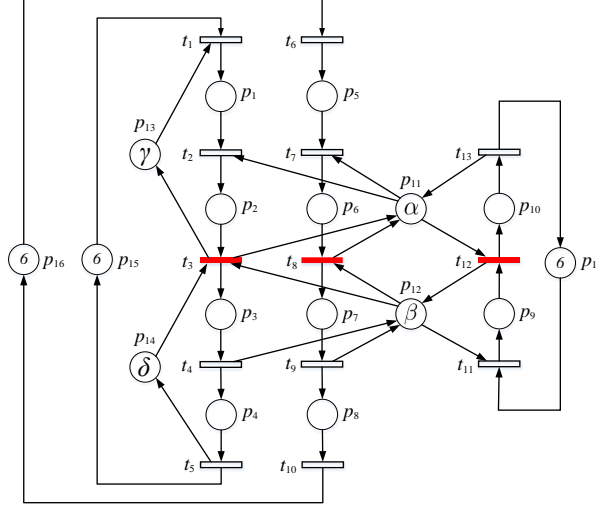


Fig. 2: Benchmark II

Modified from a Petri net in [3], a parameterized net system shown in Fig. 2 is adopted as the second benchmark. The four parameters α, β, γ , and δ represent the numbers of tokens in places p_{11}, p_{12}, p_{13} and p_{14} , respectively. This system contains 17 places and 13 transitions and its scale does not change with changes in parameters. With $T_E = \{t_3, t_8, t_{12}\}$ (marked in red) and $T_I = \{t_1, t_2, t_4, t_5, t_6, t_7, t_9, t_{10}, t_{11}, t_{13}\}$, the analysis of minimax-BRG in comparison with the corresponding RG is illustrated in Table 2.

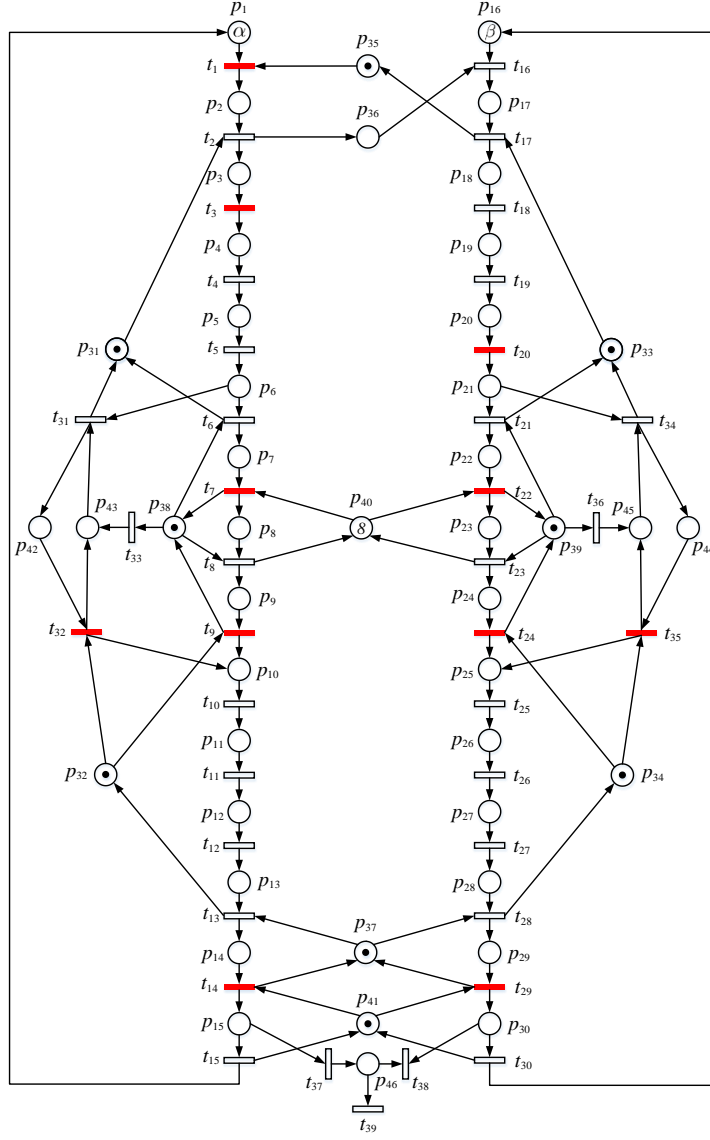


Fig. 3: Benchmark III