Model Checking Contest @ Petri Nets 2017

7th edition, Zaragoza, Spain, June 27, 2017

Complete Results for the 2017 Edition of the Model Checking Contest

Last Updated
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1. Introduction

This page summarizes the results for the 2017 edition of the Model Checking Contest (MCC'2017). This page is divided in three sections:

- First, we **list the qualified tools** for the MCC'2017,
- Then, we provide some informations about **the experimental conditions of the MCC'2017**,
- Then, we present an access **to details about results**,
- Then, we provide the **list of winners of the MCC'2017**,
- Finally, we provide an attempt to evaluate **tool reliability** based on the comparison of the results provided in the contest.

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2. List of Qualified Tools in 2017

Ten tools where submitted this year. They all successfully went through a qualification process requiring about 1500 runs (each tool had to answer each examination for the first instance of each «known» model).

Data about these tools are summarized in the table below. For any tool, you can download the disk image that was provided with all its data. You may use these to reproduce measures locally and perform comparison with your own tool on the same benchmark.

Summary of the Participating Tools (alphabetical order)

Tool name	Supported Petri nets	Representative Author	Origin	Type of execution	Link to the submitted disk image	Reported Techniques (all examinations)
GreatSPN-Meddly	P/T and colored	Elvio Amparore	Univ. Torino (Italy)	Sequential Processing		DECISION_DIAGRAMS TOPOLOGICAL UNFOLDING_TO_PT USE_NUPN
ITS-Tools	P/T and colored	Yann Thierry-Mieg	UNiv. P & M. Curie (France)	Collateral Processing		BMC DECISION_DIAGRAMS EXPLICIT INITIAL_STATE K_INDUCTION LTSMIN PARTIAL_ORDER SAT_SMT TAUTOLOGY TOPOLOGICAL USE_NUPN
LoLA	P/T and colored	Karsten Wolf & Torsten Liebke	Univ. Rostock (Germany)	Collateral Processing		EXPLICIT SAT_SMT SEQUENTIAL_PROCESSING STATE_COMPRESSION STUBBORN_SETS SYMMETRIES TOPOLOGICAL USE_NUPN
LTSMin	P/T	Jeroen Meijer & Jaco van de Pol	Univ. Twente (The Netherlands)	Parallel Processing		DECISION_DIAGRAMS EXPLICIT USE_NUPN
MARCIE	P/T and colored	Christian Rohr	Univ. Cottbus (Germany)	Sequential Processing		DECISION_DIAGRAMS UNFOLDING_TO_PT
smart	P/T	Andrew Miner & Gianfranco Ciardo	Iowa State University (USA)	Sequential Processing		DECISION_DIAGRAMS
Spot	P/T and colored	Maximilien Colange	Epita (France)	Sequential Processing		EXPLICIT STATE_COMPRESSION
Tapaal	P/T and colored	Jiri Srba	Univ. Aalborg (Denmark)	Collateral Processing		EXPLICIT STATE_COMPRESSION STRUCTURAL_REDUCTION STUBBORN_SETS LINEAR_PROGRAMMING
Tina.sift	P/T and colored	Bernard Berthomieu & Silvano Dal Zilio	LAAS/CNRS, Univ. de Toulouse (France)	Sequential Processing		EXPLICIT STATE_COMPRESSION STRUCTURAL_REDUCTION
Tina.tedd	P/T and colored	Bernard Berthomieu & Silvano Dal Zilio	LAAS/CNRS, Univ. de Toulouse (France)	Sequential Processing		DECISION_DIAGRAMS STATE_COMPRESSION STRUCTURAL_REDUCTION

The table below lists the techniques reported per examination (and for all the tool variants when applicable).

Techniques Reported by the Participating Tools (per examination)

Tool name	StateSpace	UpperBounds	Reachability	CTL	LTL
GreatSPN	DECISION_DIAGRAMS TOPOLOGICAL UNFOLDING_TO_PT USE_NUPN	DECISION_DIAGRAMS TOPOLOGICAL UNFOLDING_TO_PT USE_NUPN	DECISION_DIAGRAMS TOPOLOGICAL UNFOLDING_TO_PT USE_NUPN	DECISION_DIAGRAMS TOPOLOGICAL UNFOLDING_TO_PT USE_NUPN	—
ITS-Tools	DECISION_DIAGRAMS TOPOLOGICAL USE_NUPN	DECISION_DIAGRAMS TOPOLOGICAL USE_NUPN	BMC DECISION_DIAGRAMS EXPLICIT INITIAL_STATE K_INDUCTION LTSMIN PARTIAL_ORDER SAT_SMT TAUTOLOGY TOPOLOGICAL USE_NUPN	DECISION_DIAGRAMS TOPOLOGICAL USE_NUPN	DECISION_DIAGRAMS EXPLICIT LTSMIN PARTIAL_ORDER SAT_SMT TOPOLOGICAL USE_NUPN
LoLA	—	EXPLICIT STATE_COMPRESSION STUBBORN_SETS USE_NUPN	EXPLICIT SAT_SMT STATE_COMPRESSION STUBBORN_SETS SYMMETRIES TOPOLOGICAL USE_NUPN	EXPLICIT STATE_COMPRESSION STUBBORN_SETS TOPOLOGICAL USE_NUPN	EXPLICIT STATE_COMPRESSION STUBBORN_SETS TOPOLOGICAL USE_NUPN
LTSMin	DECISION_DIAGRAMS USE_NUPN	DECISION_DIAGRAMS USE_NUPN	DECISION_DIAGRAMS USE_NUPN	DECISION_DIAGRAMS USE_NUPN	EXPLICIT USE_NUPN
MARCIE	DECISION_DIAGRAMS UNFOLDING_TO_PT	DECISION_DIAGRAMS UNFOLDING_TO_PT	DECISION_DIAGRAMS UNFOLDING_TO_PT	DECISION_DIAGRAMS UNFOLDING_TO_PT	—
smart	DECISION_DIAGRAMS	—	—	—	—
Spot	—	—	—	—	EXPLICIT STATE_COMPRESSION
Tapaal	EXPLICIT STATE_COMPRESSION	EXPLICIT STATE_COMPRESSION STRUCTURAL_REDUCTIONS	EXPLICIT STATE_COMPRESSION LINEAR_PROGRAMMING	EXPLICIT STATE_COMPRESSION STRUCTURAL_REDUCTION STUBBORN_SETS	—

Tina.sift	STATE_COMPRESSION EXPLICIT STRUCTURAL_REDUCTION	—	—	—	—
Tina.tedd	DECISION_DIAGRAMS STATE_COMPRESSION STRUCTURAL_REDUCTION	—	—	—	—

3. Experimental Conditions of the MCC'2017

Each tool was submitted to 9 171 executions in various conditions (1019 model/instances and 9 examinations per model/instance) for which it could report: DNC (do not compete), CC (cannot compute) or the result of the query. These executions were handled by **BenchKit**, that was developed in the context of the MCC for massive testing of software. Then, from the raw data provided by **BenchKit**, some post-analysis scripts consolidated these and computed a ranking.

The number of model/instances has been reduced since 2016 because, for «Known» (and thus «Stripped») models, we removed numerous instances for which all tools where providing results in the past edition, in order to preserve a reasonable ratio between «Surprise» models and existing ones. This could save some CPU time too.

16 GB of memory were allocated to each virtual machine (both parallel and sequential tools) and a confinement of one hour was considered (execution aborted after one hour). So, a total of 91 710 runs (execution of one examination by the virtual machine) generated 29 GB of raw data (essentially log files and CSV of sampled data).

The table below shows some data about the involved machines and their contribution to the computation of these results.

Involved Machines and Execution of the Benchmarks

	bluewhale03	bluewhale07	Caserta	Ebro	Quadhexa-2	Small	Total
Logical Cores	40 @ 2.8GHz	32 @ 3.2 GHz	96 @ 2.20 GHz	64 @ 2.7GHz	24 @ 2.66GHz	12×24 @ 2.4GHz	—
Memory (GB)	512	1024	1024	1024	128	12×64	—
Used Cores (sequential tools)	31, 31 VM in //	31, 31 VM in //	63, 63 VM in //	63, 63 VM in //		12×3, 12×3 VM in //	—
Used Cores (parallel tools)	36 (4 per VM), 9 VM in //	28 (4 per VM), 7 VM in //	92 (4 per VM), 23 VM in //	60 (4 per VM), 15 VM in //	used to generate formulas	12×12 (4 per VM), 12×3 VM in //	—
Number of runs	15 210	10 080	24 660	21 600		20 160	**91 710**
Total CPU required	221d, 11h, 34m, 37s	143d, 12h, 49m, 57s	389d, 20h, 43m, 6s	422d, 10h, 24m, 3s	≈7d (not in total)	370d, 15h, 27m, 29s	**1547d, 22h, 59m, 11s**
Total CPU	***about 4 years and 2 months and 27 days***						-
Time spent to complete benchmarks	**about 15 days**						-
Estimated boot time of VMs + management (overhead)	**15d, 22h (Included in total CPU)**						-

We are pleased to thanks those who helped in the execution of tools:

- Bluewhale03 and Bluewhale07 were made available by colleagues at ***Université de Genève*** ,
- Caserta was made available by colleagues at ***University of Twente*** ,
- Ebro was made available by colleagues at ***Rostock University*** ,
- Quadhexa-2 was made available by colleagues at ***Université Paris Nanterre*** ,
- Small is one of the two clusters at LI6 (we got 12 nodes out of 23) ***Université Pierre & Marie Curie*** .

4. The Results of the MCC'2017

This First table below presents detailed results about the MCC'2017.

Details about the Examinations in the MCC'2017 (part I): Details about Results and Scoring + Model Performance Charts

	Details about Results and Scoring	Model Performance Charts	Tool Resource consumption
StateSpace			
UpperBounds			
ReachabilityCardinality			
ReachabilityDeadlock			
ReachabilityFireability			
CTLCardinality			
CTLFireability			
LTLCardinality			
LTLFireability			

This Second table below presents some performance analysis related to tools during the MCC'2017.

Details about the examinations in the MCC'2017 (part II) Tool Performance Charts

	All models	«Surprise» models only	«Stripped» models only	«Known» models only
GreatSPN				
ITS-Tools				
LoLA				
LTSMin				
MARCIE				
smart				
Spot				
Tapaal				
TINA.sift				
TINA.tedd				

You can **download the full archive** (2 GB compressed and 29 GB uncompressed) of the 91 710 runs processed to compute the results of the MCC'2017. This archive contains execution traces, execution logs and sampling, as well as a large CSV files that summarizes all the executions and gnuplot scripts and data to generate the charts produced in the web site (please have a look on the READ_ME.txt file). Yo may get separately the two mostly interesting CSV files:

- `GlobalSummary.csv` that summarizes all results from all runs in the contest (15 MB when expanded),
- `raw-result-analysis.csv` that contains the same data as the previous one but enriched with scoring information and the expected results (computed as a majority of tools pondered by their confidence rate, 21 MB when expanded).

Note that from the two CSV file, you can identify the unique run identifier that allors you to find the traces and any information in the archive (theyr are also available on the web site when the too did participated).

5. The Winners for the MCC'2017

This section presents the results for the main examinations that are:

- ***State Space*** generation,
- ***UpperBounds*** computation,
- ***Reachability*** Formulas (ReachabilityCardinality, ReachabilityDeadlock, ReachabilityFireability),
- ***CTL*** Formulas (CTLCardinality, CTLFireability),
- ***LTL*** Formulas (LTLCardinality, LTLFireability),

Each examination for a given model brought 16 points (see the details in the slides). A multiplier was applied depending to the model category:

- ***×1*** for «Known» models,
- ***×2*** for «Stripped» models,
- ***×6*** for «Surprise» models.

We manually detected a few values (3 or 4) for which apparently the majority of tools where wrong. However, this has only a minor impact on the scoring and could not change the order of tools for any category. A way to deal with such (rare) situations will be considered for the next edition.

Presented scores are dispatched over the three categories of models (yellow for «Known» models, blue for «Stripped» models and red for «Surprise» models). The maximum number of points that a tool could get for a given examination was:

- ***8 400*** for «Known» models (+ a maximum of 4 200 bonus points),
- ***25 200*** for «Stripped» models (+ a maximum of 12 600 bonus points),
- ***11 120*** for «Surprise» models (+ a maximum of 5 560 bonus points).

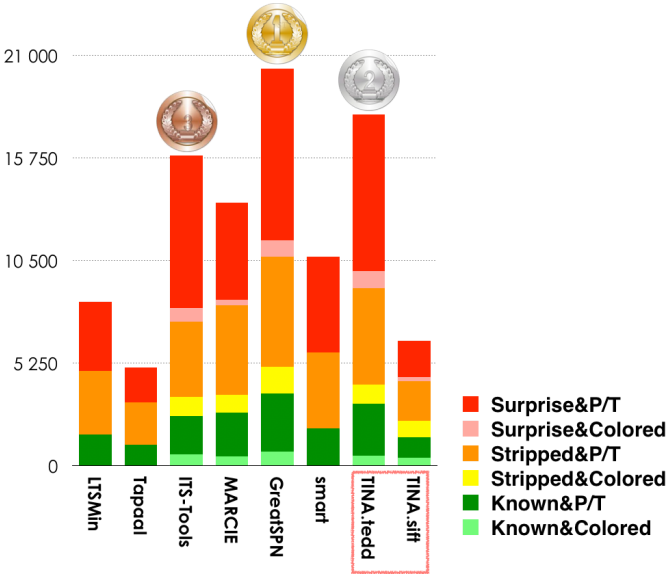
Note that bonuses are not always collected.

5.1. Winners in the StateSpace Category

This examination had the highest participation rate (8 tools out of 10). Results based on the scoring shown below is:

- ***GreatSPN*** ranked first (20 302 pts),
- ***TINA.tedd*** ranked second (17 988 pts),
- ***ITS-Tools*** ranked third (15 880 pts).

Then, tools rank in the following order: MARCIE (13 462 pts), smart (10 688 pts), LTSMin (8 400 pts), TINA.stif (6 402 pts), and Tapaal (5 040 pts).



Note that all the variants of Tina were considered as one tool with regards to the scoring (see rule ***E-4.5.***).

Estimated Tool Confidence rate for StateSpace (based on the «significant values» computed by tools) see section 6. for details

Tool name	Reliability	Correct Values	«significant values»
GreatSPN	100%	1611	1611
ITS-Tools	100%	1143	1143
LTSMin	100%	792	792
MARCIE	100%	1499	1499
smart	79.59%	862	862
Tapaal	100%	477	477
TINA.sift	97.84%	724	740
TINA.tedd	100%	1641	1641

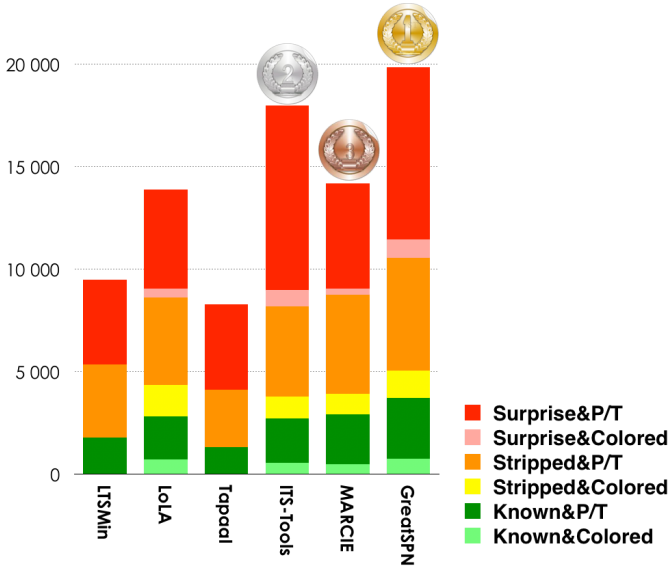
Please consider note 1 on tool confidence (bottom of this page).

5.2. Winners in the UpperBounds Category

6 (+1, see below) tools out of 12 participated in this examination. Results based on the scoring shown below is:

- ***GreatSPN*** ranked first (19 834 pts),
- ***ITS-Tools*** ranked second (17 933 pts),
- ***MARCIE*** ranked third (14 200 pts).

Then, tools rank in the following order: LoLA (13 894 pts), LTSMin (9 496 pts), and Tapaal (8 286 pts).



Estimated Tool Confidence rate for UpperBound (based on the «significant values» computed by tools) see section 6. for details

Tool name	Reliability	Correct Values	«significant values»
GreatSPN	98.89%	5709	5773
ITS-Tools	100%	5645	5645
LoLA	100%	4014	4014
LTSMin	100%	3958	3958
MARCIE	100%	5726	5726
Tapaal	100%	3088	3088

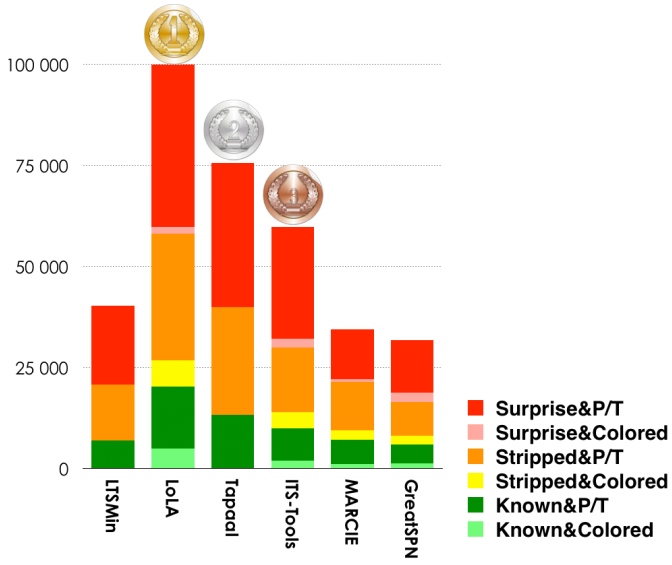
Please consider note 1 on tool confidence (bottom of this page).

5.3. Winners in the Reachability Formulas Category

8 tools out of 12 participated in these examinations (ReachabilityDeadlock, ReachabilityCardinality and ReachabilityFireability). Results based on the scoring shown below is:

- ***LoLA*** ranked first (99 942 pts),
- ***Tapaal*** ranked second (75 669),
- ***ITS-Tools*** ranked third (59 805 pts).

Then, tools rank in the following order: LTSMin (40 217 pts), MARCIE (34 345 pts), and greatSPN (31 733 pts).



Estimated Tool Confidence rate for Reachability (based on the «significant values» computed by tools) see section 6. for details

Tool name	Reliability	Correct Values	«significant values»
GreatSPN	99.18%	7742	7806
ITS-Tools	94.68%	15933	16828
LoLA	100%	17908	17908
LTSMin	100%	11964	11964
MARCIE	100%	10701	10701
Tapaal	100%	16205	16205

Please consider note 1 on tool confidence (bottom of this page).

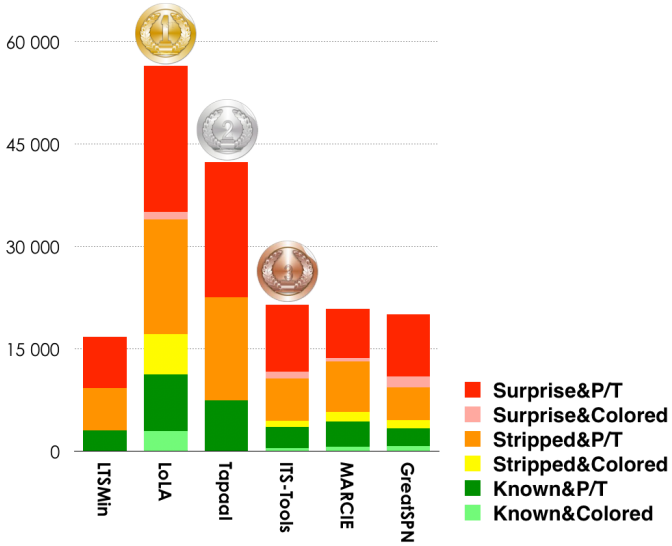
5.4. Winners in the CTL Formulas Category

5 tools out of 12 participated in these examinations (CTLCardinality and CTLFireability). Results based on the scoring shown below is:

- ***LoLA*** ranked first (56 429 pts),

- ***Tapaal*** ranked second (42 429 pts),
- ***ITS-Tools*** ranked third (21436 pts).

Then, tools rank in the following order: MARCIE (20 851 pts), GreatSPN (20 091 pts), and LSMin (16 792 pts).



Estimated Tool Confidence rate for CTL (based on the «significant values» computed by tools) see section 6. for details

Tool name	Reliability	Correct Values	«significant values»
GreatSPN	99.07%	6864	6928
ITS-Tools	100%	7603	7603
LoLA	99.62%	8598	8630
LTSMin	100%	7055	7055
MARCIE	100%	9115	9115
Tapaal	100%	7462	7462

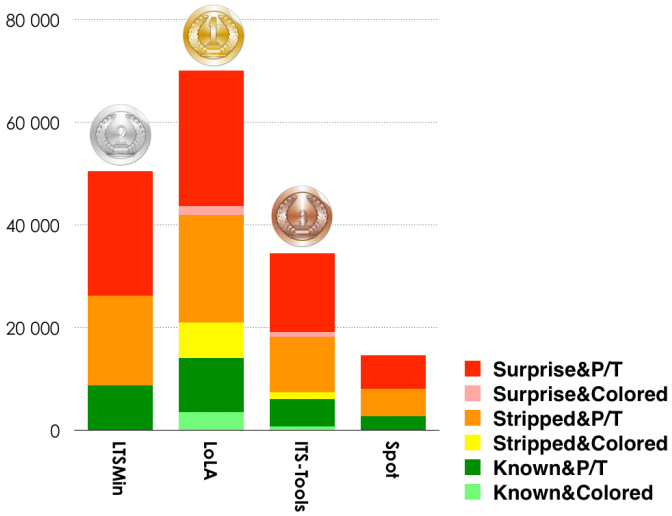
Please consider note 1 on tool confidence (bottom of this page).

5.5. Winners in the LTL Formulas Category

4 tools out of 12 participated in these examinations (LTLCardinality and LTLFireability). Results based on the scoring shown below is:

- ***LoLA*** ranked first (70 127 pts),
- ***LTSMin*** ranked second (50 520 pts),
- ***ITS-Tools*** ranked third (34 419 pts).

Then, Spot ranks 4th (14 591 pts). Please note hat Spot was participating in the LTLCardinality examination only, which explains the gap between 3rd and 4th ranked tools.



Estimated Tool Confidence rate for LTL (based on the «significant values» computed by tools) see section 6. for details

Tool name	Reliability	Correct Values	«significant values»
ITS-Tools	96.33%	11809	12259
LoLA	99.97%	13647	13651
LTSMin	100%	13718	13718
Spot	100%	5764	5764

Please consider note 1 on tool confidence (bottom of this page).

6. Estimation of Tool Confidence

As for last year, we tried to introduce some confidence analysis to enforce the computation of «right results» based on the answers of participating tools. To do so, we considered each value provided in the contest (a value is a partial result such as the result of a formula or a number provided for state space, bound computation, etc.). To do so, we processed as follows:

1. For each «line» (all tools for a given examination for a given instance), we selected all «significant values» where at least 3 tools do agree.
2. Based on this subset of values, we computed the ratio between the selected values for the tool and the number of good answers. This ratio gave us a tool confidence rate (called reliability rate last year) that is provided in the table below.
3. This tool confidence rate rate was then applied to compute the scores presented in the dedicated section.

The table below provides, in first column, the computed confidence rates (that are naturally lower for tools where a bug was detected). Then, the table provides the number of correct results (column 2) out of the number of «significant values» selected for the tool (column 3). The last column shows the number of examination (and their type) the tool was involved in.

Estimated Tool Confidence rate (based on the «significant values» computed by tools)

Tool name	Reliability	Correct Values	«significant values»	Involved Examinations
GreatSPN	99.13%	21926	22118	**7** (StateSpace, UpperBounds, ReachabilityDeadlock, ReachabilityCardinality, ReachabilityFireability, CTLCardinality, CTLFireability)
ITS-Tools	96.91%	42133	43478	**9** (StateSpace, UpperBounds, ReachabilityDeadlock, ReachabilityCardinality, ReachabilityFireability, CTLCardinality, CTLFireability, LTLCardinality, LTLFireability)
LoLA	99.92%	44567	44603	**7** (UpperBounds, ReachabilityCardinality, ReachabilityFireability, CTLCardinality, CTLFireability, LTLCardinality, LTLFireability)
LTSMin	100%	37487	37487	**9** (StateSpace, UpperBounds, ReachabilityDeadlock, ReachabilityCardinality, ReachabilityFireability, CTLCardinality, CTLFireability, LTLCardinality, LTLFireability)
MARCIE	100%	27041	27041	**7** (StateSpace, UpperBounds, ReachabilityDeadlock, ReachabilityCardinality, ReachabilityFireability, CTLCardinality, CTLFireability)
smart	79.59%	862	1083	**1** (StateSpace)
Spot	100%	5764	5764	**1** (LTLCardinality)
Tapaal	100%	27498	27498	**7** (StateSpace, UpperBounds, ReachabilityDeadlock, ReachabilityCardinality, ReachabilityFireability, CTLCardinality, CTLFireability)
Tina.sift	97.84%	724	740	**1** (StateSpace)
Tina.tedd	100%	1641	1641	**1** (StateSpace)

Note 1 on tool confidence: there was a late change in the Â«KnownÂ» model Simpleloadbal (and, subsequently, for its corresponding Â«StrippedÂ» version) due to an unambiguity in the definition of color domains, detected during the qualification phase of some tools. Since it generated inconsistencies between the colored and version and its P/T equivalents depending of the ambiguous interpretation, it could potentially affecting the values of some results. Thus, tool confidence has been computed without the instances of this model. Simpleloadbal was not considered too when computing scores.