Model Checking Contest
results for 2016

Fabrice Kordon — LIP6, Univ. P. & M. Curie, France
Hubert Garavel — Inria/LIG, France
Lom Messan Hillah — LIP6 & Univ. Paris Ouest Nanterre, France
Francis Hulin-Hubard — LSV, CNRS/ENS de Cachan, France
Emmanuel Paviot-Adet — LIP6 & Univ. Paris Descartes, France
Loïg Jézequel, IRCCyN, Univ. Nantes, France
César Rodrígez — LIPN, Univ. Paris 13, France
Objectives

Promoting model checking tools

- Compare and debug
  - Oracle handled by the developers themselves
- Enhance reproducibility of results
  - BenchKit + dedicated environment using virtualization (easier replay)
  - Submissions available online
- Encourage tools and tool support
  - Observatory for the community
  - Provide reusable and fair comparison charts and data

Creating a common database of benchmark

- Models from various origins (more to tell later)
  - PNML is a good format for this

Competing tools not only dedicated to Petri nets

- Tools coming from other communities
Model Checking Contest — who does what?

Managing Models

Hubert Garavel (Inria)

Managing Execution + analysis

Fabrice Kordon (UPMC)

Managing Formulas

Loïg Jezequel (U. Nantes)

Emmanuel Paviot-Adet (UP5)

Lom Hillah (UPOND)

Francis Hulin-Hubard (CNRS)

César Rodríguez (UP13)
Tools Submitted this Year

- **ITS-Tools**
  - Univ. P. & M. Curie, F

- **LoLA**
  - Univ. Rostock, D

- **LTSMin**
  - Univ. Twente, NL

- **MARCIE**
  - Univ. Cottbus, D

- **PeCan (new)**
  - Univ. HoChiMinh, VN

- **pnmc**
  - Steery.io, F

- **PNXDD**
  - Univ. P. & M. Curie, F

- **Smart (new)**
  - Iowa State Univ, USA

- **tapaal**
  - Univ. Aalborg, DK
  - 3 variants (PAR, SEQ, EXP)

- **ydd-pt (new)**
  - Univ. Geneva, CH
Tools Submitted this Year

- ITS-Tools
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- pnmc
  - Steery.io, F

- Not present this year
  - Cunf, GreatSPN, StraTAGem

- ydd-pt (new)
  - Univ. Geneva, CH

- All VMs will be published
  - Reproducibility can be achieved

-‣ 3 variants (PAR, SEQ, EXP)
Techniques Reported by Tools

<table>
<thead>
<tr>
<th>Tools</th>
<th>parallelism</th>
<th>Techniques</th>
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<tbody>
<tr>
<td>Marcie</td>
<td>/</td>
<td>SEQUENTIAL_PROCESSING DECISION_DIAGRAMS</td>
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<td></td>
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<td>/</td>
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<td></td>
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<td>DECISION_DIAGRAMS EXPLICIT</td>
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# Processing Capacity

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<thead>
<tr>
<th></th>
<th>bluewhale03</th>
<th>Ebro</th>
<th>Quadhexa-2</th>
<th>Small (cluster)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cores</td>
<td>40 @ 2.8GHz</td>
<td>64 @ 2.7GHz</td>
<td>24 @ 2.66GHz</td>
<td>11x24 @ 2.4GHz</td>
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</tr>
<tr>
<td>Memory (GB)</td>
<td>512</td>
<td>1024</td>
<td>128</td>
<td>11x64</td>
<td></td>
</tr>
<tr>
<td>Used Cores (1 per VM) for sequential tools</td>
<td>31</td>
<td>63</td>
<td>7</td>
<td>11x3, 5x3 VM in //</td>
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<td></td>
<td>31 VM in //</td>
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<td>5x3 VM in //</td>
<td></td>
</tr>
<tr>
<td>Used Cores (4 per VM) for parallel tools</td>
<td>36, 9 VM in //</td>
<td>60, 15 VM in //</td>
<td>20, 5 VM in //</td>
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<td>15 VM in //</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of runs</td>
<td>13 374</td>
<td>36 936</td>
<td>15 768</td>
<td>62 604</td>
<td>128 682</td>
</tr>
<tr>
<td>Total CPU required</td>
<td>156d, 17h, 44m, 59s</td>
<td>485d, 19h, 27m, 43s</td>
<td>203d, 0h, 25m, 47s</td>
<td>636d, 9h, 11m, 36s</td>
<td>1481d, 22h, 50m, 5s</td>
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<td>Total CPU</td>
<td></td>
<td></td>
<td></td>
<td>about 4 years and 20 days</td>
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<tr>
<td>Time spent to complete benchmarks</td>
<td></td>
<td></td>
<td></td>
<td>about 22 days and 1 hours</td>
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<td>VM boot time of VMs + management (overhead)</td>
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**Less CPU than in 2015**

128 682 runs instead of 169 078 but more completed runs

**Thank you very much**

Université de Genève  
Rostock University  
Université Paris Ouest  
Université P. & M. Curie
Categories of Models

«known» models
- Those from past years
  - Test the tool as used by its developers

«Stripped» models
- «known» (original archive) and set as «surprise» ones
  - Test the tool as used by «non experts» of the tool

«Surprise» models
- New models proposed by the community this year
  - Test the tool as used by «non experts» of the tool
  - new situations for the tool
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Coefficients (after pool)
- «known» = x₁
- «stripped» = x₃
- «surprise» = x₅

Execution consistency
On the same machine
- «known» / «stripped» colored + associated P/T
11 New Models for 2016

- B. Barbot
  - PaceMaker

- B. Barbot and M. Kwiatkowska
  - DNAwalker

- H. Evrard and F. Lang
  - DLCshifumi

- M. Heiner
  - GPPP

- F. Jebali and E. Jenn
  - AutoFlight

- F. Kordon
  - AirplaneLD

- G. Salaün
  - CloudDeployment

- W. Serwe and H. Garavel
  - DES

- T. Shmeleva
  - TriangularGrid

- D. Zaistev
  - HypertorusGrid
  - TCPcondis
11 New Models for 2016

- B. Barbot
  - PaceMaker
- B. Barbot and M. Kwiatkowska
- M. Heiner
  - GPPP
- F. Jebali and E. Jenn
  - AutoFlight

With scaling parameters
139 models in fact

- CloudDeployment
- W. Serwe and H. Garavel
  - DES
- T. Shmeleva
  - TriangularGrid

Thanks!!!
We really need various models

Already from past years
525 instances of models

T. Shmeleva

F. Jebali and E. Jenn

AutoFlight

M. Heiner

GPPP

B. Barbot

PaceMaker
Examinations

- **StateSpace**
- **UpperBound**
- **Reachability**
  - ReachabilityDeadlock
  - ReachabilityCardinality → atomic propositions refer to tokens
  - ReachabilityFireability → atomic propositions refer to firing
- **CTL**
  - CTLCardinality → atomic propositions refer to tokens
  - CTLFireability → atomic propositions refer to firing
- **LTL**
  - LTLCardinality → atomic propositions refer to tokens
  - LTLFireability → atomic propositions refer to firing
The Submission Protocol

May 1st, delivery of disk images

- Qualification phase
- Completed by mid May
  - ~37 500 test runs

May 17, starting to operate tools

- 128 682 runs distributed over 4 different machines over Europe
- VM with 4 cores / 16GB
  - ITS-Tools, LTSMin, TAPAAL(PAR), LoLa
- WM with 1 core / 16 GB
  - Marcie, PeCan, pnmc, PNXDD Tapaal (SEQ, EXP), ydd-pt

Time confinement, 1h
Mid June, consolidation + analysis of outcomes

- 31 GByte of logs and CSV files
  - Post analysis = ~18KLOC Ada + ~800 LOC bash

Analysis Protocol

- Pass 1, computing results for the majority in a «line»
  - All tools for an examination for a model instance
- Pass 2, evaluating tool reliability
  - Only considering values with a large majority
- Pass 3, reconstructing the results using tool reliability
  - Help to decide when only 2 different answers
  - A result must be of confidentiality 0.93 or more (0.9 in 2015)
  - Some results are tagged «insecure»
- Pass 4 computing scores
  - «insecure» results not considered when counting points
The Analysis Protocol

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- 31 GByte of logs and CSV files
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**Analysis Protocol**

- **Pass 1**, computing results for the majority in a «line»
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  - Some results are tagged «insecure»
- **Pass 4** computing scores
  - «insecure» results not considered when counting points

**Scoring**
- StateSpace, 10 / 2 / 2 / 2
- Deadlock, 16
- Other formulas, 1 per formula

**Bonus for a «line»**
- +4 for the fastest tool
- +4 for the smallest memory footprint

**Penalty for mistakes**
- Twice the score for a good value
- No bonus if at least one error
Checking the Results

Consistency checks

- Colored versus equivalent P/T nets
- «known» models versus «stripped» models

Computing the «reliability rate»

- Section III.2 in http://mcc.lip6.fr/rules.php

- Computing $\mathbf{V}$, the set of values with a majority of 3 and more tools
- For each tool $t$, selecting $\mathbf{V}_t$, the values computed $\in \mathbf{V}$
- For each tool $t$, selecting $\mathbf{V}_{tt}$, the correct values computed $\in \mathbf{V}$

Reliability rate $= \frac{|\mathbf{V}_{tt}|}{|\mathbf{V}_t|}$
<table>
<thead>
<tr>
<th>Tools</th>
<th>Reliability</th>
<th>success</th>
<th>selected</th>
<th>Examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cunf</td>
<td>96.96 %</td>
<td>4728</td>
<td>4876</td>
<td>3 (Reach)</td>
</tr>
<tr>
<td>GreatSPN-Meddly</td>
<td>62.30 %</td>
<td>11966</td>
<td>19206</td>
<td>10 (Sate, Reach, CTL)</td>
</tr>
<tr>
<td>ITS-Tools</td>
<td>64.05 %</td>
<td>10890</td>
<td>17003</td>
<td>4 (Sate, Reach)</td>
</tr>
<tr>
<td>LoLA 2.0</td>
<td>97.80 %</td>
<td>25796</td>
<td>26378</td>
<td>6 (Reach)</td>
</tr>
<tr>
<td>LTSMin</td>
<td>79.13 %</td>
<td>13995</td>
<td>17687</td>
<td>5 (State, Reach)</td>
</tr>
<tr>
<td>Marcie</td>
<td>92.52 %</td>
<td>18443</td>
<td>19934</td>
<td>10 (Sate, Reach, CTL)</td>
</tr>
<tr>
<td>pnmc</td>
<td>99.59 %</td>
<td>741</td>
<td>744</td>
<td>1 (State)</td>
</tr>
<tr>
<td>PNXDD</td>
<td>88.89 %</td>
<td>56</td>
<td>63</td>
<td>1 (State)</td>
</tr>
<tr>
<td>STrataGEM0.5.0</td>
<td>100.00 %</td>
<td>243</td>
<td>243</td>
<td>1 (State)</td>
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<tr>
<td>TAPAAL (SEQ)</td>
<td>99.88 %</td>
<td>22880</td>
<td>22907</td>
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<tr>
<td>TAPAAL(MC)</td>
<td>99.75 %</td>
<td>23247</td>
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<tr>
<td>TAPAAL-OTF (SEQ)</td>
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<td>TAPAAL-OTF(PAR)</td>
<td>88.43 %</td>
<td>15253</td>
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# Tool Reliability in 2015-2016

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<tr>
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<td>98,38 %</td>
<td>33 634</td>
<td>34 189</td>
<td>9 (SS, UB, Reach, CTL, LTL)</td>
</tr>
<tr>
<td>LoLa</td>
<td>99,22 %</td>
<td>41 011</td>
<td>41 335</td>
<td>8 (UB, Reach, CTL, LTL)</td>
</tr>
<tr>
<td>LTSMin</td>
<td>99,98 %</td>
<td>34 902</td>
<td>34 910</td>
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<tr>
<td>Marcie</td>
<td>99,99 %</td>
<td>27 361</td>
<td>27 364</td>
<td>7 (SS, UB, Reach, CTL)</td>
</tr>
<tr>
<td>PeCan</td>
<td>37,54 %</td>
<td>3 967</td>
<td>10 568</td>
<td>5 (Reach, LTL)</td>
</tr>
<tr>
<td>pnmc</td>
<td>99,84 %</td>
<td>1 219</td>
<td>1 221</td>
<td>1 (State Space)</td>
</tr>
<tr>
<td>PNXDD</td>
<td>99,11 %</td>
<td>222</td>
<td>224</td>
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<tr>
<td>Smart</td>
<td>98,72 %</td>
<td>926</td>
<td>938</td>
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<tr>
<td>ydd-pt</td>
<td>97,70 %</td>
<td>85</td>
<td>87</td>
<td>2 (SS, UB)</td>
</tr>
<tr>
<td>Tapaal(EXP)</td>
<td>99,95 %</td>
<td>22 421</td>
<td>22 434</td>
<td>5 (SS, UB, Reach)</td>
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<tr>
<td>Tapaal(PAR)</td>
<td>99,98 %</td>
<td>19 555</td>
<td>19 558</td>
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Answering protocol not respected.
StateSpace Examination

The most attended one

10 tools/variants participating

Out of 12

- ITS-Tools
- LTSMin
- Marcie
- pnmc
- PNDD
- Smart
- Tapaal(EXP)
- Tapaal(PAR)
- Tapaal(SEQ)
- Ydd-pt

Known
Stripped
Surprise
A popular one
- 7 tools/variants participating
  - Out of 12

Ydd-pt
- Not really participating
- Answering problem
  - Should always answers DNC
A popular one

- 8 tools/variants participating
  - Out of 12

PeCan

States erroneous values in case where it should state CC

- Negatives score in
  - ReachabilityFireability
  - ReachabilityCardinality

Known

Stripped

Surprise
All CTL Examinations

- **Less popular**
  - 6 (-1) tools/variants participating
    - Out of 12

- **Tapaal (par)**
  - Compilation optimization issue lately detected
    - Crash for CTL in numerous situations
    - The parallel version was withdrawn

![Graph showing tool participation and performance](image_url)
All LTL Examinations

No participating tool in 2015

4 tools/variants participating

Out of 12

- ITS-Tools
- LoLa
- LTSMin
- PeCan

Known
Stripped
Surprise
Full HTML report

64,481 charts and 58,828 web pages
Generated Report

Full HTML report

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Generated Report

Full HTML report

64,481 charts and 58,828 web pages
Full HTML report

64,481 charts and 58,828 web pages
Feel free to reuse in papers

esps available on demand

Kindly cite the MCC (see bibliography online)
Some Issues for Next Year

- Counting transitions for StateSpace
  - Discussion about semantics (consistency P/T versus Colored)

- Handling some rare bugs in the benchmark
  - Possibly on one surprise model

- Small «almost surprise»
  - Some instance of GPPP with more than $2^{32}$ tokens...

- Better generator for LTL
  - Possible use of SPOT

- Please check carefully your logs
  - Some discussion issues already started
As a Conclusion...

### HypertorusGrid — P/T

<table>
<thead>
<tr>
<th></th>
<th>ITS-Tools</th>
<th>LTSMin</th>
<th>Tapaal(PAR)</th>
<th>Marcie</th>
<th>pnmC</th>
<th>PNXDD</th>
<th>Smart</th>
<th>Tapaal(EXP)</th>
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<tr>
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### PaceMaker — P/T

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### As a Conclusion...

#### DNAwalker — P/T

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#### DLCshifumi — P/T

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### DLCshifumi — P/T

- **2a**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
  - TFFFTFTTTFTFTTF
- **2b**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
- **3a**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
- **3b**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
- **4a**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
- **4b**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
- **5a**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
- **5b**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
- **6a**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
- **6b**: CC
  - PM / 80
  - TFFFTFTTTFTFTTF
  - DNF
And now...
let’s have time for discussion