

Tom van Dijk

Curriculum Vitae

Formal Models and Verification
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github: [trolando](https://github.com/trolando)

I am a postdoctoral researcher at the FMV group in Linz. My research is on parity games, where I study new efficient algorithms to solve parity games and develop fast practical implementations of existing algorithms. Parity games are an important tool to solve verification and synthesis problems related to, for example, LTL properties and ω -automata, which are popular techniques in formal verification. I also study parallelizing SAT-solving with prof.dr. Armin Biere. My research interests include fast and efficient tools, lock-free algorithms, and formal verification.

For my PhD thesis, I studied multi-core operations on decision diagrams and created a low-overhead work-stealing framework. For these, I designed lock-free algorithms, where different threads work on the same bytes in memory without explicit locking techniques. Lock-free algorithms can be difficult to reason about, but are sometimes the only way to obtain scalable performance on multi-core computers.

I'm interested in bridging the gap between low-level programming and studying complex and parallel algorithms. To make complex algorithms useful in practice, for example to solve large problem instances, high-performance and/or parallel implementations are essential. My approach to problem solving combines operational understanding (in terms of how low-level algorithms *think*) with abstract reasoning.

Education

- 2012 – 2016 **Ph.D.**, *Formal Methods and Tools*, University of Twente, NL.
Thesis: [Sylvan: Multi-core Decision Diagrams](#).
- 2009 – 2012 **M.Sc.**, *Computer Science*, University of Twente, NL, *cum laude*.
Thesis: [The parallelization of binary decision diagram operations for model checking](#).
Won the honorary mention (2nd place) of the Dutch M&I Informatie Scriptieprijs 2012.
- 2003 – 2009 **B.Sc.**, *Computer Science*, University of Twente, NL.
Thesis: [Analysing And Improving Hash Table Performance](#).
Combined with Applied Physics in 2003–2005.

Employment History

Academic

- 2016 – **Postdoc**, *Formal Models and Verification*, Johannes Kepler University, Linz.
Topics: parity games and parallel satisfiability solving.
- Implemented Oink, a new tool and library for solving parity games, a fundamental method for the model checking of transition systems and for synthesis problems ([Oink on Github](#)).
 - Invented a new approach to solve parity games based on an improved understanding of their underlying structure, which outperforms all previous algorithms.
- 2012 – 2016 **Ph.D.**, *Formal Methods and Tools*, University of Twente, Enschede.
Topic: low-level parallel/multi-core binary decision diagrams
- The first scalable multi-core implementation of binary decision diagrams, scaling up to 40× on a 64-core machine ([Sylvan on Github](#)).
 - A low-level high-performance task parallelism framework ([Lace on Github](#)).
 - Orders of magnitude faster (sequential and parallel) implementation of symbolic bisimulation minimisation for LTS, CTMC, IMC ([SigrefMC on Github](#)).

Software Engineering

2007 – 2009 **Freelance Developer**, *Scangineers*, *Scanpoint*, Amersfoort, NL.

Writing real-time controller software for an R&D project involving self checkout counters.

- Responsible for all programming using C, Java and assembly language.
- Debugging kernel drivers and inter-process communication.
- Real-time processing of large amounts of data from different sensors and cameras.
- After the initial project, I was hired again to do a follow-up project.
- Both projects were successfully completed.

2000 – 2003 **Development of game modification tools**.

During high school, I developed several game modification tools in Visual C++ to customize the computer game The Sims, in particular IFF Pencil 2. I developed these programs by reverse engineering the raw data files. One of these let the user change the jobs a sim could pursue. This program was published and sold worldwide under the name Career Creator Pro. Another tool, Script Station, involved reverse engineering the internal scripting language of The Sims from the data files.

Awards

- Best paper award for the paper with Wytse Oortwijn and Jaco van de Pol on parallelizing binary decision diagram operations for (distributed) computer clusters (SPIN'17) ([doi](#)).
- The honorary mention (2nd place) of the Dutch national M&I Informatie Scriptieprijs 2012 for my Master thesis ([pdf](#)).

Top 5 Publications

A full list of publications is included at the end.

- [pdf](#) 2018 Tom van Dijk. "Attracting Tangles to Solve Parity Games". In: *CAV*. 2018
Published at CAV (CORE rank A conference), my novel algorithm to solve parity games, based on new insights on the structure of parity games.*
- [doi pdf](#) 2018 Tom van Dijk. "Oink: An Implementation and Evaluation of Modern Parity Game Solvers". In: *TACAS (1)*. Vol. 10805. LNCS. Springer, 2018, pp. 291–308
Published at TACAS (CORE rank A conference), on new insights to understand existing parity game algorithms and much faster implementations of these algorithms than the state-of-the-art.
- [doi](#) 2017 Wytse Oortwijn, Tom van Dijk, and Jaco van de Pol. "Distributed binary decision diagrams for symbolic reachability". In: *SPIN*. **Best paper award**. ACM, 2017, pp. 21–30
Best paper award, work with my student Wytse Oortwijn to lift multi-core decision diagram algorithms to distributed (cluster) computers, which required a completely different implementation of work-stealing and of the hash tables.
- [doi pdf](#) 2017 Tom van Dijk and Jaco van de Pol. "Sylvan: multi-core framework for decision diagrams". In: *STTT* 19.6 (2017), pp. 675–696
Extended invited version of a publication at TACAS (CORE rank A conference). Presents the techniques used to parallelize operations on decision diagrams as well as their application in a model checking toolset. Extended version as invited journal paper (STTT).
- [doi](#) 2018 Tom van Dijk and Jaco van de Pol. "Multi-core symbolic bisimulation minimisation". In: *STTT* 20.2 (2018), pp. 157–177
Extended invited version of a publication at TACAS (CORE rank A conference). Application of multi-core decision diagrams to a particular domain, also showcases the benefits of domain-specific decision diagram operations to obtain 100× speedup.

Teaching

Courses

- 2018 **Guest lecture**, *Institute for Advanced Computer Science*, Leiden, NL.
Taught a 2 hour guest lecture about parity games, the current state of the art, with emphasis on the attractor-based algorithms, to students of the model checking course.
- 2017 – 2018 **Parallel programming course**, *Johannes Kepler University*, Linz.
 - 2× a lecture on Lace, load balancing, lock-free programming.
 - Designed appropriate homework assignments.
- 2013 – 2015 **Languages & Machines (Basismodellen in de Informatica)**, *University of Twente*.
 - Course in the Bachelor of Computer Science, in 2013, 2014 and 2015.
 - Taught the tutorial sessions.
- 2013 – 2014 **Modeling and Analysis of Concurrent Systems 2**, *University of Twente*.
 - Course in the Master of Computer Science, in 2013 and 2014.
 - Designed the lectures on BDDs and on IC3 in model checking.
 - Assisted with the practical assignment to implement model checking with BDDs.

Student supervision

- 2015 **Supervised Master student Wytse Oortwijn**.
Topic: Symbolic state space exploration with distributed BDDs
- 2015 **Supervised Bachelor student Thijs van Ede**.
Topic: Verifying lockless dequeues
- 2014 **Co-supervised Bachelor student Simon de Vries**.
Topic: Optimizing state vector compression by reordering program variables
- 2013 **Supervised Master student Maryam Haji Ghasemi**.
Topic: Zero-suppressed binary decision diagrams in model checking
Wytse, Thijs and Maryam continued as PhD Students at the University of Twente.

Academic Service

- 2018 – **Program committees**.
FMCAD 2018 Student Forum.
- 2018 **FMCAD webmaster**.
For the 2018 edition of FMCAD, I am keeping the website updated.
- 2017 **Competition co-organizer**.
With Armin Biere and Keijo Heljanko, I co-organized the Hardware Model Checking Competition.
- 2016 **Workshop co-organizer**.
I co-organized the Dutch Model Checking Day 2016, which this year had a focus on symbolic approaches to model checking, as well as parallel computation of model checking algorithms.
- 2014 – **External conference reviewer**.
SPIN 2014, ICFEM 2014, FASE 2016, ATVA 2016, TACAS 2017, FCT 2017, TACAS 2018, SAT 2018, FORTE 2018, CSL 2018, FMCAD 2018.
- 2014 – **Journal reviewer**.
IEEE Transactions on Computers (2014), Formal Methods in System Design (2018), Software Tools for Technology Transfer (2018), MDPI Algorithms (2018), VLSI Integration (2018).

Societal Service

- 2006 – 2007 **Secretary of the board of a student association**.
Of a student association with about 90 active members and several weekly activities.
- 2012 – 2013 **Chairman of a regional department**, of a national political youth organization.

- 2015 **National symposium on sustainability for entrepreneurs.**
As a member of two study groups Economy and Sustainability of a political youth organization, I co-organized a national symposium (“Duurzaam denken & duurzaam ondernemen”, January 2015) on environmental sustainability for entrepreneurs.
- 2012 – **Webapp developer.**
As part of a group of volunteers, I developed and maintain several open source web applications in Python and Django to streamline and support the internal processes of a political youth organization.

Research Visits and Summer Schools

- 2018 **DIMAP/FoCS**, short research visit to Marcin Jurdziński and colleagues on parity games.
- 2016 **SAT/SMT/AR**, summer school on SAT, SMT solving and Automated Reasoning.
- 2015 **ISCASMC**, short research visit to the group of Lijun Zhang in Beijing.
- 2014 **MOVES**, short research visit to the group of Joost-Pieter Katoen in Aachen.
- 2014 **SAT/SMT**, summer school on SAT and SMT solving.
- 2013 **Marktoberdorf**, two-week summer school on Software Systems Safety.
- 2012 **VTSA**, summer school on Verification Technology, Systems & Applications.

Publications

Google Scholar (September 2018): Number of citations: 193. H-index: 7

Journals

- [doi](#) 2018 Dijk, Tom van and Jaco van de Pol. “Multi-core symbolic bisimulation minimisation”. In: *STTT* 20.2 (2018), pp. 157–177.
- [doi pdf](#) 2017 Dijk, Tom van and Jaco van de Pol. “Sylvan: multi-core framework for decision diagrams”. In: *STTT* 19.6 (2017), pp. 675–696.

Conferences and workshops

- [pdf](#) 2018 Dijk, Tom van. “Attracting Tangles to Solve Parity Games”. In: *CAV*. 2018.
- [doi pdf](#) 2018 Dijk, Tom van. “Oink: An Implementation and Evaluation of Modern Parity Game Solvers”. In: *TACAS (1)*. Vol. 10805. LNCS. Springer, 2018, pp. 291–308.
- [doi](#) 2017 Biere, Armin, Tom van Dijk, and Keijo Heljanko. “Hardware model checking competition 2017”. In: *FMCAD*. IEEE, 2017, p. 9.
- [doi](#) 2017 Dijk, Tom van, Robert Wille, and Robert Meolic. “Tagged BDDs: Combining reduction rules from different decision diagram types”. In: *FMCAD*. IEEE, 2017, pp. 108–115.
- [doi](#) 2017 Oortwijn, Wytse, Tom van Dijk, and Jaco van de Pol. “Distributed binary decision diagrams for symbolic reachability”. In: *SPIN*. **Best paper award**. ACM, 2017, pp. 21–30.
- [doi pdf](#) 2016 Dijk, Tom van and Jaco van de Pol. “Multi-core Symbolic Bisimulation Minimisation”. In: *TACAS*. Vol. 9636. LNCS. Springer, 2016, pp. 332–348.
- [doi](#) 2015 Dijk, Tom van, Ernst Moritz Hahn, David N. Jansen, Yong Li, Thomas Neele, Mariëlle Stoelinga, Andrea Turrini, and Lijun Zhang. “A Comparative Study of BDD Packages for Probabilistic Symbolic Model Checking”. In: *SETTA*. Vol. 9409. LNCS. Springer, 2015, pp. 35–51.
- [doi pdf](#) 2015 Dijk, Tom van and Jaco van de Pol. “Sylvan: Multi-Core Decision Diagrams”. In: *TACAS 2015*. 2015, pp. 677–691.
- [doi](#) 2015 Kant, Gijs, Alfons Laarman, Jeroen Meijer, Jaco van de Pol, Stefan Blom, and Tom van Dijk. “LTSmin: High-Performance Language-Independent Model Checking”. In: *TACAS 2015*. 2015, pp. 692–707.

- doi 2015 Oortwijn, Wytse, Tom van Dijk, and Jaco van de Pol. "A Distributed Hash Table for Shared Memory". In: *Parallel Processing and Applied Mathematics*. Springer, 2015.
- doi 2014 Dijk, Tom van and Jaco van de Pol. "Lace: Non-blocking Split Deque for Work-Stealing". In: *MuCoCoS*. Vol. 8806. LNCS. Springer, 2014, pp. 206–217.
- doi 2012 Dijk, Tom van, Alfons W. Laarman, and Jaco van de Pol. "Multi-core and/or Symbolic Model Checking". In: *AVOCS*. Vol. 53. 2012.
- doi 2012 Dijk, Tom van, Alfons Laarman, and Jaco van de Pol. "Multi-Core BDD Operations for Symbolic Reachability". In: *PDMC*. Vol. 296. ENTCS. 2012, pp. 127–143.

Book chapters

- doi 2018 Dijk, Tom van and Jaco van de Pol. "Multi-core Decision Diagrams". In: *Handbook of Parallel Constraint Reasoning*. Springer, 2018, pp. 509–545.

Other

- pdf 2018 Dijk, Tom van. "A Parity Game Tale of Two Counters". in submission. 2018.
- pdf 2018 Dijk, Tom van, Rüdiger Ehlers, and Armin Biere. "Revisiting Decision Diagrams for SAT". arXiv. 2018.
- doi pdf 2016 Dijk, Tom van. "Sylvan: multi-core decision diagrams". PhD thesis. University of Twente, Enschede, Netherlands, 2016.

Presentations

- 24 Sept. 2018 **Conference**, *Alpine Verification Meeting*, Wagrein.
Presentation of the highlights of my work on parity games, especially tangle learning. (In situ invited talk after the original invited speaker was delayed.)
- 19 Sept. 2018 **Conference**, *Highlights of Logic, Games and Automata*, Berlin.
Presentation of the highlights of my work on parity games, especially tangle learning.
<https://easychair.org/smart-program/Highlights2018/index.html>
- 18 July 2018 **Workshop**, *Parallel Logical Reasoning*, Oxford.
Presentation of my work on parallel parity game solving.
<https://easychair.org/smart-program/FLoC2018/PLR-program.html>
- 17 July 2018 **Conference**, *Computer Aided Verification (CAV)*, Oxford.
Presentation of my paper on tangle learning.
<https://easychair.org/smart-program/FLoC2018/CAV-2018-07-17.html>
- 20 April 2018 **Seminar**, *Institute for Advanced Computer Science*, Leiden.
Talk to the research group of Dr. Laarman in Leiden about my work on parity games, the current state of the art, with emphasis on the attractor-based algorithms.
- 17 April 2018 **Conference**, *Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*, Thessaloniki.
Presentation of my paper on Oink.
<http://easyconferences.eu/etaps2018/program/>
- 6 Dec. 2017 **Seminar**, *RiSE*, Vienna.
Talk to the RiSE project members in Vienna about my work on parity games.
- 4 Oct. 2017 **Conference**, *Formal Methods in Computer-Aided Design (FMCAD)*, Vienna.
Presentation of the work on tagged binary decision diagrams.
<http://www.cs.utexas.edu/users/hunt/FMCAD/FMCAD17/program/>
- 5 April 2016 **Conference**, *Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*, Eindhoven.
Presentation of the work on parallel symbolic signature refinement.
<https://www.etaps.org/index.php/2016/etaps-2016-programme-menu?id=289>

- 9 Nov. 2015 **Seminar**, *Probabilistic Model Checking Team*, Beijing.
Talk to the research group of Prof. Zhang in Beijing about my work on bisimulation minimisation using BDDs.
- 9 June 2015 **Seminar**, *Software Modeling and Verification*, Aachen.
Talk to the research group of Prof. Katoen in Aachen about my work on bisimulation minimisation using BDDs.
- 17 April 2015 **Conference**, *Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*, London.
Presentation of the work on parallel binary decision diagrams.
<https://www.etaps.org/user-profile/archive/40-etaps-2015/etaps-2015/240-tacas-programme>
- 26 Aug. 2014 **Workshop**, *Multi-/Many-Core Computing Systems (MuCoCoS)*, Porto.
Presentation of the work on a lock-free work-stealing split deque.
<https://www.univie.ac.at/mucocos2014/program>
- 17 Sept. 2012 **Workshop**, *Parallel and Distributed Methods in verifiCation (PDMC)*, London.
Presentation of my Master Thesis work on parallel binary decision diagrams.
<http://anna.fi.muni.cz/PDMC/PDMC12/programme.html>