Sarah Winkler — Curriculum Vitae

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Personal Information

name:	Sarah Winkler
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language proficiency:	German (native speaker) English (C1 level, unibz certificate 28.7.2023) Italian (C1 level, unibz certificate 7.3.2022)
habilitation:	Italian scientific habilitation for the sector of computer science (ASN seconda fascia, sector INF/01, call 1796/2023

Higher Education

University of Innsbruck
Doctoral degree in Technical Sciences, cum laude *11/2008–3/2013*
supervised by Aart Middeldorp; Thesis: *Termination Tools in Automated Reasoning*

University of Innsbruck
Master degree of Computer Science, cum laude *10/2006–10/2008*

University of Innsbruck
Bachelor degree of Computer Science, cum laude *10/2003–9/2006*

Professional Experience

Free University of Bozen-Bolzano
tenure-track researcher (RTT) *04/2025-*
working on process analysis and process mining techniques based on AI, automated reasoning and formal methods

Free University of Bozen-Bolzano
postdoctoral researcher (RTD-A) *10/2023 - 04/2025*
working with Marco Montali on AI and formal methods for the analysis of data-aware processes
(maternity leave from 03/2024 to 01/2025)

Free University of Bozen-Bolzano
postdoctoral researcher (AR) *11/2022–9/2023*
employed on ADAPTERS project led by Marco Montali and Massimiliano Renzi

The aim of the ADAPTERS project is to develop an Energy Management System (EMS) for smart grid systems that, given a specification of the needs and resources of an energy community, proposes the best solution according to a user-specified objective function. The developed software uses robust optimization and decision mining techniques to this end. My responsibilities were in the identification of suitable automated reasoning techniques, and the implementation of a respective tool. The latter is still ongoing.

Free University of Bozen-Bolzano
postdoctoral researcher (AR) *11/2021–11/2022*
employed on SMART-APP project led by Marco Montali and Paolo Felli

The SMART-APP project performed foundational research and software development activities in the context of automated process planning for cyber-physical production systems of smart factories. My responsibilities comprised (1) foundational research on the representation of state spaces of processes that operate over arithmetic data, and (2) the implementation of a tool that constructs a production plan from a given specification.

Free University of Bozen-Bolzano
postdoctoral researcher (AR) *10/2020–10/2021*
employed on DACoMan project led by Paolo Felli

In the DACoMan project, controller-synthesis procedures for a large class of data-aware manufacturing processes were investigated. To this aim, the modelling and analysis of data-aware processes were studied, with particular emphasis on the interplay and interdependence between data and control-flow activities. Specifically, my contributions were in theoretical investigations that focused on the formal modelling of data-aware processes by adopting and extending available representation models, and developing suitable analysis techniques.

Università degli Studi di Verona
postdoctoral researcher (AR) *09/2019–08/2020*
working with Maria Paola Bonacina on conflict-driven theorem proving

The paradigm of conflict-driven theorem proving gained traction in the last decade based on the tremendous success of SAT solvers, which also pursue a conflict-driven approach. In this project, conflict-driven first-order theorem proving was studied, more precisely the approach of SGGS (syntax-guided goal-sensitive reasoning). My contributions were in the identification of fragments of first-order formulas that can be decided by SGGS, as well as the implementation of the SGGS-based theorem prover **Koala**.

University of Innsbruck
postdoctoral researcher *10/2016–9/2019*
PI of FWF project "Instantiation- and Learning-Based Methods in Equational Reasoning"

In this project a novel approach for equational theorem proving was developed that leverages the success of SAT solvers to first-order reasoning with equalities, combining it with proof guidance based on machine learning techniques and approaches from instantiation-based theorem proving. I was principal investigator of this project, both designing the reasoning techniques and implementing them in the equational theorem prover **maedmax**.

Microsoft Research, Cambridge, UK
research software developer *9/2015–9/2016*
working with Nuno Lopes on translation validation for C/C++ compilers

In this project a static analysis tool was developed to perform fully automatic translation validation of a C/C++ compiler, with the aim to detect compilation bugs, which are a dangerous and costly source of software errors. To this end, for every compilation step in the middle end, an SMT solver was employed to check whether the return value, memory use, and potential undefined behaviour remain the same before and after each compilation step. I was the main

developer of this tool.

Microsoft Research, Cambridge, UK
contractor *4/2015–7/2015*
working with Andrey Rybalchenko on invariant inference for Dafny

Dafny is a verification-aware programming language that has native support for recording specifications and is equipped with a static program verifier. However, verification conditions typically need to be specified by the programmer. This project aimed to develop a prototype of a plugin where suitable invariants were inferred fully automatically, using solvers for constraint Horn clauses.

University of Innsbruck
postdoctoral researcher *4/2013–3/2015*
task leader in FWF Austria-Japan joint project "Constrained Rewriting and SMT"

The overall aim is to advance applicability of rewriting techniques in verification by focusing on constrained rewriting, a paradigm that suits program analysis better than unconstrained rewriting. I was a task leader on the Austrian side for the work package concerned with equational reasoning. Specifically, we developed formalizations in the proof assistant Isabelle of several results related to Knuth-Bendix completion and constrained rewriting.

University of Innsbruck
PhD student *2/2009–1/2013*
PhD project funded by ÖAW docfForte grant

In my PhD studies on "Termination Tool in Automated Reasoning" I investigated how to overcome limitations that are present in classical equational reasoning techniques by the fact that a term ordering has to be chosen in the beginning. Specifically, I designed deduction mechanisms that avoid this initial choice, by exploiting the power of automatic termination tools for term rewriting instead. My PhD project was funded for a period of three years by the Austrian Academy of Science (ÖAW).

Software Development in Various Projects
free-lance programmer and web developer *2002–2009*

During my bachelor and master studies I worked as a programmer and web-developer for various small projects.

Research

In my research I broadly work on the analysis and verification of infinite-state systems using logic and automated reasoning techniques, focusing on the analysis of data-aware processes and program verification. In this context, I aim at both developing theoretical approaches, and tools that leverage these in practice.

Five Important Activities

- Invited speaker at the 4th International Conference on Formal Structures for Computation and Deduction (FSCD 2019) in Dortmund, Germany.

- Invited speaker at the 8th International Workshop on Theorem Proving Components for Educational Software (ThEdu 2019) in Natal, Brazil.
- Co-organizer of two editions of the International Workshop on Automated Reasoning: Challenges, Applications, Directions, Exemplary Achievements (ARCADE 2019 resp. ARCADE 2021), associated with the 27th Conference on Automated Deduction (CADE-27/Natal, Brazil) resp.the 28th Conference on Automated Deduction (CADE-28/virtual event).
- Member of the Skolem Award Committee organized by the Conference on Automated Deduction (CADE), 2023. The committee consists of eight experienced members of the Automated Reasoning community who are invited to choose papers published in past CADE conferences whose authors will receive the Skolem Award.
- Publicity Chair of the 22nd International Conference on Business Process Management (BPM 2024) in Krakow, Poland.

Research Areas

My main research lines are currently the following:

- **Analysis of processes with arithmetic data**: development of methods for linear- and branching-time model checking, data-aware soundness checking, and monitoring techniques. This resulted in several contributions to top-rated international conferences [25, 26, 24, 19] and received also attention in the BPM community [52, 4]. In this line of work, we developed SMT- and automata-based procedures that we proved to be decision procedures for a class of processes which satisfy a novel property called *finite summary*. This abstract decidability condition was proven to generalize several concrete, checkable, and practically relevant classes of systems. I implemented the respective procedures for LTL, CTL*, and data-aware soundness checking as well as monitoring in the tool **ada**. We also extended these results to more general processes that can query a read-only database [17], an expressive class of processes that is highly important in practice.
- Results on **temporal logic modulo theories** emerged as a spinoff of the research line above. LTL$_f$ modulo theories is a very powerful temporal logic which combines LTL over finite traces with the expressivity of SMT (satisfiability modulo theories). Satisfiability is in general undecidable. However, we generalized our idea of the *finite summary* condition to discover fragments of LTL$_f$ modulo theories where satisfiability is decidable [21].
- My second main research line is currently **data-aware process mining**, with a focus on conformance checking. Specifically, we developed an SMT-based conformance checking framework for multi-perspective processes with data, called *CoCoMoT*. This work was published in the International Conference on Business Process Management [27], where it received the best paper award; an extended version came out recently [6]. Subsequently, we extended this approach to logs with uncertainty [23, 7], a setting that is highly relevant in practice, as well as object-centric processes [18], a highly current research topic in process mining.
  Most recently, we incorporated machine learning techniques in data-aware conformance checking, to obtain an efficient, approximative conformance checking technique [22].
  In a very recent work, we combined our results on data-aware process analysis with this line of data-aware process mining. Precisely, we constructed an approach for *process repair* that allows to modify processes which violate the crucial *data-aware soundness condition* [20].
- Building on my background in **automated reasoning**, I also worked recently on conflict-driven theorem proving [5, 28] and equational theorem proving [35, 34, 8].

Research Impact

- **Publications:** I am the author of numerous publications in international venues (11 journal contributions, 37 conference papers, and 15 workshop contributions), many of these published at A* and A-rated conferences. Frequently, I presented these works at conferences (23 presentations) and workshops (10 presentations). At the 19th Conference on Business Process Management (BPM 2021), we received the Best Paper Award for [27]. As of January 2025, I have an h-index of 13 (according to Google Scholar) resp. 9 (according to Scopus).
- **International recognition:** I have been a member of program committees of 34 internationally reknown conferences. Moreover, I was invited to organize two editions of two international workshops each (International Workshop on Confluence, IWC; and ARCADE: Automated Reasoning: Challenges, Applications, Directions, Exemplary Achievements). In addition, I have been a keynote speaker at the 4th International Conference on Formal Structures for Computation and Deduction (FSCD 2019), as well as the 8th International Workshop on Theorem Proving Components for Educational Software (ThEdu 2019). In 2021, I was also invited to become a member of the IFIP Working Group 1.6 on Rewriting.
- **Tool development:** As documented in the list below, I have extensively contributed to and developed software artifacts for a wide range of applications, and in a variety of languages. I am also proud to have worked as a research software developer at Microsoft Research, one of the most active industrial research labs in the area of automated reasoning and program analysis.

Research Grants and Projects

My research has been funded by several funding institutions. The following table lists projects where I was the principal investigator/grant holder.

date	funded by	project title	funded amount
11/2023	Lamborghini Automotive	*TelAIo Diablo*: This industry project aimed to develop an AI-based planning system to schedule tasks in a production line.	45.800€
12/2021	Free University of Bozen-Bolzano	*TEKE*: Threshold Expressions for Knowledge Representation and Explanation of Models	30.000€
6/2015	Austrian Science Fund (FWF)	*Instantiation- and Learning-Based Methods in Equational Reasoning* (Hertha Firnberg project T789)	226.530€
2/2010	Austrian Academy of Science (ÖAW)	*Termination Tools in Automated Reasoning* (docfForte PhD grant)	90.000€
2/2009	University of Innsbruck	Doktoratsstipendium aus der Nachwuchsförderung	14.400€
7/2008	Deutscher Freundeskreis der Universitäten Innsbrucks	Förderpreis	6.000€

Teaching Experience

I currently teach a course on Intelligent Agents at the Free University of Bozen/Bolzano. Beforehand, I taught a variety of courses on theoretical computer science (formal methods, logic, automata theory, term rewriting) at the University of Innsbruck. In 2015, 2017, 2019, and 2022,

I taught the basic track of the International Summer School on Rewriting (ISR) with Aart Middeldorp. In 2021, I gave a similar but condensed course at the *Logical Perspectives* Summer School Moscow on my own.
In the summer terms 2018 and 2019, and in the winter term 2022, I had the opportunity to plan, design and teach an elective course for graduate and undergraduate students on SAT and SMT solving at the University of Innsbruck (5 ECTS). The content and structure of this course was rated 1.0 by students (on a scale from 1 to 5), and the average reply to whether students would recommend the course to others was 1.1. In the evaluation forms, I got several comments such as "This was the best course in the whole bachelor, and I am nearly finished".

The following is a list of my teaching experiences, with links to student evaluations.

- **Intelligent Agents Project** (lecture and labs, 6 ECTS), Free University of Bozen/Bolzano, winter term 2025/2026.
- **SAT and SMT Solving** (lecture and labs, 5 ECTS), University of Innsbruck.
  The concept and material for this course were developed by myself. I taught it in the summer term 2018, summer term 2019, and in the winter term 2022/2023. The course was twice rated 1.0 by the participants, on a scale from 1 (best) to 5 (worst), see the student evaluations from 2018, 2019, and 2022. In the latter one can also see that the evaluation is clearly above the average of the faculty.
- **Fundamentals of Programming Lab**, Free University of Bozen-Bolzano. Winter term 2022.
- **International Summer School on Rewriting** (basic track, 25 hour course).
  I taught this course in 2015, 2017, 2019, and 2022, in all cases shared equally with Aart Middeldorp. The course is intended for post-graduate and PhD students.
- **Logical Perspectives** Summer School Moscow 2021, lecture on term rewriting (6 hour course)
- **Logic** (labs), University of Innsbruck. Taught in summer term 2021; this course is compulsory for all students of computer science, it was rated 1.2 by the participants, on the same scale, see the student evaluations. As indicated in the document, the evaluation is clearly above the average of the faculty.
- **Formal Language and Automata Theory** (labs, 2 ECTS), University of Innsbruck.
  This course is compulsory for all students of computer science. I most recently taught it in winter term 2017/2018, where it was rated 1.45 by the participants, on the same scale, see the student evaluations.
  I had already taught this course in the winter term 2012/2013 (evaluations), winter term 2013/2014 (evaluations), and winter term 2014/2015 (evaluations).
- **Term Rewriting** (labs, 2 ECTS), University of Innsbruck.
  I taught this course in the winter term 2009/2010 (evaluations), winter term 2010/2011 (evaluations), winter term 2011/2012 (evaluations), and winter term 2012/2013 (evaluations).
- **Functional Programming** (labs, 2 ECTS), University of Innsbruck.
  I taught this course in the winter term 2009/2010 (evaluations).
- **Algorithms and Data Structures** (labs, 2 ECTS), University of Innsbruck.
  I taught this course in summer term 2008 (evaluations).
- **Formal Methods** (labs, 2 ECTS), University of Innsbruck.
  I taught this course in summer term 2007 (evaluations).
- **Logic in Computer Science** (labs, 2 ECTS), University of Innsbruck.
  I taught this course in winter term 2006/2007 (evaluations).

Student Supervision

I supervised the following master and bachelor students:

- Enisa Huseni, bachelor thesis, BSc in Informatics and Management of Digital Business, Free University of Bozen-Bolzano, title "Subjective conformance checking for business processes" (2024, co-supervised with Marco Montali and Alessandro Gianola)
- Delia Mennitti, bachelor thesis, BSc in Informatics and Management of Digital Business, Free University of Bozen-Bolzano, title "Modelling object-centric processes with procedural and declarative notations" (2024, co-supervised with Marco Montali and Alessandro Gianola)
- Elena Battiston, bachelor thesis, BSc in Informatics and Management of Digital Business, Free University of Bozen-Bolzano, title "Integrating Chatbots and BPM for Conversational Process Analysis" (2024, co-supervised with Marco Montali and Alessandro Gianola)
- Johan Leandro Porras Galindo, master thesis, MSc in Computing for Data Science, Free University of Bozen-Bolzano, title "Semantic analysis of manufacturing processes" (2024, co-supervised with Marco Montali and Alessandro Gianola)
- Jonas Schöpf, master thesis, MSc in Computer Science, University of Innsbruck, title "The weighted path order in TTT2" (2019, co-supervised with Christian Sternagel)
- Manuel Schischkoff, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "Companion planting tool" (2019)
- Florian Stalzer, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "15 Puzzle" (2019)
- Christoph Bessei, bachelor thesis, BSc in Computer Science, University of Innsbruck, title" A web front end for CL tools" (2019)
- Sonja Wirtenberger, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "Ordinal Calculator" (2014)
- Nina Doschek, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "Linear Diophantine Equation Systems" (2014)
- Franziska Rapp, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "Unification Modulo Theories" (2013)
- Sebastian Stabinger, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "Abstract Rewrite Tool" (2011)
- Simon Legner, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "Term Indexing Techniques in OCaml" (2013)
- Margit Mutschlechner, bachelor thesis, BSc in Computer Science, University of Innsbruck, title "Watten" (2011)

Reviewer of PhD Thesis

- Yago Fontenla-Seco: "Process-to-Text: A Framework for the Automatic Generation of Natural Language Descriptions of Processes", Universidade de Santiago de Compostela, 2024.

Academic Responsibilities

Event Organization

- 3rd International Workshop on *Automated Reasoning: Challenges, Applications, Directions, Exemplary Achievements* (ARCADE 2021), associated with CADE-28, joint organization with Martin Suda. Natal, Brazil.
- 2nd International Workshop on *Automated Reasoning: Challenges, Applications, Directions, Exemplary Achievements* (ARCADE 2019), associated with CADE-27, joint organization with

Martin Suda. On-line.
- 11th *International Workshop on Confluence* (IWC 22), joint organization with Camilo Rocha, Haifa, Israel. Website.
- 12th *International Workshop on Confluence* (IWC 23), joint organization with Cyrille Chenavier, Obergurgl, Austria. Website.

Participation in Program Committees

- *35th International Joint Conference on Artificial Intelligence* (IJCAI 2026), Bremen, Germany
- *24th International Conference on Business Process Management* (BPM 2026), Toronto, Canada
  13th International Joint Conference on Automated Reasoning (IJCAR 2026), Lisbon, Portugal
- *11th International Conference on Formal Structures for Computation and Deduction* (FSCD 2026), Lisbon, Portugal
- *23rd International Conference on Business Process Management* (BPM 2025), Sevilla, Spain
- *31st International Conference on Tools and Algorithms for the Construction and Analysis of Systems* (TACAS 2025), Hamilton, Canada
- *39th AAAI Conference on Artificial Intelligence* (AAAI 2025), Philadelphia, USA
- *12th International Joint Conference on Automated Reasoning* (IJCAR 2024), Nancy, France
- *30th International Conference on Tools and Algorithms for the Construction and Analysis of Systems* (TACAS 2024), Luxembourg
- *22nd International Conference on Business Process Management* (BPM 2024), Krakow, Poland
- *9th International Conference on Formal Structures for Computation and Deduction* (FSCD 2024), Tallinn, Estonia
- *38th AAAI Conference on Artificial Intelligence* (AAAI 2024), Vancouver, Canada
- *26th European Conference on Artificial Intelligence* (ECAI 2023), Krakow, Poland. I received the "Quality Champion Award" given to 58 out of over 700 reviewers.
- *29th International Conference on Automated Deduction* (CADE-29), Rome, Italy
- *8th International Conference on Formal Structures for Computation and Deduction* (FSCD 2023), Rome, Italy
- *32nd International Joint Conference on Artificial Intelligence* (IJCAI 2023), Macao
- *1st International Workshop on Formal Methods in Business Process Management* (FM-BPM 2023), Utrecht, Netherlands
- *12th International Workshop on Confluence* (IWC 2023, co-organizer), Obergurgl, Austria
- *11th International Joint Conference on Automated Reasoning* (IJCAR 2022), Haifa, Israel
- *8th Workshop on Practical Aspects of Automated Reasoning* (PAAR 2022), Haifa, Israel
- *7th Conference on Artificial Intelligence and Theorem Proving* (AITP 2022), Aussois, France
- *31st International Joint Conference on Artificial Intelligence* (IJCAI 2022), Vienna, Austria
- *11th International Workshop on Confluence* (IWC 2022, co-organizer), Haifa, Israel
- *33rd International Conference on Computer-Aided Verification* (CAV 2022): member of artifact evaluation committee
- *30th International Joint Conference on Artificial Intelligence* (IJCAI 2021), virtual event
- *27th International Conference on Tools and Algorithms for the Construction and Analysis of Systems* (TACAS 2021), Luxembourg
- *6th International Conference on Formal Structures for Computation and Deduction* (FSCD 2021), Buenos Aires, Argentina
- *10th International Workshop on Confluence* (IWC 2021)
- *22nd International Symposium on Symbolic and Numeric Algorithms for Scientific Computing* (SYNACS 2020), Timisoara, Romania

- *Workshop on Practical Aspects of Automated Reasoning* (PAAR 2020), virtual event
- *23rd International Conference on Logic for Programming, Artificial Intelligence and Reasoning* (LPAR-23), virtual event
- *9th International Workshop on Confluence* (IWC 2020), virtual event
- *5th Conference on Artificial Intelligence and Theorem Proving* (AITP 2020), Aussois, France
- *27th International Conference on Automated Deduction* (CADE-27), Natal, Brazil
- *8th International Workshop on Confluence* (IWC 2019), Dortmund, Germany

Other Scientific Responsibilities

- Member of the *Skolem Award Committee* organized by the Conference on Automated Deduction (CADE), 2023
- Publicity Chair of the 22nd International Conference on Business Process Management (BPM 2024)
- since 2024, I am one of two members of the steering committee of the International Workshop on Confluence (jointly with Mauricio Ayala-Rincón)

Presentations

Invited Talks

Dagstuhl Seminar 21371: Integrated Deduction
invited participant *09/2021*
title of presentation: "Linear-time verification of data-aware dynamic systems with arithmetic"

meeting of the IFIP Working Group 1.6 on Rewriting
invited speaker *09/2021*
title of presentation: "Decidable Fragments of First-Order Logic via Termination of Rewriting"

ThEdu 2019
invited speaker *08/2019*
8th International Workshop on Theorem Proving Components for Educational Software, title of presentation"Automation of Rewriting—for Fun in Research and Profit in Teaching"

Dagstuhl Seminar 19371: Deduction Beyond Satisfiability
invited participant *09/2019*
title of presentation: "Loop Detection by Logically Constrained Rewriting"

FSCD 2019
invited speaker *06/2019*
4th International Conference on Formal Structures for Computation and Deduction, title of presentation "Extending maximal completion"

Dagstuhl Seminar 15381: Information from Deduction: Models and Proofs
invited participant *09/2015*
title of presentation: "Partial Models for More Proofs?"

Research Visits

During the following research visits I gave talks presenting my research:

Technical University of Denmark (DTU)
hosted by Andrey Rivkin *09/2023*
one week

Nagoya University, Japan
hosted by Naoki Nishida *02/2018*
one week
Japan Advanced Institute of Science and Technology, Nomi City, Japan
hosted by Nao Hirokawa *02/2017*
one week
University of Hokkaido, Sapporo, Japan
hosted by Masahito Kurihara *09/2014*
one week
University of Hokkaido, Sapporo, Japan
hosted by Masahito Kurihara *11/2013*
four weeks
MIT, Cambridge, USA
hosted by Kurt Fendt *02/2006*
extending the on-line learning environment *Metamedia*, three weeks

Presentations at Conferences and Workshops

Among the publications that I presented at international conferences and workshops are [19, 21, 22, 24, 25, 27, 28, 30, 31, 33, 34, 35, 37, 40, 42, 43, 44, 45, 46, 47, 48] and [52, 54, 55, 57, 58, 59, 60, 61] from the publication list below, respectively.

Other Presentations

Further international events where I presented my work include the following:
- 50th TRS Meeting, 02/2019, Atami, Japan
- 46th TRS Meeting, 02/2017, Shinojima, Japan
- Microsoft Research Dafny Mini-Workshop, 07/2015, Redmond, United States
- 41st TRS Meeting, 09/2014, Sapporo, Japan
- Austria-Japan Summer Workshop on Rewriting, 08/2010, Obergurgl, Austria
- Workshop Paris-Innsbruck-Tbilisi, 05/2010, Paris, France

Software Development

In the last years I developed and contributed to a variety of software for automated reasoning, program analysis, and model checking. The following are the most recent and most extensive projects:

ada: arithmetic DDS analyzer *main developer, Python, since 2021*

This tool performs different analysis tasks for data-aware dynamic systems and data Petri nets. These include linear-time model checking [25, 17], data-aware soundness checking [26], branching-time model checking [24], and monitoring arithmetic traces [19]. A web interface and source code are available.

cocomot: conformance checker *main developer, Python, since 2021*

This tool performs data-aware conformance checking of data Petri nets, possibly with uncertainty [27, 23, 6, 18]. Source code.

SMART-APP: planning tool *contributor, Java, 2021-2022*

This manufacturing tool constructs a production plan for a given specification.

Koala: SGGS-based theorem prover *main developer, OCaml, 2019–2023*

This tool is a first-order theorem prover based on Semantically Guided Goal-Sensitive Reasoning (SGGS), and it implements a decision procedure for a variety of fragments [28, 5]. Source code.

TCT: complexity tool *contributor, Haskell, 2012–2015*

This is an automatic complexity analyzer for term rewrite systems and some types of programs, to which I contributed techniques for logically constrained rewrite systems [30]. Source code.

mædmax: equational theorem prover *main developer, OCaml, since 2016*

This tool is a powerful equational theorem prover that combines instantiation-based reasoning and proof guidance by both an SMT-solver and machine learning techniques [35, 32]. The output can be checked by the trusted certifier CeTA [31, 38]. **maedmax** is written in OCaml, source code is available.

Ctrl: constrained rewrite tool *contributor, OCaml, 2018*

This is a tool that supports different analysis tasks for logically constrained rewrite systems. I added support for non-termination [33] and Knuth-Bendix completion [34]. **Ctrl** is written in OCaml, source code is available.

TV: compiler validator *main contributor, C++, 2015–2016*

The tool performs compilation validation for a C/C++ compiler; it was developed while I was at Microsoft Research.

IsaFoR: Isabelle Formalization of Rewriting *contributor, Isabelle, 2013–2018*

The Isabelle Formalization of Rewriting is a by now vast collection of results about term rewriting an theorem proving in the proof assistant Isabelle, developed at the University of Innsbruck. I contributed a number of results, mostly about equational theorem proving [8, 31, 39, 40]. Details and source code are available.

T$_\text{T}$T$_\mathbf{2}$: termination tool *contributor, OCaml, 2012–2015*

This is an automatic termination prover for term rewrite systems, to which I contributed an ordinal interpretation technique [10] and AC-KBO [9]. **T$_\text{T}$T$_\mathbf{2}$** is written in OCaml, details and source code are available.

mkb$_{\text{TT}}$: completion tool *main developer, OCaml, 2008–2015*

This is a Knuth-Bendix completion tool that I developed in my PhD project. It implements standard, ordered, AC- and normalized completion, and supports the use of external termination tools [11, 46, 42]. Source code is available.

Publications

Five Most Important Publications

- A. Gianola, M. Montali, and S. Winkler. Linear-time verification of data-aware processes modulo theories via covers and automata. In *Proc. 38th AAAI Conference on Artificial Intelligence* (*AAAI 2024*), pages 10525–10534, 2024. doi: 10.1609/aaai.v38i9.28922.
- P. Felli, M. Montali, F. Patrizi, and S. Winkler. Monitoring arithmetic temporal properties on finite traces. In *Proc. 37th AAAI Conference on Artificial Intelligence* (*AAAI 2023*), pages 6346–6354, 2023. doi: 10.1609/aaai.v37i5.25781.
- P. Felli, M. Montali, and S. Winkler. Linear-time verification of data-aware dynamic systems with arithmetic. In *Proc. 36th AAAI Conference on Artificial Intelligence* (*AAAI 2022*), pages 5642–5650, 2022. doi: 10.1609/aaai.v36i5.20505.
- P. Felli, A. Gianola, M. Montali, A. Rivkin, and S. Winkler. Cocomot: Conformance checking of multi-perspective processes via SMT. In *Proc. 19th International Conference on Business Process Management* (*BPM 2021*), volume 12875 of *LNCS*, pages 217–234, 2021. doi: 10.1007/978-3-030-85469-0_15. Best paper award.
- S. Winkler, H. Sato, A. Middeldorp, and M. Kurihara. Multi-completion with termination tools. *Journal of Automated Reasoning*, 50(3):317–354, 2013. doi: 10.1007/s10817-012-9249-2.

Journal Publications

[1] R. Hipler, H. Kallwies, M. Leucker, M. Montali, C. Sánchez, and S. Winkler. Symbolic runtime verification for monitoring under uncertainties and assumptions. *Inf. Softw. Technol.*, 191:108004, 2026. doi: 10.1016/J.INFSOF.2025.108004.

[2] A. Gianola, J. Ko, F.M. Maggi, M. Montali, and S. Winkler. Approximate conformance checking: Fast computation of multi-perspective, probabilistic alignments. *Inf. Syst.*, 129:102510, 2025. doi: 10.1016/j.is.2024.102510.

[3] A. Gianola, M. Montali, and S. Winkler. SMT techniques for data-aware process mining. *Künstliche Intell.*, 39(3):221–237, 2025. doi: 10.1007/S13218-025-00890-Z.

[4] M. Montali and S. Winkler. Relating behaviour of data-aware process models. *Data Knowl. Eng.*, 154:102363, 2024. doi: 10.1016/J.DATAK.2024.102363.

[5] M. P. Bonacina and S. Winkler. Semantically-guided goal-sensitive reasoning: Decision procedures and the Koala prover. *J. Autom. Reason.*, 67(1):6, 2023. doi: 10.1007/s10817-022-09656-w.

[6] P. Felli, A. Gianola, M. Montali, A. Rivkin, and S. Winkler. Data-aware conformance checking with SMT. *Inf. Syst.*, 117:102230, 2023. doi: 10.1016/j.is.2023.102230.

[7] P. Felli, A. Gianola, M. Montali, A. Rivkin, and S. Winkler. Multi-perspective conformance checking of uncertain process traces: An SMT-based approach. *Eng. Appl. Artif. Intell.*, 126(B):106895, 2023. doi: 10.1016/j.engappai.2023.106895.

[8] N. Hirokawa, A. Middeldorp, C. Sternagel, and S. Winkler. Abstract completion, formalized. *Log. Meth. Comput. Sci.*, 15(3):1:1–1:19, 2019. doi: 10.23638/LMCS-15(3:19)2019.

[9] A. Yamada, S. Winkler, N. Hirokawa, and A. Middeldorp. AC-KBO Revisited. *Theor. Pract. Log. Prog.*, 16(2):163–188, 2016. doi: 10.1017/S1471068415000083.

[10] H. Zankl, S. Winkler, and A. Middeldorp. Beyond Polynomials and Peano Arithmetic — Automation of Elementary and Ordinal Interpretations. *J. Symb. Comput.*, 69(C):129–158, 2015. doi: 10.1016/j.jsc.2014.09.033.

[11] S. Winkler, H. Sato, A. Middeldorp, and M. Kurihara. Multi-completion with termination tools. *J. Autom. Reasoning*, 50(3):317–354, 2013. doi: 10.1007/s10817-012-9249-2.

Conference Publications

[12] J. Casas-Ramos, S. Winkler, A. Gianola, M. Montali, M. Mucientes, and M. Lama. Efficient conformance checking of rich data-aware declare specifications. In *Proc. 23rd BPM*, LNCS, pages 88–105, 2025. doi: 10.1007/978-3-032-02867-9_7.

[13] A. Gianola, M. Montali, and S. Winkler. Object-centric processes with structured data and exact synchronization - formal modelling and conformance checking. In *Proc. 37th CAiSE*, LNCS, pages 185–202, 2025. doi: 10.1007/978-3-031-94571-7_11.

[14] A. Seidel, S. Winkler, A. Gianola, M. Montali, and M. Weske. To bind or not to bind? discovering stable relationships in object-centric processes. In *Proc. 44th ER*, LNCS, pages 223–241, 2025. doi: 10.1007/978-3-032-08623-5_12.

[15] S. Winkler. First-order LTLf synthesis with lookback. In *Proc. 28th ECAI*, FAIA, pages 1615–1622. IOS Press, 2025. doi: 10.3233/FAIA250987.

[16] A. Burigana, A. Gianola, M. Montali, and S. Winkler. Glocal conformance checking. In *Proc. 22nd BPM*, volume 14940 of *LNCS*, pages 75–92, 2024. doi: 10.1007/978-3-031-70396-6_5.

[17] A. Gianola, M. Montali, and S. Winkler. Linear-time verification of data-aware processes modulo theories via covers and automata. In *Proc. 38th AAAI*, pages 10525–10534, 2024. doi: 10.1609/aaai.v38i9.28922.

[18] A. Gianola, M. Montali, and S. Winkler. Object-centric conformance alignments with synchronization. In *Proc. 36th CAiSE*, volume 14663 of *LNCS*, pages 3–19, 2024. doi: 10.1007/978-3-031-61057-8_1.

[19] P. Felli, M. Montali, F. Patrizi, and S. Winkler. Monitoring arithmetic temporal properties on finite traces. In *Proc. 37th AAAI*, pages 6346–6354, 2023. doi: 10.1609/aaai.v37i5.25781.

[20] P. Felli, M. Montali, and S. Winkler. Repairing soundness properties in data-aware processes. In *Proc. 5th International Conference on Process Mining*, pages 41–48, 2023. doi: 10.1109/ICPM60904.2023.10271969.

[21] L. Geatti, A. Gianola, N. Gigante, and S. Winkler. Decidable fragments of LTLf modulo theories. In *Proc. 26th European Conference on Artificial Intelligence*, volume 372 of *FAIA*, pages 811–818, 2023. doi: 10.3233/FAIA230348.

[22] A. Gianola, J. Ko, F. M. Maggi, M. Montali, and S. Winkler. Approximating multi-perspective trace alignment using trace encodings. In *Proc. 23rd BPM*, volume 14159 of *LNCS*, pages 74–91, 2023. doi: 10.1007/978-3-031-41620-0_5.

[23] P. Felli, A. Gianola, M. Montali, A. Rivkin, and S. Winkler. Conformance checking with uncertainty via SMT. In *Proc. BPM 2022*, volume 13420 of *LNCS*, pages 199–216, 2022. doi: 10.1007/978-3-031-16103-2_15.

[24] P. Felli, M. Montali, and S. Winkler. CTL* model checking for data-aware dynamic systems with arithmetic. In *Proc. 11th IJCAR*, volume 13385, pages 36–56, 2022. doi: 10.1007/978-3-031-10769-6_4.

[25] P. Felli, M. Montali, and S. Winkler. Linear-time verification of data-aware dynamic systems with arithmetic. In *Proc. 36th AAAI*, pages 5642–5650, 2022. doi: 10.1609/aaai.v36i5.20505.

[26] P. Felli, M. Montali, and S. Winkler. Soundness of data-aware processes with arithmetic conditions. In *Proc. 34th CAiSE*, volume 13295 of *LNCS*, pages 389–406, 2022. doi: 10.1007/978-3-031-07472-1_23.

[27] P. Felli, A. Gianola, M. Montali, A. Rivkin, and S. Winkler. Cocomot: Conformance checking of multi-perspective processes via SMT. In *Proc. 19th BPM*, volume 12875 of *LNCS*, pages 217–234, 2021. doi: 10.1007/978-3-030-85469-0_15. Best paper award.

[28] M. P. Bonacina and S. Winkler. SGGS decision procedures. In *Proc. 10th IJCAR*, volume 12166 of *LNCS*, pages 356–374, 2020. doi: 10.1007/978-3-030-51074-9_20 Nominated for best paper award.

[29] S. Winkler and A. Middeldorp. Tools in term rewriting for education. In *Proc. 8th ThEdu*, volume 313 of *EPTCS*, pages 54–72, 2020. doi: 10.4204/EPTCS.313.4.

[30] S. Winkler and G. Moser. Runtime complexity analysis of logically constrained rewriting. In *Proc. 30th LOPSTR*, LNCS, pages 37–55, 2020. doi: 10.1007/978-3-030-68446-4_2.

[31] C. Sternagel and S. Winkler. Certified equational reasoning via ordered completion. In *Proc. 27th CADE*, volume 11716 of *LNCS*, pages 508–525, 2019. doi: 10.1007/978-3-030-29436-6_30.

[32] S. Winkler. Extending maximal completion. In *Proc. 4th FSCD*, volume 131 of *LIPIcs*, pages 3:1–3:15, 2019. doi: 10.4230/LIPIcs.FSCD.2019.3.

[33] N. Nishida and S. Winkler. Loop detection by logically constrained term rewriting. In *Proc. 10th VSTTE*, volume 11294 of *LNCS*, pages 309–321, 2018. doi: 10.1007/978-3-030-03592-1_18.

[34] S. Winkler and A. Middeldorp. Completion for logically constrained rewriting. In *Proc. 3rd FSCD*, volume 108 of *LIPIcs*, pages 30:1–30:18, 2018. doi: 10.4230/LIPIcs.FSCD.2018.30.

[35] S. Winkler and G. Moser. Mædmax: A maximal ordered completion tool. In *Proc. 9th IJCAR*, volume 10900 of *LNCS*, pages 472–480, 2018. doi: 10.1007/978-3-319-94205-6_31.

[36] N. Hirokawa, A. Middeldorp, C. Sternagel, and S. Winkler. Infinite runs in abstract completion. In *Proc. 2nd FSCD*, volume 84 of *LIPIcs*, pages 19:1–19:16, 2017. doi: 10.4230/LIPIcs.FSCD.2017.19.

[37] H. Sato and S. Winkler. Encoding dependency pair techniques and control strategies for maximal completion. In *Proc. 25th CADE*, volume 9195 of *LNCS*, pages 152–162, 2015. doi: 10.1007/978-3-319-21401-6_10.

[38] T. Sternagel, S. Winkler, and H. Zankl. Recording completion for certificates in equational reasoning. In *Proc. 4th CPP*, pages 41–47, 2015. doi: 10.1145/2676724.2693171.

[39] S. Winkler and R. Thiemann. Formalizing soundness and completeness of unravelings. In *Proc. FroCoS 2015*, volume 9322 of *LNCS*, pages 239–255, 2015. doi: 10.1007/978-3-319-24246-0_15.

[40] J. Nagele, R. Thiemann, and S. Winkler. Certification of nontermination proofs using strategies and nonlooping derivations. In *Proc. 6th VSTTE*, volume 8471 of *LNCS*, pages 216–232, 2014. doi: 10.1007/978-3-319-12154-3_14.

[41] A. Yamada, S. Winkler, N. Hirokawa, and A. Middeldorp. AC-KBO revisited. In *Proc. 12th FLOPS*, volume 8475 of *LNCS*, pages 319–335, 2014. doi: 10.1007/978-3-319-07151-0.

[42] S. Winkler and A. Middeldorp. Normalized completion revisited. In *Proc. 24th RTA*, volume 21 of *LIPIcs*, pages 319–334, 2013. doi: 10.4230/LIPIcs.RTA.2013319.

[43] S. Winkler, H. Zankl, and A. Middeldorp. Beyond Peano Arithmetic — Automatically Proving Termination of the Goodstein Sequence. In *Proc. 24th RTA*, volume 21 of *LIPIcs*, pages 335–351, 2013. doi: 10.4230/LIPIcs.RTA.2013335.

[44] S. Winkler, H. Zankl, and A. Middeldorp. Ordinals and Knuth-Bendix orders. In *Proc. 18th LPAR*, volume 7180 of *LNCS*, pages 420–434, 2012. doi: 10.1007/978-3-642-28717-6_33.

[45] S. Winkler and A. Middeldorp. AC completion with termination tools. In *Proc. 23rd CADE*, volume 6803 of *LNCS*, pages 492–498, 2011. doi: 10.1007/978-3-642-22438-6_37.

[46] S. Winkler and A. Middeldorp. Termination tools in ordered completion. In *Proc. 5th IJCAR*, volume 6173 of *LNCS*, pages 518–532, 2010. doi: 10.1007/978-3-642-14203-1_43.

[47] S. Winkler, H. Sato, A. Middeldorp, and M. Kurihara. Optimizing mkbTT (system description). In *Proc. 21st RTA*, volume 6 of *LIPIcs*, pages 373–384, 2010. doi: 10.4230/LIPIcs.RTA.2010.373.

[48] H. Sato, S. Winkler, M. Kurihara, and A. Middeldorp. Multi-completion with termination tools (system description). In *Proc. 4th IJCAR*, volume 5195 of *LNCS*, pages 306–312, 2008. doi: 10.1007/978-3-540-71070-7_26.

Thesis

[49] S. Winkler. *Termination Tools in Automated Reasoning*. PhD thesis, University of Innsbruck, 2013.

Workshops and Other Publications

[50] R. Thiemann, C. Sternagel, C. Kirk, M. Avanzini, B. Felgenhauer, J. Nagele, T. Sternagel, S. Winkler, and A. Yamada. First-order rewriting. *Arch. Formal Proofs*, 2025, 2025.

[51] Y. Fontenla-Seco, S. Winkler, A. Gianola, M. Montali, M. Lama Penín, and A. José Bugarín Diz. The droid you're looking for: C-4PM, a conversational agent for declarative process mining. In *Proc. Demonstration & Resources Forum at BPM 2023*, volume 3469 of *CEUR Workshop Proceedings*, pages 112–116, 2023.

[52] M. Montali and S. Winkler. Equivalence of data Petri nets. In *Proc. BPM 2023 International Workshops*, volume 492 of *LNBIP*, pages 409–421, 2023. doi: 10.1007/978-3-031-50974-2_31.

[53] P. Felli, A. Gianola, M. Montali, A. Rivkin, and S. Winkler. A modular SMT-based approach for data-aware conformance checking. In *Proc. 4th Workshop on Artificial Intelligence and Formal Verification, Logic, Automata, and Synthesis at AIxIA 2022*, volume 3311 of *CEUR Workshop Proceedings*, pages 87–92, 2022.

[54] P. Felli, M. Montali, and S. Winkler. Reasoning and verification with data Petri nets. In *Proc. Workshop on Process Management in the AI Era at IJCAI-ECAI 2022*, volume 3310 of *CEUR Workshop Proceedings*, pages 73–76, 2022.

[55] M. Suda and S. Winkler. Learning strategy design: First lessons. In *Proc. 5th Conference on Artificial Intelligence and Theorem Proving*, 2020.

[56] M. Suda and S. Winkler, editors. *Proceedings of the Second International Workshop on Automated Reasoning: Challenges, Applications, Directions, Exemplary Achievements (ARCADE 2019)*, volume 311 of *EPTCS*, 2019. doi: 10.4204/EPTCS.311.

[57] S. Winkler. Mædmax at school: Learning selection in equational reasoning. In *Proc. 4th Conference on Artificial Intelligence and Theorem Proving*, pages 38–40, 2019.

[58] S. Winkler and G. Moser. Smarter features, simpler learning? In *Proc. 2nd ARCADE*, volume 311 of *EPTCS*, pages 25–31, 2019. doi: 10.4204/EPTCS.311.4.

[59] C. Sternagel and S. Winkler. Certified ordered completion. In *Proc. 7th International Workshop on Confluence*, pages 41–45, 2018.

[60] S. Winkler. A ground joinability criterion for ordered completion. In *Proc. 6th International Workshop on Confluence*, pages 45–49, 2017.

[61] H. Sato and S. Winkler. A satisfiability encoding of dependency pair techniques for maximal completion. In *Proc. 14th International Workshop on Termination*, pages 80–84, 2014.

[62] H. Zankl, S. Winkler, and A. Middeldorp. Automating elementary interpretations. In *Proc. 14th International Workshop on Termination*, pages 90–94, 2014.

[63] H. Zankl, S. Winkler, and A. Middeldorp. Automating ordinal interpretations. In *Proc. 12th International Workshop on Termination*, pages 94–98, 2012.

[64] H. Sato, M. Kurihara, S. Winkler, and A. Middeldorp. Constraint-based multi-completion procedures for term rewriting systems. *IEICE Transactions on Information and Systems*, E92-D(2):220–234, 2009.

[65] C. Sternagel, R. Thiemann, S. Winkler, and H. Zankl. CeTA — a tool for certified termination analysis. In *Proc. 10th International Workshop on Termination*, pages 84–87, 2009.

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