Sasha Rubin
✉ *rubin@unina.it*

Hiring Committee
Department of Computer Science, NUS
Tenure-Track Faculty Position in Artificial Intelligence.

November, 2017

Background and Esteem. I am a computer scientist with an interest in Artificial Intelligence, especially knowledge representation, logic, multi-agent systems, and automated planning.

My PhD thesis, mentored by Bakhadyr Khoussainov, won the best-doctoral thesis in the faculty of computer science at the University of Auckland (one of seven awardees). I then won a prestigious New Zealand Science and Technology Postdoctoral Fellowship (NZ$224532) on the same topic. I then held various postdoctoral positions, including a teaching position at Cornell University (2008-2009). Since 2012 I've been working in Formal Methods for Distributed Systems, and since 2014 in Formal Methods for Artificial Intelligence. In 2015-2016 I held another individual fellowship, a Marie Curie fellowship (€107000) jointly funded by the European Research Commission and the Institute for Higher Mathematics (INdAM "F. Severi") in Italy, on the topic of Formal Methods for lightweight mobile multi-agent systems, which led to a best-paper award.

Since 2013, I am chair or organiser of 5 events (workshops and conferences). In 2017 I co-founded and co-organised the First Workshop on Formal Methods in Artificial Intelligence (FMAI'17). I serve as a PC member for top AI/MAS conferences including AAAI, IJCAI, and AAMAS. I co-organised the Young Scientists Symposium at IST Austria on the topic "Understanding Shape: in silico and in vivo". I am guest editor of two special issues of International workshops and Italian conferences. In 2017 I served as an external reviewer for the Icelandic Research Fund and the IRISA Master Research Internship (France).

Research. My vision is to bring Formal Methods and Artificial Intelligence closer together. This is motivated by the need to ensure that the systems being built using, e.g., machine learning, can explain their decisions and actions to human users, so-called "explainable AI" (for instance, in healthcare, a diagnostic and prescription system without such features will likely go unused and untrusted). I bring personal expertise on logics and formal methods for temporal, strategic and epistemic reasoning.

The quality of my research can be quickly but roughly gauged from the venues in which I publish (that said, I strongly maintain that the only way to gauge the strength of a paper is for an expert to read it). These include 16 papers [C2-C11, C17, C22, C26, C27, C29, C30] in conferences ranked A* by the CORE ranking (`portal.core.edu.au/conf-ranks/`), 10 of which were published since 2016, as well as a book on verification of distributed systems [B1] (references of the form [X#] are in the attached CV).

Teaching and Supervision. I work hard at finding angles on the material that will engage my students; this often involves finding questions that are fun for students to solve, or engaging students in big ideas. I seek out, formally and informally, talented teachers and educators from who I can learn best practices as well as some pedagogy theory. If I have the opportunity to statistically evaluate teaching strategies and student outcomes then you can expect that I will make an effort to do so.

As evidence of this effort I make some remarks about my teaching at Cornell University 2008-2009. I sought a number of teaching mentors, including Maria Terrell (Department of Mathematics) and

David Way (Centre for Teaching Excellence) to discuss successful teaching strategies, both philosophical and concrete. As an example of innovativeness in teaching, I remark that I noticed that students who had read the relevant chapter of the textbook before coming to class would ask much deeper questions in class. As a result I instituted a "pre-class test" that was administered online and tested whether or not the student had basic knowledge of the contents of the chapter to be covered in class. Although the tests took time to set up and administer, the payoff was enormous to them and me.

Here is a sample of written student responses to my teaching, the first from my teaching at The University of Cape Town, the rest from Cornell University:

- "*I have enjoyed your maths course the most of all the maths courses I've taken so far. Even more than the content, your delivery was excellent. I made the decision during one of your lectures to do honours in mathematics and computer science.*"
- "*Sasha was a wonderful lecturer – very organized, clear, and willing to help anyone with difficulties (proactively, as well – he sought out people who were doing poorly and offered assistance, which was extremely beneficial).*"
- "*The class was interesting, fun, and easier. Professor was very well prepared and made us really understand what we were learning by having us write mathematical formulas in words. Instead of memorizing formulas, he helped us understand what we were learning, why we were learning it and why it was useful.*"

I am open to teaching theory and programming courses at all levels.

I have supervised 8 undergraduate students in research, and have mentored three PhD students of Aniello Murano in Italy. All completed projects and collaborations with students resulted in publications in, e.g., IJCAI, AAMAS.

My usual approach to undergraduate supervision is to discuss possible problems with students and let them pick one to work on. If the student lacks confidence or is unsure about how to proceed, I create a mini-proposal and timeline for them to follow. I meet with students once a week to discuss progress and troubleshoot. I consider undergraduate research successful if the student a) has fun, b) is challenged, and c) produces and publishes novel research.

Integration in the Department of Computer Science at the NUS. My recent breakthrough work [C2,C3] on verification of a very broad class of multi-agent systems (in which agents communicate by *broadcast*), as well as previous work on verification of *probabilistic* systems [C26] and verification of *quantitative* properties [C12, C7, C6, J2], has applications to formal methods for analysis of: social networks like twitter; collusions in e-auctions and e-voting; distributed secret sharing and data-dispersal; games with public moves and bids such as poker, etc. This work aligns with the research interests of **Roland Yap** (constraint programming languages and social networks), **Lee Wee Sun** and **David Hsu** (planning under uncertainty), and **Bryan Low** (multi-robot systems). My recent work in logic in computer science, specifically games on graphs [J5], aligns with the stunning breakthrough result on parity games of **Frank Stephan** and **Sanjay Jain**.

I look forward to hearing from you,

Sasha Rubin

Sasha Rubin

Curriculum Vitae, 12/2017

University of Naples "Federico II"
Naples, Italy
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sasharubin.github.io

Personal Information

Citizenship New Zealand

Languages English (first language), Italian (beginner)

Current Appointment

2017-present **PostDoc. (Computer Science)**, *University of Naples "Federico II"*, Department of Electrical Engineering and Information Technology, Fellow of the ASTREA lab headed by Aniello Murano, for the study of formal methods, artificial intelligence, and multi-agent systems.

Academic Qualifications

Begun 1999, Defence 2004, Awarded 2007. **PhD**, *Mathematics and Computer Science*, University of Auckland, Best Doctoral Thesis in the Faculty of Science (one of seven awardees in 2004).

1997-1998 **MSc**, *Mathematics*, University of Auckland, First Class.

1994-1996 **BSc**, *Department of Mathematics and Department of Computer Science*, University of Cape Town, Dean's Merit List.

Previous Appointments

2015-2017 **Marie Curie Fellow of INdAM "F. Severi"**, *University of Naples "Federico II"*.
Research in collaboration with Aniello Murano and his group

2014-2015 **PostDoc. (Computer Science)**, *TU Wien and TU Graz*.
Research in collaboration with Helmut Veith and Roderick Bloem, and their groups

2012-2014 **PostDoc. (Computer Science)**, *TU Wien and IST Austria*.
Research in collaboration with Helmut Veith and Krishnendu Chatterjee and their groups

2010-2012 **Honorary Research Fellow (Computer Science)**, *University of Auckland*.

Visiting Researcher (Computer Science), *University of Tel Aviv*.
Research in collaboration with Alexander Rabinovich, one semester in 2011

Visiting Lecturer (Mathematics), *University of Cape Town*.
1 semester in 2010

2008-2009 **Visiting Assistant Professor (Mathematics)**, *Cornell University*.
Lecturer, and Research in collaboration with Anil Nerode and his group, 3 semesters

2007-2008 **Visiting Researcher (Computer Science)**, *University of Auckland*.

2004-2007 **Foundation for Research, Science and Technology (FRST) New Zealand Science and Technology (NZST) Postdoctoral Fellowship**, *University of Auckland*.
NZ Government funded 3 year fellowship

Research Portfolio

My main research interest is in artificial intelligence, including logic, knowledge representation, multi-agent systems and automated planning. I have contributed to the following areas:

- Formal methods (modeling, verification, synthesis) of Multi-agent Systems (including parameterised systems, distributed systems, probabilistic systems, timed systems).
- Logics (for games and strategic reasoning)
- Foundations of planning and generalised planning.
- Automated reasoning (including verification and synthesis).
- Automata theory.
- Finite and algorithmic model theory.

Research Accomplishments

Citation source: google scholar 11/10/17

2017	I published 5 CORE A* conference papers in 2017 [C2]–[C6].
2016	I published 5 CORE A* conference papers in 2016 [C7]–[C11].
2016-2017	I teamed up with world-experts in automated planning and multi-agent systems and made theoretical and practical contributions to verification and synthesis under imperfect information. In particular, I extended logics for strategic reasoning in two ways: allowing imperfect information (with Moshe Vardi et.al. [C4] and Alessio Lomuscio et.al. [C2]), and by graded modalities (with Aniello Murano et.al. [J2]). I extended the belief-space construction to infinite games (with Giuseppe De Giacomo et. al. [C11]), and I studied an application of these ideas to Generalised Planning (with Giuseppe de Giacomo, Blai Bonet, and Hector Geffner) [C5].
2014-2015	I opened the direction of formal methods for parameterised light-weight mobile agents with [C17]. Subsequently (with my co-authors) I continued this direction with [C13] (which won a best-paper award) and [C8].
2015	Co-authored a book surveying decidability results in parameterised verification [B1], published by Morgan & Claypool, (30 citations).
2012-2014	I (with my co-authors) generalised a cornerstone paper on verification of parameterised systems ("Reasoning about Rings", E.A. Emerson, K.S. Namjoshi, POPL, 1995) from ring topologies to arbitrary topologies (36 citations) [C18].
2008-2011	I published a survey and extension of the main results in my thesis in the Bulletin of Symbolic Logic [J8]. With a PhD student of Erich Grädel's (Tobias Ganzow) I solved a 12 year-old conjecture of Courcelle's [C23].
1999-2007	During and after my PhD I (and my co-authors) pioneered the development of the theory of automatic structures. My most cited publications in this area are: [C27] (100 citations) and [J8] (93 citations). My PhD thesis has 73 citations.

Bibliometrics

conf. papers	16 x CORE A* (including 5 LICS, 4 IJCAI, 4 AAMAS, 1 KR, 1 IJCAR, 1 CAV), 7 x CORE A and 5 x CORE B
journal articles	3 x SJR Q1, and 4 x SJR Q2
citations	790 citations on Google Scholar
H-index	According to Google Scholar, my H-index is 15 (since 2002), and 12 (since 2012)

Awards

PhD Prize **Best doctoral thesis in the Faculty of Science, University of Auckland, 2004**, *At most five awarded per year.*

PhD Prize **Montgomery memorial prize in logic from the Department of Philosophy, 2004**, *At most one awarded per year*.

Paper Prize **Best-paper award at PRIMA 2015, [C13]**, *One awarded per year*.

Competition **As part of a team of three, won the national heats and represented New Zealand in the world finals of the 1998 ACM Programming Contest**, *Atlanta, Georgia USA*.

Funding and Grant writing

Individual Funding

2004-2007 **Foundation for Research, Science and Technology (FRST) New Zealand Science and Technology (NZST) Post Doctoral Fellowship (n. UOAX0413, "Automatic Structures")**, *3 years*, NZ$224532.

2015-2016 **Marie Curie Fellowship of INdAM "F. Severi"**, *2 years*, €107000, one of four awarded in 2015.

2011 **Exchange Grant within the framework of the European Science Foundation (ESF) activity on "Games for Design and Verification"**, *12 weeks*, €5300.

2015-2016 **GNSAGA grants for research travel**, €4909.

2011 **Short Visit Grant (n. 4391) of the European Science Foundation (ESF) activity on "Games for Design and Verification"**, *15 days*, €1475.

2011 **Short Visit Grant (n. 4500) of the European Science Foundation (ESF) activity on "Games for Design and Verification"**, *10 days*, €1350.

Grant writing

2017 Assisted Aniello Murano with writing a Programma Operativo Nazionale (PON) "Ricerca e Innovazione" 2014-2020 grant application.

2017 Assisted Giuseppe De Giacomo with writing an ERC grant application.

2017 Assisted Aniello Murano's postdoc with writing an INdAM postdoctoral application.

2016-2017 Assisted Florian Zuleger with writing an Austrian Science Fund grant application.

2014 Assisted Helmut Veith with writing and editing Austrian Science Fund grant applications and reports for the National Research Network (NFN).
`http://arise.or.at/`

Supervision and Mentoring

I've supervised/mentored a number of students, resulting in publications.

PhD Mentoring

2015-2017 Closely worked with PhD students of Aniello Murano (Vadim Malvone, Antonio di Stasio, Loredanna Sorrentino) and produced [W2], [C7], [C11]

2007 Closely worked with a PhD student of Erich Gradel's (Tobias Ganzow) and solved a 12-year open problem [C23]

Masters Supervision

2017 **Masters Internship: Aurele Barriere**, *University of Naples*, Topic: Epistemic Logic.
co-supervision, ongoing

Undergraduate Supervision

2017 **Undergraduate thesis: Paolo Lambiase**, *University of Naples*, Topic: Graphical Games.
co-supervision, ongoing

2012 **Summer undergraduate project: Siddhesh Chaubal**, *IST Austria*, Topic: Edit-distance and Formal Languages.
co-supervision, produced [C20]

2009 **Summer research experience for undergraduates: Andrey Grinshpun, Pakawat Phalitnonkiat, Andrei Tarfulea**, *Cornell University*, Topic: Parity Games.
supervision, produced [J7]

2009 **Summer research experience for undergraduates: Alex Kruckman, John Sheridan, Ben Zax**, *Cornell University*, Topic: Automatic Structures with Advice.
supervision, produced [C21]

Teaching

Graduate courses

2017 **PhD course**, *Milestones in Solving Games on Graphs*, Technical University of Vienna, Duties: design, present and examine.

2017 **PhD course**, *Games on Graphs*, University of Naples, Duties: designed and presented.

2009 **PhD course**, *Logical Definability and Random Graphs*, Cornell University, Duties: designed and presented.

School course

2006 **Advanced course**, *Logic and Computation in Finitely Presentable Infinite Structures*, European Summer School in Logic, Language and Information (ESSLLI 2006), Duties: designed and presented.
co-taught

Undergraduate courses

2015/2016 **System specification**, *University of Naples "Federico II"*, Duties: Teaching assistant.

2010 **Logic and Computation**, *Department of Mathematics, University of Cape Town*, Duties: Lecturer, course design.

2008-2009 **Calculus for Engineers**, *Department of Mathematics, Cornell University*, Duties: Lecturer, weekly online quizzes, marking.
taught the course 5 times

2007 **Discrete Structures in Mathematics and Computer Science**, *Department of Computer Science, University of Auckland*, Duties: Lecturerer (including tutorials), course design.
co-taught

2007 **Mathematical Foundations of Software Engineering** , *Department of Computer Science, University of Auckland*, Duties: Lectures (including tutorials), course design.
co-taught

2003 **Introduction to Formal Verification**, *Department of Computer Science, University of Auckland*, Duties: Lecturer (including tutorials), course design.
co-taught

2002 **Automata theory**, *Department of Computer Science, University of Auckland*, Duties: Lecturer (including tutorials), course design.
co-taught

2000-2001 **Pre-calculus**, *Department of Mathematics, University of Wisconsin, Madison*, Duties: Lecturer, tutorials, marking.
taught the course 2 times

Dissemination and Outreach

Recent Talks of Accepted Papers

2017 **IJCAI, Melbourne**, *Generalised Planning: Non-Deterministic Abstractions and Trajectory Constraints*.

2017 **FMAI, Naples**, *Verification of Multi-agent Systems with Imperfect Information and Public Actions*.

2016 **SR, New York**, *LTL Reactive Synthesis under Assumptions*.

2016 **KR, Cape Town**, *Model Checking Prompt Alternating-Time Epistemic Logics*.

2016 **IJCAI, New York**, *Imperfect-Information Games and Generalized Planning*.

2016 **AAMAS, Singapore**, *Automatic Verification of Multi-Agent Systems in Parameterized Grid-Environments*.

2015 **PRIMA, Bertinoro**, *Verification of Asynchronous Mobile-Robots in Partially-Known Environments*.

2015 **HIGHLIGHTS, Prague**, *The Composition Method and Parameterised Verification*.

2015 **AAMAS, Istanbul**, *Parameterised Verification of Autonomous Mobile-Agents*.

2014 **VMCAI, San Diego**, *Cutoffs for Parameterised Token-Passing Systems*.

2014 **SR, Grenoble**, *First Cycle Games*.

2014 **HIGHLIGHTS, Paris**, *First Cycle Games*.

2014 **FRIDA, Vienna**, *Using automata and logic to reason about parameterised robot protocols*.

2013 **LATA, Bilbao**, *How to Travel between Languages*.

Outreach

2010 I briefly volunteered at a secondary school in Accra, Ghana, teaching, observing and commenting on grade 5 mathematics classes.

2010 I briefly volunteered in Khayelitsha, South Africa, helping high-school students prepare for their mathematics exams.

2009 I taught two interactive lectures to non-mathematics majors at Cornell University on i) Hilbert's Hotel and Infinite Cardinals and ii) Algorithms and Termination.

Esteem

Chairs, Organisation, Committees

2018 PC member of the International Workshop on Strategic reasoning (SR)
`http://projects.lsv.fr/sr18/`

2018 PC member of the International Conference on Autonomous Agents and Multi-agent Systems (AAMAS)

2018 PC member of the AAAI Conference on Artificial Intelligence (AAAI)
https://aaai.org/Conferences/AAAI-18/

2017 External reviewer for Icelandic Research Fund

2017 Co-chair and co-organiser of the Italian Conference on Theoretical Computer Science (ICTCS)
http://ictcs2017.unina.it/

2017 Co-chair of the International Workshop on Strategic reasoning (SR)
http://sr2017.csc.liv.ac.uk/

2017 Co-organiser of the Italian Conference on Computational Logic (CILC)
http://cilc2017.unina.it/

2017 Co-organiser and -chair of the First Workshop on Formal Methods in AI (FMAI)
https://sites.google.com/site/fmai2017homepage/

2017 PC member of the International Joint Conference on Artificial Intelligence (IJCAI)

2017 PC member of the AAAI Conference on Artificial Intelligence (AAAI)

2017 PC member for IRISA Master Research Internship

2016 PC member of the International Workshop of Strategic Reasoning (SR)

2016 PC member of the International Symposium on Games, Automata, Logics and Formal Verification (GandALF)

2016 PC member of the European Conference on Artificial Intelligence (ECAI)

2013 Co-organiser of the IST Austria Young Scientist Symposium on the topic 'Understanding Shape: in silico and in vivo'
ist.ac.at/young-scientist-symposium-2013/

2012 Founded the computer science seminar at IST Austria whose goal was to foster collaborations within the institute between computer scientists and, at the time, biologists.
ist.ac.at/computer-science-seminar/

Editorship

2017 Guest-editor, Special issue of SR 2017, Information and Computation, In process.

2017 Guest-editor, Special issue of ICTCS 2017 and CILC 2017, Theoretical Computer Science, In process.

2017 Editor, Joint proceedings of ICTCS 2017 and CILC 2017, CEUR Workshop proceedings, ISSN 1613-0073, ceur-ws.org/Vol-1949/

Project co-ordinator

2013-2016 Handbook of Model Checking, to be published by Springer, and edited by Edmund Clarke, Thomas Henzinger, Helmut Veith and Roderick Bloem. Duties included: assisted editors in managerial, organisational, and technical matters, including: organising reviews, reviewers, and copy-editors; liasing between editors and Springer editor. ISBN 978-3-319-10575-8, http://www.springer.com/us/book/9783319105741

Reviewing

Funding Icelandic Research Fund

Book Handbook of Model Checking

Journals Artificial Intelligence (AIJ), Journal of Symbolic Logic (JSL), Logical Methods in Computer Science (LMCS), Transactions on Computational Logic (ToCL), Theory of Computing Systems (ToCS), Central European Journal of Mathematics, Information and Computation (IC), Journal of Logic and Computation (JLC), Annals of Mathematics and Artificial Intelligence (AMAI), Theory and Practice of Logic Programming (TLP), Science of Computer Programming (SCP)

Conferences IJCAI, KR, AAMAS, AAAI, EUMAS, ECAI, LICS, STACS, ICALP, MFCS, CONCUR, CSL, FoSSaCS, FSTTCS, SR, KRR@SAC, CiE, GandALF, RV, LPAR, LATA

Recent Research Visits

2015,2016,2017 **Host: Giuseppe De Giacomo, Sapienza University of Rome**, *Topic 1: Synthesis under Assumptions; Topic 2: Generalised Planning with Partial Observability*.

2016,2017 **Host: Mike Wooldridge, Oxford University**, *Topic: Rational Synthesis*.

2016,2017 **Host: Alessio Lomuscio, Imperial College London**, *Topic: Strategic-Epistemic logics for Multi-Agents Systems*.

2016 **Host: Diego Calvanese and Marco Montali, University of Bolzanno**, *Topic 1: Data-aware strategic logics; Topic 2: Knowledge Representation for Business Process Management*.

2016 **Hosts: Frank Stephan and Sanjay Jain, National University of Singapore**, *Topic: Learning Theory and Verification*.

2015 **Host: Helmut Veith, TU Wien**, *Topic 1: Logic and Impossibility Results in Distributed Computing; Topic 2: Abstractions for Fault-tolerant Distributed Algorithms*.

Invited Workshop Talks

2017 **Games of Imperfect-information with Public Actions**, *RoboLog, Rennes*.

2017 **Verification of Multi-Agent Systems with Imperfect Information and Public Actions**, *FMAI17, Napoli*.

2012 **Finite and Algorithmic Model Theory**, *Les Houches, France*.

2011 **Automata theory and Applications**, *IMS programme, Singapore*.

2008 **Computational Model Theory**, *CNRS SIG, Bordeaux, France*.

2007 **Algorithmic-Logical Theory of Infinite Structures**, *Dagstuhl, Germany*.

2006 **Finite and Algorithmic Model Theory**, *Newton Institute, England*.

2004 **Workshop on Automata, Structures and Logic**, *Auckland, New Zealand*.

Invited Seminar Talks

2018 **To be determined**, *Yale-NUS, Singapore*.

2018 **To be determined**, *University of Auckland, New Zealand*.

2018 **To be determined**, *IRIF, Université Paris-Diderot*.

2017 **Complexity of strategic reasoning under partial observability**, *IMT Lucca, Italy*.

2017 **Complexity of strategic reasoning under partial observability**, *GSSI, Italy*.

2017 **Temporal-Strategic Reasoning for Partial-Observation Games**, *University of New South Wales, Australia*.

2016 **Imperfect-Information Games and Generalized Planning**, *Free university of Bolzano, Italy*.

2014 **Verification of Mobile Agents in Partially Known Environments**, *University of Naples, Italy*.

2014 **Memoryless Determinacy of Cycle Games**, *University of California, San Diego, USA*.

2012 **Automata theoretic approach to mixed integer and rational arithmetic**, *IST Austria, Austria*.

2011 **Representing infinite structures by automata**, *TU Wien, Austria*.

2011 **An introduction to automatic structures**, *Tel Aviv University, Israel*.

2011 **Representing infinite structures by automata**, *EPFL, Switzerland*.

2008 **Generalised Quantifiers on Automatic Structures**, *LSV Cachan, France*.

2007 **Generalised Quantifiers on Automatic Structures**, *LIAFA Paris, France*.

2007 **Decidable extensions of the Monadic Second-order theory of one successor by unary predicates**, *Cornell University, USA*.

2007 **Automatic Structures**, *Heidelberg University, Germany*.

Refereed Publications

The cited bibliometrics are as follows: conferences are given their CORE (`http://portal.core.edu.au/conf-ranks/`) letter ranking, followed by the acceptance rate, followed by the number of submissions (where available); journal are given their SJR letter ranking (`http://www.scimagojr.com/journalrank.php`) at time of publication (if a ranking is not available for the current year, then an average of the last 5 years is taken).

Book

[B1] Roderick Bloem, Swen Jacobs, Ayrat Khalimov, Igor Konnov, Sasha Rubin, Helmut Veith, and Josef Widder. *Decidability of Parameterized Verification*. Synthesis Lectures on Distributed Computing Theory. Morgan & Claypool Publishers, 2015. DOI: 10.2200/S00658ED1V01Y201508DCT013.

Book Chapter

[BC1] Vince Bárány, Erich Grädel, and Sasha Rubin. "Automata-based presentations of infinite structures". In: *Finite and Algorithmic Model Theory*. Ed. by Javier Esparza, Christian Michaux, and Charles Steinhorn. London Mathematical Society Lecture Note Series 379. Cambridge Books Online. Cambridge University Press, 2011, pp. 1–76. ISBN: 978-0-521-71820-2.

[BC2] Sasha Rubin. "Automatic Structures". In: *Automata: From mathematics to applications*. Ed. by Jean-Eric Pin. Invited chapter, in process. European Mathematics Society (EMS).

Conference Articles

[C1] Benjamin Aminof, Ilina Stoilkovska, Sasha Rubin, Josef Widder, and Florian Zuleger. "Parameterized Model Checking of Synchronous Distributed Algorithms by Abstraction". In: *VMCAI'18*. To appear. 2018. **CORE B**

[C2] Francesco Belardinelli, Alessio Lomuscio, Aniello Murano, and Sasha Rubin. "Verification of Broadcasting Multi-Agent Systems against an Epistemic Strategy Logic". In: *International Joint Conference on Artificial Intelligence (IJCAI 2017)*. 2017. DOI: DOI10.24963/ijcai.2017/14. **CORE A*, 25%, 2540**

[C3] Francesco Belardinelli, Alessio Lomuscio, Aniello Murano, and Sasha Rubin. "Verification of Multi-agent Systems with Imperfect Information and Public Actions". In: *Proceedings of the 2017 International Conference on Autonomous Agents & Multiagent Systems (AAMAS 2017)*. 2017. **CORE A*, 26%, 595**

[C4] Raphaël Berthon, Bastien Maubert, Aniello Murano, Sasha Rubin, and Moshe Y. Vardi. "Strategy logic with imperfect information". In: *32nd Annual ACM/IEEE Symposium on Logic in Computer Science, LICS 2017, Reykjavik, Iceland, June 20-23, 2017*. IEEE Computer Society, 2017, pp. 1–12. ISBN: 978-1-5090-3018-7. DOI: 10.1109/LICS.2017.8005136. **CORE A***

[C5] Blai Bonet, Giuseppe De Giacomo, Hector Geffner, and Sasha Rubin. "Generalized Planning: Non-Deterministic Abstractions and Trajectory Constraints". In: *International Joint Conference on Artificial Intelligence (IJCAI 2017)*. 2017. **CORE A*, 25%, 2540**

[C6] Julian Gutierrez, Aniello Murano, Giuseppe Perelli, Sasha Rubin, and Michael Wooldridge. "Nash Equilibria in Concurrent Games with Lexicographic Preferences". In: *International Joint Conference on Artificial Intelligence (IJCAI 2017)*. 2017. DOI: DOI10.24963/ijcai.2017/148. **CORE A*, 25%, 2540**

[C7] Benjamin Aminof, Vadim Malvone, Aniello Murano, and Sasha Rubin. "Graded Strategy Logic: Reasoning about Uniqueness of Nash Equilibria". In: *Proceedings of the 2016 International Conference on Autonomous Agents & Multiagent Systems (AAMAS 2016)*. 2016, pp. 698–706. **CORE A*, 25%, 550**

[C8] Benjamin Aminof, Aniello Murano, Sasha Rubin, and Florian Zuleger. "Automatic Verification of Multi-Agent Systems in Parameterised Grid-Environments". In: *Proceedings of the 2016 International Conference on Autonomous Agents & Multiagent Systems (AAMAS 2016)*. 2016, pp. 1190–1199. **CORE A*, 25%, 550**

[C9] Benjamin Aminof, Aniello Murano, Sasha Rubin, and Florian Zuleger. "Prompt Alternating-Time Epistemic Logics". In: *Principles of Knowledge Representation and Reasoning: Proc. of the 15th International Conference, (KR 2016)*. 2016, pp. 258–267. **CORE A*, 27%, 182**

[C10] Benjamin Aminof and Sasha Rubin. "Model Checking Parameterised Multi-token Systems via the Composition Method". In: *Proc. 8th International Joint Conference on Automated Reasoning, (IJCAR 2016)*. 2016, pp. 499–515. DOI: 10.1007/978-3-319-40229-1_34. **CORE A***

[C11] Giuseppe De Giacomo, Antonio Di Stasio, Aniello Murano, and Sasha Rubin. "Imperfect-Information Games and Generalized Planning". In: *Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence (IJCAI 2016)*. 2016, pp. 1037–1043. **CORE A*, 25%, 2294**

[C12] Benjamin Aminof, Aniello Murano, and Sasha Rubin. "On CTL* with Graded Path Modalities". In: *Logic for Programming, Artificial Intelligence, and Reasoning - 20th International Conference, LPAR-20 2015, Suva, Fiji, November 24-28, 2015, Proceedings*. 2015, pp. 281–296. DOI: 10.1007/978-3-662-48899-7_20. **CORE A**

[C13] Benjamin Aminof, Aniello Murano, Sasha Rubin, and Florian Zuleger. "Verification of Asynchronous Mobile-Robots in Partially-Known Environments". In: *PRIMA 2015: Principles and Practice of Multi-Agent Systems - 18th International Conference, Bertinoro, Italy, October 26-30, 2015, Proceedings*. 2015, pp. 185–200. DOI: 10.1007/978-3-319-25524-8_12. **CORE B**

[C14] Benjamin Aminof, Sasha Rubin, Francesco Spegni, and Florian Zuleger. "Liveness of Parameterized Timed Networks". In: *Automata, Languages, and Programming - 42nd International Colloquium, ICALP 2015, Kyoto, Japan, July 6-10, 2015, Proceedings, Part II*. 2015, pp. 375–387. DOI: 10.1007/978-3-662-47666-6_30. **CORE A**

[C15] Benjamin Aminof, Sasha Rubin, and Florian Zuleger. "On the Expressive Power of Communication Primitives in Parameterised Systems". In: *Logic for Programming, Artificial Intelligence, and Reasoning - 20th International Conference, LPAR-20 2015, Suva, Fiji, November 24-28, 2015, Proceedings*. 2015, pp. 313–328. DOI: 10.1007/978-3-662-48899-7_22. **CORE A**

[C16] Aniello Murano, Giuseppe Perelli, and Sasha Rubin. "Multi-agent Path Planning in Known Dynamic Environments". In: *PRIMA 2015: Principles and Practice of Multi-Agent Systems - 18th International Conference, Bertinoro, Italy, October 26-30, 2015, Proceedings*. 2015, pp. 218–231. DOI: 10.1007/978-3-319-25524-8_14. **CORE B**

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Research Statement

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Overview

Systems built on the insights of Artificial Intelligence are increasingly deployed in the world as agents, e.g., software agents negotiating on our behalf on the internet, driverless cars, robots exploring new and dangerous environments, bots playing games with humans. There is an obvious need for humans to be able to trust the decisions made by artificial agents, the need for meaningful interactions between humans and agents, and the need for transparent agents.

This need can only be met if humans are able to model, control and predict the behaviour of agents. This challenge is made all the more complicated since: 1) agents are often deployed with *other* agents leading to *multi-agent systems*, 2) agent behaviour is complex, and extends into the future, leading to *temporal reasoning*, 3) agents are often "self-interested", leading to *strategic reasoning*, 4) agents may have uncertainty about the state, or even the structure, of other agents and the environment, leading to *epistemic reasoning*.

I approach these questions by developing and applying formal and logical methods to modeling and reasoning about multi-agent systems. I also pursue more foundational/speculative questions such as "What is synthesis and how should it be formalised?".

Current Research — Formal methods for multi-agent systems

Multi-agent systems (MAS) involve multiple individual agents (these may be people, software, robots) each with their own goals. Such systems can be viewed as multi-player games, and thus notions from game-theory (e.g., strategies, knowledge, and equilibria) are used to reason about them. Agents in realistic MAS often lack information about other agents and the environment, and this is often categorised in one of two ways: a) *incomplete information* and b) *imperfect information*.

a) MAS with incomplete information

Incomplete-information refers to uncertainty about the environment (i.e., the structure of the game). I have considered two sources of incomplete information for MAS.

First, the *number of agents* may not be known, or may not be bounded a priori. In a series of papers, I have contributed to a generalisation of a cornerstone paper on verification of such systems ("Reasoning about Rings", E.A. Emerson, K.S. Namjoshi, POPL, 1995) from ring topologies to arbitrary topologies [1, 2, 8, 3]. Other work on this topic studied the relative power of standard communication-primitives assuming an unknown number of agents [10], as well as the complexity of model-checking timed systems assuming an unknown number of agents [9]. I also contributed to a book on this topic published by Morgan & Claypool in 2015 [14, 15].

Second, the agents may be operating in a *partially-known environment*. For instance, the agents may know they are in a ring, but may not know the size of the ring. I launched the application of automata theory for the verification of high-level properties of light-weight mobile agents in partially-known environments [29]. In follow-up work I explored this theme further, including finding ways to model agents on grids — the most common abstraction of 2D and 3D space [4, 5, 26].

b) MAS with imperfect information

Even if agents have certainty about the structure of the system, they may not know exactly which state the system is in. This is called imperfect information and the associated logic for reasoning about such cases are called *epistemic*. I have studied strategic-epistemic logics in a number of works, namely, with a prompt modality (thus allowing one to express that a property holds "promptly" rather than simply "eventually") [6], and on systems with public-actions (such as certain card games, including a hand of Poker or a round of Bridge) [13, 12]. The importance of these last works is that they give the first decidability (and sometimes optimal complexity) results for strategic reasoning about games of imperfect information in which the agents may have arbitrary observations. In contrast, following classical restrictions on the observations or information of agents, I have also shown how to extend strategy logic by epistemic operators and identified a decidable fragment in which one can express equilibria concepts [12].

Foundations of Automated Planning

Planning in AI can be viewed as the problem of finding strategies in succinct representations of one- or two-player graph-games. In this model vertices represent states, edges represent transitions, and the players represent the agents. I have contributed foundational work to such games. Concretely, I recently extended the classic belief-space construction for games of imperfect-information from finite arenas to infinite-arenas [18] (infinite arenas often arise in the study of MAS with incomplete information, see above). I have also used these ideas to elucidate the role of observation-projections in generalised planning problems [17, 16]. I have generalised classic results about certain games with quantitative objectives (i.e., Ehrenfeucht and J. Mycielski. Positional strategies for mean payoff games. International Journal of Game Theory, 8:109–113, 1979) to so-called first-cycle games [7].

Past Research — Algorithmic Model Theory

My prior work contributed to a research program called "Algorithmic Model Theory" whose aim is to develop and extend the success of Finite Model Theory to infinite structures that can be reasoned about algorithmically.

Specifically, my PhD work pioneered the development of "automatic structures": this is a generalisation of the regular languages from sets to mathematical objects with structure, such as graphs, arithmetics, algebras, etc. The fundamental property of automatic structures is that one can automatically answer logic-based queries about them (precisely, their first-order theory is decidable). I gave techniques for proving that structures are or are not automatic (similar to, but vastly more complicated than, pumping lemmas for regular languages), I studied the computational complexity of deciding when two automatic structures are the same (isomorphic), and I found extensions of the fundamental property, thus enriching the query language [11, 19, 20, 21, 22, 23, 24, 28]. I have also worked on extensions of automatic structures to include oracle computation [25, 27].

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Teaching Statement

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The most influential course I've attended was a graduate level introduction to mathematical logic at the University of Auckland. It was taught by a topologist, David McIntyre, based on Moore's method — we were given basic definitions, followed by statements of fundamental theorems that we were to prove ourselves and present the following lesson. The material was to form the background of my graduate study. I probably did my best learning when my classmates presented a proof that I was unable to produce beforehand. Identifying the points in the proof that I did not think of trained me to get a focus on why and where my own reasoning had fallen short. It is these sorts of insights that I try generate in my own classroom.

Undergraduate teaching

I take every opportunity to improve my teaching.

I taught three semesters of Calculus for Engineers at Cornell University, essentially a second course in calculus for first year students that follows a textbook very closely.

After each lecture I reflected on how I could improve presentation of the material. This usually involved improving the pace, refining what to write on the board, and finding better ways to break up the material into chunks that students could follow.

My students were generally capable of acquiring, on their own, the skills to work routine problems. Consequently my main goal was to get them to reason mathematically, both verbally and in writing. I noticed that students are very sensitive to the wording I use. I keep a list of phrases to which they seem to respond, such as 'can anyone help A with her answer?', 'can you explain B's idea to me?', 'what do you mean by X?', 'are you sure?', 'who will summarise today's class?', 'if all I do is teach you computational procedures I'm short-changing you'.

I worked hard finding angles on the material that would engage my students. This invariably involved finding a question that sounded fun to try to solve. My favourite moments in class were those that involved discussing the big ideas in calculus. After writing a theorem on the board I asked: 'why should we believe this?' (a soft version of 'how do we prove it?') and the often overlooked 'how is this theorem useful?'.

I also learned to ask questions that probe student knowledge and understanding. For instance 'why would you say that?' and 'tell me more' helps to diagnose their logic, while asking easy recall-level questions lets me see whether students have been listening.

Although my students were most comfortable with being given algorithms to solve problems I instead focused on problem solving techniques *ala* Pólya: 1) identify the unknown, 2) if you can't solve the problem find a problem that you can solve that has a similar unknown.

I experimented with small group work in class to alter the pacing of lectures and encourage my students to think and reflect on what they had and had not understood.

Early in 2010 I gave the undergraduate course on logic and computation in the mathematics department at the University of Cape Town. Student abilities in the class were very mixed which meant I had to structure the course and pace very carefully. I slowed the lectures down a bit and moved harder questions to the tutorials. One of the strongest students sent me an email at the end of the term:

```
I have enjoyed your maths course the most of all the maths courses
I've taken so far at UCT. Even more than the content, your delivery
was excellent.

I made the decision during one of your lectures to do honours in
mathematics and computer science next year at UCT.
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Graduate Teaching

I've designed and taught three graduate-level courses: a generalist course "Milestones in Solving Games on Graphs" at the Technical University of Vienna (2017), a PhD course "Games on Graphs" at the University of Naples (2017), and a PhD course "Logical Definability and Random Graphs" at Cornell University (2009), an advanced course "Logic and Computation in Finitely Presentable Infinite Structures" at ESSLLI (2006, with Valentin Goranko).
I list a student comment from the most recent course:

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I especially liked the fact that you let us engage with the ideas.
I think I was able to deepen my understanding of graph games a
lot because I never took an actual course in it.
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Undergraduate Supervision

My usual approach to supervision is to discuss possible problems with students and let them pick one to work on. If the student lacks confidence or is unsure about how to proceed, I create a mini-proposal and timeline for them to follow. I meet with students once a week to discuss progress and troubleshoot. I consider undergraduate research successful if the student a) has fun, b) is challenged, and c) produces and publishes novel research.

In 2007 I started collaborations with a number of graduate students, two of which resulted in publications at STACS 2008.

In 2009 I supervised six undergraduate students for a two month research experience (REU). The student selection process was very competitive and so I received exceptionally talented undergraduates. The students formed two groups and worked on two projects. During this time I learned the value of giving students a few days to brew and filter their ideas before group discussions. Overall it was a rich experience for both me and, I gather, for my students. One exceptional student expressed to me that the experience helped him decide to pursue a career in research. The results were subsequently published in the journal *Theoretical Computer Science* and the conference *GandALF*.

In 2012 I co-supervised an undergraduate summer project which led to a publication in the conference *LATA*. While the student was writing up I realised that a proof required some formalities that the student did not know. At that point the student was keen to learn *how* I came to realise there was a problem. This episode taught me the value of modelling good mathematical thinking for learners.

In 2017 I supervised an undergraduate thesis, that included theoretical and practical components, on "graphical games", a topic at the interface of game-theory and graph-theory. We are writing up this work.

I recently worked with four junior PhD students, resulting in papers published at VMCAI'14, IJCAI'16, AAMAS'16, and VMCAI'18. In all cases I learned the value of helping graduate students to structure their thinking so they could contribute more to the collaboration than they otherwise might.