Ben Wooding (Google Scholar)

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Background

I am a research fellow with an EPSRC Doctoral Prize Research Fellowship for the topic "Reliable AI-Enabled Design of Cyber-Physical Systems". My research focus is the provision of rigorous mathematical guarantees over the behaviour of cyber-physical systems particularly for domains where preventing failure is critical. Lately, I my research has involved designing software tools to implement both abstraction and barrier certificate approaches, as well as theoretically providing guarantees over systems where the underlying model is (partially) unknown but we have access to some data.
I have contributed to the international academic community with published works, program committee memberships, paper reviews, conference presentations and invited talks. In 2024, I was a guest speaker at the PARTNERS24 'Ask the Experts' event. I was also a website chair for the VARS2021 Workshop, a part of CPS-IoT week.

Previously, I was a PhD student in the School of Computing at Newcastle University, United Kingdom, supervised by Dr Sadegh Soudjani - I was awarded an EPSRC Studentship in October 2019. My research focused on the intersection of formal methods in computer science and control theory applied to power system frequency regulation. I considered both model-based and data-driven approaches. In 2019, I completed an integrated Masters in Computing for Computer Science (Security and Resilience) with 1st Class Honours also at Newcastle University. For the project and dissertation I received 92%.

At Newcastle University, I spent 4 years as the chair of AMBER, organising seminars and other group activities. I have given multiple internal research presentations, and assisted widely by teaching as a demonstrator and marking. I have experience with supervising BSc, MSc and PhD student projects. Alongside these I was the co-lead of research communication and dissemination in the HyCoDeV Lab.

Academic Degrees

Oct.19-Nov.23 **PhD** in Formal Methods for Cyber-Physical Systems, School of Computing, Newcastle University, UK
Thesis title: *Model-Based and Data-Driven Formal Synthesis of Power Systems*

Oct.15-Sep.19 **M.Comp (Hons.)** in Computer Science (Security and Resilience), Newcastle University, UK
Dissertations: *(i) Using Formal Methods and Proof to Verify a CANDO Epilepsy Medical Device (2019)*
(ii) Modelling Computer Security Principles as a Strategy Game (2018)

Research Interests

Trustworthy Autonomy & AI, *Cyber-Physical Systems*, *Formal Learning & Control*, *Data-Driven Methods*, *Abstraction Techniques*, *Control Barrier Certificates*

Honours and Awards

Nov.23-Nov.25 EPSRC Doctoral Prize Fellowship
Oct.19-Mar.23 EPSRC PhD Studentship
Oct.15-Sep.20 Newcastle University Sports Scholarship

Publications: Journal

[J4] **B. Wooding**, A. Lavaei, "Learning k-Inductive Control Barrier Certificates for Unknown Nonlinear Dynamics Beyond Polynomials", *under review to Automatica*, 2024

[J3] A.S. Laino, **B. Wooding**, S. Soudjani, R. Davenport, "Logic-Based Robustness for Resilience of Water Resource Recovery Facilities (WRRFs)", *Environmental Science: Water Research & Technology*, 2024

[J2] **B. Wooding**, A. Lavaei, S. Soudjani, "Leveraging Robust Simulation Functions for Interconnected Systems under Large Disturbances", *under review in European Journal of Control*, 2023

[J1] M. Kazemi*, R. Majumdar, M. Salamati*, S. Soudjani, **B. Wooding***, "Data-Driven Abstraction-Based Controller Synthesis", *Nonlinear Analysis: Hybrid Systems (NAHS)*, 2024 ***(*contributed equally)***

Publications: Conference

[C8] J.Gardner*, **B. Wooding***, A. Nejati, A. Lavaei. "TRUST: Stability and Safety Controller Synthesis for Unknown Dynamical Models Using a Single Trajectory", *accepted to Hybrid Systems: Computation and Control (HSCC)*, 2025 ***(*contributed equally)***

[C7] **B. Wooding**, A. Lavaei. "PRoTECT: Parallelized Construction of Safety Barrier Certificates for Nonlinear Polynomial Systems", *under review in Computer Aided Verification (CAV)*, 2024

[C6] **B. Wooding**, A. Lavaei. "IMPaCT: Interval MDP Parallel Construction for Controller Synthesis of Large-Scale Stochastic Systems", *Quantitative Evaluation of Systems and Formal Modeling and Analysis of Timed Systems (QEST+FORMATS)*, 2024

[C5] O. Schön, S. Naseer, **B. Wooding**, S. Soudjani, "Data-Driven Abstractions via Binary-Tree Gaussian Processes for Formal Verification", *Analysis and Design of Hybrid Systems (ADHS)*, 2024

[C4] **B. Wooding**, A. Lavaei, V. Vahidinisab, and S. Soudjani, "Robust Simulation Functions with Disturbance Refinement", *European Control Conference (ECC)*, 2023

[C3] S. Bogomolov, J. Fitzgerald, FF. Foldager, C. Gamble, PG. Larsen, K. Pierce, P. Stankaitis, **B.Wooding**, "Tuning Robotti: the machine-assisted exploration of parameter spaces in multi-models of a cyber-physical system", *18th International Overture Workshop*, 2021 ***(authors in alphabetical order)***

[C2] A. Abate, H. Blom, N. Cauchi, J. Delicaris, A. Hartmanns, M. Khaled, A. Lavaei, C. Pilch, A. Remke, S. Schupp, F. Shmarov, S. Soudjani, A. Vinod, **B. Wooding**, M. Zamani, and P. Zuliani, "ARCH-COMP20 Category Report: Stochastic Models", *"7th International Workshop on Applied Verification of Continuous and Hybrid Systems (ARCH20)"*, 2020 ***(authors in alphabetical order)***

[C1] **B. Wooding**, V. Vahidinisab, S. Soudjani, "Formal Controller Synthesis for Frequency Regulation Utilising Electric Vehicles", *Smart Energy Systems and Technologies (SEST)*, 2020

Publications: Book Chapter

[B3] **B. Wooding**, V. Vahidinisab, and S. Soudjani, "Cyber-Physical Smart Homes/Buildings", *accepted Elsvier chapter*, 2023

[B2] **B. Wooding**, V. Vahidinisab, S. Soudjani,"Operation and control of a population of active buildings at network level", *Active Building Energy Systems: Operation and Control*, 2021

[B1] **B. Wooding**, V. Vahidinisab, M. Kazemi, S. Soudjani,"Control and management of active buildings", *Active Building Energy Systems: Operation and Control*, 2021

Publications: Poster

[P1] **B. Wooding**, A. Lavaei, "Poster Abstract: IMPaCT: A Parallelized Software Tool for IMDP Construction and Controller Synthesis with Convergence Guarantees", *Hybrid Systems: Computation and Control (HSCC)*, 2024

Teaching Experiences (Demonstrating and Marking)

Cloud Computing; *Engineering for AI*; *Research Methods*; *Computer Architecture*; *Software Engineering*; *Software Verification*; *Algorithm Design and Analysis*; *Building Systems for People*; *Understanding Programming Languages*; *Group Project in Data Science*; *Development and Operation of Systems*.

Supervision/Mentoring Experiences

- 8 BSc Projects, 5 MSc Projects, 2 PhD Projects
Related work to mentorships include [J3],[C5],[C7],[C8]

Academic Services: Program Committees

- Artifact Evaluation Program Committee for Foundations of Software Engineering (FSE) 2024
- Artifact Evaluation Program Committee for Formal Modeling and Analysis of Timed Systems (FORMATS) 2023

- Repeatability Program Committee for Hybrid Systems: Computation and Control (HSCC) 2020, 2021, 2022
- Repeatability Program Committee for IFAC Conference on Analysis and Design of Hybrid Systems (ADHS) 2021
- Website Chair for Verification of Autonomous & Robotic Systems (VARS) Workshop at CPS-IoT Week 2022

Academic Services: Membership

[2024] IEEE Member

[2023] IEEE Student Membership

Academic Services: Reviewing Activities

- Journals: IEEE Transactions on Control Systems Technology (TCST), IEEE Access, Elsevier European Journal of Control (EJCON)
- Conferences: ACM Hybrid Systems Control Conference (HSCC), IEEE European Control Conference (ECC), IEEE Conference on Control Technology and Applications (CCTA), IFAC Conference on Analysis and Design of Hybrid Systems (ADHS), International Symposium on Automated Technology for Verification and Analysis (ATVA), ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS), International Conference on Computer Aided Verification (CAV), Computation-Aware Algorithmic Design for Cyber-Physical Systems (CAADCPS), International Symposium On Leveraging Applications of Formal Methods, Verification and Validation (ISoLA), Learning for Decision and Control (L4DC), IEEE International Conference on Intelligent Transportation Systems (ITSC), IFAC American Control Conference (ACC)
- Book Chapters: Active Building Energy Systems: Operation and Control

Conference Presentations

[Sep. 24] International Conference on Quantitative Evaluation of Systems and Formal Modeling and Analysis of Timed Systems (QEST+FORMATS), Calgary, Canada. **[Regular, Work-in-Progress, and Demo Sessions]**

[Jun. 23] 21st European Control Conference (ECC), Bucharest, Romania.

[Sep. 20] 3rd International Conference on Smart Energy Systems and Technologies (SEST), Istanbul, Turkey. **[Virtual]**

Invited Talks and Panels

Upcoming:

[Feb. 25] *unconfirmed title*, **TU Eindhoven**, NL.

Past:

[Dec. 24] *Safety Barrier Certificates for Nonlinear Systems*, School of Computing and Communications, **Lancaster University**, UK.

[Nov. 24] *IMPaCT: A software tool for controller synthesis of stochastic systems using interval Markov decision processes*, Software Systems Group (SSY) Seminar, **Kings College London**, UK.

[Nov. 24] *Safety Barrier Certificates for Nonlinear Polynomial Systems*, Institute of Perception, Action and Behaviour (IPAB) Seminar, **Edinburgh University**, UK.

[Nov. 24] *IMPaCT: A software tool for controller synthesis of stochastic systems using interval Markov decision processes*, Scientific Computing (SciComp) Seminar, **Durham University**, UK.

[Jul. 24] "Ask the Experts" Session, PARTNERS24, **Newcastle University**, UK.
[The PARTNERS program intends to inspire and support young people who may have barriers that make it less likely they would attend university.]

Relevant Courses Taken

EECI M17 (2024): *The scenario approach: data science for systems, control, and machine learning*
During PhD: *Smart Grids and Applications of Computational Intelligence*; *Applied Probability*; *Differential Equations*; *Systems and Control*; *Signals and Communication*
During MComp: *Machine Learning; Big Data Analytics; Distributed Algorithms; System Evaluation; System Validation; System Verification Technologies; System and Network Security; Cryptography; Reliability and Fault Tolerance; High Integrity Software Development; The Challenge of Dependable Systems.*

Miscellaneous

Leadership: I held a sports scholarship for Volleyball at Newcastle University for 4 seasons. In my last season (my first PhD year) I also played semi-professionally in the Men's Super League, the highest division of Volleyball in the UK. During this time I had many leadership opportunities as the Men's Team Captain, Club Secretary and then as Club President. I am currently Chairman of JPCFC, a football team, playing in an FA registered league.
Global Perspective: I spent 10 years of my childhood living in Uganda in East Africa, including attending an international school which had over 70 different nations represented. These opportunities have given me an important global perspective of different countries, different cultures, and different worldviews.

References

PhD Supervisor: Sadegh Soudjani, Max Planck Institute: sadegh@mpi-sws.org
Fellowship Collaborator: Abolfazl Lavaei, Newcastle University: abolfazl.lavaei@ncl.ac.uk