Alessandro Zocca

TENURED ASSISTANT PROFESSOR

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RESEARCH INTERESTS

Stochastic networks, rare events analysis, network optimization, operations research, reinforcement learning, power systems resilience, extreme weather events.

My research is centered around the study of complex networked systems in which randomness plays a crucial role. More specifically, I study **dynamics and rare events in networks affected by uncertainty**, drawing motivation from real-world applications in power systems. My work lies mostly in the area of applied probability but has deep ramifications in areas as diverse as operations research, graph theory, and optimization.

My long-term goal as a researcher is twofold. First, I aim to quantify and analyze the randomness emerging in these complex systems using both **rigorous mathematical tools** and **data-driven learning methods**. Second, I plan to develop adaptive algorithms and reinforcement learning control strategies to mitigate the impact of high-impact, low-probability events and enhance network robustness.

As the **climate crisis** exacerbates the frequency and severity of extreme weather events, my research aims to develop a novel and rigorous mathematical understanding of **power systems resilience** against such phenomena, which naturally exhibit pronounced spatial and temporal correlations.

More broadly, I am interested in stochastic dynamics on networks, especially when a non-trivial interplay emerges between the network structure and the system's randomness, a setting where **applied probability**, **learning**, and **optimization** naturally meet.

EDUCATION

Sep 2011 – Dec 2015	**Eindhoven University of Technology**, The Netherlands PHD in *Mathematics* Thesis: SPATIO-TEMPORAL DYNAMICS OF RANDOM-ACCESS NETWORKS: AN INTERACTING PARTICLE APPROACH Advisors: Prof. Sem Borst, Prof. Johan van Leeuwaarden, Prof. Francesca Nardi
2012 – 2013	DIPLOMA (grade 9.0/10) by the **LNMB** (*Dutch Network for the Mathematics of Operations Research*)
2010 – 2011	**University of Cambridge**, United Kingdom MASTER OF ADVANCED STUDIES (PART III) in *Mathematics*, **with merit** Essay: RANDOM SPANNING TREES Assessor: Prof. Geoffrey Grimmett
2007 – 2010	**Università degli Studi di Padova**, Italy BACHELOR in *Mathematics*, **110/110 cum laude** *(with honors)* Thesis: RANDOM FRAGMENTATION CHAINS Supervisor: Prof. Paolo Dai Pra

Academic Employment

Oct 2019 – present	**Vrije Universiteit Amsterdam**, Amsterdam *Department of Mathematics* Tenured assistant professor
Mar 2021 – present	**Centrum Wiskunde & Informatica (CWI)**, Amsterdam Affiliate Researcher
Sep 2017 – Sep 2019	**California Institute of Technology**, Pasadena, CA *Computing and Mathematical Sciences Department* Postdoctoral scholar Mentors: Prof. Adam Wierman and Prof. Steven Low
Dec 2017 – Sep 2019	**Resnick Sustainability Institute**, Pasadena, CA Affiliate postdoctoral fellow
Jan 2016 – Aug 2017	**Centrum Wiskunde & Informatica (CWI)**, Amsterdam Postdoctoral scholar Mentor: Prof. Bert Zwart

Awards and grants

2015	**Applied Probability Trust award** for the best PhD thesis in applied probability
2017	**NWO Rubicon grant** (€135.000, 2 years of postdoc funding, ref. # 680.50.1529) Project: *"Renewables and uncertainty in future power systems: Mathematical challenges and solutions"*

Rubicon is a highly competitive grant open for all scientific disciplines awarded by the NWO (Netherlands Organization for Scientific Research), which gives talented young researchers the chance to gain experience at a top research institution abroad.

Travel grants
- 2020, 2021 STAR Visitor grant (co-applicant)
- 2019 Isaac Newton Institute CPS bursary (recipient) for the thematic semester *"The mathematics of energy systems"* in Cambridge, UK
- 2018, 2016, 2012 Stochastic Networks conferences travel grants (recipient)
- 2013 Performance conference travel grants (recipient)

Professional memberships

IEEE, INFORMS and Applied Probability Society, ACM and Sigmetrics, LNMB

Certifications

Oct 2021	**University Teaching Qualification (UTQ)** recognized by Dutch universities
Sep 2019	Italian **National Scientific Habilitation** (ASN) as Associate Professor (sector 01/A3 - Analysis, Probability Theory and Statistics - MAT/06)

List of publications

In reverse chronological order (see also my Google Scholar webpage):

1. B. Markhorst, J. Berkhout, A. Zocca, J. Pruyn, R. van der Mei, **Robust ship pipe routing: Navigating the energy transition**, 2023. Submitted to *Networks*. arXiv:2312.09088

2. F. Giacomarra, G. Bet, A. Zocca, **Generating synthetic power grids using Exponential Random Graphs**, 2023. Submitted to *Physical Review X Energy*. arXiv:2310.19662

3. E. van der Sar, A. Zocca, S. Bhulai, **Multi-Agent Reinforcement Learning for Power Grid Topology Optimization**, 2023. Submitted to *PSCC 2024*. arXiv:2310.02605

4. S. Baldassarri, V. Jacquier, A. Zocca, **Critical configurations of the hard-core model on square grid graphs**, 2023. Submitted to *Combinatorics, Probability and Computing*. arXiv:2308.05041

5. M. Goodridge, S. Lakshminarayana, A. Zocca, **Analysis of Cascading Failures Due to Dynamic Load-Altering Attacks**, 2023. *2023 IEEE SmartGridComm conference*. 10.1109/SmartGridComm57358.2023.10333960

6. L. Werner, N. Christianson, A. Zocca, A. Wierman, S. Low, **Pricing uncertainty in stochastic multi-stage electricity markets**, 2023. Accepted for publication at *2023 IEEE Conference on Decision and Control (CDC)*

7. M. Goodridge, S. Lakshminarayana, A. Zocca, **Uncovering Load-Altering Attacks Against N-1 Secure Power Grids: A Rare-Event Sampling Approach**, 2023. Submitted to *IEEE Transactions on Power Systems*. arXiv:2307.08788

8. L. Lan, A. Zocca, **Mixed-integer linear programming approaches for tree partitioning of power networks**, 2023. Submitted to *IEEE Transactions on Power Systems*. arXiv:2110.07000

9. S. Baldassarri, A. Gallo, V. Jacquier, A. Zocca, **Ising model on clustered networks: A model for opinion dynamics**, 2023. In *Physica A: Statistical Mechanics and its Applications*, vol. 623, pp. 128811. 10.1016/j.physa.2023.128811

10. L. Guo, C. Liang, A. Zocca, S.H. Low, A. Wierman, **Adaptive Network Response to Line Failures in Power Systems**, vol. 10, no. 1, pp. 333-344, 2022. In *IEEE Transactions on Control of Network Systems*. 10.1109/TCNS.2022.3203367

11. C. Liang, A. Zocca, S.H. Low, A. Wierman, **Interface Networks for Failure Localization in Power Systems**, 2022. In *2022 American Control Conference (ACC)*, pp. 4540-4546. 10.23919/ACC53348.2022.9867209

12. M. Goodridge, J. Moriarty, J. Vogrinc, and A. Zocca, **Hopping between distant basins**, 2022. *Journal of Global Optimization*, vol. 84, pp. 465–489. 10.1007/s10898-022-01153-z

13. A. Zocca, C. Liang, L. Guo, S.H. Low, and A. Wierman, **A Spectral Representation of Power Systems with Applications to Adaptive Grid Partitioning and Cascading Failure Localization**, 2021. *Submitted* arXiv:2105.05234

14. G. Bet, J. Selen, A. Zocca, **Weighted Dyck paths for nonstationary queues**, 2022. *Stochastic Models*, 38:2, 268-287. 10.1080/15326349.2021.2011748

15. J. Moriarty, J. Vogrinc, and A. Zocca, **A Metropolis-class sampler for targets with non-convex support**, 2021. *Statist. Comput.*, vol. 31, no. 72. 10.1007/s11222-021-10044-4

16. T. Nesti, J. Moriarty, A. Zocca, B. Zwart, **Large Fluctuations in Locational Marginal Prices**, 2021. *Philosophical Transactions of the Royal Society A*, vol. 379, no. 2202, pp. 20190438. 10.1098/rsta.2019.0438

17. L. Guo, C. Liang, A. Zocca, S.H. Low, and A. Wierman, **Line Failure Localization of Power Networks Part I: Non-cut outages**, 2021. *IEEE Transactions on Power Systems*, vol. 36, no. 5, pp. 4140–4151. 10.1109/TPWRS.2021.3066336

18. L. Guo, C. Liang, A. Zocca, S.H. Low, and A. Wierman, **Line Failure Localization of Power Networks Part II: Cut Set Outages**, 2021. *IEEE Transactions on Power Systems*, vol. 36, no. 5, pp. 4152–4160. 10.1109/TPWRS.2021.3068048

19. C. Liang, L. Guo, A. Zocca, S. Yu, S.H. Low, and A. Wierman, **An integrated approach for failure mitigation and localization in power systems**, 2021. *Electric Power Systems Research*, Vol. 190, 106613. 10.1016/j.epsr.2020.106613

20. A. Zocca, B. Zwart, **Optimization of stochastic lossy transport networks and applications to power grids**, 2021. In *Stochastic Systems*, vol. 11, no. 1, pp. 34–59. 10.1287/stsy.2019.0063

21. C. Liang, F. Zhou, A. Zocca, S.H. Low, and A. Wierman, **Mitigating Cascading Failures via Local Responses**, 2020. In Proceedings of the *2020 IEEE SmartGridComm conference*. 10.1109/SmartGridComm47815.2020.9302934

22. L. Guo, C. Liang, A. Zocca, S.H. Low, and A. Wierman, **Less is More: Real-time Failure Localization in Power Systems**, 2019. In *2019 IEEE Conference on Decision and Control (CDC)*, pp. 3871–3877, 10.1109/CDC40024.2019.9029393.

23. A. Zocca, **Temporal starvation in multi-channel CSMA networks: an analytical framework**, 2019. In *Queueing Systems*, vol. 91, no. 3-4, pp. 241–263, 10.1007/s11134-019-09598-y.

24. F.R. Nardi, A. Zocca **Tunneling behavior of Ising and Potts models in the low-temperature regime**, 2019. In *Stochastic Processes and their Applications*, vol. 129, no. 11, pp. 4556–4575, 10.1016/j.spa.2018.12.001.

25. L. Guo, C. Liang, A. Zocca, S.H. Low, A. Wierman, **Failure Localization in Power Systems via Tree Partitions**, 2018. In *2018 IEEE Conference on Decision and Control (CDC)*, pp. 6832–6839, 10.1109/CDC.2018.8619562.

26. J. Moriarty, J. Vogrinc, A. Zocca, **Frequency violations from random disturbances: an MCMC approach**, 2018. In *2018 IEEE Conference on Decision and Control (CDC)*, pp. 1598–1603, 10.1109/CDC.2018.8619304.

27. A. Zocca, **Tunneling of the hard-core model on finite triangular lattices**, 2019. In *Random Structures & Algorithms*, vol. 55, no. 1, pp. 215–246 10.1002/rsa.20795.

28. T. Nesti, A. Zocca, B. Zwart, **Emergent failures and cascades in power grids: A statistical physics perspective**. In *Physical Review Letters 120, 258301*, June 2018, 10.1103/PhysRevLett.120.258301. **Article featured in APS Synopsis 11, s72** (June 2018).

29. A. Zocca, **Low-temperature behavior of the multicomponent Widom-Rowlison model on finite square lattices**. In *Journal of Statistical Physics*, vol. 171, no. 1, 2018, pp. 1–37, 10.1007/s10955-018-1961-9.

30. T. Nesti, A. Zocca, B. Zwart, **Line failure probability bounds for power grids**. In *Proceedings of 2017 IEEE Power & Energy Society General Meeting*, Chicago, IL, USA, 2017, pp. 1–5, 10.1109/PESGM.2017.8274716.

31. T. Nesti, A. Zocca, B. Zwart, **Assessing safe operating regions in power grids under uncertainty** (Extended abstract). In *Proceedings of the Energy-Open conference*, University of Twente, 2017. Available at https://energy-open.nl/.

32. A. Zocca, B. Zwart, **Minimizing heat loss in DC networks using batteries**. In *Proceedings of the 54th Allerton Conference on Communication, Control, and Computing (Allerton)*, Monticello, IL, USA, 2016, pp. 1306–1313, 10.1109/ALLERTON.2016.7852385.

33. F.R. Nardi, A. Zocca, S.C. Borst, **Hitting times asymptotics for hard-core interactions on grids**. In *Journal of Statistical Physics*, vol. 162, no. 2, 2016, pp. 522–576, 10.1007/s10955-015-1391-x.

34. B. Bellalta, A. Checco, A. Zocca and J. Barcelo, **On the interactions between multiple overlapping WLANs using channel bonding**. In *IEEE Transactions on Vehicular Technology*, vol. 65, no. 2, 2016, pp. 796–812, 10.1109/TVT.2015.2400932.

35. A. Zocca, **Spatio-temporal dynamics of random-access networks: An interacting particle approach** (PhD thesis). October 2015, available at the TU/e repository.

36. A. Zocca, S.C. Borst and J.S.H. van Leeuwaarden, **Slow transitions and starvation in dense random-access networks**. In *Stochastic Models*, vol. 31, no. 3, July 2015, pp. 361–402, 10.1080/15326349.2015.1018441.

37. B. Bellalta, A. Zocca, C. Cano, A. Checco, J. Barcelo, A. Vinel. (2014) **Throughput analysis in CSMA/CA networks using continuous-time Markov networks: a tutorial**. Book chapter in *Wireless Networking for Moving Objects*, Lecture Notes in Computer Science, Vol. 8611, pp. 115-133, 10.1007/978-3-319-10834-6.

38. A. Zocca, S.C. Borst, J.S.H. van Leeuwaarden and F.R. Nardi, **Delay performance in random-access grid networks**. In *Performance Evaluation*, vol. 70, no. 10, October 2013, pp. 900–915, 10.1016/j.peva.2013.08.019.

39. A. Zocca, S.C. Borst and J.S.H. van Leeuwaarden, **Mixing properties of CSMA networks on partite graphs**. In *Proceedings of VALUETOOLS 2012*, pp. 117–126, 10.4108/valuetools.2012.250264.

Books

K. Postek, A. Zocca, J. Gromicho, J. Kantor, **Hands-on Mathematical Optimization in Python**, 2024. *Textbook in preparation for Cambridge University Press.*

Resources and companion code available at https://mobook.github.io/MO-book/

Supervision, teaching, and service

Supervision Co-supervision of PhD students:

- Jobke Janssen at CWI (2023-present)
  Topic: *"Rare event approaches to frequency reserve markets"*
- Erica van der Sar at VU (2021-present)
  Topic: *"Multi-agent reinforcement learning for power system topology control"*
- Berend Markhorst at VU (2022-present)
  Topic: *"Stochastic optimization for ship design to enable energy transition"*
- Chris Franssen at VU (2022-present)
  Topic: *"First-order gradient methods for network connectivity optimization"*
- Chen Liang at Caltech (2017-2022)
  Topic: *"Cascading failures in power systems, control and mitigation algorithms"*
- Linqi Guo at Caltech (2017-2019)
  Thesis: *"Impact of transmission network topology on electrical power systems"*
- Tommaso Nesti at CWI (2016-2020)
  Thesis: *"Stochastic analysis of energy networks"*

Supervision of master students:

"Household energy flexibility and battery control through reinforcement learning" (Floris Schmidt, VU, 2023)
"Planning under uncertainty: strategic decision making in supply chain networks" (Fergus Hathorn, VU, 2023)
"Integration of maintenance and routing optimization" (Nina Malbasic, VU, 2023)
"Online Stock Allocation Strategies: An explorative study of the alternating shipment landscape" (Renze Dijkstra, VU, 2023)
"Heineken's cost-effective strategy for achieving Carbon Net Zero (Anna Tschouridi, VU, 2023)
"A Green Supply Chain for Repairable Items at KLM cargo" (Daan Otto, VU, 2023)
"Exponential random graph models for synthetic power grids generation" (Francesco Giacomarra, VU, 2022)
"Logistics demand forecasting using machine learning models in the animal food industry" (Rein van Lennep, VU, 2022)
"Fuel usage estimation and optimization in temperature-controlled vehicle routing" (Jasper van Doorn, VU, 2021)
"Spectral Clustering and Combinatorial Optimization for Power Networks reliability" (Leon Lan, VU, 2021)
"Imbalance Price Forecasting in the Dutch Energy Market: A Machine Learning Approach" (Bram Vermeulen, VU, 2020, in collaboration with ENECO)
"Metastability for the Hard-Core Model on Grid Graphs: Critical Configurations" (Tommaso Monni, Università di Firenze, 2018)

Supervision of summer undergraduate research projects:

"Detecting a botnet in geometric random graphs" (Maciek Sidor, VU, 2023)
"Frequency Failure Simulation Using the Kuramoto Model" (Weiting Yu, VU, 2020)
"Failures in Power Networks: Nonlinear Dynamics" (Anish Senapati, Caltech, 2019)
"Failure in Power Networks: Linear Dynamics" (Maya Mutic, Caltech, 2019)

Supervision of final bachelor theses:

"Data-Driven Prediction of Renewable Power Generation", 2023
"Adaptive forecasting methods for abnormal hospital patients inflow", 2020

Teaching   Lecturer for:
- *"Mathematical Optimization"* (master level, VU, 2019-2024)
- *"Probability Theory"* (bachelor level, VU, 2022-2024)
- *"Project Big Data"* (bachelor level, VU, 2020-2024)
- *"Business Analytics Research Seminar"* (master level, VU, 2019-2024)
- *"Statistical Methods"* (bachelor level, VU, 2021)
- *"Project Business Analytics 1"* (bachelor level, VU, 2019-2021)

Editor   Performance Evaluation journal (2021 – present)

Reviewer   Journals:
- Operations Research
- Mathematics of Operations Research
- Mathematical Methods of Operations Research
- INFORMS Journal on Computing
- IEEE Transactions on Power Systems
- IEEE Transactions on Network Science and Engineering
- IEEE Transactions on Automatic Control
- IEEE Control Systems Letters

- IEEE Transactions on Information Theory
- Journal of Applied Probability
- Stochastic Models
- Nature Communications
- ACM ToMPECS
- Performance Evaluation
- Philosophical Transactions of the Royal Society A
- Journal of Statistical Mechanics: Theory and Experiment (JSTAT)

Conferences:
- ACM Sigmetrics conference
- Power Systems Computation Conference (PSCC)
- IEEE CDC conference
- ACM-SIAM Symposium on Discrete Algorithms (SODA)
- Probabilistic Methods Applied to Power Systems (PMAPS) conference

Conferences (as TPC member):
- IFIP Performance conference 2021
- ACM e-Energy conference 2022, 2023, 2024
- Valuetools conference 2022, 2023

Organizer Organizer of the workshop in memory of Francesca Romana Nardi (2022)

EURANDOM ambassador for QPA theme (2021 – present)

Invited sessions at INFORMS Annual Meeting (2018, 2019)

YEQT workshop "Winter school on energy systems" at Eurandom (2017)

Eindhoven Stochastic Seminar and Colloquium (2014, 2015)

"*Markov Chains and Mixing Times*" reading seminar at TU/e (2012)

Other activities Partner member of the Amsterdam Data Science initiative (2022 – present)

Member of the Business Analytics internship committee (2019 – present) and of the outreach committee (2021 – present) at VU Amsterdam

Participant of the *Future Distribution Grid R&D Workshop,* organized by the Electric Power Research Institute and DoE (2019)

Initiator of the *Welcome program for new employees* for the department of mathematics at VU Amsterdam (2020)

Collaborator of SEED-Insight (LA chapter) for short explainers for the public of sustainability issues in the context of power grids (2019)

Trainer for Italian (2007-2010) and Dutch Math Olympiads (2022)

Invited research visits

Aug 2021	California Institute of Technology, Pasadena (host: prof. Wierman)
Mar 2020	California Institute of Technology, Pasadena (host: prof. Wierman)
Jan 2019	Thematic semester *The mathematics of energy systems* at Isaac Newton Institute (Cambridge, UK)
Sep 2018	DISMA at Politecnico di Torino (hosts: prof. Fagnani and prof. Como)
Sep 2017	Università degli Studi di Firenze (host: prof. Nardi)
Dec 2016	LAMA at Université Paris Est Créteil (host: prof. Sohier)
Nov 2016	California Institute of Technology, Pasadena (host: prof. Wierman)
Nov 2015	Universitat Pompeu Fabra, Barcelona (host: prof. Bellalta)
Jul 2014	EPFL, Lausanne (host: prof. Thiran)
May 2014	Hamilton Institute, Dublin (host: prof. Leith and prof. Duffy)

INVITED TALKS AND SEMINARS

Nov 2023	PGMO Days 2023, Paris
Jun 2023	INFORMS Applied Probability Society Conference, Nancy
Feb 2023	SIAM Conference on Computational Science and Engineering, Amsterdam
Jul 2022	Workshop for Francesca Romana Nardi, Florence
Jun 2022	3rd Italian Meeting on Probability and Mathematical Statistics, Bologna
Feb 2022	Digital Energy seminar at CWI (virtual)
Oct 2021	INFORMS Annual Meeting 2021 (virtual)
Aug 2021	Two-part RSRG seminar at Caltech, Pasadena
Apr 2021	KdVI Math Colloquium at University of Amsterdam
Nov 2020	SPOR Seminar at TU Eindhoven
Nov 2020	Mathematics seminar at Università degli Studi di Padova
Feb 2020	Probability and Statistics seminar at TU Delft
Jul 2019	12th Conference on Monte Carlo Methods and Applications, Sydney
Jul 2019	INFORMS Applied Probability Society Conference, Brisbane
May 2019	Resnick Fellows Seminar Day, Pasadena
Jan 2019	Workshop *"Reliability and Resiliency in Network Infrastructure"*, Santiago
Jan 2019	CUED Control Group Seminar, Cambridge
Dec 2018	IFIP WG Performance Conference 2018, Toulouse
Dec 2018	YEQT workshop 2018, Toulouse
Nov 2018	INFORMS Annual Meeting 2018, Phoenix
Oct 2018	CMI seminar at Caltech, Pasadena
Sep 2018	Seminar at DISMA, Politecnico di Torino
Jun 2018	Poster at 2018 Stochastic Networks conference, Edinburgh
Jun 2018	Poster at 2018 ACM Sigmetrics conference, Irvine
Mar 2018	Seminar at Simons Institute, Berkeley
Dec 2017	Opening conference VPSMS 2018, Verona
Oct 2017	INFORMS Annual Meeting 2017, Houston
Oct 2017	CMS seminar at Caltech, Pasadena
Jul 2017	INFORMS Applied Probability Society Conference, Evanston
Jun 2017	1st Italian Meeting on Probability and Mathematical Statistics, Torino
May 2017	Seminar at CWI *"Future Energy Systems"* workshop, Amsterdam
Apr 2017	IMA & OR Society Conference on Mathematics of OR, Birmingham
Dec 2016	Seminar at Université Paris Est Créteil, Paris
Apr 2016	Workshop *"Metastability in statistical mechanics and stochastic processes"* EURANDOM, Eindhoven
Nov 2015	Seminar at Università degli Studi di Padova
Jul 2015	INFORMS Applied Probability Society Conference, Istanbul
Apr 2015	Seminar at Mathematical Institute of Leiden University
Oct 2014	Berlin-Padova Young Researchers Meeting, Berlin
Jul 2014	Seminar at EPFL, Lausanne
May 2014	Seminar at Hamilton Institute, Dublin
Sep 2013	IFIP WG Performance Conference 2013, Vienna
Jul 2013	INFORMS Applied Probability Society Conference, San Josè
Oct 2012	6th International VALUETOOLS Conference, Cargèse

OTHER CONFERENCES, SCHOOLS, AND WORKSHOPS ATTENDED

- 6th NREL Workshop on Autonomous Energy Systems, Golden (Sep 2023)
- ACM Sigmetrics and e-Energy conferences, Orlando (Jun 2023)
- XXII Power Systems Computation Conference (PSCC), Porto (Jun 2022)
- *"Real-Time Decision Making Boot Camp"* and *"Societal Networks"* workshops, Simons Institute at Berkeley, January and March 2018
- *"Learning, Algorithm Design and Beyond Worst-Case Analysis"* workshop, Simons Institute at Berkeley, November 2016
- Winter School *"Mathematics of the Energy Transition"*, Munich, February 2016
- Stochastic Networks conferences: June 2012 (Boston), June 2014 (Amsterdam), June 2016 (San Diego), June 2018 (Edinburgh)
- Young European Queueing Theorists (YEQT) workshops (2011-2018)