Alessandro Zocca

Tenure-track Assistant Professor
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Research interests

Stochastic networks, rare events analysis, power systems reliability, optimization, MCMC methods, learning, operations research, uncertainty quantification.

My research is centered around the study of complex networked systems where randomness plays a crucial role. More specifically, I study **dynamics and rare events on networks affected by uncertainty**, drawing motivation from applications to power systems and wireless networks. My work lies mostly in the area of applied probability, but has deep ramifications in areas as diverse as operations research, graph theory, algorithm design, statistical physics, and control theory.

My long-term goal as a researcher is to analyze the randomness emerging in these complex systems using both **rigorous mathematical tools** and **data-driven learning methods**, as well as to understand how such randomness can be either mitigated or, potentially, leveraged to improve the system performances, by means of adaptive algorithms and control mechanisms.

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

Education

Sep 2011 – Dec 2015 | **Eindhoven University of Technology**, The Netherlands
PhD, *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* Tenure-track assistant professor
Sep 2017 – Sept 2019	**California Institute of Technology**, Pasadena, CA *Computing and Mathematical Sciences Department* Postdoctoral scholar Mentors: Prof. Adam Wierman and Prof. Steven Low
Dec 2017 – Sept 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 Sigmetrics

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. L. Lan, and A. Zocca, **Refining bridge-block decompositions through two-stage and recursive tree partitioning**, 2021. *Submitted to PSCC 2022*. arXiv:2110.06998.
2. L. Lan, and A. Zocca, **An MILP-based approach to tree partitioning with minimal power flow disruption and generator coherency constraints**, 2021. *Submitted to PSCC 2022*. arXiv:2110.07000.

3. M. Goodridge, J. Moriarty, J. Vogrinc, and A. Zocca, **Hopping between distant basins**, 2021. *Submitted to Journal of Global Optimization*. arXiv:2108.05229.

4. 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

5. L. Guo, C. Liang, A. Zocca, S.H. Low, and A. Wierman, **Fast-timescale Control of Cascading Failures in Power Systems**, 2021. *Submitted to IEEE Transactions on Control of Network Systems* arXiv:2005.11319.

6. G. Bet, J. Selen, A. Zocca, **Weighted Dyck paths for nonstationary queues**, 2022. To appear in *Stochastic Models*. 10.1080/15326349.2021.2011748.

7. J. Moriarty, J. Vogrinc, and A. Zocca, **A Metropolis-class sampler for targets with non-convex support**, 2021. *Statistics and Computing*, Volume 31, Issue 72. 10.1007/s11222-021-10044-4.

8. T. Nesti, J. Moriarty, A. Zocca, B. Zwart, **Large Fluctuations in Locational Marginal Prices**, 2021. *Philosophical Transactions of the Royal Society A*, Volume 379, Issue 2202, pp. 20190438. 10.1098/rsta.2019.0438

9. 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.

10. 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.

11. 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. Presented at 2020 Power Systems Computation Conference (PSCC) and published at *Electric Power Systems Research*, Vol. 190, 106613. 10.1016/j.epsr.2020.106613.

12. A. Zocca, B. Zwart, **Optimization of stochastic lossy transport networks and applications to power grids**, 2021. In *Stochastic Systems*, Volume 11, Issue 1, pp. 34–59. 10.1287/stsy.2019.0063.

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

14. 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.

15. A. Zocca, **Temporal starvation in multi-channel CSMA networks: an analytical framework**, 2019. In *Queueing Systems*, Volume 91, Issue 3-4, pp. 241–263, 10.1007/s11134-019-09598-y.

16. F.R. Nardi, A. Zocca **Tunneling behavior of Ising and Potts models in the low-temperature regime**, 2019. In *Stochastic Processes and their Applications*, Volume 129, Issue 11, pp. 4556–4575, 10.1016/j.spa.2018.12.001.

17. 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.

18. 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.

19. A. Zocca, **Tunneling of the hard-core model on finite triangular lattices**, 2019. In *Random Structures & Algorithms*, Volume 55, Issue 1, pp. 215–246 10.1002/rsa.20795.

20. 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).

21. A. Zocca, **Low-temperature behavior of the multicomponent Widom-Rowlison model on finite square lattices**. In *Journal of Statistical Physics*, Volume 171, Issue 1, 2018, pp. 1–37, 10.1007/s10955-018-1961-9.

22. 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.

23. 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/.

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

25. F.R. Nardi, A. Zocca, S.C. Borst, **Hitting times asymptotics for hard-core interactions on grids**. In *Journal of Statistical Physics*, Volume 162, Issue 2, 2016, pp. 522–576, open-access version available at 10.1007/s10955-015-1391-x.

26. 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*, Volume 65, Issue 2, 2016, pp. 796–812, 10.1109/TVT.2015.2400932.

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

28. A. Zocca, S.C. Borst and J.S.H. van Leeuwaarden, **Slow transitions and starvation in dense random-access networks**. In *Stochastic Models*, Volume 31, Issue 3, July 2015, pp. 361–402, 10.1080/15326349.2015.1018441.

29. A. Zocca, S.C. Borst, J.S.H. van Leeuwaarden and F.R. Nardi, **Delay performance in random-access grid networks**. In *Performance Evaluation*, Volume 70, Issue 10, October 2013, pp. 900–915, 10.1016/j.peva.2013.08.019.

30. 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.

Book contributions

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**. In *Wireless Networking for Moving Objects. Protocols, Architectures, Tools, Services and Applications*, Lecture Notes in Computer Science, Vol. 8611, pp. 115-133

Service

Teaching

Lecturer for:

- "*Mathematical Optimization*" (master level, VU, 2019-2021)
- "*Statistical Methods*" (bachelor level, VU, 2021)
- "*Project Big Data*" (bachelor level, VU, 2020-2021)
- "*Project Business Analytics 1*" (bachelor level, VU, 2019-2021)
- "*Business Analytics Research Seminar*" (master level, VU, 2019-2021)

Teaching assistant for:

- "*Stochastic processes*" (bachelor level, TU/e, 2012-2014)
- "*Calculus*" (bachelor level, TU/e, 2012-2013)

Supervision

Co-supervision of PhD students

- Erica van der Sar at VU (2021-present)
  Topic: *"Learning and Stochastic Optimization for Power Networks"*
- Nanne Dieleman at VU (2021-present)
  Topic: *"Machine Learning Methods for Power Systems Reliability"*
- Chen Liang at Caltech (2017-present)
  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 theses:

"*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:

"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 projects (VU, 2019-2020)
Topic: *Adaptive forecasting methods for abnormal hospital patients inflow*

Editor

Performance Evaluation journal (2021 – present)

Reviewer

Journals:

- Operations Research
- Mathematics of Operations Research
- Mathematical Methods of Operations Research
- IEEE Transactions on Network Science and Engineering
- IEEE Transactions on Automatic Control
- IEEE Control Systems Letters
- IEEE Transactions on Information Theory
- Stochastic Models
- Nature Communications

- ACM ToMPECS
- Performance Evaluation
- Electric Power Systems Research
- Philosophical Transactions of the Royal Society A
- iScience
- Journal of Statistical Mechanics: Theory and Experiment (JSTAT)
- Sustainable Energy Grids and Networks
- International Journal of Electrical Power and Energy Systems

Conferences:

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

Conferences (as TPC member):

- IFIP Performance conference
- ACM e-Energy conference
- Valuetools conference

Organizer

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

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 sustanability issues in the context of power grids (2019)
Member of the Caltech Postdoc Association (2019)
Trainer for high-school Math Olympiads (2007-2010)

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

October 2021	INFORMS Annual Meeting 2021 (virtual)
August 2021	Two-part RSRG seminar at Caltech, Pasadena
April 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
Sept 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
July 2017	INFORMS Applied Probability Society Conference, Evanston
June 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
July 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
July 2013	INFORMS Applied Probability Society Conference, San Josè
Oct 2012	6th International VALUETOOLS Conference, Cargèse

Other conferences, schools, and workshops attended

- CDC conferences: Miami (December 2018), and Nice (December 2019)
- *"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)