

Nathaniel Karst

32 Charnwood Road
Somerville, MA 02144
901-605-8670

316 Babson Hall, Babson College
Wellesley, MA 02457
781-239-5508

EDUCATION

Ph.D. in Applied Mathematics, August 2011
Cornell University, Ithaca, NY
Dissertation: Combinatorial Designs for Key Distribution and Secure Re-keying in Group Communication Systems
Adviser: Stephen B. Wicker

B.S. in Electrical and Computer Engineering, May 2007
Franklin W. Olin College of Engineering, Needham, MA

EXPERIENCE

<i>Invited researcher</i> Laboratoire Interdisciplinaire de Physique Université Grenoble-Alpes, Grenoble, France	May 2019 – July 2019
<i>Associate professor of applied mathematics</i> Division of Mathematics and Science Babson College, Wellesley, MA	Sep. 2017 – present
<i>Assistant professor of applied mathematics</i> Division of Mathematics and Science Babson College, Wellesley, MA	Sep. 2011 – Aug. 2017
<i>Visiting research assistant</i> Advanced Technology Research Group Research In Motion, Rolling Meadows, IL	Sep. 2010 – Dec. 2010
<i>Visiting research assistant</i> Department of Neurobiology and Behavior Cornell University, Ithaca, NY	May 2009 – Aug. 2009
<i>Visiting research assistant</i> Hawai'i Institute of Marine Biology University of Hawai'i, Honolulu, HI	May 2008 – Aug. 2008

SCHOLARLY ACTIVITY

PUBLICATIONS

In many mathematical subdisciplines, authors are traditionally listed in alphabetical order, regardless of overall contribution to the project. References for publications following this convention are italicized below; non-italicized references indicate authorship in order of overall contribution to the project. Bold typeface indicates co-authors who were undergraduates at the time of submission. References to published articles are live links – just click.

33. W. Firth, J. Geddes, N. Karst, G.L. Oppo, “Analytic instability thresholds in folded Kerr resonators of arbitrary finesse”, *Physical Review A*, doi:10.1103/PhysRevA.103.023510, 2021.
32. D. Dralle, W. Hahm, D. Rempe, N. Karst, L. Anderegg, S. Thompson, T. Dawson, W. Dietrich, “Plants as sensors: vegetation response to rainfall predicts subsurface water storage capacity in Mediterranean climates”, *Environmental Research Letters*, doi:10.1088/1748-9326/abb10b, 2020.
31. *N. Karst*, **X. Shen**, *D. Troxell*, **M. Vu**, “Blocking Zero Forcing Processes in Cartesian Products of Graphs”, *Discrete Applied Mathematics*, doi:10.1016/j.dam.2020.06.002, 2020.
30. **M. Beaudouin-Lafon**, **S. Chen**, **M. Crawford**, *N. Karst*, **L. Nielsen**, *D. Troxell*, “On the zero blocking number of rectangular, cylindrical, and Möbius grids”, *Discrete Applied Mathematics*, doi:10.1016/j.dam.2019.11.015, 2020.
29. **M. Beaudouin-Lafon**, **S. Chen**, *N. Karst*, *D. Troxell*, **X. Zheng**, “Pairwise compatibility graphs: complete characterization for wheels”, *Involve*, doi:10.2140/involve.2019.12.871, 2019.
28. N. Karst, D. Dralle, M. Müller, “On the effect of non-linear recessions on low flow variability: Diagnostic of an analytical model for annual flow duration curves”, *Water Resources Research*, doi:10.1029/2019WR024912, 2019.
27. N. Karst, R. Slegers, “Cryptography in context: co-teaching ethics and mathematics”, *Problems, Resources, and Issues in Mathematics Undergraduate Studies (PRIMUS)*, doi:10.1080/10511970.2018.1488316, 2019.
26. D. Dralle, W. Hahm, D. Rempe, N. Karst, S. Thompson, W. Dietrich, “Quantification of the seasonal hillslope water storage that does not drive streamflow”, *Hydrologic Processes*, doi:10.1002/hyp.11627, 2018.
25. **M. Beaudouin-Lafon**, **S. Chen**, *N. Karst*, *J. Oehrlein*, *D. Troxell*, “Labeling crossed prisms with a condition at distance two”, *Involve*, doi:10.2140/involve.2017..101, 2018.

24. D. Dralle, N. Karst, M. Müller, G. Vico, S. Thompson, “Stochastic modeling of inter-annual variation of hydrologic variables”, *Geophysical Research Letters*, doi:10.1002/2017GL074139, 2017.
23. N. Karst, **J. Langowitz**, **J. Oehrlein**, D. Troxell, “Radio k -chromatic number of cycles for large k ”, *Discrete Mathematics, Applications and Algorithms*, doi:10.1142/S1793830917500318, 2017.
22. N. Karst, J. Geddes, R. Carr, “Model microvascular networks can have many equilibria”, *Bulletin of Mathematical Biology*, doi:10.1007/s11538-017-0251-z, 2017.
21. D. Dralle, N. Karst, **K. Charalampous**, **A. Veenstra**, S. Thompson, “Event-scale power law recession analysis: quantifying methodological uncertainty”, *Hydrology and Earth System Sciences*, doi:10.5194/hess-21-65-2017, 2017.
20. D. Khachatryan, N. Karst, “V for voice: strategies for bolstering communication skills in undergraduate and graduate classrooms”, *Journal of Statistics Education*, doi:10.1080/10691898.2017.1305261, 2017.
19. N. Karst, D. Dralle, S. Thompson, “Spiral and rotor patterns produced by fairy ring fungi”, *PLoS ONE*, doi:10.1371/journal.pone.0149254, 2016.
18. D. Dralle, N. Karst, S. Thompson, “Dry season streamflow persistence in seasonal climates”, *Water Resources Research*, doi:10.1002/2015WR017752, 2016.
17. D. Dralle, N. Karst, S. Thompson, “a, b careful: The challenge of scale invariance for comparative analyses in power law models of the streamflow recession”, *Geophysical Research Letters*, doi:10.1002/2015GL066007, 2015.
16. N. Karst, J. Geddes, and B. Storey, “Oscillations and multiple equilibria in microvascular blood flow”, *Bulletin of Mathematical Biology*, doi:10.1007/s11538-015-0089-1, 2015.
15. B. Storey, **D. Hellen**, N. Karst, and J. Geddes, “Observations of spontaneous oscillations in simple two-fluid networks”, *Physical Review E*, doi:10.1103/PhysRevE.91.023004, 2015.
14. N. Karst, **J. Oehrlein**, D. Troxell, and **J. Zhu**, “ $L(d,1)$ -labeling of the edge-path-replacement by factorization of graphs”, *Journal of Combinatorial Optimization*, doi:10.1007/s10878-013-9632-x, 2015.
13. N. Karst, **J. Oehrlein**, D. Troxell, and **J. Zhu**, “On distance labelings of amalgamations and injective labelings of general graphs”, *Involve*, doi:10.2140/involve.2015.8.535, 2015.
12. N. Karst, **J. Oehrlein**, D. Troxell, and **J. Zhu**, “The minimum span of $L(2, 1)$ -labelings of generalized flowers”, *Discrete Applied Mathematics*, doi:10.1016/j.dam.2014.10.010, 2015.

11. N. Karst, **J. Oehrlein**, D. Troxell, and **J. Zhu**, “Labeling amalgamations of Cartesian products of complete graphs with a condition at distance two.” *Discrete Applied Mathematics*, doi:10.1016/j.dam.2014.06.022, 2014.
10. N. Karst, B. Storey, and J. Geddes, “Spontaneous oscillations in simple fluid networks”, *SIAM Journal on Applied Dynamical Systems*, doi:10.1137/130926304, 2014.
9. K. Montovan, N. Karst, T. Seeley, and L. Jones, “Local behavioral rules sustain the cell allocation pattern in the combs of honey bee colonies (*Apis mellifera*)”, *Journal of Theoretical Biology*, doi:10.1016/j.jtbi.2013.07.010, 2013.
8. S. Adams, **N. Howell**, N. Karst, D. Troxell, and **J. Zhu**, “On the $L(2,1)$ -labelings of amalgamations of graphs”, *Discrete Applied Mathematics*, doi:10.1016/j.dam.2012.11.007, 2013.
7. N. Karst and S. Wicker, “On the rekeying load in group key distributions using cover-free families”, *IEEE Transactions on Information Theory*, doi:10.1109/TIT.2012.2204542, 2012.
6. S. Adams, N. Karst, **M. Murugan**, and T. Wysocki, “On transceiver signal linearization and the decoding delay of maximum rate complex orthogonal space-time block codes”. *IEEE Transactions on Information Theory*, doi:10.1109/TIT.2011.2137050, 2011.
5. S. Adams, J. Davis, N. Karst, **M. Murugan**, **B. Lee**, **M. Crawford**, and **C. Greeley**, “Novel classes of minimal delay and low PAPR rate-1/2 complex orthogonal designs” *IEEE Transactions on Information Theory*, doi:10.1109/TIT.2011.2110730, 2011.
4. S. Adams, N. Karst, and **M. Murugan**, “The final case of the decoding delay problem for maximum rate complex orthogonal designs”, *IEEE Transactions on Information Theory*, doi:10.1109/TIT.2009.2034818, 2010.
3. S. Adams, J. Seberry, **N. Karst**, **J. Pollack**, and T. Wysocki, “Quaternion orthogonal designs from complex companion designs”, *Linear Algebra and Its Applications*, doi:10.1016/j.laa.2007.09.013, 2008.
2. S. Adams, **N. Karst**, and **J. Pollack**, “The minimum decoding delay of maximum rate complex orthogonal designs”, *IEEE Transactions on Information Theory*, doi:10.1109/TIT.2007.901174, 2007.
1. J. Geddes, R. Carr, **N. Karst**, F. Wu, “The onset of oscillations in microvascular blood flow”, *SIAM Journal on Applied Dynamical Systems*, doi:10.1137/060670699, 2007.

PRESENTATIONS

Bold typeface indicates an invited talk.

27. “Minimal Zero Blocking Sets of Rectangular, Cylindrical, and Möbius Grids”, Joint Mathematics Meetings, 17 January 2020.
26. **“Babson’s MS in Business Analytics Program”, Mathematical Association of America, Northeast Section Meeting, 23 November 2019.**
25. “Using Google Colabs in the Classroom”, Babson College, 30 October 2019.
24. “Small data, big data: cautionary tales and new approaches”, Fidelity Investments, Boston, MA, June 2018.
23. “Spectrum allocation and graph labelings: why research is awesome”, Olin College, Discrete Mathematics guest lecture, 19 October 2017.
22. **“Restructuring the mathematics sequence at business schools”, Innovations in Undergraduate Business Education, Rutgers University, 17 October 2017.**
21. “Critical zone mediation of water storage and streamflow”, Babson College Faculty Research Presentation, 19 September, 2017.
20. “An introduction to R: linear and logistic regression”, 2-hour workshop for the Babson College Graduate Student Analytics Club, 21 February 2017.
19. “Babson teaching methods: Innovative curriculum development in science and mathematics”, Babson College, 1 November 2016.
18. “Babson assessment strategies: Leveraging old and new technologies in formative and summative assessment in science and mathematics ”, Babson College, 1 November 2016.
17. “Spectrum allocation and graph labelings: why research is awesome”, Olin College, Discrete Mathematics guest lecture, 14 October 2016.
16. **“I’m not a statistic (even if everyone else is)”, Marketing Management Association Fall Educators’ Conference, 16 September 2016.**
15. “An introduction to R: linear and logistic regression”, 2-hour workshop for the Babson College Graduate Student Analytics Club, 12 April 2016.
14. Panelist at “Distractingly sexy in the sciences and beyond”, hosted by Babson’s Center for Women’s Entrepreneurial Leadership, 24 March 2016.
13. **“Data analytics for non-STEM majors (in the age of big data)” (with D. Khachatryan), Joint Mathematical Meetings, 7 January 2016.**

12. **“Spiral and rotor patterns produced by fairy ring fungi”, Fall National Meeting of the American Geophysical Union, 14 December 2015.**
11. “Eliminating a confounding factor in power law parameter interpretation” (poster), Fall National Meeting of the American Geophysical Union, 16 December 2015.
10. “Spectrum allocation and graph labelings: why research is awesome”, Olin College, Discrete Mathematics guest lecture, 19 October 2015.
9. “Oscillations in Microvascular Bloodflow”, Babson College, Honors Seminar II guest lecture, 18 February 2015.
8. “Spectrum allocation and graph labelings: why research is awesome”, Olin College, Discrete Mathematics guest lecture, 23 October 2014.
7. “Spontaneous oscillations in simple fluid networks”, Babson Faculty Research Chat, 16 October 2014.
6. “Ideation exercise”, Babson Faculty Learn & Share, 27 August 2014.
5. “From blood flow to lava: the mathematics of oscillating fluids”, Wellesley College Mathematics Colloquium Series, 22 April 2014.
4. “Spontaneous oscillations in simple fluid networks”, AMS Contributed Paper Session on Applied Mathematics I: Mechanics, Fluids, Waves, Joint Mathematics Meetings, 16 January 2014.
3. “When ‘catastrophic’ means ‘not that bad’”, Babson-Olin-Wellesley Applicable Mathematics Series, Olin College, 21 February 2012.
2. “Combinatorial designs for key distribution and secure rekeying in group communication systems”, Cornell University, 3 June 2011.
1. “Security, scheduling and statistics: some applications of combinatorial designs”, Babson College, 2 March 2011.

BOOK CHAPTERS

2. “I am not a statistic (even if everyone else is): a cross-disciplinary activity”, with R. Slegers, in *Evolving Entrepreneurial Education: Innovation in the Babson Classroom*, V. Crittenden, K. Esper, N. Karst, and R. Slegers, eds. Emerald, 2015.
1. “Secure key distribution and revocation for advanced metering infrastructure” with S. Wicker, in *Distributed Sensor Networks*, Second Edition. S. Iyengar and R. Brooks, eds. Chapman & Hall, 2012.

PATENTS

2. “Message rearrangement for improved wireless code performance” (US 8769365 B2), with M. Buckley, S. Simmons, Y. Heo, M. Fong, M. Mahalleh, Z. Cai, A. Earnshaw, 2014.
1. “Message rearrangement for improved code performance” (WO/2012/047235), with M. Buckley, S. Simmons, Y. Heo, M. Fong, M. Mahalleh, Z. Cai, and A. Earnshaw, 2012.

TEACHING

COURSES

- Business Intelligence, Analytics, and Visualization (QTM7571, full- and part-time MBA programs)
- Storytelling and Communicating with Data (MSB6310, MS Business Analytics program)
- Business Analytics Field Project (MSB6300, MS Business Analytics program)
- Data Exploration and Analytics (QTM6300, MS Business Analytics program)
- Big Data and Business Analytics (QTM6100, MS Entrepreneurial Leadership program)
- Probability for Risk Management (QTM3675, UG program)
- Cryptology and Coding Theory (QTM3674, UG program)
- Linear Algebra and Dynamical Systems (QTM2600, UG program)
- Case Studies in Business Analytics (QTM2000, UG program)
- Applied Calculus and Quantitative Methods (QTM1300, UG program)
- Quantitative Methods for Business Analytics I (QTM1000, UG program)

INDEPENDENT STUDY SUPERVISION

All students were undergraduates at the time of the independent study unless otherwise noted.

(AY 2021 – 2022) Liam Early, TBD (honors thesis)

(AY 2021 – 2022) Shira Berkin, TBD (honors thesis)

(2020) Jake Heller, “Learning data analytics through a Kaggle competition”

(2020) Bruno Meinhardt, “Zero blocking”, (co-advsd with Denise Troxell)

- (2019) Bruno Meinhart, Xierui (Sherrie) Shen (Olin) and MinKhang Vu (Olin), “L(2,1)-labelings of directed generalized Petersen graphs”, (co-advised with Denise Troxell)
- (2019) Angela Castillo (MBA), “Predictive Analytics in R”
- (2019) Xierui (Sherrie) Shen (Olin) and MinKhang Vu (Olin), “Minimal Zero-Blocking Sets on Cartesian Products of Graphs”, (co-advised with Denise Troxell)
- (2018) Matthew Beaudouin-Lafon (Olin), Serena Chen (Olin), Margaret Crawford (Olin), and Louise Nielsen (Olin), “Blocking the Spread of Belief on Graphs”, (co-advised with Denise Troxell)
- (2018) Cyan Chen, Liam Flaherty, Sam Gaudet, Julia Harrigan, and Kyle Waldron, “*The Math You Missed* Book Club” (co-advised with Rick Cleary)
- (2018) Matthew De Marte, “BLAST sensor data and on-field baseball performance”
- (2018) Matthew Beaudouin-Lafon (Olin), Serena Chen (Olin), and Louise Nielsen (Olin), “Blocking the Spread of Belief on Graphs” (co-advised with Denise Troxell)
- (2017) Matthew Beaudouin-Lafon (Olin), and Serena Chen (Olin), “Holes in L(3,2,1) labelings” (co-advised with Denise Troxell)
- (2017) Matthew Beaudouin-Lafon (Olin), Serena Chen (Olin), and Xudong Zheng, “Pairwise compatibility graphs” (co-advised with Denise Troxell)
- (2017) Sophia Nielsen (Olin), Robert Siegel (Olin), “L(2,1)-labelings” (co-advised with Denise Troxell)
- (2017) Jonathan Martin, “Anonymity and Online Behavior” (honors thesis)
- (2016) Matthew Beaudouin-Lafon (Olin), Serena Chen (Olin), and Xudong Zheng (Babson), “Pairwise compatibility graphs” (co-advised with Denise Troxell)
- (AY 2016 – 2017) Christopher Bruno, “An entropic analysis of John Coltrane’s contributions on *Kind of Blue* and *A Love Supreme*: The interaction between the soloist and complexity” (honors thesis)
- (2016) Alison Henry (MBA) , Jonathan Lee (MBA), Jordan Tuch (MBA), Paul vom Eigen (MBA), Haotian Wu (MBA), and Zichen Xu (MBA), “Predictive Analytics in R”
- (2016) Matthew Beaudouin-Lafon (Olin), Serena Chen (Olin), and Jessica Oehrlein (Olin), “L(2,1) labeling of single cross generalized Peterson graphs” (co-advised with Denise Troxell)
- (2015) Jessica Oehrlein (Olin) and Joshua Langowitz (Olin), “Radio k -chromatic number of cycles for large k ” (co-advised with Denise Troxell)

- (2015) James Gregory, “Gödel, Escher, Bach”
- (2015) Simon Shi, “Analysis of a Hubway data set”
- (2015) Jessica Oehrlein (Olin) and Joshua Langowitz (Olin), “Radio k -labelings of cycles” (co-advised with Denise Troxell)
- (AY 2014–2015) Roy Murdock, “On the denationalization of money through virtual currency: What can we do to prevent the next financial crisis?” (honors thesis)
- (2014) Shivani Janani, “Sagrada Familia: Gaudi’s Mathematical or Natural Inspiration?” (honors thesis)
- (2014) Raagini Rameshwar (Olin), Joshua Langowitz (Olin), Mafalda Borges (Olin), “Computational aspects of $L(2,1)$ -labelings”
- (2013) Jessica Oehrlein, Junjie Zhu, “Labeling amalgamations of Cartesian products of complete graphs with a condition at distance two” (co-advised with Denise Troxell)
- (2013) Marjorie Kasten (Wellesley), Sophia Guo, Elize Huang (Wellesley), Sarika Patel, and Rachel Insoft (Wellesley), “Optimizing trash collection for BigBelly” as part of the Babson-Olin-Wellesley mathematical consulting in business, industry, and government program
- (2013) Paul Booth (Olin), Jessica Oehrlein (Olin), Junjie Zhu (Olin), “ $L(d,1)$ -labeling of the edge-path-replacement by factorization of graphs”, (co-advised with Denise Troxell)
- (2012) Trisha Bakeman, “Linear algebra and dynamical systems”
- (2012) Junjie Zhu (Olin), Geoff M. Pleiss (Olin), Paul Booth (Olin), “ $L(d,1)$ -labeling of edge-path replacement of graphs”, (co-advised with Sarah Adams [Olin] and Denise Troxell)
- (2012) Nico von Stackelberg, “Cybersecurity for end users”
- (2012) Noura Howell (Olin), and Junjie Zhu (Olin) “On the $L(2,1)$ -labelings of amalgamations of graphs”, (co-advised with Sarah Adams [Olin] and Denise Troxell)
- (2012) Paul Booth (Olin), Connor Stokes (Olin), “Spread in graphs”
- (2012) Amy Whitcombe (Olin), Hannah Sarver (Olin), “A scheduling problem related to faculty assignment to honors projects”, (co-advised with Sarah Adams [Olin] and Denise Troxell)

SERVICE

DEPARTMENTAL SERVICE

- (2021 – 2022) Junior faculty mentor
- (2020 – 2021) Postdoctoral mentor
 - (2020) QTM1000 course coordinator
 - (2020) QTM1000 First Year Pathways team lead
- (2020 – 2021) Pre-tenure review committee
- (2019 – 2020) Pre-tenure review committee
- (2019 – 2022) Quantitative Methods coordinator (staffing, curricular oversight, etc.)
- (2016 – 2017) EdX curriculum development committee
- (2015 – 2016) Faculty search committee for assistant professor of statistics
- (2013 – 2014) MSM program design committee
 - (2013) QTM1000 curriculum design committee
- (2012 – 2013) Faculty search committee for division chair
- (2012 – 2013) Faculty search committee for assistant professor of statistics
- (2012 – 2013) Curriculum refresh committee

COLLEGIATE SERVICE

- (2020 – 2021) Appointments Decision Making Body (tenure & promotion) co-chair
 - (2020) MS in Advanced Entrepreneurial Leadership design team
- (2019 – 2020) MS in Business Analytics re-design team
- (2019 – 2020) Babson Faculty Research Fund co-chair
- (2019 – 2021) Appointments Decision Making Body (tenure & promotion, campus-wide elected)
- (2019 –) Blended Learning faculty peer mentor
- (2017 – 2018) MS in Business Analytics curriculum development team
- (2017 – 2018) Interdepartmental search committee member for assistant professor of analytics
- (2017 – 2020) Babson Faculty Research Fund committee member (campus-wide elected)
 - (2016) Center for Engaged Learning and Teaching steering committee

- (2015 – 2016) Provost search committee
- (2014) Co-editor of *Evolving Entrepreneurial Education: Innovation in the Babson Classroom*
- (2014) Center for Engaged Learning and Teaching faculty collaborative committee
- (2014) Co-organizer of the Center for Engaged Learning and Teaching’s annual Faculty Learn & Share event (focused on pedagogical research)
- (2013 – 2018) Honors council member
- (2012 – 2014) Faculty senate alternate
- (2012 – 2019) Honor board member
- (2012 – 2014) Babson-Olin-Wellesley committee
- (2011 – 2013) First Year Seminar adviser

PROFESSIONAL SERVICE

- (2014) Co-chaired AMS Contributed Paper Session: Mechanics, Fluids, and Waves at 2014 Joint Mathematics Meetings
- (2013) Co-organized flipped classroom panel for Project NExT participants at 2013 Mathfest

AWARDS AND HONORS

- (2020) Poets & Quants “2020 Best 40 Under 40 Professors”
- (2018) Selected as 2018-2019 American Mathematical Society Congressional Fellow (one awarded annually nation-wide)
- (2017) Babson Teaching Innovation Fund grant “Eco-analytics: Using predictive analytics to assess forest patches for ecological and economic benefit” (joint work with Vikki Rodgers)
- (2017) Babson Faculty Research Fund stipend for “Variability in annual flow duration curves”
- (2016) Babson Faculty Research Fund course release for “Variability in streamflow recession”
- (2015) Dean’s Award for Excellence in Scholarship (four awarded annually college-wide)
- (2015) Babson Faculty Research Fund course release for “Spiral wave formation in fairy ring fungi”

- (2014) Dean's Award for Excellence in Undergraduate Teaching (four awarded annually college-wide)
- (2014) Babson Faculty Research Fund grant for "Oscillations and spontaneous flow reversal in a simple fluid network"
- (2013) Babson Teaching Innovation Fund grant "Cryptology in context"
- (2012 – 2013) Project NExT (New Experiences in Teaching) Fellow, Mathematical Association of America
- (2007 – 2009) Integrative Graduate Education and Research Traineeship (IGERT), National Science Foundation
- (2003 – 2007) Franklin W. Olin full tuition scholarship, Franklin W. Olin Foundation