

Todd Kemp

Current Address

University of California, San Diego
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Personal Data

Born: Calgary, Canada
Citizenship: Canada, USA, UK
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EMPLOYMENT

UC San Diego	Professor and Vice Chair for Graduate Affairs	2023 –
UC San Diego	Professor	2018 –
UC San Diego	Associate Professor	2014 – 2018
UC San Diego	Assistant Professor	2009 – 2014
MIT	Visiting Assistant Professor	2009 – 2010
MIT	CLE Moore Instructor	2006 – 2009
Cornell University	Escobar Assistant Professor	2005 – 2006

EDUCATION

PhD	Cornell University, Mathematics (Advisor: Leonard Gross)	2000 – 2005
MS	Cornell University, Mathematics	2000 – 2002
BSc	University of Calgary, Pure Mathematics, Applied Mathematics, and Physics	1996 – 2000

RESEARCH INTERESTS

Probability Theory, Mathematical Physics, and Functional Analysis: random matrix theory and free probability; stochastic analysis; machine learning and neural networks; quantum information theory; Yang–Mills theory; analysis on Lie groups; functional inequalities (esp. logarithmic Sobolev inequalities); holomorphic and subharmonic function spaces.

AWARDS & GRANTS

Research Grants

NSF Grant DMS-2400246: \$295,000 supporting my research program at UCSD. (2024-2027)
NSF Grant DMS-2318731: \$28,245 supporting the Southern California Probability Symposium. (2023-2025)
NSF Grant DMS-2055340: \$324,193 supporting my research program at UCSD. (2021-2024)
NSF Grant DMS-1800733: \$210,000 supporting my research program at UCSD. (2018-2021)
NSF CAREER Award DMS-1254807: \$550,000 supporting my research program at UCSD. (2013-2018)
Hellman Fellowship: \$26,585 research award for young faculty at UCSD. (2011-2012)
NSF Grant DMS-1001894: \$123,500 supporting my research program at UCSD. (2010–2013)
NSF Grant DMS-0701162: \$117,000 supporting my research program at MIT. (2007–2010)

Teaching Awards

Academic Senate Distinguished Teaching Award: for outstanding teaching at UCSD. (2018-2019)
CDIIP Grant: \$45,000 supporting my development of online resources for linear algebra. (2018-2019)

PUBLICATIONS All available on my **webpage** and on the **arXiv**.

- (35) Jekel, D.; **Kemp, T.**; Nikitopoulos, E.: *Noncommutative L^p -integrators and Stochastic Differential Equations in L^p* . Preprint (2026)
- (34) Cranston, C.; Wang, Z.; **Kemp, T.**: *NTK Regression Under Dual Power-Law Model: Deterministic Equivalents via SDE and PDE Methods*. Accepted to the Conference on Neural Information Processing Systems NeurIPS (2026)

- (33) Cranston, C.; Wang, Z.; Mahoney, M.; **Kemp, T.**: *Eigen-Spike Emergence and Quadratic Deterministic Equivalents for Nonlinearly-Separable Data*. Proceedings of the Thirty-Ninth Conference on Learning Theory COLT – in Proceedings of Machine Learning Research, vol. 336, 1476-1574 (2026)
- (32) **Kemp, T.**; Miyagawa, A.: *q-Wigner Chaos and the Fourth Moment*. Preprint (2026)
- (31) Brailovskaya, T.; Cook, N.; **Kemp, T.**; Parraud, F.: *Eigenvalues of Brownian Motions on $GL(N, \mathbb{C})$* . Preprint (2026)
- (30) Driver, B.; Hall, B.; Ho, C. W.; **Kemp, T.**; Nemish, Y.; Nikitopoulos, E.; Parraud, F.: *Matrix Random Walks and the Lima Bean Law*. Preprint (2026)
- (29) Goldstein, L.; **Kemp, T.**: *Free Zero Bias and Infinite Divisibility*. Preprint (2026)
- (28) **Kemp, T.**; Miyagawa, A.: *The Strong Haagerup Inequality for q-Circular Systems*. Int. Math. Res. Not. IMRN no. 1, Paper No. rna358, 33pp. (2026)
- (27) Jekel, D.; **Kemp, T.**; Nikitopoulos, E.: *A Martingale Approach to Noncommutative Stochastic Calculus*. J. Funct. Anal. 290, no. 2, Paper No. 111200, 117pp. (2026)
- (26) Driver, B.; Hall, B.; **Kemp, T.**: *The Brown Measure of the Free Multiplicative Brownian Motion*. Probab. Theory Related Fields 184, no. 1-2, 209-273 (2022)
- (25) Dumitriu, I.; **Kemp, T.**; Ramanan, K.: *Stochastic Networks and Reflecting Brownian Motion: the Mathematics of Ruth Williams*. Notices Amer. Math. Soc. 69, no. 3, 363-374 (2022)
- (24) Cébron, G.; **Kemp, T.**: *Fluctuations of Brownian Motions on GL_N* . Ann. Inst. Henri Poincaré Probab. Stat. 58, no. 1, 524-547 (2022)
- (23) **Kemp, T.**; Zimmermann, D.: *Random matrices with log-range correlations, and log-Sobolev inequalities*. Ann. Math. Blaise Pascal. 27, no. 2, 207-232 (2020)
- (22) Hall, B.; **Kemp, T.**: *Brown Measure Support and the Free Multiplicative Brownian Motion*. Adv. Math. 355, 106771, 36 pp. (2020)
- (21) Driver, B.; Hall, B.; **Kemp, T.**: *The Complex Time Segal–Bargmann Transform*. J. Funct. Anal. 278, no. 1, 108303, 42 pp. (2019)
- (20) Gryc, W.; **Kemp, T.**: *Corrigendum to “On Sharp Constants for Dual Segal–Bargmann L^p Spaces*. J. Math. Anal. Appl. 475, no. 2, 1992-1995 (2019)
- (19) Friedland, S.; **Kemp, T.**: *Most Boson Quantum States are Almost Maximally Entangled*. Proc. Am. Math. Soc. 146, no. 12, 5035-5049 (2018)
- (18) Collins, B.; Dahlqvist, A.; **Kemp, T.**: *The Spectral Edge of Unitary Brownian motion*. Probab. Theory Related Fields. 170, no. 1-2, 49-93 (2018)
- (17) Gour, G.; **Kemp, T.**: *The Minimum Renyi Entropy Output of a Quantum Channel is Locally Additive*. Lett. Math. Phys. 107, no. 6, 1131-1155 (2017)
- (16) Driver, B.; Gabriel, F.; Hall, B.; **Kemp, T.**: *The Makeenko-Migdal equation for Yang-Mills Theory on Compact Surfaces*. Comm. Math. Phys. 352, no. 3, 967-978 (2017)
- (15) Driver, B.; Hall, B.; **Kemp, T.**: *Three proofs of the Makeenko-Migdal equation for Yang-Mills theory in the Plane*. Comm. Math. Phys. 352, no. 3, 967-978 (2017)
- (14) **Kemp, T.**: *Heat Kernel Empirical Laws on U_N and GL_N* . J. Theoret. Probab. 30, no. 2, 397-451 (2017)
- (13) **Kemp, T.**: *The Large- N Limits of Brownian Motions on GL_N* . Int. Math. Res. Not. IMRN, no. 13, 4012-4057 (2016)
- (12) Graczyk, P.; **Kemp, T.**; Leob, J.: *Strong logarithmic Sobolev inequalities for log-subharmonic functions*. Canad. J. Math. 67 (6), 1384-1410 (2015)
- (11) Gryc, W.; **Kemp, T.**: *On sharp constants for dual Segal–Bargmann L^p spaces*. J. Math. Anal. Appl. 424, no. 2, 1198-1222 (2015)
- (10) Collins, B.; **Kemp, T.**: *Liberation of Projections*. J. Funct. Anal. 266, no. 4, 1988-2052 (2014)
- (9) Driver, B.; Hall, B.; **Kemp, T.**: *The Large- N Limit of the Segal-Bargmann Transform on U_N* . J. Funct. Anal. 265, no. 11, 2585-2644 (2013)
- (8) **Kemp, T.**; Nourdin, I.; Peccati, G.; Speicher, R.: *Wigner Chaos and the Fourth Moment*. Ann. Prob. 40, 1577–1635 (2012)
- (7) Gryc, W.; **Kemp, T.**: *Duality in Segal-Bargmann Spaces*. J. Funct. Anal. 261, 1591-1623 (2011)
- (6) **Kemp, T.**; Mahlborg, K.; Rattan, A.; Smyth, C.: *Enumeration of non-crossing pairings on bit strings*. J. Comb. Theory A. 118, 129-151 (2011)

- (5) Haagerup, U.; **Kemp, T.**; Speicher, R.: *Resolvents of $\mathcal{R}$ -diagonal operators*. Trans. Amer. Math Soc. 362, 6029-6064 (2010)
- (4) Graczyk, P.; **Kemp, T.**; Loeb, J.: *Hypercontractivity for log-subharmonic functions*. J. Funct. Anal. 258, 1785-1805 (2010)
- (3) **Kemp, T.**: *$\mathcal{R}$ -diagonal dilation semigroups*. Math. Z. 264, 111–136 (2010)
- (2) **Kemp, T.**; Speicher, R.: *Strong Haagerup inequalities for $\mathcal{R}$ -diagonal elements*. J. Funct. Anal. 251, 141-173 (2007)
- (1) **Kemp, T.**: *Hypercontractivity in non-commutative holomorphic spaces*. Commun. Math. Phys. 259, 615-637 (2005)

PRESENTATIONS Complete list on my [webpage](#).

Colloquium Lectures, 2014 - present

Santa Clara University. Santa Clara, CA. (Lecture by Zoom.) January, 2021.
 Temple University. Philadelphia, PA. April, 2019.
 DePaul University. Chicago, IL. April, 2018.
 University of Illinois, Urbana-Champaign. Urbana, IL. April, 2018.
 University of Calgary. Calgary, Canada. March, 2017.
 University of Illinois, Chicago. Chicago, IL. September, 2016.
 University of Virginia. Charlottesville, VA. March, 2016.
 University of Southern California. Los Angeles, CA. February, 2016.
 University of Calgary. Calgary, Canada. November, 2015.
 UCLA. Los Angeles, CA. April, 2015.

Seminar Lectures, 2014 - present

Functional Analysis Seminar, UC San Diego. May, 2026.
 Probability Seminar, University of Utah. March, 2026.
 Probabilistic Operator Algebras Seminar, UC Berkeley (Mathematics). Lecture given by Zoom. March, 2024.
 Probability Seminar, UC Berkeley (Statistics). Berkeley, CA. February, 2024.
 Probability Seminar, University of Colorado Boulder. Boulder, CA. April, 2023.
 Functional Analysis Seminar, UC San Diego. La Jolla, CA. May, 2022.
 Probability Seminar, University of Virginia. Lecture given by Zoom. October, 2021.
 Integrable Probability Seminar, Columbia University. Lecture given by Zoom. May, 2020.
 Probability Seminar, University of Southern California. Los Angeles, CA. February, 2019.
 Probability Seminar, UCLA. Los Angeles, CA. February, 2019.
 Stochastics Seminar, University of Utah. Salt Lake City, UT. August, 2018.
 Optimization and Data Science Seminar, UC San Diego. La Jolla, CA. May, 2018.
 Felix Klein Seminar in Geometry, University of Notre Dame. South Bend, IN. October, 2017.
 Probability Seminar, MIT. Cambridge, MA. September, 2017.
 Quantum Information Seminar, UC San Diego. La Jolla, CA. June, 2017.
 Functional Analysis Seminar, University of California, Los Angeles. Los Angeles, CA. May, 2017.
 Stochastics Seminar, University of Utah. Salt Lake City, UT. September, 2016.
 Probability Seminar, Northwestern University. Evanston, IL. September, 2016.
 Probability Seminar, University of British Columbia. Vancouver, Canada. September, 2016.
 Probability Seminar, Stanford University. Palo Alto, CA. May, 2016.
 Probability Seminar, UC San Diego. La Jolla, CA. May, 2015.
 Computational Finance Seminar, Carnegie Mellon University. Pittsburgh, PA. April, 2015.
 Probability Seminar, University of Washington. Seattle, WA. January, 2015.
 Probability Seminar, University of Luxembourg. Luxembourg City, Luxembourg. September, 2014.
 Free Probability Seminar, Universität des Saarlandes. Saarbrücken, Germany. September, 2014.
 Analysis Seminar, Cornell University. Ithaca, NY. April, 2014.
 Communication Theory Seminar, ECE UC San Diego. La Jolla, CA. February, 2014.

Analysis Seminar, University of Victoria. Victoria, Canada. February, 2014.

Invited Conference Lectures, 2014 - present

Workshop: Stein's Method Meets Statistics Learning. Banff (BIRS), Canada. June, 2026.
Southern California Probability Symposium (Keynote Speaker). Los Angeles, CA. April, 2026.
Midwest Probability Colloquium (Keynote Speaker). Evanston, IL. October, 2025.
Workshop: Algebraic Aspects of Random Matrices. CIRM, Luminy, France. October, 2024.
Workshop: Noncommutative Function Theory and Free Probability. Oberwolfach, Germany. May, 2024.
Workshop: Operator Algebras and Applications: Free Probability. Fields Institute, Toronto. November, 2023.
Random Matrices and Applications. Kyoto, Japan. June, 2023.
Kyoto Operator Algebra Theory Workshop. Lecture given by Zoom. January, 2022.
IPAM Reunion Conference on Quantitative Linear Algebra. Riverside, CA. December, 2021.
IPAM Reunion Conference on Quantitative Linear Algebra. Riverside, CA. December, 2019.
AMS Sectional Meeting, Session on Random Matrices and Related Structures. Riverside, CA. November, 2019.
BIRS Workshop: From Many Body Problems to Random Matrices. Banff, Canada. August, 2019.
CRM Thematic Program on New Developments in Free Probability. Montréal, Canada. March, 2019.
West Coast Operator Algebras Seminar, Seattle University. Seattle, WA. October, 2018.
IPAM Workshop on Random Matrices and Free Probability Theory. Los Angeles, CA. May, 2018.
Joint Mathematical Meetings, Special Session on Advances in Operator Algebras. San Diego, CA. January, 2018.
Extended Operator Algebras Seminar. Berkeley, CA. November, 2017.
AMS Sectional Meeting, Special Session on Random Matrices. Riverside, CA. November, 2017.
AMS Sectional Meeting, Special Session on Advances in Operator Algebras. Riverside, CA. November, 2017.
Mathematical Congress of the Americas, Special Session on Free Probability. Montreal, Canada. July, 2017.
Workshop: Analytic versus Combinatorial in Free Probability. Banff (BIRS), Canada. December, 2016.
Mini-course: Random Matrices, Free Probability and Determinantal Processes. Lille, France. May, 2016.
Free Probability and the Large N Limit, V. Berkeley, CA. March, 2016.
Oberwolfach Workshop on Free Probability Theory. Oberwolfach, Germany. June, 2015.
Frontier Probability Days. (Plenary Speaker) Tuscon, AZ. May, 2014.

Conferences Organized

BIRS Workshop 27w5820: Stochastics and Geometry. Banff, Canada. September, 2027.
BIRS Workshop 224w5314: Stochastics and Geometry. Banff, Canada. September, 2024.
Southern California Probability Symposium. La Jolla, CA. May, 2023.
BIRS Workshop 21w5184: Stochastics and Geometry. (Zoom Conference.) March, 2021.
Networked Life: Celebrating the life and career of Fan Chung and Ron Graham. La Jolla, CA. January, 2016.
AMS Western Spring Sectional Meeting, Special Session on Stochastic Processes in Noncommutative Probability. Albuquerque, NM. April, 2014.
JMM, AMS Special Session on Free Analysis and Free Probability. Baltimore, MD. January, 2014.
Probability and Statistics Day, UC San Diego. La Jolla, CA. April, 2013.
JMM, AMS Special Session on Stochastic Analysis and Mathematical Physics: A Session in Honor of the 80th Birthday of Len Gross. New Orleans, LA. January, 2011.

ADVISING AND TEACHING

Postdoc Mentoring

I have mentored 7 postdocs.

Ian Charlesworth was an SEW Visiting Assistant Professor, 2017-2018; I was his mentor. He graduated from UCLA under the supervision of Dima Shlyakhtenko. Ian left UC San Diego after one year, when he was awarded the NSF Postdoctoral Fellowship to work with Dan Voiculescu at UC Berkeley, which he followed with a postdoc KU Leuven. He is currently a Lecturer (tenured Associate Professor) at Cardiff University (Wales).

Benson Au Benson Au was an SEW Visiting Assistant Professor, 2018-2021. I co-mentored him jointly with Jonathan Novak. Benson graduated from UC Berkeley under the supervision of Steve Evans. After leaving UC San Diego, he went on to a second postdoc in Statistics at UC Berkeley. He currently works in industry as a data scientist in the Bay Area.

Yuriy Nemish was an SEW Visiting Assistant Professor, 2019-2023. I was his mentor. He graduated from the University of Toulouse, under the supervision of Mireille Capitaine and Michel Ledoux; he was then a postdoc at IST, Austria in the group of László Erdős. He currently works in industry as a data scientist in Chicago.

David Jekel was an NSF Postdoctoral Research Fellow at UC San Diego, 2020-2023. I was his mentor. He graduated from UCLA under the supervision of Dima Shlyakhtenko. After leaving UC San Diego, he did a 1-year postdoc in Toronto split between the Fields Institute and York University and then moved to the University of Copenhagen for a 2-year postdoc. He is now a tenure-track Assistant Professor at the University of Ottawa.

Marco Carfagnini was an SEW Visiting Assistant Professor, 2022-2024. I was his mentor. He graduated from the University of Connecticut, under the supervision of Masha Gordina. Marco left UC San Diego after two years, having received a tenure-track offer at the University of Melbourne, Australia. He is currently a faculty member there.

Priyanga Ganesan was a President's Postdoctoral Fellow, 2022-2024, and then an SEW Visiting Assistant Professor, 2024-2026. I was her mentor. She graduated from Texas A&M University, under the supervision of Michael Brannan. Priyanga is now moving to Cal State San Bernardino as a tenure-track Assistant Professor.

Akihiro Miyagawa was a JSPS (Japan Society for the Promotion of Science) postdoctoral fellow at UC San Diego, 2024-2026. I was his mentor. He graduated from Kyoto University, under the supervision of Benoit Collins. He is now a Research Assistant Professor at Kyoto University.

Graduate Research Advising

I have mentored 7 PhD students.

Natasha Blitvic Natasha Blitvic graduated with a PhD from MIT, under my supervision, in 2012. She was a postdoc at Vanderbilt, Berkeley, and then a Zorn Postdoctoral Fellow at Indiana University. She began her career at Lancaster University in the UK and has since moved to Queen Mary University of London where she is a Reader (roughly in between tenured Associate Professor and Full Professor in the US system).

David Zimmerman was a UCSD ARCS fellow. He graduated with a PhD from UCSD, under my supervision, in 2015. He was an LE Dickson Instructor (prestigious 3-year postdoc) at the University of Chicago and then went into industry. He now works at Google, in Mountainview, CA.

Ching Wei Ho graduated with a PhD from UCSD, under my supervision, in 2018. He was a Zorn Postdoctoral Fellow at Indiana University in Bloomington, IN. Since 2022, he has been a (now tenured) faculty member in the Institute for Mathematics in Academia Sinica, Taiwan.

Alice Chan was an NSF graduate fellow. She graduated with a PhD from UCSD, under my supervision, in 2019. She is currently working in industry.

Evangelos (Vaki) Nikitopoulos was an NSF graduate fellow. I co-advised him with Bruce Driver. He graduated with a PhD from UCSD in 2025. He is currently a Lewis Research Assistant Professor (postdoc) at the University of Michigan.

Zhichao Wang graduated with a PhD from UCSD in 2025. I co-advised him with Ioana Dumitriu. He is currently a postdoctoral researcher at UC Berkeley, joint between the Department of Statistics and the International Computer Science Institute.

Colin Cranston graduated with a PhD from UCSD in 2026. I was his PhD supervisor. He is currently working in industry, as a data science intern in San Diego.

Undergraduate Research Advising

CURE: Collaborative Undergraduate Research Experience. (UCSD Summer 2013 - 2020)

I coordinated a program (originally under the aegis of my NSF CAREER Award, later funded through my other NSF awards) for undergraduate research. Each summer, 4-5 math majors entering their third or fourth years of study worked together on an intense 8-week research project, which is supervised by one graduate student research assistant and myself (along with Prof. Brendon Rhoades in 2013-2014, and Dr. Ian Charlesworth in 2018). Projects were in the realm of probability theory and combinatorics, and had significant theoretical and computational components. Nearly all of the more than 40 participants went on to PhD programs at MIT, Princeton, Stanford, the University of Chicago, Cornell, Duke, and many other top universities.

Honors thesis on “Fluctuations of Eigenvalues and Concentration Inequalities for Patterned Random Matrices” (UCSD Fall 2022 - Spring 2023)

I advised Fred Rajasekaran on his honors thesis studying fluctuations (i.e. Central Limit Theorems) for eigenvalues of generalized random Toeplitz matrices and related random matrices with correlational structures. In Fall 2023, he began a PhD program in mathematics at Stanford University.

Honors Thesis on “Optimal Coupling in Non-Commutative Probability” (UCSD Fall 2021 - Spring 2022)

I co-advised Junchen Zhao, together with David Jekel, on his honors thesis studying optimal couplings and factorizable completely positive maps in matrix algebras, with applications to quantum information theory. In Fall 2022, he began a PhD program in mathematics at Texas A&M University.

Honors Thesis on “Maximally Correlated Random Band Matrices” (UCSD Fall 2016 - Spring 2017)

I advised Jiayi (Jessie) Tong, a graduating probability and statistics major, on her honors thesis, studying random matrices with independent bands $\{X_{ij} : |i - j| = k\}_{k=0 \dots n-1}$ but correlated entries along each band. This work generalized several papers on random Töplitz matrices, and suggested interesting new spectral distributions that may arise in these models. She was awarded High Honors for her project. In Fall 2016, she began a Masters program in statistics at Columbia University.

Honors Thesis on “Card Shuffling: Commuting Random-to-Random Shuffles” (UCSD Fall 2012 - Spring 2013)

I advised Camille Briat, a graduating probability and statistics major, on her honors thesis, studying the Markov chains given by random-to-random card shuffling techniques. Her work was both probabilistic and combinatorial, and suggested a new proof of a result about the commutativity of these processes. She was awarded the Silagi Prize, awarded each year to the best student graduating in all of science at UCSD. In Fall 2013, Camille began her PhD in mathematics as a MacCracken Fellow at the Courant Institute.

UROP on “Vector Fields on the 3-Sphere” (MIT Summer 2009 - Summer 2010)

As part of MIT’s UROP (Undergraduate Research Opportunities Program), I advised a rising sophomore, Lauren McGough, in a year-long project on vector fields on spheres. She resolved a special case of an old conjecture, showing that any linear 3-field on the 3-sphere can be continuously deformed into a special orthonormal 3-field. She went on to complete a PhD in physics at Princeton University, with an NSF Graduate Fellowship.

REU on “Free Probability and Combinatorics” (Cornell Summer 2007)

I ran a very successful NSF REU (Research Experience for Undergraduates) project in summer 2007 at Cornell University. The aim of the project was to introduce a group of undergraduate students to combinatorial aspects of free probability theory, and engage in group projects to resolve functional analytic conjectures with enumerative techniques. The participants all went on to enter highly-ranked PhD programs.

Graduate Courses Taught

Probability Theory (Math 280ABC: UCSD 2020/2021, 2024/2025)

A full-year graduate core course on probability theory and stochastic processes. Topics include measure and integration theory, independence, Kolmogorov’s Extension theorem and 0-1 law, the Strong Law of Large Numbers, renewal theory, large deviations, convergence in metric spaces of probability measures, Prokhorov’s compactness theorem, Skorohod’s theorem, Dynkin’s multiplicative systems theorem, characteristic functions and Lévy’s continuity theorem, the (Lindberg–Feller) Central Limit Theorem, Stein’s

method, the Berry–Esseen theorem, conditioning, Poisson process, Markov processes, stopping times, the strong Markov property, Martingales, the Martingale Convergence Theorem, Kolmogorov’s continuity criterion and tightness criterion, Wiener measure, Donsker’s functional central limit theorem, Brownian motion path properties, rough paths, the Dirichlet problem, and the Feynman–Kac formula. *Available as an asynchronous course with 136 lectures.* <https://www.youtube.com/@toddkemp-probability>

Stochastic Differential Equations (Math 286: UCSD Fall 2018, Fall 2022, Fall 2026)

This is an advanced graduate course on stochastic integration and stochastic calculus and stochastic (ordinary) differential equations. Topics included the stochastic integral with respect to a square integrable martingale integrator, the Ito / Doleans isometry, extension to local martingales and semi-martingales, quadratic variation and the Doob-Meyer decomposition, Ito’s formula with applications to stochastic processes, the Feynman-Kac formula and other applications to PDE and harmonic analysis, Brownian local time, martingale representation theorems, and introduction to stochastic differential equations: strong existence and uniqueness for locally Lipschitz and sublinear growth drift and diffusion, weak solutions, and the Cameron-Morton-Girsanov theorem. We loosely follows the textbook “Introduction to Stochastic Integration” by Chung and Williams.

Introduction to Random Matrix Theory (Math 247A: UCSD Fall 2011, Fall 2013, Spring 2022)

Topics graduate course I designed. Wigner matrices, Wigner’s semicircle law (with reduced moment assumptions) via combinatorial methods, convergence of the largest eigenvalue. The Cauchy-Stieltjes transform and vague convergence, Wigner’s law (complex analytic techniques). Logarithmic Sobolev inequalities, concentration of measure; concentration for eigenvalues of Wigner matrices. Gaussian random matrices: genus expansion; change of variables and joint distribution of eigenvalues and eigenvectors; Vandermonde determinant and Hermite kernel; empirical eigenvalue distribution. Fluctuations of the largest eigenvalue: hypercontractivity, Ledoux’s argument; Harer-Zagier recursion and optimal tail bounds. The Tracy-Widom Law and level spacing of zeroes.

Lie Groups (Math 251ABC: UCSD 2014/2015, 2018/2019)

A two quarter graduate introduction to Lie groups, Lie algebras, and representation theory. Topics included smooth homomorphisms, smooth group actions, left invariant vector fields and Lie algebras, the exponential map, the Baker-Campbell-Hausdorff formula, the closed subgroup theorem, the Lie correspondence, quotients and covering groups, homogeneous spaces, the Lie-Cartan theorem, compact Lie groups, the Weyl group, Cartan’s torus theorem, the Weyl integration formula, representation theory of $\mathfrak{sl}(n, \mathbb{C})$, representative functions and characters, and the Peter-Weyl theorem. I sampled from many sources and synthesized my own lecture notes.

Differential Geometry (Math 250A: UCSD Fall 2014)

First graduate quarter course introducing differentiable manifolds. Topics included differentiable manifolds, partitions of unity, submanifolds, imbeddings and immersions, tangent maps and the tangent bundle, vector fields, flows, cotangent bundle, tensor fields, and differential forms. Textbook: *Introduction to Smooth Manifolds* by John M. Lee.

Quantum Mechanics for Mathematicians (Math 247A: UCSD Spring 2017)

A one quarter graduate topics course I designed, on the basics of (non-relativistic) quantum mechanics, from a rigorous functional analytic perspective. Topics included a review of classical mechanics (Newtonian and Hamiltonian formulations), the key experiments of the early 20th Century that necessitated quantum mechanics, the Bohr–de Broglie “old quantum theory”, the position and momentum operators (with careful domain analysis), the “axioms” of quantum mechanics, Schrödinger’s equation, detailed analysis of the free Schrödinger equation, the quantized harmonic oscillator, the Heisenberg uncertainty principle, the spectral theorem for unbounded self adjoint operators, representation theory of $SO(3)$, and the bound states of the Hydrogen atom. This was a *very* popular course, with almost 60 students initially signed up (and more than 25 finishing the course, despite a term paper and final exam being added to dissuade those who were not fully invested). Textbook: *Quantum Theory for Mathematicians* by Brian C. Hall.

Functional Analysis (Math 241AB: UCSD Fall 2016 & Winter 2017)

A two quarter graduate introduction to functional analysis. Topics included Hilbert spaces and Banach spaces and linear operators between them, the spectral theorem (for compact operators on Banach space;

for bounded normal operators on Hilbert space), unbounded operators and the spectral theorem (for self-adjoint operators), Banach algebras, C^* -algebras, locally convex vector spaces, and weak topologies. Textbook: *A Course in Functional Analysis* by John B. Conway.

Complex Analysis (Math 220ABC: UCSD Fall 2012/2013)

Standard full-year sequence of core graduate courses on complex analysis (in one complex variable). Topics included complex numbers and functions, Cauchy's integral formula and its applications, calculus of residues, expansions of analytic functions, analytic continuation, conformal mapping and Riemann mapping theorem, Carathéodory's theorem, harmonic functions, Dirichlet principle, Hardy spaces, and Bergman spaces. Textbooks: *Functions of One Complex Variable, Volumes I and II* by John B. Conway, and *Function Theory of One Complex Variable* by Robert Greene and Steven Krantz.

Stochastic Processes (Math 285: UCSD Spring 2012)

A graduate course introduction to stochastic processes, without measure theory. Topics included Markov chains (finite and countable state space), hidden Markov models, martingales, Brownian motion, and Gaussian processes. Textbook: *Introduction to Stochastic Processes, 2nd Edition* by Greg Lawler.

Introduction to Free Probability (Math 247A: UCSD Spring 2011)

Topics graduate course I designed. General noncommutative probability, introduction to C^* -algebras and the GNS construction, free independence, free product constructions; partition lattices, non-crossing partitions, Möbius inversion in lattices, free cumulants, the Stieltjes transform and the $\mathcal{R}$ -transform; asymptotic freeness of random matrices. Textbook: *Lectures on the Combinatorics of Free Probability* by Alexandru Nica and Roland Speicher.

Probability Theory (18.175: MIT Spring 2009)

Basic probability theory, laws of large numbers, central limit theorems, introduction to martingales, Brownian motion, and basics of Lévy processes. Textbook: *Probability: an analytic view* by Dan Stroock.

Measure and Integration (18.125: MIT Spring 2008)

Basic measure theory, Lebesgue integration theory, L^p spaces and basic functional analysis, and elements of Fourier analysis. Textbooks: *A Concise Introduction to the Theory of Integration* by Dan Stroock and *Real and Complex Analysis* by Walter Rudin.

Stochastic Analysis (18.177: MIT Fall 2007)

Brownian motion, martingales and stochastic integration; Malliavin calculus on Euclidean space and its application to PDE. Textbooks: *Brownian Motion and Stochastic Calculus* by Ioannis Karatzas and Steven Shreve, and *The Malliavin calculus and related topics* by David Nualart.

Topics in Functional Analysis (Math 712: Cornell Spring 2004)

Topics graduate course I designed, "Compact operators on Hilbert space," detailing the classical theory of Schatten p -ideals. The course (three one-hour lectures per week for the fourteen week term) was regularly attended by nine graduate students and two faculty members.

Undergraduate Courses Taught

Linear Algebra (Math 18 UCSD Fall 2012, Winter 2017, Winter 2018, Winter 2022, Winter 2023, Summer 2024)

Standard first linear algebra quarter course, covering matrix algebra, Gaussian elimination, determinants. Linear and affine subspaces, bases of Euclidean spaces, eigenvalues and eigenvectors, quadratic forms, orthogonal matrices, diagonalization of symmetric matrices; computing symbolic and graphical solutions using Matlab. Textbook: *Linear Algebra and its Applications* by David Lay.

Hidden Data in Random Matrices (Math 182 / DSC 155, Fall 2019)

This is a topics course I designed, on the mathematical theory underlying principal component analysis (PCA): a core tool for analysis of high-dimensional data sets. The course begins with topics from linear algebra (the singular value decomposition - SVD), probability (random vectors, covariance and correlation), and statistics (unbiased estimators, maximal likelihood estimation, sample covariance, linear least squares, and regression). I then presented the main PCA algorithm, both as the best approximation d -dimensional affine subspace projection and the highest variance d -dimensional affine subspace projection, demonstrating the equivalence of these two characterizations for fixed d . After relating to the SVD and

doing complexity analysis, the middle of the course turned to the question of choosing the appropriate d (the number of principal components in the signal). To analyze this, we delved into basic random matrix theory: the method moments and Wigner's law, leading up to the Marchenko-Pastur law for purely random sample covariance matrices, and the universality of bulk eigenvalue statistics. Finally, we turned to the study of outlier singular values, in the context of spiked covariance models and the BBP (Baik, Ben Arous, Peché) transition, which explains the existence of principal components and also describes quantitative deformations of the data set that are not a result of noise but inherent to the models. The course followed my notes (available on my webpage), and also had a weekly Python lab component in Jupyter notebooks.

Introduction to Probability (Math 180A: UCSD Fall 2010, Winter 2016, Fall 2019)

Probability spaces, random variables, distribution, expectation, independence; combinatorial probability; inclusion-exclusion, conditional probability, Bayes' theorem; joint marginal and conditional distributions; cumulative distributions and densities; law of large numbers; central limit theorem. [In Fall 2019, I taught a Data Science-flavored version of the course, which also included some statistical concepts, and had a new Python lab component to require live coding assignments, connecting the concepts of the course to analysis of real-world data sets.] Textbooks: *Elementary Probability for Applications* by Rick Durrett, and *Introduction to Probability* by David Anderson, Timo Seppäläinen, and Benedek Valkó.

Real Analysis (18.100B/C: MIT Fall 2008 & Spring 2010, Math 140AB: UCSD Winter 2014, 2016)

The first course in real analysis, with topics including topology of metric spaces, continuity and differentiability on the real line, the Riemann-Stieltjes integral, and sequences and series of functions. Textbook: *Principles of Mathematical Analysis* by Walter Rudin (which he wrote for this course while at MIT). [18.100C has the same course content as 18.100B, but an extra hour of face-time per week and more written work for the students, to satisfy communication requirements in the math major.]

Vector Calculus (Math 20E: UCSD Fall 2014)

Standard vector calculus in 2 and 3 dimensions, with topics including change of variables in multiple integrals, Jacobian, line integrals, Green's theorem, vector fields, gradient fields, divergence, curl, spherical/cylindrical coordinates, Taylor series in several variables, surface integrals, Stokes's theorem, Gauss's theorem, and conservative fields. Textbook: *Vector Calculus, 6th Edition* by Jerrold Marsden and Anthony Tromba.

Multivariate Calculus (18.022: MIT Fall 2009, Math 20C: UCSD Fall 2011)

Standard multivariate calculus in 2 and 3 dimensions, with topics including basic linear algebra, continuity and differentiability of multivariate functions, parametrized curves, vector fields, grad, div, and curl, multiple integrals; 18.022 at MIT also included line and surface integrals, manifolds with boundary, and Stokes's theorem. Textbooks: *Calculus: Early Transcendentals, 2nd Edition* by Jon Ragowski at UCSD; *Vector Calculus, 3rd Edition* by Susan Colley at MIT.

Theoretical Calculus (Math 223/224: Cornell 2005/2006, 18.014/18.024: MIT 2006/2007)

Standard material in first and second year courses in calculus and multivariate calculus, at a theoretical level with additional topics (such as a self-contained treatment of linear algebra, and differential forms). Textbooks: *Calculus: Volumes I and II* by Tom Apostol (augmented by significant course-notes in the second term) at MIT; *Vector Calculus, Linear Algebra, and Differential Forms: A Unified Approach* by John Hubbard and Barbara Hubbard at Cornell.

Calculus II (Math 112: Cornell Summer 2002)

The second semester of first-year calculus in the summer, covering integral calculus and sequences and series. Textbook: *Calculus* by Robert Adams.

SERVICE AND OUTREACH

Service to the University

Task Force on the Performance of Undergraduate Degree Programs (University of California Systemwide Academic Senate). (2025-2026) I served as the UC San Diego representative on a task force that designed metrics and assessed required resources and infrastructure for existing and new undergraduate degree programs in the UC, particularly with a major online component. I served as the Co-Chair for the subcommittee on infrastructure.

Workgroup on California General Education Transfer Curriculum (Intersegmental Committee of Academic Senates, University of California, California State University, and California Community Colleges). (2024-2026) I served as one of two University of California representatives on the committee that reviewed and proposed changes to the new Cal-GETC standards for Area 2 (Mathematics) for which courses articulate and transfer from California high schools and between the three post-secondary state university systems in California.

Revelle College Executive Committee (Colleges). (2023-2027) I serve as an elected faculty member on the Executive Committee for Revelle College, advisory to the Provost of the College, on all academic matters. We meet quarterly for 2-hours, in addition to many subcommittees and further discussions.

Area-C Workgroup (University of California Systemwide Academic Senate). (2023-2024) A Workgroup of mathematics pedagogy experts, one from each UC campus, with charge to evaluate the Area-C (Mathematics) admissions standard for the University of California. The committee met for at least two hours by Zoom every week for a full academic year, often with additional subcommittee and full committee meetings. Our final report to the Regents of the UC resulted in substantial changes to admissions practices (that are currently being challenged by the California Legislature).

Enrollment Management Ad Hoc Committee (UCSD Senate–Administration). (2022-2024) A committee formed to address changes in the system of “capped” majors, making recommendations on how oversubscribed departments should prioritize admission of applicants to their majors. The committee met approximately monthly for 18 months for 1-2 hours meetings, and produced a final report that proposed substantial changes and uniformization to yield a more equitable major admissions process across campus.

Committee on Admissions (UCSD Academic Senate). (2020-2024) A standing committee of the Academic Senate, whose role is to where we discuss and make policy for the admissions decisions for hundreds of thousands of applicants every year. The committee meet for a 2+ hour meeting monthly each academic year.

Workgroup: Distance Education for Academic Excellence & Resilience (UCSD Senate–Administration). (2020-2022) I served on a workgroup that met twice a month for almost two years to make recommendations for sustainably preparing UCSD for coming societal changes that will require more remote and hybrid education for college students. Our final report led to widespread systemic changes to the way courses are created and approved.

Dean Review Committee (Administration). (2022)

I was an appointed member of the 12-person Five Year Review committee for Prof. Steven Boggs, Dean of the UC San Diego Division of Physical Sciences.

Dean Review Committee (Administration). (2018)

I was an appointed member of the 8-person Five Year Review committee for Prof. Mary Alshok, Dean of the UC San Diego Extension Program.

Remote Teaching Leader (Administration). (Spring-Summer 2020)

From March - August, 2020, at the onset of the Covid-19 pandemic crisis, I was appointed the Remote Teaching Leader for the Division of Physical Sciences for Mathematics. I met weekly with the Dean of Physical Sciences and other Remote Teaching Leaders, held twice-weekly Zoom hours to discuss remote teaching issues, met with UC Counsel and Privacy Officer to set department remote assessment policies, designed, ordered, and organized department IT equipment support, and acted as a general resource person for all remote teaching matters. (This position was later converted to a full committee, as it was eventually realized it is far too much work for one faculty member.)

Division of Physical Science: Lattimer Fellowship Selection Committee (Administration). (2018 - 2020)

The Lattimer Fellowship is for faculty engaging in interdisciplinary research in physical sciences, and between physical sciences and engineering or biology. Each year, faculty propose projects and several are selected to receive teaching relief and seed funding to pursue interdisciplinary research projects that are “risky” (uncertain to produce results worth publishing). I served on the selection committee for the Fellowship for three years.

Division of Physical Science Development Committee (Administration). (2018 - 2020)

I served on the Development Committee for the Dean of Physical Sciences. This is an executive advisory committee with three invited senior faculty from each of the mathematics, physics, and chemistry departments. We advised the Dean on matters of divisional importance, in particular evaluating funding requests for academic ventures within the division and across the university.

Service to the Department of Mathematics

Vice Chair for Graduate Affairs. (2023 - present) I am appointed as one of the two Vice Chairs for the department, where I oversee our graduate programs and our graduate advising staff. The responsibilities of this position are too many to list, and generally take approximately half of all my work time.

Postdoc Coordinator. (2019 - 2025)

After proposing a formal mentoring program for our growing postdoc program, I was appointed the Postdoc Coordinator in 2019. I conducted intake interviews with the 10-12 incoming postdocs each year, advised on assigning their teaching, ran a teaching workshop for them, conducted teaching observations and coordinated their research mentors, and acted as a resource person and conduit to the department administration for them. (I continue to run teaching workshops for incoming postdocs and faculty.)

Teaching Committees. (2018 - 2024)

I was the chair of the SEW / Teaching Visitor teaching committee, and a member of the faculty teaching committee in the math department at UCSD. The committee does teaching observations and assessments of instructors in the department and give additional pedagogical support and advice.

Faculty Advisor, Probability and Statistics Major. (2018 - 2024)

I considered all petitions from students in the Probability and Statistics major, asking for exceptions to set policy on course prerequisites, electives, and replacements.

Math Department Council. (2019 - 2021)

I was elected to the UCSD Math Department Council (the executive committee) for the term 2019-2021. In this capacity, the three elected members meet weekly with the chair, vice chairs, and COO of the department to advise on all department matters.

Undergraduate Affairs Committee. (2019 - 2021)

Quarterly meetings with the undergraduate advising and managing staff to advise on issues related to course enrollment, placement exams, prerequisites, etc.

SEW Mentoring Proposal. (2018-2019) The UCSD Math Department named postdoc program (SEW) expanded to 4 new SEWs per year starting in Fall 2016. Never having had a full-fledged postdoc program before, our department did not have an established mentoring program for our SEWs (and other postdocs), relying only on the individual research mentors. The teaching evaluations for a number of our new SEWs were (unsurprisingly) very low in their first quarters, and this was brought to the attention of our then-new EVC. Starting in Spring 2018, I worked with a group of Teaching Professors to formulate a plan for a robust teaching mentoring program to help. I was later given the mandate to implement a pilot of the mentoring program beginning in Fall 2019, with the help of the Teaching + Learning Commons. The pilot was very successful, and played a key role in the SEW program external review in Fall 2019, which resulted in the administration doubling the program again to 8 lines per year. I am now continuing as the Postdoc Coordinator, organizing the mentoring of all incoming SEWs and postdocs in Fall 2020.

San Diego Honors Math Contest. (2011 - 2018)

I was the liaison from the UCSD math department to the Greater San Diego school district. In that capacity, I coordinate and write the annual San Diego Honors Math Contest (which has run since 1958). More than

200 high school students write the two-part exam each year. I also coordinate grading, and an awards banquet for the event.

Curriculum Redesign. (2013 - 2017)

I undertook a project, jointly with Senior Teaching Professor John Eggers, to significantly change the structure of the lower division undergraduate engineering-and-science-streamed courses offered by the math department (the Math 20 sequence). Formerly, the course in Linear Algebra, Math 20F, had been the last course in the sequence of six, and actually had multivariate calculus (Math 20C) as a prerequisite. This was at odds with almost all of UCSD's peer institutions, and was more than awkward from a pedagogical standpoint. After significant conversations with people in math, physics, chemistry, and various engineering departments, it became clear nobody really knew the original reasoning. Over the course of several years, I prepared a plan to change the curriculum to have Linear Algebra first (which entailed *positive* pedagogical changes throughout several of the courses and a lot of administrative changes), and a proposal extensively studying its effects. In Winter 2016, the math department accepted this proposal, and then it was referred to the Undergraduate Council of the whole university. It received positive support from many departments, and it became official in Fall 2016. Linear Algebra is now taught as Math 18, the first course in the sequence, and is a prerequisite for vector calculus (Math 20E). I am closely following student outcomes in the new curriculum and I am so far very pleased with the positive effects it has had.

Graduate Admissions. (2014 - 2017)

I served on the graduate admissions committee for the UCSD PhD program. In that capacity, I reviewed nearly 100 applications in probability and analysis each year, and participated in ranking discussions for admission of prospective students. I also spearheaded a new initiative to attract more highly ranked and minority candidates with a combination of longer fellowships and campus incentives, which proved very effective.

Undergraduate Honors & Awards. (2017)

I served on the committee that decided on the status of the Math 199H honors theses submitted by the graduating majors in 2017. This involved reading 5 honors theses (totaling more than 180 pages), attending the students' presentations, and debating the standing of the theses with the committee of three faculty members.

Undergraduate Colloquium. (2011)

I organized the undergraduate colloquium for math majors at UCSD in Fall 2011. This involved finding speakers (mostly from within the department) to give weekly talks about their current research, made accessible to an audience of junior and senior math majors. I also gave the introductory lecture in the series (on random matrix theory and planar diagrams).

MIT Integration Bee. (2007 - 2009)

I organized and ran the MIT Integration Bee, which entailed writing a challenging qualifying written test (of integrals) and preparing a live round-robin tournament of integration. There were more than 100 contestants for the qualifying exam each year, and between 12-20 who qualified for the Bee. There were frequently several hundred spectators (including some who traveled from across the country), and one year the event was televised.

Service to the Mathematics Community

Associate Editor, IDAQP. (2020 - present) Editorial Board of the journal Infinite Dimensional Analysis and Quantum Probability.

Reviews, Refereeing. (2005 - present)

I have served on NSF and NSERC panels, and reviewed applications for Simons grants. I have refereed several books and over 100 papers for journals including J. Funct. Anal., Commun. Math. Phys., J. Comb. Theory A, the Annals of Probability, Prob. Theory Related Fields, AIHP, Memoirs of the American Mathematical Society, the American Mathematical Monthly, and many others.

Ithaca High School Senior Math Seminar (2002)

I founded and co-taught this program to introduce high school students to advanced material that usually

would not be covered in introductory college courses in mathematics. The Senior Seminar is now a highly-successful NSF-funded outreach program at Cornell; three graduate students teach it each term to fulfill their regular teaching duties.