Elvan Ceyhan — Narrative Curriculum Vitae

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Research contributions: ideas, tools, methodologies, and knowledge

My research develops statistical and probabilistic methods for spatial and geometric data, particularly through proximity and nearest-neighbor digraphs. I have worked on spatial inference, graph-based classification, and stochastic navigation under uncertainty, alongside collaborative statistical research in neuroimaging.

Random geometric digraphs and probabilistic foundations. With Carey Priebe and David Marchette, I studied proximity catch digraphs for testing spatial segregation and association. Using relative arc density as a test statistic, we derived its asymptotic distribution through U-statistic theory and examined finite-sample behavior and asymptotic efficiency [12]. In single-authored work, I derived domination-number distributions for class cover catch digraphs with non-uniform one-dimensional data, extending earlier uniform-sampling results [11]. I subsequently developed geometric constructions of higher-dimensional proximity regions, including Delaunay-based constructions, and studied the distributions and geometry invariance of associated graph invariants [9]. With John Wierman and Pengfei Xiang, I made substantial contributions to proofs of laws of large numbers for class-cover domination numbers: a strong law for planar Poisson input and weak laws for uniform and bounded continuous sampling distributions, with higher-dimensional extensions [2]. With Selim Bahadır, I contributed to proofs of asymptotic results for counts of weakly connected subdigraphs in random k-nearest-neighbor digraphs under homogeneous Poisson and uniform binomial input, including corollaries for fixed indegree and shared and reflexive nearest-neighbor configurations [3].

Spatial inference and disease clustering. I developed overall and cell-specific tests based on nearest-neighbor contingency tables to assess spatial segregation and association among labeled point patterns [10]. I examined their null distributions under random labeling and complete spatial randomness independence, and compared their finite-sample size and power with existing tests. I later proposed two distance-based segregation indices for detecting disease clustering among cases and controls under random labeling [6], derived their asymptotic distributions, and evaluated their performance under homogeneous and inhomogeneous background patterns.

Graph-based statistical classification. With Artur Manukyan, a former doctoral advisee, I studied class cover catch-digraph classifiers for imbalanced two-class problems [5]. We used simulation and real-data comparisons to examine substantial undersampling of the majority class while retaining information about discarded observations, and assessed performance under class imbalance. I subsequently led the construction of semiparametric, prototype-based classifiers using the proportional-edge family of proximity catch digraphs [4]. For this family, the minimum dominating set—and therefore the minimum prototype set—can be found in polynomial time, unlike the generally intractable minimum domination problem for class cover catch digraphs. We evaluated the resulting classifiers' predictive performance, including under class imbalance.

Stochastic navigation and adversarial obstacle placement. With Vural Aksakallı, I studied where to place true obstacles in fields containing uncertain or false obstacles, when a navigating agent can determine an obstacle's status only by local disambiguation [7]. I led the stochastic modeling and analysis of how layouts, background clutter, and placement choices affect traversal length, including an application to maritime minefield data. More recently, with Li Zhou and Polat Charyyev, I shared responsibility for stochastic modeling and analysis of obstacle configurations generated by Strauss (regular) and Matérn (clustered) point processes [1]. We used Monte Carlo experiments and stochastic-order comparisons to study traversal costs under these spatial scenarios.

Statistical methods for neuroimaging. In collaborative work on labeled cortical distance maps, I shared responsibility for study design and led the statistical methodology for comparing cortical morphometry across diagnostic groups using pooled voxel-level distances rather than only subject-level summaries [8]. Through simulation, we examined the effects of non-normality and within-sample dependence on parametric and nonparametric comparisons,

then applied the methods to ventral medial prefrontal cortex data from individuals with major depressive disorder, those at elevated risk, and healthy controls.

Research software and reproducible outputs. I develop and maintain the R packages `nnspat`, `pcds`, and `pcds.ugraph`, which implement spatial and proximity-digraph methods, and have contributed to the `PCDSL` research software. Since their respective initial CRAN releases, `pcds`, `pcds.ugraph`, and `nnspat` have recorded 55,517, 55,517, and 34,303 cumulative downloads, respectively (figures reported as of October 2026 and including repeat downloads). Code accompanying the 2025 obstacle-placement paper is available on Zenodo (doi:10.5281/zenodo.17074761); that paper acknowledges NSF Award 2319157 and ONR Grant N00014-22-1-2572. Other support for my research has included the Simons Foundation, TÜBİTAK, and a Marie Curie International Outgoing Fellowship.

Selected research publications

1. L. Zhou, E. Ceyhan, and P. Charyyev (2025). "Adversarial obstacle placement with spatial point processes for optimal path disruption." *ISPRS International Journal of Geo-Information*, 14(10), 374.
2. E. Ceyhan, J. C. Wierman, and P. Xiang (2021). "Law of large numbers for a two-dimensional class cover problem." *ESAIM: Probability and Statistics*, 25, 376–407.
3. S. Bahadır and E. Ceyhan (2021). "On the number of weakly connected subdigraphs in random kNN digraphs." *Discrete & Computational Geometry*, 65(1), 116–142.
4. A. Manukyan and E. Ceyhan (2020). "Classification using proximity catch digraphs." *Machine Learning*, 109(4), 761–811.
5. A. Manukyan and E. Ceyhan (2016). "Classification of imbalanced data with a geometric digraph family." *Journal of Machine Learning Research*, 17(189), 1–40.
6. E. Ceyhan (2014). "Segregation indices for disease clustering." *Statistics in Medicine*, 33(10), 1662–1684.
7. V. Aksakallı and E. Ceyhan (2012). "Optimal obstacle placement with disambiguations." *Annals of Applied Statistics*, 6(4), 1730–1774.
8. E. Ceyhan, M. Hosakere, T. Nishino, J. Alexopoulos, R. D. Todd, K. N. Botteron, M. I. Miller, and J. T. Ratnanather (2011). "Statistical analysis of cortical morphometrics using pooled distances based on labeled cortical distance maps." *Journal of Mathematical Imaging and Vision*, 40(1), 20–35.
9. E. Ceyhan (2010). "Extension of one-dimensional proximity regions to higher dimensions." *Computational Geometry: Theory and Applications*, 43(9), 721–748.
10. E. Ceyhan (2009). "Overall and pairwise segregation tests based on nearest neighbor contingency tables." *Computational Statistics & Data Analysis*, 53(8), 2786–2808.
11. E. Ceyhan (2008). "The distribution of the domination number of class cover catch digraphs for non-uniform one-dimensional data." *Discrete Mathematics*, 308(23), 5376–5393.
12. E. Ceyhan, C. E. Priebe, and D. J. Marchette (2007). "A new family of random graphs for testing spatial segregation." *Canadian Journal of Statistics*, 35(1), 27–50.

Development of researchers and collaborations

At Koç University and Auburn, I have advised six researchers who completed doctorates: Artur Manukyan and Selim Bahadır (2016), Polat Charyyev (2017), Jordan Eckert and Rui Shi (2025), and Li Zhou (2026). Their research has spanned proximity and nearest-neighbor digraphs, statistical classification and clustering, and network navigation under uncertainty. Several advising relationships have continued through joint publications, including work with Manukyan on classification [4, 5], Bahadır on nearest-neighbor digraph theory [3], and Zhou and Charyyev on obstacle placement [1].

My master's advising has included work on geometric digraphs, statistical classification, obstacle modeling, and applications in engineering and biology. Former doctoral researchers have moved into academia and research, including Li Zhou (Mercer University), Selim Bahadır (Ankara Yıldırım Beyazıt University), and Artur Manukyan (Max Delbrück Center), as well as applied positions held by Rui Shi (MedWatcher) and Polat Charyyev (MAP Akademi, Istanbul). Former master's advisees include Enes Özel (University of Tennessee) and Yu Gu (U.S. Bank). At Auburn, I supervised three postdoctoral fellows during 2020–2025; Fekadu Bayisa subsequently held a postdoctoral appointment at the University of Guelph. I also serve as the designated research mentor to two junior

faculty colleagues at Auburn and have served on graduate committees in statistics, mathematics, engineering, and computer science.

As Deputy Director of the Statistical and Applied Mathematical Sciences Institute (SAMSI, 2017–2019), I organized professional-development workshops for postdoctoral fellows and graduate students, participated in postdoctoral recruitment and evaluation, observed teaching and provided feedback, and coordinated mentoring and interdisciplinary presentations for graduate fellows. I also directed undergraduate modeling workshops, including activities involving minority-serving institutions. These responsibilities brought together training and collaborative research across institutions, particularly through SAMSI's climate-science and precision-medicine programmes.

At Auburn, I introduced graduate and undergraduate Bayesian statistics courses and a two-course Fundamentals of Statistical Inference sequence designed to connect theory and computation. At Koç, I helped develop Statistics for Sciences and led revisions of mathematics course requirements and pure and applied mathematics pathways. I received Auburn's Marie Kraska Award for Excellence in Teaching in 2024 and taught a continuing-education course on Bayesian generalized linear models at the 2026 Joint Statistical Meetings. I have also mentored through programmes of the American Statistical Association, INFORMS, and the Marie Curie Alumni Association.

Contributions to the research and innovation community

Editorial and research evaluation. As Associate Editor of the *Journal of Statistical Computation and Simulation* (since 2025), *Computational Statistics & Data Analysis* (2008–2016), and the *Journal of Probability and Statistical Science* (2007–2013; 2021–2026), I have assessed manuscripts, coordinated peer review, and contributed to editorial decisions. I have also served on the editorial boards of *Measurement: Interdisciplinary Research and Perspectives* and *Model Assisted Statistics and Applications*.

Professional-society leadership and scientific exchange. As President of the Alabama–Mississippi Chapter of the American Statistical Association (2024–2026), I organized the 2024 chapter meeting, chaired its 2025 and 2026 conferences, and co-organized a 2025 traveling course on statistics, AI, and mental health. I also convened a 2026 Joint Statistical Meetings discussion on statistical foundations in data-science education. Earlier, I served on the International Association for Statistical Computing–European Regional Section board (2012–2016), co-chaired local arrangements for the 2012 World Congress in Probability and Statistics and its preceding young-researchers meeting, and organized international invited sessions. At Auburn, I established a Statistics & Data Science Seminar Series with programmes in 2020 and 2022.

National research-institute leadership. As Deputy Director of the NSF-funded Statistical and Applied Mathematical Sciences Institute (SAMSI, 2017–2019), I coordinated scientific programming and operations and co-led activities in climate science and precision medicine. I organized interdisciplinary workshops and planning meetings with university and national-laboratory researchers, including the 2017 climate opening workshop with more than 40 speakers. I also took part in personnel coordination, budget oversight, strategic planning, and preparation for the institute's NSF recompetition.

Institutional governance and research assessment. As Chair of Mathematics (2010–2011) and a faculty council member (2006–2011) at Koç University, I worked on academic governance and curricular decisions. At Auburn, I have served on faculty recruitment, graduate-studies, promotion, and research-proposal review committees and, since fall 2026, on COSAM's Promotion and Tenure Committee and Auburn's AI Governance Working Group. I have also evaluated European Commission Marie Skłodowska-Curie fellowships and Simons proposals and contributed to International Science Council discussions of research assessment and a 2026 consultation on AI-disclosure standards.

Broader applications, engagement, and societal contributions

Statistical contributions to applied problems. My interdisciplinary research has brought statistical methods to questions in biomedical science, engineering, and public safety. In neuroimaging collaborations, I developed approaches to cortical and hippocampal morphometry in studies of neuropsychiatric disease and dementia. With bioengineering researchers, I contributed stochastic models of cell encapsulation in microdroplets. Other collaborations addressed spatial and temporal patterns in residential fires and navigation through uncertain obstacle fields.

External engagement and institution building. At SAMSI, I helped develop the Associates Program to connect the institute with industry organizations, including Bayer, SAS, Lenovo, and Cerner Health. I also participated in activities with national laboratories and supported modeling opportunities with minority-serving institutions. My statistical consulting has included academic, industry, and legal work. At Auburn, I co-founded the proposed Center for Data Science Innovation (CDSI) and helped develop its research, education, and external-partnership plans. COSAM has approved the proposal, which is awaiting Provost approval. I have presented data-science partnership initiatives at Auburn outreach and production-agriculture forums and initiated discussions with the Chambers County Health & Wellness Center about possible research, analytics, and workforce-development collaboration.

Science-policy dialogue and public communication. I coauthored a 2019 study in *Frontiers in Ecology and the Environment* on researchers' perceptions of policy engagement and its professional recognition. As a planning-committee member, I co-organized a 2022–2023 National Academies workshop series on preventing harmful exploitation of advanced data analytics and biological data. I reviewed UNDRR–International Science Council hazard information profiles and contributed to a public consultation on data quality for real-world evidence in European medicines regulation. I have also participated in international discussions of open science, AI disclosure, research assessment, and emerging technologies. My 2025 *GYA Connections* article discussed AI and educational inclusion.

This narrative CV is organized using the Résumé for Research and Innovation (R4RI) framework developed by UK Research and Innovation (UKRI).