JAMES M. MURPHY

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SUMMARY OF RESEARCH INTERESTS

My work is in applied harmonic analysis, statistical and machine learning, and data science. I develop approaches for problems in unsupervised and semisupervised learning, anomaly detection, and image processing using methods of high-dimensional statistics, spectral graph theory, and multiscale approximation. I also design and implement fast algorithms and develop methodologies for signal, image, and network processing. I'm particularly interested in problems in remote sensing and computational medicine.

POSITIONS HELD

Tufts University — September 2018 - present
Assistant Professor — *Medford, MA*

Johns Hopkins University — July 2016 - August 2018
Assistant Research Scientist and Senior Lecturer — *Baltimore, MD*

Duke University — August 2015 - June 2016
Visiting Assistant Professor — *Durham, NC*

NASA Goddard Space Flight Center — June 2014-July 2015
Research Intern — *Greenbelt, MD*

EDUCATION

University of Maryland, College Park
M.A. in Mathematics (2013), Ph.D. in Mathematics (2015)

University of Chicago
B.S. in Mathematics (2011)

RESEARCH PUBLICATIONS

[31] S. Polk, K. Kashkooli, S. Nagaraj, S. Chamadia, **J.M. Murphy**, H. Sun, M. Westover, R. Barbieri, and O. Akeju, "Electrocardiogram-derived autonomic nervous system dynamics predict anesthetic states," 2020. Submitted.

[30] S. Zhang and **J.M. Murphy**, "Hyperspectral image clustering with spatially-regularized ultrametrics," *arXiv:2004.05048*, 2020.

[29] L. Cowen, K. Devkota, X. Hu, **J.M. Murphy**, and K. Wu, "Diffusion state distances: Multitemporal analysis, fast algorithms, and applications to biological networks," *arXiv:2003.03616*, 2020*.

[28] E. Gnang and **J.M. Murphy**, "Spectral analysis for non-Hermitian matrices and directed graphs," *Linear Algebra and its Applications*, vol. 604, pp. 72 – 91, 2020.

[27] K. Kashkooli, S. Polk, E. Hahm, **J.M. Murphy**, B. Ethridge, J. Gitlin, R. Ibala, J. Mekonnen, J. Pedemonte, H. Sun, M. Westover, R. Barbieri, O. Akeju, and S. Chamadia, "Improved tracking of sevoflurane anesthetic states with drug-specific machine learning models," *Journal of Neural Engineering*, vol. 17, no. 4, 2020.

[26] **J.M. Murphy**, "Spatially regularized active diffusion learning for high-dimensional images," *Pattern Recognition Letters*, vol. 135, pp. 213–220, 2020.

[25] K. Devkota, **J.M. Murphy**, and L. Cowen, "GLIDE: Combining local methods and diffusion state embeddings to predict missing interactions in biological networks," *Bioinformatics*, vol. 36, pp. i464–i473, 2020.

[24] **J.M. Murphy**, "Patch-based diffusion learning for hyperspectral image clustering," in *IEEE International Geoscience and Remote Sensing Symposium*, 2020. To appear.

[23] A. Little, M. Maggioni, and **J.M. Murphy**, "Path-based spectral clustering: Guarantees, robustness to outliers, and fast algorithms," *Journal of Machine Learning Research*, vol. 21, no. 6, pp. 1–66, 2020*.

[22] **J.M. Murphy** and M. Maggioni, "Spectral-spatial diffusion geometry for hyperspectral image clustering," *IEEE Geoscience and Remote Sensing Letters*, vol. 17, no. 7, pp. 1243–1247, 2020.

[21] **J.M. Murphy** and M. Maggioni, "Unsupervised discriminative dimension reduction for hyperspectral chemical plume segmentation," in *IEEE International Geoscience and Remote Sensing Symposium*, pp. 3828–3831, 2019.

[20] M. Maggioni and **J.M. Murphy**, "Learning by unsupervised nonlinear diffusion," *Journal of Machine Learning Research*, vol. 20, no. 160, pp. 1–56, 2019*.

[19] Y. Liu, B. Tracey, S. Aeron, E. Miller, **J.M. Murphy**, T. Sun, and N. McDannold, "Artifact suppression for passive cavitation imaging using U-net CNNs with uncertainty quantification," in *IEEE International Conference on Signal and Image Processing*, pp. 1037–1042, 2019.

[18] S. Polk, K. Kashkooli, S. Nagaraj, S. Chamadia, **J.M. Murphy**, H. Sun, M. Westover, R. Barbieri, and O. Akeju, "Automatic detection of general anesthetic-states using ecg-derived autonomic nervous system features," in *International Conference of the IEEE Engineering in Medicine and Biology Society*, pp. 2019–2022, 2019.

[17] K. Kashkooli, S. Polk, S. Chamadia, E. Hahm, B. Ethridge, J. Gitlin, R. Ibala, J. Mekonnen, J. Pedemonte, **J.M. Murphy**, H. Sun, M. Westover, and O. Akeju, "Drug-specific models improve the performance of an eeg-based automated brain-state prediction system," in *International Conference of the IEEE Engineering in Medicine and Biology Society*, pp. 5808–5811, 2019.

[16] M. Maggioni and **J.M. Murphy**, "Learning by active nonlinear diffusion," *Foundations of Data Science*, vol. 1, no. 3, pp. 271–291, 2019*.

[15] N. Kapsin and **J.M. Murphy**, "Spatially regularized multiscale graph clustering for electron microscopy," in *SPIE Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XXV*, vol. 109860S, 2019.

[14] **J.M. Murphy** and M. Maggioni, "Unsupervised clustering and active learning of hyperspectral images with nonlinear diffusion," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 57, no. 3, pp. 1829–1845, 2019.

[13] **J.M. Murphy** and M. Maggioni, "Iterative active learning with diffusion geometry for hyperspectral images," in *IEEE Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing*, pp. 1–5, 2018.

[12] W. Czaja and **J.M. Murphy** and D. Weinberg, "Single-image superresolution through directional representations," *IEEE Geoscience and Remote Sensing Letters*, no. 12, pp. 1837 – 1841, 2018*.

[11] W. Czaja, B. Manning, **J.M. Murphy**, and K. Stubbs, "Discrete directional Gabor frames," *Applied and Computational Harmonic Analysis*, vol. 45, no. 1, pp. 1–21, 2018*.

[10] **J.M. Murphy** and M. Maggioni, "Diffusion geometric methods for fusion of remotely sensed data," in *SPIE Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XXIV*, vol. 10644, p. 106440I, 2018.

[9] E. King and **J.M. Murphy**, "A theoretical guarantee for data completion via geometric separation," *Proceedings in Applied Mathematics and Mechanics*, vol. 17, pp. 833–834, 2017*.

[8] **J.M. Murphy**, O. Leija, and J. L. Moigne, "Agile multi-scale decompositions for automatic image registration," in *SPIE Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XXII*, vol. 9840, p. 984011, 2016.

[7] **J.M. Murphy**, J. L. Moigne, and D. Harding, "Automatic image registration of remotely sensed data with global shearlet features," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 54, no. 3, pp. 1685–1704, 2016.

[6] W. Czaja, B. Manning, L. McLean, and **J.M. Murphy**, "Fusion of aerial gamma-ray survey and remote sensing data for a deeper understanding of radionuclide fate after radiological incidents: examples from the Fukushima Dai-Ichi response," *Journal of Radioanalytical and Nuclear Chemistry*, vol. 307, no. 3, 2016*.

[5] **J.M. Murphy** and J. L. Moigne, "Shearlet features for registration of remotely sensed multitemporal images," in *IEEE International Geoscience and Remote Sensing Symposium*, pp. 1084–1087, 2015.

[4] W. Czaja, **J.M. Murphy**, and D. Weinberg, "Superresolution of remotely sensed images with anisotropic features," in *IEEE International Conference on Sampling Theory and Applications*, pp. 317–321, 2015*.

[3] E. Bosch, W. Czaja, **J.M. Murphy**, and D. Weinberg, "Anisotropic representations for superresolution of hyperspectral data," in *SPIE Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XXI*, vol. 9472, p. 947213, 2015*.

[2] **J.M. Murphy**, *Anisotropic Harmonic Analysis and Integration of Remotely Sensed Data.* PhD thesis, University of Maryland, College Park, 2015.

[1] W. Czaja, T. Doster, and **J.M. Murphy**, "Wavelet packet mixing for image fusion and pansharpening," in *SPIE Algorithms and Technologies for Multispectral, Hyperspectral, and Ultraspectral Imagery XX*, vol. 9088, p. 908803, 2014*.

*Authors listed alphabetically

OTHER PUBLICATIONS

[1] Murphy, J.M. "Freshman year can be free online for anyone." *The Baltimore Sun.* August 9, 2018.

SEMINAR AND CONFERENCE PRESENTATIONS

- Mathematical Modeling Seminar, Rochester Institute of Technology, Rochester, NY. April 2020.
- Tufts Tripods Institute Online Seminar, Tufts University, Medford, MA. March 2020.
- Probability and Statistics Seminar, Boston University, Boston, MA. February 2020 .
- Mathematics Colloquium, Amherst College, Amherst, MA. February 2020.

- T-Tripods Launch, Tufts University, Medford, MA. January 2020.
- Data Science Seminar, Schlumberger Doll Research, Cambridge, MA. December 2019.
- Computing at PNNL Lecture Series, Pacific Northwest National Laboratory, Seattle, WA. November 2019.
- Machine Learning Seminar, University of Massachusetts, Lowell, MA. October 2019.
- NSF ATD+AMPS Workshop, George Washington University, Washington D.C. October 2019.
- INFORMS Annual Meeting, Seattle, WA, October 2019.
- Jubilee of Fourier Analysis and Applications, College Park, MD, September 2019.
- International Geoscience and Remote Sensing Symposium (IGARSS), Yokohama, Japan, August 2019.
- Large Scale Scientific Computing Conference '19, Bulgarian Academy of the Sciences, Sozopol, Bulgaria, June 2019.
- Geometric Data Analysis Conference, University of Chicago, Chicago, IL, May 2019.
- International Conference on Approximation Theory, Vanderbilt University, Nashville, TN, May 2019.
- Applied Mathematics Colloquium, MIT, Cambridge, MA, May 2019.
- Statistics Seminar, UW Madison, Madison, WI, May 2019.
- Machine Learning in Spectral Sensing, SPIE Defense+Commercial Sensing, Baltimore, MD. April 2019.
- AMS Sectional Meeting: Special Session on Topological Data Analysis, Statistics and Applications, Auburn University, Auburn, AL. March 2019.
- Applied Mathematics Colloquium, UCLA, Los Angeles, CA. January 2019.
- Applied Mathematics Seminar, Tufts University, Medford, MA. November 2018.
- IMA Workshop: Recent Advances in Machine Learning and Computational Methods for Geoscience, University of Minnesota, Minneapolis, MN. October 2018.
- NSF ATD+AMPS Workshop, American University, Washington D.C. October 2018.
- Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing, Amsterdam, Netherlands. September 2018.
- Machine Learning in Spectral Sensing, SPIE Defense+Security, Orlando, FL. April 2018.
- Data Science Seminar, University of Tennessee, Knoxville TN, January 2018.
- Machine Learning Seminar, Naval Research Laboratory, Washington D.C. December 2017.
- Mathematics Colloquium, Tufts University, Medford, MA. December 2017.
- Mathematics Colloquium, Goucher College, Baltimore, MD. December 2017.
- Norbert Wiener Center Seminar, University of Maryland, College Park, MD. December 2017.
- Mathematics Colloquium, University of Alabama, Tuscaloosa, AL. November 2017.
- NSF/NGA Anomaly Threat Detection Workshop, American University, Washington D.C. September 2017.
- Norbert Wiener Center Seminar, University of Maryland, College Park, MD. November 2016.
- Symposium on Advanced Computational Methods in Biomedical Imaging, National Institutes of Health, Bethesda, MD. October 2016.
- Novel Mathematically-Inspired Methods of Processing Hyperspectral Imagery, SPIE Defense+Security, Baltimore, MD. April 2016.
- Conference on Harmonic Analysis, Graphs, and Learning Poster Session, Hausdorff Institute for Mathematics, Bonn, Germany. March 2016.
- Harmonic Analysis Theory and Applications Seminar, Technical University of Denmark, Copenhagen, Denmark. February 2016.
- Norbert Wiener Center Seminar, University of Maryland, College Park, MD. December 2015.

- Novel Mathematically-Inspired Methods of Processing Hyperspectral Airborne and Satellite Imagery: Novel Mathematics Algorithms, SPIE Defense+Security, Baltimore, MD. April 2015.
- CIRM Winter School Poster Session, University of Marseille, Marseille, France. October 2014.
- Applied Math and Scientific Computing Student Seminar, University of Maryland, College Park, MD. October 2014.
- Software Engineering Division, NASA Goddard Space Flight Center, Greenbelt, MD. July 2014.
- Southeastern Analysis Meeting, Clemson University, Clemson, SC. March 2014.
- Internet Analysis Seminar, Georgia Tech, Atlanta, GA. August 2013.

GRANTS AND AWARDS

Grants:

- The Camille & Henry Dreyfus Foundation, "Low-supervision Machine Learning for Automated Analysis of Molecular Dynamics Simulations" (Co-PI, 2020-2023)
- NSF DMS 1924513, "ATD: Landscape Networks and Nonlinear Diffusions for Anomaly Detection and Active Learning" (PI, 2019-2022)
- NSF DMS 1912737, "Collaborative Research: Data-driven Path Metrics for Machine Learning" (PI, 2019-2021)
- Tufts Collaborates, "Decoding the Complexity of Commuting Networks in the United States," (Co-PI, 2019-2020)

Awards: Professor Joel Dean Award for Excellence in the Teaching of Mathematics (JHU, 2018); First place in Defense Science and Technology Lab Temporal Anomaly Detection Challenge (Duke, 2015); Jacob K. Goldhaber Travel Grant (UMD, 2014); Aziz/Osborn Gold Medal for Teaching (UMD, 2013); Student Marshall (top 3 % of undergraduate class) (UChicago, 2011); Graduation with general and departmental honors (UChicago, 2011); Phi Beta Kappa (UChicago, 2010).

TEACHING

Tufts University

MATH 34 (Calculus II). Fall 2020.
MATH 123 (Math Aspects of Data Analysis). Fall 2018, Fall 2019.
MATH 165 (Probability Theory). Fall 2020.
MATH 166 (Statistics). Spring 2019, Spring 2020.
MATH 260 (Foundations of Statistical and Machine Learning). Spring 2020.

Johns Hopkins University

MATH 106 (Calculus I for Biology and Social Sciences). Summer 2017.
MATH 202 (Calculus III). Fall 2017.
MATH 302 (ODE and PDE). Fall 2016, Summer 2018.

Duke University

MATH 353 (ODE and PDE). Fall 2015, Summer 2016.
MATH 790 (Graduate topics course in anisotropic harmonic analysis). Fall 2015.

University of Maryland

STAT 100 (Intro. Statistics). Fall 2011, Spring 2013, Summer 2015.
MATH 115 (Pre-Calculus). Summer 2013.
MATH 140 (Calculus I). Fall 2013.

Modern States

College Algebra
College Mathematics
PreCalculus
Calculus

MENTORSHIP OF STUDENTS

Ph.D. Student Mentor:

Marshall Mueller, "Anomaly detection, optimal transport, and harmonic analysis". Tufts University. September 2019-present.
Sam Polk, "Unsupervised methods for medical data analysis". Tufts University. September 2018-present.

M.A. Student Mentor:

Harrison Miller, "TBA". Tufts University. May 2020-present.
Mengnan Zhao, "Geometric machine learning of ECG Data". Johns Hopkins University. September 2017-May 2019.

Undergraduate Research Mentor:

Opemipo Boluwarin: "Anomaly detection on spatio-temporal graphs". Tufts University/Pennsylvania State University. May 2020-present.
Harris Hardiman-Mostow: "Anomaly detection on spatio-temporal graphs". Tufts University. May 2020-present.
Shukan Zhang "Ultrametric machine learning for high dimensional images". Tufts University. December 2018-present.
Jonathan Conroy: "Harmonic analysis for transportation networks". Tufts University. August 2019-June 2020.
Sebastian Coates: "Harmonic analysis for transportation networks". Tufts University. August 2019-May 2020. Now at Microsoft.
Bhushan Suwal "Patch-based unsupervised learning for remotely sensed data," Tufts University. December 2018-June 2019.
Nathan Kapsin "Unsupervised learning of electron microscopic images," Johns Hopkins University. May 2018-September 2018. Now an undergraduate at the University of Chicago
Miriam Goldman, "Analysis of night vision performance." Duke University. May-July 2016. Now a Ph.D. student at UCSF
Kevin Stubbs, "The discretization of directional Gabor systems." University of Maryland. March 2014-June 2015. Now a Ph.D. student at Duke University.

Thesis Defense Committees

Joao Marcos Vensi Basso, B.S., Tufts University, 2020
Elizabeth Newman, Ph.D., Tufts University, 2019
Yue Shen, M.A., Tufts University, 2019
Zian Jiang, B.S., Tufts University, 2019

SERVICE

Journal Editorial Service: AIMS Foundations of Data Science (Member of Editorial Board, November 2018-present); Remote Sensing (Topic Editor, April 2020-present)

Reviewer (selected): Annals of Statistics, Applied and Computational Harmonic Analysis, Physica D, SIAM Review, SIAM Journal of Mathematical Analysis, SIAM Journal of Imaging Science, IEEE Transactions on Image Processing, IEEE Transactions on Geoscience and Remote Sensing, IEEE Geoscience and Remote Sensing Letters, IEEE Journal of Selected Topics in Applied Remote

Sensing, IEEE Geoscience and Remote Sensing Magazine, Journal of Computational Physics, Signal Processing, Remote Sensing

Conference & Seminar Organizer:

- Tufts Tripods Online Data Science Seminar. Co-organizer. Online version of AMS special session cancelled due to COVID-19. March 2020-June 2020.
- 12th International Conference on Large-Scale Scientific Computations. Sozopol, Bulgaria. Organizer of special session "Large Scale Machine Learning: Multiscale Algorithms and Performance Guarantees." Member of the scientific committee. June 2019.
- Applied Mathematics Seminar, Tufts University: January 2019-present.
- Data Science Seminar, Johns Hopkins University: July 2016-August 2018.

Grant Review Panel Service: NSF

Other Panel Service: Science, Technology, and Society Lunch Seminar, Tufts University, November 2019; Guest Lecturer in "Data Analytics", Tufts University, October 2019; Graduate Research Excellence at Tufts (GREAT) Panel, Tufts University, June 2019; Prospective Ph.D. Student Panel, Loyola University, November 2017

University Committee Service: Undergraduate Admissions and Financial Aid Committee, Tufts University, September 2019-present; Masters in Data Analytics Steering Committee, Tufts University, May 2019-present; Graduate Committee for Mathematics Department, Tufts University, September 2018-present

SKILLS

Languages: English (native speaker), German (elementary proficiency).

Programming: MATLAB, C, Python, R, HTML, SQL, LaTeX.