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Preview of Award 1934568 - Annual Project Report

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Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1934568
Project Title:	HDR TRIPODS: UC Davis TETRAPODS Institute of Data Science
PD/PI Name:	Naoki Saito, Principal Investigator Annamaria B Amenta, Co-Principal Investigator Chen-Nee Chuah, Co-Principal Investigator Thomas Chun Man Lee, Co-Principal Investigator
Recipient Organization:	University of California-Davis
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Submitting Official (if other than PD\PI):	N/A
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Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

Accomplishments

* What are the major goals of the project?

The UC Davis TETRAPODS Institute of Data Science (UCD4IDS)---composed of thirty-five researchers (four PIs and thirty-one senior personnel) coming from four departments (Computer Science, Electrical & Computer Engineering, Mathematics, and Statistics)---will break interdepartmental barriers and promote interdisciplinary research collaborations among faculty members, postdocs, and graduate students. Our project will encourage innovative and robust research, and provide education and mentoring of graduate students and postdocs in data science.

In particular, research at the UCD4IDS will focus on three broad themes: 1) Fundamentals of machine learning directed toward biological and medical applications; 2) Optimization theory and algorithms for machine learning including numerical solvers for large-scale nontrivial learning problems; and 3) High-dimensional data analysis on graphs and networks.

The technical goals of the above themes are: 1) geometric understanding of high-dimensional data, which may allow efficient (re)sampling from manifolds representing certain phenomena of interest and classifying subtle yet critical differences that often appear in biological and medical applications; 2) providing theoretical guarantees and efficient numerical algorithms for non-convex optimization, which is crucial to machine learning; and 3) deepening understanding of how local interactions between individual entities (e.g., neurons) lead to global coordination and decision making.

Students and postdocs engaged in this project will be trained to be the next generation of interdisciplinary data scientists: they will gain deep knowledge of some focused areas, and at the same time, broaden their perspectives in other diverse fields.

The UCD4IDS will bring in the insights gained by the experience of the faculty members in the four primary departments as well as application fields such as neuroscience, medical and health sciences, and veterinary medicine.

*** What was accomplished under these goals and objectives (you must provide information for at least one of the 4 categories below)?**

Major Activities:

- * Conducted research; prepared and published some of our results; presented and disseminated some of our results at conferences and seminars
- * Co-organized the 2022 ADVANCE Symposium together with Center for the Advancement of Multicultural Perspectives on Science (CAMPOS) on May 21, 2022, which highlighted and celebrated the contributions that the ADVANCE awardees have made to their fields and communities. The annual ADVANCE Scholar Award for UC Davis faculty acknowledges outstanding research, leadership and outreach to underserved communities, including through mentorship of under-represented students.
- * Participated in the inaugural 2022 CITRIS (Center for Information Technology Research in the Interest of Society) Workshop on K-12 Outreach for Data Science Education, on July 15, 2022, whose participants included K-12 teachers/principals from several local California high schools: Davis High School (Davis, CA), LeRoy Greene Academy (A Charter School of Natomas Unified School District), and Lincoln High School.
- * Initiated many UC Davis internal collaborations
- * Collaborated with three UC Davis groups that engage in data science research and education: Center for Data science and Artificial intelligence Research (CeDAR); the UC Davis DataLab; and the following two NSF-funded institutes: AI Institute for Next Generation Food Systems (AIFS); and HSI Strategic Innovation Summit for Advanced Research and Instruction in Artificial Intelligence and Quantum Information Sciences (HSI-SIS)
- * Organized online seminar series related to data science throughout the academic quarters: the Mathematics of Data and Decision at Davis (MADDD) seminars; the Statistics seminars
- * Organized annual Joint Mathematics/Statistics Colloquium
- * Organized reading seminars on the subjects closely related to the project
- * Maintained and constantly updated a website dedicated to our UCD4IDS
- * Selected 16 graduate students among our four departments (CS: 3; ECE: 5; Math: 9; Stat: 1) and supported them partially as Graduate Student Researcher
- * More users have been added for the use of the GPU cluster in our UC Davis High Performance Computing (HPC) Core Facility

Specific Objectives:

- 1) Improve our geometric understanding of high-dimensional data, which may allow efficient (re)sampling from manifolds representing certain phenomena of interest and classifying subtle yet critical differences that often appear in biological and medical applications
- 2) Investigate and develop data harnessing, feature selection, statistical unsupervised learning, data sampling/streaming methodologies and algorithms
- 3) Provide theoretical guarantees and efficient numerical algorithms for non-convex optimization, which is crucial to machine learning
- 4) Investigate private, secure, and on-device machine learning
- 5) Investigate and develop tools for analyzing hypergraphs, tensors, and high-volume neural data, detecting anomalies/changes over networks, analyzing network structures

- via random matrix theory, and making cloud-based machine learning more efficient
- 6) Launch more internal collaborations within our four disciplines
 - 7) Guide postdocs to become more independent data scientists who can contribute to our overall aims
 - 8) Guide graduate students for data science research and education

Significant Results: The numbering corresponds to that of Specific Objectives section.

1) Amenta(CS)/Hass(Math)/Koehl(CS) developed new algorithms to compute the 3D Zernike moments (geometric signatures) of a homogeneous shape defined by a triangulation of its surface without facing numerical inaccuracies observed in current state-of-the-art algorithms, and examined the nature of profile curves that play a key part in reconstructing a surface from 2D images.

Arsuaga(Math/MCB)/Vazquez(Math/MMG) developed a new method to predict whether a coronavirus has the potential to bind to human receptors and identified two bat viruses, expanded their TDA suite TAaCGH to identify chromosome aberrations associated with specific subtypes of breast cancer, and developed a new mathematical linguistic method to identify R-loops in genomic data.

Chuah (ECE) explored self-adaptive algorithms to design better weights and refine soft labels to improve the robustness of semi-supervised learning models with no assumptions about the unlabeled dataset distribution; also explored model-based approaches to MRI/CT reconstruction problems, and demonstrated visible improvements for image recovery from low-frequency measurements.

De Loera(Math) examined polyhedral structure of the value function for a finite state-action discounted Markov decision processes, shed light on understanding the success of reinforcement learning, and proposed the Geometric Policy Iteration aiming at a faster value improvement, which allows asynchronous state updates and has the best known iteration bound.

Polonik(Stat) developed bootstrap-based statistical inference methods for the Euler characteristic of the Vietoris-Rips/Check complexes, and topological regularization approaches for regression.

Devambu(CS) on developing a new method for tokenizing large text corpora to both minimize the number of tokens and handle unlimited vocabularies.

Jiang(Stat) derived precise asymptotic results on confidence intervals and Wald hypothesis tests for likelihood-based generalized linear mixed model analysis.

Rademacher(Math) made progress on a well-known open problem in theoretical computer science, the Mihail-Vazirani conjecture, on the expansion properties of 0/1 polytopes, and showed the edge expansion of the graph of a random 0/1 polytope in R^d is at least $1/12d$ with high probability.

2) Ghiasi(ECE) built a 4th generation prototype of their transabdominal fetal oxygen saturation measurement technology, which was validated in ewe-lamb pairs under induced labor contractions, while validation in human subjects is ongoing through an IRB-approved protocol that is open to patient enrollment.

Tagkopoulos(CS) developed a knowledge-base graph from integrating omics transcriptomics and antibiotics resistance data, and applied knowledge graph completion algorithms to discover novel antimicrobial resistance (AMR) genes, which led to the discovery of 26 new AMR genes in *E. coli*.

Burman(Stat) obtained the asymptotic formula for the MSE of the ridge regression estimate of the mean vector in a linear model under various decay conditions on the

singular values of the design matrix, indicating performance improvement with higher level of multicollinearity.

Fushing(Stat) developed algorithms of major factor selection in Categorical Exploratory Data Analysis based on Theoretical Information Measurements to effectively display data's information content with heterogeneity.

Lopes(Stat) established some of the fastest known rates for the central theorem and bootstrap approximation in HD's and a dimension-free bound on the rate of approximation of the top eigenvalue of a sample covariance matrix with low effective rank.

Rajaratnam(Stat) developed a unified framework for mining correlations in the ultra-HD sample starved setting under the neoclassical setting. The work brings together precise conditions when inference is possible in this regime.

3) Balasubramanian(Stat) proved results on topological penalized regression models; high-dimensional (HD) inference for optimization algorithms; stochastic optimization/inference with dependent data; provable sampling from heavy-tailed densities; and particle methods for sampling.

Ma(Math)/Lai(ECE) studied the equitable/optimal transport problem, and designed an accelerated projected alternating maximization algorithm for solving this problem. Significant performance improvement over existing methods is observed. They also studied how to escape the saddle point in bilevel optimization, applicable for hyperparameter selection and meta learning.

Fannjiang (Math) analyzed 3D tomographic phase retrieval for discrete objects supported on an n^3 grid, and proved that $n+1$ is nearly the minimum number of diffraction patterns needed for 3D tomographic phase retrieval under the Born approximation.

Koeppel (Math) developed a reusable Continuous Integration infrastructure for the SageMath system, which has been adopted by various open source software packages, e.g., Singular, setuptools, meson-python, LinBox, LattE integrale, and SymPy.

4) Strohmer(Math) developed a preprocessing algorithm for fair data representation via L2-objective supervised learning algorithms that leads to estimations of the Pareto frontier between prediction error and statistical disparity.

5) Chaudhuri (Math/NPB) showed that for many common information encoding strategies in the brain, the resulting low-dimensional structures in neural data are highly nonlinear and poorly captured by existing methods of analysis, and then developed neural network-based approaches that can successfully capture these structures.

Chen(Stat) developed a framework for causal inference with point-process treatments showing the deconvolution estimator corresponds to the classic Wald estimator; extended stochastic block models to handle point processes with unknown time shifts, which identified three clusters of neurons that play distinct roles during the embryogenesis of zebrafish.

T.Lee(Stat) developed methods on: change point detection for time series of graph and uncertainty quantification for graphon estimation; HD multi-task learning; and HD PC regression.

Le(Stat) proposed a novel method for refining the variational inference method and proving its validity in the context of the community detection problem of sparse random networks.

Li(Stat) proposed a method to select the number of communities in count-weighted networks via stepwise model-assisted spectral thresholding.

Paul/Aue(Stat) developed a procedure for testing linear hypotheses in HD regression models when the noise follows a factor model structure, and applied to identify different anatomical regions of the brain that are associated with various behavioral traits.

Paul/T.Lee(Stat) developed a Bayesian inference procedure for understanding the dependency structure in HD data that builds upon the representation of the correlatedness in such data in terms of graph wavelets.

Saito(Math) developed methods to analyze signals recorded on edges and faces of simplicial complexes by proposing a hierarchical partitioning method using Hodge Laplacians and the Haar-like transform for such a class of graphs.

Zhi(ECE) achieved the end-to-end optimization of a networked deep learning system where a remote node gathers data for a server node to classify via optimizing both the data encoder at the remote node, the server decoder, and deep learning classifier.

Results from our postdocs:

Schonsheck(Math) published a paper on convolutional methods for manifold structured data that are stable under small deformations; proposed a method to approximate functions on manifolds with nontrivial topology; answered a 13-year-old problem in TDA and provided a method for mapping arbitrary point-cloud data to the unit sphere while preserving homotopical information.

Shi(Stat) worked on the best subset selection using an iteratively re-weighted LASSO approach to approximate the l_0 cost minimization.

Key outcomes or Other achievements:

6) Launch more internal collaborations within our four disciplines:

During this period the following new collaborations within UC Davis have been initiated by the participants on this grant, which should be considered as key outcomes. Note that we are not listing those already listed in our last year's report.

+ Arsuaga/Vazquez(Math/MCB): with Priya Sha(Microbiology and Human Genetics) on the development of computational and experimental methods to track the evolution of SARS-CoV2.

+ Arsuaga/Vazques(Math/MCB)/Burman(Stat): with Maxime Pouokam(Stat) on statistics of topological analysis in evaluation and reproducibility of 3D chromatin reconstruction.

+ Aue/Burman(Stat): Estimation of prediction error in time series.

+ Balasubramanian/Burman/Paul(Stat): Shrinkage-based prediction strategies for high-dimensional linear models.

+ Burman/Polonik(Stat): Statistics of topological analysis in evaluation and reproducibility of 3D chromatin reconstruction.

+ Chaudhuri(Math/NPB): with Timothy Hanks (Neurology) on studying interactions between brain regions during decision-making.

+ Chuah(ECE): with Brittany N. Dugger (Pathology and Laboratory Medicine) and Amparo C. Villablanca (Internal Medicine) on developing deep learning algorithms for scalable detection of cerebrovascular brain abnormalities (infarctions) within human brain whole slide images (via UC Davis Center for Women's Cardiovascular and Brain Health award).

+ Hsieh(Stat): with Koehl(CS) and Jennifer Schultens (Math) on color analysis of van Gogh's sunflower painting.

+ Vazquez(Math/MCB): with Frederic Chédin(MCB) on the entanglement of R-loops.

Also during this review period, some of the UCD4IDS members received the following noteworthy awards:

+ Jesus De Loera (Math) elected as a vice president of the AMS (2022-2025)

+ Nina Amenta (CS) won the 2021 Outstanding Faculty Award for Excellence in Teaching, UCD College of Engineering

+ Chen-Nee Chuah (ECE) awarded the Child Family Professorship in Engineering

*** What opportunities for training and professional development has the project provided?**

7) Guide postdocs to become more independent data scientists who can contribute to our overall aims

* For this purpose, we asked our postdoc, Stefan Schonscheck (Math) to organize the weekly seminar series "Mathematics of Data and Decision at Davis" (MADDD) for Spring 2022. He got to know various scientists and engineers within and outside of UC Davis, and learned to interact with the speakers, videotaped their talks, collected their talk slides, and put these to a website for dissemination purposes.

* In addition, Schonscheck also served as a mentor in the London Geometry Machine Learning summer school (LogML), focusing on harmonic analysis and machine learning on simplicial complexes, and as a reviewer for a workshop on geometric methods for data science at the International Conference on Representation Learning (ICLR).

* Finally, Schonscheck gave 3 conference talks while Xueheng Shi (Stat) gave one seminar as reported in the dissemination section.

8) Guide graduate students for data science research and education

* We have organized two regular weekly seminar series throughout the year, i.e., The Mathematics of Data and Decisions at Davis (MADDD) seminars and the Statistics Seminars. These seminars are targeted toward not only faculty experts but also graduate students interested in data science and machine learning. Many of these talks, especially, the MADDD seminar talks, were videotaped and placed on a public website for dissemination purposes.

* We also encouraged and supported our students to attend conferences and give their talks. One of our students, David Gros(CS) gave a guest lecture on the long-term future of AI as a part of ECS 160 course (Software Engineering). Begum Kasap(ECE) attended 2022 Virtual Silicon Valley Women in Engineering Conference as well as the iREDEFINE workshop at the 2022 ECE Department Heads Association Conference.

* Many graduate students took online courses and tutorials on data science related subjects, in particular, via some YouTube channels and the online courses provided by Stanford University.

* UC Davis DataLab, with which we collaborate, provided several useful workshops on programming languages and software tools such as Python, R, Git. Our graduate students benefited by these.

*** Have the results been disseminated to communities of interest? If so, please provide details.**

Beyond our publications/other products listed in the Products section, we gave more than 170 seminars and talks during this review period (many of them via online).

Arsuaga(Math/MCB): Plenary talk, CMC3 Conf. Apr. 2022

Applied Topol. in Frontier Sci. Inst. of Math. Sci., Nat. U. Singapore, Jul. 2022

TDA Sem., Nanyang Tech. U., Singapore, May 2022

BIRS Workshop on Novel Math. Methods in Material Sci.: Appl.'s to Biomaterials, Jun. 2021

SIAM Conf. Math. Aspects of Material Sci., May 2021
JMM, Special session: Math of RNA & DNA, Jan. 2021
MASAMU colloq., Auburn U., Apr. 2021

Aue(Stat): Math Colloq., Tulane U., New Orleans, LA, Dec. 2021
Stat Sem., U. Georgia, Athens, GA, Mar. 2022
Probab. & Stat Sem., TU Delft, Mar. 2022
EcoSta, Kyoto, Japan, Jun. 2022
ISNPS Conf., Paphos, Cyprus, Jun. 2022

Balasubramanian(Stat): EcoSta, Kyoto, Japan, Jun. 2022
IMS Meeting: Stein's Method: The Golden Anniversary, Singapore, Jun. 2022
Intern. Conf. Continuous Optim., Bethlehem, PA, Jul. 2022
Stat Sem., London School of Economics, May 2022
New Adv. in Stat & Data Sci., Hawaii, May 2022
Robustness & Resilience in Stochastic Optim. & Statist. Learning: Math. Foundations, Erice, Italy, May 2022
Math Sci Sem., SUNY Binghamton U. Apr. 2022
Stat Sem., UCD, Mar. 2022
ENAR Meeting, Houston, Mar. 2022
INFORMS Optim. Soc. Conf., Greenville, SC, Mar. 2022
Stat Sem., U. Washington, Mar. 2022
CMStat, London, Dec. 2021
INFORMS Annual Meeting, Anaheim, CA, Oct. 2021
Stat Sem., Florida State U., Tallahassee, Oct. 2021
Geom. Methods in Sampling & Optim., Simon's Institute, UCB, Sep. 2021
Stat Sem., Texas A&M U., College Station, Sep. 2021

Chaudhuri(Math/NPB): 40th Anniv. of GGAM, UCD, Oct. 2021
Math Bio Sem., UCD, Oct. 2021
Minisymp. on Manifold Learning, Soc. Neurosci. Annual Meeting, Nov. 2021
Colloq., School of Math, Georgia Tech, Nov. 2021
Davis Math Day Conf., UCD, Apr. 2022

Chen(Stat): New England Stat Symp., May 2022
Shenzhen Inst. Adv. Tech, Chinese Academy of Sci., Jun. 2022

Chuah(ECE): ADVANCED Award Symp.: Inclusivity, Equity, & Ethics in Res. & Data Sci., UCD, May 2022
UCD Team Res. Forum, Dec. 2021
Sandia-UCD Res. Partnership Symp., Nov. 2021
Sem., U. Arizona, Nov. 2021

De Loera(Math): Colloq. speaker, U. Kansas, Apr. 2022
Colloq. & Kieval Lectures, Humboldt State U., Apr. 2022
CIMPA Summer School Lecturer, Escuela Colombiana de Combinatoria, Bogota, Colombia, Jun. 2022
Conf. in Honor of G. Cornuejol's 70th birthday, Pittsburgh, May 2022
Workshop on Ehrhart polynomials: inequalities & extremal constructions, Amer. Inst. Math., May 2022
Keynote speaker, Workshop on Algebraic Stat 2022, U. Hawaii at Manoa, May 2022.

Devanbu(CS): Distinguished Speaker series, UCI Bren School of Computing, Nov. 2021
Ten-year Most Influential Paper Award, ICSE 2022 Conf., May 2022

Ding(ECE): Lecturer, IEEE Comm. Soc. Summer School, Harbin, China, Jul. 2021

Drake(Stat): Conf. Cyclostationary Processes, Poland, Feb. 2022
Sem., Polytechnika Krakowska, Poland, Feb. 2022
Intern. Biometric Conf., Riga, Latvia, Jul. 2022

Fannjiang(Math): Lecturer, Short Course on Optical Fourier Transform & Imaging, Nat. Chung Hsing U., Taiwan, 10/13/2021-12/06/2021

Jiang(Stat): JSM, Washington, D.C., Aug. 2022

Koepe(Math): Global Sage Days 112.358, Jun. 2022
Discr. math/geometry Sem., TU Berlin, Germany, Dec. 2021

Lai(ECE): InnoPeak Technology, Inc., Palo Alto, CA, Jul. 2022.

Le(Stat): Stat Sem., U. Wisconsin-Madison, Apr. 2022
Stat Sem., U. Virginia, Apr. 2022
Stat Sem., UCD, Apr. 2022
EcoSta, Kyoto, Japan, Jun. 2022
Intern. Symp. on Nonparametric Stat, Paphos, Cyprus, Jun. 2022

T.Lee(Stat): UA TRIPODS Sem. Series, U. Arizona, AZ, Oct. 2021
Sem., Dept. Stats & Oper. Res., U. North Carolina, Chapel Hill, Nov. 2021
Progress in Stat Decision Theory 2022, Stanford, CA, May 2022

Li(Stat): Intern. Chinese Stat. Assoc. Conf., Sep. 2021
Stat Sem., Columbia U., Oct. 2021.
Annual Conf. on Information Sci. & Syst., Princeton, NJ, Mar. 2022
2022 Workshop on Statist. Network Analysis & Beyond, New York, Aug. 2022

Lopes(Stat): EcoSta, Kyoto, Jun. 2022
Stat Sem., U. Pittsburgh, Mar. 2022
CMStat, Dec. 2021

Ma(Math): Math & Stat Sem., Henan U., China, Aug. 2022
Workshop Robustness & Resilience in Stochastic Optim. & Statist. Learning: Math. Foundations, Erice, Italy, May 2022
Workshop on Optim. Transport & Appl.'s to ML, East China Normal U., Shanghai, China, May 2022
Optim. & Data Sci. Sem., UCSD, Apr. 2022
SIAM Conf. on Imaging Sci., TU Berlin, Berlin, Germany, Mar. 2022
Industrial & Systems Eng. Sem., U. Minnesota, Mar. 2022
Keynote speaker, 6th Intern. Conf. on Statist. Optim. & Learning, Beijing, China. Dec. 2021
Intern. Conf. on Current Progress in Math, Shanghai U., China, Nov. 2021
Math Sem., Nanjing U., China, Nov. 2021
INFORMS Annual Meeting, Anaheim, CA, Oct. 2021
Data Sci. Sem., Johns Hopkins U., Baltimore, MD, Sep. 2021
Math in Imaging, Data & Optim. Sem., RPI, Troy, NY, Sep. 2021
Sem., Shanghai U. of Finance & Econ., China, Aug. 2021

Paul(Stat): Biostat Sem., UCD, Jan. 2022
Appl. Stat Sem., Indian Statist. Inst., Kolkata, Feb. 2022
Progress in Statist. Decision Theory 2022, Stanford U., May 2022
New Adv. in Stat & Data Sci., Honolulu, May 2022

Polonik(Stat): Stat Sem., Arizona State U., Dec. 2021
Conf. on Interactions of Stat & Geom., IMS Singapore, Feb. 2022

Rademacher(Math): MADDD Sem., UCD, Sep. 2021

Rajaratnam(Stat): Plenary Speaker, the SLIIT Intern. Conf. on Adv.'s in Sci. & Humanities 2021: Math & Stat, Colombo, Dec. 2021

Saito(Math): CodEx (Codes & Expansions) Sem., Colorado State U., Sep. 2021
TRIPODS Sem., U. Arizona, Oct. 2021
Data Sem., CSD, ENS (Ulm), Paris, France, Nov. 2021

Sem., Schlumberger Riboud Product Center, Clamart, France, Nov. 2021
Sem., Paris-East Creteil U., France, Dec. 2021
Faculty Res. Sem., UCD, Jan. 2022
Workshop on Manifold & Graph-based Learning, the Fields Inst., Toronto, Canada, May 2022
CITRIS Workshop on DSAI Education Partnership, UCD, Jul. 2022

Strohmer(Math): Invited talk, Department of Homeland Security, Feb. 2022
Invited talk, Agency for Threat Detection, NSF, Jan. 2022
UCD Team Res. Forum, Dec. 2021.
Sem., Norbert Wiener Center, U. Maryland, Nov. 2021.
Data Sci. Sem., Texas A&M, Oct. 2021.
Sem., Ludwig-Maximilian U., Munich, Germany, Feb. 2022
Sem., Hausdorff Institute for Math, Bonn, Germany, Apr.2022
Workshop on Manifold & Graph-based Learning, the Fields Inst., Toronto, Canada, May 2022

Vazquez(Math/MCB): UCD Pure & Appl. Math REU, Oct. 2021
40th Anniv. of GGAM, UCD, Oct. 2021
Math Bio Sem., Georgia Tech, Nov. 2021
Darwin Lecture Series, Charleston, SC, Feb. 2022
Mosaic Lecture Series: Celebrating Diversity in the Math. Sci., Grand Valley State U., MI, Mar. 2022
Faculty Res. Sem., UCD, Apr. 2022
Workshop on Discr. & Topol. Models in Molecular Biol., USF, Tampa, FL, May 2022

Postdocs:

Schonsheck(Math): LogML, Jul. 2022
SIAM Imaging Conf., Mar. 2022
BIRS Geom. & Learning from Data, Oct. 2021

Shi(Stat): Stat Sem., U. Nebraska-Lincoln, Jun. 2022

Graduate Students:

Chak(Math): CeDAR Res. Symp., UCD, Mar. 2022
ADVANCE Award Symp.: Inclusivity, Equity, & Ethics in Res. & Data Sci., UCD, May 2022

He(Math): BIRS workshop: Adv. in Stein's method & its appl.'s in ML & Optim., Apr. 2022

Jaramillo-Rodriguez(Math): SIAM Conf. on Discr. Math 2022, CMU, Jun. 2022.
Algebraic Stat 2022, U. Hawaii at Manoa, May 2022.
AIM Latinx Mathematician Res. Community Meeting, Dec. 2021.

Kasap(ECE): IEEE Eng. in Medicine & Biol. Soc. Conf., Nov. 2021
Poster, ECEDHA Annual Conf., New Orleans, LA, Mar. 2022
CeDAR Res. Symp., UCD, Mar. 2022
UCD ECEXpo, Jun. 2022

Xu(Math): ADVANCE Award Symp.: Inclusivity, Equity, & Ethics in Res. & Data Sci., May 2022

Dissemination effort other than talks:

Saito(Math) has maintaining the UCD4IDS GitHub website, which currently lists 11 open-source software packages including his own packages.

Koeppel(Math) has been the lead developer of SageMath, an open source mathematical system that has become important in data science.

*** What do you plan to do during the next reporting period to accomplish the goals?**

We will plan to have more in-person seminars, meetings, and roundtable discussions in the forthcoming year to make further progress on every front of research, teaching, and training of our graduate students. In addition, we plan to organize a workshop in December 2022 and use the external evaluation on our progress provided by the Institute for Social Research (ISR) at Sacramento State Univ. ISR is an interdisciplinary applied research center that has served as the external evaluator for numerous NSF-funded projects that support the STEM disciplines. In particular, ISR was an external evaluator for the NSF-sponsored project, "Interdisciplinary Training in Feminist Research for STEM Scholars" at UC Davis. In addition, we plan to organize a opening ceremony for our data science activity space (with offices, meeting rooms, a lot of open space for interactions, etc.) on the first floor and the basement of the Physical Science and Engineering Library (currently under renovation) combined with the data science workshop sometime in Fall 2023.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
2022_ADVANCE_Symposium_Summary.pdf	Summary of the 2022 ADVANCE Symposium that we co-organized.	Naoki Saito	09/27/2022

Products

Books

Jiang, Jiming (2022). *Large Sample Techniques for Statistics 2nd ed.*. Springer Cham. Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes ; DOI: 10.1007/978-3-030-91695-4

Book Chapters

Jonoska, N., Obatake, N., Poznanović, S., Price, C., Riehl, M., Vazquez, M. (2021). Modeling RNA:DNA Hybrids with Formal Grammars. *Using Mathematics to Understand Biological Complexity* 22. Segal, R., Shtylla, B., Sindi, S.. Springer. 35. Status = PUBLISHED; Acknowledgement of Federal Support = No ; Peer Reviewed = Yes ; DOI: https://doi.org/10.1007/978-3-030-57129-0_3.

Strohmer, T.; Wertz, T. (2021). Almost eigenvalues and eigenvectors for almost Mathieu operators. *Excursions in Harmonic Analysis: In Honor of John Benedetto's 80th Birthday* 6. Matthew Hirn, Shidong Li, Kasso A. Okoudjou, Sandra Saliani, Özgür Yılmaz. Springer. 77. Status = PUBLISHED; Acknowledgement of Federal Support = No ; Peer Reviewed = Yes ; DOI:

Wang, C.; Chan, R. H.; Plemmons, R. J.; Prasad, S. (2021). Point spread function engineering for 3D imaging using a continuous exact L0 penalty (CEL0) based algorithm. *Mathematical Methods in Image Processing and Inverse Problems* 360. Xue-Cheng Tai, Suhua Wei, Haiguang Liu. Springer. 1. Status = PUBLISHED; Acknowledgement of Federal Support = No ; Peer Reviewed = Yes ; DOI: 10.1007/978-981-16-2701-9.

Inventions

Journals or Juried Conference Papers

View all journal publications currently available in the [NSF Public Access Repository](#) for this award.

The results in the NSF Public Access Repository will include a comprehensive listing of all journal publications recorded to date that are associated with this award.

Hiltner, Lindsey and Carne Calderer, M. and Arsuaga, Javier and Vázquez, Mariel. (2021). Chromonic liquid crystals and packing configurations of bacteriophage viruses. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. 379 (2201) 20200111. Status = Deposited in NSF-PAR [doi:https://doi.org/10.1098/rsta.2020.0111](https://doi.org/10.1098/rsta.2020.0111) ; Federal Government's License = Acknowledged. (Completed by Saito, null on 09/24/2022) [Full text](#) [Citation details](#)

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Technologies or Techniques

Thesis/Dissertations

Ding, Qin. *Advances in Stochastic Contextual Bandits*. (2021). University of California, Davis. Acknowledgement of Federal Support = No

Xu, Cong. *Change Point Detection for Image, Graph and Network Data*. (2021). University of California, Davis. Acknowledgement of Federal Support = No

Zhang, Zhenyang. *Combinatorial and Machine Learning Problems Motivated by the Simplex Method*. (2022). University of California, Davis. Acknowledgement of Federal Support = Yes

Eetemadi, Ameen. *Computational Methods for Optimization of Biological Organisms*. (2021). University of California, Davis. Acknowledgement of Federal Support = No

Leroux, Brett Elliott. *Halving point configurations; techniques from algebraic and convex geometry*. (2021). University of California, Davis. Acknowledgement of Federal Support = Yes

Huang, Minhui. *Minimax problems in Optimal Transport: Algorithm design and convergence analysis*. (2022). University of California, Davis. Acknowledgement of Federal Support = No

Kim, Amy Taeyen. *Modeling Data Observed on Spheres and Graphs*. (2020). University of California, Davis. Acknowledgement of Federal Support = No

Tang, Tongyi. *Multiscale Statistical Analysis of Vector Fields on a Sphere with Applications to Geophysics*. (2021). University of California, Davis. Acknowledgement of Federal Support = No

Chen, Ji. *Nonconvex Matrix Completion: From Geometric Analysis to Algorithmic Analysis*. (2020). UC Davis. Acknowledgement of Federal Support = Yes

Weber, David S.. *On Interpreting Sonar Waveforms via the Scattering Transform*. (2021). University of California, Davis. Acknowledgement of Federal Support = Yes

Roy, Abhishek. *On Online Nonconvex Nonstationary Optimization and Game Theory*. (2020). UC Davis. Acknowledgement of Federal Support = No

Deng, Shaofeng. *Performance Analysis of Spectral Clustering*. (2022). University of California, Davis. Acknowledgement of Federal Support = No

Sheng, Jun-Da. *Semi-Supervised Clustering of Sparse Graphs: Crossing the Information-Theoretic Threshold*. (2022). University of California, Davis. Acknowledgement of Federal Support = No

Blandino, Andrew. *Some Bootstrap Methods for Regression and Time Series*. (2021). University of California, Davis. Acknowledgement of Federal Support = No

Wei, Zhenyu. *Some Contributions to High-dimensional Statistical Machine Learning*. (2021). University of California, Davis. Acknowledgement of Federal Support = No

Lou, Xingmei. *Statistical Consistency of Structural Learning in Networks and Graphical Models*. (2022). University of California, Davis. Acknowledgement of Federal Support = Yes

Websites or Other Internet Sites

4ti2

<https://github.com/UCD4IDS/4ti2>

A software package for algebraic, geometric and combinatorial problems on linear spaces. By R. Hemmecke, R. Hemmecke, P. Malkin, M. Walter. UCD4IDS member [@mkoeppe](#) is the current maintainer.

ContinuousWavelets

<https://github.com/UCD4IDS/ContinuousWavelets.jl>

This package is an offshoot of [Wavelets.jl](#) for the continuous wavelets. Thanks to [Felix Gerick](#) for the initial implementation there, with extension and further adaptation by David Weber and any other contributors listed on the right. Currently, it implements 1D continuous wavelet transforms with the following mother wavelets: Morlet; Paul; Derivatives of Gaussian; Haar; Beylkin; Vaidyanathan; Daubechies; Coiflets; Symmlets; Battle-Lemarie; which covers several standard continuous wavelet families, both real and analytic, as well as continuous versions of the orthogonal wavelet transforms implemented in [Wavelets.jl](#).

This package was created and has been maintained by Dr. David Weber, a former graduate student member of the UCD4IDS.

HodgeEigs.jl

<https://github.com/UCD4IDS/HodgeEigs.jl>

A Julia package with tools for spectral analysis on simplicial complexes. This package was created and has been maintained by Eugene Shvarts, a graduate student member of the UCD4IDS.

Sage: Open Source Mathematical Software
<https://github.com/UCD4IDS/sage>

The Sage Library is free software released under the GNU General Public Licence GPLv2+, and included packages have [compatible software licenses](#). [Over 800 people](#) have contributed code to Sage. In many cases, documentation for modules and functions list the authors.

TetrapodsRegistry
<https://github.com/UCD4IDS/TetrapodsRegistry>

Julia package registry, public and private, for UCD4IDS. This package was created and has been maintained by Eugene Shvarts, a graduate student member of the UCD4IDS.

latte
<https://github.com/UCD4IDS/latte>

LattE integrale, software for counting lattice points and integration over convex polytopes. By UCD4IDS members J.A. De Loera and [@mkoepppe](#), and others.

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Saito, Naoki	PD/PI	4
Amenta, Annamaria	Co PD/PI	1
Chuah, Chen-Nee	Co PD/PI	1
Lee, Thomas Chun Man	Co PD/PI	1
Arsuaga, Javier	Faculty	1
Aue, Alexander	Faculty	1
Balasubramanian, Krishna	Faculty	1
Burman, Prabir	Faculty	1
Chaudhuri, Rishidev	Faculty	1
Chen, Shizhe	Faculty	1
De Loera, Jesus	Faculty	2
Devanbu, Premkumar	Faculty	2
Ding, Zhi	Faculty	1
Drake, Christiana	Faculty	1

Name	Most Senior Project Role	Nearest Person Month Worked
Fannjiang, Albert	Faculty	4
Ghiasi, Soheil	Faculty	1
Hass, Joel	Faculty	0
Hsieh, Fushing	Faculty	1
Jiang, Jiming	Faculty	1
Koehl, Patrice	Faculty	1
Koeppe, Matthias	Faculty	1
Lai, Lifen	Faculty	1
Le, Can	Faculty	1
Li, Xiaodong	Faculty	1
Lopes, Miles	Faculty	1
Ma, Shiqian	Faculty	2
Paul, Debashis	Faculty	1
Polonik, Wolfgang	Faculty	1
Rademacher, Luis	Faculty	1
Rajaratnam, Balakanapathy	Faculty	1
Strohmer, Thomas	Faculty	2
Tagkopoulos, Ilias	Faculty	1
Vazquez, Mariel	Faculty	1
Schonsheck, Stefan	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Shi, Xueheng	Postdoctoral (scholar, fellow or other postdoctoral position)	11
Bhattacharjee, Samayita	Graduate Student (research assistant)	3
Chak, Wai Ho	Graduate Student (research assistant)	12

Name	Most Senior Project Role	Nearest Person Month Worked
Chen, Xiaotie	Graduate Student (research assistant)	2
Feng, Xue	Graduate Student (research assistant)	3
Gros, David	Graduate Student (research assistant)	5
Haydari, Ammar	Graduate Student (research assistant)	8
He, Ye	Graduate Student (research assistant)	1
Huang, Minhui	Graduate Student (research assistant)	3
Jaramillo-Rodriguez, Edgar	Graduate Student (research assistant)	9
Joarder, Rishad	Graduate Student (research assistant)	4
Kasap, Begum	Graduate Student (research assistant)	9
Liang, Jia-Wei	Graduate Student (research assistant)	5
Ni, Yuan	Graduate Student (research assistant)	3
Shvarts, Eugene	Graduate Student (research assistant)	9
Xu, Shizhou	Graduate Student (research assistant)	6
Youn, Jaesung	Graduate Student (research assistant)	12
Zhang, Zhenyang	Graduate Student (research assistant)	6

Full details of individuals who have worked on the project:

Naoki Saito

Email: saito@math.ucdavis.edu

Most Senior Project Role: PD/PI

Nearest Person Month Worked: 4

Contribution to the Project: Coordinated and managed almost all the activities of the UCD4IDS; Organized the Joint Mathematics-Statistics Colloquium (Spring 2022); Co-organized ADVANCE Award Symposium: Inclusivity, Equity, and Ethics in Research and Data Science (Spring 2022); Managed and maintained the dedicated UCD4IDS website as well as its GitHub.com site; Conducted research; supervised one postdoc, three Ph.D. students, and two undergraduate students; gave presentations on our research and projects at various conferences and seminars.

Funding Support: NSF Grant DMS-1912747; NSF Grant IIS-1631329; NSF RTG Grant DMS-1148643; ONR Grant N00014-20-1-2381; UC Davis CeDAR Seed Grant

Change in active other support: No

International Collaboration: Yes, France

International Travel: Yes, France - 0 years, 3 months, 0 days

Annamaria B Amenta

Email: amenta@cs.ucdavis.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; participated in the roundtable discussions

Funding Support: None

Change in active other support: No

International Collaboration: No

International Travel: No

Chen-Nee Chuah

Email: chuah@ucdavis.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised postdocs and graduate students; attended seminars; participated in the roundtable discussions; served as a member of the Steering Committee

Funding Support: NIH grant 1R21HD099239-01

Change in active other support: No

International Collaboration: No

International Travel: No

Thomas Chun Man Lee

Email: tcmllee@ucdavis.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students and a postdoc; attended seminars; served as a member of the Steering Committee

Funding Support: None

Change in active other support: No

International Collaboration: No

International Travel: No

Javier Arsuaga

Email: jarsuaga@math.ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Oversaw and designed studies; ensured the integrity of the research; mentored students and researchers; prepared manuscripts; worked on some experiments required for the COVID-19 project.

Funding Support: NSF grants: DMS-1854770; DMS-2030491 UC Davis CeDar seed grant.

International Collaboration: No

International Travel: No

Alexander Aue

Email: aaue@ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; participated in the roundtable discussions; served as a member of the Steering Committee

Funding Support: None

International Collaboration: No

International Travel: No

Krishna Balasubramanian

Email: kbala@ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students and a postdoc; attended seminars

Funding Support: UC Davis CeDAR Innovative Data Science Seed Funding Program; NSF Grant DMS-2053918

International Collaboration: No

International Travel: No

Prabir Burman

Email: pburman@ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; co-supervised a graduate student in Biostatistics (Maxime Pouokam); attended seminars; participated in the roundtable discussions

Funding Support: None

International Collaboration: No

International Travel: No

Rishidev Chaudhuri

Email: rchaudhuri@ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; gave talks

Funding Support: UC Davis New Faculty Startup Funds; Sloan Research Fellowship

International Collaboration: No

International Travel: No

Shizhe Chen**Email:** szdchen@ucdavis.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 1**Contribution to the Project:** Conducted research; supervised graduate and undergraduate students; attended seminars**Funding Support:** NSF DMS-1916476**International Collaboration:** No**International Travel:** No**Jesus De Loera****Email:** deloera@math.ucdavis.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 2**Contribution to the Project:** Conducted research; supervised graduate students; attended seminars; participated in the roundtable discussions, helped prepare a new grant for renewal, was active as steering committee member and looking at funding for Math/Applied Math students.**Funding Support:** NSF DMS-1818969**International Collaboration:** No**International Travel:** No**Premkumar Devanbu****Email:** ptdevanbu@ucdavis.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 2**Contribution to the Project:** Supervised graduate students; attended seminars; participated in the roundtable discussions. Gave tutorial lectures on the use of Docker Containers in Scientific research in some settings.**Funding Support:** NSF grants: 1414172; 2107592. A grant from Sandia National Laboratories.**International Collaboration:** No**International Travel:** No**Zhi Ding****Email:** zding@ucdavis.edu**Most Senior Project Role:** Faculty**Nearest Person Month Worked:** 1**Contribution to the Project:** Conducted research; supervised graduate students; attended seminars; joint work with student and post-doctoral researchers to draft and revise manuscripts for publications; served as a member of the Steering Committee**Funding Support:** NSF grants: 1711823, 1824553.**International Collaboration:** No**International Travel:** No**Christiana Drake****Email:** cmdrake@ucdavis.edu

Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars

Funding Support: CA Dept. Transportation grant 65A0686; US Dept. Veterans Affairs grant 1BX004423-01A1

International Collaboration: No

International Travel: No

Albert Fannjiang

Email: fannjiang@math.ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 4

Contribution to the Project: Conducted research; supervised graduate students; attended seminars.

Funding Support: Simons Foundation Grant FDN 2019-24

International Collaboration: Yes, Taiwan

International Travel: Yes, Taiwan - 0 years, 1 months, 24 days

Soheil Ghiasi

Email: ghiasi@ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; participated in the roundtable discussions

Funding Support: NSF grants IIS-1838939 & CBET-1937158; NIH grant R21HD097467-A1; UC Davis CeDAR Innovative Data Science Seed Funding Program

International Collaboration: No

International Travel: No

Joel Hass

Email: hass@math.ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 0

Contribution to the Project: Conducted research; attended seminars

Funding Support: NSF DMS-1719582 & DMS-1760485 BSF grant 2018313

International Collaboration: No

International Travel: No

Fushing Hsieh

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Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars

Funding Support: None

International Collaboration: No

International Travel: No

Jiming Jiang

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Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducting research; Supervising graduate students; Attended seminars

Funding Support: NSF DMS-1713120

International Collaboration: No

International Travel: No

Patrice Koehl

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Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; served as a member of the Steering Committee

Funding Support: NSF grant DMS-1760485 & DMS-1719582

International Collaboration: No

International Travel: No

Matthias Koepe

Email: mkoepe@math.ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Developed software; conducted research; supervised graduate students; organized a weekly seminar (Winter 2022); curated a weekly selection of international online research seminars (Fall 2021); organized an online conference on open-source mathematical software

Funding Support: NSF DMS-2012764

International Collaboration: No

International Travel: No

Lifen Lai

Email: llai@ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; participated in the roundtable discussions

Funding Support: None

International Collaboration: No
International Travel: No

Can Le

Email: canle@ucdavis.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars

Funding Support: NSF grant DMS-2015134

International Collaboration: No
International Travel: No

Xiaodong Li

Email: xdgli@ucdavis.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars

Funding Support: NSF DMS-1848575

International Collaboration: No
International Travel: No

Miles Lopes

Email: melopes@ucdavis.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars.

Funding Support: NSF grant: DMS-1915786

International Collaboration: No
International Travel: No

Shiqian Ma

Email: sqma@ucdavis.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 2

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; presented works in conferences.

Funding Support: NSF grants DMS-1953210 & CCF-2007797

International Collaboration: Yes, Hong Kong
International Travel: No

Debashis Paul

Email: debpaul@ucdavis.edu

Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars.

Funding Support: NSF grants DMS-1713120, DMS-1811405 and DMS-1915894

International Collaboration: Yes, Italy, United Kingdom

International Travel: No

Wolfgang Polonik

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Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars.

Funding Support: None

International Collaboration: No

International Travel: No

Luis Rademacher

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Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars

Funding Support: NSF CCF-2006994

International Collaboration: No

International Travel: No

Balakanapathy Rajaratnam

Email: brajaratnam@ucdavis.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars; involved in curriculum development.

Funding Support: NSF DMS-1916787

International Collaboration: No

International Travel: No

Thomas Strohmer

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Most Senior Project Role: Faculty

Nearest Person Month Worked: 2

Contribution to the Project: Conducted research; supervised graduate students; attended seminars

Funding Support: NSF-DMS-1737943 and NSF-DMS-2027248; NIH-R01HL16351

International Collaboration: No
International Travel: No

Ilias Tagkopoulos

Email: itagkopoulos@ucdavis.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; supervised graduate students; attended seminars.

Funding Support: NSF/USDA/NIH grants

International Collaboration: No
International Travel: No

Mariel Vazquez

Email: mariel@math.ucdavis.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Conducted research pertaining to Theme 1a: Geometry of Data. Supervised graduate and undergraduate students; attended seminars; applied for extramural funding. Organized ADVANCE Symposium on "Inclusivity, Equity, and Ethics in Research and Data Science: Challenges and Opportunities in Math, Engineering, Agriculture, and Health" which was co-organized by PI N. Saito, co-sponsored by TRIPODS, and featured a plenary talk by co-PI C.-N. Chuah.

Funding Support: NSF DMS/NIGMS-2054347; DMS-1817156; the UC Davis CeDAR Seed Grant

International Collaboration: No
International Travel: No

Stefan C. Schonsheck

Email: scschonsheck@ucdavis.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: Conducted research: Stability of geometric convolutions, geometric normal flows, Chart-based parameterization of data, Hodge-Decomposition for high-order simplexes, Persistent homology in spherical coordinates, Spectral simplex convolution Organized Mathematics of Data and Decision at Davis (MADDD) seminar series (Spring 2022). Constantly attended One World IMAGINE seminar series.

Funding Support: Partially supported by the A. J. Krener Assistant Professorship, Department of Mathematics, UC Davis

International Collaboration: Yes, Germany, Switzerland
International Travel: No

Xueheng Shi

Email: xhshi@ucdavis.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 11

Contribution to the Project: Conducted research; attended seminars

Funding Support: NSF DMS-2113592 Partially supported by Department of Statistics for his teaching classes

International Collaboration: Yes, United Kingdom

International Travel: No

Samayita Bhattacharjee

Email: saabhattacharjee@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Conducted research; attended seminars

Funding Support: None

International Collaboration: No

International Travel: No

Wai Ho Chak

Email: wchak@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 12

Contribution to the Project: Conducted research; attended seminars; presented in research symposiums; published research papers

Funding Support: ONR N00014-20-1-2381

International Collaboration: No

International Travel: No

Xiaotie Chen

Email: xtjchen@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 2

Contribution to the Project: Conducted research; attended seminars

Funding Support: Summer support from a faculty member in the Graduate School of Management

International Collaboration: No

International Travel: No

Xue Feng

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Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Conducted research; attended seminars.

Funding Support: NSF-DMS-1737943 and NSF-DMS-2027248

International Collaboration: No

International Travel: No

David Gros

Email: dgros@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 5

Contribution to the Project: Designed projects and implementation, conducted experiments, collected data, analyzed, and wrote a paper

Funding Support: None

International Collaboration: No

International Travel: No

Ammar Haydari

Email: ahaydari@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 8

Contribution to the Project: Conducted research; attended seminars.

Funding Support: None

International Collaboration: No

International Travel: No

Ye He

Email: leohe@math.ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 1

Contribution to the Project: Conducted research; attended seminars.

Funding Support: None

International Collaboration: No

International Travel: No

Minhui Huang

Email: mhhuang@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Conducted research; attended seminars

Funding Support: None

International Collaboration: No

International Travel: No

Edgar Jaramillo-Rodriguez

Email: edgarjr@math.ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 9

Contribution to the Project: Conducted research; attended seminars; mentored undergraduate students

Funding Support: NSF AGEP supplement

International Collaboration: Yes, Mexico

International Travel: No

Rishad Joarder

Email: rrjoarder@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 4

Contribution to the Project: Conducted research; attended seminars

Funding Support: NSF IIS-1838939; NIH 1838939

International Collaboration: No

International Travel: No

Begum Kasap

Email: bkasap@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 9

Contribution to the Project: Conducted research; attended conferences and workshops

Funding Support: NSF IIS-1838939; NIH 5R21HD097467-02

International Collaboration: No

International Travel: No

Jia-Wei Liang

Email: jwliang@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 5

Contribution to the Project: Conducted research; attended speeches/seminars; participated in relative topic discussions

Funding Support: TAship from CS Dept.

International Collaboration: No

International Travel: No

Yuan Ni

Email: yuani@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Conducted research; attended seminars; participated in the group meetings

Funding Support: Math Department Teaching Assistant job

International Collaboration: No

International Travel: No

Eugene Shvarts

Email: eshvarts@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 9

Contribution to the Project: Conducted research; attended seminars; assisted managing UCD4IDS website for PI

Funding Support: NSF DMS-1912747

International Collaboration: No

International Travel: No

Shizhou Xu

Email: shzxu@ucdavis.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

Contribution to the Project: 1. Conducted research: "Fair Data Representation for Machine Learning at the Pareto Frontier" 2. Attended seminars: 2022 ADVANCE Award Symposium 3. Roundtable discussions: synthetic (privacy) data group discussion with UC Irvine collaborators

Funding Support: UCD Applied Math Graduate Fellowship

International Collaboration: No

International Travel: No

Jaesung Youn

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Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 12

Contribution to the Project: Conducted research

Funding Support: 1) USDA-NIFA AI Institute for Next Generation Food Systems (AIFS), USDA-NIF Award number 2020-67021-32855 2) NIEHS grant P42ES004699

International Collaboration: No

International Travel: No

Zhenyang Zhang

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Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 6

Contribution to the Project: Conducted research; attended seminars; wrote up the final version of the dissertation, and gave exit seminar

Funding Support: Math Department TAship

International Collaboration: No

International Travel: No

What other organizations have been involved as partners?

Nothing to report.

Were other collaborators or contacts involved? If so, please provide details.

Nothing to report

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The theory, algorithms, and software tools that have been and are being developed will be likely to make a positive impact in solving practical data-analysis and machine-learning problems in our core disciplines, i.e., computer science (analyzing social networks and website links); electrical engineering (monitoring and controlling sensor networks); mathematics (nonconvex optimization theory and algorithms; data analysis on higher-order graphs); and statistics (inverse problems, statistical graph and network analysis).

What is the impact on other disciplines?

Our research and development above will also be likely to make a positive impact on other disciplines, e.g., civil engineering (monitoring traffic flow on a road network); biology and medicine (analyzing data measured on real neural networks, detecting changes in the brain structures due to diseases, imaging live biological cells for analyzing their growth, real-time monitoring of health of fetuses, privacy-protected medical diagnostics); agriculture and veterinary medicine (monitoring and improving milk reproduction management), etc.

What is the impact on the development of human resources?

Through this project, many of our students have become familiar with data obtained from scientists in the different fields such as neuroscience, biomedical engineering, medicine, environmental sciences, and anthropology, etc. Also, through the weekly Mathematics of Data and Decision at Davis (MADDD) seminars, the weekly Statistics seminars, and the annual Joint Mathematics/Statistics Colloquia, students in each of our four departments had opportunities to get to know the students from the other three departments better. In addition, they had opportunities to meet and discuss with invited speakers from industry to hear their experience in industry and what kind of knowledge and skills are expected in industry. Finally, through the interdisciplinary UC Davis internal seed grants provided by the Center for Data Science and Artificial Intelligence Research (CeDAR), some of our students actually collaborated on research projects beyond the departmental boundaries.

What was the impact on teaching and educational experiences?

We believe that we, as a group of 35 faculty members, have influenced on the major decision of our campus: we are offering Data Science Undergraduate Major degrees starting Fall 2022! The curriculum for this DS major degree will be organized into four initial tracks: 1) Foundations; 2) Agricultural and Environmental Sciences; 3) Biological Sciences; and 4) Social Sciences. Then, majors in every track will receive ethics training as well as some foundational courses in CS, Math, and Stat, e.g., MAT 19 sequence (Calculus for Data-Driven Applications). About 100 students have enrolled as DS major in Fall 2022. We plan to accept about 100 students every year (totalling about 400 undergraduate students eventually).

What is the impact on physical resources that form infrastructure?

The project will contribute the campus-wide High Performance Computing (HPC) Core Facility for their GPU purchase. As we reported in the Major Activities section, 28 members of the UCD4IDS created their CPU/GPU cluster accounts at the HPC Core Facility, and started running their jobs on the currently available GPUs. UC Davis administration has allocated space for our activities in the first and ground floors of the Physical Sciences and Engineering Library. Currently, the building renovation is underway for this purpose with the planned completion date of early fall 2023.

What is the impact on institutional resources that form infrastructure?

UC Davis administration has allocated space for our activities in the first and ground floors of the Physical Sciences and Engineering Library. Currently, the building renovation is underway for this purpose with the planned completion date of early fall 2023.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

Nothing to report.

What percentage of the award's budget was spent in a foreign country?

Nothing to report.

Changes/Problems

Changes in approach and reason for change

Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.

Change in primary performance site location

Nothing to report.