Andrew Kruse Gillette

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Employment

Lawrence Livermore National Laboratory

Computational Scientist, Center for Applied Scientific Computing — 2019– now

Faculty Scholar, Center for Applied Scientific Computing — summer 2019

University of Arizona

Member, Program in Applied Mathematics — 2014– now

Designated Campus Colleague, Associate — 2020– now

Associate Professor *(tenured, on leave)*, Department of Mathematics — 2019–2020

Assistant Professor, Department of Mathematics — 2013–2019

University of California, San Diego

Postdoctoral Scholar in Mathematics *(advisor: Michael Holst)* — 2011–2013

Education

University of Texas at Austin: Ph.D. in Mathematics, *(advisor: Chandrajit Bajaj)* — 2011

Amherst College: B.A. in Mathematics, summa cum laude, *(advisor: Robert Benedetto)* — 2004

Computing Skills and Interests

Python, Pytorch, Pandas, C++, Matlab, Mathematica; Experience with MFEM and other finite element packages, including vector finite elements; high performance computing and machine learning.

Research Interests

Finite element and other numerical methods for partial differential equations; meshing, computational geometry and topology; scientific and high performance computing; applications to multiphysics simulations; graphics and visualization; scientific machine learning and AI.

Grants and Awards

LDRD Feasibility Study, 20-FS-034, Lawrence Livermore National Lab, $150,000, single PI — 2019

NSF Computational Math Award, DMS-1913094, Collaborative Research with Rob Kirby — 2019–2022

University of Arizona share: $132,999 Baylor University share: $167,000

Simons Collaboration Grants for Mathematicians, declined due to NSF award — *(2019–2024)*

Interdisciplinary Link Student Team Award, University of Arizona, $17,593, (co-PI: Sam Gralla) — 2018

NSF Computational Math Award, DMS-1522289, $224,998, single PI — 2015–2018

NSF Conference Award, DMS-1542183, $25,000, co-PI (PI: Chunmei Wang, Georgia Tech) — 2015

AMS-Simons Travel Grant, $4000, single PI — 2012–2014

Refereed Journal Publications

21. J.Crum, C. Cheng, D. Ham, L. Mitchell, R. C. Kirby, J. Levine, A. Gillette, *Bringing trimmed serendipity methods to computational practice in Firedrake*, Submitted; preprint: arXiv:2104.12986, 2021.
20. A. Gillette, K. Hu, S. Zhang, *Nonstandard finite element de Rham complexes on cubical meshes*, BIT Numerical Mathematics, 60, pp. 373–409, 2020.
19. J. Crum, J. Levine, A. Gillette, *Extending discrete exterior calculus to a fractional derivative*, Computer Aided Design, 114:9, pp. 64–72, 2019.
18. A. Gillette, T. Kloefkorn, V. Sanders, *Computational Serendipity and Tensor Product Finite Element Differential Forms*, SMAI Journal of Computational Mathematics, 5. pp. 1–21, 2019.
17. A. Gillette, T. Kloefkorn, *Trimmed serendipity finite element differential forms*, Mathematics of Computation, 88:316. pp. 583–606, 2019.
16. A. Gillette, C. Gross, K. Plackowski, *Numerical studies of serendipity and tensor product elements for eigenvalue problems*, Involve, a journal of Mathematics, 11:4, pp. 661–678, 2018.
15. A. Gillette, M. Holst, Y. Zhu, *Finite element exterior calculus for evolution problems*, ICMSEC Journal of Computational Mathematics, 35:2, pp. 187–212, 2017.
14. A. Gillette, *Serendipity and tensor product affine pyramid finite elements*, SMAI Journal of Computational Mathematics, 2, pp. 215–228, 2016.
13. A. Gillette, A. Rand, C. Bajaj, *Construction of scalar and vector finite element families on polygonal and polyhedral meshes*, Computational Methods in Applied Math, 16:4, pp. 667–683, 2016.
12. M. Floater, A. Gillette, *Nodal bases for the serendipity family of finite elements*, Foundations of Computational Mathematics, 17:4, pp. 879–893, 2016.
11. A. Gillette, A. Rand, *Interpolation error estimates for harmonic coordinates on polytopes*, ESAIM: Mathematical Modelling and Numerical Analysis, 50:3, pp. 651–676, 2016.
10. S. Christiansen, A. Gillette, *Constructions of some minimal finite element systems*, ESAIM: Mathematical Modelling and Numerical Analysis, 50:3, pp. 833–850, 2016.
9. K. Vincent, M. Gonzales, A. Gillette, C. Villongco, S. Pezzuto, J. Omens, M. Holst, A.D. McCulloch, *High-order interpolation methods for cardiac monodomain simulations*, Frontiers in Physiology, 6:217, 2015.
8. M. Floater, A. Gillette, N. Sukumar, *Gradient bounds for Wachspress coordinates on polytopes*, SIAM Journal on Numerical Analysis, 52:1, pp. 515–532, 2014.
7. P. Kekenes-Huskey, A. Gillette, J.A. McCammon, *Predicting the influence of long-range molecular interactions on macroscopic-scale diffusion by homogenization of the Smoluchowski equation*, Journal of Chemical Physics, 140:17, article 174106, 2014.
6. P. Kekenes-Huskey, T. Liao, A. Gillette, J. Hake, Y. Zhang, A. Michailova, A.D. McCulloch, J.A. McCammon, *Molecular and sub cellular-scale modeling of nucleotide diffusion in the cardiac myofilament lattice*, Biophysical Journal, 105:9, pp. 2130–2140, 2013.
5. P. Kekenes-Huskey, A. Gillette, J. Hake, J. McCammon, *Finite element estimation of protein-ligand association rates with post-encounter effects: Applications to calcium binding in Troponin C and SERCA*, Computational Science and Discovery, 5:1, pp. 1–20, 2012.
4. A. Rand, A. Gillette, C. Bajaj, *Quadratic serendipity finite elements on polygons using generalized barycentric coordinates*, Mathematics of Computation, 83:290, pp. 2691–2716, 2014.
3. A. Rand, A. Gillette, C. Bajaj, *Interpolation error estimates for mean value coordinates*, Advances in Computational Mathematics, 39:2, pp. 327–347, 2013.
2. A. Gillette, A. Rand, C. Bajaj, *Error estimates for generalized barycentric interpolation*, Advances in Computational Mathematics, 37:3, pp. 417–439, 2012.
1. A. Gillette, C. Bajaj, *Dual formulations of mixed finite element methods*, Computer Aided Design, 43:10, pp. 1213–1221, 2010.

Refereed Conference Proceedings

7. A. Gillette, *Hermite and Bernstein style basis functions for cubic serendipity spaces on squares and cubes*, Proc. Approximation Theory XIV: San Antonio 2013, Springer, pp. 103–121, 2014.
6. A. Gillette, C. Bajaj, *A generalization for stable mixed finite elements*, Proc. ACM Symposium on Solid and Physical Modeling, Association for Computing Machinery, pp. 41–50., 2010.
5. C. Bajaj, A. Gillette, Q. Zhang, *Stable mesh decimation*, Proc. SIAM/ACM Joint Conf. on Geometric and Physical Modeling, Association for Computing Machinery, pp. 277–282., 2009.
4. C. Bajaj, A. Gillette, S. Goswami, B. Kwon, J. Rivera, *Complementary space for enhanced uncertainty and dynamics visualization*, chapter in 'Topological Methods in Data Analysis and Visualization: Theory, Algorithms and Applications,' Springer-Verlag, pp. 217–228., 2009.
3. C. Bajaj, A. Gillette, S. Goswami, *Topology based selection and curation of level sets*, chapter in 'Topology-Based Methods in Visualization,' Springer-Verlag, pp. 45–58, 2009.
2. C. Bajaj, A. Gillette, *Quality meshing of a forest of branching structures*, Proc. 17th International Meshing Roundtable, Springer-Verlag, pp. 433–449, 2008.
1. S. Goswami, A. Gillette, C. Bajaj, *Efficient Delaunay mesh generation from sampled scalar functions*, Proc. 16th International Meshing Roundtable, Springer-Verlag, pp. 495–511, 2007.

Other Publications

4. A. Gillette, A. Rand, *Shape quality for generalized barycentric interpolation,* chapter in 'Generalized Barycentric Coordinates in Computer Graphics and Computational Mechanics', K. Hormann, N. Sukumar, editors, CRC Press, 2017.
3. A. Gillette, *Serendipity methods: Using mathematics to accelerate computation*, UA Mathematics Newsletter (for public audience), Fall 2014.
2. A. Gillette, *Stability of dual discretization methods for partial differential equations*, UT Austin Digital Repository, PhD Dissertation, 2011.
1. A. Gillette, *Notes on Discrete Exterior Calculus*, Technical Report, UT Austin, 2009.

Recent Invited Talks

"Delaunay-Based Assessment of Variational Autoencoders" 2021
SIAM Conference on Computational Science and Engineering, Fort Worth, TX *(virtual)*

"Delaunay-Guided Neural Network Design" 2021
Colorado State Applied Math Seminar, Fort Collins, CO *(virtual)*

"Basis construction techniques for serendipity-type spaces" 2019
Polytopal Element Methods in Mathematics and Engineering (POEMS'19), Marseille, France

"How to speed up your tensor product finite element code without really trying" 2019
Special Session at AMS Sectional Meeting, Honolulu, HI

"Structure Preservation in (Trimmed) Serendipity Finite Element Methods" 2018
Canadian Mathematical Society Winter Meeting, Vancouver, Canada

"(Trimmed) Serendipity Finite Element Methods in Theory and Practice" 2018
Louisiana State University Computational Mathematics Seminar, Baton Rouge, LA

"Polynomial Differential Forms for Efficient Finite Element Methods" 2018
Baylor University Mathematics Colloquium, Waco, TX

"From Squares and Cubes to Quads and Hexes: Recent Advances in Finite Elements" 2018
UC San Diego Center for Computational Mathematics Seminar, San Diego, CA

"An Introduction to Trimmed Serendipity Finite Element Spaces" 2018
Joint Mathematics Meetings, San Diego, CA

"A Plethora of Basis Functions for Quadrilaterals and Hexahedra" 2017
European Conference on Numerical Mathematics and Advanced Applications, Voss, Norway.

"Decompositions of (Trimmed) Serendipity Spaces" 2017
European Conference on Numerical Mathematics and Advanced Applications, Voss, Norway.

Recent Contributed Talks

"Serendipity Elements: Old and New" 2018
Geometric & Image Data Sciences: Big Data Analysis, Graphics & Visualization, Austin, TX

"Computational Finite Element Differential Forms on Quadrilateral Meshes" 2018
SIAM Annual Meeting, Portland, OR

"What is a good linear finite element… on a generic polytope?" 2015
13th US National Congress on Computational Mechanics, San Diego, CA

"Nodal Bases for the Serendipity Family of Finite Elements" 2014
International Conference on Spectral and High Order Methods, Salt Lake City, UT

"Serendipity Basis Functions for Any Degree in Any Dimension" 2014
Isogeometric Analysis 2014: Integrating Design and Analysis, Austin, TX

Recent Poster Presentations

4. A. Gillette, T. Kloefkorn, *Trimmed Serendipity Finite Elements*, SIAM Conference on Computational Science and Engineering, 2017.
3. A. Gillette, *Serendipity and tensor product pyramid finite elements*, Advances in Mathematics of Finite Elements (Ivo Babuska 90th Birthday Conference), 2016.
2b. A. Gillette, A. Rand, *What is a good linear finite element... on a generic polytope?*, Advanced Numerical Methods in the Mathematical Sciences (Workshop at Texas A&M), 2015.
2a. A. Gillette, A. Rand, *What is a good linear finite element... on a generic polytope?*, SIAM Conference on Computational Science and Engineering, 2015.
1. A. Gillette, M. Floater, *Nodal basis functions for serendipity finite elements*, ICERM Workshop: Robust Discretization and Fast Solvers for Computable Multi-Physics Models, 2014.

Recent Workshop and Mini-symposium Co-organizer

Geometric & Image Data Sciences: Big Data Analysis, Graphics & Visualization 2018
Co-organizer, special workshop celebrating 60th birthday of Chandrajit Bajaj

Polytopal Discretization Methods for Partial Differential Equations 2018
SIAM Annual Meeting, mini-symposium

Polygonal and Polyhedral Discretizations in Computational Mechanics 2018
13th World Congress on Computational Mechanics, mini-symposium

Mathematics of Gravitational Wave Science 2018
Joint Mathematics Meetings, AMS Special Session

Advances in Quadrilateral and Hexahedral Finite Elements (poster collection) 2017
SIAM Computational Science and Engineering

Polytopal Element Methods in Mathematics and Engineering (special workshop) 2015
Co-organizer; 24 speakers and 54 participants, including many non-US researchers.

Postdoctoral advising

Tyler Kloefkorn: University of Arizona Mathematics Department Postdoc, 2014–2017

Dissertations in progress, as PhD advisor

Justin Crum: PhD in Applied Mathematics, University of Arizona, expected 2021

Other graduate research advising

Brian Bell	NSF Mathematical Sciences Graduate Internship (at LLNL), 2021
Justin Crum	LLNL Computing Scholar, 2021
	LLNL Data Science Summer Institute, 2020
Craig Gross	LLNL Data Science Summer Institute, 2020
Nikki Plackowski	PhD advisor in Applied Mathematics, 2017–2020
Ken Plackowski	supervised Masters in Applied Mathematics, 2017
Kevin Gomez	supervised 1st year PhD project, 2015
Jeff Walter	supervised 1st year PhD project, 2015
Ammon Washburn	supervised 1st year PhD project, 2015
Ethan Lockhart	supervised 1st year PhD project, 2014

Undergraduate research advising

Victoria Sanders: undergraduate research assistant, 2017–2019
Craig Gross: undergraduate research assistant, 2014–2017
Michael Cullan: supervised honors thesis, 2015–2016

Professional Service

Reviewer

AMS Mathematical Reviews; Mathematics of Computation; Numerische Mathematik; ICMSEC Journal of Computational Mathematics; SIAM Numerical Analysis; SIAM Scientific Computing; Finite Elements in Analysis and Design; SIGGRAPH; SIGGRAPH Asia; ESAIM: Mathematical Modelling and Numerical Analysis; Int'l Journal for Numerical Methods in Engineering; Journal of Aerospace Engineering; ACM Transactions on Mathematical Software; Computer Methods in Applied Mechanics and Engineering; Computer Aided Design; Mathematische Zeitschrift; others.

Program Committee Member, Geometric Modeling and Processing 2016, 2017

Guest Editor, Computer Aided Geometric Design Special Issue: GMP2015 2015

Program Co-Chair, 9th International Conference on Geometric Modeling and Processing 2015

Panelist and "ad hoc" Grant Reviewer, National Science Foundation & Department of Energy

Department-level Service

Math Department Computer Committee	2017–2019
Modeling & Computation Seminar Organizer (weekly event)	2018–2019
Applied Mathematics Academic Program Review Committee	2018–2019
Applied Mathematics PhD Qualifying Exam Committee	2014–2019
Applied Mathematics Colloquium Committee	2014–2019
Applied Mathematics PhD Admissions Committee	2015–2016

Outreach to K-12 Teachers

Instructor, Tucson Math Teachers' Circle Session 2016–2018
Planned and led research-inspired activities for Southern Arizona teachers (annually).

K-12 Alliance Professional Development Institute, Montebello, CA 2007, 2008
Taught week-long activity-based seminars for math teachers of grades 3-9.

Teaching

Inquiry-based learning section of Linear Algebra (supported by internal grant; *spring 2019)*

Course coordinator

Introduction to Linear Algebra (*8 sections*)	fall 2018, spring 2019
Exploring and Understanding Data (*6 sections*)	spring 2018

Course instructor

Introduction to Linear Algebra	fall 2016, 2018–2019
Exploring and Understanding Data (*new UA course*)	2017–2018
Principles of Analysis (*graduate core course*)	2014–2016
Discrete Mathematics in Computer Science	spring 2014
Calculus I	fall 2013
Vector Calculus (*Lecturer, UC San Diego*)	spring 2012
Precalculus (*Instructor, UT Austin*)	2009–2010
Calculus (*Teaching Assistant, UT Austin*)	2005–2007

Membership

Society for Industrial and Applied Mathematics
Budapest Semesters in Mathematics (alumnus)