Joe Kileel

curriculum vitae

Contact Information

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Current Position

Princeton University
Postdoctoral Fellow, Program in Applied and Computational Mathematics, Simons Collaboration on Algorithms and Geometry, 2017–present
Advisor: *Amit Singer*

Education

University of California, Berkeley
Ph.D. in Mathematics, 2012–2017
Advisor: *Bernd Sturmfels*

University of Cambridge
M.Math. (with Merit) and B.A. in Mathematics (with First Class Honors all years), 2008–2012

Research Interests

mathematics of data science, image processing, cryo-electron microscopy, computer vision, tensor decomposition, applied algebraic geometry

Publications and Preprints

15. Fast moment inversion for cryo-EM and XFEL with uniform distribution of viewing angles. J. Kileel and C. Liu. To submit to *SIAM Journal on Imaging Sciences*.

14. Subspace power method for symmetric tensor decomposition and generalized PCA. J. Kileel and J. Pereira. Submitted to *Mathematical Programming*, arXiv:1912.04007.

13. Earthmover-based manifold learning for analyzing molecular conformation spaces. N. Zelesko, A. Moscovich, J. Kileel and A. Singer. Accepted to *IEEE International Symposium on Biomedical Imaging (ISBI) 2020*, arXiv:1911.06107.

12. Method of moments for 3-D single particle *ab initio* modeling with non-uniform distribution of viewing angles. N. Sharon, J. Kileel, Y. Khoo, B. Landa and A. Singer. *Inverse Problems* **36** 044003 (2020), pp. 1–40.

11. On the expressive power of deep polynomial neural networks. J. Kileel, M. Trager and J. Bruna. *Advances in Neural Information Processing Systems (NeurIPS) 2019*, pp. 10310–10319.

10. Estimation under group actions: recovering orbits from invariants. A. Bandeira, B. Blum-Smith, J. Kileel, A. Perry, J. Weed and A. Wein. In revision, *Journal of the American Mathematical Society*, arXiv:1712.10163.

9. 3D *ab initio* modeling in cryo-EM by autocorrelation analysis. E. Levin, T. Bendory, N. Boumal, J. Kileel and A. Singer. *IEEE International Symposium on Biomedical Imaging (ISBI) 2018*, pp. 1569–1573.

8. Algebraic geometry for computer vision. J. Kileel. *University of California, Berkeley*, Ph.D. thesis, 139 pages, 2017.

7. Distortion varieties. J. Kileel, Z. Kukelova, T. Pajdla and B. Sturmfels. *Foundations of Computational Mathematics* **18** (2018), pp. 1043–1071.

6. Numerical implicitization. J. Chen and J. Kileel. *Journal of Software for Algebra and Geometry* **9** (2019), pp. 55–63.

5. The Chow form of the essential variety in computer vision. G. Fløystad, J. Kileel and G. Ottaviani. *Journal of Symbolic Computation* **86** (2018), pp. 97–119.

4. Minimal problems for the calibrated trifocal variety. J. Kileel. *SIAM Journal on Applied Algebra and Geometry* **1** (2017), pp. 575–598.

3. A clever elimination strategy for efficient minimal solvers. Z. Kukelova, J. Kileel, T. Pajdla and B. Sturmfels. *IEEE Conference on Computer Vision and Pattern Recognition (CVPR) 2017*, pp. 3605–3614.

2. Rigid multiview varieties. M. Joswig, J. Kileel, B. Sturmfels and A. Wagner. *International Journal of Algebra and Computation* **26** (2016), pp. 775–788.

1. Hadamard product of linear spaces. C. Bocci, E. Carlini and J. Kileel. *Journal of Algebra* **448** (2016), pp. 595–617.

Awards and Fellowships

- Simons Collaboration on Algorithms and Geometry, Postdoctoral Fellowship, 2017–present
- Visiting Research Grant, Czech Technical University in Prague, June–July 2017
- Bernard Friedman Memorial Prize for Best Thesis in Applied Mathematics, University of California, Berkeley, 2017 **(thesis prize)**
- Outstanding Graduate Student Instructor Award, University of California, Berkeley, 2016 **(teaching prize)**
- Chateaubriand STEM Fellowship, Embassy of France in USA, 2016
- Macaulay2 Software Development Grant, 2015
- Berkeley Fellowship for Outstanding Doctoral Applicants, 2012–2014
- Cambridge Commonwealth Trust Scholarship, 2011–2012
- Blyth Cambridge Commonwealth Trust Scholarship, 2008–2011 (two in Canada)

Invited Talks and Presentations

67. Program on Tensor Methods and Emerging Applications to the Physical and Data Sciences, Institute for Pure and Applied Mathematics (IPAM), March–June 2021
66. International Conference on Approximation Theory and Beyond, Vanderbilt University, Minisymposium on Approximation Theoretic Flavors of Machine Learning, May 2020 (postponed)
65. SIAM Conference on Mathematics of Data Science, Cincinnati, Special Session on Algebraic Geometry and Machine Learning, May 2020 (postponed)
64. Colloquium, School of Mathematics, Georgia Institute of Technology, March 2020
63. Colloquium, Division of Applied Mathematics, Brown University, February 2020
62. Colloquium, Courant Institute, New York University, February 2020
61. Colloquium, Department of Mathematics, University of Wisconsin–Madison, February 2020
60. Colloquium, Department of Mathematics, Duke University, January 2020
59. Colloquium, Department of Mathematics, Rutgers University–New Brunswick, January 2020
58. Colloquium, Department of Mathematics and Oden Institute for Computational Engineering and Sciences, University of Texas at Austin, January 2020
57. Colloquium, Department of Mathematics, University of Toronto, January 2020
56. Conference on Neural Information Processing Systems, Vancouver, December 2019
55. Joint Applied Mathematics/Statistics & Data Science Seminar, Yale University, December 2019
54. Novel Medical Imaging Workshop, Texas A&M University, November 2019
53. Linear Algebra Seminar, Auburn University, November 2019
52. Computational Harmonic Analysis and Data Science Workshop, Casa Matemática Oaxaca, October 2019
51. Algebra Seminar, University of Washington, Seattle, October 2019
50. SIAM Pacific Northwest Section, Seattle University, Special Session on Algebra, Geometry and Applications, October 2019
49. AMS Sectional Meeting, University of Wisconsin–Madison, Special Session on Applications of Algebra and Geometry, September 2019
48. Big Data Conference, Center of Mathematical Sciences and Applications, Harvard University, August 2019
47. NYC Computational Cryo-EM Summer Workshop, Center for Computational Mathematics, Flatiron Institute, August 2019
46. SIAM Conference on Applied Algebraic Geometry, Universität Bern, Switzerland, Minisymposium on Algebraic Vision, July 2019
45. Computational and Applied Mathematics Colloquium, University of Chicago, May 2019
44. Applied Algebra Seminar, University of Wisconsin–Madison, May 2019
43. Algebra Seminar, Georgia Institute of Technology, April 2019
42. AMS Sectional Meeting, Auburn University, Special Session on Applications of Algebraic Geometry, March 2019
41. Algebraic Vision Research Cluster, Institute for Computational and Experimental Research in Mathematics, Brown University, January 2019
40. Joint CUNY Graduate Center-Courant Seminar, Symbolic-Numeric Computing, City University of New York, December 2018
39. Mathematics, Information and Computation Seminar, Center for Data Science, Courant Institute, November 2018

38. Nonlinear Algebra Seminar, Institute for Computational and Experimental Research in Mathematics, Brown University, November 2018
37. Math and Data Working Group at Center for Data Science, Courant Institute, October 2018
36. AMS Sectional Meeting, University of Michigan, Ann Arbor, Special Session on Extensions-Interpolation-Shape Matching in $\mathbb{R}^d$, Symmetry-Invariance, Algorithms and Related Topics, October 2018
35. Dagstuhl Seminar, Leibniz-Zentrum für Informatik, Shape Analysis: Euclidean, Discrete and Algebraic Geometric Methods, October 2018
34. Joint KMS-DMV Mathematics Conference in Seoul, Special Session on Algebraic Geometry and Computer Vision, October 2018
33. Simons Collaboration on Algorithms and Geometry, Simons Foundation, New York, March 2018
32. SIAM Southeastern Atlantic Sectional Conference, University of North California at Chapel Hill, Special Session on Topics in the Mathematics of Data Analysis, March 2018
31. Mathematics, Information and Computation Seminar, Center for Data Science, Courant Institute, December 2017
30. Invited Lecture Series on Algebraic Vision at Seoul National University, December 2017
29. IDeAS Seminar, Program in Applied and Computational Mathematics, Princeton University, November 2017
28. SIAM Conference on Applied Algebraic Geometry, Georgia Institute of Technology, Minisymposium on Algebraic Vision, August 2017
27. Mini-course, Young Researchers' School on Image Processing and Computer Vision, University of Tübingen, July 2017
26. Special Seminar, Czech Institute for Infomatics, Robotics and Cybernetics, Prague, June 2017
25. Special Seminar, WILLOW Computer Vision and Machine Learning Research Laboratory, INRIA, Paris, May 2017
24. AMS Sectional Meeting, Washington State University, Special Session on Combinatorial and Computational Commutative Algebra and Algebraic Geometry, April 2017
23. Colloquium, Department of Mathematics and Statistics, University of Saskatchewan, Canada, February 2017
22. Applied Algebra Seminar, University of California, Berkeley, January 2017
21. What is . . . ? Talks, Interdisciplinary Afternoon, Max Planck Institute for Mathematics in the Sciences, Leipzig, November 2016
20. Algebraic Geometry Seminar, Technische Universität Chemnitz, November 2016
19. Diskrete Mathematik, Geometrie und Optimierung Seminar, Goethe Universität Frankfurt Am Main, November 2016
18. AMS Sectional Meeting, North Carolina State University, Special Session on Geometry and Topology in Image and Shape Analysis, November 2016
17. Special Seminar at Computing + Mathematical Sciences, California Institute of Technology, November 2016
16. Czech Workshop on Applied Mathematics in Engineering, Czech Technical University in Prague, October 2016
15. Algebra Seminar, Georgia Institute of Technology, September 2016
14. Applied Algebra Days 3, University of Wisconsin–Madison, May 2016
13. Algebraic Geometry Seminar, University of Chicago, April 2016
12. AMS Sectional Meeting, University of Utah, Special Session on Combinatorial and Computational Commutative Algebra and Algebraic Geometry, April 2016

11. Joint Mathematics Meetings at Seattle, AMS Special Session on Nonlinear Algebra, January 2016
10. Geometry of Polynomials Seminar, University of California, Berkeley, November 2015
9. Commutative Algebra and Algebraic Geometry, University of California, Berkeley, November 2015
8. Applied Algebra Seminar, University of California, Berkeley, November 2015
7. London Algebra Colloquium, Queen Mary University of London, October 2015
6. SIAM Conference on Applied Algebraic Geometry, Daejeon, South Korea, Minisymposium on Algebraic Vision, August 2015
5. Diskrete Geometrie Seminar, Technische Universität Berlin, June 2015
4. Geometry and Optimization with ALgebraic (GOAL) Methods Workshop, University of California, Berkeley, May 2015
3. Computational Algebraic Geometry Seminar, University of California, Berkeley, March 2015
2. Computational Algebraic Geometry Seminar, University of California, Berkeley, November 2014
1. Colloquium, Mathematics and Statistics Department, University of New Brunswick, Fredericton, Canada, January 2014

Professional Service

- Referee for journals: Journal of the American Mathematical Society (quick opinion), SIAM Journal on Imaging Science (SIIMS), Journal of Algebra, IEEE Journal of Selected Topics in Signal Processing, Advances in Applied Mathematics, Journal of Mathematical Imaging and Vision, International Journal of Computer Vision, Image Analysis and Stereology
- Referee for conferences: STOC, NeurIPS, CVPR, EECV, BMVC, AACV
- Referee for volumes: Springer's Applied and Numerical Harmonic Analysis
- Co-organizer for "Theoretical and Computational Aspects of the Method of Moments" minisymposium, SIAM Conference on Mathematics of Data Science (MDS20), Cincinnati, Ohio, May 5–7, 2020 (postponed)
- Co-organizer of PACM IDeAS seminar, Princeton University, 2018–present
- Co-organizer of Young Researchers' School on Image Processing and Computer Vision, University of Tübingen, Germany, July 24–26, 2017

Students and Mentorship

- *Changshuo Liu*, Princeton University, A.B. Mathematics 2019. Co-advised senior thesis on microscopy and nonlinear algebra, which received the Middleton Miller '29 Prize for outstanding research from Princeton's mathematics department.
- *Nathan Zelesko*, Brown University, Sc.B. Mathematics 2021. Co-advised summer research internship at Princeton on manifold learning and Earthmover's Distance.
- *Eitan Levin*, Princeton University, A.B. Mathematics 2020. Co-advising senior thesis on numerical optimization on algebraic varieties.

Teaching Experience

University of California, Berkeley

Spring 2017: *Introduction to Optimization* (upper division), consultant

Spring 2016: *Tropical Geometry* (graduate), grader and guest lecturer

Spring 2016: *Analytic Geometry and Calculus* (lower division), TA

Fall 2015: *Methods of Mathematics: Calculus, Statistics, Combinatorics* (lower division), TA

Spring 2015: *Methods of Mathematics: Calculus, Statistics, Combinatorics* (lower division), TA

Fall 2014: *Calculus* (lower division), TA

Patents

Inventor in USPTO application "Fully-automatic, template-free particle picking for electron microscopy" with A. Singer et al., submitted June 2018.

References

- **Amit Singer**. Professor, Department of Mathematics, Program in Applied and Computational Mathematics.
  – e-mail: amits@math.princeton.edu
  – website: https://web.math.princeton.edu/∼amits/
- **Bernd Sturmfels**. Director, Max Planck Institute for Mathematics in the Sciences, Leipzig. Professor, Departments of Mathematics, Computer Science and Statistics, University of California, Berkeley.
  – e-mail: bernd@mis.mpg.de
  – website: https://math.berkeley.edu/∼bernd/
- **Tamara Kolda**. Distinguished Member of Technical Staff, Sandia National Laboratories. Editor-in-Chief of SIAM Journal on Mathematics of Data Science.
  – e-mail: tgkolda@sandia.gov
  – website: https://www.kolda.net/
- **Afonso Bandeira**. Professor, Department of Mathematics, ETH Zurich.
  – e-mail: bandeira@math.ethz.ch
  – website: https://people.math.ethz.ch/∼abandeira/
- **Tomas Pajdla**. Associate Professor and Leader of Applied Algebra and Geometry Group, Czech Technical University in Prague.
  – e-mail: pajdla@cvut.cz
  – website: https://people.ciirc.cvut.cz/∼pajdla/
- **Richard Bamler** (teaching). Associate Professor, Department of Mathematics, University of California, Berkeley.
  – e-mail: rbamler@berkeley.edu
  – website: https://math.berkeley.edu/∼rbamler/

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