

# LEK-HENG LIM

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## EMPLOYMENT

### University of California, Berkeley

Charles B. Morrey Assistant Professor, Department of Mathematics  
(dates: 7/2007–6/2010; mentors: Ming Gu and Bernd Sturmfels)

## EDUCATION

### Stanford University

Ph.D. in Computational and Mathematical Engineering  
(dates: 9/2001–6/2007; principal advisors: Gene Golub and Gunnar Carlsson)

### Cambridge University

Cornell University's 2000/01 Clare Hall Fellow  
(dates: 9/2000–8/2001; matriculated Ph.D. student; transferred to Stanford in 2001)

### Cornell University

M.S. in Mathematics  
(dates: 8/1998–8/2000; won fellowship to Cambridge in 2000)

### National University of Singapore

B.Sc. (Honors) in Mathematics  
(dates: 7/1993–5/1996; graduated with honors in three years)

## SELECTED AWARDS AND HONORS

### International Linear Algebra Society

LAA Plenary Lecture, 2010  
(quadrennial lecture sponsored by journal *Linear Algebra and its Applications*; past speakers: C. de Boor, N. Trefethen, O. Alter)

### Stanford University

Gerald J. Lieberman Fellowship, 2006/2007  
(citation: 'in recognition of outstanding scholarship, teaching, and university service'; 'awarded on the basis of potential for academic leadership')

### Cornell University

Clare Hall Fellowship, 2000/2001  
(tenable at Cambridge; selectivity: each department at Cornell nominates one candidate, 2 fellowships awarded)

Graduate School Scholarship, September 2000  
(citation: 'awarded in recognition of academic excellence')

### Cambridge University

Cambridge Commonwealth Trust Overseas Student Award, May 1997  
(for graduate studies at Cambridge; declined award because of employment contractual restrictions)

## PUBLICATIONS

- L.-H. Lim and P. Comon, "Nonnegative approximations of nonnegative tensors," *J. Chemometrics*, **23** (2009), no. 7–8, pp. 432–441.
- M. Mørup, L.K. Hansen, S.M. Arnfred, L.-H. Lim, and K.H. Madsen, "Shift-invariant multilinear decomposition of neuroimaging data," *NeuroImage*, **42** (2008), no. 4, pp. 1439–1450.
- P. Comon, G. Golub, L.-H. Lim, and B. Mourrain, "Symmetric tensor and symmetric tensor rank," *SIAM J. Matrix Anal. Appl.*, **30** (2008), no. 3, pp. 1254–1279.
- V. de Silva and L.-H. Lim, "Tensor rank and the ill-posedness of the best low-rank approximation problem," *SIAM J. Matrix Anal. Appl.*, **30** (2008), no. 3, pp. 1084–1127.

- P. Comon, G. Golub, L.-H. Lim, and B. Mourrain, "Genericity and rank deficiency of high order symmetric tensors," *Proc. IEEE Int. Conference on Acoustics, Speech, and Signal Process.* (ICASSP '06), **31** (2006), no. 3, pp. 125–128.
- L.-H. Lim, "Singular values and eigenvalues of tensors: a variational approach," *Proc. IEEE Int. Workshop on Computational Advances in Multi-Sensor Adaptive Process.* (CAMSAP '05), **1** (2005), pp. 129–132.
- L.-H. Lim, J. Packer, and K. Taylor, "Direct integral decomposition of the wavelet representation," *Proc. Amer. Math. Soc.*, **129** (2001), no. 10, pp. 3057–3067.
- L.-H. Lim, "Security of the Cao-Li public key cryptosystem," *Electron. Lett.*, **34** (1998), no. 2, pp. 170–172.
- M. Mahoney, L.-H. Lim, and G. Carlsson, "MMDS 2008: Algorithmic and statistical challenges in modern large-scale data analysis are the focus," *Statist. Comput. Graph.*, **20** (2009), no. 1, pp. 12–18.
- M. Mahoney, L.-H. Lim, and G. Carlsson, "Algorithmic, statistical challenges in data analysis focus of MMDS 2008," *AMSTAT News*, **384** (2009), pp. 16–19.
- M. Mahoney, L.-H. Lim, and G. Carlsson, "MMDS 2008: Algorithmic and statistical challenges in modern large-scale data analysis, Parts I & II," *SIAM News*, **42** (2009), no. 1, pp. 8, & no. 2, pp. 8–9.
- M. Mahoney, L.-H. Lim, and G. Carlsson, "Algorithmic and statistical challenges in modern large-scale data analysis are the focus of MMDS 2008," *KDD Explorations*, **10** (2008), no. 2, pp. 57–60.
- M. Mahoney, L.-H. Lim, and G. Carlsson, "Algorithms for modern massive data sets," *IMS Bulletin*, **37** (2008), no. 10, pp. 10–11.
- P. Drineas, G. Golub, L.-H. Lim, and M. Mahoney "Bridging the gap between numerical linear algebra, theoretical computer science, and data applications," *SIAM News*, **39** (2006), no. 8, pp. 1 & 16.

#### TEACHING

#### University of California, Berkeley

Instructor, Department of Mathematics

(Fall 2007/Spring 2008: Math 110 Linear Algebra; Fall 2007/Fall 2008/Fall 2009: Math 185 Complex Analysis; Spring 2009/Spring 2010: Math 104 Introductory Analysis; Spring 2009: Math 114: Galois Theory; Fall 2009: Math 191 Mathematical Tools for the Information Sciences)

#### Mathematical Sciences Research Institute, Berkeley

Lecturer, Summer Graduate Workshop

(July 7–20, 2008; [http://www.msri.org/calendar/sgw/WorkshopInfo/451/show\\_sgw](http://www.msri.org/calendar/sgw/WorkshopInfo/451/show_sgw))

#### Stanford University

Course Assistant, Departments of Computer Science and Management Science & Engineering

(Spring 2006: CS 336 Advanced Methods in Matrix Computations; Fall 2005: CS 237A Numerical Linear Algebra; Spring 2003: MS&E 315 Linearly Constrained Optimization)

#### Cambridge University

Supervisor, Queen's College and Trinity College

(Lent 2001: tutored 32 undergraduates for Part IIB of the Mathematical Tripos)

#### Cornell University

Grader/Recitation Instructor, Department of Mathematics

(Fall 1998: Math 193 Calculus for Engineers; Spring 1999: Math 423 Applied Functional Analysis; Fall 1999: Math 332 Algebra and Number Theory; Spring 2000: Math 422 Complex Analysis and Distribution Theory)

#### VISITING APPOINTMENTS

#### University of Copenhagen

Visiting Assistant Professor, Faculty of Life Sciences

(June–August 2009; host: R. Bro)

#### Technical University of Denmark

Visiting Assistant Professor, Institute of Informatics and Mathematical Modeling

(June–August 2008; host: L.K. Hansen)

#### Yahoo! Research

Summer Intern, Yahoo! Research Talent Search Program

(July–September 2006; selectivity: 15 offers out of 394 applications)

## RESEARCH GRANTS

### **Villum Kann Rasmussen Foundation, Denmark**

Metabonomic Cancer Diagnostics

(amount awarded: DKK 7,000,000; consultant; with R. Bro (P.I.); 2007/2008/2009)

### **France-Stanford Center for Interdisciplinary Studies Grant**

Numerical Multilinear Algebra and its Applications to Science and Engineering

(amount awarded: \$4,500; with P. Comon, G. Golub; 2007/2008)

### **Okawa Foundation Research Grant 2006**

Numerical Multilinear Algebra in Engineering Sciences

(amount awarded: \$10,000; with G. Golub; ; 2006/2007)

### **National Science Foundation DMS 0532668**

Special Meeting: Workshop on Algorithms for Modern Massive Data Sets

(amount awarded: \$15,000; with G. Golub, M. Mahoney, P. Drineas; June 2006)

### **National Science Foundation CCF 0430617 (extension)**

Collaborative Research: Large Scale Regularized Least Squares Problems via Quadratic Eigenvalue Problems

(amount awarded for project extension: \$57,862; with G. Golub; 2005/2006)

## MEETINGS ORGANIZED

### **2009 SIAM Conference on Applied Linear Algebra**

Organizer (with E. Tyrtyshnikov), Minisymposium on *Multilinear Methods in Numerical Linear Algebra*, Monterey, CA, October 26–29, 2009.

Organizer (with J. Morton), Minisymposium on *Applied Multilinear Algebra*, Monterey, CA, October 26–29, 2009.

(<http://www.siam.org/meetings/la09/invited.php>)

### **2009 European Workshop on Challenges in Modern Massive Data Sets**

Organizer (with M. Mørup, L.K. Hansen, G. Carlsson), Technical University of Denmark, Lyngby, Denmark, July 1–4, 2009. (<http://mmds.imm.dtu.dk>)

### **AIM Research Workshop**

Organizer (with J.M. Landsberg, J. Morton, J. Weyman), Workshop on *Geometry and Representation Theory of Tensors for Computer Science, Statistics and Other Areas*, American Institute of Mathematics, Palo Alto, CA, July 21–25, 2008. (<http://www.aimath.org/pastworkshops/repnsoftensors.html>)

### **2008 SIAM Annual Meeting**

Organizer, Minisymposium on *Numerical Multilinear Algebra*, San Diego, CA, July 11, 2008.

(<http://multilinear.stanford.edu/siam08.html>)

Organizer (with I. Dhillon), Minisymposium on *Mathematical Methods in Data Mining*, San Diego, CA, July 7, 2008. (<http://datamining.stanford.edu>)

### **MSRI Summer Graduate Workshop**

Organizer (with J.M. Landsberg, J. Morton), Summer Graduate Workshop on *Geometry and Representation Theory of Tensors for Computer Science, Statistics and Other Areas*, Mathematical Sciences Research Institute, Berkeley, CA, July 7–20, 2008. ([http://www.msri.org/calendar/sgw/WorkshopInfo/451/show\\_sgw](http://www.msri.org/calendar/sgw/WorkshopInfo/451/show_sgw))

### **2008 Workshop on Algorithms for Modern Massive Data Sets**

Organizer (with G. Carlsson, M. Mahoney, P. Drineas), Stanford University, Stanford, CA, June 25–28, 2008.

(<http://mmds.stanford.edu>)

### **6th International Congress on Industrial and Applied Mathematics**

Organizer (with A. Dasgupta, G. Golub, M. Mahoney), Minisymposium on *Novel Matrix Methods for Internet Data Mining*, ETH, Zürich, July 19, 2007. (<http://datamining.stanford.edu/iciam2007.html>)

Organizer (with P. Comon, L. De Lathauwer, G. Golub), Minisymposium on *Numerical Multilinear Algebra: a new beginning*, ETH, Zürich, July 17, 2007. (<http://multilinear.stanford.edu/iciam07.html>)

### **2006 Workshop on Algorithms for Modern Massive Data Sets**

Organizer (with G. Golub, M. Mahoney, P. Drineas), Stanford University and Yahoo! Research, Stanford, CA, June 21–24, 2006. (<http://mmds.stanford.edu/mmds2006.html>)

## OTHER PROFESSIONAL ACTIVITIES

### Linear Algebra and its Applications

Special Editor, Special issue on *Tensors and Multilinear Algebra*, November 2009–June 2010  
(with S. Friedland, T. Kolda, E. Tyrtyshnikov)

### U.S. Department of Energy

Member of the Review Panel on *Mathematics for Analysis of Petascale Data*, June 23–25, 2009

### Stanford University

President, *SIAM Stanford Student Chapter*, July 2004–June 2005

### Cambridge University

Fellow, *Cambridge Philosophical Society*, elected 2001

Life Member, *Clare Hall College*, since 2002

### Cornell University

Admissions Interviewer, *Cornell Alumni Admissions Ambassador Network*, since 2003

### Referee Services

*Computational Statistics and Data Analysis, Data Mining and Knowledge Discovery, Discrete and Computational Geometry, Electronics Letters, Foundations of Computational Mathematics, Information and Computation, Journal of Chemometrics, Journal of Computational Physics, Linear Algebra and its Applications, Mathematical and Computer Modelling, Mathematical Programming, Pacific Symposium on Biocomputing, SIAM Journal on Matrix Analysis and Applications, SIAM Journal on Scientific Computing, Theoretical Computer Science*

### Visitors Hosted

Morten Mørup (Fall 2007), Sune Lehmann (January 2008), Lars Kai Hansen (January 2009), Kristoffer Madsen (October 2009), Shmuel Friedland (October 2009), Eugene Tyrtyshnikov (November 2009)

## OTHER AWARDS

### Travel Awards

*NIPS* (2009), *Institute for Mathematics and its Applications* (2008), *Society for Industrial and Applied Mathematics* (2003, 2004, 2007), *Institute for Pure and Applied Mathematics* (2003, 2006, 2010), *National Science Foundation* (2001), *Centre de Recerca Matemàtica* (2001), *RSA Security Inc.* (2001), *Mathematical Sciences Research Institute* (2001), *American Institute of Mathematics* (2001, 2008, 2009)

### Cambridge University

Clare Hall College Book Grant, November 2000

### National University of Singapore

Direct Honors Program, 1994/1995/1996  
(completed four-year program in three years; selectivity: 7 out of a cohort of 1614)

Dean's List, 1993/1994/1995  
(citation: 'awarded for meritorious performance'; selectivity: top 5% of cohort; made Dean's List throughout college)

## FUTURE INVITED TALKS

Workshop on *Convex Optimization and Algebraic Geometry*, Program on Modern Trends in Optimization and its Application, Institute for Pure and Applied Mathematics, Los Angeles, CA, September 28–October 1, 2010.

*LAA Plenary Lecture*, 16th Conference of the International Linear Algebra Society, Pisa, Italy, June 21–25, 2010.

SIAM Conference on *Imaging Science*, Chicago, IL, April 12–14, 2010.

3rd International Conference on *Structured Matrices and Tensors*, Hong Kong, January 19–22, 2010.

AMS Special Session on *Algebraic Methods in Signal Processing*, Joint Mathematics Meetings, San Francisco, CA, January 13–16, 2010.

NIPS '09 Workshop on *Advances in Ranking*, Whistler, Canada, December 11–12, 2009.

- "Most tensor problems are NP hard," Session on *Semidefinite Programming and its Applications*, 20th International Symposium of Mathematical Programming (ISMP '09), Chicago, IL, August 23–28, 2009.
- "Principal cumulant components analysis," European Workshop on *Challenges in Modern Massive Data Sets*, Technical University of Denmark, Lyngby, Denmark, July 1–4, 2009.
- "Analysis of cumulants," *Applied Mathematics Seminar*, Stanford University, Stanford, CA, March 6, 2009.
- "Modeling and learning with tensors," Workshop on *Future Directions in Tensor-based Computation and Modeling*, National Science Foundation, Arlington, VA, February 20–21, 2009.
- "Symmetric eigenvalue decompositions for symmetric tensors," *Algebra and Discrete Mathematics Seminar*, University of California, Davis, CA, January 29, 2009.
- "Lectures on numerical multilinear algebra I, II, III," *Institute for Computational Mathematics Lecture Series*, Hong Kong Baptist University, Hong Kong, January 5–7, 2009.
- "Polynomial optimization in tensor computations," Workshop of *Computational Polynomial Optimization and Multilinear Algebra*, Hong Kong Polytechnic University, Hong Kong, December 22–23, 2008.
- "Algebraic models for higher-order correlations," Workshop on *Algebraic Statistics*, Mathematical Sciences Research Institute, Berkeley, CA, December 15–18, 2008.
- "Graph Helmholtzian and rank learning," NIPS '08 Symposium and Workshop on *Algebraic and Combinatorial Methods in Machine Learning*, Vancouver/Whistler, Canada, December 11–12, 2008.
- "Cumulant component analysis: a simultaneous generalization of PCA and ICA," *Computational Algebraic Statistics, Theories and Applications*, Kyoto University, Kyoto, Japan, December 10–11, 2008.
- "Spectrum and pseudospectrum of a tensor," Minisymposium on *Tensor Decompositions and Applications*, 2008 SIAM Annual Meeting, San Diego, CA, July 11, 2008.
- "Projection, matching and basis pursuits for multilinear approximations," Minisymposium on *Nonlinear and Multilinear Approximations of Operators in Higher Dimensions*, 2008 SIAM Annual Meeting, San Diego, CA, July 10, 2008.
- "Ranking via Hodge decompositions of graphs and skew-symmetric matrices," Workshop on *Algorithms for Modern Massive Data Sets*, Stanford, CA, June 25–28, 2008.
- "Hyperdeterminants, secant varieties, and tensor approximations," San Jose State University *Mathematics Colloquium*, San Jose, CA, April 23, 2008.
- "Eigenvalues of tensors and spectral hypergraph theory," *Matrix Computations and Scientific Computing Seminar*, Berkeley, CA, April 16, 2008.
- "Numerical multilinear algebra: from matrices to tensors," Symposium on Gene Golub's legacy: *Matrix Computations — Foundation and Future*, Stanford, CA, March 1, 2008.
- "Multilinear algebra in signal processing and machine learning," Minisymposium on *Numerical Multilinear Algebra*, 6th International Congress on Industrial and Applied Mathematics, Zürich, Switzerland, July 16–20, 2007.
- "Ten ways to decompose a tensor — with applications in data mining," *Computer Science Colloquium*, University of Texas, Austin, TX, April 5, 2007; *ITMAN Visiting Researcher Seminar*, Technical University of Denmark, Lyngby, Denmark, June 27, 2007; (with Gene H. Golub), 22nd Biennial Conference on *Numerical Analysis*, Dundee, UK, June 26–29, 2007.
- "Numerical multilinear algebra in data analysis," *Computer Science Colloquium*, Cornell University, Ithaca, NY, February 20, 2007; *Computational Engineering and Sciences Seminar*, University of Texas, Austin, TX, February 13, 2007.
- "Numerical multilinear algebra: a new beginning?," *Matrix Computations and Scientific Computing Seminar*, University of California, Berkeley, CA, October 18, 2006.
- "Multilinear least squares, eigenvalue, and singular value problems," *Linear Algebra and Optimization Seminar*, Stanford University, Stanford, CA, October 11, 2006.
- "Multilinear algebra in data analysis: tensors, symmetric tensors, nonnegative tensors," one hour tutorial, Workshop on *Algorithms for Modern Massive Data Sets*, Stanford, CA, June 21–24, 2006.
- "Singular and eigenvalues of tensors, multilinear Perron-Frobenius theory, and spectral hypergraph theory," 1st IEEE International Workshop on *Computational Advances in Multi-Sensor Adaptive Processing*, Puerto Vallarta, Mexico, December 13–15, 2005.

- “Optimal solutions to non-negative PARAFAC/multilinear NMF always exist,” and “Hyperdeterminant and tensor rank,” and “Multilinear spectral theory,” Workshop on *Tensor Decompositions and Applications*, Centre International de rencontres Mathématiques, Luminy, France, August 29–September 2, 2005.
- “Globally convergent algorithms for CANDECOMP/PARAFAC with semi-definite programming,” and “Tensors for chemists and psychologists,” 6th ERCIM Workshop on Matrix Computations and Statistics: *Data Analysis — a key technology in modern society*, European Research Consortium on Informatics and Mathematics, Copenhagen, Denmark, April 1–3, 2005.
- “Low-rank approximation of tensors and the statistical analysis of multi-indexed data,” *Scientific Computing Seminar*, Lawrence Berkeley National Laboratory, Berkeley, CA, March 11, 2005.
- “Numerical multilinear algebra and multiway statistical models,” *Scientific Computing and Computational Mathematics Seminar*, Stanford University, Stanford, CA, November 1, 2004.
- “What’s possible and what’s not possible in tensor decompositions,” Workshop on *Tensor Decompositions*, American Institute of Mathematics, Palo Alto, CA, July 19–23, 2004.
- “Geometric sparsity and mimetic discretization,” Conference on *Mimetic Discretizations of Continuum Mechanics*, San Diego, CA, July 9–11, 2003.
- “A multiscale technique for decomposing sparse matrices motivated by spectral sequences,” Session on *Computational Science and Engineering*, 2003 SIAM Annual Meeting, Montréal, QC, June 16–20, 2003.
- “Wavelet sets and the harmonic analysis of  $\mathbb{D} \rtimes_{\theta} \mathbb{Z}$ ,” Special Session on *Abstract Wavelet Theory*, American Mathematical Society 2000 Fall Western Sectional Meeting, San Francisco, CA, October 21–22, 2000.