CURRICULUM VITAE
JORGE NOCEDAL

ADDRESS: Jorge Nocedal
                                  Department of Industrial Engineering and Management Sciences
                                  Northwestern University
                                  Evanston IL 60208

EDUCATION:

     1974-1978   Rice University, Ph.D. in Mathematical Sciences
     1970-1974   National University of Mexico (UNAM), B. Sc. in Physics

PROFESSIONAL EXPERIENCE:

     2017-present   Walter P. Murphy Professor, Northwestern University
     2013-2017   David and Karen Sachs Professor and Chair, IEMS Department,
                          Northwestern University
     1983-2012   Assistant Professor, Associate and Professor, Dept. of Electrical
                          Engineering and Computer Science, Northwestern University
     1981-1983   Research Associate, Courant Institute of Mathematical Sciences, NYU
     1978-1981   Assistant Professor, National University of México

RESEARCH INTERESTS:
     Nonlinear optimization, stochastic optimization, scientific computing, software; applications of
     optimization in machine learning, optimal design, and energy.

HONORS AND DISTINCTIONS:

     2021   Lagrange Prize in Continuous Optimization
     2020   Elected to the US National Academy of Engineering
     2019   Outstanding Engineering Alumnus Award, Rice University
     2017   John Von Neumann Theory Prize
     2012   George B. Dantzig Prize
     2010   SIAM Fellow
     1998   Bette and Neison Harris Professor of Teaching Excellence, Northwestern
     1998   Invited Speaker, International Congress of Mathematicians

EDITORIAL BOARDS:

     2010- 2014   Editor-in-Chief, SIAM Journal on Optimization
     1989- 2016   Associate Editor, Mathematical Programming
     2006- 2009   Associate Editor, SIAM Review
     1995- 2001   Co-Editor, Mathematical Programming
     1990- 2014   Associate Editor, SIAM Journal on Optimization

ACADEMIC ACTIVITIES:

Development, planning and implementation of *Engineering First*, a novel curriculum for undergraduate engineering education at Northwestern in which mathematics, physics, design, and computing are integrated and taught in the context of engineering applications.

PATENT:

*Debt Collection Practice*s, Patent 7,403,923, issued July 22, 2008, US Patent Trademark Office.

PH.D. AND M.S. STUDENTS SUPERVISED:

2024 (exp)	Shigeng Sun
2023 (exp)	Melody Qiming Xuan
2021	Michael Shi, PhD
2021	Yuchen Xie, PhD
2019	Vijaya Bollapragada, PhD
2018	Albert Berahas, PhD
2017	Nitish Keskar, PhD
2016	Stefan Solntsev, PhD
2014	Samantha Hansen, PhD
2013	Gillian Chin, PhD
2010	Yuchen Wu, PhD
2007	Frank Curtis, PhD
2007	Long Hei, Ph.D.
2006	Gabriel López Calva, Ph.D.
2002	Richard Waltz, Ph.D
2001	Marcelo Marazzi, Ph.D.
1999	Marcel Good, M.S.
1999	Guanghui Liu, Ph.D.
1995	Mary Beth Hribar, Ph.D.
1994	Todd Plantega, Ph.D.
1992	Paul Sally, M.S.
1992	Marucha Lalee,Ph.D.
1992	Peihuang Lu, Ph.D.
1989	James Lee, M.S.
1987	Dong C. Liu, Ph.D.
1987	Kathryn Connolly, M.S.
1987	Susan Mulvey, M.S.
1986	Dong C. Liu, M.S.
1986	Denise Skelton, M.S.

TECHNOLOGY AND BUSINESS:

2001	Co-founder and President, Ziena Optimization Inc.
2001	Co-Developer, KNITRO software package
2002-2015	Chief Scientist, Ziena Optimization Inc.

CONSULTING:

2012-2020	Artelys
2001-2012	Ziena Optimization LLC
2012-2014	Google
2004	Chevron-Texaco
2001-2002	Accenture
1998-2002	Synopsys, Sunnyvale California
1993	AMOCO
1988	Resource Control Systems, Chicago Il
1987	SYSTAT, Evanston Il
1984	Gould Research, Chicago Il
1983, 1988	United Kingdom Atomic Energy Research Establishment, Harwell, England

PUBLICATIONS: For a list of publications since 2019, see Google Scholar

1. *Derivative-Fee Optimization of Noisy Functions via Quasi-Newton Methods,* with A. Berahas and R. Byrd, SIAM Journal on Optimization, vol. 29. No 2, pp. 965-993, (2019).

2. *A Progressive Batching L-BFGS Method for Machine Learning,* with R. Bollapragada and M. Shi, International Conference on Machine Learning (ICML) (2018).

3. *Adaptive Sampling Strategies for Stochastic Optimization,* with R. Bollapragada and R. Byrd, SIAM Journal on Optimization, vol. 28. No.4. pp. 3312-3343, *(2018).*

4. *Exact and Inexact Subsampled Newton Methods for Optimization*, with R. Bollapragada and R. Byrd, IMA Journal of Numerical Analysis (2018).

5. *Optimization methods for Large-Scale Machine Learning*, with L. Bottou, F. Curtis, SIAM Review 60-2, pp. 223-311 (2018).

6. *An Investigation of Newton-Sketch and Subsampled Newton Methods,* with A. Berahas and R. Bollapragada, arxiv preprint 1705.06211 (2017).

7. *On Large-Batch Training for Deep Learning: Generalization gap and sharp minima*, with N. Keskar, D. Mudigere, M. Smelyanskiy and P. Tang, NIPS (2017).

8. *A Multi-Batch L-BFGS Method for Machine Learning*, with A. Berahas and M. Takáč, NIPS (2016).

9. *A Second-Order Method for Convex-Regularized Optimization with Active-Set Prediction,* Optimization Methods and Software, with N. Keskar, F. Oztoprak and A. Waechter: 1-17, (2016).

10. *An Algorithm for Quadratic L1-Regularized Optimization with a Flexible Active-Set Strategy,* with R. Byrd and S. Solntsev, Optimization Methods and Software, 30.6, 1213-1237 (2015).

11. *A Stochastic Quasi-Newton Method for Large Scale Optimization,* with R. Byrd, S. Hansen and Y. Singer, SIAM Journal on Optimization, 26.2, 1008-1031 (2016).

12. *An Inexact Successive Quadratic Approximation Method for Convex L1 Regularized Optimization,* with R. Byrd and Figen Oztoprak, Mathematical Programming B, 1-22 (2015).

13. *On the Use of Piecewise Linear Models in Nonlinear Programming,* with R. Byrd, R. Waltz and Y. Wu, Mathematical Programming, vol. 137, issue 1, pp. 289-324 (2013).

14. *Second Order Methods for Optimizing Convex Matrix Functions and Sparse Covariance Clustering,* with G. Chin, P. Olsen and S. J. Rennie, IEEE Transactions on Audio, Speech and Language Processing, Vol. 20, No. 6, August (2013).

15. *A Family of Second Order Methods for L1 Regularized Optimization, with R. Byrd, G. Chin, and F. Oztoprak,* Mathematical Programming, 1-33 (2012).

16. *Newton-Like Methods for Sparse Inverse Covariance Estimation,* with P. Olsen, F. Oztoprak and S. Rennie, NIPS (2012).

17. *Sample Size Selection in Optimization Methods for Machine Learning,* R. Byrd, G. Chin, J. Nocedal and Y. Wu, Mathematical Programming B, (2012).

18. *A Line Search Exact Penalty Method Using Steering Rules,* with R. Byrd and G. López-Calva, Mathematical Programming, 133, 1, pp 39-73, (2012).

19. *Subspace Accelerated Matrix Splitting Algorithms for Bound Constrained Quadratic Programming and Linear Complementarity Problems,* D. Robinson, L. Feng, J. Nocedal and J. S. Pang, SIAM Journal on Optimization, 23.3, 1371-1397 (2013).

20. *An Interior Point Method for Nonlinear Programming with Infeasibility Detection Capabilities*, J. Nocedal, F. Oztoprak and R. Waltz, Methods and Software, Vol 29, Issue 4, (2014).

21. *On the Use of Stochastic Hessian Information in Optimization Methods for Machine Learning,* with R. Byrd, G. Chin and W. Neveitt, SIAM Journal on Optimization, 21, 3, pp. 977-995 (2011).

22. *On the Solution of Complementarity Problems Arising in American Options Pricing,* with L. Feng, V. Linetsky and J.L. Morales Optimization Methods and Software, 26, 4-5, pp 813-825 (2011).

23. *A Sequential Quadratic Programming Algorithm with an Additional Equality Constrained Phase,* with J.L. Morales and Y. Wu, IMA Journal on Numerical Analysis (2011).

24. *Infeasibility Detection and SQP Methods for Nonlinear Optimization,* with R. Byrd and F. Curtis, SIAM J. Optimization, Vol 20, no. 5, (2010).

25. *A Matrix-Free Algorithm for Equality Constrained Optimization Problems with Rank-Deficient Jacobians*, with F. Curtis and A. Waechter, SIAM J. Optimization, Vol 20, Issue 3, pp. 1224-1249, (2009).

26. *On the Geometry Phase in Model-Based Algorithms for Derivative-Free Optimization,* Optimization Methods and Software, Volume 24, Issue 1, February 2009, pp. 145-154, with G. Fasano and J.L. Morales, (2009). (This paper was awarded the *Broyden Prize*.)

27. *Adaptive Barrier Strategies for Nonlinear Interior Methods,* SIAM J. Optimization, Volume 19, Issue 4, pp. 1674-1693, with A. Waechter and R. Waltz, (2008).

28. *An Inexact Newton Method for Nonconvex Equality Constrained Optimization,* Mathematical Programming, vol 122, Issue 2, pp. 273-299, with R. Byrd and F. Curtis (2009). (2010)

29. *An Algorithm for the Fast Solution of Linear Complementarity Problems,* Numerische Mathematik, vol. 111, Issue 2, pp. 251-266, with J.L. Morales and M. Smelyanskiy (2008)

30. *Flexible Penalty Functions for Nonlinear Constrained Optimization*, IMA Journal on Numerical Analysis, Volume: 28   Issue: 4   pp.: 749-769, with F. Curtis (2008).

31. *Data Assimilation in Weather Forecasting: A Case Study in PDE-Constrained Optimization,* Optimization and Engineering, Volume 10, Issue 3, Page 409. with M. Fisher, Y. Tremolet and S. Wright, `DOI: 10.1007/s11081-008-9051-5` (2009).

32. *Steering Penalty Methods,* Optimization Methods and Software, 23, 2, pp. 197-213, with R. Byrd and R. Waltz, (2008).

33. *Inexact SQP Methods for Equality Constrained Optimization,* SIAM J. Optimization, vol. 19, no. 1, pp. 351-369, with R. Byrd and F. Curtis (2008).

34. *A Numerical Study of Active-Set and Interior-Point Methods for Bound Constrained Optimization,* in "Modeling, Simulation and Optimization of Complex Processes", editors Bock H. G., Kostina E. A., Phu H. X. and Rannacher R, pp.: 273-292, with L. Hei and R. Waltz (2008).

35. *Steplength Selection in Interior-Point Methods*, with F. Curtis, Applied Math Letters, Volume 20, Issue 5, (2007), Pages 516-523.

36. *KNITRO: An Integrated Package for Nonlinear Optimization*, in "Large-Scale Nonlinear Optimization", G. Di Pillo and M. Roma, eds, pp.35-60, with R. Byrd and R. Waltz, Springer, (2006).

37. *Interior Point Methods for Mathematical Programs with Complementarity Constraints,* SIAM. J. Optimization, 17, 1, pp: 52-77, with G. Lopez-Calva and S. Leyffer, (2006).

38. *An Interior Algorithm for Nonlinear Optimization that Combines Line Search and Trust Region Steps*, Mathematical Programming B, vol. 102, pp. 391-408, with R. Waltz, J.L. Morales and D. Orban, (2006).

39. *On the Convergence of Successive Linear Programming Algorithms*, SIAM J. Optimization, 16,2, pp.471-489, with R. Byrd, N. Gould and R. Waltz (2005).

40. *A Starting-Point Strategy for Nonlinear Interior Methods*, Applied Math Letters, Vol 17, pp. 945-952, with M. Gertz and A. Sartenaer (2004).

41. *An Active-Set Algorithm for Nonlinear Programming Using Linear Programming and Equality Constrained Subproblems*, Mathematical Programming B, 100, 1, pp. 27-48, (2004).

42. *Assessing the Potential of Interior Methods for Nonlinear Optimization*, in Large-Scale PDE-Constrained Optimization, edited by L. T. Biegler, O. Ghattas, M. Heinkenschloss, B. van

Bloemen, Lecture Notes in Computational Science and Engineering, Vol. 30, pp. 167-183, (2003), Springer Verlag, with J.L. Morales, J.P. Goux,G. Liu and R. Waltz.

43. *On the Convergence of Newton Iterations to Non-Stationary Points*, Mathematical Programming A, 99, pp. 127-148 (2004), with R. Byrd and M. Marazzi.

44. *Feasible Interior Methods Using Slacks for Nonlinear Optimization*, Computational Optimization and Applications, Vol 26,1, (2003), with R. Byrd and R. Waltz.

45. *On the Behavior of the Gradient Norm in the Steepest Descent Method,* Computational Optimization and Applications, 22, pp. 5-35, (2002), with A. Sartenaer and C. Zhu.

46. *Wedge Trust Region Methods for Derivative Free Optimization*, Mathematical Programming, 91 (2002) 2, 289-305, with M. Marazzi.

47. *iNEOS: An Interactive Environment for Optimization*, Applied Numerical Math. 40: 49-58, January 2002, with M. Good, J-P. Goux and V. Pereyra.

48. *Feasibility Control in Nonlinear Optimization*, (2001), in Foundations of Computational Mathematics, eds. A DeVore, A. Iserles, and E. Suli, London Mathematical Society Lecture Note Series 284, pp. 125-154, Cambridge University Press, with M. Marazzi.

49. *An Enriched Algorithm for Large-Scale Nonlinear Optimization*, Computational Optimization and Applications (COAP), February 2002, Volume 21, Number 2, pp. 143-154, with J.L. Morales.

50. *On the Solution of Equality Constrained Quadratic Programming Problems Arising in Optimization*, SIAM. J. Scientific Computing, (2001), 23,4, pp. 1375-1394, with N.I.M. Gould and M. Hribar.

51. *Algorithm PREQN: FORTRAN Subroutines for Preconditioning the Conjugate Gradient Method*, ACM Transactions on Mathematical Software, 27,1, pp.83-91, (2001), with J.L. Morales.

52. A Trust Region Method Based on Interior Point Techniques for Nonlinear Programming, Mathematical Programming A, 89: 149-185 (2000) with R. Byrd and J.C. Gilbert.

53. *Active Set and Interior Point Methods for Nonlinear Optimization*, Documenta Mathematica, Vol. III, Journal der Deutschen Mathematiker-Vereinigung, 1998, (Proceedings of the International Congress of Mathematicians) with R.Byrd.

54. Combining Trust Region and Line Search Techniques, in: Y. Yuan, ed., *Advances in Nonlinear Programming*, (Kluwer, 1998), pp. 153--175, with Ya-xiang Yuan.

55. *The modified absolute-value factorization norm for trust-region minimization*, in High Performance Algorithms and Software in Nonlinear Optimization, pp. 225--241, eds. R. De Leone and A. Murli and P. M. Pardalos and G. Toraldo, Kluwer 1998, with N.I.M. Gould.

56. *On the Local Behavior of an Interior Point Method for Nonlinear Programming*, in Numerical Analysis 1997, D.F. Griffiths and D.J. Higham, eds, pp.37-56, Addison Wesley Longman, with Richard Byrd and Guanghui Liu.

57. *Numerical Experience with a Reduced Hessian Method for Large-Scale Constrained Optimization*, Computational Optimization and Applications, 15,1, 2000, pp.45-67, with L Biegler, C. Schmid and D. Ternet.

58. Mechanics in the Engineering First Curriculum at Northwestern University, (1997) *Int J. Engineering Education* ,vol. 13, No. 6, pp. 457-472, 1997, with T. Belytschko, A. Bayliss, C. Brinson, S. Carr, W. Kath, S. Krishnaswamy, B. Moran and M. Peshkin.

59. Automatic Preconditioning by Limited Memory Quasi-Newton Updating (2000), *SIAM J. Optimization*, 10,4, pp. 1079-1096, with J.L. Morales.

60. An Interior Point Method for Large Scale Nonlinear Programming (1999), *SIAM J. Optimization*, 9,4, pp.877-900, with R. Byrd and M.B. Hribar.

61. Large Scale Unconstrained Optimization (1997), in The State of the Art in Numerical Analysis, A. Watson and I. Duff., eds, pp. 311-338, Oxford University Press.

62. Conjugate Gradient Methods and Nonlinear Optimization, (1996), in Linear and Nonlinear Conjugate Gradient-Related Methods, pp. 9-23, eds. Loyce Adams and J.L. Nazareth, SIAM Publications.

63. Towards a Discrete Newton Method with Memory for Large-scale Optimization, (1996), in Nonlinear Optimization and Applications, edited by G. Di Pillo and F. Giannessi, Plenum, with R. Byrd and C. Zhu.

64. Recent Advances in Large-scale Nonlinear Optimization, in Mathematical Programming; State of the Art 1994, edited by J. Birge and K. Murty, University of Michigan.

65. On the Implementation of an Algorithm for Large-Scale Equality Constrained Optimization, *SIAM. J. Optimization*, 8,3, pp.682-706, 1998, with M. Lalee and T. Plantenga.

66. A Limited Memory Algorithm for Bound Constrained Optimization, (1995), *SIAM Journal on Scientific and Statistical Computing*, 16, 5, pp. 1190-1208, with R.H. Byrd and P. Lu.

67. A Reduced Hessian Method for Large Scale Constrained Optimization, (1995) *SIAM Journal on Optimization*, 5,2, pp.314-347, with L. Biegler and C. Schmid.

68. Representations of Quasi-Newton Matrices and their use in Limited Memory Methods, *Mathematical Programming*, 63, 4, 1994, pp. 129-156, with R. Byrd and R. Schnabel.

69. Automatic Column Scaling Strategies for Quasi-Newton Methods, *SIAM Journal on Optimization*, Vol.3, no.3, 1993, pp. 637-653, with M. Lalee.

70. The Limited Memory Step Computation and Automatic Differentiation, (1993), *Applied Math Letters*, Vol. 6, No. 3, pp. 47-50, with J. C. Gilbert.

71. Analysis of a Self-Scaling Quasi-Newton Method, (1993), *Mathematical Programming*, Vol. 61, no. 1, pp. 19-37, with Y. Yuan.

72. Theory of Algorithms for Unconstrained Optimization, *Acta Numerica*, Vol. 1, pp. 199-242, 1992.

73. On the Behavior of Broyden's Class of Quasi-Newton Methods, (1992), *SIAM Journal on Optimization*, 2, 4, pp. 533-557, with R. Byrd and D. Liu.

74. Global Convergence Properties of Conjugate Gradient Methods for Optimization, (1992) *SIAM J. on Optimization*, 2, 1, pp.21-42, with J.C. Gilbert.

75. A Numerical Study of the Limited Memory BFGS Method and the Truncated-Newton Method for Large Scale Optimization, (1991), *SIAM Journal on Optimization*, 1, 3, pp. 358-372, with S. Nash.

76. The Performance of Several Algorithms for Large Scale Unconstrained Optimization, (1990), in Large Scale Numerical Optimization, eds. T. Coleman, and Y. Li, SIAM Publications.

77. An Analysis of Reduced Hessian Methods for Constrained Optimization (1991), *Mathematical Programming*, 49, pp. 285-323, with R. Byrd.

78. On the Limited Memory Method for Large Scale Optimization (1989), *Mathematical Programming B*, 45, 3, pp. 503-528, with D.C. Liu.

79. Algorithms with Conic Termination for Nonlinear Optimization (1989), *SIAM J. Scient. Stat. Computing*, Vol. 10, No. 1, pp. 1-17, with D.C. Liu.

80. A Tool for the Analysis of Quasi-Newton Methods with Application to Unconstrained Minimization (1989), *SIAM J. Numerical Analysis*, 26, 3, pp. 727-739, with R. Byrd.

81. Global Convergence of a Class of Quasi-Newton Methods on Convex Problems (1987), *SIAM J. on Numerical Analysis*, 24, No.3, pp. 1171-1189, with R. Byrd and Y. Yuan.

82. The Formulation and Analysis of Numerical Methods for Inverse Eigenvalue Problems (1987), *SIAM J. on Numerical Analysis*, 24, 3, pp. 634-667, with S. Friedland and M. Overton.

83. Viewing the Conjugate Gradient Method as a Trust Region Algorithm (1987), in Numerical Analysis, ed. J.P. Hennart, Lecture Notes in Mathematics 1230, Springer Verlag.

84. The Use of Linear Programming for the Solution of Sparse Sets of Nonlinear equations (1987), *SIAM Journal on Scient. Stat. Computing*, 8, 2, with I. Duff and J. Reid.

85. Four Quadratically Convergent Methods for Solving Inverse Eigenvalue Problems (1986), in Numerical Analysis, eds. D.F. Griffiths and G.A. Watson, Wiley, pp. 47-65, with S. Friedland and M. Overton.

86. On the Implementation of the Conjugate Gradient Method for Function Minimization (1985), Proc. 23rd Allerton Conf. on Comm., Control, Comp., Monticello Il, with B. Sullivan.

87. Projected Hessian Updating Algorithms for Nonlinearly Constrained Optimization (1985), *SIAM J. on Numerical Analysis*, Vol 22. No. 5, pp. 821-850, with M. Overton.

88. Evaluation of Step Directions in Optimization Algorithms (1985), *ACM Transactions on Mathematical Software*, Vol. 11, No.1, pp. 12-19, with W. Davidon.

89. A Conic Method for Optimization (1985), *SIAM Journal on Scientific and Statistical Computing*, Vol 6, No.2, pp. 253-267, with H. Gourgeon.

90. Trust Region Algorithms for Solving Large Systems of Nonlinear Equations (1984), in Innovative Methods for Nonlinear Problems, eds., W. Liu, T. Belytschko and K. C. Park , pp. 93-102, Pineridge Press.

91. Numerical Methods for Solving Inverse Eigenvalue Problems (1983), in Numerical Methods, eds. V. Pereyra and A. Reinoza, Lecture Notes in Mathematics 1005, pp. 212-226, with M. Overton.

92. Conjugate Direction Methods with Variable Storage (1982), *Mathematical Programming* 23, pp. 326-340, with Larry Nazareth

93. Solving Large Nonlinear Systems of Equations Arising in Mechanics (1982), in Numerical Analysis, ed. J. P. Hennart, Lecture Notes in Mathematics 909, Springer Verlag, pp. 99-105.

94. Updating Quasi-Newton Matrices with Limited Storage (1980), *Mathematics of Computation* 35, pp. 773-782.

95. Numerical Analysis Program Library - User's Guide (1980), Comunic. Tec. No. 50, IIMAS, Universidad Nacional Autonoma de Mexico, with A. Calderon.

96. Analysis of a New Algorithm for One-dimensional Minimization (1979), *Computing* 22, pp. 93-100, with P. Bjorstad.

97. On the Method of Conjugate Gradients for Function Minimization (1978), Ph.D. Dissertation, Dept. of Mathematical Sciences, Rice University.

PUBLISHED SOFTWARE:

1. VA15, Harwell Library, A Limited Memory Method for Large Scale Optimization, (1990).

2. Algorithm 778: L-BFGS-B, FORTRAN routines for large scale bound constrained optimization, (1997), ACM Transactions on Mathematical Software, Vol. 23, Num. 4, pp. 550 - 560, with C. Zhu, R. Byrd and P. Lu.

3. PREQN: FORTRAN Routines for Preconditioning the Conjugate Gradient Method (1999), *ACM Transactions on Mathematical Software*, 27,1, pp.83-91, (2001), with J.L. Morales.

4. KNITRO, A Package for Nonlinear Optimization, Manual, May 2002, with R. Waltz.

BOOK:

Numerical Optimization, Springer, (1999), 650 pp., with Stephen Wright.
Numerical Optimization, Second Edition, Springer (2006), 664 pp. with Stephen Wright.

SELECTED INVITED PRESENTATIONS AND LECTURES:

Nov 2022. Nonlinear Optimization in the Presence of Noise, Cornell University

February 2022, Nonlinear Optimization in the Presence of Noise, Purdue University.

Jan 2021, Derivative-Free Optimization of Noisy Functions, Computer Science Department, University of California, Los Angeles.

Oct 2021, Constrained Optimization in the Presence of Noise, University of Southern California,

April 2021, Derivative-Free Optimization of Noisy Functions, Online Seminar on the Mathematical Foundations of Data Science.

Nov 2019, Derivative Free Optimization for Stochastic Optimization, Rice University.

Sept 2019, Zero Order Optimization Methods with Applications in Machine Learning, MIT Operations Research Center.

March 2019, *Zero Order Methods for Noisy Optimization Problems*, University of Chicago

October 2018, *Nonlinear Optimization and Statistical Learning*, Georgia Tech

September 2018, *Nonlinear Optimization and Neural Networks*, University of California, Davis

April 2018, *Adaptive Sampling Methods for Stochastic Optimization*, Emory University.

February 2018, *Optimization Methods for Training Deep Neural Networks*, **MIT Distinguished Lecture** in Computational Science and Engineering, MIT

October 2017, *Optimization Methods for Training Deep Neural Networks*, Department of Computer Science, Cornell University

October 2017, *Optimization Methods for Training Deep Neural Networks*, Department of Operations Research and Financial Engineering, Princeton University

September 2017, *Zero-Order Methods for Nonlinear Optimization*, Simons Institute, Berkeley.

March 2017, *Large-Batch Training and Generalization Properties in Machine Learning*, Department of Industrial Engineering, University of Michigan.

March 2017, *Stochastic Methods for Machine Learning*, **Plenary Talk, SIAM** Conference on Computational Science and Engineering, Atlanta.

February 2017, Subsampled Newton Methods for Stochastic Optimization, Department of Industrial and Systems Engineering, Purdue University.

June 2016, *Stochastic Gradient Methods for Machine Learning*, International Conference on Machine Learning (ICML), New York.

May 2016, *A Doubly Stochastic Second Order Method for Large-Scale Optimization*, University of California, Berkeley

Dec 2015, *An Evolving Gradient Resampling Method for Machine Learning*, NIPS, Montreal

October 2015 *An Evolving Gradient Sampling Method for Stochastic Optimization*, University of Minnesota

June 2015 *Nonlinear Optimization Methods for Machine Learning*, International Conference on Machine Learning (ICML), Lille, France

March 2015, *Semi-Stochastic Methods for Machine Learning*, Oxford University, UK

Jan 2015 *Variance Reduction Optimization Methods for Machine Learning*, University of Southern California

July 2014 *Optimization Methods for Machine Learning*, **Plenary Talk, SIAM National Meeting**, Chicago

March 2014 *The Role of Optimization in Machine Learning*, New York Academy of Sciences Meeting on Machine Learning, New York, NY.

March 2014 *Stochastic Approximation Methods for Large Scale Learning*, INFORMS Optimization Society Meeting, Houston, **Plenary Talk**.

Feb 2014, *A Stochastic Quasi-Newton Method for Machine Learning*, IPAM, UCLA, Los Angeles

Sept 2013, *Stochastic Newton-like Methods*, Microsoft Research, Redmond, Washington

April, 2013, **Illinois Distinguished Lecture** in Operations Research: *"Optimization and the Science of Big Data",* University of Illinois at Urbana-Champaign

Aug 2012, *Second-Order Methods for Stochastic, Semi-Smooth and Nonlinear Programming*, **Plenary presentation**, International Symposium on Mathematical Programming, Berlin

Aug 2011, *Large-Scale Optimization and Regularization*, Courant Institute, New York

Nov 2010, *A Second-Order Method for Machine Learning*, Georgia Tech

Nov 2010, *A New Optimization Method for Machine Learning*, IBM Watson Research Center

Nov 2010, *A Sub-sampled Hessian Newton Method for Large-Scale Statistical Training*, Google

Aug 2010, *A Semi-Stochastic Method for Machine Learning*, International Conference on Continuous Optimization (ICCOPT), **plenary presentation**

May 2009, *Optimization of Systems Described by Differential Equations*, MIT Sloan School of Business

May 2009, *PDE-Constrained Optimization*, University of California at Davis

February 2008, *Penalty Methods, Duality and Applications*, Rice University

February 2008, *Linear Complementarity, Options Pricing and Optimization Methods*, Texas A&M

University

September 2007, *Inexact Newton Methods for PDE-Constrained Optimization*, **Plenary talk**, IMA Conference on Linear Algebra and Optimization, Birmingham, UK

April 2007, *Fast Solution of Rigid Body Simulations by Linear Complementarity*, University of Illinois at Urbana-Champaign

February 2007, *Demand Optimization*, Deloitte & Touche Workshop on Demand Optimization, New York (invited talk).

February 2007, *Equilibrium, Differential Equations and Optimization*, University of Southern California

February 2007, *Optimization, Equilibrium and Games*, Courant Institute of Mathematical Sciences, New York University, New York

Feb 2006, *Optimization and Power Generation and Electricity Markets,* Fields Institute, Toronto

October 2005, *Advances in Optimization,* London School of Economics, England

March 2005, *Interior and Penalty Methods for Nonlinear Optimization*, School of Industrial Engineering and Operations Research, Cornell University.

March 2005, *Optimization Methods for Computational Chemistry*, Dept of Chemistry, University of California, Berkeley

February 2005, *Optimizacion y Aplicaciones*, Instituto de Ciencias Nucleares, UNAM, Mexico

September 2004, *Steering Penalty Methods*, IBM T.J. Watson Research Center, New York.

June, 2004, Erice, Italy, *Penalty and Interior Methods*, Plenary Talk, International Workshop on Large-Scale Optimization.

May 2004, University of Waterloo, Canada, *Nonlinear Programming: Iterative Solution, Preconditioning and Regularization*, Plenary Talk, Meeting on Large-Scale and Semi-Definite Programming

March 2004, ChevronTexaco, California, *Optimization and Differential Equations.*

Sept 2003, University of British Columbia, Canada, Distinguished Lecture: *New Developments in Nonlinear Programming*.

Oct 2003, Napa Valley, California. Plenary lecture: "*Preconditioners for Optimization*", Third Conference on Preconditioning for Industrial and Scientific Applications, organized by the Department of Energy.

Oct 2003, INTEL, Sunnyvale, California: *Advances in the Solution of Very Large Nonlinear Optimization Problems.*

Sept 11-12, 2003. The Mathworks, Boston, MA: *The Future of Optimization Software*.

June 2003. Universitá di Roma, La Sapienza: *Active Set and Interior Methods for Large Scale Optimization.*

Nov 2002. McMaster University, Computer Science Department*: Advances in Nonlinear Programming.*

April 2001, Tahoe City, Plenary lecture: *Preconditioners for Constrained Optimization.*

April 3-10, Santa Fe, New Mexico, *The Potential of Interior Methods in PDE constrained Optimization,* invited lecture, First Conference on PDE Constrained Optimization.

Feb 2001, *SQP and Interior Methods*, Carnegie Mellon University, Chemical Engineering Department.

Nov 2000, *On the Convergence of Newton Iterations to Singular Nonstationary Points*, George Mason University, School of Computational Sciences.

Nov 2000, *The Dark Secrets of Newton's Method*, INRIA, Paris

July 1999, *Feasibility Control in Nonlinear Optimization*, plenary lecture at the Foundations of Computational Mathematics Meeting, Oxford, England.

Aug 1998, *Nonlinear Optimization: The Interplay Between Mathematical Characterizations and Algorithms,* invited talk, International Congress of Mathematicians, Berlin, Germany.

June 1998, *A Survey of Interior Point Methods for Nonlinear Programming*, invited talk at ERICE 98, Italy.

April 1998, *Metacomputing Environments for Optimization*, CERFACS, Toulouse, France.

Oct 1997, *Internet-based Optimization*, Electricité de France.

June 1997, *Interior Points vs Active Set Methods for Nonlinear programming*, invited talk at the Dundee Conference on Numerical Analysis, Dundee UK.

February 1997, *The Solution of Large Nonlinear Programming Problems*, Stanford University, EES+OR Department Seminar.

January 1997, *Interior Point Methods for Nonlinear Optimization*, invited talk at the meeting on the Foundations of Computational Mathematics, Rio de Janeiro, Brazil.

Nov 1996, *Challenges in Optimization*, invited talk during the 50th year celebration of ITAM, Mexico City.

April 1996, *Linear Algebra Problems in Constrained Optimization*, invited talk at the Linear Algebra Year, Albi, France.

April 1996, *Unconstrained Optimization*, invited talk at the State of the Art in Numerical Analysis Meeting, York, England

Nov 1995, *Bound Constrained Optimization and Limited Memory Methods*, Universidad de Buenos Aires, Argentina.

July 1995, *Constrained Optimization*, invited lecture, Meeting of the Institute of Mathematics and its Applications, Minneapolis.

June 1995, *Conjugate Gradients: A View from Nonlinear Op*timization, invited talk, AMS-SIAM Meeting, Seattle.

June 1995, *Limited Memory Methods for Optimization*, invited talk, ERICE 1995, Erice, Italy.

August 1994, *Recent Advances in Nonlinear Optimization*, semi-plenary talk at the Mathematical Programming Meeting, Ann Arbor, Michigan.

July 1993, *Trust Region Methods for Constrained Optimization*, invited talk, KTH Optimization Days, Stockholm, Sweden.

June 1993, *The Application of Optimization Methods in the Solution of Large Inverse Problems*, AMOCO Research Center, Tulsa.

May 1993, *Optimization Calculations with Applications to Meteorology and Oceanography*, **plenary talk at the Meeting of the Canadian Applied Mathematics Society**, Toronto, Canada.

June 1991, University of Minnesota AHPCRC, *A New Algorithm for Large-Scale Nonlinear Optimization with Simple Bounds*.

October 1989, Cornell University, Workshop on Large-Scale Numerical Optimization, *On the Performance of Several Algorithms for Large Scale Optimization.*

April 1989, Boston, **Plenary talk at the SIAM Meeting on Optimization**, *Practical Convergence Results for Nonlinear Programming Algorithms.*

March 1987, Johns Hopkins University, Mathematical Sciences Department, Convergence *Theory for Unconstrained Optimization*.

July 1986, University of Colorado, Boulder, Computer Science Dept., *Inverse Eigenvalue Problems.*

April 1986, Courant Institute of Mathematical Sciences, New York University, *Practical Convergence Results in Optimization*.

October 1985, Penn. State University, Computer Science Dept., *Analysis of Quasi-Newton Methods with Practical Line Searches.*

October 1984, International Conference on Innovative Methods for Nonlinear Mechanics, New Orleans, *Trust Region Algorithms for Solving Sparse Sets of Nonlinear Equations*.

April 1984, University of Toronto, Department of Computer Science, *Numerical Methods for Large Systems of Nonlinear Equations.*

July 1983, United Kingdom Atomic Research Establishment, Harwell, England, Numerical *Methods for Inverse Eigenvalue Problems*.

June 1983, Cambridge University, Dept. of Applied Mathematics and Theoretical Physics, Cambridge, England, *Conic Methods for Optimization*.

June 1982, Caracas, Venezuela, International Workshop on Numerical Analysis, *Inverse Eigenvalue Problems.*

April 1982, Bell Laboratories, Murray Hill, Computer Science Section, *On the Numerical Solution of some Inverse Eigenvalue Problems.*

Sept 1981, University of Waterloo, Computer Science Dept., *Solving Large Systems of Nonlinear Equations Arising in Mechanics.*

GRANTS AWARDED:

Airforce Office of Scientific Research, "Machine Learning and Physics Based Systems Optima

Approximation Algorithms and Training", 12/15/20 - 12/14/23, $380,000

Office of Naval Research, "Stochastic Constrained Optimization", 6/1/2021-5/30/2024, $446,000.

National Science Foundation, "Zero-Order and Stochastic Methods for Nonlinear Optimization",

8/1/20 - 7/31/23, $200,000.

DARPA, "Optimization Methods for Stochastic Data-Driven Optimization", 2018-2019, $250,000.

Office of Naval Research, "Methods for High-Dimensional Nonlinear Optimization", Jan 1, 2018 – Dec 31, 2020, $421,900.

National Science Foundation, "Collaborative Research: Algorithms for Large-Scale Stochastic Optimization", Division of Mathematical Sciences, June 2016 – July 2019, $277,000.

INTEL, "Optimization Methods for Large Scale Machine Learning, Feb 2016- Dec 2018, $150,000.

Office of Naval Research "Large Scale Optimization Methods for Data Science Applications" February 2015 - January 2018, $440,000.

Department of Energy, ``Statistical Learning, Stochastic Optimization and Active-Set Methods for Nonlinear Programming'', June 2011 – May 2014, $360,000.

Google, ``New Optimization Solvers for Machine Learning Applications'', Aug 2011- July 2012, $40,000.

National Science Foundation, ``Market-Based Calibration of Pricing Models for Financial and Energy Option Contracts'', Sept 2010-Aug 2013, $160,000.

Google, ``Large-Scale Optimization Methods for Machine Learning'', Jan 2010- Dec 2010, $70,000.

National Science Foundation, Nonlinear Optimization: Theory, Algorithms and Software, Aug 2008-

July 2011, $291,172.

Department of Energy, Nonlinear Optimization and Applications, Jan 2008—Jan 2011, $339,000.

National Science Foundation, Active-Set and Interior Algorithms for Nonlinear Optimization, $174,000, Jul 2005- Jun 2008.

INTEL, Parallel Nonlinear Optimization Algorithms, $150,000, April 2005-March 2008.

National Science Foundation, STTR, Phase II: Integrated Software and Systems for Nonlinear Optimization, $150,000, Jan 2004- Jan 2006.

Department of Energy, Nonlinear Optimization: Algorithms, Theory and Software, Aug 2004-Jul, 2008, $343,000, Grant DE-FG02-87ER25047-A008.

National Science Foundation, STTR, Phase I: Integrated Software and Systems for Nonlinear Optimization, $30,000, Jan 2003- Jan 2004.

National Science Foundation, ITR: Optimization of Systems Governed by Partial Differential Equations, Oct 2002-Sept 2005, $175,000

Department of Energy, Algorithms and Software for Nonlinear Optimization, Aug 2001-Jul 2004, $307,000, Grant DE-FG02-87ER25047-A007.

National Science Foundation, Improved Minimization Techniques in Meteorological Data Assimilation, Jan 2001-Dec 2003, $240,000, Grant No. ATM-0086579.

National Science Foundation, Large Scale Nonlinear Programming, Sept 200-Aug 2003, $270,000, Grant No. CCR 9907818.

Sandia National Laboratory, Interactive Environments for Optimization, June 1998- Oct 1998, $20,000, Contract LF-5540.

Department of Energy, Nonlinear Programming: Algorithms and Software Environments, Aug 1998-Jul 2001, $274,000, Grant DE-FG02-87ER25047-A006.

Electricite′ de France, Interior Point Methods for Power Generation Schedules, Jan 1998-Jun 1998, $10,000.

National Science Foundation, Challenges in CISE: Metacomputing Environments for Optimization, Sept 1997-Aug 2000, $1,800,000, Grant No. CDA-9726385.

Argonne National Lab, The Network Enabled Optimization System, April 97-April 98, $72,800.

Argonne National Lab, Climate Modeling on Parallel Computers, April 96-Mar 97, $53,705.

National Science Foundation, Nonlinear Optimization, Aug 96-Aug 98, $135,951, Grant No. CCR-9625613.

Argonne National Lab, Climate Modeling on Parallel Computers, Jan 96-Dec 96, $64,191. $21,750, Grant No. INT-9416004.

National Science Foundation, US-Mexico Cooperative Science: Nonlinear Optimization Techniques for Seismic Inversion Problems, March 1995-Feb 1998,

Department of Energy, Large Scale Optimization and its Application to Weather Forecasting, Aug 1995-July 1998, $249,280 Grant No. DE-FG02-87ER25047-A005.

National Science Foundation, US-France Cooperative Research: Algorithms for Large-Scale Constrained Optimization, Jun 1993-May 1996, $21,388, Grant No. INT-9220773.

Argonne National Laboratory, Climate Modeling on Parallel Computers, July 1993-March 1996, $134,885, Grant No. 31872402.

National Science Foundation, Numerical Optimization Techniques, Sep. 1994-Aug 1996, $109,998, Grant No. CCR-9400881.

National Science Foundation, Optimization Algorithms for Advanced Computer Architectures, Sep. 1992-Aug 1995, $484,593, Grant. No. ASC-9213149.

Department of Energy, Optimization and Eigenvalue Computations with Application to Meteorology and Oceanography, Aug 1992-July 1995, $226,609 Grant No. DE-FG02-87ER25047 A004.

National Science Foundation, Large Scale Nonlinear Optimization, Aug. 1991-July 31, 1994, $158,583, Grant No. CCR-9101359.

National Science Foundation, US-France (INRIA) Research; Numerical Methods for Nonlinear Optimization, Jul. 1991-May 1992, $5,250, Grant No. INT-9101901.

National Science Foundation, Numerical Methods for Nonlinear Optimization, Feb. 1990-Feb. 1992, $55,000, Grant No. CCR-8902096.

Department of Energy, Algorithms and Software for Large Scale Optimization, Aug 1989-Sept 1992, $229,850, Grant No. DE-FG02-87ER25047 A001.

National Science Foundation, Adaptive Mode Decomposition Methods, Sep. 1988-Feb. 1991, $176,902, Grant No. ASC 8719583, co-principal investigator with Alvin Bayliss and Ted Belytschko.

Department of Energy, Optimization Software and Parallel Eigenvalue Computations, Aug 1987-Sept. 1989, $131,000, Grant No. DE-FG02-87ER25047.

National Science Foundation, Algorithms for Optimization and Inverse Eigenvalue Problems, July 1986-Dec. 1989, $115,000, Grant No. DCR-8602071.

National Science Foundation, Numerical Methods for Nonlinear Optimization, July 1984-Dec. 1986, $41,000, Grant No.DCR-8401903.

National Science Foundation-Conacyt Cooperative Science Program, 1980-1981, on Numerical Computations in Nonlinear Mechanics.