

CURRICULUM VITAE
JORGE NOCEDAL

ADDRESS: Jorge Nocedal
Department of Electrical Engineering and Computer Science
Northwestern University
Evanston IL 60208-3118

EDUCATION:

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

PROFESSIONAL EXPERIENCE:

2001-2004	Director, Computational Science Institute, Northwestern University
1994-2000	Co-Director and Founder, Optimization Technology Center (OTC)
1992-present	Professor, Dept. of Electrical and Computer Engineering and Dept. of Industrial Engineering and Management Sciences, Northwestern University
1986-1992	Associate Professor, Dept. of Electrical Engineering and Computer Science, Northwestern University
1987, 1993	Visiting Research Scientist, Argonne National Laboratory
1983-1985	Assistant Professor, Dept. of Electrical Engineering and Computer Science Northwestern University
1981-1983	Research Associate, Courant Institute of Mathematical Sciences, NYU
1978-1981	Assistant Professor, IIMAS, National University of Mexico

RESEARCH INTERESTS:

Optimization, scientific computing, software; applications of optimization in computer-aided design, finance, atmospheric sciences, machine learning, and medical imaging.

HONORS AND DISTINCTIONS:

2004	ISI Highly Cited Researcher (Mathematics category)
1998	Harris Professor of Teaching Excellence
1998	Invited Speaker, International Congress of Mathematicians
1995	Co-Editor, <i>Mathematical Programming</i>

EDITORIAL BOARDS:

1989- present	Mathematical Programming - Associate Editor
1989- present	SIAM Journal on Optimization - Associate Editor
2006- 2009	SIAM Review
2003- 2007	SIAM-MPS Book Series – Associate Editor

1995- 2001	Mathematical Programming - Co-Editor
1991-1995	Mathematics of Computation - Associate Editor

ACADEMIC ACTIVITIES:

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

PATENT:

Debt Collection Practices, Patent 7,403,923, issued July 22, 2008, US Patent Trademark Office.

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

2012(exp)	Gillian Chin, PhD
2010(exp)	Yuchen Wu, PhD
2007	Frank Curtis, PhD
2007	Long Hei, Ph.D.
2006	Gabriel Lopez 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 Conolly, 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 (copyright by Northwestern)
2002-present	Chief Scientist, Ziena Optimization Inc.

CONSULTING:

2004	Chevron-Texaco, San Ramon, California
2001-present	Ziena Optimization Inc
2001-2002	Accenture, Chicago, Il

1998-2002	Synopsys, Sunnyvale California
1993	AMOCO, Tulsa Oklahoma
1988	Resource Control Systems, Chicago II
1987	SYSTAT, Evanston II
1984	Gould Research, Chicago II
1983, 1988	United Kingdom Atomic Energy Research Establishment, Computer Science Div., Harwell, England
1980	Instituto Mexicano del Petróleo, México D.F.

PUBLICATIONS:

1. *A Line Search Exact Penalty Method Using Steering Rules*, with R. Byrd and G. Lopez-Calva, submitted for publication in *Mathematical Programming* (2009).
2. *A Sequential Quadratic Algorithm with an Additional Equality Constrained Phase*, with J.L. Morales and Y. Wu, submitted for publication in *SIAM J. Optimization* (2008)
3. *Infeasibility Detection and SQP Methods for Nonlinear Optimization*, with R. Byrd and F. Curtis, submitted for publication in *SIAM J. Optimization* (2008)
4. *A Matrix-Free Algorithm for Equality Constrained Optimization Problems with Rank-Deficient Jacobians*, with F. Curtis and A. Waechter, submitted for publication in *SIAM J. Optimization* (2008)
5. *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). DOI: 10.1080/10556780802409296
6. *Adaptive Barrier Strategies for Nonlinear Interior Methods*, *SIAM J. Optimization*, Volume 19, Issue 4, pp. 1674-1693, with A. Waechter and R. Waltz, (2008).
7. *An Inexact Newton Method for Nonconvex Equality Constrained Optimization*, to appear in *Mathematical Programming*, with R. Byrd and F. Curtis (2009).
8. *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)
9. *Flexible Penalty Functions for Nonlinear Constrained Optimization*, *IMA Journal on Numerical Analysis*, Volume: 28 Issue: 4 pp.: 749-769, with F. Curtis (2008).
10. *Data Assimilation in Weather Forecasting: A Case Study in PDE-Constrained Optimization*, *Optimization and Engineering*, with M. Fisher, Y. Tremolet and S. Wright, DOI: 10.1007/s11081-008-9051-5 (2008).
11. *Steering Penalty Methods*, *Optimization Methods and Software*, 23, 2, pp. 197-213, with R. Byrd and R. Waltz, (2008).

12. *Inexact SQP Methods for Equality Constrained Optimization*, SIAM J. Optimization, vol. 19, no. 1, pp. 351-369, with R. Byrd and F. Curtis (2008).
13. *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).
14. *Steplength Selection in Interior-Point Methods*, with F. Curtis, Applied Math Letters, Volume 20, Issue 5, (2007), Pages 516-523.
15. *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).
16. *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).
17. *An Interior Algorithm for Nonlinear Optimization that Combines Line Search and Trust Region Steps*, Mathematical Programming A, vol. 102, pp. 391-408, with R. Waltz, J.L. Morales and D. Orban, (2006).
18. *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).
19. *A Starting-Point Strategy for Nonlinear Interior Methods*, Applied Math Letters, Vol 17, pp. 945-952, with M. Gertz and A. Sartenaer (2004).
20. *An Active-Set Algorithm for Nonlinear Programming Using Linear Programming and Equality Constrained Subproblems*, Mathematical Programming B, 100, 1, pp. 27-48, (2004).
21. *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.
22. *On the Convergence of Newton Iterations to Non-Stationary Points*, Mathematical Programming A, 99, pp. 127-148 (2004), with R. Byrd and M. Marazzi.
23. *Feasible Interior Methods Using Slacks for Nonlinear Optimization*, Computational Optimization and Applications, Vol 26,1, (2003), with R. Byrd and R. Waltz.
24. *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.
25. *Wedge Trust Region Methods for Derivative Free Optimization*, Mathematical Programming, 91 (2002) 2, 289-305, with M. Marazzi.
26. *iNEOS: An Interactive Environment for Optimization*, Applied Numerical Math. 40: 49-58, January 2002, with M. Good, J-P. Goux and V. Pereyra.

27. *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.
28. *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.
29. *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.
30. *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.
31. 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.
32. *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.
33. Combining Trust Region and Line Search Techniques, in: Y. Yuan, ed., *Advances in Nonlinear Programming*, (Kluwer, 1998), pp. 153--175, with Ya-xiang Yuan.
34. *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.
35. *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.
36. *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.
37. 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.
38. Automatic Preconditioning by Limited Memory Quasi-Newton Updating (2000), *SIAM J. Optimization*, 10,4, pp. 1079-1096, with J.L. Morales.
39. 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.
40. 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.
41. 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.

42. 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.
43. 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.
44. 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.
45. 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.
46. 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.
47. 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.
48. Automatic Column Scaling Strategies for Quasi-Newton Methods, *SIAM Journal on Optimization*, Vol.3, no.3, 1993, pp. 637-653, with M. Lalee.
49. The Limited Memory Step Computation and Automatic Differentiation, (1993), *Applied Math Letters*, Vol. 6, No. 3, pp. 47-50, with J. C. Gilbert.
50. Analysis of a Self-Scaling Quasi-Newton Method, (1993), *Mathematical Programming*, Vol. 61, no. 1, pp. 19-37, with Y. Yuan.
51. Theory of Algorithms for Unconstrained Optimization, *Acta Numerica*, Vol. 1, pp. 199-242, 1992.
52. 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.
53. Global Convergence Properties of Conjugate Gradient Methods for Optimization, (1992) *SIAM J. on Optimization*, 2, 1, pp.21-42, with J.C. Gilbert.
54. 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.
55. The Performance of Several Algorithms for Large Scale Unconstrained Optimization, (1990), in *Large Scale Numerical Optimization*, eds. T. Coleman, and Y. Li, SIAM Publications.
56. An Analysis of Reduced Hessian Methods for Constrained Optimization (1991), *Mathematical Programming*, 49, pp. 285-323, with R. Byrd.
57. On the Limited Memory Method for Large Scale Optimization (1989), *Mathematical Programming B*, 45, 3, pp. 503-528, with D.C. Liu.
58. Algorithms with Conic Termination for Nonlinear Optimization (1989), *SIAM J. Scient. Stat. Computing*, Vol. 10, No. 1, pp. 1-17, with D.C. Liu.

59. 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.
60. 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.
61. 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.
62. 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.
63. 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.
64. 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.
65. 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.
66. Projected Hessian Updating Algorithms for Nonlinearly Constrained Optimization (1985), *SIAM J. on Numerical Analysis*, Vol 22. No. 5, pp. 821-850, with M. Overton.
67. Evaluation of Step Directions in Optimization Algorithms (1985), *ACM Transactions on Mathematical Software*, Vol. 11, No.1, pp. 12-19, with W. Davidon.
68. A Conic Method for Optimization (1985), *SIAM Journal on Scientific and Statistical Computing*, Vol 6, No.2, pp. 253-267, with H. Gourgeon.
69. 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.
70. 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.
71. Conjugate Direction Methods with Variable Storage (1982), *Mathematical Programming* 23, pp. 326-340, with Larry Nazareth
72. 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.
73. Updating Quasi-Newton Matrices with Limited Storage (1980), *Mathematics of Computation* 35, pp. 773-782.
74. Numerical Analysis Program Library - User's Guide (1980), Comunic. Tec. No. 50, IIMAS, Universidad Nacional Autonoma de Mexico, with A. Calderon.
75. Analysis of a New Algorithm for One-dimensional Minimization (1979), *Computing* 22, pp. 93-100, with P. Bjorstad.

76. 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 Steve Wright.
Numerical Optimization, Second Edition, Springer (2006), 664 pp. with Steve Wright.

SELECTED INVITED PRESENTATIONS AND LECTURES:

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

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. Università 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 Optimization*, 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 AHPARC, *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:

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 2000-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.

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