COMBINATORICS & OPTIMIZATION Waterloo Prof. Henry Wolkowicz
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www.math.uwaterloo.ca/~hwolkowi/

as of August 1, 2024

Personal Data

Citizenship: Canadian (as of 1956)

Born: Lodz, Poland, Feb. 25, 1948 (arrived in Canada December, 1949)

Married: Sept. 19, 1970.

Children: Son Daniel Howard, born Sept. 19, 1990.

Academic Information

Degrees:

1972 B.Sc. (Mathematics)	McGill University, Montreal
1975 M.Sc. (Applied Mathematics)	McGill University, Montreal
1978 Ph.D. (Mathematics)	McGill University, Montreal

Academic Positions:

1977	Lecturer, Department of Mathematics, McGill University
1978-1979	Assistant Professor, Department of Mathematics, Dalhousie University
1979-1985	Assistant Professor (promoted to assoc. in 1981), Department of Mathematics, University of Alberta
1985-1986	Associate Professor, Department of Mathematical Sciences, University of Delaware
1986-	Professor, tenured (promoted to full in 1989), Dept. of Comb. & Opt., Univ. of Waterloo

Research Activities

Areas of Interest: Optimization; Mathematical Programming (linear, nonlinear, semidefinite programming, semi-infinite); Low Rank Matrix Completions, Compressive Sensing; Quadratic Assignment, Graph Partitioning, Knapsack Problems; Numerical Analysis (numerical linear algebra); Convex Analysis; Matrix Theory (eigenvalue bounds, invariant cones); Generalized Inverses (operators and matrices).

Visiting Appointments:

1982	Visiting Associate professor,, Teaching and Research (invited)
	Institute for Physical Science and Technology, The University of Maryland
1984-1985	Visiting Associate Professor (invited)
	Department of Mathematics and Computer Science, Emory University
1992/93	Visiting professor and Research Fellow (invited)
	Department of Civil Engineering and Operations Research, Princeton University
1999	Summer Research Visitor (invited)
	Laboratoire Approximation & Optimisation, Universite Paul Sabatier (Toulouse III)
2001	Summer Lecturer (invited)
	CEFET-RJ, UFRJ, UFF, IMPA, Rio de Janeiro, Brazil
2002	Summer Lecturer (invited)
	Scuola Matematica Interuniversitaria, Cortona/Firenze, Italy
2007	Summer Lecturer (invited)
	MSRI, Berkeley/CA, USA
2008-	Various research visits; info. available at this link/my web page

Recognitions

- **Fellow** Society for Industrial and Applied Mathematics (SIAM) 2015-

- Elected to the ILAS (International Linear Algebra Society) Board, January, 2015-

- Elected Chair for the SIAM Activity Group on Optimization (SIAG/OPT) 2001-2004

- Co-Chair Organizing Committee, SIAM Optimization Meeting, Stockholm, 2005

- Elected to SIAM Council, 2006; re-elected 2008.

- Program Chair for ICCOPT II, at McMaster University, August, 2007.

- Program Committee for SIAM Conference on Optimization (OP20), May, 2020.

Teaching/Seminars/Students and Activities:

Courses (and Short Courses) Given:

1. The webpage www.math.uwaterloo.ca/~hwolkowi//henry/reports/talks.d/talks.html contains a list of seminars, tutorials, workshops, invited talks, and conferences attended, by year. Links to the talks are included. A few pre-2016 items are included below.

2. Graduate and related:

   (a) **Invited Optimization Courses/Workshops Given**:
   • DIMACS Workshop on Distance Geometry: Theory and Applications, July 26 - 29, 2016, Tutorial on Facial Reduction. • MSRI, Berkeley, CA, July 9-20, 2007
   • Short Course on Semidefinite Programming, Eigth SIAM Conference on Optimization, Stockholm, May 15-18, 2005
   • Short course presentation Waterloo, ON, May, 2004
   • Scuola Matematica Interuniversitaria, Firenze, Italy, Aug. 18-31, 2002
   • Fields Institute, Jan.-Apr. 2002
   • Joint Short Course, UFRJ, CEFET, IMPA in Rio de Janeiro, Brazil, on SDP and QAP, Apr. 10-24, 2001. • Tutorial on SDP at the 44th annual conference of the Canadian Operational Research Society, June 3-5, 2002. At the Toronto Colony Hotel, Toronto, Canada. • Invited special 90 minute talk/tutorial on Facial at the 2018 INFORMS annual meeting, Phoenix, Arizona.

(b) **Selection of University Courses Given**:
University of Alberta - Convex Analysis and Optimization
The University of Maryland - Nonlinear Programming
Emory University - Numerical Analysis
University of Delaware - Nonlinear Programming; Advanced Linear Programming; Introduction to Statistics
University of Waterloo - Continuous Optimization; Convex Optimizaton; Infinite Linear Programming; Topics courses on Semidefinite Programming

3. Undergraduate:
McGill University - Applied Matrix Algebra
Dalhousie University - Calculus; Numerical Methods and Structured programming; Nonlinear Programming
University of Alberta - Numerical Analysis ; Calculus; Mathematical Programming
University of Delaware - Introduction to Statistics; Finite Mathematics
University of Waterloo - Nonlinear Programming; Methods of Operations Research (coordinator); Linear Programming; Linear Algebra

NSERC Scholarship Summer Students

Mike Lamoreaux, The University of Alberta, 1983.

Luo Quan Zheng, University of Waterloo, 1988.

Cathy Bakos, University of Waterloo, 1990.

Bernard Hsiung, University of Waterloo, 1990.

Miguel Anjos, University of Waterloo, 1991.

Dorian Birsan, University of Waterloo, 1991

Jason Hinek, University of Waterloo, 1999

Leo Tzou, University of Waterloo, 2000

Charles Fortin, University of Waterloo, 2001

Oleg Grodzevich, University of Waterloo, 2002

David Tweedle, University of Waterloo, 2004

David Tweedle, University of Waterloo, 2005

Jamie Sikora, University of Waterloo, 2005

Jiawei Qian, University of Waterloo, 2006

Hao Sun, University of Waterloo, 2012

Bo Yang Liu, University of Waterloo, 2013

Hao Sun, University of Waterloo, 2013

Hao Sun, University of Waterloo, 2014

Ian Davidson, University of Waterloo, 2015-2016 (research report)

Shimeng Huang, University of Waterloo, 2016 Published paper)

Linchuan Wei, University of Waterloo, 2017 Published Paper

Chong Rong (Matt) Dong, USRA, Winter 2020.

Graduate Students:

M.Math.:

- Ravindar Kumar, "Bounds for Eigenvalues", University of Alberta, 1984, [1].
- Christopher Schoettle, "The teaching assignment problem", Emory University, 1985, [2].
- Peter Stephan, "An explicit solution to the quadratic dynamic programming problem", Emory University, 1985, [3].
- Donna Tudhope, University of Waterloo (by essay) 1987.
- Joe Lund, "Optimal vehicle replacement policy", 1988, [4].
- Qing Zhao, "Measures for Least Change Secant Methods", University of Waterloo, 1992 [5].
- Steven Thomas, "Optimal Project Planning for a Pharmaceutical Company", University of Waterloo.
- Stefan Karisch, "Trust Regions and the Quadratic Assignment Problem", "University of Waterloo", 1992, [6].
- Serge Kruk, "Semidefinite Programming Applied to General Nonlinear Programming", "University of Waterloo", 1996, [7].
- Charles Fortin, "A Survey of the Trust Region Subproblem within a Semidefinite Framework" "University of Waterloo", 2000, [8].
- Mike Froh, Thesis, "University of Waterloo", 2003, [9]
- Kathrin Schaeke, Essay, "University of Waterloo", Mar. 2004, [10]
- Oleg Grodzevich, Thesis, "University of Waterloo", Dec. 2004, [11]
- Yichuan Ding, "University of Waterloo", Dec. 2005, [12]
- Xuezhi (Daniel) Cui, "University of Waterloo", Sept. 2010, [13]
- Heng (Jerry) Ye, "University of Waterloo", completed,
- Ningchuan Wang, "University of Waterloo", Sept. 2014 completed.
- Tom Sumbler, "University of Waterloo", Aug. 2015.
- Xinghang Ye, "University of Waterloo", completed Sept. 2016.
- Alister Zhenyu Liao, "University of Waterloo", completed Sept. 2016.
- Jiyoung (Haesol) Im, "University of Waterloo", completed Sept. 2016-18.
- Lanlan Yu, "University of Waterloo", Sept. 2018 - Sept 2019. (thesis)
- Naomi Graham, "University of Waterloo", Sept. 2018 - Sept 2020. (thesis)
- Mingyu Yang, "University of Waterloo", Sept. 2018 - Dec. 2019. (thesis)
- Ryan Hughes, "University of Waterloo", May. 2018 - Sept 2019. (thesis)
- Tyler Weams, "University of Waterloo", Sept. 2021-ongoing.
- Xuetong Wang, "University of Waterloo", Sept. 2021- Sept. 2022. (thesis)
- Jeff Cheng, "University of Waterloo", Jan. 2022- Apr. 2023. (thesis)
- Tina Xu, "University of Waterloo", Sept. 2023- Sept. 2024.

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Ph.D.:

- Scott Hadley, "Continuous Optimization Approaches for the Quadratic Assignment Problem", University of Waterloo, 1990, [14].
- Qing Zhao, "Semidefinite Programming and Applications", University of Waterloo, 1996, [15].
- Serge Kruk, "High Accuracy Algorithms for the Solutions of Semidefinite Linear Programs", "University of Waterloo", (Dec/01), [16].
- Miguel Anjos, "New Convex Relaxations for the Maximum Cut and VLSI Layout Problems", University of Waterloo, [17], 2001.
- Francesc Rossell, visiting graduate student from Dept. of Statistics & Operations Research. Pau Gargallo, 5, 08026, Barcelona, Catalonia, 2002.
- Renata Sotirov, visiting graduate student from Institut fuer Mathematik, Universitaet Klagenfurt, Austria, 2003.
- Pawoumodom L. Takouda, visiting graduate student from Laboratoire Approximation & Optimisation, Universite Paul Sabatier (Toulouse III), France, 2004.
- Hua Wei, Thesis, "Robust Solutions for Large Sparse Linear and Semidefinite Programming", 2005, [18].
- Marina Potaptchik, Thesis, "Portfolio Selection Under Nonsmooth Convex Transaction Costs", 2006, [19].
- Nathan Krislock, "University of Waterloo", Apr. 2010, [20]
- Minghua LIn, Thesis, "Angles, Majorization, Wielandt Inequality and Applications", 2013, [21].
- Yuen-Lam Cheung, Thesis, "Preprocessing and Reduction for Semidefinite Programming via Facial Reduction: Theory and Practice", 2013, [22].
- Dessalegn Hirpa, Sept. 2014, stopped early Dec. 2015.
- Hao Hu, May-Sept. 2018. (visiting PhD)
- Stefan Sremac, Sept. 2015-2020. (thesis)
- Xiao-Bo Li, Sept. 2015 - 2019, completed in C.S.
- Lubke, Daniela, Feb. - Sept. 2017. (visiting PhD)
- Sina Rezazadeh Baghal, May 2018 - May 2019 (not completed)
- Jiyoung (Haesol) Im, "University of Waterloo", Sept. 2019 - Feb. 2023. (thesis)
- Leo Woosuk Jung, "University of Waterloo", Sept. 2022 (ongoing)
- David Torregrosa-Belen, "University of Waterloo", Feb. 2023 (visiting PhD)
- Mengmeng Song "University of Waterloo", Feb. 2023 (visiting PhD)
- Tyler Weams, "University of Waterloo", Jan. 2024-ongoing.

Post. Doctorate Supervision:

- V. Jeyakumar, 1986
- Julie Falkner 1994
- Abdo Alfakih 1997-98
- Abdo Alfakih 1/2001-4/2001
- Veronica Piccialli, March-April, 2004.
- Pawoumodom L. Takouda, Sept. 2004 - July 2005.
- Veronica Piccialli, Sept. 2005 - March 2006.

- Simon Schurr, Nov. 2006 - Nov 2008.
- Pang Chin How (Jeffrey) Pang, Sept. 2009 - Sept. 2010.
- Vinh Xuan Doan, Nov. 2009 - Aug. 2011.
- Jason, Hinek, Sept. 2010 - Dec. 2010.
- Nathan Krislock, May. 2010 - Dec. 2010.
- Gillis, Nicolas, Sept. 2011 - 2012.
- Yuen-Lam Cheung, Oct. 2013 - Feb. 2014.
- Pong, Ting Kei, May 2011 - May 2013.
- Drusvyatskiy, Dmitriy, Sept. 2013 - Sept. 2014.
- Xu, Yangyang, Aug. 2014 - Aug. 2015.
- Oliveira, Danilo, Mar. - Dec. 2015.
- Wang, Fei, Feb. - Sept. 2017.
- Li, Minghua, Jan. - Sept. 2018.
- Wang, Fei, Sept. - Dec. 2019.
- Hu, Hao, Oct. - Oct. 2019-21.
- Bui, Minh, Oct. 2021- May 2022.
- Barshad, Kay, May. 2023 (continuing)

Sabbatical/Research Visitors

- Gonzalez-Lima, Maria, Sept. 2001 - Sept. 2002.
- Salahi, Maziar, Mar. 2015-16.
- Li, Xinxin, Jan. 2019 to Dec. 2019.

Service
Library Committee – University of Alberta – 1980-1985.
Undergraduate Affairs Committee – University of Waterloo – 1987-1989.
Tenure and Promotions Committee – University of Waterloo – 1996-1997.
Student Appeals Committee – University of Waterloo – 1996-1997.
Associate Chairman, Graduate Student Affairs – University of Waterloo – 1989-1991.
Associate Chairman, Graduate Student Affairs – University of Waterloo – 1997-1998.
University Student Appeals Committee – University of Waterloo – 2005-6.
Dept. representative to the University committee for the Fields Instit. — 2006-7. (various other committees including examiner of theses and promotion)
Graduate officer Computational Mathematics, University of Waterloo, 2017-2020, in progress.

Professional Activities
Societies:

Society for Industrial and Applied Mathematics,

Mathematical Programming Society,

International Linear Algebra Society,

INFORMS

Consulting and Technological Transfers:
Edmonton Transit, 1983.
Teleride-Sage, Toronto, 1988-1989.
CIBA-GEIGY, Toronto, 1991-1992.
Private Company - Sam Bottner 1997-98.
Canada Correctional Services 1998.
Kitchener Transit 1999.
Bell University Labs, 2002-6.
Waterfront International Ltd (Financial), 2007-2013.

Other:

Elected to the ILAS (International Linear Algebra Society) Board, January, 2015.

Elected Chair for the SIAM Activity Group on Optimization (SIAG/OPT) for a three-year term beginning retroactively on January 1, 2001 and ending December 31, 2004.

Elected to SIAM Council, 2006; re-elected 2008.

Co-chair organizer for MOTPA06 conference at Univ. of Waterloo, July, 2006.

Program Chair for ICCOPT II, to be held at McMaster University, August, 2007.

Chair Organizing Committee, SIAM Optimization Meeting, Stockholm, 2005.

Co-chair Organizing Committee, SIAM Optimization Meeting, Stockholm, 2005.

Associate Editor Mathematics of Operations Research.

Associate Editor Mathematical Programming, 2007-2014.

Associate Editor SIOPT (SIAM J. of Optimization).

Associate Editor of Operations Research, 1996-98.

Associate Editor, SIAM Book Series on Fundamentals of Algorithms

Associate Editor, Optimization and Engineering, OPTE, (Kluwer)

Associate Editor, J. of Computational Optimization and Applications , COAP,

Associate Editor, of the Canadian Applied Mathematics Quarterly, CAMQ,

Associate Editor, Algorithmic Operations Research, (FACETS Inc.)

Associate Editor, J. of Global Optimization, JOGO,

Associate Editor, J. of Combinatorial Optimization, JOCO,

Associate Editor, Canadian Applied Mathematics Quaterly

Associate Editor, American J. of Mathematical and Management Sciences

Associate Editor, Special Issue in Mathematical Programming on Fields Workshop in Memory of Jos Sturm

Associate Editor, Special Issue in Linear Algebra and its Applications, Regina ILAS Conference

Invited Associate editor, "Algorithmic Operations Research, FACETS

Editorial Advisory Board of The Encyclopedia of Optimization, Kluwer

Many invited plenary talks and also organizer of several conferences. More details are available on my WWW home page.

Member of the Division of Mathematics for Industry and Commerce, University of Waterloo

Joint organizer of several workshops on semidefinite programming and optimization, 1993 (DIMACS), 1996 (Fields), 2000 April and August (Fields), and Waterloo, 2004.

SIAG Prize Committee in Numerical Linear Algebra, 1991-92.

Invited editor for special issue on Convex Analysis in Mathematical Programming, 1993

Invited editor for special issue in honour of Ingram Olkin's birthday in Linear Algebra and its Applications, 1994.

Invited editor for secial issue on Semidefinite Programming, in Mathematical Programming, 1995

Editor of special issue on Semidefinite Programming in J. Global Optimization, 1997.

Editor of Handbook on Semidefinite Programming, Kluwer, 2000.

Invited editor for secial issue on Semidefinite Programming, in Mathematical Programming, 2005

Referee of approximately 12 papers per year

Math Reviews for 4 papers per year

Reviews for promotion and tenure and grant applications for approximately 4 per year.

Research and Publications:
A list of publications (including student theses) is included below. A record of my various research activities, talks, and publications is kept on my home page with URL:
 www.math.uwaterloo.ca/~hwolkowi/. A list of publications (with abstracts and links to ps/pdf files) can be obtained with URL:
 orion.math.uwaterloo.ca/~hwolkowi/henry/reports/ABSTRACTS.html. A complete list of publications can be obtained with:
 www.math.uwaterloo.ca:80/~hwolkowi/henry/reports/refpubl/node1.html. Plenary talks, invited courses and other presentations can be obtained with www.math.uwaterloo.ca:80/ hwolkowi/henry/reports/talks.d/talks.html

Publications Links; Including Student Theses:

References

[1] R. Kumar. Bounds for eigenvalues. Master's thesis, University of Alberta, 1984. 4

[2] C. Schoettle. The teaching assignment problem. Master's thesis, Emory University, 1985. 4

[3] P. Stephan. An explicit solution to the quadratic dynamic programming problem. Master's thesis, Emory University, 1985. 4

[4] J. Lund. Optimal vehicle replacement policy. Master's thesis, University of Waterloo, 1988. 4

[5] Q. Zhao. Measures for least change secant methods. Master's thesis, University of Waterloo, 1993. 4

[6] S.E. Karisch. Trust regions and the quadratic assignment problem. Master's thesis, University of Waterloo, 1992. 4

[7] S. Kruk. Semidefinite programming applied to nonlinear programming. Master's thesis, University of Waterloo, 1996. 4

[8] C. Fortin. A survey of the trust region subproblem within a semidefinite framework. Master's thesis, University of Waterloo, 2000. 4

[9] M. Froh. Trust region subproblems and linear least-squares regularization. Master's thesis, University of Waterloo, 2003. 4

[10] K. Schaecke. Essay on: The Kronecker product. Master's thesis, University of Waterloo, 2004. 4

[11] O. Grodzevich. Regularization using a parameterized trust region subproblem. Master's thesis, University of Waterloo, 2004. 4

[12] Y. Ding. On efficient semidefinite relaxations for quadratically constrained quadratic programming. Master's thesis, University of Waterloo, 2007. 4

[13] X. Cui. Computing the nearest correlation matrix using difference map method. Master's thesis, University of Waterloo, 2010. 4

[14] S.W. Hadley. *Continuous Optimization Approaches to the Quadratic Assignment Problem*. PhD thesis, University of Waterloo, 1989. 5

[15] Q. Zhao. *Semidefinite Programming for Assignment and Partitioning Problems*. PhD thesis, University of Waterloo, 1996. 5

[16] S. Kruk. *High Accuracy Algorithms for the Solutions of Semidefinite Linear Programs*. PhD thesis, University of Waterloo, 2001. 5

[17] M.F. Anjos. *New Convex Relaxations for the Maximum Cut and VLSI Layout Problems*. PhD thesis, University of Waterloo, 2001. 5

[18] H. Wei. *Numerical Stability in Linear Programming and Semidefinite Programming*. PhD thesis, University of Waterloo, 2006. 5

[19] M. Potaptchik. *Portfolio Selection Under Nonsmooth Convex Transaction Costs*. PhD thesis, University of Waterloo, 2006. 5

[20] N. Krislock. *Semidefinite Facial Reduction for Low-Rank Euclidean Distance Matrix Completion*. PhD thesis, University of Waterloo, 2010. 5

[21] M. Lin. *Angles, Majorization, Wielandt Inequality and Applications*. PhD thesis, University of Waterloo, 2013. 5

[22] Y.-L. Cheung. *Preprocessing and Reduction for Semidefinite Programming via Facial Reduction: Theory and Practice*. PhD thesis, University of Waterloo, 2013. 5

[23] Heinz H. Bauschke, Regina S. Burachik, Patrick L. Combettes, Veit Elser, D. Russell Luke, and Henry Wolkowicz, editors. *Fixed-point algorithms for inverse problems in science and engineering*, volume 49 of *Springer Optimization and Its Applications*. Springer, New York, 2011.

[24] R. Bhatia, R. Guralnick, S. Kirkland, and H. Wolkowicz, editors. *12th ILAS Conference Proceeding, Regina 2005*, volume 421,1. Elsevier, 2007. Held in Regina, SK, June 26–29, 2005.

[25] E. Andersen, E. de Klerk, L. Tunçel, H. Wolkowicz, and S. Zhang, editors. *Large Scale Nonlinear and Semidefinite Programming*, volume 109, 2-3, Ser. B. North-Holland Publishing Co., Amsterdam, 2007. Dedicated to the memory of Jos Sturm, Math. Programming, Ser. B.

[26] P. Pardalos and H. Wolkowicz, editors. *New approaches for hard discrete optimization.* Springer, Norwell, MA, 2002. Papers from the Fields Workshop on Novel Approaches to Hard Discrete Optimization held at the University of Waterloo, Waterloo, ON, April 26–28, 2001, J. Comb. Optim. **6** (2002), no. 3.

[27] Panos Pardalos and Henry Wolkowicz, editors. *Novel approaches to hard discrete optimization*, volume 37 of *Fields Institute Communications.* American Mathematical Society, Providence, RI, 2003. Papers from the workshop held at the University of Waterloo, Waterloo, ON, April 26–28, 2001.

[28] P. Pardalos and H. Wolkowicz, editors. *Topics in Semidefinite and Interior-Point Methods*, The Fields Institute for Research in Mathematical Sciences, Communications Series, Providence, RI, 1998. American Mathematical Society.

[29] P. Pardalos and H. Wolkowicz, editors. *Semidefinite Programming and Interior-Point Approaches for Combinatorial Optimization Problems.* Kluwer Academic Publishers, Hingham, MA, 1998. Papers from the workshop held at the University of Toronto, Toronto, ON, May 15–17, 1996, J. Comb. Optim. **2** (1998), no. 1.

[30] M.L. Overton and H. Wolkowicz, editors. *Semidefinite Programming.* North-Holland Publishing Co., Amsterdam, 1997. Dedicated to the memory of Svatopluk Poljak, Math. Programming **77** (1997), no. 2, Ser. B.

[31] F. Pukelsheim, G. P. H. Styan, H. Wolkowicz, and I. Zaballa, editors. *Special Issue Honoring Ingram Olkin.* Elsevier Science Inc., 1994. Linear Algebra and Its Applications **199** (1994).

[32] P. Pardalos and H. Wolkowicz, editors. *Quadratic assignment and related problems.* American Mathematical Society, Providence, RI, 1994. Papers from the workshop held at Rutgers University, New Brunswick, New Jersey, May 20–21, 1993.

[33] H. Wolkowicz, R. Saigal, and L. Vandenberghe, editors. *Handbook of semidefinite programming.* International Series in Operations Research & Management Science, 27. Kluwer Academic Publishers, Boston, MA, 2000. Theory, algorithms, and applications.

[34] N. Krislock and H. Wolkowicz. Euclidean distance matrices and applications. In *Handbook on semidefinite, conic and polynomial optimization*, volume 166 of *Internat. Ser. Oper. Res. Management Sci.*, pages 879–914. Springer, New York, 2012.

[35] H. Wolkowicz. Generating eigenvalue bounds using optimization. In *Nonlinear analysis and variational problems*, volume 35 of *Springer Optim. Appl.*, pages 465–490. Springer, New York, 2010.

[36] H. Wolkowicz. Semidefinite programming. In L. Hogben, editor, *CRC Handbook of Linear Algebra (HLA)*, pages 51–1–51–13. CRC Press, Bacon Raton, Fl, 2007. 2008 Choice Magazine Outstanding Academic Title.

[37] H. Wolkowicz. Semidefinite programming approaches to the quadratic assignment problem. In *Nonlinear assignment problems*, volume 7 of *Comb. Optim.*, pages 143–174. Kluwer Acad. Publ., Dordrecht, 2000.

[38] A.Y. Alfakih and H. Wolkowicz. Matrix completion problems. In *Handbook of semidefinite programming*, volume 27 of *Internat. Ser. Oper. Res. Management Sci.*, pages 533–545. Kluwer Acad. Publ., Boston, MA, 2000.

[39] Y.E. Nesterov, H. Wolkowicz, and Y. Ye. Semidefinite programming relaxations of nonconvex quadratic optimization. In *Handbook of semidefinite programming*, volume 27 of *Internat. Ser. Oper. Res. Management Sci.*, pages 361–419. Kluwer Acad. Publ., Boston, MA, 2000.

[40] S. Kruk and H. Wolkowicz. Sequential, quadratic constrained, quadratic programming for general nonlinear programming. In *Handbook of semidefinite programming*, volume 27 of *Internat. Ser. Oper. Res. Management Sci.*, pages 563–575. Kluwer Acad. Publ., Boston, MA, 2000.

[41] H. Wolkowicz. Semidefinite and Lagrangian relaxations for hard combinatorial problems. In M.J.D. Powell, editor, *Proceedings of 19th IFIP TC7 Conference on System Modelling and Optimization, July, 1999, Cambridge*, pages 269–309. Kluwer Academic Publishers, Boston, MA, 2000.

[42] H. Wolkowicz. Semidefinite programming. In P.M. Pardalos and M.G.C. Resende, editors, *Handbook of Applied Optimization*, pages 40–50. Oxford University Press, New York, 2002.

[43] H. Wolkowicz. Duality for semidefinite programming. In *Encyclopedia of Optimization*. Kluwer Academic Publishers, Boston, MA, 2001.

[44] Mengmeng Song, Douglas Goncalves, Woosuk L. Jung, Carlile Campos Lavor, Antonio Mucherino, and Henry Wolkowicz. Exact recovery of points for a given Euclidean distance matrix. Technical report, University of Waterloo, Waterloo, Ontario, 2024. 43 pages, research report.

[45] Abdo Alfakih, Jeffrey Cheng, Woosuk L. Jung, Walaa M. Moursi, and Henry Wolkowicz. Exact solutions for the np-hard Wasserstein barycenter problem using a doubly nonnegative relaxation and a splitting method. Technical report, University of Waterloo, Waterloo, Ontario, 2023. 25 pages, research report.

[46] Y. Censor, , W. Moursi, T. Weames, and H. Wolkowicz. Regularized nonsmooth Newton algorithms for best approximation with applications. Technical report, University of Waterloo, Waterloo, Ontario, 2022 submitted. 37 pages, research report.

[47] Fei Wang and Henry Wolkowicz. Singularity degree of non-facially exposed faces. Technical report, University of Waterloo, 2022 submitted. 19 pages.

[48] Zhenan Fan, Haesol Im, Tyler Weames, Henry Wolkowicz, Yong Zhang, and Zirui Zhou. Machine learning with knowledge under infinitely many constraints. Technical report, University of Waterloo, University of Waterloo, 2022 under revision. 21 pages.

[49] Zhenan Fan, Haesol Im, Tyler Weames, Henry Wolkowicz, Yong Zhang, and Zirui Zhou. A stable primal-dual interior-point algorithm for linear programming with simplex type steps and warm starts. Technical report, University of Waterloo, 2023 in progress. 31 pages.

[50] W.L. Jung, D. Torregrosa-Belen, and H. Wolkowicz. Preconditioning, numerical computations and the Omega-condition number. Technical report, University of Waterloo, Waterloo, Canada, 2023 in progress. 31 pages.

[51] H. Im and H. Wolkowicz. Revisiting degeneracy, strict feasibility, stability, in linear programming. *European J. Oper. Res.*, 310(2):495–510, 2023. 35 pages, 10.48550/ARXIV.2203.02795.

[52] H. Im and H. Wolkowicz. A strengthened Barvinok-Pataki bound on SDP rank. *Oper. Res. Lett.*, 49(6):837–841, 2021.

[53] H. Hu, H. Im, J. Lin, N. Lütkenhaus, and H. Wolkowicz. QKD key rate with inequalities and nuclear norm. Technical report, University of Waterloo, Waterloo, Ontario, 2023. 25 pages, research report.

[54] H. Hu, H. Im, J. Lin, N. Lütkenhaus, and H. Wolkowicz. Robust interior point method for quantum key distribution rate computation. *Quantum*, 6:792–840, 2022.

[55] H. Hu, H. Im, X. Li, and H. Wolkowicz. A semismooth Newton-type method for the nearest doubly stochastic matrix problem. *Math. Oper. Res.*, May, 2023. arxiv.org/abs/2107.09631, 35 pages.

[56] B. Ghaddar, H. Hu, O. Kuryatnikova, and H. Wolkowicz. SDP relaxations and ADMM for power flow problems. Technical report, University of Waterloo, Waterloo, Ontario, 2021. 45 pages, research report.

[57] F. Burkowski, H. Im, and H. Wolkowicz. A Peaceman-Rachford splitting method for the protein side-chain positioning problem. Technical report, University of Waterloo, Waterloo, Ontario, 2022. arxiv.org/abs/2009.01450,21.

[58] X. Li, T.K. Pong, H. Sun, and H. Wolkowicz. A strictly contractive Peaceman-Rachford splitting method for the doubly nonnegative relaxation of the minimum cut problem. *Comput. Optim. Appl.*, 78(3):853–891, 2021.

[59] H. Hu, R. Sotirov, and H. Wolkowicz. Facial reduction for symmetry reduced semidefinite programs. *Math. Program.*, 200:475–529, 2023. published Sept. 2022.

[60] H. Hu, S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Finding a "nice" principal submatrix completion. Technical report, University of Waterloo, Waterloo, Ontario, 2019. 16 pages, research report.

[61] N. Graham, H. Hu, H. Im, X. Li, and H. Wolkowicz. A restricted dual Peaceman-Rachford splitting method for a strengthened DNN relaxation for QAP. *INFORMS J. Comput.*, 34(4):2125–2143, 2022.

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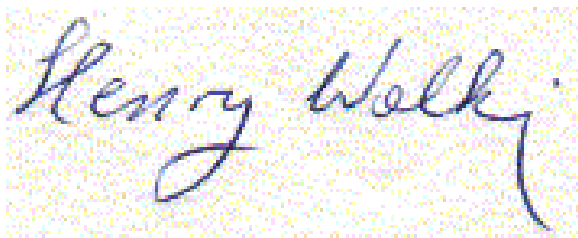[156] H. Wolkowicz. Measures for symmetric rank-one updates. *Math. Oper. Res.*, 19(4):815–830, 1994.

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