

COMBINATORICS
& OPTIMIZATION



Prof. Henry Wolkowicz
hwolkowicz@uwaterloo.ca

www.math.uwaterloo.ca/~hwolkowi/

as of January 6, 2019

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

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.

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, and conferences attended, by year. Links to the talks are included.
2. Graduate and related:

(a) **Invited Optimization Courses/Workshops Given:**

- MSRI, Berkeley, CA, July 9-20, 2007
- Short Course on Semidefinite Programming, Eighth 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

Shimeng Huang, University of Waterloo, 2016

Graduate Students:

M.Math.:

- Ravindar Kumar, “Bounds for Eigenvalues”, University of Alberta, 1984, [225].
- Christopher Schoettle, “The teaching assignment problem”, Emory University, 1985, [224].
- Peter Stephan, “An explicit solution to the quadratic dynamic programming problem”, Emory University, 1985, [223].
- Donna Tudhope, University of Waterloo (by essay) 1987.
- Joe Lund, “Optimal vehicle replacement policy”, 1988, [222].
- Qing Zhao, “Measures for Least Change Secant Methods”, University of Waterloo, 1992 [218].
- 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, [220].
- Serge Kruk, “Semidefinite Programming Applied to General Nonlinear Programming”, “University of Waterloo”, 1996, [215].
- Charles Fortin, “A Survey of the Trust Region Subproblem within a Semidefinite Framework” “University of Waterloo”, 2000, [213].
- Mike Froh, Thesis, “University of Waterloo”, 2003, [214]
- Kathrin Schaeke, Essay, “University of Waterloo”, Mar. 2004, [219]
- Oleg Grodzevich, Thesis, “University of Waterloo”, Dec. 2004, [209]
- Yichuan Ding, “University of Waterloo”, Dec. 2005, [210]
- Xuezhai (Daniel) Cui, “University of Waterloo”, Sept. 2010, [211]
- 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”, Sept. 2016.
- Lanlan Yu, “University of Waterloo”, Sept. 2018.
- Naomi Graham, “University of Waterloo”, Sept. 2018.
- Mingyu Yang, “University of Waterloo”, Sept. 2018.
- Ryan Hughes, “University of Waterloo”, May. 2018.

Ph.D.:

- Scott Hadley, “Continuous Optimization Approaches for the Quadratic Assignment Problem”, University of Waterloo, 1990, [221].
- Qing Zhao, “Semidefinite Programming and Applications”, University of Waterloo, 1996, [216].
- Serge Kruk, “High Accuracy Algorithms for the Solutions of Semidefinite Linear Programs”, “University of Waterloo”, (Dec/01), [208].
- Miguel Anjos, “New Convex Relaxations for the Maximum Cut and VLSI Layout Problems”, University of Waterloo, [217], 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, [206].
- Marina Potapchik, Thesis, ”Portfolio Selection Under Nonsmooth Convex Transaction Costs”, 2006, [207].
- Nathan Krislock, “University of Waterloo”, Apr. 2010, [205]
- Minghua Lin, Thesis, ”Angles, Majorization, Wielandt Inequality and Applications”, 2013, [204].
- Yuen-Lam Cheung, Thesis, ”Preprocessing and Reduction for Semidefinite Programming via Facial Reduction: Theory and Practice”, 2013, [203].
- Dessalegn Hirpa, Sept. 2014, stopped early Dec. 2015.
- Stefan Sremac, Sept. 2015, in progress.
- Xiao-Bo Li, Sept. 2015, in progress.
- Lubke, Daniela, Feb. - Sept. 2017.
- Sina Rezazadeh Baghal, May 2018, in progress.

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.

Sabbatical Visitors

- Gonzalez-Lima, Maria, Sept. 2001 - Sept. 2002.

- Salahi, Maziar, Mar. 2015-16.

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, 2017-2018, 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 social 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 social 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/~hwoikowi/. A list of publications (with abstracts and links to ps/pdf files) can be obtained with URL:

orion.math.uwaterloo.ca/~hwoikowi/henry/reports/ABSTRACTS.html. A complete list of publications can be obtained with:

www.math.uwaterloo.ca:80/~hwoikowi/henry/reports/refpubl/node1.html. Plenary talks, invited courses and other presentations can be obtained with www.math.uwaterloo.ca:80/hwoikowi/henry/reports/talks.d/talks.html

References

- [1] H.H. Bauschke, R.S. Burachik, P.L. Combettes, V. Elser, D.R. Luke, and H. Wolkowicz, editors. *Fixed-Point Algorithms for Inverse Problems in Science and Engineering*, volume 49 of *Springer Optimization and Its Applications*. Springer, 2011.
- [2] 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.
- [3] 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.
- [4] 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.
- [5] P. Pardalos and H. Wolkowicz, editors. *Novel approaches to hard discrete optimization*, volume 37 of *Fields Institute Communications*, Providence, RI, 2003. American Mathematical Society. Papers from the workshop held at the University of Waterloo, Waterloo, ON, April 26–28, 2001.
- [6] 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.
- [7] 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.
- [8] 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.
- [9] 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).
- [10] 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.
- [11] 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.

- [12] N. Krislock and H. Wolkowicz. Euclidean distance matrices and applications. In *Handbook on Semidefinite, Cone and Polynomial Optimization*, number 2009-06 in International Series in Operations Research & Management Science, pages 879–914. Springer-Verlag, 2011.
- [13] 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.
- [14] 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.
- [15] 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.
- [16] A. 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.
- [17] 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.
- [18] 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.
- [19] 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.
- [20] 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.
- [21] H. Wolkowicz. Duality for semidefinite programming. In *Encyclopedia of Optimization*. Kluwer Academic Publishers, Boston, MA, 2001.
- [22] H. Hu, S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Finding a “nice” principal submatrix”, completions. Technical report, University of Waterloo, Waterloo, Ontario, 2018. 16?? pages, research report.
- [23] S. Sremac, F. Wang, and H. Wolkowicz. Noisy euclidean distance matrix completion with a single missing node. Technical report, University of Waterloo, Waterloo, Ontario, 2017. 19 pages, research report.
- [24] M. Fampa, D. Lubke, F. Wang, and H. Wolkowicz. Parametric semidefinite relaxations of the quadratic knapsack problem. Technical report, University of Waterloo, Waterloo, Ontario, 2017. 34 pages, research report.
- [25] *Extending cover inequalities for the quadratic knapsack problem to relaxations in lifted space*, The Latin-Iberoamerican Conference on Operations Research, Waterloo, Ontario, 2018. 34 pages, research report, , CLAIO.
- [26] S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Complete facial reduction in one step for spectrahedra. Technical report, University of Waterloo, Waterloo, Ontario, 2017. 34 pages, research report.

- [27] S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Maximum determinant positive definite Toeplitz completions. 2017. 21 pages, accepted LAMA Nov. 2018.
- [28] G. Reid, F. Wang, and H. Wolkowicz. An SDP-based method for the real radical ideal membership test. SYNASC2017, International Symposium on Symbolic and Numeric Algorithms for Scientific Computing, accepted, Nov. 2017, 8 pages, Waterloo, Ontario, 2017.
- [29] Y. Nesterov, H. Wolkowicz, and Y. Xia. Completely positive low-rank matrix completion using nuclear norm with facial reduction. Technical report, University of Waterloo, Waterloo, Ontario, 2017. in progress.
- [30] S. Ma, F. Wang, L. Wei, and H. Wolkowicz. Robust principal component analysis using nuclear norm minimization and facial reduction. Technical report, University of Waterloo, Waterloo, Ontario, 2017. submitted, 30 pages.
- [31] D. Drusvyatskiy, S. Sremac, and H. Wolkowicz. Three views of facial reduction in cone optimization. Technical report, University of Waterloo, Waterloo, Ontario, 2017. survey in progress.
- [32] D. Drusvyatskiy and H. Wolkowicz. The many faces of degeneracy in conic optimization. *Foundations and Trends[®] in Optimization*, 3(2):77–170, 2017.
- [33] I. Davidson and H. Wolkowicz. Rank restricted semidefinite matrices and image closedness. Technical report, University of Waterloo, Waterloo, Ontario, 2016. submitted.
- [34] H. Wolkowicz. Tutorial: Facial reduction in cone optimization with applications to matrix completions, at: Dimacs workshop on distance geometry: Theory and applications, 2016. Based on survey paper: The many faces of degeneracy in conic optimization, (with D. Drusvyatskiy).
- [35] S. Huang and H. Wolkowicz. Low-rank matrix completion using nuclear norm with facial reduction. *J. Global Optim.*, 72(1):5–26, 2018.
- [36] M. Salahi, A. Taati, and H. Wolkowicz. Local nonglobal minima for solving large-scale extended trust-region subproblems. *Comput. Optim. Appl.*, 66(2):223–244, 2017. submitted Dec. 23, 2015, 25 pages, accepted to COAP Aug. 20, 2016, 25 pages, online Sept. 2016, doi:10.1007/s10589-016-9867-4.
- [37] D.E. Oliveira, H. Wolkowicz, and Y. Xu. ADMM for the SDP relaxation of the QAP. *Math. Program. Comput.*, 10(4):631–658, 2018. arXiv:1512.05448, 12 pages.
- [38] Z. Tang and H. Wolkowicz. ADMM for the second lifting SDP relaxation of MC. Technical report, University of Waterloo, Waterloo, Ontario, 2017. in progress.
- [39] X-B Li, F. Burkowski, and H. Wolkowicz. Semidefinite facial reduction and rigid cluster interpolation in protein structure elastic network models. IEEE BIBM 2016, Waterloo, Ontario, 2016. submitted for refereed conference, Dec. 1, 2016, 10 pages, unpublished.
- [40] X-B Li, F. Burkowski, and H. Wolkowicz. Semidefinite facial reduction and rigid cluster elastic network interpolation of protein structures. IEEE International Conference on Bioinformatics and Biomedicine (BIBM), IEEE Xplore, January 19, 2017, Waterloo, Ontario, 2017.
- [41] X-B Li, F. Burkowski, and H. Wolkowicz. Protein structure normal mode analysis on the positive semidefinite matrix manifold. Technical report, University of Waterloo, Waterloo, Ontario, 2015. submitted Nov. 1, 2015, 10 pages.
- [42] Y.-L. Cheung and H. Wolkowicz. Sensitivity analysis of semidefinite programs without strong duality. Technical report, University of Waterloo, Waterloo, Ontario, 2014. submitted June 2014, 37 pages.

- [43] G. Reid, F. Wang, H. Wolkowicz, and W. Wu. Facial reduction and SDP methods for systems of polynomial equations. Technical report, University of Western Ontario, London, Ontario, 2014. submitted Dec. 2014, 38 pages.
- [44] G. Reid, F. Wang, and H. Wolkowicz. Finding maximum rank moment matrices by facial reduction on primal form and douglas-rachford iteration. *ACM Commun. Comput. Algebra*, 51(1):35–37, May 2017. submitted Dec. 2014, 38 pages.
- [45] D. Drusvyatskiy, C.-K. Li, Y.-L. Cheung Voronin, D.C. Pelejo, and H. Wolkowicz. Projection methods for quantum channel construction. *Quantum Inf. Process.*, 14(8):3075–3096, 2015.
- [46] Y.-L. Cheung, D. Drusvyatskiy, C.-K. Li, D.C. Pelejo, and H. Wolkowicz. Projection methods in quantum information science. *Quantum Information Processing*, 14(8):3075–3095, 2015. submitted July. 2014, 15 pages, under revision Oct. 2014.
- [47] D. Drusvyatskiy, G. Li, and H. Wolkowicz. A note on alternating projections for ill-posed semidefinite feasibility problems. *Math. Program.*, 162(1-2, Ser. A):537–548, 2017. submitted Sept. 2014, 12 pages, accepted June 27, 2016, doi:10.1007/s10107-016-1048-9, appeared Mar. 2017.
- [48] D. Drusvyatskiy, S.A. Vavasis, and H. Wolkowicz. Extreme point inequalities and geometry of the rank sparsity ball. *Math. Program.*, 152(1-2, Ser. A):521–544, 2015.
- [49] D. Drusvyatskiy, G. Pataki, and H. Wolkowicz. Coordinate shadows of semidefinite and Euclidean distance matrices. *SIAM J. Optim.*, 25(2):1160–1178, 2015.
- [50] T.K. Pong, H. Sun, N. Wang, and H. Wolkowicz. Eigenvalue, quadratic programming, and semidefinite programming relaxations for a cut minimization problem. *Comput. Optim. Appl.*, 63(2):333–364, 2016.
- [51] D. Drusvyatskiy, N. Krislock, Y-L. Cheung Voronin, and H. Wolkowicz. Noisy Euclidean distance realization: robust facial reduction and the Pareto frontier. *SIAM Journal on Optimization*, 27(4):2301–2331, 2017.
- [52] T.K. Pong and H. Wolkowicz. The generalized trust region subproblem. *Comput. Optim. Appl.*, 58(2):273–322, 2014.
- [53] M-H. Lin and H. Wolkowicz. A general hua-type matrix equality and its applications. Technical report, University of Waterloo, 2013. 7 pages, submitted Jan. 2013.
- [54] M-H. Lin and H. Wolkowicz. Hiroshima’s theorem and matrix norm inequalities. *Acta Sci. Math. (Szeged)*, 81(1-2):45–53, 2015.
- [55] B. Alipanahi, N. Krislock, A. Ghodsi, and H. Wolkowicz. Large-scale manifold learning by semidefinite facial reduction. Technical report, University of Waterloo, Waterloo, Ontario, 2012. 19pages.
- [56] B. Alipanahi, N. Krislock, A. Ghodsi, H. Wolkowicz, L. Donaldson, and M. Li. Protein structure by semidefinite facial reduction. In Benny Chor, editor, *Research in Computational Molecular Biology*, volume 7262 of *Lecture Notes in Computer Science*, pages 1–11. Springer Berlin / Heidelberg, 2012.
- [57] B. Alipanahi, N. Krislock, A. Ghodsi, H. Wolkowicz, L. Donaldson, and M. Li. Determining protein structures from NOESY distance constraints by semidefinite programming. *J. Comput. Biol.*, 20(4):296–310, 2013.
- [58] B. Alipanahi, N. Krislock, A. Ghodsi, H. Wolkowicz, L. Donaldson, and M. Li. Protein structure by semidefinite facial reduction. In *URL: recomb2012.crg.cat*, Waterloo, Ontario, 2012. poster session at RECOMB2012.
- [59] M-H. Lin and H. Wolkowicz. An eigenvalue majorization inequality for positive semidefinite block matrices. *Linear Multilinear Algebra*, 60(11-12):1365–1368, 2012.

- [60] Y-L. Cheung, S. Schurr, and H. Wolkowicz. Preprocessing and regularization for degenerate semidefinite programs. In D.H. Bailey, H.H. Bauschke, P. Borwein, F. Garvan, M. Thera, J. Vanderwerff, and H. Wolkowicz, editors, *Computational and Analytical Mathematics, In Honor of Jonathan Borwein's 60th Birthday*, volume 50 of *Springer Proceedings in Mathematics & Statistics*, pages 225–276. Springer, 2013.
- [61] Yuen-Lam Cheung, Simon Schurr, and Henry Wolkowicz. Preprocessing and regularization for degenerate semidefinite programs. In *Computational and analytical mathematics*, volume 50 of *Springer Proc. Math. Stat.*, pages 251–303. Springer, New York, 2013.
- [62] Heinz H. Bauschke, Michel Théra, and Henry Wolkowicz. Preface [Special issue: Computational and analytical mathematics]. *Math. Program.*, 139(1-2, Ser. B):1–3, 2013.
- [63] D.H. Bailey, H.H. Bauschke, P. Borwein, F. Garvan, M. Thera, J. Vanderwerff, and H. Wolkowicz, editors. *Preprocessing and Regularization for Degenerate Semidefinite Programs*, volume 50 of *Springer Proceedings in Mathematics & Statistics*. Springer, 2013.
- [64] Henry Wolkowicz Heinz H. Bauschke, Michel Thera, editor. *Computational and Analytical Mathematics*. Springer, 2013. Special issue in honour of Jon Borwein's 60th birthday, *Math. Programming* **139** (2013), no. 1-2.
- [65] B. Alipanahi, N. Krislock, A. Ghodsi, H. Wolkowicz, L. Donaldson, and M. Li. SPROS: An SDP-based protein structure determination from NMR data. In *URL: compbio.cs.sfu.ca/recomb2011*, Waterloo, Ontario, 2011. poster session at RECOMB2011.
- [66] B. Alipanahi, N. Krislock, A. Ghodsi, H. Wolkowicz, L. Donaldson, and M. Li. Determining protein structures from NOESY distance constraints by semidefinite programming. *J. Comput. Biol.*, 20(4):296–310, 2013.
- [67] X.V. Doan and H. Wolkowicz. Numerical computations and the ω -condition number. Technical Report CORR 2011-03, University of Waterloo, Waterloo, Ontario, 2011. submitted in July, 2011, 19 pages.
- [68] F. Burkowski, Y-L. Cheung, and H. Wolkowicz. Efficient use of semidefinite programming for selection of rotamers in protein conformations. *INFORMS J. Comput.*, 26(4):748–766, 2014.
- [69] X.V. Doan, S. Kruk, and H. Wolkowicz. A robust algorithm for semidefinite programming. *Optim. Methods Softw.*, 27(4-5):667–693, 2012.
- [70] Y. Ding, D. Ge, and H. Wolkowicz. On equivalence of semidefinite relaxations for quadratic matrix programming. *Math. Oper. Res.*, 36(1):88–104, 2011.
- [71] N. Krislock and H. Wolkowicz. Explicit sensor network localization using semidefinite representations and facial reductions. *SIAM Journal on Optimization*, 20(5):2679–2708, 2010.
- [72] A. Alfakih, M.F. Anjos, V. Piccialli, and H. Wolkowicz. Euclidean distance matrices, semidefinite programming, and sensor network localization. *Portug. Math.*, 68(1):53–102, 2011.
- [73] L. Tunçel and H. Wolkowicz. Strong duality and minimal representations for cone optimization. *Comput. Optim. Appl.*, 53(2):619–648, 2012.
- [74] Y. Ding, N. Krislock, J. Qian, and H. Wolkowicz. Sensor network localization, Euclidean distance matrix completions, and graph realization. *Optim. Eng.*, 11(1):45–66, 2010.
- [75] Y. Ding, N. Krislock, J. Qian, and H. Wolkowicz. Sensor network localization, Euclidean distance matrix completions, and graph realization. In *MELT'08: Proceedings of the First ACM International Workshop on Mobile Entity Localization and Tracking in GPS-less Environments*, pages 129–134, 2008.

- [76] M.F. Anjos, M. Desroches, A. Haque, O. Grodzevich, H. Wei, and H. Wolkowicz. Multi-stage investment decision under contingent demand for networking planning. In *Proceedings of the 2006 IEEE GLOBECOM Conference in San Francisco*, pages 1–5, 2007.
- [77] M. Potapchik, L. Tunçel, and H. Wolkowicz. Large scale portfolio optimization with piecewise linear transaction costs. *Optimization Methods and Software*, 23(6):929–952, 2008.
- [78] Y. Ding and H. Wolkowicz. A low-dimensional semidefinite relaxation for the quadratic assignment problem. *Math. Oper. Res.*, 34(4):1008–1022, 2009.
- [79] A. Alfakih and H. Wolkowicz. Necessary and sufficient trace inequalities for Euclidean distance matrices. *Linear and Multilinear Algebra*, 55(5):499–506, 2007.
- [80] O. Grodzevich and H. Wolkowicz. Regularization using a parameterized trust region subproblem. *Math. Programming*, 116(1-2):193–220, 2009.
- [81] M. Gonzalez-Lima, H. Wei, and H. Wolkowicz. A stable primal-dual approach for linear programming under nondegeneracy assumptions. *Comput. Optim. Appl.*, 44(2):213–247, 2009.
- [82] S. Al-Homidan and H. Wolkowicz. Approximate and exact completion problems for Euclidean distance matrices using semidefinite programming. *Linear Algebra Appl.*, 406:109–141, 2005.
- [83] H. Wei and H. Wolkowicz. Generating and measuring instances of hard semidefinite programs. *Math. Program.*, 125(1, Ser. A):31–45, 2010.
- [84] L. Tunçel and H. Wolkowicz. Strengthened existence and uniqueness conditions for search directions in semidefinite programming. *Linear Algebra Appl.*, 400:31–60, 2005.
- [85] H. Wolkowicz. Solving semidefinite programs using preconditioned conjugate gradients. *Optim. Methods Softw.*, 19(6):653–672, 2004.
- [86] M.F. Anjos and H. Wolkowicz. Geometry of semidefinite max-cut relaxations via matrix ranks. *J. Comb. Optim.*, 6(3):237–270, 2002. New approaches for hard discrete optimization (Waterloo, ON, 2001).
- [87] C. Fortin and H. Wolkowicz. The trust region subproblem and semidefinite programming. *Optim. Methods Softw.*, 19(1):41–67, 2004.
- [88] A. Alfakih and H. Wolkowicz. Two theorems on Euclidean distance matrices and Gale transform. *Linear Algebra Appl.*, 340:149–154, 2002.
- [89] M.F. Anjos and H. Wolkowicz. Semidefinite programming for discrete optimization and matrix completion problems. *Discrete Appl. Math.*, 123(1-3):513–577, 2002. Workshop on Discrete Optimization, DO’99 (Piscataway, NJ).
- [90] S. Kruk and H. Wolkowicz. Convergence of a short-step primal-dual algorithm based on the Gauss-Newton direction. *J. Appl. Math.*, 2003(10):517–534, 2003.
- [91] M.F. Anjos and H. Wolkowicz. Strengthened semidefinite relaxations via a second lifting for the Max-Cut problem. *Discrete Appl. Math.*, 119(1-2):79–106, 2002. Foundations of heuristics in combinatorial optimization.
- [92] H. Wolkowicz. A note on lack of strong duality for quadratic problems with orthogonal constraints. *European J. Oper. Res.*, 143(2):356–364, 2002. Interior point methods (Budapest, 2000).
- [93] J.L. Nazareth, H. Wolkowicz, and M. Zhu. The quasi-Cauchy relation and diagonal updating. *SIAM J. Optim.*, 9(4):1192–1204 (electronic), 1999. Dedicated to John E. Dennis, Jr., on his 60th birthday.

- [94] M. F. Anjos and H. Wolkowicz. Strengthened semidefinite programming relaxations for the max-cut problem. In *Advances in convex analysis and global optimization (Pythagorion, 2000)*, volume 54 of *Nonconvex Optim. Appl.*, pages 409–420. Kluwer Acad. Publ., Dordrecht, 2001.
- [95] K.M. Anstreicher, X. Chen, H. Wolkowicz, and Y. Yuan. Strong duality for a trust-region type relaxation of the quadratic assignment problem. *Linear Algebra Appl.*, 301(1-3):121–136, 1999.
- [96] K.M. Anstreicher and H. Wolkowicz. On Lagrangian relaxation of quadratic matrix constraints. *SIAM J. Matrix Anal. Appl.*, 22(1):41–55, 2000.
- [97] S. Kruk, M. Muramatsu, F. Rendl, R.J. Vanderbei, and H. Wolkowicz. The Gauss-Newton direction in semidefinite programming. *Optim. Methods Softw.*, 15(1):1–28, 2001.
- [98] S. Kruk and H. Wolkowicz. Pseudolinear programming. *SIAM Rev.*, 41(4):795–805 (electronic), 1999.
- [99] H. Wolkowicz. Semidefiniteness of a sum: Problem solution 19-5.5. *IMAGE, The Bulletin of ILAS*, 20:30–31, 1998.
- [100] A. Alfakih, A. Khandani, and H. Wolkowicz. Solving Euclidean distance matrix completion problems via semidefinite programming. *Comput. Optim. Appl.*, 12(1-3):13–30, 1999. A tribute to Olvi Mangasarian.
- [101] S. Kruk and H. Wolkowicz. SQ²P, sequential quadratic constrained quadratic programming. In *Advances in Nonlinear Programming (Beijing, 1996)*, pages 177–204, Dordrecht, 1998. Kluwer Acad. Publ.
- [102] H. Wolkowicz and Q. Zhao. Semidefinite programming relaxations for the graph partitioning problem. *Discrete Appl. Math.*, 96/97:461–479, 1999. Selected for the special Editors’ Choice, Edition 1999.
- [103] Q. Zhao, S.E. Karisch, F. Rendl, and H. Wolkowicz. Semidefinite programming relaxations for the quadratic assignment problem. *J. Comb. Optim.*, 2(1):71–109, 1998. Semidefinite programming and interior-point approaches for combinatorial optimization problems (Fields Institute, Toronto, ON, 1996).
- [104] C.R. Johnson, B. Kroschel, and H. Wolkowicz. An interior-point method for approximate positive semidefinite completions. *Comput. Optim. Appl.*, 9(2):175–190, 1998.
- [105] M.V. Ramana, L. Tunçel, and H. Wolkowicz. Strong duality for semidefinite programming. *SIAM J. Optim.*, 7(3):641–662, 1997.
- [106] C. Helmberg, S. Poljak, F. Rendl, and H. Wolkowicz. Combining semidefinite and polyhedral relaxations for integer programs. In *Integer Programming and Combinatorial Optimization (Copenhagen, 1995)*, pages 124–134. Springer, Berlin, 1995.
- [107] F. Rendl and H. Wolkowicz. A semidefinite framework for trust region subproblems with applications to large scale minimization. *Math. Programming*, 77(2, Ser. B):273–299, 1997.
- [108] S. Poljak, F. Rendl, and H. Wolkowicz. A recipe for semidefinite relaxation for $(0, 1)$ -quadratic programming. *J. Global Optim.*, 7(1):51–73, 1995.
- [109] C. Helmberg, F. Rendl, R.J. Vanderbei, and H. Wolkowicz. An interior-point method for semidefinite programming. *SIAM J. Optim.*, 6(2):342–361, 1996.
- [110] P. Pardalos, F. Rendl, and H. Wolkowicz. The quadratic assignment problem: a survey and recent developments. In P.M. Pardalos and H. Wolkowicz, editors, *Quadratic assignment and related problems (New Brunswick, NJ, 1993)*, pages 1–42. Amer. Math. Soc., Providence, RI, 1994.

- [111] J. Falkner, F. Rendl, and H. Wolkowicz. A computational study of graph partitioning. *Math. Programming*, 66(2, Ser. A):211–239, 1994.
- [112] R. Stern and H. Wolkowicz. Trust region problems and nonsymmetric eigenvalue perturbations. *SIAM J. Matrix Anal. Appl.*, 15(3):755–778, 1994.
- [113] R. Stern and H. Wolkowicz. Indefinite trust region subproblems and nonsymmetric eigenvalue perturbations. *SIAM J. Optim.*, 5(2):286–313, 1995.
- [114] S.E. Karisch, F. Rendl, and H. Wolkowicz. Trust regions and relaxations for the quadratic assignment problem. In *Quadratic assignment and related problems (New Brunswick, NJ, 1993)*, pages 199–219. Amer. Math. Soc., Providence, RI, 1994.
- [115] F. Rendl and H. Wolkowicz. A projection technique for partitioning the nodes of a graph. *Ann. Oper. Res.*, 58:155–179, 1995. Applied mathematical programming and modeling, II (APMOD 93) (Budapest, 1993).
- [116] S. Poljak and H. Wolkowicz. Convex relaxations of $(0, 1)$ -quadratic programming. *Math. Oper. Res.*, 20(3):550–561, 1995.
- [117] H. Wolkowicz. Measures for symmetric rank-one updates. *Math. Oper. Res.*, 19(4):815–830, 1994.
- [118] H. Wolkowicz and Q. Zhao. An all-inclusive efficient region of updates for least change secant methods. *SIAM J. Optim.*, 5(1):172–191, 1995.
- [119] H. Wolkowicz. Explicit solutions for interval semidefinite linear programs. *Linear Algebra Appl.*, 236:95–104, 1996.
- [120] F. Rendl, R. J. Vanderbei, and H. Wolkowicz. Max-min eigenvalue problems, primal-dual interior point algorithms, and trust region subproblems. *Optim. Methods Softw.*, 5:1–16, 1995.
- [121] J.E. Dennis Jr. and H. Wolkowicz. Sizing and least-change secant methods. *SIAM J. Numer. Anal.*, 30(5):1291–1314, 1993.
- [122] S.W. Hadley, F. Rendl, and H. Wolkowicz. A new lower bound via projection for the quadratic assignment problem. *Math. Oper. Res.*, 17(3):727–739, 1992.
- [123] S.W. Hadley, F. Rendl, and H. Wolkowicz. Symmetrization of nonsymmetric quadratic assignment problems and the Hoffman-Wielandt inequality. *Linear Algebra Appl.*, 167:53–64, 1992. Sixth Haifa Conference on Matrix Theory (Haifa, 1990).
- [124] V. Jeyakumar and H. Wolkowicz. Generalizations of Slater’s constraint qualification for infinite convex programs. *Math. Programming*, 57(1, Ser. B):85–101, 1992.
- [125] A. Ben-Israel and H. Wolkowicz. A recursive volume reducing algorithm for semi-infinite linear programming. In *Systems and Management Science by Extremal Methods*, Boston, MA, 1992. Kluwer Academic Publishers. invited paper.
- [126] S.W. Hadley, F. Rendl, and H. Wolkowicz. Bounds for the quadratic assignment problems using continuous optimization. In *Integer Programming and Combinatorial Optimization*, pages 237–248, Waterloo, Ontario, Canada, 1990. University of Waterloo Press.
- [127] V. Jeyakumar and H. Wolkowicz. Zero duality gaps in infinite-dimensional programming. *J. Optim. Theory Appl.*, 67(1):87–108, 1990.
- [128] R.J. Stern and H. Wolkowicz. Results on invariant cones. *Linear Algebra Appl.*, 166:1–26, 1991. Proceedings from the Haifa Matrix Theory Conference, June 1990.

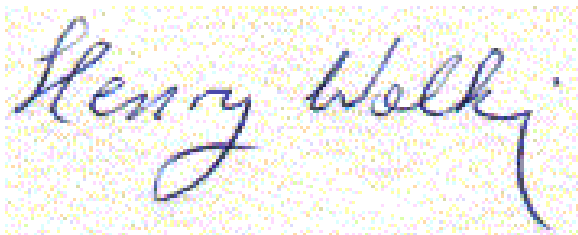
- [129] R. BEATSON and H. Wolkowicz. Post-processing piecewise cubics for monotonicity. *SIAM J. Numer. Anal.*, 26(2):480–502, 1989.
- [130] F. Rendl and H. Wolkowicz. Applications of parametric programming and eigenvalue maximization to the quadratic assignment problem. *Math. Programming*, 53(1, Ser. A):63–78, 1992.
- [131] W.R.S. Sutherland, H. Wolkowicz, and V. Zeidan. An explicit linear solution for the quadratic dynamic programming problem. *J. Optim. Theory Appl.*, 58(2):319–330, 1988.
- [132] H. Wolkowicz and G.P.H. Styan. Samuelson’s inequality. In S. Kotz and N. Johnson, editors, *Encyclopedia of Statistical Sciences*, volume 8. Wiley-Interscience, 1987. invited paper.
- [133] B. Grone, C.R. Johnson, E. Marques de Sa, and H. Wolkowicz. Normal matrices. *Linear Algebra Appl.*, 87:213–225, 1987.
- [134] P.W. SMITH and H. Wolkowicz. A nonlinear equation for linear programming. *Math. Programming*, 34(2):235–238, 1986.
- [135] J.M. Borwein and H. Wolkowicz. A simple constraint qualification in infinite-dimensional programming. *Math. Programming*, 35(1):83–96, 1986.
- [136] B. Grone, C.R. Johnson, E. Marques de Sa, and H. Wolkowicz. A note on maximizing the permanent of a positive definite Hermitian matrix, given the eigenvalues. *Linear and Multilinear Algebra*, 19(4):389–393, 1986.
- [137] J. Merikoski and H. Wolkowicz. Improving eigenvalue bounds using extra bounds. *Linear Algebra Appl.*, 68:93–113, 1985.
- [138] M. Lamoureux and H. Wolkowicz. Numerical decomposition of a convex function. *J. Optim. Theory Appl.*, 47(1):51–64, 1985.
- [139] C.R. Johnson, R. Kumar, and H. Wolkowicz. Lower bounds for the spread of a matrix. *Linear Algebra Appl.*, 71:161–173, 1985.
- [140] G. Butler, C.R. Johnson, and H. Wolkowicz. Nonnegative solutions of a quadratic matrix equation arising from comparison theorems in ordinary differential equations. *SIAM J. Algebraic Discrete Methods*, 6(1):47–53, 1985.
- [141] P.W. Smith and H. Wolkowicz. Dimensionality of bi-infinite systems. *Linear Algebra Appl.*, 57:115–130, 1984.
- [142] B. Grone, C.R. Johnson, E. Marques de Sa, and H. Wolkowicz. Improving Hadamard’s inequality. *Linear and Multilinear Algebra*, 16(1-4):305–322, 1984.
- [143] B. Grone, C.R. Johnson, E. Marques de Sa, and H. Wolkowicz. Positive definite completions of partial Hermitian matrices. *Linear Algebra Appl.*, 58:109–124, 1984.
- [144] B. Grone, C.R. Johnson, E. Marques de Sa, and H. Wolkowicz. Positive definite completions of partial Hermitian matrices. *Linear Algebra Appl.*, 58:109–124, 1984.
- [145] J. Merikoski, G.P.H. Styan, and H. Wolkowicz. Bounds for ratios of eigenvalues using traces. *Linear Algebra Appl.*, 55:105–124, 1983.
- [146] H. Wolkowicz. Optimality conditions and shadow prices. In *Mathematical programming with data perturbations, II (Washington, D.C., 1980)*, pages 49–63. Dekker, New York, 1983.
- [147] H. Wolkowicz. Method of reduction in convex programming. *J. Optim. Theory Appl.*, 40(3):349–378, 1983.

- [148] H. Wolkowicz. An optimality condition for a nondifferentiable convex program. *Naval Res. Logist. Quart.*, 30(3):415–418, 1983.
- [149] J.M. Borwein and H. Wolkowicz. Characterizations of optimality without constraint qualification for the abstract convex program. *Math. Programming Stud.*, 19:77–100, 1982. Optimality and stability in mathematical programming.
- [150] H. Wolkowicz. A strengthened test for optimality. *J. Optim. Theory Appl.*, 35(4):497–515, 1981.
- [151] J.M. Borwein and H. Wolkowicz. Facial reduction for a cone-convex programming problem. *J. Austral. Math. Soc. Ser. A*, 30(3):369–380, 1980/81.
- [152] J.M. Borwein and H. Wolkowicz. Characterization of optimality for the abstract convex program with finite-dimensional range. *J. Austral. Math. Soc. Ser. A*, 30(4):390–411, 1980/81.
- [153] J.M. Borwein and H. Wolkowicz. Regularizing the abstract convex program. *J. Math. Anal. Appl.*, 83(2):495–530, 1981.
- [154] H. Wolkowicz. Some applications of optimization in matrix theory. *Linear Algebra Appl.*, 40:101–118, 1981.
- [155] J.M. Borwein and H. Wolkowicz. Cone-convex programming stability and affine constraint functions. In *Generalized Concavity in Optimization and Economics*, pages 379–397. NATO conference, Academic Press, 1981. invited paper.
- [156] H. Wolkowicz. Geometry of optimality conditions and constraint qualifications: the convex case. *Math. Programming*, 19(1):32–60, 1980.
- [157] H. Wolkowicz and G.P.H. Styan. A history of Samuelson’s inequality. *Amer. Statist.*, 34:250, 1980.
- [158] H. Wolkowicz. Shadow prices for an unstable convex program. *Utilitas Math.*, 18:119–139, 1980.
- [159] H. Wolkowicz and G.P.H. Styan. More bounds for eigenvalues using traces. *Linear Algebra Appl.*, 31:1–17, 1980.
- [160] H. Wolkowicz and G.P.H. Styan. Bounds for eigenvalues using traces. *Linear Algebra Appl.*, 29:471–506, 1980.
- [161] H. Wolkowicz. Convex programs with equivalent duals. *Appl. Math. Notes*, 5(2):45–62, 1980.
- [162] H. Wolkowicz and G.P.H. Styan. Extensions of Samuelson’s inequality. *Amer. Statist.*, 33(3):143–144, 1979.
- [163] H. Wolkowicz. Calculating the cone of directions of constancy. *J. Optim. Theory Appl.*, 25(3):451–457, 1978.
- [164] H. Wolkowicz and S. Zlobec. Calculating the best approximate solution of an operator equation. *Math. Comp.*, 32(144):1183–1213, 1978.
- [165] R.J. Stern and H. Wolkowicz. A note on generalized invariant cones and the Kronecker canonical form. *Linear Algebra Appl.*, 147:97–100, 1991.
- [166] R.J. Stern and H. Wolkowicz. Exponential nonnegativity on the ice cream cone. *SIAM J. Matrix Anal. Appl.*, 12(1):160–165, 1991.
- [167] R.J. Stern and H. Wolkowicz. Invariant ellipsoidal cones. *Linear Algebra Appl.*, 150:81–106, 1991.
- [168] H. Wolkowicz. Problem solution 93-17. *SIAM Review*, 36(4):657–659, 1994.

- [169] C.R. Johnson, G. Wolkowicz, and H. Wolkowicz. Elem. prob. e. 3234. *Amer. Math. Monthly*, 94:877, 1987.
- [170] J.M. Borwein, G.P.H. Styan, and H. Wolkowicz. Some inequalities involving statistical expressions. *SIAM Review*, 24:340–342, 1982.
- [171] H. Wolkowicz. A constrained matrix optimization problem. *SIAM Review* 23, 101, 1981.
- [172] H. Wolkowicz. *Constructive approaches to approximate solutions of operator equations and convex programming*. PhD thesis, McGill University, 1978.
- [173] H. Wolkowicz. Kantorovich’s general theory of approximation methods. Master’s thesis, McGill University, 1975. M.Sc. Thesis.
- [174] V. Piccialli and H. Wolkowicz. Solution to problem 34-6.1. *IMAGE-The Bulletin of the International Linear Algebra Society*, 35:33–34, 2005.
- [175] H. Wolkowicz. Book review of: Optimization: Insights and Applications, by Brinkhuis and Tikhomirov. *IEEE Control Systems Magazine*, 2007.
- [176] A. Alfakih and H. Wolkowicz. On the embeddability of weighted graphs in Euclidean spaces. Technical Report CORR 98-12, University of Waterloo, 1998.
- [177] A. Alfakih and H. Wolkowicz. A new semidefinite programming model for large sparse Euclidean distance matrix completion problems. Technical Report CORR 2000-37, University of Waterloo, Waterloo, Canada, 2000.
- [178] Y-L. Cheung, N. Krislock, and H. Wolkowicz. Facial reduction for compressive sensing. Technical Report CORR 2010, University of Waterloo, Waterloo, Ontario, 2010. in progress.
- [179] M.F. Anjos and H. Wolkowicz. A strengthened SDP relaxation via a second lifting for the Max-Cut problem. Technical Report CORR 99-55, University of Waterloo, Waterloo, Ontario, 1999. 28 pages.
- [180] G. Gruber, S. Kruk, F. Rendl, and H. Wolkowicz. Presolving for semidefinite programs without constraint qualifications. Technical Report CORR 98-32, University of Waterloo, Waterloo, Ontario, 1998.
- [181] M.F. Anjos, N. Krislock, M. Takouda, and H. Wolkowicz. A semidefinite programming approach for the closest correlation matrix problem. Technical Report in progress, University of Waterloo, Waterloo, Ontario, 2009.
- [182] N. Krislock, F. Rendl, and H. Wolkowicz. Noisy sensor network localization using semidefinite representations and facial reduction. Technical Report CORR 2010-01, in progress, University of Waterloo, Waterloo, Ontario, 2010.
- [183] E. Andersen, E. de Klerk, L. Tunçel, H. Wolkowicz, and S. Zhang. Foreword: special issue on large-scale nonlinear and semidefinite programming. *Math. Program.*, 109(2-3, Ser. B):207–209, 2007.
- [184] S.W. Hadley and H. Wolkowicz. The Hessian of a function of the eigenvalues. Unpublished research report, University of Waterloo, 1988.
- [185] H. Wolkowicz and A. Ben-Israel. Taking advantage of degeneracy in linear programming. Unpublished Research Report CORR 86-23, University of Waterloo, 1986.
- [186] H. Wolkowicz and A. Ben-Israel. A volume and constraint reducing algorithm for linear programming. Unpublished Research Report CORR 86-29, University of Waterloo, 1986.

- [187] H. Wolkowicz. Generating eigenvalue bounds using optimization. Unpublished research report, University of Waterloo, 1985.
- [188] C. Schoettle and H. Wolkowicz. The teaching assignment problem. Unpublished research report, Emory University, 1985.
- [189] B. Grone, C.R. Johnson, E. Marques de Sa, and H. Wolkowicz. Constrained ranges of sesquilinear forms. Unpublished research report, University of Waterloo, 1983.
- [190] H. Wolkowicz. Bounds for the Kantorovich ratio. Unpublished research report, The University of Alberta, 1981.
- [191] H. Massam and H. Wolkowicz. Regularization and convex approximation. Unpublished research report, The University of Alberta, 1981.
- [192] H. Wolkowicz. Optimality and the cone of affine directions. Unpublished research report, The University of Alberta, 1980.
- [193] C. Fortin and H. Wolkowicz. A survey of the trust region subproblem within a semidefinite programming framework. Technical Report CORR 2002-22, University of Waterloo, Waterloo, Canada, 2002. URL:<http://orion.uwaterloo.ca/~hwolkowi/henry/reports/ABSTRACTS.html#surveytrs>.
- [194] A. Alfakih and H. Wolkowicz. Euclidean distance matrices and the molecular conformation problem. Technical Report 17, University of Waterloo, Waterloo, Ontario, 2002.
- [195] H. Wolkowicz. Semidefinite programming. Technical Report 4, University of Waterloo, Waterloo, Ontario, 2002.
- [196] F. Rendl, R. Sotirov, and H. Wolkowicz. A note on a simplified HKM direction for special classes of SDP. Technical Report CORR Report 2002-16, University of Waterloo, Waterloo, Canada, 2002.
- [197] N. Krislock, V. Piccialli, and H. Wolkowicz. Robust semidefinite programming approaches for sensor network localization with anchors. Technical Report CORR 2006-12, University of Waterloo, Waterloo, Ontario, 2006. URL:orion.uwaterloo.ca/~hwolkowi/henry/reports/ABSTRACTS.html#sensorKPW.
- [198] E. Andersen, E. de Klerk, L. Tunçel, H. Wolkowicz, and S. Zhang. Foreword: special issue on large-scale nonlinear and semidefinite programming. *Math. Program.*, 109(2-3, Ser. B):207–209, 2007.
- [199] R. Bhatia, R. Guralnick, S. Kirkland, and H. Wolkowicz. Preface to the 12th ILAS Conference Proceedings, Regina 2005. *Linear Algebra Appl.*, 421(1):1–2, 2007. Held in Regina, SK, June 26–29, 2005.
- [200] H. Sun. ADMM for SDP relaxation of GP. Master’s thesis, University of Waterloo, 2016.
- [201] Z. Liao. Branch and bound via ADMM for the quadratic assignment problem. Master’s thesis, University of Waterloo, 2016.
- [202] X. Ye. Low rank matrix completion through semi-definite programming with facial reduction. Master’s thesis, University of Waterloo, 2016.
- [203] Y.-L. Cheung. *Preprocessing and Reduction for Semidefinite Programming via Facial Reduction: Theory and Practice*. PhD thesis, University of Waterloo, 2013. 5
- [204] M. Lin. *Angles, Majorization, Wielandt Inequality and Applications*. PhD thesis, University of Waterloo, 2013. 5
- [205] N. Krislock. *Semidefinite Facial Reduction for Low-Rank Euclidean Distance Matrix Completion*. PhD thesis, University of Waterloo, 2010. 5

- [206] H. Wei. *Numerical Stability in Linear Programming and Semidefinite Programming*. PhD thesis, University of Waterloo, 2006. 5
- [207] M. Potapchik. *Portfolio Selection Under Nonsmooth Convex Transaction Costs*. PhD thesis, University of Waterloo, 2006. 5
- [208] S. Kruk. *High Accuracy Algorithms for the Solutions of Semidefinite Linear Programs*. PhD thesis, University of Waterloo, 2001. 4
- [209] O. Grodzevich. Regularization using a parameterized trust region subproblem. Master's thesis, University of Waterloo, 2004. 4
- [210] Y. Ding. On efficient semidefinite relaxations for quadratically constrained quadratic programming. Master's thesis, University of Waterloo, 2007. 4
- [211] X. Cui. Computing the nearest correlation matrix using difference map method. Master's thesis, University of Waterloo, 2010. 4
- [212] H. Ye. Efficient trust region subproblem algorithms. Master's thesis, University of Waterloo, 2011.
- [213] C. Fortin. A survey of the trust region subproblem within a semidefinite framework. Master's thesis, University of Waterloo, 2000. 4
- [214] M. Froh. Trust region subproblems and linear least-squares regularization. Master's thesis, University of Waterloo, 2003. 4
- [215] S. Kruk. Semidefinite programming applied to nonlinear programming. Master's thesis, University of Waterloo, 1996. 4
- [216] Q. Zhao. *Semidefinite Programming for Assignment and Partitioning Problems*. PhD thesis, University of Waterloo, 1996. 4
- [217] M.F. Anjos. *New Convex Relaxations for the Maximum Cut and VLSI Layout Problems*. PhD thesis, University of Waterloo, 2001. 4
- [218] Q. Zhao. Measures for least change secant methods. Master's thesis, University of Waterloo, 1993. 4
- [219] K. Schaecke. Essay on: The Kronecker product. Master's thesis, University of Waterloo, 2004. 4
- [220] S.E. Karisch. Trust regions and the quadratic assignment problem. Master's thesis, University of Waterloo, 1992. 4
- [221] S.W. Hadley. *Continuous Optimization Approaches to the Quadratic Assignment Problem*. PhD thesis, University of Waterloo, 1989. 4
- [222] J. Lund. Optimal vehicle replacement policy. Master's thesis, University of Waterloo, 1988. 4
- [223] P. Stephan. An explicit solution to the quadratic dynamic programming problem. Master's thesis, Emory University, 1985. 4
- [224] C. Schoettle. The teaching assignment problem. Master's thesis, Emory University, 1985. 4
- [225] R. Kumar. Bounds for eigenvalues. Master's thesis, University of Alberta, 1984. 4



Henry Wolkowicz