

COMBINATORICS  
& OPTIMIZATION



Prof. Henry Wolkowicz  
hwolkowicz@uwaterloo.ca

[www.math.uwaterloo.ca/~hwolkowi/](http://www.math.uwaterloo.ca/~hwolkowi/)

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as of October 24, 2020

## 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

## 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](http://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:**

- 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, 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

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 [162] [163] [164] [165] [166] [167] [168] [169] [170] [171] [172] [173] [174] [175] [176] [177] [178] [179] [180] [181]  
 [182] [183] [184] [185] [186] [187] [188] [189] [190] [191] [192] [193] [194] [195] [196] [197] [198] [199] [200] [201]  
 [202] [203] [204] [205] [205] [206] [207] [208] [209] [210] [211] [212] [213] [214] [215] [216] [217] [218] [219] [220]  
 [221] [222] [223] [224] [225] [226] [227] [228] [229] [230] [231] [232] [233]

Graduate Students:

M.Math.:

- Ravindar Kumar, “Bounds for Eigenvalues”, University of Alberta, 1984, [233].
- Christopher Schoettle, “The teaching assignment problem”, Emory University, 1985, [232].
- Peter Stephan, “An explicit solution to the quadratic dynamic programming problem”, Emory University, 1985, [231].
- Donna Tudhope, University of Waterloo (by essay) 1987.
- Joe Lund, “Optimal vehicle replacement policy”, 1988, [230].
- Qing Zhao, “Measures for Least Change Secant Methods”, University of Waterloo, 1992 [226].
- 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, [228].
- Serge Kruk, “Semidefinite Programming Applied to General Nonlinear Programming”, “University of Waterloo”, 1996, [223].
- Charles Fortin, “A Survey of the Trust Region Subproblem within a Semidefinite Framework” “University of Waterloo”, 2000, [221].
- Mike Froh, Thesis, “University of Waterloo”, 2003, [222]
- Kathrin Schaeke, Essay, “University of Waterloo”, Mar. 2004, [227]
- Oleg Grodzevich, Thesis, “University of Waterloo”, Dec. 2004, [217]
- Yichuan Ding, “University of Waterloo”, Dec. 2005, [218]
- Xuezhi (Daniel) Cui, “University of Waterloo”, Sept. 2010, [219]
- 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.
- 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, [229].
- Qing Zhao, “Semidefinite Programming and Applications”, University of Waterloo, 1996, [224].
- Serge Kruk, “High Accuracy Algorithms for the Solutions of Semidefinite Linear Programs”, “University of Waterloo”, (Dec/01), [216].
- Miguel Anjos, “New Convex Relaxations for the Maximum Cut and VLSI Layout Problems”, University of Waterloo, [225], 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, [214].
- Marina Potapchik, Thesis, “Portfolio Selection Under Nonsmooth Convex Transaction Costs”, 2006, [215].
- Nathan Krislock, “University of Waterloo”, Apr. 2010, [213]
- Minghua Lin, Thesis, “Angles, Majorization, Wielandt Inequality and Applications”, 2013, [212].
- Yuen-Lam Cheung, Thesis, “Preprocessing and Reduction for Semidefinite Programming via Facial Reduction: Theory and Practice”, 2013, [211].
- 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, not completed.
- Jiyoung (Haesol) Im, “University of Waterloo”, Sept. 2019.

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.

#### 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 Quarterly

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 special 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 special 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/](http://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](http://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](http://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](http://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. 4
- [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. 4
- [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
- [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. 4
- [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. 4
- [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. 4



- [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. 4
- [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. 4
- [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). 4
- [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. 4
- [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. 4
- [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. 4
- [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. 4
- [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. 4
- [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. 4
- [16] 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. 4
- [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. 4
- [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. 4
- [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. 4
- [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. 4
- [21] H. Wolkowicz. Duality for semidefinite programming. In *Encyclopedia of Optimization*. Kluwer Academic Publishers, Boston, MA, 2001. 4

- [22] F. Burkowski, J. Im, and H. Wolkowicz. A peaceman-rachford splitting method for the protein side-chain positioning problem, 2020. 4
- [23] 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. Technical report, University of Waterloo, Waterloo, Ontario, 2019. 40 pages, research report. 4
- [24] H. Hu, R. Sotirov, and H. Wolkowicz. Facial reduction for symmetry reduced semidefinite programs, 2019. 4
- [25] H. Hu, S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Finding a “nice” principal submatrix”, completions. Technical report, University of Waterloo, Waterloo, Ontario, 2019. 16 pages, research report. 4
- [26] N. Graham, H. Hu, H. Im, X. Li, and H. Wolkowicz. A restricted dual Peaceman-Rachford splitting method for QAP. Technical report, University of Waterloo, Waterloo, Ontario, 2020. 29 pages, research report. 4
- [27] L. Pattersson, S. Sremac, F. Wang, and H. Wolkowicz. Noisy Euclidean distance matrix completion with a single missing node. *J. Global Optim.*, 75:973–1002, 2019. 19 pages, research report. 4
- [28] M. Fampa, D. Lubke, F. Wang, and H. Wolkowicz. Parametric convex quadratic relaxation of the quadratic knapsack problem. *European Journal of Operational Research*, 281(1):36–49, 2020. submitted 2017, 34 pages; EJOR Editors Choice Articles, January 2020. 4
- [29] *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. 4
- [30] S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Error bounds and singularity degree in semidefinite programming, 2019. 4
- [31] S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Complete facial reduction in one step for spectrahedra. Technical report, University of Waterloo, Waterloo, Ontario, 2017. 4
- [32] S. Sremac, H.J. Woerdeman, and H. Wolkowicz. Maximum determinant positive definite Toeplitz completions. In *Operator Theory, Analysis and the State Space Approach: In Honor of Rien Kaashoek*, volume 271, pages 421–441. Birkhäuser/Springer, Cham, 2018. 4
- [33] 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, 2017. 4
- [34] 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. 4
- [35] S. Ma, F. Wang, L. Wei, and H. Wolkowicz. Robust principal component analysis using facial reduction. *Optimization and Engineering*, Nov 2019. 4
- [36] 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. 4
- [37] D. Drusvyatskiy and H. Wolkowicz. The many faces of degeneracy in conic optimization. *Foundations and Trends<sup>®</sup> in Optimization*, 3(2):77–170, 2017. 4
- [38] I. Davidson and H. Wolkowicz. Rank restricted semidefinite matrices and image closedness. Technical report, University of Waterloo, Waterloo, Ontario, 2016. submitted. 4

- [39] 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). 4
- [40] S. Huang and H. Wolkowicz. Low-rank matrix completion using nuclear norm with facial reduction. *J. Global Optim.*, 72(1):5–26, 2018. 4
- [41] 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. 4
- [42] D.E. Oliveira, H. Wolkowicz, and Y. Xu. ADMM for the SDP relaxation of the QAP. *Math. Program. Comput.*, 10(4):631–658, 2018. 4
- [43] Z. Tang and H. Wolkowicz. ADMM for the second lifting SDP relaxation of MC. Technical report, University of Waterloo, Waterloo, Ontario, 2017. in progress. 4
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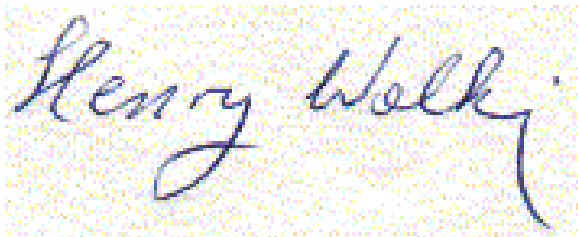
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Henry Wolkowicz